General Engineering Academic Requirements

2021-2022

UC SANTA BARBARA
College of Engineering
2021-2022 Academic Calendar

Note: Dates subject to change without notice.

<table>
<thead>
<tr>
<th>Event</th>
<th>Fall 2021</th>
<th>Winter 2022</th>
<th>Spring 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter begins</td>
<td>September 19, 2021</td>
<td>January 3, 2022</td>
<td>March 28, 2022</td>
</tr>
<tr>
<td>New Student Convocation</td>
<td>September 20, 2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First day of instruction</td>
<td>September 23, 2021</td>
<td>January 3, 2022</td>
<td>March 28, 2022</td>
</tr>
<tr>
<td>Last day of instruction</td>
<td>December 3, 2021</td>
<td>March 11, 2022</td>
<td>June 3, 2022</td>
</tr>
<tr>
<td>Final examinations</td>
<td>December 4-10, 2021</td>
<td>March 12-18, 2022</td>
<td>June 4-10, 2022</td>
</tr>
<tr>
<td>Quarter ends</td>
<td>December 10, 2021</td>
<td>March 18, 2021</td>
<td>June 10, 2022</td>
</tr>
<tr>
<td>Commencement</td>
<td></td>
<td></td>
<td>June 11-12, 2022</td>
</tr>
</tbody>
</table>

2021-2022 Campus Holidays Observed

Veterans’ Day: November 11, 2021
Thanksgiving: November 25-26, 2021
Christmas: December 23-24, 2021
New Year: December 30-31, 2021
Martin Luther King, Jr. Day: January 17, 2022
Presidents’ Day: February 21, 2022
Cesar Chavez Holiday: March 25, 2022
Memorial Day: May 30, 2022
Independence Day: July 4, 2022
Labor Day: September 5, 2022

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, 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.
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. 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 1,500 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
# Table of Contents

Message from the Associate Dean ........................................2

**College Overview**
- Honors Programs .......................................................... 4
- Education Abroad Program ............................................. 4
- Student Organizations ...................................................... 4
- Change of Major and Change of College ............................ 5
- Degree Requirements ....................................................... 5
- Minimal Progress Requirements and College Policy .......... 6
- Five-Year B.S./M.S. Programs ............................................ 6

**General University Requirements** ......................... 10
- UC Entry Level Writing Requirement ............................. 10
- American History and Institutions Requirement ............ 10

**College General Education Requirements** ........... 10
- General Subject Area Requirements ................................. 11
- Special Subject Area Requirements
  - Writing Requirement .................................................. 11
  - Ethnicity Requirement ................................................ 11
  - European Traditions/World Cultures Requirement .... 11
- General Education Course Listing ................................. 12
- Checklist of General Education Requirements ............. 21

**Department and Program Information**
- Chemical Engineering ................................................... 22
- Computer Engineering ................................................... 25
- Computer Science ........................................................ 26
- Electrical and Computer Engineering ............................ 30
- Engineering Sciences ..................................................... 37
- Materials ........................................................................ 38
- Mechanical Engineering ................................................. 40
- Technology Management Program ............................... 56

**Major Requirements (2021-2022)**
- Chemical Engineering ................................................... 46
- Computer Engineering ................................................... 48
- Computer Science ........................................................ 50
- Electrical Engineering .................................................... 52
- Mechanical Engineering .................................................. 54

**Additional Resources** ................................................... 56

**Academic Year Calendar** ................................................. Inside Front Cover

**College Policy on Academic Conduct** ....................... 57
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, in later years, as members of research teams.

Participation in the Honors Program offers housing in Scholar's Halls located in several university-owned residence halls to eligible first-year students, as well as graduate student library privileges to all students in the program. Special lectures and tours will be offered throughout the academic year.

The College of Engineering invites approximately the top 10% of incoming freshmen into the Honors Program based on a comprehensive application review. (Please note: eligibility criteria are subject to change at any time.) Select transfer students will be invited to join the Program upon admission. Students who do not enter the College of Engineering with honors at the time of admission to UCSB may apply to join the program between first and second year after completing at least 36 letter-graded units with a cumulative GPA of 3.5 or higher, or between second and third year after completing at least 72 letter-graded units with a cumulative GPA of 3.5 or higher. Students may not join the Honors Program the summer between their junior and 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, 198, 199 courses, graduate level courses (numbered 200-299), or completing courses toward their engineering major through the UC Education Abroad Program with grades of B or higher.

Notes: Capstone participation/courses do not apply to honors credit, nor do graduate courses taken to satisfy requirements for a graduate degree. Paid research positions cannot apply, 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 3.75 grade-point average for the quarter and have completed a program of 12 or more letter-graded units. Grades of Not Passed automatically disqualify students for eligibility for Dean's Honors. 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. Gradu-
ate 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
• Coders SB
• Data Science at UCSB
• Engineering Student Council
• Engineers without Borders
• Entrepreneurs Association
• Institute of Electrical and Electronics Engineers
• The Lighthouse Journal
• Los Ingenieros (Mexican-American Engineering Society/Society of Hispanic Professional Engineers)
• Machine Shop Club
• National Society of Black Engineers
• Out in Science, Technology, Engineering, and Mathematics (out in Science, Technol-
ogy, Engineering, and Mathematics)
• Phi Sigma Rho
• Photonics Society at UCSB
• Robotics Club
• SB Hacks
• Society for Advancement of Chicano and Native Americans in Science
• Society of Asian Scientists and Engineers
• Society of Women Engineers
• Theta Tau
• Women in Computer Science
• Women in Science and Engineering
• Women in Software and Hardware

Change of Major and Change of College

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

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

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. Students must be at or below 105 units at the time required change of major courses are completed. 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 each student’s academic performance and trajectory, as well as current enrollments in Chemical Engineering classes. Freshman should apply during the spring term of their freshman year, and may reapply during their sophomore year. Sophomores may only apply one time during the spring term of their sophomore year. Applicants must have a 3.0 GPA or above, and satisfactorily complete the following courses or their equivalents: Math 3A, 3B, 4A; Chem 1A-1AL or 2A-2AC, 1B-1BL or 2B-2BC, and 1C-1CL or 2C-2CC. Recommended courses include: ENGR 3; Physics 1-2; CHE 5, 10, 110AB (110AB may be taken concurrently at time of application).

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 (CMP-SC) 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.

Acceptance into the major will be based on UC grade point averages, applicable courses completed, and space availability. All students considering changing into Computer Engineering are required to meet with the ECE Academic Advisor during their first year.

Computer Science. The application process is extremely competitive. A very limited number of change of major applications to Computer Science will be approved. Students may apply for consideration to the Computer Science major when the following requirements are met; no exceptions are made for these requirements and meeting these requirements does not guarantee admission to the Computer Science major:

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

Denied change of major applications will not be reconsidered. More information can be found at https://cs.ucsb.edu/education/undergrad/admissions. No exceptions are made for these requirements.

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
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.

Acceptance into the major will be based on UC grade point averages, applicable courses completed, and space availability. All students considering changing into Electrical Engineering are required to meet with the ECE Academic Advisor during their first year.

Mechanical Engineering. Mechanical Engineering Change of Major: Admission by change of major into Mechanical Engineering is both limited and competitive. Petitions are required once students have been admitted through the change of major process. Mechanical Engineering requires a minimum of six (6) core courses from the following list: Chem 1A-1B; ENGR 3; Math 3A-B; Math 4A-B; Math 6A-B; PHYS 1-2; ME 10; ME 14; ME 15 (ME 14 is required to be part of the minimum 6 core courses). Acceptance into the major is based on UC grade point average, applicable courses completed, and space availability. Starting for freshmen fall 2021, ME will be allowing CSU and CCC grades to be included in the minimum six courses that are calculated for a prep GPA (these grades are not calculated into your official UCSB GPA). These grades must be submitted officially and be reflected in GOLD. Students are able to repeat courses as long as they follow the university guidelines for repeating courses. All students considering changing into Mechanical Engineering must notify the ME Academic Advisor and report all core course grades after each quarter to update preparatory GPA calculation. It is highly recommended to follow the ME program as closely as possible to best be prepared to switch into ME; all while keeping a backup major in mind in the likely chance the department is not able to accommodate your request to change into ME.

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 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 6 quarter units in addition to the units earned for individual Higher Level exams.

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 Computer Engineering or Electrical Engineering / M.S. in Electrical and Computer Engineering.** 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 Electrical and Computer Engineering 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 Electrical and Computer Engineering office.

**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 6 quarter units in addition to the units earned for individual Higher Level exams. 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 INFORMATION

<table>
<thead>
<tr>
<th>Exam with score of 5, 6, Or 7</th>
<th>Units</th>
<th>COE GE Credit</th>
<th>UCSB Equivalent Course(s)</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</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English A: Language And Literature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score Of 5</td>
<td>8</td>
<td>Entry Level Writing</td>
<td>Writing 1, 1E</td>
</tr>
<tr>
<td>Score Of 6</td>
<td>8</td>
<td>A1</td>
<td>Writing 1, 1E, 2, 2E, 2LK</td>
</tr>
<tr>
<td>Score Of 7</td>
<td>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>Mathematics, Analysis &amp; Approaches</td>
<td>8</td>
<td>none</td>
<td>Mathematics 2A, 3A</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>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>
<tr>
<td>Psychology</td>
<td>8</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
</tbody>
</table>

^ Course also satisfies the european traditions requirement
+ Course also satisfies the world cultures requirement
% Last Offered Fall 2020
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</th>
<th>Units Awarded</th>
<th>General Ed. Course Credit</th>
<th>UCSB Course Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>with score of 3, 4, or 5</td>
<td></td>
<td></td>
<td>(You may not enroll in these courses for credit at UCSB)</td>
</tr>
<tr>
<td>2D Art and Design</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>3D Art and Design</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Art History</td>
<td>8</td>
<td>F: 1 course</td>
<td>Art History 1</td>
</tr>
<tr>
<td>Biology</td>
<td>8</td>
<td>none</td>
<td>EEMB 22, MCDB 20</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Chinese Language and Culture</td>
<td></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>Comparative Government and Politics</td>
<td>4</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>+Computer Science A (through S17)</td>
<td>2 or 8+</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>Computer Science 8</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 (effective S17 and S18)</td>
<td></td>
<td></td>
<td></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 or 5</td>
<td>8</td>
<td>none</td>
<td>Computer Science 8</td>
</tr>
<tr>
<td>Computer Science Principles (effective S19)</td>
<td></td>
<td></td>
<td></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 or 5</td>
<td>8</td>
<td>none</td>
<td>Computer Science 4</td>
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<tr>
<td>Drawing</td>
<td>8</td>
<td>none</td>
<td>Art 18</td>
</tr>
<tr>
<td>Macroeconomics</td>
<td>4</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Microeconomics</td>
<td>4</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>*English – Composition and Literature or Language and Composition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>Entry Level Writing</td>
<td>Writing 1, 1E</td>
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<td>With score of 4</td>
<td>8</td>
<td>A1</td>
<td>Writing 1, 1E, 2, 2E, 2LK</td>
</tr>
<tr>
<td>With score of 5</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></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>With score of 5</td>
<td>8</td>
<td>none</td>
<td>German 1-3</td>
</tr>
<tr>
<td>German Language and Culture</td>
<td></td>
<td>none</td>
<td>German 1-4</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>German 1-5</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>See department for level placement</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>none</td>
<td>none</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></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>
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<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>Italian 1-6</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>none</td>
<td>See department for level placement</td>
</tr>
<tr>
<td>Japanese Language &amp; Culture</td>
<td></td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-3</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-4</td>
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<tr>
<td>With score of 5</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>Latin</td>
<td>8</td>
<td>none</td>
<td>Latin 1-3</td>
</tr>
<tr>
<td>*Calculus AB (or AB subscore of BC exam)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*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>Mathematics 2A, 2B, 3A, 3B, 34A, 34B, or equivalent</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></td>
<td>none</td>
<td>Spanish 1-3</td>
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<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-4</td>
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<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>none</td>
</tr>
</tbody>
</table>
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.

### A Level Examination Credit

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

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

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

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

* A maximum of 8 units EACH in art studio, English, Mathematics, and Physics is allowed.
+ 8 units effective Spring 2018. Computer Science A exam is 2 units through Spring 2017.

Note: Information on this chart is subject to change. For updates go to: http://my.sa.ucsb.edu/catalog/current/UndergraduateEducation/APCreditandChart.aspx.
General University Requirements

UC Entry Level Writing Requirement

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

1. by achieving a score of 680 or higher on the Writing section of the SAT Reasoning Test;
2. by achieving a score of 30 or higher on the ACT Combined English Language Arts (ELA) test;
3. by achieving a score of 3 or higher on the College Board Advanced Placement Examination in English Composition and Literature or English Language and Composition;
4. by achieving a score of 5, 6, or 7 on the higher level English A International Baccalaureate Examination;
5. by achieving a score of 6 or 7 on the standard level English A1 International Baccalaureate Examination;
6. by passing the University of California systemwide Analytical Writing Placement Exam while in high school;
7. by earning a grade of C or higher in a course accepted as equivalent to Writing 2 worth 4 quarter or 3 semester units.

Students who have not met the UC Entry Level Writing Requirement in one of the ways listed above will be required to take a placement exam. Students who do not achieve an appropriate score on the placement exam to fulfill the Entry Level Writing Requirement must enroll in Writing 1, 1E, or Linguistics 12 within their first year at UCSB.

Visit the Writing Program’s website (writing.ucsb.edu/academics) for placement exam information.

American History and Institutions Requirement

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

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

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

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

College of Engineering General Education Requirements

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

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

It should be noted that for College of Engineering transfers who completed IGETC (Intersegmental General Education Transfer Curriculum), it may be used to substitute for entire UCSB College of Engineering General Education pattern (IGETC does not satisfy the American History and Institutions requirement).

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


Chemical Engineering, Computer Engineering, Electrical Engineering, and Mechanical Engineering majors
are strongly encouraged to take Writing 2E and 50E in their first year at UCSB. Computer Science majors may take Writing 2E and 50E space permitting.

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 the philosophical, intellectual, historical, and/or cultural experiences of historically oppressed and excluded racial minorities in the United States. At least one course in this area is required. Courses that meet this requirement are marked with an ampersand (&) on the lists in this document.

3. European Traditions or World Cultures Requirement.

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

World Cultures objective: To learn to identify, 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.

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

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

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

AREA A: ENGLISH READING AND COMPOSITION (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 one course from the following list:
Writing 50 Writing and the Research Process
Writing 50E Writing and the Research Process for Engineers
Writing 105CD Writing with Code
Writing 105CW Writing in Community
Writing 107 Business and Administrative Writing
Writing 107EP Writing for Environmental Professions
Writing 107G Professional Writing for Global Careers
Writing 107J Journalism and News Writing
Writing 107L Legal Writing
Writing 107M Magazine Writing for Publication
Writing 107T Technical Writing
Writing 107WC Writing for Web Content
Writing 109ED Writing for the Teaching Professions
Writing 109ES Writing for Environmental Studies
Writing 109HP Writing for Health Professions
Writing 109ST Writing for Science and Technology

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
+ Anthropology 3
+ Anthropology 3SS
* Anthropology 7
+ Anthropology 103A
+ Anthropology 103B
+ Anthropology 103C
* Anthropology 109
+ Anthropology 110
+ Anthropology 122
+ Anthropology 130A
+ Anthropology 130B
+ Anthropology 130G
* Anthropology 131
* Anthropology 134
+ Anthropology 135
# Anthropology 136
* Anthropology 137
* Anthropology 141

Introductory Cultural Anthropology
Introduction to Archaeology
Introduction to Biosocial Anthropology
Violence and the Japanese State
Anthropology of China
Anthropology of Japan
Anthropology of Korea
Human Universals
Technology and Culture
Anthropology of World Systems
Coupled Human and Natural Systems: Risks, Vulnerability, Resilience, and Disasters
Global Tourism and Environmental Conservation
North American Indians
Modern Cultures of Latin America
Modern Mexican Culture
People and Cultures of the Pacific
The Ancient Maya
Agriculture and Society in Mexico: Past and Present
Peoples and Cultures of India
Understanding Africa
Representations of Sexuality in Modern Japan (Same as HIST 188S and JAPAN 162)
Indigenous Movements in Asia
Introduction to Asian American History, 1850-Present
Asian American Migration since 1965
Asian American Globalization
Asian American Gender and Sexuality
Asian American Freedom Struggles and Third World Resistance
Chinese Americans
Japanese Americans
South Asian Americans
Asian American Communities and Contemporary Issues
Asian Americans and Race Relations
Colonialism and Migration in the Passage to America
Asian American Women's History
Asian American Families
Race and Law in Early American History
Racial Segregation from the Civil War to the Civil Rights Movement
Race and Law in Modern America
Asian Americans and Education
Ethnographies of Asian Americans
Introduction to Afro-American Studies
The Civil Rights Movement
Africa and United States Policy
Black Radicals and the Radical Tradition
The Politics of Black Liberation-The Sixties
The Education of Black Children
Housing, Inheritance and Race
Queer Black Studies
The Urban Dilemma
Race and Public Policy
Analyses of Racism and Social Policy in the U.S.

& Black Studies 169AR-BR-CR
+ Black Studies 169AR-BR-CR
++ Black Studies 174
* Chicano Studies 1A-B-C
& Chicano Studies 114
& Chicano Studies 124G
& Chicano Studies 137
& Chicano Studies 140
& Chicano Studies 144
& Chicano Studies 151
& Chicano Studies 168A-B
& Chicano Studies 172
& Chicano Studies 173
& Chicano Studies 174
& Chicano Studies 175
& Chicano Studies 176
& Chicano Studies 178A
* Chicano Studies 179
# Chicano Studies 187
* Communication 1
* Comparative Literature 119
* Comparative Literature 186FL

Chicano/a Oral Traditions
The Mexican Cultural Heritage of the Chicano
The Chicano Community
De-Colonizing Feminism
History of the Chicano (Same as HIST 168A-B)
Law and Civil Rights
Immigrant Labor Organizing
Chicano/a Politics (Same as POL S 174)
Comparative Social Movements
Theories of Social Change and Chicano Political Life
Global Migration, Transnationalism in Chicano/a Contexts
Democracy and Diversity
Language, Power, and Learning
Introduction to Communication
Psychoanalytic Theory
Gender and Sexuality in Modern Asia

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

**AREA E: CULTURE AND THOUGHT (2 courses minimum)**

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

- *Anthropology 138TS* Archaeology of Egypt
- *Anthropology 176* Representations of Sexuality in Modern Japan (Same as HIST 188S and JAPAN 162)
- *Anthropology 176TS* Ancient Egyptian Religion
- ^Art History 6A-B-C* Art Survey
- *Art History 6L* History of Games
- *Art History 6R* Rome: The Game
- *Art History 115E* The Grand Tour: Experiencing Italy in the Eighteenth Century
- *Art History 136I* The City in History
- Art History 144D
- Art History 148A Contemporary Art History: 1960-2000
Area F: Arts (1 course minimum)

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

* Art 1A  Visual Literacy
  Art 7A  The Intersections of Art and Life
  Art 106W  Introduction to 2D/3D Visualizations in Architecture
  Art 125  Art History 1
  Art History 5A  Introduction to Architecture and the Environment
  Art History 5B
  * Art History 6A
  * Art History 6B
  * Art History 6C
  * Art History 6D
  * Art History 6DW
  + Art History 6E
  * Art History 6F
  * Art History 6G
  + Art History 6H
  Art History 103A
  Art History 103B
  Art History 103C
  Art History 105C
  * Art History 6J
  * Art History 6K
  * Art History 6L
  * Art History 6M
  * Art History 6N
  Art History 109A
  Art History 109B
  Art History 109C
  Romans: The Game
  Romance Architecture
  Roman Art: From the Republic to Empire (509 BC to AD 337)
  Greek Architecture
  Medieval Architecture: From Constantine to Charlemagne
  The Origins of Romanesque Architecture
  Late Romanesque and Gothic Architecture
  Art and Society in Late Medieval Tuscany
  Painting in Fifteenth-Century Netherlands
  Painting in Sixteenth-Century Netherlands
  Italian Renaissance Art 1400-1500
  Italian Renaissance Art 1500-1600
  Art as Technique, Labor, and Idea in Renaissance Italy
  Art and the Formation of Social Subjects in Early Modern Italy
  Michelangelo
  Italian Journeys
  Leonardo Da Vinci: Art, Science and Technology in Early Modern Italy
  Dutch Art in the Age of Rembrandt
  Dutch Art in the Age of Vermeer
  Rethinking Rembrandt
  Seventeenth-Century Art in Southern Europe
  Seventeenth-Century Art in Italy
  Bernini and the Age of the Baroque
  Eighteenth-Century Art 1750-1810
  Eighteenth-Century British Art and Culture
  Eighteenth-Century Art in Italy: The Age of the Grand Tour
  Nineteenth-Century Art 1848-1900
  Nineteenth-Century British Art and Culture
  Impressionism and Post-Impressionism
  Contemporary Art
  Expressionism to New Objectivity, Early Twentieth-Century German Art
  Art in the Post-Modern World
  Early Twentieth-Century European Art 1900-1945
  Art of the Postwar Period 1945-1968
  Critical Approaches to Visual Culture
  American Art from the Revolution to Civil War: 1700-1860
  @ Art History 121B  Reconstruction, Renaissance, and Realism in American Art 1860-1900

* 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 European Traditions requirement.
& Art History 121C Twentieth-Century American Art: Modernism and Pluralism 1900-Present
& Art History 121D African-American Art and the African Legacy
+ Art History 121E Three Dimensional Arts of the United States
+ Art History 121A African Art I
+ Art History 121B African Art II
+ Art History 130A Pre-Columbian Art of Mexico
+ Art History 130B Pre-Columbian Art of the Maya
+ Art History 130C The Arts of Spain and New Spain
+ Art History 130D Pre-Columbian Art of South America
+ Art History 130E Mediterranean Cities
+ Art History 130F Art of Empire
+ Art History 130G Buddhist Art
+ Art History 130H Early Chinese Art
+ Art History 130I Chinese Painting
+ Art History 130J Art and Modern China
+ Art History 130K The Art of the Chinese Landscape
+ Art History 130L The Art of Japan
+ Art History 130M Japanese Painting
+ Art History 130N Ukiyo-e: Pictures of the Floating World
Art History 130A Nineteenth-Century Architecture
Art History 130B Twentieth-Century Architecture
Art History 130C Architecture of the United States
Art History 130D Design & the American Architect
@ Art History 130E Housing American Cultures
@ Art History 130F The City in History
@ Art History 130G Landscape of Colonialism
@* Art History 130K Modern Architecture in Early Twentieth-Century Europe
^ Art History 130L From Modernism to Postmodernism in European Architecture
Art History 130M Revival Styles in Southern California Architecture
Art History 130N Sustainable Architecture: History and Aesthetics
Art History 130O Architecture of the Americas
Art History 130P Modern Indian Visual Culture
Art History 130Q Introduction to 2D/3D Visualizations in Architecture
Art History 130R Modern Architecture in Souther California
Art History 130S Birth of the Modern Museum
@* Art History 130T The Architecture of Museums and Galleries from c. 1800 to the Present
Art History 130U The Avant-Garde in Russia
Art History 130V Contemporary Art in Russia and Eastern Europe (Same as SLAV 130C)
Art History 130W Russian Art
Art History 130X Contemporary Art History: 1960-2000
Art History 130Y 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 Africa in Film
* Black Studies 172 Contemporary Black Cinema
+ Black Studies 175 Black Diaspora Cinema
& Chicano Studies 125B Contemporary Chicano and Chicana Art
& Chicano Studies 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 Globalism
* Classics 102 Greek Tragedy in Translation
* Classics 165 Greek Painting
* Classics 170 Roman Painting
* Comparative Literature 186FF NoIR: 1940s Film and Fiction
+ Dance 35 History and Appreciation of World Dance
* Dance 36 History of Modern Dance
* Dance 36E History of Modern Dance (online course)
Dance 45 History and Appreciation of Dance
* Dance 145A-B Studies in Dance History
* East Asian Cultural Buddhist Art
Studies 134A
Environmental Studies 136O Sustainable Architecture: History and Aesthetics
* Film & Media Studies 46 Introduction to Cinema
* Film & Media Studies 55AA-ZZ Media Arts: The High and the Low
* Film & Media Studies 56AA-ZZ Media Cultures and Thought
* Film & Media Studies 120 Japanese Cinema (Same as JAPAN 159)
* Film & Media Studies 121 Comparative Cinema
* Film & Media Studies 122AA-ZZ Topics in National Cinema
* Film & Media Studies 124 Indian Cinema
* Film & Media Studies 124V Modern Indian Visual Culture
* Film & Media Studies 125A-B Documentary Film
* Film & Media Studies 126 Curriculum
& Film & Media Studies 127 Latin American Cinema
* Film & Media Studies 127M Mexican Film and Cinema
* Film & Media Studies 134 French and Francophone Cinema
* Film & Media Studies 136 British Cinema
* Film & Media Studies 144 The Horror Film (Same as GER 183)
* Film & Media Studies 163 Women and Film: Feminist Perspectives
Film & Media Studies 169 Film Noir
Film & Media Studies 175 Experimental Film
* Film & Media Studies 178Z Technology and Cinema (Same as FR 156D)
* Film & Media Studies 184AA-ZZ 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 Fiction and Film in Italy
   Italian 180Z Italian Cinema
+ Japanese 134F Japanese Painting (Same as ARTH 134F)
+ Japanese 134G Japanese Painting (Same as ARTH 134G)
+ Japanese 134H Ukiyo-e: Pictures of the Floating World (Same as ARTH 134H)
+ Japanese 149 Traditional Japanese Drama
*+ Japanese 159 Japanese Cinema (Same as FLMST 120)
Japanese 159A Postwar Japanese Cinema (1945-1965)
+ Korean 75 Introduction to Popular Culture in Korean Film
* Music 3B Writing about Music
Music 10 Fundamentals of Music
* Music 15 Music Appreciation
* Music 16 Listening to Jazz: Demystifying America's Musical Art Form
Music 17 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 119 Music in Political Films
Religious Studies 13 Religion and Popular Culture
& Religious Studies 133B From Superman to Speigelman: The Jewish Graphic Novel
Religious Studies 139B Music and Politics
Religious Studies 143B Music in Political Films
Religious Studies 150B Religion and Popular Culture
Religious Studies 157G Persian Cinema
Slavic 130A The Avantgarde in Russia
Slavic 130B Russian Cinema
Slavic 130C Contemporary Art in Russia and Eastern Europe (Same as ARTH 144C)
Slavic 130D Russian Art
Slavic 130E Masters of Soviet Cinema
* 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.
Spanish 126
+ Theater 2A
  Performance in Global Contexts: Africa and the Caribbean
  Performance in Global Contexts: Asia
  Performance in Global Contexts: Europe
  Life of the Theater
  Introduction to Acting
  Performance of the Human Body
  Introduction to Playwriting
  The People's Voice
  American Drama
  Contemporary American Drama and Theater
  Culture Clash: Studies in U.S. Latino Theater
  Race, Gender, and Performance
  Ancient Theater and Drama
  Modern Theater and Drama
  Modern Contemporary
  Neoclassical Theater and Drama
  African American Performance
  Contemporary African Theater and Performance
  Shakespeare on Film and Stage

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
& Asian American Studies 122
* Asian American Studies 128
* Black Studies 33
* Black Studies 38A-B
* Black Studies 126
* Black Studies 127
* Black Studies 130A
* Black Studies 130B
& Chicano Studies 152
& Chicano Studies 180
& Chicano Studies 181
& Chicano Studies 184A
+ Chinese 35
+ Chinese 80
* Chinese 115A
* Chinese 124A-B
* Chinese 132A
* Chinese 148
* Classics 20A
* Classics 36
* Classics 39
* Classics 40
* Classics 55
* Classics 102
* Classics 109
* Classics 110
* Classics 130
* Classics 175
* Comparative Literature
* Comparative Literature 31
+ Comparative Literature 32
+ Comparative Literature 33
+ Comparative Literature 34
+ Comparative Literature 100
+ Comparative Literature 103
+ Comparative Literature 107
+ Comparative Literature 113
+ Comparative Literature 122A
+ Comparative Literature 122B
* Comparative Literature 126

Spanish Cinema

& Comparative Literature 133
& Comparative Literature 146
& Comparative Literature 154
& Comparative Literature 161
& Comparative Literature 170
+ Comparative Literature 171
* Comparative Literature 179A
* Comparative Literature 179B
* Comparative Literature 179C
* Comparative Literature 186A
* Comparative Literature 186B
* Comparative Literature 186E
* Comparative Literature 188
* Comparative Literature 189
* Comparative Literature 191
* English 15
* English 23
^ English 22

& English 25
& English 34
& English 34NA
&* English 38A-B
&* English 50
* English 65AA-ZZ
* English 101
* English 102
* English 103A
* English 103B
* English 104A
* English 104B
* English 105A
* English 105B
* English 113AA-ZZ
* English 114AA-ZZ
* English 114BW
* English 115
* English 116A
* English 116B
* English 119X
* English 120
* English 121
* English 122AA-ZZ
* English 122NE
* English 124
* English 126B
* English 128AA-ZZ
* English 131AA-ZZ
@* English 133AA-ZZ
@& English 134AA-ZZ

* Comparative Literature 128A
* Comparative Literature 131
* Comparative Literature 147
* Comparative Literature 152
* Comparative Literature 153
* Comparative Literature 154
* Comparative Literature 155
* Comparative Literature 156
* Comparative Literature 157
* Comparative Literature 158
* Comparative Literature 159
* Comparative Literature 160
* Comparative Literature 162
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* Comparative Literature 166
* Comparative Literature 167
* Comparative Literature 168
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* Comparative Literature 170
* Comparative Literature 171
* Comparative Literature 172
* Comparative Literature 173
* Comparative Literature 174
* Comparative Literature 175
* Comparative Literature 176
* Comparative Literature 177
* Comparative Literature 178

Children's Literature
Transpacific Literature
Borders
Science Fiction in Eastern Europe
Literary Translation: Theory and Practice
Post-Colonial Cultures (Same as FR 154G)
Interdisciplinary Comparative Literature
Narrative Studies
Narrative in the First Person
Fantasy and the Fantastic (Same as FR 153D)
Interdisciplinary Theory and Practice
The Climate Crisis: What it is and what each of us can do about it
Introduction to Literature and the Environment
Introduction to Literature and the Environment, Part 2, World Perspectives
Introduction to Literature and the Culture of Pan-Latinx Literatures Information
Animacy and the Speaking Earth: The Power of Native Story
Introduction to African American Literature
Introduction to U.S. Minority Literature
Topics in Literature
English Literature from the Medieval Period to 1650
American Literature from 1789 to 1900
British Literature from 1799 to 1900
American Literature from 1900 to Present
British Literature from 1900 to Present
Shakespeare: Poems and Earlier Plays
Shakespeare: Later Plays
Literary Theory and Criticism
Women and Literature
Black Women Authors
Medieval Literature
Biblical Literature: The Old Testament
Medieval Literature in Translation
Modern Drama
The Art of Narrative
Cultural Representations
Cultural Representations of Nature and the Environment (Same as ENV 5 122NE)
Readings in the Modern Short Story
Survey of British Fiction
Literary Genres
Studies in American Literature
Studies in American Regional Literature
Literature of Cultural and Ethnic Communities in the United States
Seventeenth and Eighteenth Century
American Literature
Poetry in America
Contemporary American Literature
Anglo-Irish Literature
Chaucer: Canterbury Tales
Literature of Chivalry
English Renaissance Drama
Milton
Topics in Literature
Studies in Literature and the Mind
Studies in the Enlightenment
British Romantic Writers
The Victorian Era
Studies in the Nineteenth Century
Modern European Literature

* 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.
**Special Subject Area Supplementary List of Courses**

Note: These courses do not fulfill requirements for Areas D, E, F, or G. They satisfy the university and special subject area requirements listed only.

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<td>Anthropology 116B</td>
<td>Anthropological Approaches to Religion</td>
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<tr>
<td>Anthropology 143</td>
<td>Introduction to Contemporary Social Theory</td>
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<tr>
<td>Anthropology 148A</td>
<td>Comparative Ethnicity</td>
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<tr>
<td>Anthropology 169</td>
<td>The Evolution of Cooperation</td>
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<tr>
<td>Anthropology 172</td>
<td>Colonialism and Culture</td>
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<td>Anthropology 174</td>
<td>Hispanic Novel and Cinema</td>
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<td>Course Code</td>
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<tr>
<td>History 179A</td>
<td>Native American History to 1838</td>
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<tr>
<td>History 179B</td>
<td>Native American History, 1838 to Present</td>
</tr>
<tr>
<td>History 184B</td>
<td>History of China</td>
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<tr>
<td>INT 36 SAA-ZZ</td>
<td>Engaging Humanities Learning Community</td>
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<tr>
<td>INT137AA-ZZ</td>
<td>Engaging Humanities Discovery Course</td>
</tr>
<tr>
<td>Japanese 17</td>
<td>Imagining the Samurai</td>
</tr>
<tr>
<td>Japanese 167A</td>
<td>Religion in Japanese Culture</td>
</tr>
<tr>
<td>Japanese 186RW</td>
<td>Seminar in Japanese Art</td>
</tr>
<tr>
<td>Latin American &amp; Iberian Studies 10</td>
<td>Introduction to the Latin American and Iberian Studies</td>
</tr>
<tr>
<td>Latin American &amp; Iberian Studies 100</td>
<td>Introduction to Latin American and Iberian Studies</td>
</tr>
<tr>
<td>Linguistics 113</td>
<td>Introduction to Semantics</td>
</tr>
<tr>
<td>Linguistics 114</td>
<td>Advanced Phonology</td>
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<tr>
<td>Linguistics 131</td>
<td>Sociolinguistics</td>
</tr>
<tr>
<td>Linguistics 137</td>
<td>Introduction to First Language Acquisition</td>
</tr>
<tr>
<td>Linguistics 138</td>
<td>Language Socialization</td>
</tr>
<tr>
<td>Materials 10</td>
<td>Materials in Society: The Stuff of Dreams</td>
</tr>
<tr>
<td>Molecular, Cellular, and Developmental Biology 134H</td>
<td>Mariculture for the 21st Century</td>
</tr>
<tr>
<td>Music 3A</td>
<td>Introduction to Music Studies</td>
</tr>
<tr>
<td>Music 10A-B-C</td>
<td>Introduction to Music from Early Modern Culture through Modernism</td>
</tr>
<tr>
<td>Philosophy 7</td>
<td>Biomedical Ethics</td>
</tr>
<tr>
<td>Physics 13AH</td>
<td>Honors Experimental Physics</td>
</tr>
<tr>
<td>Physics 128AL-BL</td>
<td>Advanced Experimental Physics</td>
</tr>
<tr>
<td>Political Science 1</td>
<td>Introduction to Political Philosophy</td>
</tr>
<tr>
<td>Political Science 7</td>
<td>Introduction to International Relations</td>
</tr>
<tr>
<td>Political Science 114</td>
<td>Democracy and Diversity</td>
</tr>
<tr>
<td>Political Science 127</td>
<td>American Foreign Policy</td>
</tr>
<tr>
<td>Political Science 129</td>
<td>The United States, Europe, and Asia in the Twenty-First Century</td>
</tr>
<tr>
<td>Political Science 152</td>
<td>American Political Parties</td>
</tr>
<tr>
<td>Political Science 153</td>
<td>Political Interest Groups</td>
</tr>
<tr>
<td>Political Science 157</td>
<td>The American Presidency</td>
</tr>
<tr>
<td>Political Science 158</td>
<td>Power in Washington</td>
</tr>
<tr>
<td>Political Science 160</td>
<td>Asian American Politics</td>
</tr>
<tr>
<td>Political Science 161</td>
<td>U.S. Minority Politics</td>
</tr>
<tr>
<td>Political Science 162</td>
<td>Urban Government and Politics</td>
</tr>
<tr>
<td>Political Science 165</td>
<td>Criminal Justice</td>
</tr>
<tr>
<td>Political Science 180</td>
<td>Bureaucracy and Public Policy</td>
</tr>
<tr>
<td>Political Science 185</td>
<td>Government and the Economy</td>
</tr>
<tr>
<td>Psychology 10A</td>
<td>Research Methods</td>
</tr>
<tr>
<td>Psychology 90A-B-C</td>
<td>First-Level Honors Seminar</td>
</tr>
<tr>
<td>Psychology 110L</td>
<td>Laboratory in Perception</td>
</tr>
<tr>
<td>Psychology 111L</td>
<td>Laboratory in Biopsychology</td>
</tr>
<tr>
<td>Psychology 112L</td>
<td>Laboratory in Social Behavior</td>
</tr>
<tr>
<td>Psychology 116L</td>
<td>Laboratory in Animal Learning</td>
</tr>
<tr>
<td>Psychology 117L</td>
<td>Laboratory in Human Memory and Cognition</td>
</tr>
<tr>
<td>Psychology 118L</td>
<td>Laboratory in Attention</td>
</tr>
<tr>
<td>Psychology 120L</td>
<td>Advanced Research Laboratory</td>
</tr>
<tr>
<td>Psychology 135A-B-C</td>
<td>Field Experience in Psychological Settings</td>
</tr>
<tr>
<td>Psychology 153L</td>
<td>Laboratory in Developmental and Evolutionary Psychology</td>
</tr>
<tr>
<td>Religious Studies 84</td>
<td>Introduction to Islamic Civilization</td>
</tr>
<tr>
<td>Religious Studies 106</td>
<td>Ritual Art and Verbal Art of the Pacific Northwest</td>
</tr>
<tr>
<td>Religious Studies 110D</td>
<td>Modernity and the Process of Secularization</td>
</tr>
<tr>
<td>Religious Studies 111D</td>
<td>Christian Thought and Cultures of the Middle Ages</td>
</tr>
<tr>
<td>Religious Studies 131F</td>
<td>The History of Anti-Semitism</td>
</tr>
<tr>
<td>Religious Studies 131J</td>
<td>Introduction to Rabbinic Literature</td>
</tr>
<tr>
<td>Religious Studies 140A</td>
<td>Islamic Traditions</td>
</tr>
<tr>
<td>Religious Studies 140B</td>
<td>Religion, Politics, and Society in the Persian Gulf Region</td>
</tr>
<tr>
<td>Religious Studies 140C</td>
<td>Islamic Mysticism and Religious Thought</td>
</tr>
<tr>
<td>Religious Studies 140D</td>
<td>Islam in South Asia</td>
</tr>
<tr>
<td>Religious Studies 140E</td>
<td>Islam in America</td>
</tr>
<tr>
<td>Religious Studies 140F</td>
<td>Modern Islamic Movements</td>
</tr>
<tr>
<td>Religious Studies 145</td>
<td>Patterns in Comparative Religion</td>
</tr>
<tr>
<td>Religious Studies 149R</td>
<td>Islamic Philosophy and Theology</td>
</tr>
<tr>
<td>Religious Studies 160A</td>
<td>Religious Traditions of India</td>
</tr>
<tr>
<td>Religious Studies 162A</td>
<td>Indian Philosophy</td>
</tr>
<tr>
<td>Religious Studies 166C</td>
<td>Confucian Traditions: The Classical Period</td>
</tr>
</tbody>
</table>
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, and G must be at least 6.

General Subject Areas

1. Area A: English Reading and Composition

   Writing 2 or 2E and Writing 50, 50E, 105CD, 105CW, 105M, 105PD, 105PS, 105S, 105SW, 107B, 107EP, 107G,

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 – (4 courses)

b. Ethnicity Requirement – (1 course)

c. European Traditions or World Cultures Requirement – (1 course)
Department of Chemical Engineering, Engineering II, Room 3357; (805) 893-3412
www.chemengr.ucsb.edu
Chair: Rachel A. Segalman
Vice-Chairs: Michael J. Gordon
M. Scott Shell

Faculty

Joseph Chada, Ph.D., University of Wisconsin, Lecturer with Potential Security of Employment
Bradley Chmelka, Ph.D., UC Berkeley, Distinguished Professor (self-assembled materials, heterogeneous catalysis, surfactants and polymers, porous and composite solids, magnetic resonance)
Phillip 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, crystal 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, Professor (surface physics, scanning probe microscopy, nanoscale materials, plasmonics, laser spectroscopy)
Song-I Han, Ph.D., Aachen University of Technology, Professor (magnetic resonance methods and applications, protein biophysics, spectroscopy)
Matthew E. Helgeson, Ph.D., University of Delaware, Associate 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)
Arnab 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, Associate Professor (genetic and cellular engineering, membrane protein characterization for drug discovery, protein biophysics, metagenomics, biofuel production)
James B. Rawlings, Ph.D., University of Wisconsin, Distinguished Professor (chemical process monitoring and control, reaction engineering, computational modeling)
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, microrheology, complex fluids)
Sho Takatori, Ph.D., California Institute of Technology, Assistant Professor (statistical mechanics and fluid dynamics of biological systems, microbial and cellular communities)

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
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
*1 Joint appointment with Materials
*2 Joint appointment with Mechanical Engineering
*3 Joint appointment with Chemistry and Biochemistry

Affiliated Faculty

Christopher Bates, Ph.D. (Materials)
David Gay, Ph.D. (ICB)
Mahdi Abu Omar, Ph.D. (Chemistry)
Philip Alan Pincus, Ph.D. (Materials)

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

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

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

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

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

Mission Statement

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

Objectives for the Undergraduate Program

Educational Objectives
• Our graduates will be innovative, competent, contributing chemical engineers.
• Our graduates will demonstrate their flexibility and adaptability in the 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 judgments, 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) DOHERTY, SHELL, CHADA
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. Material & Energy Balances
(3) GORDON, CHADA
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; Space may be limited and registration priority will be given to Chemical engineering and CoE majors.

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) O’MALLEY, 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
(3) SHELL
Prerequisite: Chemical Engineering 5, Chemical Engineering 10, Mathematics 4B or 4BI; Space may be limited and registration priority will be given to Chemical engineering and CoE majors.

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, SCOTT
Prerequisite: Chemical Engineering 110A with a minimum grade of C; Mathematics 4B or 4BI. Space may be limited and registration priority will be given to Chemical engineering and CoE majors.

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

118. Technical Communication of Chemical Engineering (1) STAFF
Prerequisites: Chemical Engineering 110A. Provides an introduction to technical communication in the form of writing reports and oral presentations. Emphasis placed on how to analyze and present data; critical thinking; organization; logic and constructing a technical narrative; literature searching and citations for written reports; and how to give oral presentations. Includes various lectures on technical communication, individual and group assignments, and peer-review exercises.

120A. Transport Processes (4) SOURES, DEY
Prerequisites: Chemical Engineering 10 with a minimum grade of C- (may be taken concurrently); Mathematics 4B or 4BI; Mathematics 6A or 6A-I-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) HELGESON, CHMELKA
Prerequisite: Chemical Engineering 10 with a minimum grade of C; Chemical Engineering 110A with minimum grade of C (may be taken concurrently); Chemical Engineering 120A. Introductory course in the mathematical analysis of conductive, convective and radiative heat transfer with practical applications to design of heat exchange equipment and use.

120C. Transport Processes (3) DEY, SOURES
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 (3) MCFARLAND
Prerequisites: Chemical Engineering 120A-B-C or Mechanical Engineering 151A-B; and Mechanical Engineering 152A. Same course as ME 124.
Hazard identification and assessments, runaway reactions, emergency response, plant accidents and safety issues. Dispersion and consequences of releases.

125. Principles of Bioengineering (3) STAFF
Prerequisites: Chemical Engineering 110A-B or consent of instructor. Thermodynamics, kinetics, mass and energy transport considerations associated with complex homogeneous and heterogeneous reacting systems. Catalytic and catalysis reactor rates and mechanisms. Adsorption and reaction at solid surfaces, including effects of diffusion in porous materials. Chemical reactors using heterogeneous catalysts.

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

146. Heterogenous Catalysis (3) STAFF
Prerequisite: 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 (3) CHMELKA, CHAD
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) RAWLINGS
Prerequisite: Chemical Engineering 152A.
The theory, design, and experimental application of advanced process control strategies including feedback control, cascade control, enhanced single-loop strategies, and model predictive control. Analysis of multi-loop control systems. Introduction to on-line optimization.

154. Engineering Approaches to Systems Biology (3) STAFF
Prerequisite: Chemical Engineering 107; Mathematics 4B or 4BI; Mathematics 6A or 6A-I 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
Prerequisite: Chemical Engineering 110A or Chemisty 113A or equivalent.
Same course as MRS 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.

166. Mechtronics and Instrumentation for Chemical Engineers (3) GORDON
Prerequisite: Engineering 3 and Chemical Engineering 110A and B, or consent of instructor.
Recommended Preparation: Chemical Engineering 120A and B and Chemical Engineering 132A and B.

Enrollment Comments: Concurrently offered with Chemical Engineering 26A.

Introduction to electromechanical systems and instrumentation used in Chemical Engineering. Fundamentals of transducers, sensors and actuators; interfacing and controlling hardware with software (Arduino & Matlab programming); analog and digital circuits; hands-on electrical and mechanical design, prototyping, and construction. Students produce a final computer-controlled electromechanical project of their own design, or in conjunction with a CHE-faculty research laboratory.

171. Introduction to Biochemical Engineering (3) DEY, O’MALLEY
Prerequisite: Chemical Engineering 107 or MCDB 1A.
Introduction to biochemical engineering covering cell growth kinetics, bioreactor design, enzyme processes, biotechnologies for modification of cellular information, and molecular and cellular engineering.

173. Omics-Enabled Biotechnology (3) O’MALLEY
Prerequisite: Chemical Engineering 107 or MCDB 1A.
This course will integrate genomic, transcriptomic, metabolomic, and proteomic approaches to quantify and understand intricate biological systems.

174. Model-Guided Engineering of Biological Systems (3) MUKHERJEE
Prerequisites: Chemical Engineering 10; Chemical Engineering 107 or equivalent, or consent of instructor.
Introduces students to fundamental principles underlying synthetic biology with an emphasis on mathematical modeling of gene regulation using differential equations and mass action kinetics. Students will also learn to design and predict the functional outcomes of synthetic gene circuits and review primary literature in the field.

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

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

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

184B. Design of Chemical Processes (3) DOHERTY, MCFARLAND, CHADA
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
Prerequisite: Consent of Department.
Enrollment Comments: Student must have a minimum 3.0 GPA. May not be used as departmental elective. May be repeated to a maximum of 12 units. Special projects for selected students. Offered in conjunction with engineering practice in selected industrial and research firms, under direct faculty supervision. A 2-4 page paper and an evaluation from the supervisor will be required for credit.

196. Undergraduate Research (2-4) STAFF
Prerequisite: Upper-division standing, completion of 2 upper-division courses in Chemical Engineering; consent of the instructor.
Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated for up to 12 units. Not more than 3 units may be applied to departmental electives.
Research opportunities for undergraduate students. Students will be expected to give regular oral presentations, actively participate in a weekly seminar, and prepare at least one written report on their research.

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

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

Computer Engineering Major, 
Trailer 380, Room 101;  
(805) 893-5615  
info@ce.ucsb.edu  
www.ce.ucsb.edu  
Director: Li-C. Wang

Faculty
Jonathan Balkind, Ph.D., Princeton University, Assistant Professor (Computer Architecture, Programming Languages, and Operating Systems)
Koustav Banerjee, Ph.D., UC Berkeley, Professor (high performance VLSI and mixed signal system-on-chip designs and their design automation methods; single electron transistors; 3D and optoelectronic integration)
Forrest D. Brewer, Ph.D., University of Illinois at Urbana-Champaign, Professor (VLSI and computer system design automation, theory of design and design representations, symbolic techniques in high level synthesis)
Tevfik Bultan, Ph.D., University of Maryland, College Park, Professor (specification and automated analysis of concurrent systems, computer-aided verification, model checking)
Kerem Camsari, Ph.D., Purdue University, Assistant Professor (Nanoelectronics, Spintronics, Emerging Technologies for Computing, Digital & Mixed-signal VLSI, Neuromorphic & Probabilistic Computing, Quantum Computing, Hardware Acceleration)
Yufei Ding, Ph.D., North Carolina State University, Assistant Professor (high-level large-scale program optimizations, highperformance domain-specific languages, heterogeneous massively parallel computing, high-performance machine learning, and quantum computing)
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)
Chandra Krintz, Ph.D., University of California, San Diego, Professor (dynamic and adaptive compilation systems, high-performance internet (mobile) computing, runtime and compiler optimizations for Java/CL, efficient mobile program transfer formats)
Peng Li, Ph.D., Carnegie Mellon University, Professor (Integrated circuits and systems, learning algorithms and circuits for brain-inspired computing, electronic design automation, computational brain modeling, hardware machine learning systems)
Behrooz Parhami, Ph.D., UC Los Angeles, Professor (parallel architectures and algorithms, computer arithmetic, computer design, dependable and fault-tolerant computing)
Tim Sherwood, Ph.D., UC San Diego, Professor (computer architecture, dynamic optimization, network and security processors, embedded systems, program analysis and characterization, and hardware support of software systems)
Dmitri B. Strukov, Ph.D., Stony Brook University, Assistant Professor (hybrid circuits, nanoelectronics, resistance switching devices, memristors, digital memories, programmable circuits, bio-inspired computing)
Luke Theogarajan, Ph.D., Massachusetts Institute of Technology, Associate Professor (low-power analog VLSI, biomimetic nanosystems, neural prostheses, biosensors, block co-polymer synthesis, self-assembly, and microfabrication)
Li-C. Wang, Ph.D., University of Texas at Austin, Professor (design verification, testing, computer-aided design of microprocessors)
Richard Wolski, Ph.D., UC Davis/Livermore, Professor (high-performance distributed computing, computational grids, computational economies for resource allocation and scheduling)
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)

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.

Student Outcomes

Upon graduation, students from the CE 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 judgments, 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—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 letter grades. They cannot be taken for the passed/not passed grading option.

The upper-division requirements consist of a set of required courses and a minimum of 48 units (12 classes) of additional departmental elective courses comprised of at least two sequences chosen from a set of eight specialty sequences. Each sequence must consist of two or more courses taken from the same course/sequence group. The department electives must also include a capstone design project (CMPSC 189A-B/ECE 189A-B-C).

Upper-division courses required for the major are: Computer Science 130A; ECE 152A, 154A; either ECE 139 or PSTAT 120A; Engineering 101.

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

- Computer Systems Design: ECE/CMPSC 153A, ECE 153B
- Computer Networks: CMPSC 176A, CMPSC 176B
- Distributed Systems: CMPSC 171 and one or both of the Computer Networks courses
- Programming Languages: CMPSC 160, 162
- Real-Time Computing & Control: ECE 147A-B
- Multimedia: ECE 178, ECE/CMPSC 181, ECE 160
- VLSI: ECE 122A or ECE 123, ECE 122B
- Signal Processing: ECE 130A-B
- Robotics: ECE 179D, ECE 179P
- Design & Test Automation: ECE 157A, ECE 157B
- Machine Learning: CMPSC 165A, CMPSC 165B
- System Software Architecture: CMPSC 170, CMPSC 171

Satisfactory Progress & Prerequisites

A majority of Computer Science and Electrical and Computer Engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite classes requires a grade of C or better in Mathematics 3A-B and 4A, and a grade of C- or better in ECE classes. Students will not be permitted to take any ECE or CMPSC course if they received a grade of F in one or more of its prerequisites. Students who fail to maintain a grade-point average of at least 2.0 in the major may be denied the privilege of continuing in the major.

Computer Engineering Courses

See listings for Computer Science starting on page 28 and Electrical and Computer Engineering starting on page 30.
Computer Science

Department of Computer Science, Harold Frank Hall, Room 2104; (805) 893-4321; www.cs.ucsb.edu
Chair: Tevfik Bultan
Vice Chairs: Ben Hardekopf
Chandra Krintz

Faculty

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

Prabhanjan Ananth, Ph.D., University of California, Los Angeles, Glenn and Susanne Culler Glenn and Susanne Culler Chair Assistant Professor (security and cryptography)

Jonathan Balkind, Ph.D., Princeton University (computer architecture, programming languages, operating 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)

Michael Beyeler, Ph.D., University of California, Irvine, Assistant Professor (human centered and social computing; visual computing and interaction)*5

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

Shiyu Chang, Ph.D., University of Illinois at Urbana-Champaign, Assistant Professor (machine learning, artificial intelligence, natural language processing, computer vision)

Shiyu Chang, Ph.D., University of Illinois at Urbana-Champaign, Assistant Professor (machine learning, artificial intelligence, natural language processing, computer vision)

Shumo Chu, Ph.D., University of Washington, Assistant Professor (database and information systems)

Phillip Conrad, Ph.D., University of Delaware, SeniorTeaching Professor (computer science education, web technologies, computer networks and communication, transport protocols, multimedia computing)*1

Wim van Dam, Ph.D., University of Oxford and University of Amsterdum, Professor (quantum computation, quantum algorithms, quantum communication, quantum information theory)*5

Yufei Ding, Ph.D., North Carolina State University, Assistant Professor (high-level large-scale program optimizations, high-performance domain-specific languages, heterogeneous massively parallel computing, high-performance machine learning, and quantum computing)

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

Yu Feng, Ph.D., University of Texas at Austin, Assistant Professor (programming languages and software engineering)

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)*2

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)

Arpit Gupta, Ph.D. Princeton University, Assistant Professor (machine learning and data mining; security and cryptography)

Trinabh Gupta, Ph.D., University of Texas at Austin, Assistant Professor (computer systems with a focus on privacy)

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

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

Yekaterina Kharitonova, Ph.D., University of Arizona, Assistant Professor (algorithmic, optimization, and information theory)

Chandra Krintz, Ph.D., University of California, San Diego, Professor (programming systems, cloud/edge computing, Internet of Things (IOT), distributed systems, agriculture technology)

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

Lei Li, Ph.D., Carnegie Mellon University, Assistant Professor (artificial intelligence, machine learning and natural language processing)

Daniel Lokshutanov, Ph.D., University of Bergen, Associate Professor (algorithms, theory of computing)

Diba Mirza, Ph.D., University of California, San Diego, Associate Teaching Professor

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

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

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

Misha Sra, Ph.D. Massachusetts Institute of Technology, John and Eileen Gerngross Chair Assistant Professor (database and information systems)

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

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

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

Eric Vigoda, Ph.D., University of California, Berkeley, Professor (randomized algorithms, computational complexity)

Richert K. Wang, Ph.D.,
University of California, Irvine, Assistant Teaching Professor

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

Yu-Xiang Wang, Ph.D., Carnegie Mellon University, Eugene Aas Chair Assistant Professor (machine learning, statistics, optimization, artificial intelligence, data science)

William Wang, Ph.D., Carnegie Mellon University, Assistant Professor (natural language processing, machine learning, deep learning, artificial intelligence, knowledge 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)

Zoë Wood, Ph.D., California Institute of Technology, Teaching Professor (visual computing and interaction)

LingqYan, Ph.D., University of California, Berkeley, Assistant Professor (computer graphics: realistic/real-time rendering, appearance modeling/measurements, virtual/augmented reality, applied machine learning)

Xifeng Yan, Ph.D., University of Illinois at Urbana Champaign, Venkatesh Narayananurmi, Venkatesh Narayananurmi Chair/Chair Professor (Database Mining/Databases, Natural Language Processing/Machine Learning/AI)

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

**Emeriti Faculty**

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

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

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

Teofilo Gonzalez, Ph.D., University of Minnesota, Professor Emeritus (approximation algorithms; parallel computing multicasting, scheduling theory, placement and routing)

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

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

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

Terence R. Smith, Ph.D., Johns Hopkins University, Professor Emeritus (spatial databases, techniques in artificial machine intelligence)⁴

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

*¹ Joint appointment with College of Creative Studies
*² Joint appointment with Mechanical Engineering
*³ Joint appointment with Biomolecular Science & Engineering
*⁴ Joint appointment with Geography
*⁵ Joint appointment with Physics
*⁶ Joint appointment with Psychological and Brain Sciences

**Affiliated Faculty**

Francesco Bullo, Ph.D. (Mechanical Engineering)[insert after Bullo and before Chandrasekaran]

Katie Byl, Ph.D. (Electrical and Computer Engineering)

Shivkumar Chandrasekaran, Ph.D. (Electrical and Computer Engineering)

Miguel Eckstein, Ph.D. (Psychological & Brain Sciences)

Jennifer Jacobs, Ph.D. (Media Arts and Technology)

Kyle Mahowald, Ph.D. (Linguistics)

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

Yasamin Mostofi, Ph.D. (Electrical and Computer Engineering)[insert after Sen and before Zhang]

Pradeep Sen, Ph.D. (Electrical and Computer Engineering)

Sharon Tettegah, Ph.D. (Black Studies)

Simon Todd, Ph.D. (Linguistics)

Zheng Zhang, Ph.D. (Electrical and Computer Engineering)

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 Department of Computer Science 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. 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 uses 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 who wish to seek immediate employment are prepared for a wide range of computer science positions in industry and government. Outstanding graduates interested in highly technical careers, research, and/or academia, might consider furthering their education in graduate school.

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

**Program Outcomes for Undergraduate Programs**
The program enables students to achieve, by the time of graduation:
1. An ability to apply knowledge of computing and mathematics appropriate to computer science.
2. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.
3. An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.
4. An ability to function effectively on teams to accomplish a common goal.
5. An understanding of professional, ethical, and social responsibilities.
6. An ability to communicate effectively.
7. An ability to analyze the impact of computing on individuals, organizations, and society, including ethical, legal, security, and global policy issues.
8. Recognition of the need for and an ability to engage in continuing professional development.
9. An ability to use current techniques, skills, and tools necessary for computing practice.
10. An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices.
11. An ability to apply design and development principles in the construction of software systems of varying complexity.

**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**

8. Introduction to Computer Science
   (4) KHARITONOVA, MIRZA, MATNI
   Not open for credit to students who have completed Computer Science 16 or Engineering 3.
   Legal repeat for CMPSC SAA-2Z.
   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
   (4) KHARITONOVA, MIRZA
   Prerequisite: Math 3A with a grade of C or better.

**UPPER DIVISION**

100. Introduction to Teaching Methods in Computer Science
   (4) MIRZA
   Prerequisite: consent of instructor.
   May be repeated to a maximum of 12 units.
   Designed to train outstanding undergraduates for learning assistant positions in CS courses. Lecture/discussion surveys current research and best practices in CS pedagogy including student development theories, different pedagogical techniques,
and methods for assessing learning. Students gain experience working one-on-one with students, fostering positive learning environments, and providing feedback on student work. Students who successfully complete this course will earn units by serving as an apprentice undergraduate learning assistant.

110. Introduction to Research in Computer Science
(4) MIZRA
Prerequisite: Computer Science 40 and Computer Science 32; consent of instructor.

- Defining a CS research problem, finding and reading technical papers, oral communication, technical writing, and independent learning. Course participants work in teams as they apprentice with a CS research group to propose an original research problem and write a research proposal.

111. Introduction to Computational Science
(4) GILBERT, MATNI
Prerequisite: Mathematics 4B with a grade of C or better; Mathematics 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 the numerical algorithms that form the foundations of data science, machine learning, and computational science and engineering. Matrix computation, linear equation systems, eigenvalue and singular value decompositions, numerical optimization. The informed use of mathematical software environments and libraries, such as python/numpy/scipy.

130A. Data Structures and Algorithms I
(4) EL ABBADI, SINGH, SURI
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.

- Data structures and applications with proofs of correctness and analysis. Hash tables, priority queues (heaps); balanced search trees. Graph traversal techniques and their applications. Graph traversal techniques and their applications.

130B. Data Structures and Algorithms II
(4) LIKHITANOV, SINGH, 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. Applications of techniques to problems from several disciplines. NP-completeness.

138. Automata and Formal Languages
(4) ESEGOGIU
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) YANG, T., GILBERT
Prerequisite: Mathematics 4B with a grade of C or better; Mathematics 6A with a grade of C or better; Computer Science 130A.

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

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

148. Computer Science Project
(4) CONRAD
Prerequisite: Computer Science 32 with a grade of C or better; open to Computer Science majors only. Not open for credit to students who have completed Computer Science 48 with a grade of C or better.

- CMPSC 148 is a legal repeat of CMPSC 48.

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 final projects.

153A. Hardware/Software Interface
(4) KRINZ
Prerequisite: Upper-division standing in computer science, computer engineering, or electrical engineering majors only.

- Same course as ECE 153A.

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

154. Computer Architecture
(4) MATNI
Prerequisite: Computer Science 32 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.

156. Advanced Applications Programming
(4) CONRAD
Prerequisite: Computer Science 24 and 32 with a grade of C or better; open to computer science and computer engineering majors only.

- Not open for credit to students who have completed Computer Science 56 with a grade of C or better.

- CMPSC 156 is a legal repeat of CMPSC 56. Not open for credit to students who have completed Computer Science 20.

Advanced application programming using a high-level, virtual-machine-based language. Topics include generic programming, exception handling, automatic memory management, and application development, management, and maintenance tools, third-party library use, version control, software testing, issue tracking, code review, and working with legacy code.

160. Translation of Programming Languages
(4) DING, HARDEKOPP
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-construct tools.

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

- Concepts of programming languages: scopes, parameter passing, storage management; control flow, exception handling; encapsulation and modularization mechanisms; 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) WANG, YK., YAN
Prerequisite: Computer Science 130A.

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

165B. Machine Learning
(4) WANG, W., DING
Prerequisite: Computer Science 130A (the ‘recommended preparation’ should be on the next line and not italicized).

Recommended preparation: Computer Science 111.

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

170. Operating Systems
(4) WOLSKI, GUPTA T.
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.

172. Software Engineering
(4) BULTAN
Prerequisite: Computer Science 130A; computer science or computer engineering majors only, or by consent of department.

Software engineering is concerned with long-term, large-scale programming projects. Software management, cost estimates, problem specification and analysis, system design techniques, system testing and performance evaluation, and system maintenance. Students will design, manage, and implement a medium-sized project.

174A. Fundamentals of Database Systems
(4) SU
Prerequisite: Computer Science 130A.

- Recommended Preparation: Students are strongly encouraged to complete Computer Science 56 or Computer Science 156 prior to enrolling in Computer Science 174A.

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

174B. Design and Implementation Techniques of Database Systems
(4) SU, YAN
Prerequisite: Computer Science 130B.

- Recommended Preparation: Students are strongly encouraged to complete Computer Science 56 or Computer Science 156 prior to enrolling in Computer Science 174B.
181. Introduction to Computer Vision
(4) WANG YF.
Prerequisite: Upper-division standing.
Same course as ECE 181.
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 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 or Computer Science 156; 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 or Computer Science 156 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, KRINTZ
Prerequisite: Computer Science 48 or 56 or 148 or 156 or 172; Senior standing in computer science or computer engineering.
Not open for credit to students who have completed 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, KRINTZ
Prerequisite: CMPSC 189A; Senior standing in computer science or computer engineering.
Not open for credit to students who have completed ECE 189A or ECE 189B.
Student groups design a significant computer-based project. Multiple groups may cooperate toward one large project. Each group works independently; interaction among groups is via interface specifications and informal meetings. Project for course may be different from that in first course.

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

192. Projects in Computer Science
(1-5) STAFF
Prerequisite: consent of instructor.
Students must have a minimum 3.0 GPA.
May be repeated to a maximum of 6 units with consent of the department chair but only 4 units may be applied to the major.
Projects in computer science for advanced undergraduate students.

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

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

196B. Undergraduate Research
(2-4) STAFF
Prerequisites: Undergraduate Research (2) have consent of instructor.
Designed for majors. May be repeated for up to 12 units. No more than 4 units may be applied to departmental electives.
Advanced research for undergraduate students, by petition after completing a minimum of 4 units of CMPSC 196 for a letter grade. The student will propose a specific research project and make a public presentation of final results. Evaluation and grade will be based on feedback from the research faculty advisor and one other faculty member.

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

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

Department of Electrical and Computer Engineering, Building 380, Room 101; (805) 893-2269 or (805) 893-3821
www.ece.ucsb.edu
Chair: B.S. Manjunath
Vice Chair: Luke Theogarajan

Faculty

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

Mahnoosh Alizadeh, Ph.D., UC Davis, Assistant Professor (Smart power grids, demand response and renewable energy integration, cyber-physical systems, network control)

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 SOE (semiconductor device physics and electronic devices, power electronics, engineering education)

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)

Kerem Camsari, Ph.D., Purdue University, Assistant Professor (Nano electronics, Spintronics, Emerging Technologies for Computing, Digital & Mixed-signal VLSI, Neuromorphic & Probabilistic Computing, Quantum Computing, Hardware Acceleration)

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 (metalorganic 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, multi-agent control systems, game theory, optimization, distributed control over communication networks also known as networked control systems, coordination and control of groups of unmanned air vehicles, the use of vision in feedback control, network security)

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


Jonathan Klamkin, Ph.D., UC Santa Barbara, Professor (Integrated Photonics, Silicon Photonics, Optical Communications, Nonphotonic, 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)

Peng Li, Ph.D., Carnegie Mellon University, Professor (Integrated circuits and systems, learning algorithms and circuits for braininspired computing, electronic design automation, computational brain modeling, hardware machine learning 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, Professor (Feedback Control and Systems Theory; Game Theoretic Methods for Coordination of Large Scale Distributed Systems; Application to Distributed Traffic Routing, Dynamic Resource Allocation, Queueing Systems, and Sensor Networks)

Umesh 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)

Galan Moody, Ph.D., University of Colorado-Boulder, Assistant Professor (Quantum Photonics; Nanoscale Quantum Systems and Devices including Quantum Dots and 2D Materials; Quantum Light Generation, Manipulation, and Detection; Hybrid Quantum Systems; Valleytronics)

Yasamin Mostofi, Ph.D., Stanford University, Professor (RF sensing, robotics,
wireless systems, multi-agent systems, mobile sensor networks)

**Christopher Palmstrom**, Ph.D., Leeds University, 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

**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 (nm and THz electronics: THz Transistors, nm VLSI Transistors VLSI, 100-1000GHz RF/Wireless ICs, beyond-5G-wireless, ICs for fast Optical Fiber Communication)

**Kenneth Rose**, Ph.D., California Institute of Technology, Distinguished Professor, (information theory, source and channel coding, image coding, communications, pattern recognition)

**Loai Salem**, PhD, UC San Diego, Assistant Professor (power management integrated circuits, power electronics using new devices/passives, low-power mixed-signal circuits)

**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, Associate Professor (nanophotonics, organic optoelectronics, plasmonics, metamaterials)

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

**Spencer L. Smith**, PhD, UC Los Angeles, Associate Professor (neuroengineering, neuroscience, optics, imaging, visual processing neuronal circuitry)

**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)

**Yon Visell**, PhD, McGill University, Associate Professor (Haptics, robotics, sensors, virtual reality, interactive technologies) Joint Appointment: MAT

**Li-C. Wang**, Ph.D., University of Texas, Austin, Professor (Artificial Intelligence for Design and Test, Data Analysis, Machine Learning)

**Robert York**, Ph.D., Cornell University, Distinguished Professor (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, desing synthesis, 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)

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

**Petar V. Kokotovic**, Ph.D., USSR Academy of Sciences, Professor Emeritus, Director of Center for Control Engineering and Computation, Director of Center for Robust Nonlinear Control of 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)

**Malgorzata 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 Narayananmurti, 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)

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)

*1 Joint appointment with Materials

*2 Joint appointment with Computer Science

**Affiliated Faculty**

Bassam Bamieh, Ph.D. (Mechanical Engineering)

Elizabeth Belding, Ph.D. (Computer Science)

Francesco Bullo, Ph.D. (Mechanical Engineering)

Ranjit Deshmukh, Ph.D. (Environmental Studies)

Yufei Ding, Ph.D. (Computer Science)

Miguel Eckstein, Ph.D. (Psychological & Brain Sciences)

Chandra Krintz, Ph.D. (Computer Science)

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

Kunal Mukherjee, Ph.D. (Materials)

Shuji Nakamura, Ph.D. (Materials)

Tim Sherwood, Ph.D. (Computer Science)

William Wang, Ph.D. (Computer Science)

**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 post-graduate 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 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.

Student Outcomes

Upon graduation, students from the EE 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—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 large majority of electrical and computer engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite courses means receiving a grade of C- or better in prerequisite courses except for Mathematics 3A-B, Mathematics 4A-B and Mathematics 6A and 6B which require a grade of C or better to apply 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
Introductory seminar to expose students to a broad range of topics in Computer Engineering.

1B. Ten Puzzling Problems in Computer Engineering
(1) PARHAM
Prerequisite: Open to pre-computer engineering and computer engineering majors only. Not open for credit for those who have taken ECE 1
Gaining familiarity with, and motivation to study, the field of computer engineering, through puzzle-like problems that represent a range of challenges facing computer engineers in their daily problem-solving efforts and at the frontiers of research.

3. Introduction to Electrical Engineering
(1) STAFF
Prerequisites: Open to EE majors only. Lecture, 3 hours; laboratory, 2 hours
Introduction to fundamental design problems in Electrical Engineering through programming in Python. Includes basics of software engineering, algorithm design, data structures, with design problems derived from signals systems. Specific areas will include 1-D and 2-D signal processing, basic transforms and applications.

5. Introduction to Electrical & Computer Engineering
(1) 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 Electronic 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 2A-B or 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 only to electrical 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. (F)

10A. 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
Not open for credit for those who have received a C- or higher in ECE 2A.
The goal of 10Al 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, network analysis, resistors, nonlinear analysis and digital abstraction. (W)

10B. Foundations of Analog and Digital Circuits and Systems
(1) 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. (W)

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

10C. Foundations of Analog and Digital Circuits and Systems
(3) STAFF
Prerequisite: ECE 10B with a C- or better grade. Lecture: 3 hours
Not open for credit for those who have received a C- or higher in ECE 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, sinusoidal steady-state, impedance representation, feedback and resonance. (5)

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 propaga
delay in digital circuits and the resulting power dissipation, first order linear networks, second order linear networks, sinusoidal steady-state, impedance analysis and op-amp circuits.

15A. Fundamentals of Logic Design
(4) ZHANG
Prerequisites: Open to electrical engineering, computer engineering, and pre-computer engineering majors only.
Not open for credit to students who have completed ECE 15. Lecture, 3 hours; discussion, 1 hour.

Boolean algebra, logic of propositions, minterm and maxterm expansions, Karnaugh maps, Quine-McCluskey methods, multi-level circuits, combinational circuit design and simulation, multiplexers, decoders, programmable logic devices.

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

94AA-2Z. Group Studies in Electrical and Computer Engineering
(1-4) STAFF
Prerequisite: Consent of instructor.
Group studies intended for small number of advanced students who share an interest in a topic not included in the regular departmental curriculum.

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) BEN-YAA COV
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) BEN-YAACOV
Prerequisite: Either ECE 120A or ECE 124B with a minimum grade of C- or better in each of the courses. Lecture: 3 hours; Laboratory: 3 hours
Not open for credit to those who have taken ECE 124A.
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. Basic design 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, and positive definite matrices, singular value decomposition.

122A. VLSI Principles
(4) BANERJEE
Prerequisite: ECE 152A with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hours
Not open for credit for those who have taken ECE 124A or ECE 123.
Introduction to CMOS digital VLSI design: CMOS devices and manufacturing technology; transistor level design of static and dynamic logic gates and components and interconnections; circuit character-
ization: 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, electric-
cal 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) THEOGRARAJAN
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 137A with a minimum grade of C- in either. Lecture, 4 hours
Advanced digital VLSI design: CMOS scaling, nanoscale issues including variability, thermal manage-
ment, 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; open to EE and computer engineering majors only. Lecture: 2 hours; discussion, 2 hours
Analysis of continuous-time linear systems in the time and frequency domains. Stability criteria.

130B. Signal Analysis and Processing
(4) CHANDRASEKARAN
Prerequisite: ECE 130A with a grade of C- or better; open to EE and computer engineering majors only. Lecture, 3 hours; discussion, 2 hours
Analysis of discrete time linear systems in the time and frequency domains. Z transforms, Discrete Fourier transforms. Sampling and aliasing.

130C. Signal Analysis and Processing
(4) CHANDRASEKARAN
Prerequisites: ECE 130A-B with a minimum grade of C- in both. Lecture, 3 hours; discussion, 2 hours
Basic techniques for the analysis of linear models in electrical engineering: Gaussian elimination, vector spaces and linear equations, orthogonality, determinants, eigenvalues and eigenvectors, systems of linear differential equations, and positive definite matrices, singular value decomposition.

132. Introduction to Solid-State Electronic Devices
(4) STAFF
Prerequisite: Physics 4 or 24 with a minimum grade of C-. Mathematics 4B or 4B1 or 5A and Mathematics 5B or 6A or 6A1 or a minimum grade of C in each; and Mathematics 5C or 6B with a minimum grade of C-; open to EE and computer engineering majors only. Lecture: 3 hours; Discussion: 2 hours
Introduction to applied electromagnetics and wave phenomena in high frequency electron circuits and systems. Waveon transmission-lines, elements of electrostatistics and magnetostatics and applications plane waves, examples and applications to RF, microwave, and optical systems.

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

137A. Circuits and Electronics I
(4) RODWELL
Prerequisites: ECE 10A-B-C and ECE 10AL-BL-CL or ECE 2A-B-C, 130A, and 132 all with a minimum grade of C- in all; open to EE majors only. Lecture, 3 hours; laboratory, 3 hours.
Analysis and design of single stage and multistage transistor circuits including biasing, gain, impedances and maximum signal levels.

137B. Circuits and Electronics II
(4) RODWELL
Prerequisites: ECE 10C and 10CL or ECE 2C and 137A with a minimum grade of C- in both; open to EE majors only. Lecture, 3 hours; laboratory, 3 hours.
Analysis and design of single stage and multistage transistor circuits at low and high frequencies. Transient response. Analysis and design of feedback circuits. Stability criteria.

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

141A. Introduction To Nanoelectro-mechanical and Microelectromechanical Systems (NEMS/

146A. Digital Communication Fundamentals (5) MADHOW
Prerequisite: ECE 130A-B with a minimum grade of C-; open to EE majors only. Lecture: 3 hours; Laboratory: 6 hours
Signal and channel models, with emphasis on wireless systems; digital modulation; demodulation basics; statistical modeling of noise, including review of probability theory and random variables.

146B. Communication Systems Design (5) MADHOW
Prerequisite: ECE 130A-B and 146A with minimum grades of C-; open to EE majors only. Lecture: 3 hours; Laboratory: 6 hours
Optimal demodulation, including signal space geometry; communication performance characterization; advanced wireless communication techniques, including multi-antenna and multicarrier systems; other emerging frontiers in communications.

147A. Feedback Control Systems - Theory and Design (5) TEEL
Prerequisite: ECE 130A-B with a minimum grade of C- in each; open to EE and computer engineering majors only. Lecture: 3 hours; laboratory: 6 hours
Feedback systems design, specifications in time and frequency domains. Analysis and synthesis of closed loop systems. Computer aided analysis and design.

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

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.

149. Game Theory for Networked Systems (4) MADSEN
Prerequisite: upper division standing or consent of instructor.
An overview of game theory with an emphasis on application to multiagent systems. Game theory focuses on the study of systems that are comprised of interacting and possibly competing decision-making entities. Examples drawn from engineered, economic, and social systems.

150. Mobile Embedded Systems (4) STAFF
Prerequisite: Proficiency in JAVA programming, and a C-in ECE 152A.
Architectures of modern smartphones and their key hardware components including mobile application processors, communications chips, display, touchscreen, graphics, memory, battery, GPS, and various sensors; the OS and software development platform of smartphones; smartphone applications; low power design techniques.

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

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

153B. Sensor and Peripheral Interface Design (4) STAFF
Prerequisite: ECE 152A with a minimum grade of C-.
Lecture: 3 hours; Laboratory: 3 hours
Hardware description languages; field-programmable logic and ASIC design techniques. Mixed-signal 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) PARHAMI
Prerequisite: ECE 152A with a minimum grade of C-; open to EE and CMPEN majors only. Lecture: 3 hours; Discussion: 1 hour
Not open for credit to students who have completed Computer Science 154. ECE 154A is the formerly numbered ECE 154. Students who have taken ECE 154 and have received a grade of C- or lower may take ECE 154A for a better grade.
Instruction-set architecture (ISA) and computer performance; Machine instructions, assembly, addressing modes; Memory map, arrays, pointers; Procedure calls; Number formats; Simple ALU; Data path, control, microprogram; Buses, I/O programming, interrupts, Pipelined data paths and control schemes.

154B. Advanced Computer Architecture (4) STRUKOV
Prerequisite: ECE 154A with a C- grade or better.
Open to EE and CMPEN majors only. Lecture: 3 hours; Laboratory: 4 hours
Not open for credit to those who have taken Computer Science 154.
ISA variations; Pipeline data and control hazards; Fast ALU design; Instruction-level parallelism, multi-threading, VLIW; Vector and array processing, multi-/many-core chips; Cache and virtual memory; Disk, arrays; Shared- and distributed-memory systems, supercomputers; Reconfigurable and application-specific circuits.
157A. Machine Learning in Design and Test Automation
(4) LI C. WANG
Prerequisite: ECE 152A with a minimum grade of C-
Introduces the various machine learning techniques and how they are utilized to improve hardware design and test automation processes. The potential benefits and theoretical barriers for implementing a machine learning solution in practice are explained.

157B. Artificial Intelligence in Design and Test Automation
(4) LI C. WANG
Prerequisite: ECE 157A with a minimum grade of C-
Introduces an artificial intelligence system view to apply machine learning in design and test automation processes. The various components for building an Intelligent Engineering Assistant (IEA) to perform an engineering task in an industrial setting are explained.

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.
Recommended Preparation: Mathematics 124A.
Mathematics 124A is recommended but not required
Digital Signal Processing, with Applications: The
Fast Fourier transform, discrete cosine transform, and
multirate digital signal processing techniques, with
applications to digital cellular communications and wireless access points, and audio, voice, still image, video, and biological signal analysis, recognition and compression.

160. Multimedia Systems
(4) MANJUNATH
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 CM/NS 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
Prerequisites: ECE 130A-B and 134 with a minimum grade of C- in all; open to EE, seniors in the BS/MS program and Materials graduate students only.
Same course as Materials 162A. Lecture, 4 hours.
electrons as particles and waves, Schrodinger's equation and illustrative solutions. Tunnelling, Atomic structure, the exclusion principle and the periodic table. Bonds. Free electrons in metals, periodic potentials and energy bands.

162B. Fundamentals of the Solid State
(4) STAFF
Prerequisite: ECE 162A with a minimum grade of C-
open to EE, senior students in the BS/MS programs and Materials graduate students only.
Same course as Materials 162B. Lecture, 3 hours; discussion, 1 hour.

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

178. Introduction to Digital Image and Video Processing
(4) STAFF
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, imaging and video compression including JPEG and MPEG coding standards.

179D. Introduction to Robotics: Dynamics and Control
(4) BYL
Prerequisites: ECE 130A or ME 155A (may be taken concurrently).
Same course as ME 179D.
Dynamic modeling and control methods for robotic systems. LaGrangian method for deriving equations of motion, introduction to the Jacobian, and modeling and control of forces and contact dynamics at a robotic end effector. Laboratories encourage a problem-solving approach to control.

179P. Introduction to Robotics: Planning and Kinematics
(4) BULLO
Prerequisites: ENGR 3, and either ME 17 or ECE 130C (may be taken concurrently).
Not open for credit to student who have completed Mechanical Engineering 170A or ECE 181.
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, decomposi-
tion and sampling methods, and advanced planning algorithms. Kinematics: reference frames, rotations and displacements, kinematic motion models.

180. Introduction to Deep Learning
(4) MANJUNATH
Prerequisite: Open to EE, Computer Engineering and Computer Science with upper-division standing.

181. Introduction to Computer Vision
(4) MANJUNATH
Prerequisite: Upper-division standing in Electrical Engineering, Computer Engineering, Computer Science, Chemical Engineering or Mechanical Engineer-
ing. 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 Physics 103; or ME 163 or upper-division standing in ECE.
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.
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  
(1-8) 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.

194AA-ZZ. Special Topics in Electrical and Computer Engineering  
(1-5) STAFF  

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

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

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

Engineering Sciences, Office of Associate Dean for Undergraduate Studies, Harold Frank Hall, Room 1006;
(805) 893-2809
www.engineering.ucsb.edu/
undergraduate/majors-programs/
engineering-sciences
Chair & Associate Dean: Glenn E. Beltz

Faculty
Glenn E. Beltz, Ph.D., Harvard, Professor
Jeffrey M. Moehlis, Ph.D., University of California, Berkeley, Professor
Linda R. Petzold, Ph.D., University of Illinois at Urbana-Champaign, Professor
Tyler G. Susko, Lecturer Potential SOE
Robert York, Ph.D., Cornell University, Professor

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

One of the missions of the Engineering Sciences program is to provide coursework commonly needed across other educational programs in the College of Engineering. For example, courses in computer programming, computation, ethics, engineering writing, engineering economics, science communication to the public, and even an aeronautics-inspired art course are offered.

Engineering Sciences Courses

LOWER DIVISION

3. Introduction to Programming for Engineers (3) MOEHLIS, PETZOLD
Prerequisites: Open to chemical engineering, electrical engineering, and mechanical engineering majors only.

General philosophy of programming and problem solving. Students will be introduced to the programming language MATLAB. Specific areas of study will include algorithms, basic decision structures, arrays, matrices, and graphing. (F, S, M).

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

UPPER DIVISION

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

The nature of moral value, normative judgment, and moral reasoning. Theories of moral value. The engineer’s role in society. Ethics in professional practice. Safety, risk, responsibility. Morality and career choice. Code of ethics. Case studies will facilitate the comprehension of the concepts introduced. (F, W, S, M)

ENGR 120A. Molecular Bioengineering (4) STAFF
Prerequisite: Chemistry 1B, Chemistry 1BL, Mathematics 6B, and Physics 3
Recommended preparation: One or more undergraduate courses in biochemistry or cell biology similar to MCBG 108ABC or Chem 142ABC or MCBG 103, or consent of instructor.

Enrollment Comments: Quarters usually offered: Winter, Fall.

Introduces students to molecular components of biology with application of engineering principles for analysis. Topics include: molecular components of cells, DNA/RNA structure and function, protein structure/function/folding, gene and protein regulation, DNA replication, and experimental and computational research methods.

ENGR 120B. Cellular Bioengineering (4) STAFF
Prerequisite: Engr 120A or consent of Instructor
Enrollment Comments: Quarters usually offered: Winter.

Introduces students to structural components of cells with application of engineering principles for analysis. Topics include: biomembrane structure and function, membrane proteins, membrane transport, intracellular compartments, intracellular trafficking, chemotaxis, cell cycle, apoptosis, and stem cells.

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 nonexperts. The major components of the course are field work in mentoring, a biweekly seminar, presentations to precollege students and to adult nonscientists, and end-of-term research papers.

177. Art and Science of Aerospace Culture (4) STAFF
Prerequisites: upper-division standing; consent of instructor.

Same course as Art Studio 177.

Interdisciplinary course/seminar/practice for artists, academics, engineers, and designers interested in exploring the technological aesthetic, cultural, and political aspects of the space side of the aerospace complex. Design history, space complex aesthetics, cinema intersections, imaging/telecommunications, human spaceflight history, reduced/alternating gravity experimentation, space systems design/utilization.

195 A. Multidisciplinary Capstone Design (1) STAFF
Enrollment Comments: Quarters usually offered: Fall. Must be enrolled in Capstone project.

This course allows the coordination of senior students in multiple departments while they undertake a multi-departmental capstone design project. Participating students are required to concurrently enroll in their respective departmental capstone/senior design project courses (ECE 189AB, CMPS 189AB, ECE 189AB, ME 189ABC), and will additionally enroll in 1 unit of this course for the Fall, Winter and Spring quarters. By taking this course, students will understand practical engineering approaches to collaborate on complex multidisciplinary engineering systems.

195 B. Multidisciplinary Capstone Design (1) STAFF
Prerequisite: Engineering 195A.
Enrollment Comments: Quarters usually offered: Winter. Must be enrolled in Capstone project.

This course allows the coordination of senior students in multiple departments while they undertake a multi-departmental capstone design project. Participating students are required to concurrently enroll in their respective departmental capstone/senior design project courses (ECE 189AB, CMPS 189AB, ECE 189AB, ME 189ABC), and will additionally enroll in 1 unit of this course for the Fall, Winter and Spring quarters. By taking this course, students will understand practical engineering approaches to collaborate on complex multidisciplinary engineering systems.

195 C. Multidisciplinary Capstone Design (1) STAFF
Prerequisite: Engineering 195B
Enrollment Comments: Quarters usually offered: Spring. Must be enrolled in Capstone project.

This course allows the coordination of senior students in multiple departments while they undertake a multi-departmental capstone design project. Participating students are required to concurrently enroll in their respective departmental capstone/senior design project courses (ECE 189AB, CMPS 189AB, ECE 189AB, ME 189ABC), and will additionally enroll in 1 unit of this course for the Fall, Winter and Spring quarters. By taking this course, students will understand practical engineering approaches to collaborate on complex multidisciplinary engineering systems.

199. Independent Studies in Engineering (1-10) STAFF
Prerequisite: Upper-division standing; consent of instructor.

Students must have a minimum 3.0 GPA for the preceding three quarters. May be repeated for credit to a maximum of 10 units.

Directed individual study.

GRADUATE COURSES

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

Department of Materials Engineering II, Room 1355; (805) 893-4601
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)
Matthew R. Begley, Ph.D., University of California, Santa Barbara, Professor (mechanics of materials with applications to multilayered devices such as microfluidics, MEMS and protective coatings)
Irene J. Beyerlein, Ph.D., Cornell University, Professor (computational materials science, 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 thin films of polymers, electrochemical materials using magnetic resonance techniques and first principles calculations).
Xi Dai, PhD, Chinese Academy of Sciences, Professor (electronic structure of correlated materials, topological materials, quantum materials, density functional theory)
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. Gianola, Ph.D., Johns Hopkins University, Associate Professor (nanomechanical behavior of materials, tunable energy conversion, micro- and nanoelectronics, thermal management, and waste heat collection)
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)
Sriram Krishnamoorthy, PhD, The Ohio State University, Assistant Professor (ultra-wide band gap semiconductors, epitaxial materials and electronic/photonic devices, metalorganic vapor phase epitaxy, Gallium Oxide)
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
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 Palmstrøm, Ph.D., University of Cambridge, Distinguished Professor (atomic level control of interfacial phenomena, in-situ STM, surface and thin film analysis, mettallization 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
Angela A. Pitenis, Ph.D., University of Florida (interfacial engineering, soft materials, surface physics, biotribology, contact mechanics, adhesion, in situ techniques, imaging)
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 Stemmer, 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-optic materials catalysis)*5
Chris Van de Walle, Ph.D., Stanford University, Distinguished Professor (novel electronic materials, 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., Universite 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, neuron 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) *5

David R. Clarke, Ph.D., University of Cambridge, Professor Emeritus (electrical ceramics, thermal barrier coatings, piezoelectricity, mechanics of microelectronic materials) *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

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

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

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

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)

*1 Joint appointment with Electrical & Computer Engineering
*2 Joint appointment with Mechanical Engineering
*3 Joint appointment with Chemical Engineering
*4 Joint appointment with Physics
*5 Joint appointment with Chemistry & Biochemistry

Affiliated Faculty

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

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

Mahn Won Kim, Ph.D. (Physics)

Gary Leal, Ph.D. (Chemical Engineering)

Gene Lucas, Ph.D. (Chemical Engineering)

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

The department has major research groups working on a wide range of advanced inorganic and organic materials, including advanced structural 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 bio-surfaces, including biomedically relevant systems; colloids, gels and other complex fluids; lasers, LEDs and optoelectronic devices; packaging systems; microscale engineered systems, including MEMS. The groups are typically interdisciplinary 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) STAFF

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

Prerequisites: 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
Prerequisite: 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 origins. Elastic, plastic flow and fracture properties. Mechanisms of deformation and failure. Stiffening, strengthening, and toughening mechanisms.

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

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

186A. 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.

186B. Introduction to Additive Manufacturing (3) BREGLEY
Same course as ME 186B. Lecture 3 hours
Introduction to additive manufacturing processes: a review of manufacturing methods and process selection consideration, economies of production, common additive manufacturing strategies, and a brief description of the physics of photopolymerization, extrusion, selective laser melting and e-beam melting fabrication.

188. Topics in Materials (2) VANDEWALLE
Topics in Materials for renewable energy-efficient applications: Thermoelectrics, Solid State Lighting, Solar Cells, High Temperature coatings for turbines and engines. (W)

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

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

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)

Irene J. Beyerlein, PhD, Cornell University, Professor (structural mechanics of multi-phase micro- and nanostructured materials, design of metallic alloys) Joint Appointment: MATRL

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, PhD, 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)

Emelie Dressiaire, Ph.D., Harvard University, Assistant Professor (learning about and learning from biological and natural processes to control fluid flow and transport)

Frederic Gibou, Ph.D., University of California, Los Angeles, Professor (computational science and engineering) *2

Elliot W. Hawkes, Ph. D., Stanford University, Assistant Professor (Design, mechanics, and non-traditional materials to advance the vision of robust, adaptable, human-safe robots that can thrive in the uncertain, unstructured world)

Stephen Laguette, M.S., University of California, Los Angeles, Lecturer (biomedical engineering design)

Carlos Levi, Ph.D., University of Illinois at Urbana-Champaign, Professor (conceptual design, synthesis and evolution in service of structural and inorganic materials, especially for high temperature applications) *3

Bolin Liao, PhD, Massachusetts Institute of Technology, Asistant Professor (nanoscale energy transport and its application to sustainable energy technologies)

Paolo Luzzato-Fegiz, PhD, Cornell University, Assistant Professor (fluid mechanics, wind energy and instrument development)

Eric F. Matthys, 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 California at Urbana--Champaign, Distinguished Professor, Director of Computational Science and Engineering Graduate Emphasis (computational science and engineering; systems biology) *2

Beth Pruit, Ph. D., Stanford University, Professor (mechanobiology, microfabrication, engineering and science, engineering microsystems, and biointerfaces for quantitative mechanobiology) *4

Alban Sauret, Ph. D., IRPHE, Aix-Marseille University, Assistant Professor (investigating fluid dynamics, interfacial effects and particle transport mechanisms involved in environmental and industrial processes)

Tyler G. Susko, phD, Massachusetts Institute of Technology, Assistant Teaching Professor (computational fluid dynamics, engineering education, rehabilitation robotics, human-machine interaction)

Geoff Tsai, Ph.D., Massachusetts Institute of Technology, Assistant Teaching Professor (product design, early-stage design process, visual and physical design representation, design education)

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

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

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

Web site: www.me.ucsb.edu
Telephone (805) 893-2430
Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor (mechanical properties of structural materials, environmental effects, structural reliability)

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

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

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

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

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

George R. Odette, PhD, Massachusetts Institute of Technology Joint Appointment: MATRL.

Bradley E. Paden, Ph.D., UC Berkeley, Professor Emeritus (control theory, kinematics, robotics)

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

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

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

Enoch H. Yeung, Ph.D., California Institute of Technology, Assistant Professor (control theory, machine learning, synthetic biology, and systems biology)

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

Affiliated Faculty
Paul J. Atzberger (Mathematics)
Katie A. Byl (Electrical and Computer Engineering)
Hector D. Ceniceros, PhD (Mathematics)
Tommy D. Dickey, PhD (Geography)
Kimberly L. Foster, PhD (Mechanical Engineering)
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)
Libe Washburn, PhD (Geography)

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

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

Educational Objectives for the Undergraduate Program
It is the objective of the Mechanical Engineering Program to produce graduates who:
1. Successfully practice in either the traditional or the emerging technologies comprising mechanical engineering;
2. Are successful in a range of engineering graduate programs;
3. Have a solid background in the fundamentals of engineering allowing them to pass the Fundamentals of Engineering examination;
4. Engage in life-long learning opportunities such as professional workshops and activity in professional societies.

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

Student Outcomes
Upon graduation, students from the ME 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—

Mechanical Engineering

A minimum of 180 units is required for graduation. A complete list of requirements for the major can be found on page 54. Schedules should be planned to meet both General Education and major requirements.

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

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

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

Research Opportunities

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

Mechanical Engineering Courses

LOWER DIVISION

6. Basic Electrical and Electronic Circuits

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

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


Prerequisite: ME majors only.

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

11. Introductory Concepts in Mechanical Engineering

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

Prerequisites: ME majors only.

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

12S. Introduction to Machine Shop

Prerequisite: ME majors only.

Course materials fee required. 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

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

15. Strength of Materials

Prerequisites: ME 14 with a minimum grade of C;

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.


Prerequisites: Physics 2; ME 14 with a minimum grade of C;

Introduction to fundamental engineering laboratory experiments from thermosciences, fluid mechanics, and mechanics materials science and environmental engineering. Introduction to modern data acquisition and analysis techniques. (S)

110. Aerodynamics and Aeronautical Engineering

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.

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

Prerequisite: consent of instructor.

May be repeated for a maximum of 12 units, variable hours.

May be repeated for maximum of 6 units. Students are limited to 5 units per quarter and 30 units total in all 89/99/198/199/199AA-122Z courses combined. Directed study to be arranged with individual faculty members. Course offers exceptional students an opportunity to participate in a research group.

UPPER DIVISION

100. Professional Seminar

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

Prerequisite: ME 151C and ME 152B, or consent by instructor.


104. Mechatronics

Prerequisites: ME 6; open to ME majors only.

Interfacing of mechanical and electrical systems and mechatronics. Basic introduction to sensors, actuators, and computer interfacing and control. Transducers and measurement devices, actuators, A/D and D/A conversion, signal conditioning and filtering. Practical skills developed in weekly lab exercises.

105. Mechanical Engineering Laboratory

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

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.

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.
112. Energy (3) MATHYSS
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.

Same course as Chemical Engineering 124.


125AA-2Z. 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, materials 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) LAUGLOTE
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) MATHYSS
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) MEBURG
Prerequisite: 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, SIBOU, MEBURG
Prerequisite: 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.

141. 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 laws and nanoscale physics are stressed. Individual subjects at the nanoscale including materials, mechanics, photonics, electronics, and fluids will be described, with an emphasis on differences of behavior at the nanoscale and real-world examples.

141B. MEMS: Processing and Device Characterization (4) PENNATHUR
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, micro-reactors and capacitor-actuators. (W)

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

147. Mechatronics Using Labview (3) HARE
Prerequisite: Engineering 3; and ME 6

Not open for additional credit to students who have completed ME 125CH. Course materials fee required.

Introduction to mechatronics, electromechanical systems, data acquisition, software programming and Labview. Students learn programming fundamentals, hardware interfacing and controls with simulated hardware and actual motor controllers. Students compete to control a motor system through a variety of control problems. Final projects automate working hardware in research labs.

151A. Thermosciences 1 (4) BENNET, MENHART
Prerequisite: Physics 2; ME 14 with a minimum grade of C- and Mathematics 68.

Basic concepts in thermodynamics, system analysis, energy, thermodynamic laws, and cycles. (F)

151B. Thermosciences 2 (4) BENNET, MENHART
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) BENNET, SAUBERT
Prerequisite: ME 151B and 152B; open to ME majors only.

Convective heat transfer, external and internal flow, forced and free convection, phase change, heat exchangers. Introduction to radiative heat transfer.

152A. Fluid Mechanics (4) CAMPAS, MENHART
Prerequisite: Mathematics 68; 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 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) MEINHEH, BURGER, STAFF
Prerequisites: ME 15 and 16 with minimum grades of C-; open to ME majors only.

Introductory course in structural analysis and design. The theories of matrix structural analysis and finite element analysis for the solution of analytical and design problems in structures are emphasized. Lecture material includes structural theory compatibility method, slope deflection method, displacement method and virtual work. Topics include applications to bars, beams, trusses, frames, and solids.

155A. Control System Design (3) YEUNG, BAMBIE
Prerequisite: ME 17 with a minimum grade of C-.

The discipline of control and its application. Dynamical 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) BAMBIE
Prerequisite: ME 15SA.

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) BAMBIE
Prerequisite: ME 15SA.

Not open for additional credit to students who have completed ME 106A.

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 MATRL 101 (or MATRL 100B); or consent of instructor. Open to ME majors only.

The rational selection of engineering materials, and the utilization of Ashby- charts, stress, strain, strength, and fatigue failure consideration as applied to the design of machine elements. Lectures also support the development of system design concepts using assigned projects and involves the preparation of engineering reports and drawings.

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


157. Introduction to Multiphysics Simulation (3) MENHART
Prerequisite: Mechanical Engineering 151A-B; and Mechanical Engineering 152A-B; and Mechanical Engineering 140A

May not be taken for additional credit by students who have completed ME 125CM. May not be taken by students who have completed ME 225CM or ME 257. Course materials fee required.

Introduces students to the concepts of multiphysics simulation. Students are introduced to PDE’s, associated analytical solutions, and the finite elements method. Multiphysics problems are solved in multiple domains, and with fluid/structure interactions. Each student conducts a project where multiphysics tools are used to explore details of multiphysical processes.
158. Computer Aided Design and Manufacturing
(3) STAFF
Prerequisites: ME 10 and 156A; open to ME majors only.
Course materials fee required.
Emphasis on programming, operation and design of automated manufacturing tools. Students learn to program CNC tools to make parts with G&M Code and Mastercam CAM software. Students make parts in hands-on labs using CNC tools, 3D printers and laser cutters. Select topics in automated tool design and construction.

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

(3) MEDIC
Prerequisites: ME 16 with a minimum grade of C-; open to ME majors only.
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) 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.
May not be taken for additional credit by students who have completed ME W167.
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) MOHLEN
Prerequisites: Physics 105A or ME 163; or upper-division standing in ECE.
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 student 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) BEGLEY
Same course as Materials 186B.
Introduction to additive manufacturing processes: review of manufacturing methods and process selection consideration, economies of production, common additive manufacturing strategies, and brief description of the physics of photopolymerization, extrusion, selective laser melting and e-beam melting fabrication.

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.
Designed for majors. Concurrently offered with ME 189A and ME 189B-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) STAFF
Prerequisites: consent of instructor and prior departmental approval needed.
Cannot be used as a departmental elective. May be repeated to a maximum of 2 units.
Students obtain credit for a mechanical engineering-related internship and/or industrial experience under faculty supervision. A 6-10 page written report is required for credit.

197. Independent Projects in Mechanical Engineering Design
(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 3 units per quarter and 10 units total in all 98/99/198/199/199DC/199RA courses combined. No more than 4 units may be used as departmental electives. May be repeated to 12 units.
Directed individual study.

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

Technology Management Program
Phelps Hall, Room 2219
(805) 893-2729
www.tmp.ucsb.edu
Chair: Kyle Lewis

Faculty
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., Stanford University, Professor
Nelson Phillips, Ph.D., University of Alberta, Professor
Renee Rottner, Ph.D., UC Irvine, Assistant Professor
Jessica Santana, Ph.D., Stanford University, Assistant Professor
Mary Tripsas, Ph.D., Massachusetts Institute of Technology, Professor
Robert A. York, Ph.D., Cornell University, Professor

Transcending 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 as a means of determining their proclivity for an entrepreneurial lifestyle.

34. Selling High Tech Products (4) STAFF
Prerequisite: upper division standing.

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

111. Issues in Technology, Business, and Society (1) STAFF
Prerequisite: upper division standing.

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) HANGEN
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 teams, careers, 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
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 2021-22

#### PREPARATION FOR THE MAJOR

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Units</th>
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#### UNIVERSITY REQUIREMENTS

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

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

#### GENERAL EDUCATION

**General Subject Areas**

<table>
<thead>
<tr>
<th>Area</th>
<th>Minimum Units</th>
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<tr>
<td>A: English Reading &amp; Comprehension</td>
<td>2 courses required</td>
</tr>
<tr>
<td>D: Social Science</td>
<td>2 courses minimum</td>
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<tr>
<td>E: Culture and Thought</td>
<td>2 courses minimum</td>
</tr>
<tr>
<td>F: The Arts</td>
<td>1 course minimum</td>
</tr>
<tr>
<td>G: Literature</td>
<td>1 course minimum</td>
</tr>
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</table>

**Special Subject Areas**

| Ethnicity | 1 course |
| European Traditions | 1 course |
| World Cultures | 1 course |

**Writing** (4 courses required):

- Area A-1
- Area A-2

#### NON-MAJOR ELECTIVES

Free Electives taken:

#### TOTAL UNITS REQUIRED FOR GRADUATION

187 units
### FRESHMAN YEAR

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<tr>
<th>FALL</th>
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<th>Spring</th>
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<td>CHEM 1BL or 2BC</td>
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<td>ENGR 3</td>
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<td>MATH 3A</td>
<td>PHYS 1</td>
<td>MATH 4A or 4AI</td>
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<tr>
<td>WRIT 1E or 2E</td>
<td>WRIT 2E or 50E</td>
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### SOPHOMORE YEAR

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<td>CH E 110B</td>
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<td>CHEM 6BL</td>
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<td>PHYS 3</td>
<td>CHEM 109B or 109BH</td>
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### JUNIOR YEAR

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<td>CH E 120A</td>
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<td>CH E 132B</td>
<td>CHEM 113B</td>
<td>CH E 140A</td>
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### SENIOR YEAR

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<td>CH E 180B</td>
<td>CH E 184B</td>
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<td>CH E 152A</td>
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<td>Technical Elective</td>
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</tr>
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<td></td>
<td><strong>14</strong></td>
<td><strong>13</strong></td>
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* If applying to the BS/MS Materials program, student must take:
  Sophomore year- Phys 4 in Winter or Spring
  Junior year- MATRL 100A in Fall, MATRL 100B in Winter, MATRL 100C in Spring
  ^Students may only count one course toward the major. (MATRL 101 OR MATRL 100C)
# COMPUTER ENGINEERING 2021-22

## PREPARATION FOR THE MAJOR

<table>
<thead>
<tr>
<th>Course</th>
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<td>CHEM 1A, 1AL or 2A, 2AC</td>
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<td>CMPSC 24</td>
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<td>ECE 15A</td>
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## UPPER DIVISION MAJOR

<table>
<thead>
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<td>CMPSC 189 A-B* / ECE 189 A-B-C</td>
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</table>

* Prerequisite to CMPSC 189A is CMPSC 156

* Prerequisite to ECE 189A is ECE 153B

Computer Engineering electives selected from the following list: 36-40

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

Must include at least 2 sequences. See ECE Department student office for list of approved sequences.

## UNIVERSITY REQUIREMENTS

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

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

## GENERAL EDUCATION

### General Subject Areas

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

- **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

Free Electives taken: ________________________________________________________________

TOTAL UNITS REQUIRED FOR GRADUATION......191
### FRESHMAN YEAR

<table>
<thead>
<tr>
<th>FALL</th>
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<td>MATH 3B</td>
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<td>PHYS 2</td>
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<td>PHYS 1</td>
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<td>WRIT 50E or G.E. Elective</td>
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**TOTAL** 17 17 17

### SOPHOMORE YEAR

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<td>ECE 10B</td>
<td>3</td>
<td>ECE 10C</td>
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<td>ECE 10BL</td>
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<td>ECE 10CL</td>
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<td>MATH 4B</td>
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<td>ECE 15A</td>
<td>4</td>
<td>ECE 152A</td>
<td>5</td>
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<td>PHYS 3</td>
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<td>PHYS 4</td>
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<td>ECE 139 or PSTAT 120A²</td>
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**TOTAL** 17 18 18

### JUNIOR YEAR

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<th>SPRING</th>
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<tr>
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<td>CMPSC 130A</td>
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<td>CMPEN Electives</td>
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**TOTAL** 16 16 12

### SENIOR YEAR

<table>
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<th>units</th>
<th>SPRING</th>
<th>units</th>
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<td>CMPEN Elective</td>
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<td>4</td>
<td>G.E.</td>
<td>4</td>
<td>G.E.</td>
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</table>

**TOTAL** 16 15 12

---

1CMPSC 8 may be used to satisfy the Math, Science, Engineering Elective requirement.

2PSTAT 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.

*ECE 189A-B-C is taken fall, winter, and spring quarters. Prerequisite to ECE 189A is ECE 153B, taken winter of junior year.

+CMPSC 189A-B is taken fall and winter quarters. Prerequisite to CMPSC 189A is CMPSC 156.
COMPUTER SCIENCE 2021-22

PREPARATION FOR THE MAJOR 57

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<tr>
<th>Course</th>
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<td>CMPSC 64</td>
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UPPER DIVISION MAJOR 71

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<td>CMPSC 138</td>
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<td>CMPSC 148 or 156 or 172</td>
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<td>CMPSC 154</td>
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<td>CMPSC 160 or 162</td>
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<tr>
<td>PSTAT 120B</td>
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Major Field Electives 32

Eight courses selected from the following list (at least 8 units must be CMPSC courses). Prior approval of the student’s major field electives must be obtained from the faculty advisor.

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<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
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<td>CMPSC 148</td>
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<tr>
<td>CMPSC/ECE 153A</td>
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<td>CMPSC 156</td>
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<td>CMPSC 162</td>
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<td>ECE 130A-B-C</td>
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<td>ECE 152A</td>
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</table>

1 CMPSC 111 or 140 can be used as an elective if not taken as a major course.
2 CMPSC 148 or 156 or 172 can be used as an elective if not taken as a major course.
3 CMPSC 160 or 162 can be used as an elective if not taken as a major course.
4 Four units maximum from CMPSC 192 and 196 combined; only for students with GPA of 3.0 or higher.
5 Only for students who have met the requirements. Please see department advisor for more information.

Major Field Electives taken:

SCIENCE COURSES

Science Electives (see Dept. for list) 8

Science Electives taken:

To satisfy major requirements, courses taken inside or outside the Department of Computer Science, must be taken for a letter grade.

UNIVERSITY REQUIREMENTS

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

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

GENERAL EDUCATION

General Subject Areas

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

A-1: ____________________________ A-2: ____________________________

Area D: Social Science  
(2 courses minimum)

Area E: Culture and Thought  
(2 courses minimum)

Area F: The Arts  
Area G: Literature  
(1 course minimum)  
(1 course minimum)

Special Subject Areas

Ethnicity (1 course):________

European Traditions  
or World Cultures (1 course):________

Writing (4 courses required):

NON-MAJOR ELECTIVES

Free Electives taken:

TOTAL UNITS REQUIRED FOR GRADUATION ...... 184
COMPUTER SCIENCE 2021-22
This grid is intended to serve as a guide and should be adjusted for individual circumstances in consultation with academic advisors. Course availability subject to change. Changes will be announced by the department.

**FRESHMAN YEAR**

<table>
<thead>
<tr>
<th>FALL</th>
<th>units</th>
<th>WINTER</th>
<th>units</th>
<th>SPRING</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.E. Elective or CMPSC 8(^1)</td>
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<td>CMPSC 16(^1)</td>
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<td>CMPSC 24</td>
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</tr>
<tr>
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<td>4</td>
<td>MATH 3B</td>
<td>4</td>
<td>MATH 4A</td>
<td>4</td>
</tr>
<tr>
<td>WRIT 1, 2, or G.E. Elective</td>
<td>4/5</td>
<td>PHYS 1</td>
<td>4</td>
<td>PHYS 2</td>
<td>4</td>
</tr>
<tr>
<td>G.E. Elective</td>
<td>4</td>
<td>WRIT 1, 2, or G.E. Elective</td>
<td>4/5</td>
<td>Science or Free Elective</td>
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**SOPHOMORE YEAR**

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<th>SPRING</th>
<th>units</th>
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<td>CMPSC 32</td>
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<td>CMPSC 64</td>
<td>4</td>
<td>CMPSC 138</td>
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<td>MATH 6A</td>
<td>4</td>
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<tr>
<td>PSTAT 120A</td>
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<td>WRIT 50</td>
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<td>G.E.</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 3</td>
<td>3</td>
<td>CMPSC 130A</td>
<td>4</td>
<td>Science or Free Elective</td>
<td>4</td>
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<tr>
<td>PHYS 3L</td>
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**JUNIOR YEAR**

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<tbody>
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<td>CMPSC 148 or 156 or 172</td>
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<td>CMPSC 154</td>
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<td>CMPSC 130B</td>
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<td>Field Elective</td>
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<td>PSTAT 120B</td>
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</tr>
<tr>
<td>CMPSC 111(^3)</td>
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<td>Free Elective</td>
<td>4</td>
<td>Field or Free Elective</td>
<td>4</td>
</tr>
<tr>
<td>Science or Free Elective</td>
<td>4</td>
<td>G.E.</td>
<td>4</td>
<td>G.E.</td>
<td>4</td>
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**SENIOR YEAR**

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<thead>
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<th>units</th>
<th>WINTER</th>
<th>units</th>
<th>SPRING</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field or Free Elective</td>
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<td>CMPSC 170</td>
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<tr>
<td>CMPSC 160(^2)</td>
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<td>Field Elective</td>
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<td>Field or Free Elective</td>
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<tr>
<td>Field or Free Elective</td>
<td>4</td>
<td>ENGR 101(^4)</td>
<td>3</td>
<td>G.E. or Free Elective</td>
<td>4</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Field or Free Elective</td>
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</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>12</td>
<td>15</td>
<td>12</td>
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<td></td>
</tr>
</tbody>
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---

1. Consult Computer Science academic advisor for placement information.
2. Or you may take CMPSC 162 to satisfy this requirement.
3. Or you may take CMPSC 140 in Winter Quarter to satisfy this requirement.
4. ENGR 101 may be taken any quarter of senior year.
**ELECTRICAL ENGINEERING 2021-22**

**PREPARATION FOR THE MAJOR**  

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Units</th>
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<tbody>
<tr>
<td>CHEM 1A, 1AL or 2A, 2AC</td>
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</tr>
<tr>
<td>CMPSC 16</td>
<td>4</td>
</tr>
<tr>
<td>ECE 5</td>
<td>4</td>
</tr>
<tr>
<td>ECE 10A, 10AL, 10B, 10BL, 10C, 10CL</td>
<td>15</td>
</tr>
<tr>
<td>ECE 15A</td>
<td>4</td>
</tr>
<tr>
<td>ECE 3</td>
<td>4</td>
</tr>
<tr>
<td>MATH 2A-B or 3A-B, 4A-B, 6A-B</td>
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</tr>
<tr>
<td>PHYS 1, 2, 3, 3L, 4, 4L, 5, 5L</td>
<td>20</td>
</tr>
<tr>
<td><strong>Upper Division Major</strong></td>
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<td>ECE 130A-B</td>
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<td>ECE 132</td>
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<td>ECE 134</td>
<td>4</td>
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<tr>
<td>ECE 137A-B</td>
<td>8</td>
</tr>
<tr>
<td>ECE 139</td>
<td>4</td>
</tr>
<tr>
<td>ECE 152A</td>
<td>5</td>
</tr>
<tr>
<td>ENGR 101</td>
<td>3</td>
</tr>
<tr>
<td>ECE 188 A-B-C</td>
<td>9</td>
</tr>
<tr>
<td>Departmental electives selected from the following list</td>
<td>23</td>
</tr>
<tr>
<td>Approval of the student’s departmental electives must be obtained from the student’s faculty adviser. Must include at least 1 sequence, see ECE Department student office for list of approved sequences. Minimum six courses.</td>
<td></td>
</tr>
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</table>

**UNIVERSITY REQUIREMENTS**

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

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

**GENERAL EDUCATION**

**General Subject Areas**

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

A-1:  
A-2:

**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**

Free Electives taken:

**TOTAL UNITS REQUIRED FOR GRADUATION** 189
# Major Requirements

## Freshman Year

<table>
<thead>
<tr>
<th>FALL</th>
<th>units</th>
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<th>units</th>
<th>SPRING</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1A or 2A</td>
<td>3</td>
<td>MATH 3B</td>
<td>4</td>
<td>MATH 4A</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 1AL or 2AC</td>
<td>2</td>
<td>PHYS 1</td>
<td>4</td>
<td>PHYS 2</td>
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</tr>
<tr>
<td>ECE 3</td>
<td>4</td>
<td>ECE 5</td>
<td>4</td>
<td>WRIT 50E or G.E.</td>
<td>4</td>
</tr>
<tr>
<td>MATH 3A</td>
<td>4</td>
<td>WRIT 2E or 50E</td>
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<td></td>
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<tr>
<td>WRIT 1E or 2E</td>
<td>4</td>
<td></td>
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<td><strong>TOTAL</strong></td>
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## Sophomore Year

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<thead>
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<th>SPRING</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 10A</td>
<td>3</td>
<td>ECE 10B</td>
<td>3</td>
<td>ECE 10C</td>
<td>3</td>
</tr>
<tr>
<td>ECE 10AL</td>
<td>2</td>
<td>ECE 10BL</td>
<td>2</td>
<td>ECE 10CL</td>
<td>2</td>
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<td>MATH 4B</td>
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<td>ECE 15A</td>
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<td>4</td>
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<td>PHYS 3</td>
<td>3</td>
<td>MATH 6A</td>
<td>4</td>
<td>PHYS 5</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 3L</td>
<td>1</td>
<td>PHYS 4</td>
<td>3</td>
<td>PHYS 5L</td>
<td>1</td>
</tr>
<tr>
<td>CMPSC 16</td>
<td>4</td>
<td>PHYS 4L</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
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<td>17</td>
<td>13</td>
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## Junior Year

<table>
<thead>
<tr>
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<th>units</th>
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<th>SPRING</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 130A</td>
<td>4</td>
<td>ECE 130B</td>
<td>4</td>
<td>ECE 137B</td>
<td>4</td>
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<tr>
<td>ECE 132</td>
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<td>ECE 137A</td>
<td>4</td>
<td>ECE 139(^1)</td>
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<td>ECE 134</td>
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<td>ECE Elective</td>
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<td>ECE 152A(^2)</td>
<td>5</td>
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<tr>
<td>G.E.</td>
<td>4</td>
<td>G.E.</td>
<td>4</td>
<td>G.E.</td>
<td>4</td>
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<tr>
<td><strong>TOTAL</strong></td>
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## Senior Year

<table>
<thead>
<tr>
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<th>SPRING</th>
<th>units</th>
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</thead>
<tbody>
<tr>
<td>ECE 188A</td>
<td>3</td>
<td>ECE 188B</td>
<td>3</td>
<td>ECE 188C</td>
<td>3</td>
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<td>ECE Electives</td>
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<td>ECE Electives</td>
<td>8</td>
<td>ECE Electives</td>
<td>8</td>
</tr>
<tr>
<td>G.E.</td>
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<td>G.E.</td>
<td>4</td>
<td>Free Elective(^4)</td>
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<td>ENGR 101(^3)</td>
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<td></td>
<td>3</td>
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<td><strong>TOTAL</strong></td>
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<td>18</td>
<td>15</td>
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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. This course may not be required. Students must complete at least 189 units to graduate.

---

ELECTRICAL ENGINEERING 2021-22

This grid is intended to serve as a guide and should be adjusted for individual circumstances in consultation with academic advisors. Course availability subject to change. Changes will be announced by the department.
# Mechanical Engineering 2021-22

## Preparation for the Major

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>CHEM 1A, 1AL, 1B, 1BL or 2A, 2AC, 2B, 2BC</td>
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<tr>
<td>ENGR 3</td>
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</tr>
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<td>MATH 3A-B, 4A-B, 6A-B</td>
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<tr>
<td>ME 6</td>
<td>4</td>
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<td>ME 10</td>
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<tr>
<td>ME 12S</td>
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<td>ME 14</td>
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<td>ME 15</td>
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</tr>
<tr>
<td>ME 16</td>
<td>4</td>
</tr>
<tr>
<td>ME 17</td>
<td>3</td>
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## Upper Division Major

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<tr>
<td>ME 103</td>
<td>4</td>
</tr>
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<td>ME 104</td>
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</tr>
<tr>
<td>ME 107</td>
<td>3</td>
</tr>
<tr>
<td>ME 108</td>
<td>3</td>
</tr>
<tr>
<td>ME 151A-B</td>
<td>8</td>
</tr>
<tr>
<td>ME 152A</td>
<td>4</td>
</tr>
<tr>
<td>ME 153</td>
<td>3</td>
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<tr>
<td>1 Specialization Group*</td>
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<tr>
<td>L1 ENGR 120A ME 163 ME 127 ME 141A ME 166 ME 152B</td>
<td>Group 1</td>
</tr>
<tr>
<td>L2 ENGR 120B ME 155A ME 129 ME 141B ME 154 ME 151C</td>
<td>Group 2</td>
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</table>

*Two courses required: Either a group, or 1 course from L1 and 1 course from L2

## Third Year

<table>
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<tr>
<td>ME 105</td>
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<td>ME 156A-B</td>
<td>6</td>
</tr>
<tr>
<td>ME 189A-B-C</td>
<td>9</td>
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## Fourth Year

<table>
<thead>
<tr>
<th>Course</th>
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</thead>
<tbody>
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<tr>
<td>ME 105</td>
<td>4</td>
</tr>
<tr>
<td>ME 156A-B</td>
<td>6</td>
</tr>
<tr>
<td>ME 189A-B-C</td>
<td>9</td>
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### Engineering Electives

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>ME 110</td>
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<tr>
<td>CHEM 123</td>
<td>ME 112</td>
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<td>ECE 147A,C</td>
<td>ME 124</td>
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<td>CMPSC/ECE 181B</td>
<td>ME 125 AA-2Z</td>
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<td>ENGR 101</td>
<td>ME 128</td>
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<td>ENGR 120 A-B</td>
<td>ME 134</td>
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<tr>
<td>ENGR 195A-B-C</td>
<td>ME 140A-B</td>
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<td>ENV S 105</td>
<td>ME 141A-B</td>
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<td>MATRL 100A</td>
<td>ME 146</td>
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<td>MATRL 100B</td>
<td>ME 147</td>
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<td>MATRL 186A-B</td>
<td>ME 154</td>
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<td>MATRL 188</td>
<td>ME 155C-B</td>
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<td>ME 102</td>
<td>ME 157</td>
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1ME W167 online version of ME 167.
2Four units maximum from ME 197 and ME 199 combined

## University Requirements

### UC Entry Level Writing Requirement: English Composition

Must be fulfilled within three quarters of matriculation

Satisfied by: ____________________________

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

## General Education

### General Subject Areas

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

**A-1:** ____________________________

**A-2:** ____________________________

#### 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

Free Electives taken:

### Total Units Required for Graduation

180
### FRESHMAN YEAR

<table>
<thead>
<tr>
<th>FALL units</th>
<th>WINTER units</th>
<th>SPRING units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1A or 2A</td>
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<td>CHEM 1B or 2B</td>
</tr>
<tr>
<td>CHEM 1AL or 2AC</td>
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<td>CHEM 1BL or 2BC</td>
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<td>MATH 3A</td>
<td>4</td>
<td>MATH 3B</td>
</tr>
<tr>
<td>ME 12S(^1)</td>
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<td>PHYS 1</td>
</tr>
<tr>
<td>WRIT 1E or 2E</td>
<td>4</td>
<td>WRIT 2E or 50E</td>
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<tr>
<td><strong>TOTAL</strong></td>
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### SOPHOMORE YEAR

<table>
<thead>
<tr>
<th>FALL units</th>
<th>WINTER units</th>
<th>SPRING units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 4B</td>
<td>4</td>
<td>MATH 6A</td>
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<td>4</td>
<td>ME 6</td>
</tr>
<tr>
<td>ME 17</td>
<td>3</td>
<td>ME 15</td>
</tr>
<tr>
<td>PHYS 3</td>
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<td>PHYS 4</td>
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<td>PHYS 3L</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>15</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

### JUNIOR YEAR

<table>
<thead>
<tr>
<th>FALL units</th>
<th>WINTER units</th>
<th>SPRING units</th>
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</thead>
<tbody>
<tr>
<td>ME 103</td>
<td>4</td>
<td>MATRL 101(^^) or 100B(^2)</td>
</tr>
<tr>
<td>ME 107</td>
<td>3</td>
<td>ME 108</td>
</tr>
<tr>
<td>ME 151A</td>
<td>4</td>
<td>ME 151B</td>
</tr>
<tr>
<td>ME 152A</td>
<td>4</td>
<td>Specialization Course</td>
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<tr>
<td>MATRL 100A(^2)</td>
<td>3</td>
<td>MATRL 100C(^^)</td>
</tr>
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<td><strong>TOTAL</strong></td>
<td><strong>15/18</strong></td>
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### SENIOR YEAR

<table>
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<tr>
<th>FALL units</th>
<th>WINTER units</th>
<th>SPRING units</th>
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</thead>
<tbody>
<tr>
<td>ME 154, ME 157, or ME 167(^3)</td>
<td>3</td>
<td>ME 156B</td>
</tr>
<tr>
<td>ME 105</td>
<td>4</td>
<td>ME 189B</td>
</tr>
<tr>
<td>ME 156A</td>
<td>3</td>
<td>Departmental Elective</td>
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<tr>
<td>ME 189A</td>
<td>3</td>
<td>G.E. or Free Electives</td>
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<tr>
<td>Departmental Elective</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16</strong></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>

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\(^1\) 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 the 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. If either of the other courses are also taken, those additional courses will count as an engineering elective.

\(^\^\) Students may only count one course toward the major. (MATRL 101 or MATRL 100C)
Additional Resources and Information

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

Advising Staff

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

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

<table>
<thead>
<tr>
<th>College Advising staff</th>
<th>Phone</th>
<th>Email</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>College Advising staff</td>
<td>(805) 893-2809</td>
<td><a href="mailto:coe-info@engr.ucsb.edu">coe-info@engr.ucsb.edu</a></td>
<td>Harold Frank Hall, Rm. 1006</td>
</tr>
</tbody>
</table>

Departmental Advisors:
- Chemical Engineering 893-8671 cheugrads@engr.ucsb.edu Engr.II, Rm. 3357
- Computer Engineering 893-8292 ugrad-advisor@ece.ucsb.edu Trailer 380, Rm. 101
- Computer Science 893-4321 ugradhelp@cs.ucsb.edu Harold Frank Hall, Rm. 2104
- Electrical Engineering 893-8292 ugrad-advisor@ece.ucsb.edu Trailer 380, Rm. 101
- Mechanical Engineering 893-8198 meugrad@engr.ucsb.edu Engr.II, Rm. 2355
- Technology Management 893-2729 advising@tmp.ucsb.edu Phelps 2219

Academic Integrity

The UCSB Student Conduct Code exists to support the highest standards of social and academic behavior and ensure and environment conducive to student learning. It is expected that students attending the UCSB understand and subscribe to the ideal of academic integrity, and are willing to bear individual responsibility for their work. Any submission that fulfills an academic requirement must represent a student’s original work. Any act of academic dishonesty will subject a person to University disciplinary action.

Student Conduct Code and Student Due Process: http://www.sa.ucsb.edu/regulations/student-conduct-code/
Instructor Responsibilities and Procedures: https://senate.ucsb.edu/bylaws-and-regulations/ (Section 10, Reg. 90)
Academic dishonesty includes cheating, plagiarism, unauthorized collaboration, furnishing false information, and misuse of course materials. Definitions and misconduct are posted at http://studentconduct.sa.ucsb.edu/academic-integrity.

A specific note about student collaboration: 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 to 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.
Notes