# 2018-2019 Academic Calendar

Note: Dates subject to change without notice.

## 2018 - 2019 Campus Holidays

<table>
<thead>
<tr>
<th>Holiday</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor Day</td>
<td>Monday, September 3, 2018</td>
</tr>
<tr>
<td>Veterans' Day</td>
<td>Monday, November 12, 2018</td>
</tr>
<tr>
<td>Thanksgiving</td>
<td>Thursday &amp; Friday, November 22 &amp; 23, 2018</td>
</tr>
<tr>
<td>Christmas</td>
<td>Monday &amp; Tuesday, December 24 &amp; 25, 2018</td>
</tr>
<tr>
<td>New Year</td>
<td>Monday &amp; Tuesday, December 31, 2018 &amp; January 1, 2019</td>
</tr>
<tr>
<td>Martin Luther King, Jr. Day</td>
<td>Monday, January 21, 2019</td>
</tr>
<tr>
<td>Presidents' Day</td>
<td>Monday, February 18, 2019</td>
</tr>
<tr>
<td>Cesar Chavez Holiday</td>
<td>Friday, March 29, 2019</td>
</tr>
<tr>
<td>Memorial Day</td>
<td>Monday, May 27, 2019</td>
</tr>
<tr>
<td>Independence Day</td>
<td>Thursday, July 4, 2019</td>
</tr>
</tbody>
</table>

## Quarterly Schedule

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Begins</th>
<th>Convocation</th>
<th>Instruction Begins</th>
<th>Instruction Ends</th>
<th>Examinations</th>
<th>Ends</th>
<th>Commencement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>September 23, 2018</td>
<td>September 24-26, 2018</td>
<td>September 27, 2018</td>
<td>December 7, 2018</td>
<td>December 8-14, 2018</td>
<td>December 14, 2018</td>
<td>June 15-16, 2019</td>
</tr>
<tr>
<td>Spring</td>
<td>April 1, 2019</td>
<td>April 1, 2019</td>
<td>April 1, 2019</td>
<td>June 7, 2019</td>
<td>June 8-14, 2019</td>
<td>June 14, 2019</td>
<td>June 15-16, 2019</td>
</tr>
</tbody>
</table>

**EQUAL OPPORTUNITY AND NONDISCRIMINATION**

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

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

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

Produced by the College of Engineering, Student Advising Division
Glenn Beltz, Associate Dean for Undergraduate Studies
Peter Allen, Publications Director

This publication is available at: https://engineering.ucsb.edu/undergraduate/academic-advising/gear-publications

The information in this publication supersedes that in the UCSB General Catalog. All announcements herein are subject to revision without notice.
General Engineering Academic Requirements

College of Engineering • University of California • Santa Barbara

Volume 9, Summer 2018

Requirements and policies in the GEAR are subject to change each academic year.
Welcome to the College of Engineering at UC Santa Barbara. There are many reasons we are one of the top engineering schools in the nation. We bring together an amazing faculty, the members of which are highly acclaimed in the scientific communities in which they work. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. A high percentage of the faculty has been elected to the prestigious National Academy of Sciences and National Academy of Engineering. We have six Nobel Prize winners on this campus, five of whom are faculty in engineering and the sciences. We’re also home to an amazing group of smart, accomplished, high-energy students. These more than 1,400 undergraduates, pursuing a variety of interests, contribute greatly to the quality of the learning environment as well as to the overall richness of campus life.

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

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

As part of the prestigious and well-established University of California system, we have the resources as well as the breadth and depth of talent to pursue new fields of scientific inquiry. We also bring an entrepreneurial attitude to our research, focusing on applications as much as discovery.

Our leading programs in areas as diverse as biotechnology, communications, computer security, materials, nanotechnology, networking, and photonic devices attest to the success of this approach.

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

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

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

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

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

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

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

The Office of Undergraduate Studies in Harold Frank Hall, Room 1006, provides academic advising for all undergraduates in the college. Faculty and academic advisors for the individual majors are also provided by the respective departments. This publication contains detailed information about the various programs and schedules and is published yearly. It is available on the web at: https://engineering.ucsb.edu/undergraduate/academic-advising/gear-publications.

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 Indians in Science and Engineering Society
- American Institute of Chemical Engineers
- American Society of Mechanical Engineers
- Association for Computing Machinery
- Engineering Student Council
- Engineers without Borders
- Entrepreneurs Association
- Institute of Electrical and Electronics Engineers
- Los Ingenieros (Mexican-American Engineering Society/Society of Hispanic Professional Engineers)
- National Society of Black Engineers
- out in Science, Technology, Engineering, and Mathematics
- Society for Advancement of Chicano and Native Americans in Science
- Society of Asian Scientists and Engineers
• Society of Women Engineers
• 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.

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

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

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

Computer Engineering. Students may petition to enter the Computer Engineering major at any time both of the following requirements are met:

1. An overall UCSB grade point average of at least 3.0.
2. Satisfactory completion at UCSB, with a grade point average of 3.0 or better, of any five classes, including at least two Electrical & Computer Engineering (ECE) classes and two Computer Science (CMPSC) classes, from the following: Math 4B, ECE 10A/10AL, 10B/10BL, 10C/10CL (ECE 10A/10AL, 10B/10BL, 10C/10CL each count as one course), ECE 15A, CMPSC 16, 24, 32, 40.

Computer Science. Students may petition to enter the Computer Science major when the following requirements are met:

1. A cumulative grade point average of at least 3.0;
2. Satisfactory completion of Computer Science 16 and 24 with a cumulative GPA of 3.2 or higher; First takes only
3. Satisfactory completion of Math 3A, 3B, 4A, 4B and Computer Science 40 with a cumulative GPA of 3.0 or higher; First takes only

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

Electrical Engineering. Students may petition to enter the Electrical Engineering major once both of the following requirements are met:

1. An overall UCSB grade point average of at least 3.0.
2. Satisfactory completion at UCSB, with a grade point average of 3.0 or better, of at least five classes, including at least two mathematics classes, from the following: Math 4B, Math 6A, Math 6B, ECE 10A/10AL, 10B/10BL, 10C/10CL (ECE 10A/10AL, 10B/10BL, 10C/10CL each count as one course), ECE 15A. The calculation of the minimum GPA will be based on all classes completed from this list at the time of petitioning.

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

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

General University Requirements
All undergraduate students must satisfy university academic residency, UC Entry Level Writing Requirement, American History and Institutions, unit, and scholarship requirements. These requirements are described fully on page 10.

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

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

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

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

International Baccalaureate Credit
Students completing the International Baccalaureate (IB) diploma with a score of 30 or above will receive 30 quarter units total toward their UC undergraduate degree. The university grants 8 quarter units for 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 Examination credit earned prior to entering the university will not be counted toward maximum unit limitation either for selection of a major or for graduation.
Minimal Progress Requirements
A student in the College of Engineering may be placed on academic probation if the total number of units passed at UCSB is fewer than what is prescribed by the prevailing academic Senate regulation regarding Minimum Cumulative Progress. At least three-fourths of the minimum number of academic units passed must include courses prescribed for the major.

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

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

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

215–Unit and Quarter Enrollment Limitations
The college expects students to graduate within 12 regular quarters for students who are admitted as freshmen and 9 regular quarters for students admitted as junior transfers and with no more than 215 units. College credit earned before high school graduation does not count toward the 215-unit maximum. This includes credit for Advanced Placement and International Baccalaureate examinations, and also college or university credit earned while still in high school. Students who are admitted as freshmen and remain continuously enrolled will be assessed after 12 regular quarters at UCSB, and transfer students admitted as juniors will be assessed after 9 regular quarters at UCSB. Summer session does not count as a regular quarter in this calculation, but units earned in summer session do apply toward the 215-unit maximum.

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

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

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

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

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

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

Five-Year B.S. in Chemical Engineering, Electrical Engineering, or Mechanical Engineering / M.S. in 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.

Five-Year B.S. / M.S. in Mechanical Engineering
A combined B.S./M.S. program in Mechanical Engineering provides an opportunity for outstanding undergraduates to earn both degrees in five years. Additional information about this program is available from the Mechanical Engineering Undergrad Advising office. Interested students should contact the office fall quarter of their junior year. In addition to fulfilling undergraduate degree requirements, B.S./M.S. degree candidates must meet Graduate Division degree requirements, including university requirements for academic residence and units of coursework.
## 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>none</td>
<td>EEMB 22, MCDB 20</td>
</tr>
<tr>
<td>Business Management</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Computer Science</td>
<td>8</td>
<td>none</td>
<td>Computer Science 8</td>
</tr>
<tr>
<td>Dance</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Economics</td>
<td>8</td>
<td>D: 2 courses</td>
<td>Economics 1, 2</td>
</tr>
<tr>
<td>English A: Literature or English A Language and Literature</td>
<td>Score of 5 8</td>
<td>Entry Level Writing Requirement</td>
<td>Writing 1, 1E</td>
</tr>
<tr>
<td>English A: Literature or English A Language and Literature</td>
<td>Score of 6 8</td>
<td>A1</td>
<td>Writing 1, 1E, 2, 2E, 2LK</td>
</tr>
<tr>
<td>English A: Literature or English A Language and Literature</td>
<td>Score of 7 8</td>
<td>A1, A2</td>
<td>Writing 1, 1E, 2, 2E, 2LK, 50, 50E</td>
</tr>
<tr>
<td>English B</td>
<td>8</td>
<td>none</td>
<td>none</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>Global Politics</td>
<td>8</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>History</td>
<td>8</td>
<td>E: 1 course^</td>
<td>none</td>
</tr>
<tr>
<td>History of Africa</td>
<td>8</td>
<td>D: 1 course+</td>
<td>none</td>
</tr>
<tr>
<td>History of the Americas</td>
<td>8</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>History of Asia and Oceania</td>
<td>8</td>
<td>D: 1 course+</td>
<td>none</td>
</tr>
<tr>
<td>History of Europe and the Middle East</td>
<td>8</td>
<td>D: 1 course^</td>
<td>none</td>
</tr>
<tr>
<td>Languages Other Than English</td>
<td>8</td>
<td>none</td>
<td>See department for level placement</td>
</tr>
<tr>
<td>Mathematics</td>
<td>8</td>
<td>none</td>
<td>Mathematics 2A, 2B, 3A, 3B, 34A, 34B, or equivalent</td>
</tr>
<tr>
<td>Mathematics, Further</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Music</td>
<td>8</td>
<td>F: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Philosophy</td>
<td>8</td>
<td>E: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Physics</td>
<td>8</td>
<td>none</td>
<td>Physics 10</td>
</tr>
<tr>
<td>Psychology</td>
<td>8</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Social &amp; Cultural Anthropology</td>
<td>8</td>
<td>D: 1 course</td>
<td>Anthropology 2</td>
</tr>
<tr>
<td>Theater</td>
<td>8</td>
<td>F: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Visual Arts</td>
<td>8</td>
<td>F: 1 course</td>
<td>none</td>
</tr>
</tbody>
</table>

^ course also satisfies the European Traditions Requirement

^* course also satisfies the World Cultures 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>(or AB subscore of BC exam)</td>
</tr>
<tr>
<td>*Art Studio 3D Design</td>
<td>8</td>
<td>none</td>
<td>Math 2A, 3A, 34A, or equivalent</td>
</tr>
<tr>
<td>*Art Studio Drawing</td>
<td>8</td>
<td>none</td>
<td>(or AB subscore of BC exam)</td>
</tr>
<tr>
<td>Biology</td>
<td>8</td>
<td>none</td>
<td>Art 18</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
<td>none</td>
<td>EEMB 22, MCDB 20</td>
</tr>
<tr>
<td>Chinese Language and Culture</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>See department for level placement</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Comparative Government and Politics</td>
<td>4</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>+Computer Science A</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>Computer Science 8</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>none</td>
<td>Computer Science 8</td>
</tr>
<tr>
<td>Computer Science Principles</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>Computer Science 8</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>none</td>
<td>Computer Science 8</td>
</tr>
<tr>
<td>Economics – Microeconomics</td>
<td>4</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Economics – Macroeconomics</td>
<td>4</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>*English – Composition and Literature or Language and Composition</td>
<td>8</td>
<td>Entry Level Writing</td>
<td>Writing 1, 1E</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>A1</td>
<td>Writing 1, 1E, 2, 2E, 2LK</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>A1, A2</td>
<td>Writing 1, 1E, 2, 2E, 2LK, 50, 50E</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>4</td>
<td>none</td>
<td>Environmental Studies 2</td>
</tr>
<tr>
<td>European History</td>
<td>8</td>
<td>E: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>French Language and Culture</td>
<td>8</td>
<td>none</td>
<td>French 1-3</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>French 1-4</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>French 1-5</td>
</tr>
<tr>
<td>German Language and Culture</td>
<td>8</td>
<td>none</td>
<td>German 1-3</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>German 1-4</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>German 1-5</td>
</tr>
<tr>
<td>Human Geography</td>
<td>4</td>
<td>D: 1 course</td>
<td>Geography 5</td>
</tr>
<tr>
<td>Italian Language and Culture</td>
<td>8</td>
<td>none</td>
<td>Italian 1-3</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>Italian 1-5</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>Italian 1-6</td>
</tr>
<tr>
<td>Japanese Language &amp; Culture</td>
<td>8</td>
<td>none</td>
<td>See department for level placement</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Latin</td>
<td>8</td>
<td>none</td>
<td>Latin 1-3</td>
</tr>
<tr>
<td>*Mathematics – Calculus AB</td>
<td>4</td>
<td>none</td>
<td>Mathematics 2A, 3A, 34A, or equivalent</td>
</tr>
<tr>
<td>(or AB subscore of BC exam)</td>
<td></td>
<td></td>
<td>(or AB subscore of BC exam)</td>
</tr>
<tr>
<td>*Mathematics – Calculus BC</td>
<td>8</td>
<td>none</td>
<td>Mathematics 2A, 2B, 3A, 3B, 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 1 (effective S’15)</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>*Physics 2 (effective S’15)</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>*Physics – B (last offered S’14)</td>
<td>8</td>
<td>none</td>
<td>Physics 10</td>
</tr>
<tr>
<td>*Physics – C (Mechanics)</td>
<td>4</td>
<td>none</td>
<td>Physics 6A and 6AL</td>
</tr>
<tr>
<td>*Physics – C (Electricity and Magnetism)</td>
<td>4</td>
<td>none</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 and Culture</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-3</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-4</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>Spanish Literature and Culture</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-6</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-4</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-6</td>
</tr>
</tbody>
</table>
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.
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. 30 or better on the ACT, English Language Arts; or
2. 30 or better on the ACT, Combined English Writing (last administered June 2015); or
3. 680 or better on the SAT, Evidence-Based Reading and Writing*; or
4. 680 or better on the SAT Reasoning Test, Writing (last administered January 2016); or
5. 3 or above on wither Advanced Placement Examination in English; or
6. 5 or above on an International Baccalaureate Higher Level English A: Literature exam (formerly known as Higher Level English A1 exam); or
7. Passing the University of California systemwide Analytical Writing Placement Exam (AWPE) while in high school; or
8. Entering the university with transcripts showing the completion of an acceptable 3-semester unit or 4-quarter unit course in English composition equivalent to Writing 2 at UCSB, with a grade of C or better.

*UCSB is accepting a score of 680 or better on the SAT, Evidence-Based Reading and Writing to satisfy the Entry Level Writing Requirement on a pilot basis, beginning with new students entering UC in Fall 2018. It is not retroactive.

Students who have not taken the Analytical Writing Placement examination and who have not met the UC Entry Level Writing Requirement in one of the other ways listed above will be required to take the examination during their first quarter at UCSB (check with Writing Program for examination time and location). An appropriate score on the examination will satisfy the requirement. Only one UC examination may be taken – either the systemwide Entry Level Examination while in high school or the examination given at UCSB; and neither may be repeated. Students who enter UCSB without having fulfilled the university’s Entry Level Writing requirement and (if they have not previously taken the systemwide examination) who do not achieve an appropriate score on the examination given on campus must enroll in Writing 1, 1E or Linguistics 12 within their first year at UCSB. A grade of C or higher is needed to satisfy the requirement. Students who earn a grade of C- or lower in will be required to repeat the course in successive quarters until the requirement is satisfied.

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

American History and Institutions Requirement

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

1. by achieving a score of 3 or higher on the College Board Advanced Placement Examination in American History or American Government and Politics; or
2. by passing a non-credit examination in American history or American institutions, offered in the Department of History during the first week of each quarter. Consult the department for further information; or
3. by achieving a score of 650 or higher on SAT II: Subject Test in American History or Language Arts; 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
   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
   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

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

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

College of Engineering General Education Requirements

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

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

It should be noted that for College of Engineering transfers who completed IGEC (Intersegmental General Education Transfer Curriculum), it may be used to substitute for entire UCSB College of Engineering General Education pattern (IGETC does not satisfy the American History and Institutions requirements). Students who have questions about the General Education requirements should consult with the advisors in College of Engineering Office of Undergraduate Studies.
GENERAL SUBJECT AREA REQUIREMENTS

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

I. Area A: English Reading and Composition
Computer Science students will complete Writing 2; and Writing 50, 107T, or 109ST.

All other engineering majors will complete Writing 2E and Writing 50E during their first year at UCSB. Students that are unable to meet this requirement must meet an advisor with the College of Engineering Office of Undergraduate Studies to discuss alternatives.

NOTE: Students must complete the UC Entry Level Writing Requirement before enrolling in courses that fulfill the Area A requirement of the General Education program. Please refer to page 10 of this publication or the UCSB General Catalog for a list of ways to satisfy the UC Entry Level Writing requirement.

II. Areas D, E, F, & G: Social Sciences, Culture and Thought, the Arts, and Literature

At least 6 courses must be completed in these areas:

Area D: A minimum of 2 courses must be completed in Area D.
Area E: A minimum of 2 courses must be completed in Area E.
Area F: A minimum of 1 course must be completed in Area F.
Area G: A minimum of 1 course must be completed in Area G.

The general provisions relating to General Education requirements, as listed on page 12, must be followed when completing courses in Areas D, E, F, and G.

A complete listing of courses, which will satisfy all these requirements starts on page 13.

SPECIAL SUBJECT AREA REQUIREMENTS

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

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

NOTES: ENGR 101 may be used as a writing requirement class, even by those students for whom ENGR 101 is required.

New transfer students should consult with the College Undergraduate Studies Office regarding this requirement.

2. Ethnicity Requirement. Objective: To learn to identify and understand, and appreciate the history, thought, and practices of one or more cultures outside of the European Tradition. Courses that meet this requirement are marked with a plus sign (+) on the lists in this document.

At least one course from either of these areas (European Traditions or World Cultures) is required.

Other Regulations:

- 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).

Perspective students get information from advisors and student organizations at the College’s Spring Insight.
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 (2 courses required)

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

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

Area D: Social Sciences (2 courses minimum)

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.

+ Anthropology 2 Introductory Cultural Anthropology
+ Anthropology 3 Introductory Archaeology
+ Anthropology 3SS Introduction to Archaeology
Anthropology 7 Introduction to Biosocial Anthropology
* Anthropology 25 Violence and the Japanese State
+ Anthropology 103A Anthropology of China
+ Anthropology 103B Anthropology of Japan
+ Anthropology 103C Anthropology of Korea
Anthropology 109 Human Universals
+ Anthropology 110 Technology and Culture
* Anthropology 122 Anthropology of World Systems
+ Anthropology 130A Coupled Human and Natural Systems: Risks, Vulnerability, Resilience, and Disasters
+ Anthropology 130B Global Tourism and Environmental Conservation
@ + Anthropology 131 North American Indians
+ Anthropology 134 Modern Cultures of Latin America
* Anthropology 135 Modern Mexican Culture
+ Anthropology 136 Peoples and Cultures of the Pacific
+ Anthropology 137 The Ancient Maya
* Anthropology 141 Agriculture and Society in Mexico: Past Present
+ Anthropology 142 Peoples and Cultures of India
+ Anthropology 156 Understanding Africa
* Anthropology 176 Representations of Sexuality in Modern Japan
(Same as HIST 188S and JAPAN 162)
& & Asian American Studies 1 Introduction to Asian American History, 1850-Present
& & Asian American Studies 2 American Migration since 1965
& & Asian American Studies 7 Asian American Globalization
& & Asian American Studies 8 Introduction to Asian American Gender and Sexuality
& & Asian American Studies 9 Asian American Freedom Struggles and Third World Resistance
& & Asian American Studies 100AA Chinese Americans
& & Asian American Studies 100BB Japanese Americans
& & Asian American Studies 100FF South Asian Americans
& & Asian American Studies 107 Third World Social Movements
& & Asian American Studies 111 Asian American Communities and Contemporary Issues
& & Asian American Studies 119 Asian Americans and Race Relations
& & Asian American Studies 130 Colonialism and Migration in the Passage to America
& & Asian American Studies 131 Asian American Women’s History
& & Asian American Studies 136 Asian American Families
& & Asian American Studies 137 Multiethnic Asian Americans
& & Asian American Studies 154 Race and Law in Early American History
& & Asian American Studies 155 Racial Segregation from the Civil War to the Civil Rights Movement
& & Asian American Studies 156 Race and Law in Modern America
& & Asian American Studies 157 Asian Americans and Education
& & Asian American Studies 165 Ethnographies of Asian Americans
@ & + Black Studies 1, 1H Introduction to Afro-American Studies

* This course applies toward the Writing requirement.
& This course applies toward the Ethnicity requirement.
+ This course applies toward the World Cultures requirement.
@ This course applies toward the American History & Institutions requirement.
^ This course applies toward the European Traditions requirement.
& Black Studies 4 Critical Introduction to Race and Racism
& Black Studies 6, 6H The Civil Rights Movement
* Black Studies 100 Africa and United States Policy
* Black Studies 102 Black Radicals and the Radical Tradition
& Black Studies 103 The Politics of Black Liberation-The Sixties
& Black Studies 122 The Education of Black Children
* Black Studies 124 Housing, Inheritance and Race
* Black Studies 125 Queer Black Studies
& Black Studies 129 The Urban Dilemma
& Black Studies 131 Race and Public Policy
& Black Studies 160 Analyses of Racism and Social Policy in the U.S.
& Black Studies 169AR-BR-CR Afro-American History (Same as HIST 159B)
& Black Studies 171 Africa in Film
* Black Studies 174 From Plantations to Prisons
& Chicano Studies 1A-B-C Introduction to Chicano/a Studies
& Chicano Studies 114 Cultural and Critical Theory
& Chicano Studies 124G The Virgin of Guadalupe: From Tilma to Tattoo (Same as RG ST 124G)
& Chicano Studies 137 Chicana/o Oral Traditions
& Chicano Studies 140 The Mexican Cultural Heritage of the Chicano
& Chicano Studies 144 The Chicano Community
& Chicano Studies 151 De-Colonizing Feminism
& Chicano Studies 168A-B History of the Chicano (Same as HIST 168A-B)
& Chicano Studies 172 Law and Civil Rights
& Chicano Studies 173 Immigrant Labor Organizing
* Chicano Studies 174 Chicano/a Politics (Same as POL S 174)
& Chicano Studies 175 Comparative Social Movements
& Chicano Studies 176 Theories of Social Change and Chicano Political Life
& Chicano Studies 178A Global Migration, Transnationalism in Chicano/a Contexts
* Chicano Studies 179 Democracy and Diversity
& Chicano Studies 187 Language, Power, and Learning
* Communication 1 Introduction to Communication
* Comparative Literature 139 Psychoanalytic Theory
* Comparative Literature 186FL Vegetarianism: Food, Literature, Philosophy
& East Asian Cultural Gender and Sexuality in Modern Asia
& East Asian Cultural Studies 40 Anthroplgy of China
& East Asian Cultural Studies 103A Anthropology of Japan
& East Asian Cultural Studies 103B Anthropology of Contemporary Korea
& East Asian Cultural Studies 103C Indigenous Movements in Asian Studies 186
* East Asian Cultural Studies 186 The Invention of Tradition in Contemporary East Asia
Economics 1 Principles of Economics - Micro
Economics 2 Principles of Economics - Macro
Economics 9 Introduction to Economics
* Environmental Studies 1 Introduction to Environmental Studies
* Environmental Studies 130A Coupled Human and Natural Systems: Risk, Vulnerability, Resilience, and Disasters Global Tourism and Environmental Conservation
* Environmental Studies 130B Global Human Behavior and Global Environment
* Environmental Studies 132 Women, Society and Culture
* Feminist Studies 20 Women, Society and Culture (Online course)
* Feminist Studies 30 or 30H Women, Development, and Globalization
* Feminist Studies 50 or 50H Global Feminisms and Social Justice
& Feminist Studies 60 or 60H Women of Color: Race, Class and Ethnicity
* Feminist Studies 159B Women in American History (Same as HIST 159B)
* Feminist Studies 159C Women in Twentieth-Century American History (Same as HIST 159C)
French 111 Greatest French Speeches
* Geography 2 World Regions
* Geography 5 People, Place and Environment
Geography 20 Geography of Surfing
Geography 108 Urban Geography
* Geography 108E Urban Geography
Geography 150 Geography of the United States
Global Studies 2 Global Socioeconomic and Political Processes
Global Studies 11 Introduction to Law and Society

* This course applies toward the Writing requirement.
© This course applies toward the American History & Institutions requirement.
& This course applies toward the Ethnicity requirement.
+ This course applies toward the World Cultures requirement.
Sociology 131  Political Sociology
* Sociology 134  Social Movements
@* Sociology 144  The Chicano Community (Same as CH ST 144)
Sociology 152A  Sociology of Human Sexuality
&* Sociology 153  Women and Work (Same as FEMST 153)
* Spanish 178  Mexican Culture

** This course applies toward the Writing requirement.
& This course applies toward the Ethnicity requirement.
+ This course applies toward the World Cultures requirement.

**+ East Asian Cultural Studies 3 Introduction to Asian Religious Traditions (Same as RG ST 3)
* East Asian Cultural Studies 4A East Asian Traditions: Pre-Modern
* East Asian Cultural Studies 4B East Asian Traditions: Modern
* East Asian Cultural Studies 5 Introduction to Buddhism
* East Asian Cultural Studies 7 Asian Values
* East Asian Cultural Studies 80 East Asian Civilization (Same as HIST 80)
+ East Asian Cultural Studies 164B Buddhist Traditions in East Asia

** Environmental Studies 3 Introduction to the Social and Cultural Environment
* Feminist Studies 171 McN
* Feminist Studies 171CN
* French 40X
* French 50A-BX-CX
* French 149B
* French 154F
* French 154G
* French 155D
* German 35
* German 43A
* German 43C
* German 111
* German 112
* German 116A
* German 177A
* German 179A
* Global Studies 1
* History 2A-B-C
* History 2AHH-BHH-CH
* History 4A-B-C
* History 4AHH-BHH-CH
* History 8
* History 20
* History 46
* History 49A-B
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* History 87
* History 88
* History 106A
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* History 107C
* History 114B-C-D
* History 133B-C
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* History 140A-B
* History 164C
* History 171C
* History 171D
* History 182A-B
* History 185A
* History 186B
* History 187A
* History 187B
* History 187C
* History 188S
* History 189E
* Italian 20X
* Italian 138A-A, CX, D, DX, EX, FX, XX, XX
* Japanese 161
* Japanese 162
* Japanese 164
* Japanese 165
* Korean 182A-B
* Korean History and Civilization (Same as HIST 182A-B)
* Korean History and Civilization (Same as ENV ST 107C)
* Modern Science
* The Darwinian Revolution and Modern Biology
* History of Christianity
* Twentieth Century Germany
* The Holocaust in German History
* Early Modern Britain
* Civil War and Reconstruction
* The United States of the World, 1898-1945
* The United States and the World since 1945
* Korean History and Civilization (Same as KOR 182A-B)
* Qing Empire
* Modern China (Since 1911)
* Japan Under the Tokugawa Shoguns
* Modern Japan
* Recent Japan
* Representations of Sexuality in Modern Japan (Same as ANTH 176 and JPN 162)
* History of the Pacific
* Italia
* Introduction to Italian Culture
* Cultural Representations in Italy
* Cultural Representations in Italy
* Gender and Sexuality in Italian Culture
* Italy Mediterranean
* Representations of Sexuality in Modern Japan
* Modernity and the Masses of Taisho Japan (Same as HIST 188T)
* Popular Culture in Japan
* Korean History and Civilization (Same as HIST 182A-B)
* French 149B
* Reading Places (1830-1890)
* Time Off in Paris
* Post-Colonial Cultures (Same as C LIT 171)
* Citoyennes! Women and Politics in Modern France (Same as C LIT 155D)
* Memoria: The Humanities and Neuroscience (Same as C LIT 27 & MCDB 27)
* Tales of Love
* Reading Paris (1830-1890)
* Time Off in Paris
* Post-Colonial Cultures (Same as C LIT 171)
* Citoyennes! Women and Politics in Modern France (Same as C LIT 171)
* The Making of the Modern World

** Anthropology 138TS Archaeology of Egypt
* Anthropology 176 Representations of Sexuality in Modern Japan
* Anthropology 176TS Ancient Egyptian Religion
* Art History 6A-B-C Art Survey
* Art History 6L History of Games
* Art History 115E The Grand Tour: Experiencing Italy in the Eighteenth Century
* Art History 136I The City in History
* Art History 144D Russian Art
* Art History 148A Contemporary Art History; 1960-2000
* Art History 148B Global Art After 1980
& Asian American Studies 71 Introduction to Asian American Religions
& Asian American Studies 138 Asian American Sexualities
& Asian American Studies 161 Asian American Religions (Same as RG ST 123)
* Black Studies 3 Introduction to African Studies
* Black Studies 5 Blacks and Western Civilization
* Black Studies 7 Introduction to Caribbean Studies
& Black Studies 49A-B Survey of African History
& Black Studies 50 Blacks in the Media
* Black Studies 104 Black Marxism
* Black Studies 130A Negritude and African Literature
* Black Studies 130B The Black Francophone Novel
* Chicano Studies 113 Critical Introduction to Ancient Mesoamerica
* Chinese 26 New Phenomena in 21st Century Chinese
* Chinese 32 Contemporary Chinese Religions
* Chinese 48 Historic Lives
* Chinese 183B Religious Practice and the State in China
* Chinese 185A Qing Empire
* Chinese 185B Modern China (Since 1911)
^ Classics 20B The Romans
^ Classics 50 Introduction to Classical Archaeology
^ Classics 101 The Greek Intellectual Experience: From Poetry to Philosophy
^ Classics 106 Magic in Medicine in Ancient Greece
^ Classics 140 Slavery and Freedom in the Ancient World
^ Classics 150 The Fall of the Ancient Republic: Cicero, Caesar, and Rome
Classics 151 Emporers and Gladiators: History of the Roman Empire to 180CE
^ Classics 152 Citizenship: Ancient Origins and Modern Practices
^ Classics 171 Artifact and Text: The Archaeology and Literature of Early Greece
Comparative Literature 27 Memory: Bridging the Humanities and Neurosciences (Same as FR 40X & MCDB 27)
^ Comparative Literature 30A-B-C Major Works of European Literature
* Comparative Literature 35 The Making of the Modern World
* Comparative Literature 113 Trauma, Memory, Historiography
* Comparative Literature 119 Psychoanalytic Theory
* Comparative Literature 122A Representations of the Holocaust (Same as GER 116A)
* Comparative Literature 171 Post Colonial Cultures (Same as FR 154G)
* Comparative Literature 179A Revolutions: Marx, Nietzsche, Freud (Same as GER 179A)
* Comparative Literature 186RR Romantic Revolutions: Philosophy, History, and the Arts in Europe
* East Asian Cultural Studies 3 Introduction to Asian Religious Traditions (Same as RG ST 3)

** This course applies toward the Writing requirement.
& This course applies toward the Ethnicity requirement.
+ This course applies toward the World Cultures requirement.
@ This course applies toward the American History & Institutions requirement.
@ This course applies toward the European Traditions requirement.
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+ Art History 134F The Art of Japan
+ Art History 134G Japanese Painting
+ Art History 134H Ukiyo-e: Pictures of the Floating World
Art History 136A Nineteenth-Century Architecture
Art History 136B Twentieth-Century Architecture
Art History 136C Architecture of the United States
Art History 136D Design & the American Architect
Art History 136E Housing American Cultures
Art History 136F The City in History
+ Art History 136J Landscape of Colonialism
^ Art History 136K Modern Architecture in Early Twentieth-Century Europe
+ Art History 136L From Modernism to Postmodernism in European Architecture
Art History 136M Revival Styles in Southern California Architecture
Art History 136O Sustainable Architecture: History and Aesthetics
+ Art History 136R Architecture of the Americas
+ Art History 136V Modern Indian Visual Culture
Art History 136W Introduction to 2D/3D Visualizations in Architecture
Art History 136Y Modern Architecture in Southern California
Art History 141D Birth of the Modern Museum
+ Art History 141G The Architecture of Museums and Galleries from c. 1800 to the Present
Art History 144A The Avant-Garde in Russia
Art History 144C Contemporary Art in Russia and Eastern Europe (Same as SLAV 130C)
Art History 144D Russian Art
Art History 148A Contemporary Art History: 1960-2000
Art History 148B Global Art After 1980
&* Asian American Studies 4 Introduction to Asian American Popular Culture
* Asian American Studies 79 Introduction to Playwriting
& Asian American Studies 118 Asian Americans in Popular Culture
& Asian American Studies 120 Asian American Documentary
& Asian American Studies 127 Asian American Film, Television, and Digital Media
& Asian American Studies 140 Theory & Production of Social Experience
& Asian American Studies 146 Racialized Sexuality on Screen and Scene
& Asian American Studies 170KK Special Topics in Asian American Studies
&* Black Studies 14 History of Jazz
* Black Studies 45 Black Arts Expressions
& Black Studies 142 Music in Afro-American Culture: U.S.A.
  * Black Studies 153 Black Popular Music in America
  + Black Studies 161 Third-World Cinema
  + Black Studies 162 African Cinema
  &* Black Studies 170 Afro-Americans in the American Cinema
  & Black Studies 171 Afrika in Film
  & Black Studies 172 Contemporary Black Cinema
  & Black Studies 175 Black Diaspora Cinema
  & Chicano Studies 125B Contemporary Chicano and Chicana Art
  & Chicano Studies 138 Barrio Popular Culture
  & Chicano Studies 148 Chicana Art and Feminism
@& Chicano Studies 188C Chicano Theater Workshop
* Chinese 40 Popular Culture in Modern Chinese Societies
* Chinese 170 New Taiwan Cinema
+ Chinese 176 Chinese Cinema: Nationalism and Globalization
** Classics 102 Greek Tragedy in Translation
* Classics 165 Greek Painting
* Classics 170 Pompeii
Comparative Literature 186FF NOIR: 1940’s Film and Fiction
+ Dance 35 History and Appreciation of World Dance
+ Dance 36 History of Modern Dance
* Dance W36 History of Modern Dance (online course)
Dance 45 History and Appreciation of Dance
+ Dance 145A-B Studies in Dance History
+ East Asian Cultural Studies 134A Buddhist Art
Environmental Studies 136O Sustainable Architecture: History and Aesthetics
* Film & Media Studies 46 Introduction to Cinema
+ Film & Media Studies 120 Japanese Cinema (Same as JAPAN 159)
+ Film & Media Studies 121 Chinese Cinema
* Film & Media Studies 163 Women and Film: Feminist Perspectives
Film & Media Studies 169 Film Noir
* Film & Media Studies 175 Experimental Film
* Film & Media Studies 178Z Technology and Cinema (Same as FR 156D)
* French 156A French Cinema: History and Theory
* French 156B French and Francophone Cinema
* French 156C Modern Images of the Middle Ages: The Intersection of Text, History, and Film
* French 156D Technology and Cinema (Same as FLMST 178Z)
* German 55A Contemporary German Pop Culture
Italian 124X Italian Theatre
Italian 178B Italian Cinema
Italian 179X Italian Cinema
Italian 180Z Italian Cinema
+ Japanese 134F Arts of Japan (Same as ARTHI 134F)
+ Japanese 134G Japanese Painting (Same as ARTHI 134G)
+ Japanese 134H Ukiyo-e: Pictures of the Floating World (Same as ARTHI 143H)
+ Japanese 149 Japanese Cinema (Same as FLMST 120)
+ Korean 75 Introduction to Popular Culture in Korean Film
* Music 3B Writing about Music
* Music 11 Music Appreciation
* Music 15 World Music
* Music 113A The History of Opera: 1600-1800
Music 114 Music and Popular Culture in America
* Music 115 Symphonic Music
Music 116 American Music History: Colonial to Present
* Music 118A History and Literature of Great Composers in Western Music
* Music 179A Music and Politics
+ Religious Studies 133B From Superman to Speigelman: The Jewish Graphic Novel
& Religious Studies 137G Persian Cinema
Slavic 130A The Avantgarde in Russia
Slavic 130B Russian Cinema
Slavic 130C Contemporary Art in Russia and Eastern Europe (Same as ARTHI 144C)
Slavic 130D Russian Art
Slavic 130E Masters of Soviet Cinema
Spanish 126 Spanish Cinema
+ Theater 2A Performance in Global Contexts: Africa and the Caribbean
+ Theater 2B Performance in Global Contexts: Asia
** Theater 2C Performance in Global Contexts: Europe
* Theater 3 Life of the Theater
Theater 5 Introduction to Acting
Theater 7 Performance of the Human Body
Theater 9 Introduction to Playwriting
Theatre 143 The People’s Voice
* Theatre 180A-B American Drama
* Theatre 180C Contemporary American Drama and Theater
& Theatre 180E Culture Clash: Studies in U.S. Latino Theater
& Theatre 180G Race, Gender, and Performance
** Theatre 182A Ancient Theater and Drama
* Theatre 182M Modern Theater and Drama
* Theatre 182MC Modern Contemporary
* Theatre 182N Neoclassical Theater and Drama
* Theatre 184AA Contemporary African American Performance
** Theatre 184CA Contemporary African Theater and Performance
* Theatre 188S Shakespeare on Film and Stage
* This course applies toward the Writing requirement.
& This course applies toward the Ethnicity requirement.
+ This course applies toward the World Cultures requirement.
@ This course applies toward the American History & Institutions requirement.
© This course applies toward the European Traditions requirement.

16 • GENERAL EDUCATION
### Area G: Literature (1 course minimum)

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

- **Asian American Studies 5** - Introduction to Asian American Literature
- **Asian American Studies 122** - Asian American Fiction
- **Asian American Studies 128** - Writings by Asian American Women
- **Black Studies 33** - Major Works of African Literatures (Same as C LIT 33)
- **Black Studies 38A-B** - Introduction to Afro-American Literature
- **Black Studies 126** - Comparative Black Literatures
- **Black Studies 127** - Black Women Writers
- **Black Studies 130A** - Negritude and African Literature
- **Black Studies 130B** - The Black Francophone Novel
- **Chicano Studies 152** - Postcolonialism
- **Chicano Studies 180** - Survey of Chicano Literature
- **Chicano Studies 181** - The Chicano Novel
- **Chicano Studies 184A** - Introductions to Taiwan Literature
- **Chinese 35** - Imagism, Haiku, and Chinese Poetry
- **Chinese 115A** - Readings in Modern Chinese Literature
- **Chinese 124A-B** - Classical Chinese Poetry
- **Chinese 148** - Historic Lives
- **Classics 20A** - The Ancient Greeks
- **Classics 36** - Ancient Epic
- **Classics 39** - Women in Classical Literature
- **Classics 40** - Greek Mythology
- **Classics 55** - Troy
- **Classics 102** - Greek Tragedy in Translation
- **Classics 109** - Viewing the Barbarian: Representations of Foreign Peoples in Greek Literature
- **Classics 110** - From Homer to Harlequin: Masculine, Feminine, and the Romance
- **Classics 130** - Comedy and Satire in Translation
- **Classics 175** - Ancient Theories of Literature
- **Comparative Literature 30A-B-C** - Major Works of European Literature
- **Comparative Literature 31** - Major Works of Asian Literatures
- **Comparative Literature 32** - Major Works of Middle Eastern Literatures
- **Comparative Literature 33** - Major Works of African Literatures (Same as BL ST 33)
- **Comparative Literature 34** - Literature of the Americas
- **Comparative Literature 100** - Introduction to Comparative Literatures
- **Comparative Literature 103** - Going Postal: Epistolary Narratives (Same as ENGL 128EN)
- **Comparative Literature 107** - Voyages to the Unknown
- **Comparative Literature 113** - Trauma, Memory, Historiography
- **Comparative Literature 122A** - Representations of the Holocaust (Same as GER 115A)
- **Comparative Literature 122B** - Holocaust in France (Same as FR 154E)
- **Comparative Literature 126** - Comparative Black Literatures
- **Comparative Literature 128A** - Children’s Literature
- **Comparative Literature 133** - Transpacific Literature
- **Comparative Literature 146** - Robots
- **Comparative Literature 154** - Border Narratives
- **Comparative Literature 156** - Science Fiction in Eastern Europe
- **Comparative Literature 161** - Literature of Central Europe
- **Comparative Literature 170** - Literary Translation: Theory and Practice
- **Comparative Literature 171** - Post-Colonial Cultures (Same as FR 154G)
- **Comparative Literature 179A** - Revolutions: Marx, Nietzsche, Freud (Same as GER 179A)
- **Comparative Literature 179B** - Mysticism
- **Comparative Literature 179C** - Mediactechnology (Same as GER 179C)
- **Comparative Literature 186AD** - Adultery in the Novel
- **Comparative Literature 186EE** - Interdisciplinary Comparative Literature
- **Comparative Literature 188** - Narrative Studies
- **Comparative Literature 189** - The First Person
- **Comparative Literature 191** - Fantasy and the Fantastic (Same as FR 153D)
- **English 112** - Introduction to Shakespeare
- **English 120** - Literature and the Environment (Same as ENV S 122NE)
- **English 121** - Medieval Literature
- **English 122AA-ZZ** - American Literature from 1900 to Present
- **English 122NE** - Shakespeare: Poems and Earlier Plays
- **English 125** - Shakespeare: Later Plays
- **English 126B** - Literary Theory and Criticism
- **English 127** - Women and Literature
- **English 128AA-ZZ** - Black Women Authors
- **English 131AA-ZZ** - Medieval Literature
- **English 133AA-ZZ** - Biblical Literature: The Old Testament
- **English 135** - Medieval Literature in Translation
- **English 136** - Modern Drama
- **English 137A-B** - The Art of Narrative
- **English 138** - Cultural Representations
- **English 140** - Representations of Nature and the Environment (Same as ENV S 122NE)
- **English 141** - Readings in the Modern Short Story
- **English 144** - Survey of British Fiction
- **English 146** - Literary Genres
- **English 149C** - Studies in American Literature
- **English 149D** - Studies in American Regional Literature
- **English 151** - Literature of Cultural and Ethnic Communities in the United States
- **English 152A** - Seventeenth and Eighteenth Century American Literature
- **English 152B** - Poetry in America
- **English 153** - Anglo-Irish Literature
- **English 154** - Chaucer: Canterbury Tales
- **English 155** - Literature of Chivalry
- **English 156** - English Renaissance Drama
- **English 157** - Milton
- **English 158** - Topics in Literature
- **English 159** - Studies in Literature and the Mind
- **English 160** - Studies in the Enlightenment
- **English 161** - British Romantic Writers
- **English 162** - The Victorian Era
- **English 163** - Studies in the Nineteenth Century
- **English 164** - Modern European Literature
- **English 165** - Modernism in English
- **English 166** - Modern Studies in Literature
- **English 167** - Contemporary Literature
- **Environmental Studies 122NE** - Afro-American Fiction and Criticism, 1920s to Present
- **Environmental Studies 122CC** - Science Fiction
- **Environmental Studies 122LE** - Detective Fiction
- **Environmental Studies 122NE** - Cultural Representations: The Rhetoric of Climate Change
- **Environmental Studies 122NE** - Cultural Representations: Literature and the Environment
- **Environmental Studies 123** - Cultural Representations of Nature and the Environment (Same as ENGL 122NE)
- **English 164** - American Literature
- **English 165** - Women, Representation, and Cultural Production
- **English 166** - Contemporary Women and Politics in Modern France (Same as FR 153D)
- **French 101A-B-C** - Literary and Cultural Analysis
- **French 147A** - French and Francophone Poetry
- **French 147B** - French and Francophone Theater
- **French 147C** - Women in the Middle Ages
- **French 148E** - The Age of Louis XIV
- **French 149B** - The Politics of Paradise
- **French 149C** - Reading Paris (1830-1890)
- **French 149D** - Post-War Avant-Garde
- **French 149E** - Belgian Literature and Art
- **French 153A** - Medieval Literature in Translation
- **French 153B** - French Theater in Translation
- **French 153C** - Autobiography
- **French 153D** - Fantasy & the Fantastic (Same as C LIT 191)
- **French 154E** - The Power of Negative Thinking: Sartre, Adorno, and Marcuse

* This course applies toward the Writing requirement.
& This course applies toward the Ethnicity requirement.
+ This course applies toward the World Cultures requirement.
@ This course applies toward the American History & Institutions requirement.
This course applies toward the European Traditions requirement.
This course applies toward the World Cultures requirement.

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<td>@ Psychology 153L</td>
<td>Laboratory in Development and Evolutional Psychology</td>
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<tr>
<td>@ Religious Studies 84</td>
<td>Psychology</td>
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<tr>
<td>@ Religious Studies 106</td>
<td>Introduction to Islamic Civilization</td>
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<tr>
<td>@ Religious Studies 110D</td>
<td>Modernity and the Process of Secularization</td>
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<tr>
<td>&amp; Religious Studies 114D</td>
<td>Ritual Art and Verbal Art of the Pacific</td>
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<tr>
<td>&amp; Religious Studies 127B</td>
<td>Christian Thought and Cultures of the Middle Ages</td>
<td></td>
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<tr>
<td>&amp; Religious Studies 131F</td>
<td>The History of Anti-Semitism</td>
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<tr>
<td>&amp; Religious Studies 131J</td>
<td>Introduction to Rabbinic Literature</td>
<td></td>
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</table>
20 • General Education

** Religious Studies 140A
- Religious Studies 140B
+ Religious Studies 140C
@ Religious Studies 140D
& Religious Studies 140E
* Religious Studies 140F
* Religious Studies 145
+ Religious Studies 160A
+ Religious Studies 162A
** Religious Studies 166C
* Religious Studies 167A
* Religious Studies 169
& Religious Studies 193
& Sociology 128
** Sociology 130
* Sociology 130LA
* Sociology 130LA
** Sociology 130ME

* Sociology 134R
* Sociology 134RC
& Sociology 137E
& Sociology 139A
& Sociology 140
* Sociology 154A
& Sociology 154F
& Sociology 155A
& Sociology 155M
& Sociology 155W
* Sociology 156A

@ Sociology 157
* Sociology 170
* Sociology 176A
& Spanish 199

* Speech & Hearing Sciences 50
* Theater 1
* Theater 91
& Theater 180F
* Theater 185TH
* Writing 18
* Writing 24
* Writing 110L
* Writing 110MK
* Writing 126
* Writing 160

Stork Tower; UCSB campus

* This course applies toward the Writing requirement.
& This course applies toward the Ethnicity requirement.
+ This course applies toward the World Cultures 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

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. Area D: Social Sciences (2 courses minimum)

   ________________  ________________

3. Area E: Culture and Thought (2 courses minimum)

   ________________  ________________

4. Area F: The Arts (1 course minimum)

   ________________

5. Area G: Literature (1 course minimum)

   ________________

Special Subject Areas

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

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

   ________________  ________________  ________________  ________________

b. Ethnicity Requirement – (1 course) ________________

c. European Traditions or World Cultures Requirement – (1 course) ________________
Chemical Engineering

Department of Chemical Engineering, Engineering II, Room 3357;
Telephone (805) 893-3412
Web site: www.chemengr.ucsb.edu
Chair: Rachel A. Segalman
Vice-Chairs: Todd M. Squires
M. Scott Shell

Faculty
Bradley Chmelka, Ph.D., UC Berkeley, Distinguished Professor (self-assembled materials, heterogeneous catalysis, surfactants and polymers, porous and composite solids, magnetic resonance)
Phyllis N. Christopher, Ph.D., University of Michigan, Associate Professor (catalysis, photocatalysis, plasmonics, nanomaterials, synthesis, in-situ characterization)
Siddharth S. Dey, Ph.D., UC Berkeley, Assistant Professor (systems biology, single-cell genomics, epigenetics, stem cell biology)
Michael F. Doherty, Ph.D., Cambridge University, Distinguished Professor (process design and synthesis, separations, catalytic engineering)
Glenn Fredrickson, Ph.D., Stanford University, Distinguished 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)
Eric McFarland, Ph.D., Massachusetts Institute of Technology, M.D., Harvard, Professor (energy production, catalysis, reaction engineering, charge and energy transfer)
Arnav Mukherjee, Ph.D., University of Illinois at Urbana-Champaign, Assistant Professor (protein and cell engineering, genetic tools for molecular imaging, fluorescence imaging, magnetic resonance imaging, anaerobic biosystems, synthetic biology)
Michelle A. O’Malley, Ph.D., University of Delaware, Assistant Professor (genetic and cellular engineering, membrane protein characterization for drug discovery, protein biophysics, metabolomics, biofuel production)
Baron G. Peters, Ph.D., UC Berkeley, Professor (molecular simulation, chemical kinetics, catalytic reaction mechanisms, nucleation, electron transfer)
Susannah Scott, Ph.D., Iowa State University, Distinguished Professor

(heterogeneous catalysis, surface organometallic chemistry, analysis of electronic structure and stoichiometric reactivity to determine catalytic function) *3
Rachel A. Segalman, Ph.D., UC Santa Barbara, Professor (polymer design, self-assembly, and properties) *1
M. Scott Shell, Ph.D. Princeton, Professor (molecular simulation, statistical mechanics, complex materials, protein biophysics)
Todd M. Squires, Ph.D., Harvard, Professor (fluid mechanics, microfluidics, microtechnology, complex fluids)

Emeriti Faculty
Sanjoy Banerjee, Ph.D., University of Waterloo, Professor Emeritus (transport processes, multiphase systems, process safety) *2
Owen T. Hanna, Ph.D., Purdue University, Professor Emeritus (theoretical methods)
Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor (structural materials, mechanical properties) *2
Jacob Israelachvili, Ph.D., University of Cambridge, Distinguished Professor (surface and interfacial phenomena, adhesion, colloidal systems, surface forces, bio-adhesion, friction) *1
L. Gary Leal, Ph.D., Stanford University, Schlumberger Distinguished Professor in Chemical Engineering (fluid mechanics, physics of complex fluids, rheology)
Duncan A. Mellichamp, Ph.D., Purdue University, Professor Emeritus (process dynamics and control, digital computer control)
Robert G. Rinker, Ph.D., California Institute of Technology, Professor Emeritus (chemical kinetics, reaction engineering, catalysis)
Orville C. Sandall, Ph.D., UC Berkeley, Professor Emeritus (transport of mass, energy, and momentum; separation processes)
Dale E. Seborg, Ph.D., Princeton University, Professor Emeritus (process dynamics and control, monitoring and fault detection, system identification)
Theofanis G. Theofanous, Ph.D., University of Minnesota, Professor, Center for Risk Studies and Safety Director (transport phenomena in multiphase systems, risk analysis) *2

Affiliated Faculty
Christopher Bates, Ph.D. (Materials)
David Gay, Ph.D. (ICB)
Song-I Han, Ph.D. (Chemistry)
Mahdi Abu Omar, Ph.D. (Chemistry)
Philip Alan Pincus, Ph.D. (Materials)

We live in a technological society which ensures 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 workplace, so that they remain effective engineers, take on new responsibilities, and assume leadership roles.

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

**Student Outcomes**

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

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

**Undergraduate Program**

**Bachelor of Science—Chemical Engineering**

A minimum of 187 units is required for graduation. A complete list of requirements for the major can be found on page 46. Schedules should be planned to meet both General Education and major requirements. Courses required for the major, inside or outside of the Department of Chemical Engineering, cannot be taken for the pass/not pass grading option. They must be taken for letter grades.

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

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

**Chemical Engineering Courses**

**LOWER DIVISION**

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

10. **Introduction to Chemical Engineering 3**
    - (5) _HELSEGEN, GORDON_
    - Prerequisites: Chemical Engineering 5 (May be taken concurrently); Chemistry 1A-B-C or 2A-B-C; Mathematics 2A or 3A; Mathematics 2B or 3B, and Mathematics 4A or 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.

**99. Introduction to Research**
   - (1-3) _STAFF_
   - Prerequisites: consent of instructor and undergraduate advisor.
   - May be repeated for credit to a maximum of 6 units. Students are limited to 5 units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined.
   - Directed study, normally experimental, to be arranged with individual faculty members. Course offers exceptional students an opportunity to participate in a research group.

**UPPER DIVISION**

102. **Biomaterials and Biosurfaces**
   - (3) _STAFF_
   - 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.

107. **Introduction to Biological Processing**
   - (3) _OMalley, DeY_
   - Prerequisites: Chemical Engineering 10.
   - Familiarizes engineering students with biological processing and production at multiple scales. Chemical engineering principles will be infused with key biological concepts, including an introduction to biochemistry, cell biology, and molecular biology.

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

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

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

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

120A. **Transport Processes**
   - (4) _SQUIRES, HAN_
   - Prerequisites: Chemical Engineering 10 with a minimum grade of C-; (may be taken concurrently); Mathematics 4B or 4Bi; Mathematics 6A or 6AI-6B.
   - Introductory course in conceptual understanding and mathematical analysis of problems in fluid dynamics of relevance to Chemical Engineering. Emphasis is placed on performing microscopic and macroscopic mathematical analysis to understand fluid motion in response to forces.

120B. **Transport Processes**
   - (3) _HELSEGEN, O'MALLEY, HAN_
   - Prerequisite: Chemical Engineering 10 with minimum grade of C-; Chemical Engineering 110A with minimum grade of C-; Chemical Engineering 110A. (May be taken concurrently) and Chemical Engineering 120A.
   - Introductory course in the mathematical analysis of conductive, convective and radiative heat transfer with practical applications to design of heat exchange equipment and use.

120C. **Transport Processes**
   - (3) _PETERS, O'MALLEY, HAN_
   - Prerequisite: Chemical Engineering 10 with a minimum grade of C-; Chemical Engineering 110A with minimum grade of C-; Chemical Engineering 110B (may be taken concurrently) and Chemical Engineering 120B.
   - Introductory course in the fundamentals of mass transfer with applications to the design of mass transfer equipment.

121. **Colloids and Biosurfaces**
   - (3) _STAFF_
   - 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**
   - (1) _STAFF_
   - Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology.

125. **Principles of Bioengineering**
   - (3) _MITRAGOTRI_
   - Applications of engineering to biological and medical systems. Introduction to drug delivery, tissue engineering, and modern biomedical devices. Design and applications of these systems are discussed.

126. **Non-Newtonian Fluids, Soft Materials and Chemical Products**
   - (3) _SQUIRES, HELSEGEN_
   - Prerequisite: Chemical Engineering 120C
   - Overview of soft materials (suspensions, gels, polymers, surfactants, emulsions, powders and granules) that arise in diverse industries, including
consumer products, foods, advanced materials, and energy production. Influence of non-Newtonian rheology (shear-thickening and thinning, viscoelasticity, extension-thickening, yield stresses, normal stress differences, and metastability) upon handling, processing, production, and performance of chemical products. Strategies to design chemical products that meet performance targets, and to scale-up production. Real-world case studies and classroom demonstrations.

128. Separation Processes
(3) SCOTT
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, PETERS
Prerequisites: Mathematics 4B or 4BI; Mathematics 6A or 6AI.
Develop analytical tools to solve elementary partial differential equations and boundary value problems. Separation of variables, Laplace transforms, Sturm-Liouville theory, generalized Fourier analysis, and computer math tools.

132B. Computational Methods in Chemical Engineering
(3) FREDRICKSON, GORDON
Prerequisites: Mathematics 4B or 4BI; Mathematics 6A or 6AI-6B.

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

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

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

141. The Science and Engineering of Energy Conversion
(3) MCFARLAND
Prerequisites: Chemical Engineering 110A and 140A.
Equivalent upper-division coursework in thermodynamics and kinetics from outside of department will be considered.

Framework for understanding the energy supply issues facing society with a focus on the science, engineering, and economic principles of the major alternatives. Emphasis will be on the physical and chemical fundamentals of energy conversion technologies.

146. Heterogenous Catalysis
(3) STAFF
Prerequisites: Chemical Engineering 140A-B or consent of instructor.
Concepts and definitions. Physical and chemical methods of catalyst characterization. Adsorption, desorption, and surface reaction on well-defined surfaces. Thermodynamic and kinetic treatments of overall reactions on uniform and nonuniform surfaces. Correlations and theoretical approaches in chemical engineering catalysis.

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

152B. Advanced Process Control
(3) STAFF
Prerequisites: 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) STAFF
Prerequisites: Chemical Engineering 170 or Chemical Engineering 107; Mathematics 4B or 4BI; Mathematics 6A or 6AI and Mathematics 6B.
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) SEGALMAN
Prerequisites: Chemical Engineering 110A or Chemistry 113A or equivalent.
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 crystalization and glass transitions.

170. Molecular and Cellular Biology for Engineers
(3) O’MALLEY
Prerequisites: Chemical Engineering 120A-B-C, 140A and Chemistry 109C.
Familiarizes engineering students with key concepts from biochemistry, molecular biology, cell biology, and genetics. Students will apply chemical engineering principles to describe different biological systems at multiple scales, including an introduction to bioproduction.

171. Introduction to Biochemical Engineering
(3) DEY, O’MALLEY
Prerequisites: Chemical Engineering 170 or Chemical Engineering 107.
Introduction to biochemical engineering covering cell growth kinetics, biochemical processes, and the relationship between cellular information and molecular and cellular engineering.

173. Omics-Enabled Biotechnology
(3) O’MALLEY
Prerequisites: Chemical Engineering 170 or MCDB 1A
This course will integrate genomic, transcriptomic, metabolomic, and proteomic approaches to quantify and understand intricate biological systems.

179. Biotechnology Laboratory
(4) STAFF
Prerequisites: Chemical Engineering 170 or MCDB 1A or Chemistry 142A, with 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 processes. 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, CHMELKA
Prerequisites: Chemical Engineering 110A-B, 120A-B-C, 128B, 140A-B, and 152A.
Applications of chemical engineering principles to plant design. Conceptual design of chemical processes. Flowsheeting methods. Engineering cost principles and economic aspects.

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

193. Internship in Industry
(1-4) STAFF

196. Undergraduate Research
(2-4) STAFF
Prerequisites: Upper-division standing, completion of 2 upper-division courses in Chemical Engineering; 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 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 98/99/198/199/199DC/199RA courses combined.
Directed individual studies.

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

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

Director: Li-C. Wang

Faculty

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, Program (computer architecture, embedded systems, high-performance computing)

Li-C. Wang, Ph.D., University of Texas at Austin, Professor (design verification, testing, and formal methods for computing systems)

Zheng Zhang, Ph.D., Massachusetts Institute of Technology, Assistant Professor (Design Automation Algorithms for VLSI/MEMS/Photonics: Uncertainty Quantification and Data Analysis; Modeling and Control for Robotic and Autonomous Systems; Computation for Biomedical Imaging)

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


Mission Statement

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

Educational Objectives

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

Program Outcomes

Upon completion of this program, students will have:
1. Acquired strong basic knowledge and skills in those fundamental areas of mathematics, science, and engineering necessary to facilitate specialized professional training at an advanced level. Developed a recognition of the need for and the ability to engage in lifelong learning.
2. Experienced in-depth training in state-of-the-art specialty areas in computer engineering.
3. Benefited from hands-on, practical laboratory experiences where appropriate throughout the program. The laboratory experiences will be closely integrated with coursework and will make use of up-to-date instrumentation and computing facilities. Students will have completed both hardware-oriented and software-oriented assignments.
4. Experienced design-oriented challenges that exercise and integrate skills and knowledge acquired during their course of study. These challenges may include design of components or subsystems with performance specifications. Graduates should be able to demonstrate an ability to design and test a system, analyze experimental results, and draw logical conclusions from them.
5. Learned to function well in multidisciplinary teams and collaborative environments. To this end, students must develop communication skills, both written and oral, through teamwork and 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 191 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 48 units of senior year elective courses including completion of two out of
ten elective sequences and a senior year
capstone design project.

Because the Computer Engineering

degree program is conducted jointly by the

Department of Computer Science and the

Department of Electrical and Computer

Engineering, several of the upper-division
courses have equivalent versions offered
by ECE or CMPSC. These courses are
considered interchangeable, but only one
such course of a given equivalent ECE/

CMPSC pair may be taken for credit.

Courses required for the major, whether
inside or outside of the Departments of

Electrical and Computer Engineering or

Computer Science, must be taken for let-
ter grades. They cannot be taken for the

passed/not passed grading option.

The upper-division requirements consist of
a set of required courses and a minimum of
48 units (12 classes) of additional depart-
mental elective courses comprised of at
least two sequences chosen from a set of
eight specialty sequences. Each sequence
must consist of two or more courses taken
from the same course/sequence group.

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

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

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

• Computer Systems Design: ECE/CMPSC

153A, ECE 153B
• Computer Networks: ECE 155A/CMPSC

176A, ECE 155B/CMPSC 176B
• Distributed Systems: ECE 151/CMPSC

171 and one or both of the Computer
 Networks courses
• Programming Languages: CMPSC 160, 162
• Real-Time Computing & Control: ECE

147A-B, 157
• Multimedia: ECE 178, ECE/CMPSC

181B, ECE 160/CMPSC 182
• VLSI: ECE 122A, ECE 122B/ECE 124A,

124D
• Signal Processing: ECE 130A-B
• Robotics: ECE 179D & ECE 179P

Satisfactory Progress and
Prerequisites

A majority of Computer Science and Elec-
trical and Computer Engineering courses
have prerequisites which must be complet-
ed successfully. Successful completion of
prerequisite classes requires a grade of C
or better in Mathematics 3A-B and 4A, and
a grade of C- or better in ECE classes. Stu-
dents will not be permitted to take any ECE
or CMPSC course if they received a grade
of F in one or more of its prerequisites.

Students who fail to maintain a grade-point
average of at least 2.0 in the major may
be denied the privilege of continuing in the
major.

Computer

Engineering Courses

See listings for Computer Science starting
on page 25 and Electrical and Computer
Engineering starting on page 30.

• Design & Test Automation: ECE 156A,

ECE 156B
• Machine Learning: CMPSC 165A,

CMPSC 165B
• System Software Architecture: CMPSC

170, CMPSC 171/ECE 171

Computer Science

Department of Computer Science,

Harold Frank Hall, Room 2104;

Telephone (805) 893-4321

Web site: www.cs.ucsb.edu

Chair: Ambuj Singh

Vice Chair: Ömer Egecioglu

Chandra Krintz

Faculty

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

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

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

Tevfik Bultan, Ph.D., University of Maryland, College Park, Professor (software verification, program analysis, software engineering, and computer security)

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

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

Ömer Egecioglu, Ph.D., University of California, San Diego, Professor (bijective and enumerative combinatorics, parallel algorithms, approximation algorithms, combinatorial algorithms)

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

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

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

Ben Hardekopf, Ph.D., University of Texas at Austin, Associate Professor (programming languages: design, analysis and implementation)
representation and reasoning, information extraction, computational social science, multimodality, language and vision)

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

Xifeng Yan, Ph.D., University of Illinois at Urbana Champaign, Professor (Data Mining, Databases, Natural Language Processing/ Machine Learning/Al)

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

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

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

Emeriti Faculty

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

Teofilo Gonzalez, Ph.D., University of Minnesota, Professor (approximation algorithms; parallel computing multicasting; scheduling theory; placement and routing; Oscar H. Ibarra, Ph.D., University of California, Berkeley, Professor (design and analysis of algorithms, theory of computation, computational complexity, parallel computing)

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

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

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

Affiliated Faculty

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

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

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

Martin Raubal, Ph.D. (Geography)

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

Mission Statement

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

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

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

Additional computing facilities are available for graduate students in the Graduate Student Laboratory. Students working with faculty have access to further 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 each undergraduate class for further 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. program 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 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. Computer science majors have priority when registering for all Computer Science Courses. UCSB students can petition for a change-of-major into the Department of Computer Science once the minimum requirements are completed.

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

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 any other department must be taken for letter grades.

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/.

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.

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
4. Computer Science Boot Camp
(4) KOC
NOT open to CMPSC or CMPEN Majors.
An introduction to computational thinking, computing, data management, and problem solving using computers, for non-majors. Topics include coding basics, representing code and data using a computer, and applications of computing that are important to society.

8. Introduction to Computer Science
(4) CONRAD, FRANKLIN
Not open for credit to students who have completed Computer Science 16 or Engineering 3.
Legal repeat for CMPSC 10.
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.

16. Problem Solving with Computers I
(4) CONRAD, KRINTZ
Prerequisite: Math 3A with a grade of C or better (may be taken concurrently), Computer Science 8 or Engineering 3 with a grade of C or better; another university-level intro to programming course, or significant prior programming experience.
Legal repeat of CMPSC 10.
Fundamental building blocks for solving problems using computers. Topics include basic computer organization and programming constructs: memory CPU, binary arithmetic, variables, expressions, statements, conditions, iteration, functions, parameters, recursion, primitive and composite data types, and basic operating system and debugging tool.

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

32. Object Oriented Design and Implementation
(4) HOLLERER
Prerequisite: Computer Science 24 with a grade of C or better.
Computer Science 32 is a legal repeat for Computer Science 60.
Advanced topics in object-oriented computing. Topics include encapsulation, data hiding, inheritance, polymorphism, compilation, linking and loading, memory management, and debugging; recent advances in design and development tools, practices, libraries, and operating system support.

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

48. Computer Science Project
(4) CAPPELLO
Prerequisite: Computer Science 32 with a grade of C or better.
Team-based project development. Topics include software engineering and professional development practices, interface design, advanced library support; techniques for team-oriented design and development, testing and test-driven development, and software reliability and robustness. Students present and demonstrate their final projects.

56. Advanced Applications Programming
(4) CONRAD
Prerequisite: Computer Science 24 and 32 with a grade of C or better.
Not open for credit to students who have completed Computer Science 20.
Advanced application programming using a highlevel, virtual-machine-based language. Topics
include generic programming, exception handling, programming language implementation; automatic memory management, and application development, management, and maintenance tools; event handling, concurrency and threading, and advanced library use.

64. Computer Organization and Logic Design

Prerequisite: Computer Science 16 with a grade of C or better; and Mathematics 3C or 4A with a grade of C or better.

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

Course counts as a legal repeat of CMPSC 30.

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

95AA-ZZ. Undergraduate Seminar in Computer Science

Prerequisites: Open to pre-computer science and pre-computer engineering majors only; consent of instructor.

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

99. Independent Studies in Computer Science

(1-4) STAFF

Must have a minimum 3.0 grade point average.

May be repeated. Students are limited to 5 units per quarter and 30 units total in all 99/198/199 courses combined.

Independent studies in computer science for advanced students.

UPPER DIVISION

111. Introduction to Computational Science

(4) PETZOLD

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

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

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

130A. Data Structures and Algorithms I

(4) GONZALEZ

Prerequisite: Computer Science 40 with a grade of C or better; 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) EGEICHOGLU

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

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

140. Parallel Scientific Computing

(4) GILBER'T

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

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

Fundamental concepts 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) KRITZ

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 requirements for efficient design of embedded software and systems is discussed. Techniques for highly constrained systems.

154. Computer Architecture

(4) STAFF

Prerequisite: Computer Science 32 with a grade of C or better, Computer Science 48 with a grade of C or better, and Computer Science 64 with a grade of C or better.

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

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

160. Translation of Programming Languages

(4) SHERWOOD

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

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

162. Programming Languages

(4) HARDEKÖPP, KRINTZ

Prerequisite: Computer Science 130A and Computer Science 138; open to computer science and computer engineering majors only.

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

165A. Artificial Intelligence

(4) TURK

Prerequisite: Computer Science 130A

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

165B. Machine Learning

(4) SINDH

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 decision trees; linear and non-linear decision tree learning; genetic algorithms; Bayesian learning; analytical learning; and others.

170. Operating Systems

(4) KRUSEL, ZHAO

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

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

171. Distributed Systems

(4) EL ABBADI

Prerequisite: Computer Science 130A.

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

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

174A. Fundamentals of Database Systems

(4) SU

Prerequisite: Computer Science 130A.

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

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

176A. Introduction to Computer Communication Networks

(4) ALMROTH, BIELING

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

Not open for credit to students who have completed Computer Science 176 or ECE 155 or ECE 156.

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) BIELING, ZHENG

Prerequisite: Computer Science 176B.

General overview of wireless and mobile networking, multimedia, security multicast, quality of service, IPv6, and web caching. During the second half of the course, one or more of the above topics are studied in greater detail.

177. Computer Security

(4) KEMMERER

Prerequisite: Computer Science 170 (may be taken concurrently).

Introduction to the basics of computer security and privacy. Analysis of technical difficulties of producing secure software systems that provide guaranteed controlled sharing. Examination and critique of current systems, methods, and certification.
178. Introduction to Cryptography
(4) EGECIOGLU
Prerequisites: Computer Science 24 and Computer
Science 40 with a grade of C or better; and
PSTAT 120A or 121A or ECE 139 or permission of
instructor.
An introduction to the basic concepts and
techniques of cryptography and cryptanalysis. Topics
include: The Shannon Theory, classical systems,
the Enigma machine, the data encryption standard,
public key systems, digital signatures, file security.

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

181. Introduction to Computer Vision
(4) WANG, TURK
Prerequisite: Upper-division standing.
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.

184. Mobile Application Development
(4) HOLLERER
Prerequisite: Computer Science 56 and Computer
Science 130A.
An introduction to programming mobile
computing devices. Students will learn about and
study the shift in software development from
desktop to mobile device applications. Topics will
include software engineering and design practices,
advances in programming practice, and support
tools for mobile application development and testing.
Students will develop and deploy mobile applications
as part of their course work.

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

189A. Senior Computer Systems Project
(4) BULTAN
Prerequisite: Computer Science 56; Senior standing
in computer engineering, computer science, or
electrical engineering; consent of instructor.
Not open for credit to students who have
completed Computer Science 172 or ECE 189A.
Student groups design a significant computer-
based project. Multiple groups may cooperate
toward one large project. Each group works
independently; interaction among groups is via
interface specifications and informal meetings.
Project for follow-up course may be different.

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

Department of Electrical and Computer Engineering
Graduate programs for the College of Engineering
are described on page 30.

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, Distinguished Professor and Dean
(integrated optoelectronics, optical switching
technology and switched optical networks)
Mahnnoosh Alizadeh, Ph.D., UC Davis,
Assistant Professor (Smart power grids,
electric transportation systems, 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)
Ilan Ben-Yaacov, Ph.D., UC Santa Barbara,
Lecturer (semiconductor device physics
and electronic devices, power electronics,
education engineering)
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, Distinguished 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)

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

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

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

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, Distinguished Professor (metallocorganic vapor phase epitaxy, optoelectronic materials, compound semiconductors, indium phosphide and gallium nitride, photonic devices) *1

Jerry Gibson, Ph.D., Southern Methodist University, Distinguished 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)

Yogananda Isukapalli, Ph.D., UC San Diego (Low power hardware design, Multi-antenna wireless communications, Transmit beam forming, Vector quantization, Performance analysis of communication systems)

Jonathan Klaakin, Ph.D., UC Santa Barbara, Associate Professor (Integrated Photonics, Silicon Photonics, Optical Communications, Nonphotonics, Microwave Photonics, Compound Semiconductors, Photonic Integration Techniques, Electronic-photonic Integration)

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

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

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

Jason R. Marden, Ph.D., UC Los Angeles, Assistant Professor (Feedback Control and Systems Theory; Game Theoretic Methods for Coordination of Large Scale Distributed Systems; Application to Distributed Traffic Routing, Dynamic Resource Allocation, Queuing Systems, and Sensor Networks)

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

Yasamin Mostofi, Ph.D., Stanford University, 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)

Ramtin Pedarsani, Ph.D., UC Berkeley, Assistant Professor (information and coding theory, machine learning, applied probability, network control, transportation systems, game theory)

Mark J.W. Rodwell, Ph.D., Stanford University, Distinguished Professor (hybrid and switched systems, supervisory control, control of computer networks, probabilistic games, the use of vision in feedback control)

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

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

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

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

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

Andrew Teel, Ph.D., UC Berkeley, Distinguished 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, Professor (low-power analog VLSI, biomimetic nanosystems, neural prostheses, biosensors, block co-polymer synthesis, self-assembly, and microfabrication)

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

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

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

Zheng Zhang, Ph.D., Massachusetts Institute of Technology, Assistant Professor (Photonic, Electronic, and MEMS Design Automation; Modeling and Verification of Robots & Autonomous Driving; High-Dimensional Data Analysis and Machine Learning; Magnetic Resonance Imaging (MRI))

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)

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

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

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/interfacer studies, superconductivity)

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

Petr V. Kokotovic, Ph.D., USSR Academy of Sciences, Professor Emeritus, Director of Center for Control Engineering and Computation, Director of Center for Robust Nonlinear Control of Aeroengines (sensitivity analysis, singular perturbations, large-scale systems, non-linear systems, adaptive control, automotive and jet engine control)
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 I. Long, Ph.D., Cornell University, Professor Emeritus, (semiconductor devices and integrated circuits for high speed digital and RF analog applications)

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

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

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

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

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

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

Venkatesh 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

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

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

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

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

Affiliated Faculty

David Awschalom, Ph.D. (Physics)
Bassam Bamieh, Ph.D. (Mechanical Engineering)
Elizabeth Belding, Ph.D. (Computer Science)
Francesco Bullo, Ph.D. (Mechanical Engineering)
Frederick Chong, Ph.D. (Computer Science)
Chandra Krintz, Ph.D. (Computer Science)
Eric McFarland, Ph.D., (Chemical Engineering)
Shuji Nakamura, Ph.D. (Materials)
Bradley E. Paden, Ph.D. (Mechanical Engineering)
Tim Sherwood, Ph.D. (Computer Science)
Matthew Turk, Ph.D. (Computer Science)
William Wang, Ph.D. (Computer Science)
Haitao (Heather) Zheng, Ph.D. (Computer Science)

Electrical and Computer Engineering is a broad field encompassing many diverse areas such as computers and digital systems, control, communications, computer engineering, electronics, signal processing, electromagnetics, electro-optics, physics and fabrication of electronic and photonic devices. As in most areas of engineering, knowledge of mathematics and the natural sciences is combined with engineering fundamentals and applied to the theory, design, analysis, and implementation of devices and systems for the benefit of society. The Department of Electrical and Computer Engineering offers programs leading to the degrees of bachelor of science in electrical engineering or bachelor of science in computer engineering. (Please see the “Computer Engineering” section for further information.) The undergraduate curriculum in electrical engineering is designed to provide students with a solid background in mathematics, physical sciences, and traditional electrical engineering topics as presented above. A wide range of program options, including computer engineering; microwaves; communications, control, and signal processing; and semiconductor devices and applications, is offered. The department’s Electrical Engineering undergraduate program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. It is one of the degrees recognized in all fifty states as leading to eligibility for registration as a professional engineer.

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

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

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

Mission Statement

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

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

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

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

Educational Objectives

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

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

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

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

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

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

2. 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 at least 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 189 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. The 32 units of departmental electives must include at least 2 sequences, one of which must be an approved EE Senior Capstone Design/Project course sequence. A student’s elective course program must be approved by a departmental faculty advisor. The advisor will check the program to ensure satisfaction of the departmental requirements. A wide variety of elective programs will be considered acceptable.

Three matters should be noted: (1) students who fail to attain a grade-point average of at least 2.0 in the major may be denied the privilege of continuing in the major, (2) a majority of electrical and computer engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite courses means receiving a grade of C- or better in prerequisite courses except for Mathematics 3A-B, Mathematics 4A-B and Mathematics 6A and 6B which require a grade of C or better to apply 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 computer engineering majors only. Seminar: 1 hour

1B. Ten Puzzling Problems in Computer Engineering

(1) PARHAM
Prerequisite: Open to pre-computer engineering and computer engineering majors only.

2A. Circuits, Devices, and Systems

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

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

2B. Circuits, Devices, and Systems

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

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

2C. Circuits, Devices, and Systems

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

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

4. Design Project for Freshmen

(4) STAFF
Prerequisites: Mathematics 3A-B and Mathematics 3C or 4A and Physics 1 with minimum grades of C; Engineering 3 with a minimum grade of C-. Lecture, 3 hours; laboratory, 3 hours.

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

5. Introduction to Electrical & Computer Engineering

(4) STAFF
Prerequisite: Open only to Electrical Engineering and Computer Engineering majors. Lecture: 2 hours; Laboratory: 3 hours

Aims at exposing freshmen students to the different sub-fields within Electrical and Computer Engineering. Composed of lectures by different faculty members and a weekly laboratory based on projects that are executed using the Arduino environment.

10A. Foundations of Analog and Digital Circuits & Systems

(1) STAFF
Prerequisite: Mathematics 3A-B or Mathematics 3AH-3BH, and Mathematics 3C or 4A or 4AI with a minimum grade of C; and, Math 4B or 4BI or 5A with a minimum grade of C (may be taken concurrently); Physics 3 or 23 (may be taken concurrently); open to electrical engineering and computer engineering majors. Lecture: 3 hours

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

The objective of the course is to establish the foundations of analog and digital circuits. The course will introduce the student to the power of abstraction, resistive networks, network analysis, nonlinear analysis and the digital abstraction.

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

(1) STAFF
Prerequisite: ECE 10A (may be taken concurrently) with a C- or better grade. Laboratory: 4 hours
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Not open for credit for those who have received a C- or higher in ECE 2A. The goal of 10A is to provide the student with a hands-on application of the concepts discussed in ECE 10A. The lab will introduce the use of microcontrollers as a data acquisition system.

10B. Foundations of Analog and Digital Circuits and Systems
(3) STAFF
Prerequisite: ECE 10A with a C- or better grade.
Lecture: 3 hours
Not open for credit for those who have received a C- or higher in ECE 2B. The objective of the course is to introduce the MOSFET both as a simple digital switch and as controlled current source for analog design. The course will cover basic digital design, small-signal analysis, charge storage elements and operational amplifiers.

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

10C. Foundations of Analog and Digital Circuits and Systems
(3) STAFF
Prerequisite: ECE 10B with a C- or better grade.
Lecture: 3 hours
Not open for credit for those who have received a C- or higher in ECE 2C.
The objective of the course is to introduce the student to the basics of transient analysis. The course will energy and power dissipation in digital circuits, first-order and second-order linear time invariant circuits, sinuosidial steady state, impedance representation, feedback and resonance.

10CL. Foundations of Analog and Digital Circuits and Systems Lab
(2) STAFF
Prerequisite: ECE 10C (may be taken concurrently) with a C- grade or better.
Laboratory: 4 hours
Not open for credit for those who have received a C- or higher in ECE 2C.
The goal of 10CL is to provide the student with a hands-on application of the concepts discussed in ECE 10C. The lab will utilize the microcontroller to introduce students to the understanding of datasheets for both digital and analog circuits, single-stage amplifier design and basic instrumentation.

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

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

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

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

UPPER DIVISION

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

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

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

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

122A. VLSI Principles
(4) BANERJEE
Prerequisite: ECE 152A with a minimum grade of C-.
Lecture: 3 hours; Laboratory: 3 hours
Not open for credit for those who have taken ECE 124A or ECE 123.

Introduction to CMOS digital VLSI design: CMOS-device and manufacturing technology; transistor level design of static and dynamic logic gates and components and interconnections; circuit characterization: delay, noise margins, and power dissipation; combinational and sequential circuits; arithmetic operations and memories.

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

123. High-Performance Digital Circuit Design
(4) THIRAKUMARAN
Prerequisite: ECE 10A-B-C and ECE 10AL-BL-CL or ECE 2A-B-C with a minimum grade of C- in each of those courses; open to both electrical engineering and computer engineering majors only.
Not open for credit for those who have taken ECE 124A or ECE 122A.
Introduction to high-performance digital circuit design techniques. Basics of device physics including deep submicron effects; device sizing and logical effort; Circuit design styles; clocking & timing issues; memory & datapath design; Low-power design; VLSI design flows and associated EDA tools.

125. High Speed Digital Integrated Circuit Design
(4) BANERJEE
Prerequisite: ECE 124A or ECE 124A or ECE 122A or ECE 122C or ECE 124A or ECE 122A or ECE 122B.
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) STAFF
Prerequisite: Mathematics 4B or 5A with a minimum grade of C and ECE 2B or ECE 10B & ECE 10BL with a minimum grade of C- in each course; open to EE and computer engineering majors only.
Lecture: 3 hours; Discussion: 2 hours

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

132. Introduction to Solid-State Electronic Devices
(4) MISRA
Prerequisite: Physics 4 or 24 with a minimum grade of C-; Mathematics 4B or 5A with a minimum grade of C; and, ECE 10A-B and ECE 10AL-BL or ECE 2A-B (may be taken concurrently) with a minimum grade of C- in each; open to EE and computer engineering majors only.
Lecture: 3 hours; Discussion: 2 hours
Electrons and holes in semiconductors; doping (P and N); state occupation statistics, transport properties of electrons and holes; P-N junction
134. Introduction to Fields and Waves
(4) DAGLI, YORK
Prerequisite: Physics 3 or 23 with a minimum grade of C-. Mathematics 4B or 4BI or 5A and Mathematics 5B or 6A or 5AI with a minimum grade of C in each, and Mathematics 5C or 6B with a minimum grade of C-; open to EE and computer engineering majors only. Lecture: 3 hours; Discussion: 2 hours.
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 or a minimum grade of C- in both. 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. Microwave and optical device examples and experience with modern microwave and CAD software.

145A. Communication Electronics
(5) RODWELL
Prerequisite: ECE 145A with a minimum grade of C-. Lecture, 3 hours; laboratory, 6 hours.
RF models for CMOS and BJT. Discrete vs. IC implementation. On-chip passive components. LNAs, PAs, mixers, filters, VCOs. Polyphase filters Radio link budget. Analog and digital modulation schemes. Introduction to receiver architectures, I&Q modulation. Image-reject architectures.

145B. Communication Electronics II
(5) STAFF
Prerequisite: ECE 145A with a minimum grade of C-. Lecture, 3 hours; laboratory, 6 hours.
Feedback, observers. Design of digital control systems—controllability and observability, pole assignment, state space description of linear systems; analysis of sampled data feedback systems; state space description of linear systems; observability, controlability, pole assignment, state feedback, observers. Design of digital control systems.

147C. Control System Design Project
(5) HESPANIA
Prerequisite: ECE 147A or ME 158B 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 project. The project is implemented in hardware or in high-fidelity numerical simulators. Lectures and laboratories cover special topics related to the practical implementation of control systems.

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

150. Mobile Embedded Systems
(4) CHENG
Prerequisite: Proficiency in JAVA programming. Architectures of modern smartphones and their key hardware components including mobile application processors, communications chips, display, touchscreen, graphics, camera, battery, GPS and various sensors. Android and software development platform of smartphones and smartphone applications; low power design techniques.

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

152A. Digital Design Principles
(5) STAFF
Prerequisite: ECE 15A and 2A or ECE 10A & ECE 10AL with a minimum grade of C- in each course; or Computer Science 30 or 64 with a minimum grade of C- in each course; open to electrical engineering, computer engineering, and computer science majors only. Lecture: 3 hours; Laboratory: 6 hours.
Design of synchronous digital systems: timing diagrams, propagation delay, latches and flip-flops, shift registers and counters, Mealy and Moore finite state machines, Verilog, 2-phase clocking, timing analysis, CMOS implementation, S- RAM, RAM-based designs, ASM charts, state minimization.

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

Same course as Computer Science 153A. Issues in interfacing computer systems and software to practical I/O interfaces. Rapid response, real-time events and management of tasks, threads, and scheduling required for efficient design of embedded software and systems is discussed. Techniques for highly constrained systems.

153B. Sensor and Peripheral Interface Design (4) STAFF
Prerequisite: ECE 152A with a minimum grade of C-.
Lecture: 3 hours; Laboratory: 3 hours

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

154A. Introduction to Computer Architecture (4) FARKASH
Prerequisite: ECE 152A with a minimum grade of C-; open to EE and CMPSC majors only.
Lecture: 3 hours; Discussion: 1 hour

Not open for credit to students who have completed Computer 154. ECE 154A is the formerly numbered ECE 154. Students who have taken ECE 154 and have received a grade of C- or lower may take ECE 154A for a better grade.

Students who have taken ECE 154 and have received a grade of C- or lower may take ECE 154A for a better grade.

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

154B. Advanced Computer Architecture (4) STROIK
Prerequisite: ECE 154A with a C- grade or better.

Open to EE and CMPENS majors only.
Lecture: 3 hours; Laboratory: 4 hours

Not open for credit to those who have taken Computer Science 154. ISA variations; Pipeline data and control hazards; Fast ALU design; Instruction-level parallelism, multithreading, VLIW; Vector and array processing, multi/micro-kernel virtual memory; Disk arrays; Shared- and distributed-memory systems, supercomputers; Reconfigurable and application-specific circuits.

155A. Introduction to Computer Networks (4) MOSER
Prerequisite: Upper-division standing in Electrical Engineering, Computer Engineering and Computer Science; and CMPSC 24 with a minimum grade of C-.
Lecture: 3 hours; Discussion: 1 hour

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

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

155B. Network Computing (4) MOSER
Prerequisite: ECE 155A or CMPSC 176A with a minimum grade of C-; and CMPSC 32 with a minimum grade of C-; and experience in Java programming or consent of instructor.
Lecture: 3 hours; Discussion: 1 hour

Not open for credit to students who have completed Computer Science 176B or ECE 194W.

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

156A. Digital Design with VHDL and Synthesis (4) WANG
Prerequisite: ECE 152A with a minimum grade of C-.
Lecture: 3 hours; laboratory: 3 hours

Introduction to VHDL basics. VHDL simulation concepts. VHDL concurrent statements with examples and applications. VHDL subprograms, packages, libraries and design units. Writing VHDL for synthesis. Writing VHDL for finite state machines. Design case study.

156B. Computer-Aided Design of VLSI Circuits (4) WANG
Prerequisite: ECE 156A with a minimum grade of C-.
Lecture: 3 hours; laboratory: 3 hours

Introduction to computer-aided simulation and synthesis tools for VLSI. VLSI system design flow, role of CAD tools, layout synthesis, circuit simulation, logic simulation, logic synthesis, behavior synthesis and test synthesis.

158. Digital Signal Processing (4) GIbson
Prerequisites: ECE 130A-B with a minimum grade of C- in both; open to EE majors only.
Lecture: 3 hours; laboratory: 3 hours

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

160. Multimedia Systems (4) MILLAR-SMITH
Prerequisite: Upper-division standing; open to electrical engineering, computer engineering, computer science, and creative studies majors only.
Lecture: 3 hours; Laboratory: 3 hours

Not open for credit to students who have completed CMPSC 182.

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 (4) STAFF
Prerequisite: ECE 130A-B and 134 with a minimum grade of C- in all; open to EE and materials majors.

Same course as Materials 162A. Lecture, 4 hours


162B. Fundamentals of the Solid State (4) COLDRICK
Prerequisite: ECE 162A with a minimum grade of C-; open to EE and materials majors.

Same course as Materials 162B. Lecture, 3 hours; discussion, 1 hour


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


178. Introduction to Digital Image and Video Processing (4) MAMIDU
Prerequisites: open to EE, computer engineering, and computer science majors with upper-division standing.
Lecture, 3 hours; discussion, 1 hour

Basic concepts in image and video processing. Topics include image formation and sampling, image transforms, image enhancement, and image and video compression including JPEG and MPEG coding standards.

179D. Introduction to Robotics: Dynamics and Control (4) BYE
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. Labatories encourage a problem-solving approach to control.

179P. Introduction to Robotics: Planning and Kinematics (4) BULLO
Prerequisites: ENGR 3; and either ME 17 or ECE 130C (may be taken concurrently). Not open for credit to 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.

181. Introduction to Computer Vision (4) MANJU
Prerequisite: Upper-division standing in Electrical Engineering, Computer Engineering, Computer Science, Chemical Engineering or Mechanical Engineering.
Lecture: 3 hours; Discussion: 1 hour

Same course as Computer Science 181B.
Repeat Comments: Not open for credit to students who have completed ECE/CMPSC 181B with a grade of C- or better. ECE/CMPSC 181 is a legal repeat of ECE/CMPSC 181B.

Overview of computer vision problems and techniques for analyzing the content of images and video. Topics include image formation, edge detection, image segmentation, pattern recognition, texture analysis, optical flow, stereo vision, shape representation and recovery techniques, issues in object recognition, and case studies of practical vision systems.

183. Nonlinear Phenomena (4) STAFF
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.

189A. Senior Electrical Engineering Project 
(3) STAFF
Prerequisite: Consent of instructor. Lecture: 3 hours; Laboratory: 3 hours
Student groups design a significant project based on the knowledge and skills acquired in earlier coursework and integrate their technical knowledge through a practical design experience. The project is evaluated through written reports, oral presentations, and demonstrations of performance.

189B. Senior Electrical Engineering Project 
(3) STAFF
Prerequisite: ECE 188A with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hours
Student groups design a significant project based on the knowledge and skills acquired in earlier coursework and integrate their technical knowledge through a practical design experience. The project is evaluated through written reports, oral presentations, and demonstrations of performance.

189C. Senior Electrical Engineering Project 
(3) STAFF
Prerequisite: ECE 188B with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hour
Student groups design a significant project based on the knowledge and skills acquired in earlier coursework and integrate their technical knowledge through a practical design experience. The project is evaluated through written reports, oral presentations, and demonstrations of performance.

189A. Senior Computer Systems Project 
(4) STAFF
Prerequisite: ECE 153B; senior standing in Computer Engineering, Computer Science or EE. Lecture: 3 hours; Laboratory: 3 hours
Student groups design a significant project based on the knowledge and skills acquired in completed Computer Science 189A-B. Student groups design a significant computer-based project. Groups work independently with interaction among groups via interface specifications and informal meetings.

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

193. Internship in Industry
(1-6) STAFF
Prerequisite: consent of department.
Must have a 3.0 grade-point-average. May not be used as departmental electives. May be repeated to a maximum of 12 units. Field, 1-8 hours.
Special projects for selected students. Offered in conjunction with engineering practice in selected industrial and research firms, under direct faculty supervision.

194A-22. Special Topics in Electrical and Computer Engineering
(1-6) STAFF
Prerequisite: consent of instructor. Variable hours.

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

199. Independent Studies in Electrical and Computer Engineering
(1-6) STAFF
Prerequisites: upper division standing; completion of two upper-division courses in electrical and computer engineering; consent of instructor.
Must have a minimum 3.0 grade-point average for the preceding three quarters. Students are limited to five units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined. Directed individual study, normally experimental.

Graduate courses for this major can be found in the UCSB General Catalog.
UPPER DIVISION
101. Ethics in Engineering
(3) STAFF
Prerequisite: senior standing in engineering.

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

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

177. Art and Science of Aerospace Culture
(4) STAFF
Prerequisites: upper-division standing; consent of instructor.
   The nature of moral value, normative judgment, and crystallization. (W,S,M)

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

Materials
Department of Materials Engineering II, Room 1355;
Telephone (805) 893-4601
Web site: www.materials.ucsb.edu

Chair: Michael L. Chabinyc
Vice Chair: Stephen Wilson

Faculty
Christopher M. Bates, PhD, University of Austin Texas, Assistant Professor (polymer mesostructure and dynamics, energy storage, and crystallization)
Guillermo C. Bazan, Ph.D., Massachusetts Institute of Technology, Distinguished Professor (polymer synthesis, photophysics) *5
Matthew R. Begley, Ph.D., University of California, Santa Barbara, Professor (mechanics of materials with applications to multilayered devices such as microfluidics, MEMS and protective coatings)
Irene J. Beyerein, Ph.D., Cornell University, Professor (computational materials science, microstructure-property relationships, deformation mechanisms, composites)
John Bowers, Ph.D., Stanford, Distinguished Professor (energy efficiency, optical devices and networks, silicon photonics) *1
Michael Chabinyc, Ph.D., Stanford University, Associate Professor (organic semiconductors, thin film electronics, energy conversion using photovoltaics, characterization of thin films of polymers, x-ray scattering from polymers)
Raphaële J. Clément, PhD, University of Cambridge, Assistant Professor (energy storage and conversion using batteries and photoelectrochemical cells, characterization of inorganic (photo)electrochemical materials using magnetic resonance techniques and first principles calculations).
Steven P. DenBaars, Ph.D., University of Southern California, Distinguished Professor (metalorganic chemical vapor deposition (MOCVD) of semi-conductors, IR to blue lasers and LEDs, high power electronic materials and devices) *1
Daniel S. Gianaola, Ph.D., Johns Hopkins University, Associate Professor (nanomechanical behavior and deformation mechanisms in ultra-strong materials, mechanics of disordered materials, elastic strain engineering of transport phenomena, tunable and efficient solid state energy conversion, interface engineering of nanocrystalline materials for mechanical stability and damage tolerance, quantitative in situ electron, x-ray, and light microscopy)
John W. Harter, PhD, Cornell University, Assistant Professor (quantum materials, unconventional superconductors, strongly-correlated electrons, nonlinear optical spectroscopy, angle-resolved photoemission spectroscopy)
Craig Hawker, Ph.D., University of Cambridge, Distinguished Professor, Director of Materials Research Laboratory (synthetic polymer chemistry, nanotechnology, materials science) *5
Carlos G. Levi, Ph.D., University of Illinois at Urbana-Champaign, Professor (materials processing, and microstructure evolution, coatings, composites, functional inorganics) *2
Robert M. McMeeking, Ph.D., Brown University, Distinguished Professor (mechanics of materials, fracture mechanics, plasticity, computational mechanics, process modeling) *2
Kunal Mukherjee, PhD, Massachusetts Institute of Technology, Assistant Professor (growth and electronic properties of compound semiconductors for optoelectronic, imaging, and energy conversion devices)
Shuji Nakamura, Ph.D., University of Tokushima, Cree Professor of Solid State Lighting and Displays (gallium nitride, blue lasers, white LEDs, solid state illumination, bulk GaN substrates)
Chris Palmstrom, Ph.D., University of Leeds. Distinguished Professor (atomic level control of interfacial phenomena, in-situ STM, surface and thin film analysis, metallization of semiconductors, dissimilar materials epitaxial growth, molecular beam and chemical beam epitaxial growth of metallic compounds) *1
Philip A. Pincus, Ph.D., UC Berkeley, Distinguished Professor (theoretical aspects of self-assembled biomolecular structures, membranes, polymers, and colloids) *4
Tresa M. Pollock, Ph.D., Massachusetts Institute of Technology, Distinguished Professor (mechanical and environmental performance of materials in extreme environments, unique high temperature materials processing paths, ultrafast laser-material interactions, alloy design and 3-D materials characterization)
Cyrus R. Safinya, Ph.D., Massachusetts Institute of Technology, Distinguished Professor (biophysics, supramolecular assemblies of biological molecules, non-viral gene delivery systems)
Omar A. Saleh, Ph.D., Princeton University, Assistant Professor (single-molecule biophysics, motor proteins, DNA-protein interactions)
Rachel A. Segalman, Ph.D., University of California, Santa Barbara, Professor (synthesis of macromolecules, self-assembly, electronic properties of molecular and macromolecular materials, transport processes in polymers)
Ram Seshadri, Ph.D., Indian Institute of Science, Professor (inorganic materials, preparation and magnetism of bulk solids and nanoparticles, patterned materials)
James S. Speck, Sc.D., Massachusetts Institute of Technology, Distinguished Professor (nitride semiconductors, III-V semiconductors, ferroelectric and high-K films, microstructural evolution, extended defects, transmission electron microscopy, x-ray diffraction)
Susanne Steimer, Ph.D., University of Stuttgart, Professor (functional oxide thin films, structure-property relationships, scanning transmission electron microscopy and spectroscopy)
Galen Stucky, Ph.D., Iowa State University, Distinguished Professor (biomaterials, composites, materials synthesis, electro-optical materials catalysis) *5
Chris Van de Walle, Ph.D., Stanford University, Distinguished Professor (novel electronic mater-ials, wide-band-gap semiconductors, oxides)
Anton Van der Ven, Ph.D., Massachusetts Institute of Technology, Associate Professor (First principles prediction of thermodynamic, kinetic and and mechanical properties of alloys, ceramics and compound semiconductors, statistical mechanical methods development, electrochemical energy storage materials, high temperature structural materials corrosion)

Claude Weisbuch, Ph.D., Université Paris VII, Ecole Polytechnique-Palaiseau, Distinguished 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)

Stephen Wilson, Ph.D., University of Tennessee, Assistant Professor (Magnetism in complex oxides, phase behaviors in correlated electron systems and quantum materials, spin-orbit coupled materials, quantum criticality, neutron and x-ray scattering, bulk single crystal growth)

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) *1

David R. Clarke, Ph.D., University of Cambridge, Professor Emeritus (electrical ceramics, thermal barrier coatings, piezoelectro-optics, mechanics of microelectronics) *2

Larry A. Coldren, Ph.D., Stanford University, Kavli Professor in Optoelectronics and Sensors, Director of Optoelectronics Technology Center (semiconductor integrated optics, optoelectronics, molecular beam epitaxy, microfabrication) *1

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

Alan J. Heeger, Ph.D., UC Berkeley, Distinguished Professor, Director of Institute for Polymers and Organic Solids, 2000 Chemistry Nobel Laureate (condensed-matter physics, conducting polymers) *4

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

Jacob N. Israelachvili, Ph.D., University of Cambridge, Distinguished Professor (adhesion, friction surface forces, colloids, biosurface interactions) *3

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

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

G. Robert Odette, Ph.D., Massachusetts Institute of Technology, Professor (fundamental deformation and fracture, materials in extreme environments, structural reliability, and high-performance composites) *2

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

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

Affiliated Faculty

David Auston, Ph.D. (Electrical and Computer Engineering)
Glen 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 alloys, ceramics and polymers; high performance composites; thermal barrier coatings and engineered surfaces; organic, inorganic and hybrid semiconductor and photonic material systems; catalysts and porous materials, magnetic, ferroelectric and multiferroic materials; biomaterials and biosurfaces, including biomedically relevant systems; colloids, gels and other complex fluids; lasers, LEDs and optoelectronic devices; packaging systems; microscale engineered systems, including MEMS. The groups are typically multidisciplinary involving faculty, postdoctoral researchers and graduate students working on the synthesis and processing, structural characterization, property evaluation, microstructure-property relationships and mathematical models relating micromechanisms to macroscopic behavior.

Materials Courses

LOWER DIVISION

10. Materials in Society, the Stuff of Dreams
(4) STEMMER
Prerequisites: Not open to engineering, pre- computer science, or computer science majors.
A survey of new technological substances and materials, the scientific methods used in their development, and their relation to society and the economy. Emphasis on uses of new materials in the human body, electronics, optics, sports, transportation, and infrastructure.

UPPER DIVISION

100A. Structure and Properties I
(3) STAFF
Prerequisites: Chemistry 1A-B; Physics 4; and, Mathematics 4B, 6A-B. Lecture, 3 hours.

100B. Structure and Properties II
(3) STAFF
Prerequisite: Materials 100A.
Students who take Matrl 101 & 100B will only receive major credit for one of these courses. Lecture, 3 hours.

100C. Fundamentals of Structural Evolution
(3) STAFF
Prerequisites: Materials 100A and Materials 100B.

101. Introduction to the Structure and Properties of Materials
(3) STAFF
Prerequisite: upper-division standing.
Students who take MATRL 101 & 100B will only receive major credit for one of these courses. Students interested in following the BS Engineering/ MS Materials program should not take this course. Introduction to the structure of engineering materials and its relationship with their mechanical properties. Structure of solids and defects. Concepts of microstructure and phase behavior; time dependent flow and fracture properties. Mechanisms of deformation and failure. Stiffening, strengthening, and toughening mechanisms.

135. Biophysics and Biomolecular Materials
(4) SAFIYA
Prerequisites: Physics 5 or 6C or 25.
Same course as Physics 135.
Biomolecular materials and biomedical applications (e.g., bio-sensors, drug delivery systems, gene carrier systems).

160. Introduction to Polymer Science (3) STAFF
Prerequisite: Chemistry 109A-B.
Same course as Chemical Engineering 160. Introductory course covering synthesis, characterization, structure, and mechanical properties of polymers. The course is taught from a materials perspective and includes polymer thermodynamics, chain architecture, measurement and control of molecular weight as well as crystallization and glass transitions.

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

162B. Fundamentals of the Solid State (4) STAFF
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) STAFF
Prerequisite: Materials 100B or 101.
Same course as ME 185. Lecture, 3 hours. Introduces the student to the main families of materials and the principles behind their development, selection, and behavior. Discusses the generic properties of metals, ceramics, polymers, and composites more relevant to structural applications. The relationship of properties to structure and processing is emphasized in every case.

186. Manufacturing and Materials (3) 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) VANDENWALLE
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

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

Faculty
Bassam Bamieh, Ph.D., Rice University, Professor (control systems design with applications to fluid flow problems)
Matthew R. Begley, Ph.D., University of California, Santa Barbara, Professor (mechanics of materials with applications to multilayered devices such as microfluidics, MEMS and protective coatings)
Glenn E. Beltz, Ph.D., Harvard, Professor (solid mechanics, materials, aeronautics, engineering education)
Ted D. Bennett, Ph.D., UC Berkeley, Associate Professor (thermal science, laser processing)
Irena J. Beyerlein, Ph.D., Cornell University, Professor (structural mechanics of multi-phase micro- and nanostructured materials, design of metallic alloys) Joint Appointment: MATRRL
David Bothman, B.S., UC San Diego, Lecturer
Francesco Bullo, Ph.D., California Institute of Technology, Professor (motion planning and coordination, control systems, distributed and adaptive algorithms)
Otger Campas, Ph.D., Curie Institute (Paris) and University of Barcelona, Assistant Professor (physical biology, systems biology, quantitative biology, morphogenesis and self-organization of living matter)
Samantha H. Daly, Ph.D, California Institute of Technology, Associate Professor (mechanics of materials, development of small-scale experimental methods, effects of microstructure on the meso and macroscopic properties of materials, active materials, composites, fatigue, plasticity, fracture)
Emielie Dressaire, Ph.D., Harvard University, Assistant Professor
Kimberly L. Foster, Ph.D., Cornell University, Professor (microelectromechanical systems, dynamics, solid mechanics, measurement and characterization of microsystems motion and device parameters)
Frederic Gibou, Ph.D., University of California, Los Angeles, Professor (computational science and engineering) 2
Elliot W. Hawkes, Assistant Professor
Stephen Lagquette, M.S., University of California, Los Angeles, Lecturer (biomedical engineering design)
Carlos Levi, Ph.D., University of Illinois at Urbana-Champaign, Professor (conceptual design, synthesis and evolution in service of structural and inorganic materials, especially for high temperature applications) 3
Paolo Luzzato-Fegiz, PhD, Cornell University, Assistant Professor (fluid mechanics, wind energy and instrument development)
Eric F. Matths, Ph.D., California Institute of Technology, Professor (heat transfer, fluid mechanics, rheology)
Robert M. McMeeking, Ph.D., Brown University, Distinguished Professor (mechanics of materials, fracture mechanics, plasticity, computational mechanics) 3
Eckart Meiburg, Ph.D., University of Karlsruhe, Distinguished Professor (computational fluid dynamics, fluid mechanics)
Carl D. Meinhart, Ph.D., University of Illinois at Urbana-Champaign, Professor (wall turbulence, microfluidics, flows in complex geometries)
Igor Mezic, Ph.D., California Institute of Technology, Professor (applied mechanics, non-linear dynamics, fluid mechanics, applied mathematics)
Jeffrey M. Moehlis, Ph.D., University of California, Berkeley, Professor (nonlinear dynamics, fluid mechanics, biological dynamics, applied mathematics)
Sumita Pennathur, Ph.D., Stanford University, Associate Professor (application of microfabrication techniques and micro/nanoscale flow phenomena)
Linda R. Petzold, Ph.D., University of Illinois at Urbana-Champaign, Distinguished Professor, Director of Computational Science and Engineering Graduate Emphasis (computational science and engineering; systems biology) 2
Beth Pruitt, Ph.D., Stanford University, Professor
Alban Sauret, Ph.D., IRPHE, Aix-Marseille University, Assistant Professor
Tyler G. Susko, Lecturer Potential SOE
Megan Valentine, Ph.D., Harvard University, Assistant Professor (single-molecule biophysics, cell mechanics, motor proteins, biomaterials)
Henry T. Yang, Ph.D., Cornell University, Distinguished 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, piezospectroscopy, mechanics of microelectronics) 3
Roy S. Hickman, Ph.D., UC Berkeley, Professor Emeritus (fluid mechanics, physical gas dynamics, computer-aided design)
George Homys, Ph.D., University of Illinois, Professor Emeritus (hydrodynamic stability, thermal convection, thin film hydrodynamics, flow in microgeometries and in porous media, polymer fluid mechanics)
Keith T. Kedward, Ph.D., University of Wales, Professor (design of composite systems)
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 nanoscience and engineering and microelectro-mechanical systems; dynamics and controls and related areas of sensors, actuators and instrumentation; advanced composite materials and smart structures; computation, simulation and information science; advanced energy and transportation systems; and environmental monitoring, modeling and remediation.

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

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

Undergraduate Program
Bachelor of Science—Mechanical Engineering
A minimum of 190 units is required for graduation. A complete list of requirements for the major can be found on page 54. Schedules should be planned to meet both general education and major requirements.

Students who are not Mechanical Engineering majors may not 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

Affiliated Faculty
Paul J. Atzberger (Mathematics)
Katie A. Byl (Electrical and Computer Engineering)
Hector D. Ceniceros, PhD (Mathematics)
Tommy D. Dickey, PhD (Geography)
Joao P. Hespanha, PhD (Electrical and Computer Engineering)
Patricia Holden (Bren School of Environmental Science and Management)
Arturo Keller (Bren School of Environmental Science and Management)
L. Gary Leal (Chemical Engineering)
Kevin W. Plaxco, PhD (Chemistry and Biochemistry, Biomolecular Science and Engineering Program)
Yon Visell, PhD (Electrical and Computer Engineering and Materials)
Lib Washburn, PhD (Geography)
pursuing undergraduate research projects should contact individual faculty members in the department.

**Mechanical Engineering Courses**

**LOWER DIVISION**

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

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

11. Introductory Concepts in Mechanical Engineering
    (1) ZEIGLER
    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.

125. Introduction to Machine Shop
    (1) GREEN
    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) DAILY, BEGLEY, MCEMEKING
    Prerequisite: Math 3B, or AP Calculus AB with a score of 5, or AP Calculus BC with a score of 3 or better, and Physics 1.
    Introduction to applied mechanics. Forces, moments, couples, and resultants; vector algebra; construction of free body diagrams; equilibrium in 2- and 3-dimensional systems; free body diagrams of machines, trusses and beams; distributed forces; friction.

15. Strength of Materials
    (4) BELTZ
    Prerequisites: ME 14 with a minimum grade of C-; open to mechanical engineering majors only.
    Properties of structural materials, including Hooke’s law and behavior beyond the elastic limit. Concepts of stress, strain, displacement, force, force systems, and multiaxial stress states. Design applications to engineering structures, including problems of bars in tension, compression, and torsion, beams subject to flexure, pressure vessels, and buckling.

    (4) CAMPAIS, FOSTER
    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.

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

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

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

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

102. Finite Elements Analysis of Heat Transfer and Fluid Flow with COMSOL
    (3) MATHYS
    Prerequisite: ME 151C and ME 152B; or consent by instructor
    Study of modeling and analysis of Heat Transfer and Fluid Flow problems using Finite Elements and COMSOL. Students learn to develop sound numerical models of engineering devises using COMSOL Multiphysics Finite Elements software. Addresses geometry construction, meshing, results generation, and physical analysis.

104. Mechatronics
    (3) BAMIEN
    Prerequisites: ME 6; open to ME majors only.
    Introduction 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) VALENTINE
    Prerequisite: ME 151B, 152B, 163; and, Materials 101 or 100B.
    Introduction to fundamental engineering laboratory measurement techniques and report writing skills. Experiments from thermosciences, fluid mechanics, mechanics, materials science and environmental engineering. Introduction to modern data acquisition and analysis techniques. (S)

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
    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.

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

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

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

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

134. Advanced Thermal Science
    (3) MATHYS
    Prerequisite: ME 151C.
    This class will address advanced topics in fluid mechanics, heat transfer, and thermodynamics. Topics of interest may include combustion, phase change, experimental techniques, materials processing, manufacturing, engines, HVAC, non-Newtonian fluids, etc.

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

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

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

141B. MEMS: Processing and Device Characterization
(4) PENNATHUR
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 accelerometers, comb drives, microreactors and capacitive sensors. (W)

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

147. Mechatronics Using Labview
(3) HARE
Prerequisite: Engineering 3; and Mechanical Engineering 6
Not open for additional credit to students who have completed ME 150CH.
Introduction to mechatronics, electromechanical systems, data acquisition, software programming and Labview. Students learn programming fundamentals, hardware interfacing and controls with simulated hardware and actual motor controllers. Students compete to control a motor system through a variety of control projects. Final projects automate working hardware in research labs.

151A. Thermosciences 1
(4) BENNETT, MEINHART
Prerequisites: Physics 2; ME 14 with a minimum grade of C-; and, Mathematics 6B.
Basic concepts in thermodynamics, system analysis, energy, thermodynamic laws, and cycles. (F)

151B. Thermosciences 2
(4) BENNETT, LAO
Prerequisite: 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.
Conective heat transfer, external and internal flow, forced and free convection, phase change, heat exchangers. Introduction to radiative heat transfer.

152A. Fluid Mechanics
(4) CAMPAS, MENHART
Prerequisites: Mathematics 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) LUZZATTO
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) HAWKES
Prerequisites: ME 10 and 16; open to ME majors only.
Course materials fee required.
Design of systems using mechanics, stress analysis and finite elements. Statistical problems in manufacturing and reliability. Ethics. One paper design project plus the ASME student design project.

154. Design and Analysis of Structures
(3) MCMEEKING
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) BAREIH, BULLO
Prerequisites: ME 17 with a minimum grade of C-; ME 140A; and ME 163.
The discipline of control and its application. Dynamics and feedback. The mathematical models: transfer functions and state space descriptions. Simple control design (PID). Assessment of a control problem, specification, fundamental limitations, codesign of system and control.

155B. Control System Design
(3) BAREIH
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.

155C. Control System Design
(3) BAREIH
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.

156A. Mechanical Engineering Design - I
(3) SUSKO
Prerequisite: ME 14, with a minimum grade of C-; and ME 15, with a minimum grade of C-; and MATH 101 (or MATH 105B) or consent of instructor. Open to ME majors only.
The rational selection of engineering materials, and the utilization of Ashby-charts, stress, strain, strength, and fatigue failure consideration as applied to the design of machine elements. Lectures also support the development of system design concepts using assigned projects and involves the preparation of engineering reports and drawings.

156B. Mechanical Engineering Design II
(3) SUSKO
Prerequisites: ME 156A; open to ME majors only.

157. Introduction to Multiphysics Simulation
(3) MEINHART
Prerequisite: Mechanical Engineering 151A-B; and Mechanical Engineering 152A-B; and Mechanical Engineering 140A
May not be taken for additional credit by students who have completed ME 125CM. May not be taken by students who have completed ME 225CM or ME 257B.
Introduces students to the concepts of multiphysics simulation. Students are introduced to PDE’s, associated analytical solutions, and the finite elements method. Multiphysics problems are solved in multiple domains, and with fluid/structure interactions. Each student conducts a project where multiphysics tools are used to explore details of multiphysical processes.

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

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

(3) MEIZIC
Prerequisites: ME 16 with a minimum grade of C-; open to ME majors only.
Not open for credit to students who have completed ME 163B.
Topics relating to vibration in mechanical systems; exact and approximate methods of analysis, matrix methods, generalized coordinates and Lagrange’s equations, applications to systems. Basic feedback systems and controlled dynamic behavior.

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

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

169. Nonlinear Phenomena
(4) MOEHLS
Prerequisites: Physics 105A or ME 163; or upper-division standing in ECE.
Same course as ECE 183 and Physics 106. Not open for credit to students who have completed ME 163C.
An introduction to nonlinear phenomena. Flows and bifurcation in one and two dimensions, chaos, fractals, strange attractors. Applications to physics, engineering, chemistry, and biology.
179D. Introduction to Robotics: Dynamics and Control
(4) BYL
Prerequisites: ECE 130A or ME 155A (may be taken concurrently).
Dynamic modeling and control methods for robotic systems. LaGrangian method for deriving
equations of motion, introduction to the Jacobian, and modeling and control of forces and contact
dynamics at a robotic end effector. Laboratories encourage a problem-solving approach to control.

179L. Introduction to Robotics: Design Laboratory
(4) STAFF
Prerequisites: ENGR 3; and ME 6 or ECE 2A. Not open for credit to students who have completed
Mechanical Engineering 170C or ECE 181C.
Course materials fee required.
Design, programming, and testing of mobile robots. Design problems re formulated in
terms of robot performance. Students solve electromechanical problems, developing skills in
brainstorming, concept selection, spatial reasoning, teamwork and communication. Robots are controlled
with micro-controllers using C programming interfaced to sensors and motors.

179P. Introduction to Robotics: Planning and Kinematics
(4) BULLO
Prerequisites: Engr 3; and either ME 17 or ECE 130C (may be taken concurrently). Not open for credit to students who have completed ME 170A or
ECE 181A.
Same course as ECE 179P
Motion planning and kinematics topics with an emphasis on geometric reasoning, programming and
matrix computations. Motion planning: configuration spaces, sensor-based planning, decomposition
and sampling methods, and advanced planning algorithms. Kinematics: reference frames, rotations
and displacements, kinematic motion models.

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

186A. Manufacturing and Materials
(3) LEVI
Prerequisites: ME 15 and 151C; and, Materials 100B or 101.
Same course as Materials 186A.
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.

186B. Introduction to Additive Manufacturing
(3) BELEY
Prerequisites: ECE 130A or ME 155A (may be taken concurrently).
Dynamic modeling and control methods for robotic systems. LaGrangian method for deriving
equations of motion, introduction to the Jacobian, and modeling and control of forces and contact
dynamics at a robotic end effector. Laboratories encourage a problem-solving approach to control.

189A. Capstone Mechanical Engineering Design Project
(3) SUSKO
Prerequisite: ME 105, ME 151C, ME 152B, ME 153, and ME 163; or consent of instructor. Open to ME majors only.
Course materials fee required.
Design for majors. Concurrently offered with ME 156A. Quarters usually offered: Fall. A 3-quarter
sequence with grades issued for each quarter. Students may not concurrently enroll in ME 197 and
ME 189A-B-C with the same design project.
Course can only be repeated as a full sequence
(189A-B-C).
Students work in teams under the direction of a faculty advisor (and possibly an industrial
sponsor) to tackle an engineering design project. Engineering communication, such as reports and
oral presentations, are covered. Emphasis on practical, hands-on experience, and the integration of analytical and design skills acquired in the
companion ME 156 courses.

189B. Capstone Mechanical Engineering Design Project
(3) SUSKO
Prerequisite: ME 189A
Course materials fee required.
Design for majors. Concurrently offered with ME 156B. Quarters usually offered: Winter. A 3-quarter
sequence with grades issued for each quarter. Students may not concurrently enroll in ME 197 and
ME 189A-B-C with the same design project.
Course can only be repeated as a full sequence
(189A-B-C).
Students work in teams under the direction of a faculty advisor (and possibly an industrial
sponsor) to tackle an engineering design project. Engineering communication, such as reports and
oral presentations, are covered. Emphasis on practical, hands-on experience, and the integration of analytical and design skills acquired in the
companion ME 156 courses.

189C. Capstone Mechanical Engineering Design Project
(3) SUSKO
Prerequisite: ME 189A-B
Course materials fee required.
Design for majors. Quarters usually offered: Spring. A 3-quarter sequence with grades issued for each
quarter. Students may not concurrently enroll in ME 197 and ME 189A-B-C with the same design project. Course can only be repeated as a full
sequence (189A-B-C).
Students work in teams under the direction of a faculty advisor (and possibly an industrial
sponsor) to tackle an engineering design project. Engineering communication, such as reports and
oral presentations, are covered. Course emphasizes practical, hands-on experience, and integrates
analytical and design skills acquired in the companion ME 156 courses.

193. Internship in Industry
(1-4) STAFF
Prerequisite: consent of instructor and prior departmental approval needed.
May be repeated to a maximum of 2 units.
Students work under the supervision of a faculty advisor to gain practical experience in an area of interest. Course materials fee required.

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

199. Independent Studies in Mechanical Engineering
(1-5) STAFF
Prerequisites: consent of instructor; upper-division standing; completion of two upper-division courses in
Mechanical Engineering.
Students must have a minimum of 3.0 grade-point average for the preceding three quarters and
are limited to 5 units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined.
No more than 4 units may be used as departmental electives. May be repeated to 12 units.
Directed individual study.

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

Technology Management Program
Phelps Hall, Room 1332
Telephone (805) 893-2729
Web site: www.tmp.ucsb.edu
Chair: Kyle Lewis

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

Technology Management
transitions new technical advances and discoveries into products or services that benefit society requires business and interpersonal skills as well as technical expertise. These include an ability to work effectively in teams, build sound business models that account for the competitive environment, lead and manage other and diverse groups and apply basic marketing principals.

The Technology Management Program (TMP) provides a solid foundation in these areas to help cultivate managerial and entrepreneurial leadership for technology businesses.
Mission Statement
TMP is a unique educational program that exposes innovative, energetic, and entrepreneurial students to key aspects of technology, business practices, new venture creation, and professional development. Dedicated to the study of management, organizational and entrepreneurial business processes involved in transforming new discoveries in science and engineering into economically productive enterprises, TMP is redefining entrepreneurial education with a comprehensive curriculum for the creation and management of tomorrow’s technology ventures.

The Technology Management Certificate
The Technology Management Certificate program provides students a solid foundation in business fundamentals and entrepreneurship as it applies to new technologies and technology-oriented companies. This certificate serves as an official recognition that the student has a solid grounding in fundamental business strategies and models, opportunity recognition and new-venture creation and marketing. The program also provides access to many professionals familiar with the demands of starting new businesses as well as running existing companies through its extra-curricular offerings.

Technology Management Program Courses

21. Past, Present and Future of Entrepreneurship
(3) GREATHOUSE
Quarters usually offered: Spring.
The historical and present state of entrepreneurship will be explored, along with the potential future direction of startups. Students will be encouraged to start small ventures and discuss current business issues. For anyone interested in entrepreneurship, management, technology development, and commercialization and the impact that innovation has on society.

111. Issues in Technology, Business, and Society
(4) STAFF
Prerequisite: upper division standing.
Enrollment Comments: Quarters usually offered: Fall, Winter, Spring.
Lecture series where entrepreneurial, technological, business, and governmental leaders share their lessons of experience and discuss current business issues. For anyone interested in entrepreneurship, management, technology development, and commercialization and the impact that innovation has on society.

120. Fundamentals of Business Strategy
(4) HANSEN
Prerequisite: upper division standing.
Introduction to critical business principles and practices required by leaders for business success and societal benefit. Students will be exposed to key management theories, models and tools in strategy, finance, accounting, commercialization, marketing, and sales.

122. Entrepreneurship
(4) STAFF
Prerequisite: TMP 120 with grade of B- or better, and upper division standing
Learn how to start any kind of venture; for profit, non-profit, service, sole-proprietorship, with a focus on high-tech ventures. Analysis of new business opportunities, development of customer-centric value propositions, financing, marketing, selling and protection of intellectual property.

124. Principles of Marketing
(4) STAFF
Prerequisite: TMP 120 with a grade of B- or better and upper division standing.
Introduces fundamental principles, processes, and tools of marketing which are used to create, communicate and deliver the value of products and services to customers, clients, partners, and society. This is done with an array of essential topics, such as the identification of customer needs and wants, the assessment of the competitive environment, selection of the most appropriate target opportunities, development of an integrated marketing strategy, and disciplined execution.

127. Understanding and Managing Technology Organizations
(4) STAFF
Prerequisite: TMP 120 with a grade of B- or better and upper division standing.
Participating in, managing, and leading successful careers, teams, and organizations. Current theories and practices concerning motivation, organizational culture, communications, effective decision making, team effectiveness and others presented and discussed.

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

148A. New Venture Seminar
(3) STAFF
Recommended Preparation: TMP 122, TMP 149, or equivalent.
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. (W)

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

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

GRADUATE COURSES
Graduate courses for this program can be found in the UCSB General Catalog.
## CHEMICAL ENGINEERING 2018-19

### Major Requirements

#### Preparation for the Major

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<thead>
<tr>
<th>Course Code</th>
<th>Units</th>
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<td>CH E 5</td>
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<td>CH E 10</td>
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<td>CHEM 1A, 1B, 1C or 2A, 2B, 2C</td>
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<td>CHEM 109A or AH, 109B or BH</td>
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<td>ENGR 3</td>
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<td>MATH 3A-B, 4A or 4AI, 4B or 4BI, 6A or 6AI, 6B</td>
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#### Upper Division Major

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<th>Course Code</th>
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<td>CH E 107</td>
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<td>CH E 110A-B</td>
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<td>CH E 119</td>
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<td>CH E 120A-B-C</td>
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<td>CH E 128</td>
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<td>CH E 132A-B-C</td>
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<td>CH E 140A-B</td>
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<td>CH E 152A</td>
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<td>CH E 180A-B</td>
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<td>CH E 184A-B</td>
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<td>CHEM 113B-C</td>
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<td>MATRL 101 or MATRL 100B</td>
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**Special Subject Areas**

- Ethnicity (1 course):
- European Traditions
- or World Cultures

**Approved Technical Elective Requirement classes:**

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<tr>
<th>Course Code</th>
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<td>CH E 102</td>
<td>CHEM 115A,B,C</td>
</tr>
<tr>
<td>CH E 121</td>
<td>CHEM 123</td>
</tr>
<tr>
<td>CH E 124</td>
<td>CHEM 126</td>
</tr>
<tr>
<td>CH E 125</td>
<td>CHEM 142A,B,C</td>
</tr>
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<td>CH E 126</td>
<td>CHEM 145</td>
</tr>
<tr>
<td>CH E 141</td>
<td>CHEM 147</td>
</tr>
<tr>
<td>CH E 146</td>
<td>CHEM 150</td>
</tr>
<tr>
<td>CH E 152B</td>
<td>ECE 130A,B,C</td>
</tr>
<tr>
<td>CH E 154</td>
<td>ECE 183</td>
</tr>
<tr>
<td>CH E 160</td>
<td>ENGR 101</td>
</tr>
<tr>
<td>CH E 171</td>
<td>ENGR 103</td>
</tr>
<tr>
<td>CH E 173</td>
<td>ENV S 105</td>
</tr>
<tr>
<td>CH E 1961</td>
<td>MATH 122A,B</td>
</tr>
<tr>
<td>CH E 1981</td>
<td>MATRL 100A,C</td>
</tr>
<tr>
<td>CHEM 109C</td>
<td>MATRL 135</td>
</tr>
</tbody>
</table>

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

Technical electives taken:

Courses that can apply toward 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

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<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>
</tr>
</tbody>
</table>

Satisfied by: ___________________________

### General Education

#### General Subject Areas

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

- Area D: Social Science
  (2 courses minimum)

- Area E: Culture and Thought
  (2 courses minimum)

- Area F: The Arts
  (1 course minimum)

- Area G: Literature
  (1 course minimum)

### Special Subject Areas

- Ethnicity (1 course):
- European Traditions
- or World Cultures

Writing (4 courses required):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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### Non-Major Electives

General Education and Free Electives taken:

<table>
<thead>
<tr>
<th>Course Code</th>
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TOTAL UNITS REQUIRED FOR GRADUATION: 187
# CHEMICAL ENGINEERING 2018-19

## FRESHMAN YEAR

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<th>SPRING units</th>
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<tr>
<td>CH E 5</td>
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<td>CHEM 1B or 2B</td>
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<tr>
<td>CHEM 1A or 2A</td>
<td>3</td>
<td>CHEM 1BL or 2BC</td>
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<td>MATH 3A</td>
<td>4</td>
<td>PHYS 1</td>
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<tr>
<td>WRIT 1E or 2E</td>
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<td>WRIT 2E or 50E</td>
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## SOPHOMORE YEAR

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<th>SPRING units</th>
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<td>CH E 107</td>
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<td>CHEM 109A or 109AH</td>
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<td>CH E 110A</td>
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<td>MATH 4B or 4BI</td>
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<td>PHYS 3</td>
<td>3</td>
<td>CHEM 109B or 109BH</td>
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<tr>
<td>PHYS 3L</td>
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<td>MATH 6A or 6AI</td>
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## JUNIOR YEAR

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<td>CH E 120B</td>
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<td>CH E 128</td>
<td>3</td>
<td>CH E 132C</td>
<td>3</td>
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<tr>
<td>CH E 132B</td>
<td>3</td>
<td>CHEM 113B</td>
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<td>G.E. Elective</td>
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<tr>
<td>G.E. Elective</td>
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<td>Technical Elective</td>
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## SENIOR YEAR

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<th>SPRING units</th>
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<td>CH E 180B</td>
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<td>CH E 152A</td>
<td>4</td>
<td>CH E 184A</td>
<td>3</td>
</tr>
<tr>
<td>G.E. Elective</td>
<td>4</td>
<td>G.E. Elective</td>
<td>4</td>
</tr>
<tr>
<td>Technical Elective</td>
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<tr>
<td>TOTAL</td>
<td>14</td>
<td>13</td>
<td>14</td>
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</tbody>
</table>

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

**Students may only count one course toward the major. (MATRL 101 OR MATRL 100B)
## COMPUTER ENGINEERING 2018-19

### PREPARATION FOR THE MAJOR | Units
--- | ---
CHEM 1A, 1AL or 2A, 2AC | 5
CMPSC 16 | 4
CMPSC 24 | 4
CMPSC 32 | 4
CMPSC 40 | 5
ECE 1A-1B | 2
ECE 10A, 10AL, 10B, 10BL, 10C, 10CL | 15
ECE 15A | 4
MATH 3A-B, 4A-B | 16
PHYS 1, 2, 3, 3L, 4, 4L | 16

### UPPER DIVISION MAJOR | Units
--- | ---
CMPSC 130A | 4
ECE 139 or PSTAT 120A | 4
ECE 152A | 5
ECE 154A | 4
ENGR 101 | 3

Computer Engineering electives selected from the following list: 48

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-C.

### UNIVERSITY REQUIREMENTS

| Requirement | Units |
--- | ---
American History and Institutions – (one 4-unit course) (may be counted as G.E. if selected from approved list) | 4 |
UC Entry Level Requirement: English Composition Must be fulfilled within three quarters of matriculation | 4 |

### GENERAL EDUCATION

**General Subject Areas**

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

**A-1:**

**A-2:**

**Area D: Social Science**

(2 courses minimum)

**Area E: Culture and Thought**

(2 courses minimum)

**Area F: The Arts**

(1 course minimum)

**Area G: Literature**

(1 course minimum)

### Special Subject Areas

Ethnicity (1 course):

European Traditions or World Cultures (1 course):

Writing (4 courses required):

### NON-MAJOR ELECTIVES | 44

General Education and Free Electives taken:

### TOTAL UNITS REQUIRED FOR GRADUATION | 191

Courses that can apply toward the major, inside or outside of the Departments of Computer Science or Electrical and Computer Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.
# COMPUTER ENGINEERING 2018-19

## FRESHMAN YEAR

<table>
<thead>
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<th>SPRING units</th>
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<td>Math, Science,</td>
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<td>MATH 3A</td>
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<td>Engr. Elective</td>
<td>4</td>
</tr>
<tr>
<td>G.E. Elective or CMPSC 8&lt;sup&gt;1&lt;/sup&gt;</td>
<td>4</td>
<td>MATH 3B</td>
<td>4</td>
</tr>
<tr>
<td>WRIT 1E or 2E</td>
<td>4</td>
<td>PHYS 1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WRIT 2E or 50E</td>
<td>4</td>
</tr>
</tbody>
</table>

**TOTAL**         | 17         | 17           | 17           |

## SOPHOMORE YEAR

<table>
<thead>
<tr>
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<td>5</td>
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<td>ECE 10A</td>
<td>3</td>
<td>ECE 10B</td>
<td>3</td>
</tr>
<tr>
<td>ECE 10AL</td>
<td>2</td>
<td>ECE10BL</td>
<td>2</td>
</tr>
<tr>
<td>MATH 4B</td>
<td>4</td>
<td>ECE 15A</td>
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<td>3</td>
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<td>PHYS 3L</td>
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<td>PHYS 4L</td>
<td>1</td>
</tr>
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</table>

**TOTAL**         | 17         | 18           | 18           |

## JUNIOR YEAR

<table>
<thead>
<tr>
<th></th>
<th>FALL units</th>
<th>WINTER units</th>
<th>SPRING units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 154A</td>
<td>4</td>
<td>CMPSC 130A</td>
<td>4</td>
</tr>
<tr>
<td>CMPEN Elective</td>
<td>8</td>
<td>CMPEN Elective</td>
<td>4</td>
</tr>
<tr>
<td>G.E. or Free Electives</td>
<td>4</td>
<td>G.E. or Free Electives</td>
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</tr>
</tbody>
</table>

**TOTAL**         | 16         | 16           | 12           |

## SENIOR YEAR

<table>
<thead>
<tr>
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<th>SPRING units</th>
</tr>
</thead>
<tbody>
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<td>CMPEN Electives</td>
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<td>CMPEN Electives</td>
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<tr>
<td>Free Elective</td>
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<td>ENGR 101&lt;sup&gt;3&lt;/sup&gt;</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Free Elective</td>
<td>4</td>
</tr>
</tbody>
</table>

**TOTAL**         | 16         | 15           | 12           |

---

1. CS 8 may be used to satisfy the Math, Science, Engineering Elective requirement.
2. PSTAT 120A is offered each quarter. ECE 139 is offered only in spring quarter, and is better suited for future upper division electives for the Computer Engineering major.
3. ENGR 101 may be taken any quarter of senior year.
COMPUTER SCIENCE 2018-19

PREPARATION FOR THE MAJOR ...................................................... 53

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>CMPSC 16</td>
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<tr>
<td>CMPSC 24</td>
<td>4</td>
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<tr>
<td>CMPSC 32</td>
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<td>CMPSC 40</td>
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<tr>
<td>CMPSC 48</td>
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</tr>
<tr>
<td>CMPSC 56</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 64</td>
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</tr>
<tr>
<td>MATH 3A-B, 4A-B, 6A</td>
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<td>PSTAT 120A</td>
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UPPER DIVISION MAJOR ......................................................... 63

<table>
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<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>CMPSC 130A-B</td>
<td>8</td>
</tr>
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<td>CMPSC 138</td>
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</tr>
<tr>
<td>CMPSC 154</td>
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</tr>
<tr>
<td>CMPSC 160 or 162</td>
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</tr>
<tr>
<td>CMPSC 170</td>
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<tr>
<td>ENGR 101</td>
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<tr>
<td>PSTAT 120B</td>
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</tbody>
</table>

Major Field Electives ....................................................... 28

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

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
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<td>CMPSC 140(^1)</td>
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<tr>
<td>CMPSC/ECE 153A</td>
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<td>CMPSC 160(^2)</td>
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<td>CMPSC 162(^2)</td>
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<td>CMPSC 171/ECE 151</td>
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<td>CMPSC 174A-B</td>
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<td>CMPSC 176A-B-C</td>
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<td>CMPSC 180</td>
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<td>CMPSC/ECE 181B</td>
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<td>ECE 135B</td>
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<tr>
<td>PSTAT 160A-B</td>
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</tbody>
</table>

\(^1\)CMPSC 111 or CMPSC 140 can be used as an elective if not taken as a major course.
\(^2\)CMPSC 160 or CMPSC 162 can be used as an elective if not taken as a major course.
\(^3\)Four units maximum from CMPSC 192 and CMPSC 196 combined; only for students with GPA of 3.0 or higher.
\(^3\)Only for students who have met the requirements. Please see department advisor for more information.

Major Field Electives taken:

SCIENCE COURSES ............................................................... 12

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

Science Electives taken:

Courses that can apply toward 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.

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

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<th></th>
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<th>WINTER</th>
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<th>SPRING</th>
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<tr>
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<td>MATH 4A</td>
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<td></td>
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<tr>
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<td>WRIT 1, 2, or G.E. Electroite 4/5</td>
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<td>Science or Free Elective</td>
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<td><strong>16/17</strong></td>
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## SOPHOMORE YEAR

<table>
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<tr>
<th></th>
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<th></th>
<th>WINTER</th>
<th></th>
<th>SPRING</th>
<th></th>
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<td>Math 6A</td>
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<td>PSTAT 120A</td>
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<td>G.E. Electroite</td>
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<td>PHYS 3</td>
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<td>WRIT 50</td>
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<td><strong>16</strong></td>
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<td><strong>16</strong></td>
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</tbody>
</table>

## JUNIOR YEAR

<table>
<thead>
<tr>
<th></th>
<th>FALL</th>
<th></th>
<th>WINTER</th>
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## SENIOR YEAR

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

** Or you may take CMPSC 162 to satisfy this requirement.

*** ENGR 101 may be taken any quarter of senior year.
PREPARATION FOR THE MAJOR

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UNIT 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: ________________

Area D: Social Science
(2 courses minimum)

Area E: Culture and Thought
(2 courses minimum)

Area F: The Arts
(1 course minimum)

Area G: Literature
(1 course minimum)

Special Subject Areas

Ethnicity (1 course):

European Traditions or World Cultures (1 course):

Writing (4 courses required):

NON-MAJOR ELECTIVES

General Education and Free Electives taken:

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

TOTAL UNITS REQUIRED FOR GRADUATION ...... 189
## FRESHMAN YEAR

<table>
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<tr>
<th>FALL</th>
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## JUNIOR YEAR

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## SENIOR YEAR

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1. ECE 139 may also be taken in the spring quarter of the sophomore year.
2. ECE 152A may also be taken in the spring quarter of the sophomore year.
3. ENGR 101 may be taken any quarter of senior year.
4. ECE Electives must include at least two sequences, one of which must be an approved EE senior capstone design project sequence.
## MECHANICAL ENGINEERING 2018-19

### PREPARATION FOR THE MAJOR  77

<table>
<thead>
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<td>ME 14</td>
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<td>ME 16</td>
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<td>ME 17</td>
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### UPPER DIVISION MAJOR  70

#### Third Year

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<td>ME 105</td>
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<td>ME 151A-B-C</td>
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<td>ME 152A-B</td>
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<tr>
<td>ME 155A</td>
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<td>ME 163</td>
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*see note on next page

#### Fourth Year

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

### Approved Engineering Electives:

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<td>ECE 147A,C</td>
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<td>ME 125 AA-ZZ</td>
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<td>ME 128</td>
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<td>ENGR 195A-B-C</td>
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<td>ENV S 105</td>
<td>ME140A-B</td>
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<td>ME141A-B</td>
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<td>MATRL 186A-B</td>
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<td>MATRL 188</td>
<td>ME 155B-C</td>
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<td>ME 102</td>
<td>ME 157</td>
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<td>ME 110</td>
<td>ME 158</td>
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Please note:

1. ME W167 online version of ME 167.
2. Four units maximum from ME 197 and ME 199 combined.

### ENGINEERING 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)

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<tr>
<th>A-1</th>
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Area D: Social Science

(2 courses minimum)

Area E: Culture and Thought

(2 courses minimum)

Area F: The Arts

(1 course minimum)

Area G: Literature

(1 course minimum)

### Special Subject Areas

Ethnicity (1 course):

European Traditions  
or World Cultures (1 course):

Writing (4 courses required):

### NON-MAJOR ELECTIVES  44

General Education and Free Electives taken:

TOTAL UNITS REQUIRED FOR GRADUATION 191
# MECHANICAL ENGINEERING 2018-19

## FRESHMAN YEAR

<table>
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<tr>
<th>FALL</th>
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## JUNIOR YEAR

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## SENIOR YEAR

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</table>

$^1$ME 12S is offered every Fall, Winter, and Spring quarter. The ME 12S requirement must be finished before the start of the Third Year.

$^2$If applying to the BS/MS Materials program, juniors must take MATRL 100A in Fall, MATRL 100B in Winter, and MATRL 100C in Spring.

$^3$Course availability may vary. If using ME 154, ME 157, or ME 167 to satisfy requirement, students may not count the course as an Engineering Elective.

$^4$Students may only count one course toward the major. (MATRL 101 OR MATRL 100B)
Additional Resources and Information

Gauchos 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>
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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.