# 2020-2021 Academic Calendar

**Note:** Dates subject to change without notice.

## 2020 - 2021 Campus Holidays Observed

<table>
<thead>
<tr>
<th>Holiday</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor Day</td>
<td>September 6, 2020</td>
</tr>
<tr>
<td>Veterans' Day</td>
<td>November 11, 2020</td>
</tr>
<tr>
<td>Thanksgiving</td>
<td>November 26 &amp; 27, 2020</td>
</tr>
<tr>
<td>Christmas</td>
<td>December 24 &amp; 25, 2020</td>
</tr>
<tr>
<td>New Year</td>
<td>December 31, 2020 &amp; January 1, 2021</td>
</tr>
<tr>
<td>Martin Luther King, Jr. Day</td>
<td>January 18, 2021</td>
</tr>
<tr>
<td>Presidents' Day</td>
<td>February 15, 2021</td>
</tr>
<tr>
<td>Cesar Chavez Holiday</td>
<td>March 26, 2021</td>
</tr>
<tr>
<td>Memorial Day</td>
<td>May 31, 2021</td>
</tr>
<tr>
<td>Independence Day</td>
<td>July 5, 2021</td>
</tr>
<tr>
<td>Labor Day</td>
<td>September 6th, 2021</td>
</tr>
</tbody>
</table>

## 2020-2021 Academic Calendar

<table>
<thead>
<tr>
<th>Quarter begins</th>
<th>Fall 2020</th>
<th>Winter 2021</th>
<th>Spring 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Student Convocation</td>
<td>September 27, 2020</td>
<td>January 4, 2021</td>
<td>March 29, 2021</td>
</tr>
<tr>
<td>Pre-instruction Activities</td>
<td>September 28-30, 2020</td>
<td>January 4, 2021</td>
<td>March 29, 2021</td>
</tr>
<tr>
<td>First day of instruction</td>
<td>October 1, 2020</td>
<td>January 4, 2021</td>
<td>March 29, 2021</td>
</tr>
<tr>
<td>Last day of instruction</td>
<td>December 11, 2020</td>
<td>March 12, 2021</td>
<td>June 4, 2021</td>
</tr>
<tr>
<td>Quarter ends</td>
<td>December 18, 2020</td>
<td>March 19, 2021</td>
<td>June 11, 2021</td>
</tr>
<tr>
<td>Commencement</td>
<td></td>
<td></td>
<td>June 12-13, 2021</td>
</tr>
</tbody>
</table>

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## Equal Opportunity and Nondiscrimination

The University of California, in accordance with applicable Federal and State law and University policy, does not discriminate on the basis of race, color, national origin, religion, sex, gender identity, pregnancy\(^1\), disability, age, medical condition (cancer related), ancestry, marital status, citizenship, sexual orientation, or status as a Vietnam-era veteran or special disabled veteran. The University also prohibits sexual harassment. This nondiscrimination policy covers admission, access, and treatment in University programs and activities. Inquiries regarding the University’s student-related nondiscrimination policies may be directed to the Director of Equal Opportunity at (805) 893-3089.

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

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Produced by the College of Engineering, Student Advising Division
Glenn Beltz, Associate Dean for Undergraduate Studies
Andrew Masuda, Director of Marketing

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

All announcements herein are subject to revision without notice.
General Engineering Academic Requirements

College of Engineering • University of California • Santa Barbara

Volume 11, Summer 2020

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 why 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 their respective scientific communities in which they work. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. A high percentage of the faculty has been elected to the prestigious National Academy of Sciences and National Academy of Engineering. We have six Nobel Prize winners on this campus, five of whom are faculty in engineering and the sciences. We’re also home to an amazing group of smart, accomplished, high-energy students. These more than 1,500 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
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College of Engineering

The College of Engineering at UCSB is noted for its excellence in teaching, research, and service to the community. The college has an enrollment of approximately 1,500 undergraduate students and 750 graduate students with a full-time, tenured faculty of 129. This results in an excellent student to faculty ratio and a strong sense of community in the college.

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

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

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

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

Mission Statement

The mission of the College of Engineering is to provide its students a firm grounding in scientific and mathematical fundamentals; experience in analysis, synthesis, and design of engineering systems; and exposure to current engineering practice and cutting edge engineering research and technology. A spirit of entrepreneurship in education, scholarly activity and participation in engineering practice infuses UCSB’s mission with an educational philosophy that is relevant in today’s world.

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 hall to eligible first-year students, as well as graduate student library privileges to all students in the program. Special lectures and tours programming will be offered throughout the academic year.

The College of Engineering invites approximately the top 10% of incoming freshmen into the Honors Program. 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 38 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 level courses with grades of B or higher, complete a total of 10 hours of community service for each year they are program members and maintain a 3.5 or higher cumulative GPA at the end of each Spring quarter.

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

Dean’s Honors

The College of Engineering gives public recognition to its outstanding undergraduate students by awarding Dean’s Honors at the end of each regular academic term to students who have earned a 3.75 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. Graduate students and faculty also belong to this honor society. In addition to regular meetings on campus, the organization participates in regional and national activities and sponsors local events, such as tutoring and leadership training, to serve the campus and community.

Education Abroad Program (EAP)

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

Student Organizations

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

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

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

Students who enter UCSB as transfer students will not be able to change to or add an engineering major, if not initially accepted into one. Students who began as freshmen who plan to enter an engineering major, as well as students wishing to change from one engineering major to another will be expected to complete at least 105 units at UCSB before petitioning for a change of 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 Letters and Science after they have completed 105 Creative Studies or the College of Letters and Science 16, 24, and 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 limited number of change of major applications to Computer Science will be approved. Students who have completed their sophomore year. Sophomores may apply for consideration to the Computer Science major if the following requirements are met:

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;

Note: Denial of 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 at least 3.0;
2. Satisfactory completion at UCSB, with a grade point average of 3.0 or better, of at least five classes, including at least two Electrical & Computer Engineering (ECE) classes and two Computer Science (CMPS) 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, CMPS 16, 24, 32, 40.

Degree Requirements

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

General University Requirements

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

College General Education Requirements

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

Major Degree Requirements

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

Advanced Placement Credit

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

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

Students completing the International Baccalaureate (IB) diploma with a score of 30 or above will receive 30 quarter units total toward their UC undergraduate degree. The university grants 8 quarter units for certified IB Higher Level examinations on which a student scores 5, 6, or 7. The university does not grant credit for standard level exams. The application of this credit to the General Education requirements and course equivalents for these exams are listed on page 7.

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

Minimal Progress Requirements

A student in the College of Engineering may be placed on academic probation if the total number of units passed at UCSB is fewer than what is prescribed by the prevailing academic Senate regulation regarding Minimum Cumulative Progress. At least three-fourths of the minimum number of academic units passed must include courses prescribed for the major.

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

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

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

215–Unit and Quarter Enrollment Limitations

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

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

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

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

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

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

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

Five-Year B.S. in 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 (effective S20). 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>8</td>
<td>none</td>
<td>none</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></td>
<td>D: 1 course^</td>
<td>none</td>
</tr>
<tr>
<td>Languages Other Than English</td>
<td>8</td>
<td>none</td>
<td>See department for level placement</td>
</tr>
<tr>
<td>Mathematics</td>
<td>8</td>
<td>none</td>
<td>Mathematics 2A, 2B, 3A, 3B, 34A, 34B, or equivalent</td>
</tr>
<tr>
<td>Mathematics, Further</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Music</td>
<td>8</td>
<td>F: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Philosophy</td>
<td>8</td>
<td>E: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Physics</td>
<td>8</td>
<td>none</td>
<td>Physics 10</td>
</tr>
<tr>
<td>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
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>UnitsAwarded</th>
<th>General Ed. Course Credit</th>
<th>UCSB Course Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D Art and Design 8</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>2D Art and Design 8</td>
<td>none</td>
<td>none</td>
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</tr>
<tr>
<td>Art History 8</td>
<td>F: 1 course</td>
<td>EEMB 22, MCDB 20</td>
<td></td>
</tr>
<tr>
<td>Biology 8</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Chemistry 8</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Chinese Language and Culture With score of 3</td>
<td>none</td>
<td>See department for level placement</td>
<td></td>
</tr>
<tr>
<td>Comparative Government and Politics 4</td>
<td>D: 1 course</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>+Computer Science A (through S17) With score of 3</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Computer Science Principles (effective S17 and S18) With score of 3</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Computer Science Principles (effective S19) With score of 3</td>
<td>none</td>
<td>Computer Science 8</td>
<td></td>
</tr>
<tr>
<td>Computer Science Principles With score of 4 or 5</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Drawing 8</td>
<td>none</td>
<td>Art 18</td>
<td></td>
</tr>
<tr>
<td>Macroeconomics 4</td>
<td>D: 1 course</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Microeconomics 4</td>
<td>D: 1 course</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>*English – Composition and Literature or Language and Composition With score of 3</td>
<td>Entry Level Writing Writing 1, 1E</td>
<td></td>
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<tr>
<td>Environmental Science 4</td>
<td>none</td>
<td>Environmental Studies 2</td>
<td></td>
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<td>French Language and Culture With score of 3</td>
<td>none</td>
<td>French 1-3</td>
<td></td>
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<tr>
<td>German Language and Culture With score of 3</td>
<td>none</td>
<td>German 1-3</td>
<td></td>
</tr>
<tr>
<td>Human Geography 4</td>
<td>D: 1 course</td>
<td>Geography 5</td>
<td></td>
</tr>
<tr>
<td>Italian Language and Culture With score of 3</td>
<td>Italian 1-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japanese Language &amp; Culture With score of 3</td>
<td>See department for level placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latin 8</td>
<td>none</td>
<td>Latin 1-3</td>
<td></td>
</tr>
<tr>
<td>*Calculus AB (or AB subscore of BC exam)</td>
<td>none</td>
<td>Mathematics 2A, 3A, 34A, or equivalent</td>
<td></td>
</tr>
<tr>
<td>*Calculus BC 8</td>
<td>none</td>
<td>Mathematics 2A, 2B, 3A, 3B, 34A, 34B, or equivalent</td>
<td></td>
</tr>
<tr>
<td>Music Theory 8</td>
<td>F: 1 course</td>
<td>Music 11</td>
<td></td>
</tr>
<tr>
<td>*Physics 1 (effective S’15) 8</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>*Physics 2 (effective S’15) 8</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>*Physics – B (last offered S’14) 8</td>
<td>none</td>
<td>Physics 10</td>
<td></td>
</tr>
<tr>
<td>*Physics – C (Mechanics) 4</td>
<td>none</td>
<td>Physics 6A and 6AL</td>
<td></td>
</tr>
<tr>
<td>*Physics – C (Electricity and Magnetism) 4</td>
<td>none</td>
<td>Physics 6B and 6BL</td>
<td></td>
</tr>
<tr>
<td>Psychology 4</td>
<td>D: 1 course</td>
<td>Psychology 1</td>
<td></td>
</tr>
<tr>
<td>Spanish Language and Culture With score of 3</td>
<td>none</td>
<td>Spanish 1-3</td>
<td></td>
</tr>
<tr>
<td>Spanish Language and Culture With score of 4</td>
<td>none</td>
<td>Spanish 1-4</td>
<td></td>
</tr>
<tr>
<td>Spanish Language and Culture With score of 5</td>
<td>none</td>
<td>Spanish 1-5</td>
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</table>
College Board Advanced Placement Credit Cont.

Advanced Placement Exam

<table>
<thead>
<tr>
<th>Exam</th>
<th>Units Awarded</th>
<th>General Ed. Course Credit</th>
<th>UCSB Course Equivalent</th>
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</thead>
<tbody>
<tr>
<td>Spanish Literature and Culture</td>
<td></td>
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<tr>
<td>With score of 3</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-4</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>none</td>
<td>Spanish 1-6</td>
</tr>
<tr>
<td>Statistics</td>
<td>4</td>
<td>D: 1 course</td>
<td>Communication 87, PSTAT 5AA-ZZ, Psychology 5</td>
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<tr>
<td>United States Government and Politics</td>
<td>4</td>
<td>E: 1 course</td>
<td>Political Science 12</td>
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<tr>
<td>United States History</td>
<td>8</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>World History: Modern</td>
<td>8</td>
<td>E: 1 course</td>
<td>none</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.

A Level Examination Credit

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

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

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

<table>
<thead>
<tr>
<th>A Level Exam With A Grade of A, B, or C</th>
<th>Units Awarded</th>
<th>General Ed. Credit</th>
<th>UCSB Course Equivalent</th>
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<tbody>
<tr>
<td>Accounting</td>
<td>12</td>
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<td>Economics 3A, 3B</td>
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<td>Afrikaans</td>
<td>12</td>
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<td>Arabic</td>
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<td>Art and Design</td>
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<td>Biology</td>
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<td>Chemistry</td>
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<td>Classical Studies</td>
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<td></td>
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<tr>
<td>Computing</td>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>Economics</td>
<td>12</td>
<td>Area D: 2 courses</td>
<td>Computer Science 16</td>
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<tr>
<td>English – Language</td>
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<td>Economics 1, 2</td>
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<td>English – Literature</td>
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<td>French</td>
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<td>Geography</td>
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<td>German</td>
<td>12</td>
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<td>Hindi</td>
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<td>History</td>
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<td>Marathi</td>
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<td>Marine Science</td>
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<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</td>
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<tr>
<td>Music</td>
<td>12</td>
<td></td>
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<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>Area D: 1 course</td>
<td>Psychology 1, 3, 7</td>
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<td>Psychology</td>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>Putonghua</td>
<td>12</td>
<td></td>
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<tr>
<td>Sociology</td>
<td>12</td>
<td></td>
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<td>Spanish</td>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>Tamil</td>
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<td></td>
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<td>Telugu</td>
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<td>Urdu</td>
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</tr>
<tr>
<td>Urdu – Pakistan only</td>
<td>12</td>
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</tr>
</tbody>
</table>
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 Exam; or
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; and/or
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. Because of the COVID-19 pandemic, the Analytical Writing Placement Exam was not offered in May 2020. UCSC’s Writing Program is developing Writing Placement 2020, an alternative assessment for students who did not meet the requirement by one of the other means listed above. Students will be contacted regarding this alternative assessment, and the details will also be made available on the program’s Academics web page (https://www.writing.ucsb.edu/academics). Writing Placement 2020 will be offered during the summer as well as once a quarter on campus, and a student may fulfill the Entry Level Writing Requirement with an appropriate score. Students may take either the systemwide Analytical Writing Placement Exam or the writing placement process at UCSC; neither may be repeated.

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.

American History and Institutions Requirement

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

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

   - Anthropology 131
   - Art History 121A-B-C, 136H
   - Asian American Studies 1, 2
   - Black Studies 1, 6, 20, 60A-B, 103, 137E, 169AR-BR-CR
   - Chicano Studies 1A-B-C, 168B, 174, 188C
   - Economics 113A-B, 119
   - English 133AA-ZZ, 134AA-ZZ, 191
   - Environmental Studies 173
   - Feminist Studies 155A, 155B
   - 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, Theater 180A-B

Courses used to fulfill the American History and Institutions requirement may also be applied to General Education or major requirements, or both where appropriate. Equivalent courses taken at other accredited colleges or universities, in UC Extension, or in summer session may be acceptable. Students who transfer to UCSC 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 UCSC.

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

College of Engineering General Education Requirements

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

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

It should be noted that for College of Engineering transfer students 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

   Two courses must be completed in this area and taken for letter grades. Writing 2 or 2E, and Writing 50, 50E, 107T, or 109ST are required.

   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...
Area requirements: complete the following Special Subject areas D through G requirements, students must 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 2 courses 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 that focuses on the history and the cultural, intellectual, and social experience of one of the following groups: Native Americans, African Americans, Chicanos/Latinos, or Asian Americans. Alternatively, students may take a course that provides a comparative and integrative context for understanding the experience of oppressed and excluded racial minorities in the United States. Courses that meet this requirement are marked with an ampersand (&) on the lists in this document.

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:

- 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 Writing 50, 50E, 107T or 109ST are required.

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 quantative analysis.

+ Anthropology 2 Introductory Cultural Anthropology
+ Anthropology 3 Introductory Archaeology
+ Anthropology 33S Introduction to Archaeology
+ Anthropology 7 Introduction to Biocultural Anthropology
+ Anthropology 25 Introduction to Cultural Anthropology
+ Anthropology 103A Anthropology of China
+ Anthropology 103B Anthropology of Japan
+ Anthropology 103C Anthropology of Korea
Anthropology 109 Human Universals
+ Anthropology 110 Technology and Culture
+ Anthropology 122 Anthropology of World Systems
+ Anthropology 130A Coupled Human and Natural Systems: Risks, Vulnerability, Resilience, and Disasters
+ Anthropology 130B Global Tourism and Environmental Conservation
+ Anthropology 131 North American Indians
+ Anthropology 134 Modern Cultures of Latin America
* Anthropology 135 Modern Mexican Culture
+ Anthropology 136 Peoples and Cultures of the Pacific
+ Anthropology 137 The Ancient Maya
* Anthropology 141 Agriculture and Society in Mexico: Past Present
+ Anthropology 142 Peoples and Cultures of India
+ Anthropology 156 Understanding Africa
* Anthropology 160 Representations of Sexuality in Modern Japan (Same as HIST 188S and JAPAN 162)
& Anthropology 191 Indigenous Movements in Asia
@ & Asian American Studies 1 Introduction to Asian American History, 1850-Present
@ & Asian American Studies 2 American Migration since 1965
@ & Asian American Studies 7 Asian American Globalization
@ & Asian American Studies 8 Introduction to Asian American Gender and Sexuality
@ & Asian American Studies 9 Asian American Freedom Struggles and Third World Resistance
& Asian American Studies 100AA Chinese Americans
&* Asian American Studies 100BB Japanese Americans
&* Asian American Studies 100FF South Asian Americans
& Asian American Studies 107 Third World Social Movements
&* Asian American Studies 111 Asian American Communities and Contemporary Issues
& Asian American Studies 119 Asian Americans and Race Relations
& Asian American Studies 130 Colonialism and Migration in the Passage to America
&* Asian American Studies 131 Asian American Women’s History
&* Asian American Studies 136 Asian American Families
&* Asian American Studies 137 Multiethnic Asian Americans
& Asian American Studies 154 Race and Law in Early American History
& Asian American Studies 155 Racial Segregation from the Civil War to the Civil Rights Movement
& Asian American Studies 156 Race and Law in Modern America
& Asian American Studies 157 Asian Americans and Education
& Asian American Studies 165 Ethnographies of Asian Americans
@ & Black Studies 1 Introduction to Afro-American Studies

* This course applies toward the Writing requirement.
& This course applies toward the Ethnicity requirement.
+ This course applies toward the World Cultures requirement.
@ This course applies toward the American History & Institutions requirement.
X This course applies toward the European Traditions requirement.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geography 5</td>
<td>People, Place and Environment</td>
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<tr>
<td>French 154L</td>
<td>Globalization and Development in the Francosphere</td>
</tr>
<tr>
<td>History (Same as HIST 159C)</td>
<td>* History 25</td>
</tr>
<tr>
<td>Feminist Studies 159B</td>
<td>Women in American History (Same as FEMST 159B)</td>
</tr>
</tbody>
</table>

* 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.
+ Religious Studies 156A Anthropology of Religion
+ Religious Studies 162F South Asians in the U.S.
* Slavic 152A Slavic and East European Folklore
* Slavic 152B Language and Cultural Identity
* Slavic 152C Ideology and Representation
Sociology 1 Introduction to Sociology

Sociology 131 Political Sociology
* Sociology 134 Social Movements
@ Sociology 144 The Chicano Community (Same as CH ST 144)
Sociology 152A Sociology of Human Sexuality
&* Sociology 153 Women and Work (Same as FEMST 153)
+ Spanish 178 Mexican Culture

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
+ Anthropology 176TS Ancient Egyptian Religion
*: Art History 6A-B-C Art Survey
* Art History 6L History of Games
Art History 115E The Grand Tour: Experiencing Italy in the Eighteenth Century
Art History 136I The City in History
Art History 144D Russian Art
Art History 148A Global Art After 1980
& Art History 148B Introduction to Asian American Religions
& Asian American Studies 71 Asian American Sexualities
&* Asian American Studies 138 Asian American Religions (Same as RG ST 123)
+ Black Studies 3 Introduction to African Studies
*+ Black Studies 5 Blacks and Western Civilization
*+ Black Studies 7 Introduction to Caribbean Studies
&* Black Studies 49A-B Survey of African History
+ Black Studies 50 Blacks in the Media
*+ Black Studies 104 Black Marxism
*+ Black Studies 130A Negritude and African Literature
+ Black Studies 130B The Black Francophone Novel
&* Chicano Studies 113 New Phenomena in 21st Century Chinese Contemporary Chinese Religions
& Chinese 26 Historic Lives
& Chinese 48 Religious Practice and the State in China
*+ Chinese 183B Qing Empire
+ Chinese 185A Modern China (since 1911)
+ Chinese 185B The Romans
+ Classics 20B Introduction to Classical Archaeology
+ Classics 50 The Greek Intellectual Experience: From Poetry to Philosophy
*+ Classics 101 Magic and Medicine in Ancient Greece
+ Classics 140 Slavery and Freedom in the Ancient World
+ Classics 150 The Fall of the Ancient Republic: Cicero, Caesar, and Rome
Classics 151 Empires and Gladiators: History of the Roman Empire to 1800CE
* Classics 152 Citizenship: Ancient Origins and Modern Practices
*+ Classics 171 Artifact and Text: The Archaeology and Literature of Early Greece
Comparative Literature 27 Memory: Bridging the Humanities and Neurosciences (Same as FR 40X & MCDB 27)
*+ Comparative Literature 30A-B-C Major Works of European Literature
* Comparative Literature 35 The Making of the Modern World
+ Comparative Literature 113 Trauma, Memory, Historiography
* Comparative Literature 119 Psychoanalytic Theory
+ Comparative Literature 122A Representations of the Holocaust (Same as GER 116A)

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

*+ Comparative Literature 171 Post Colonial Cultures (Same as FR 154G)
* Comparative Literature 179A Revolutions: Marx, Nietzsche, Freud (Same as GER 179A)
+ Comparative Literature 186RR Romantic Revolutions: Philosophy, History, and the Arts in Europe
*+ East Asian Cultural Studies 3 Introduction to Asian Religious Traditions (Same as RG ST 3)
*+ East Asian Cultural Studies 4A East Asian Traditions: Pre-Modern
*+ East Asian Cultural Studies 4B East Asian Traditions: Modern
*+ East Asian Cultural Studies 5 Introduction to Buddhism
*+ East Asian Cultural Studies 7 Asian Values
*+ East Asian Cultural Studies 21 Zen
*+ East Asian Cultural Studies 80 Buddhist Traditions in East Asia
*+ East Asian Cultural Studies 164B The Climate Crisis: What is and what each of us can do about it

English 23 Introduction to Literature and the Environment
English 22 Literature and the Human Mind
Environmental Studies 3 Introduction to the Social and Cultural Environment
Feminist Studies 171CN City of Women: Women and Politics in Modern France (Same as FR 155D)

French 40X Memory: Bridging the Humanities and Neuroscience (Same as C LIT 27 & MCDB 27)

+ French 50AX-BX-CX Tales of Love
+ French 149C Reading Paris (1830-1890)
* French 154F Time Off in Paris
* French 154G Post-Colonial Cultures (Same as C LIT 171)

Comparative Literature 186RR Comparative Literature 179A
Comparative Literature 171 Post Colonial Cultures (Same as FR 154G)
Comparative Literature 171 Post Colonial Cultures (Same as C LIT 27 & MCDB 27)
Comparative Literature 171 Post Colonial Cultures (Same as C LIT 122A)

Law, Rights, and Justice
Global History, Culture, and Ideology
World History
World History (Honors)
Western Civilization
Western Civilization (Honors)
Introduction to History of Latin America
Science, Technology, and Medicine in Modern Society
The Middle East from Muhammad to the Nineteenth Century
The Middle East: From the Nineteenth Century to the Present
Survey of African History
Poverty, Inequality and Social Justice in Historical and Global Context
East Asian Civilization (Same as EACS 80)
Japanese History through Art and Literature
Survey of South Asian History
The Origins of Western Science, Antiquity to 1500 (Same as ENV S 108A)
The Scientific Revolution, 1500 to 1800
History of Modern Science
The Darwinian Revolution and Modern Biology (Same as ENV S 107C)
History of Christianity
Twentieth Century Germany
The Holocaust in German History
Early Modern Britain
Race and Juvenile Justice in U.S. History
Civil War and Reconstruction
The United States and the World since 1945
Korean History and Civilization (Same as KOR 182A-B)
This course applies toward the World Cultures requirement.

This course applies toward the Ethnicity requirement.

This course applies toward the European Traditions requirement.

**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.
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* 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.
### 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.

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* Comparative Literature 113 | Trauma, Memory, Historiography |
* Comparative Literature 122A | Representations of the Holocaust (Same as GER 116A) |
* Comparative Literature 122B | Holocaust in France (Same as FR 154E) |
* Comparative Literature 126 | Comparative Black Literatures |
* Comparative Literature 128A | Children’s Literature |
* Comparative Literature 133 | Transnational Literature |
* Comparative Literature 146 | Robots |
&* Comparative Literature 153 | Border Narratives |
* Comparative Literature 154 | Science Fiction in Eastern Europe |
* Comparative Literature 161 | Literature of Central Europe |
* Comparative Literature 170 | Literary Translation: Theory and Practice |
* Comparative Literature 171 | Post-Colonial Cultures (Same as FR 154G) |
* Comparative Literature 179A | Revolutions: Marx, Nietzsche, Freud (Same as GER 179A) |
* Comparative Literature 179B | Mysticism |
* Comparative Literature 179C | Medievalism (Same as GER 179C) |
* Comparative Literature 186AD | Adultery in the Novel |
& Comparative Literature 186EE | Interdisciplinary Comparative Literature |
* Comparative Literature 188 | Narrative Studies |
* Comparative Literature 189 | Rhetoric in the First Person |
* Comparative Literature 191 | Fantasy and the Fantastic (Same as FR 153D) |
* English 15 | Introduction to Shakespeare |
* English 16 | The Climate Crisis: What it is and what each of us can do about it |
* English 22 | Introduction to Literature and the Environment |
* English 25 | Introduction to Literature and the Culture of Information |
&* English 38A-B | Introduction to African American Literature |
&* English 50 | Introduction to U.S. Minority Literature |
&* English 65AA-ZZ | Topics in Literature |
* English 101 | English Literature from the Medieval Period to 1650 |
* English 102 | English and American Literature from 1650 to 1789 |
* English 103A | American Literature from 1789 to 1900 |
* English 103B | British Literature from 1789 to 1900 |
* English 104A | American Literature from 1900 to Present |
* English 104B | British Literature from 1900 to Present |
* English 105A | Shakespeare: Poems and Earlier Plays |
* English 105B | Shakespeare: Later Plays |
* English 113AA-ZZ | Literary Theory and Criticism |
* English 114AA-ZZ | Women and Literature |
&* English 114BW | Black Women Authors |
* English 115 | Medieval Literature |
* English 116A | Biblical Literature: The Old Testament |
* English 119X | Medieval Literature in Translation |
* English 120 | Modern Drama |
* English 121 | The Art of Narrative |
* English 122AA-ZZ | Cultural Representations |
* English 122NE | Cultural Representations of Nature and the Environment (Same as ENV S 122NE) |
* English 124 | Readings in the Modern Short Story |
* English 126B | Survey of British Fiction |
* English 128A-ZZ | Literary Genres |
* English 131AA-ZZ | Studies in American Literature |
&* English 133AA-ZZ | Studies in American Regional Literature |
&* English 134AA-ZZ | Literature of Cultural and Ethnic Communities in the United States |
&* English 136 | Seventeenth and Eighteenth Century American Literature |
&* English 137A-B | Poetry in America |
&* English 140 | Contemporary American Literature |
&* English 150 | Anglo-Irish Literature |
&* English 152A | Chaucer: Canterbury Tales |
&* English 156 | Literature of Chivalry |
&* English 157 | English Renaissance Drama |
&* English 162 | Milton |
&* English 165AA-ZZ | Topics in Literature |
&* English 170AA-ZZ | Studies in Literature and the Mind |
&* English 172 | Studies in the Enlightenment |
&* English 179 | British Romantic Writers |
&* English 180 | The Victorian Era |
&* English 181AL,MT | Studies in the Nineteenth Century |
&* English 184 | Modern European Literature |
&* English 185 | Modernism in English |

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

* Anthropology 102A Introduction to Women, Culture, and Development (Same as GLOBL 180A and SOC 156A)
* Anthropology 116A Myth, Ritual, and Symbol
* Anthropology 116B Anthropological Approaches to Religion
* Anthropology 143 Comparative Ethnicity
& Anthropology 148A The Evolution of Cooperation
* Anthropology 169 Colonialism and Culture
* Anthropology 176A The American West
* Art History 186A/ZZ Seminar in Advanced Studies in Art History
* Art History 187H Museums in Transition: From the Early Modern to the Modern Period
* Art History 187Z Museum Studies Seminar
& Asian American Studies 100CC Filipino Americans
& Asian American Studies 100DD Korean Americans
& Asian American Studies 109 Asian American Women and Work
& Asian American Studies 113 The Asian American Movement
@ & Asian American Studies 121 Asian American Autobiographies and Biographies
& Asian American Studies 124 Asian American Literature in Comparative Frameworks
* Asian American Studies 134 Asian American Men and Contemporary Men’s Issues
& Asian American Studies 138 Asian American Sexualities
& Asian American Studies 148 Introduction to Video Production
& Asian American Studies 149 Screenwriting
& Asian American Studies 162 Asian American Mental Health
@ & Black Studies 108 Obama as a Political and Cultural Phenomenon
@g & Black Studies 137E Sociology of the Black Experience
@ & Chicano Studies 168E History of the Chicano Movement
& Chicano Studies 168F Racism in American History
@ & Chicano Studies 171 The Brown/Black Metropolis: Race, Class, & Resistance in the City
& Chicano Studies 189 Immigration and the US Border
* Chinese 132B Special Topics in Modern Chinese Poetry
* Chinese 150 The Language of Vernacular Chinese Literature
* Chinese 166B Taoist Traditions in China
* Chinese 166C Confucian Tradition: The Classical Period
* Chinese 184B History of China
* Classics 60 Science and Medicine in Ancient Greece
* Communication 130 Global Communication, International Relations and the Media
* Communication 137 Global Communication, International Relations and the Media
* Communication 153 Communication and Global Advocacy
* Comparative Literature 28 Storytelling in the Anthropocene
* Comparative Literature 36 Global Humanities: The Politics and Poetics of Witnessing
* Counseling, Clinical & School Psychology 101 Introduction to Applied Psychology
* Earth Science 6 Mountains, Boots and Backpacks: Field Study of the High Sierra
* Earth Science 104A Field Studies in Geological Methods
* Earth Science 104B Field Methods
* Earth Science 117 Earth Surface Processes and Landforms
* Earth Science 123 The Solar System
* Earth Science 130 Global Warming - Science and Society
* Economics 107A History of Economics
* Economics 117A Law and Economics
* Education 20 Introduction to the University Experience
@ & EEMB 124 Biomechanical Ecology
& EEMB 134 Biology of Seaweeds and Phytoplankton
& EEMB 135 Evolutionary Ecology
& EEMB 138 Ethology and Behavioral Ecology
& EEMB 142BL Chemical and Physical Methods of Aquatic Environments
& EEMB 142CL Methods of Aquatic Biology
& EEMB 149 Marine Biology for the Twenty-first Century
& EEMB 179 Modeling Environmental and Ecological Change

* 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.
X This course applies toward the European Traditions requirement.
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<td>* Psychology 117L</td>
<td>Laboratory in Human Memory and Cognition</td>
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<td>* Psychology 118L</td>
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<td>* Psychology 120L</td>
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<td>@ Sociology 155A</td>
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<td>&amp; Sociology 155M</td>
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<td>* Sociology 156A</td>
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* This course applies toward the Writing requirement.
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@ This course applies toward the American History & Institutions requirement.
@ This course applies toward the European Traditions requirement.
CHECKLIST OF GENERAL UNIVERSITY AND GENERAL EDUCATION REQUIREMENTS

GENERAL UNIVERSITY REQUIREMENTS

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

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

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

One course _________ or Advanced Placement _________ or International waiver _________

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

GENERAL EDUCATION REQUIREMENTS

A course listed in more than one General Subject Area can be applied to only one area. Course total in Areas D, E, F, 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, 107T or 109ST _______________

2. Area D: Social Sciences (2 courses minimum)

   __________________________

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

   __________________________

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

   __________________________

5. Area G: Literature (1 course minimum)

   __________________________

Special Subject Areas

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

a. Writing Requirement – (4 courses)

   __________________________

b. Ethnicity Requirement – (1 course) _______________________

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

Department of Chemical Engineering, Engineering II, Room 3357; Engineering, Engineering II, Room 3357; Engineering and Applied Science, 1320 West Valley Court; 200 High Street; 1117 Socorro Road; 93506-1063; Ph. (805) 893-3412; Fax (805) 893-3419; E-mail: chemengr.ucsb.edu; Web site: 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)
Philip N. Christopher, Ph.D., University of Michigan, Associate Professor (catalysis, photocatalysis, photoprocesses, 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, energy 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)
Rachel A. Segalman, Ph.D., UC Santa Barbara, Professor (polymer design, self-assembly, and properties)
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)
Owen T. Hanna, Ph.D., Purdue University, Professor Emeritus (theoretical methods)
Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor (structural materials, mechanical properties)
L. Gary Leal, Ph.D., Stanford University, Schlinger 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)

*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 judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Undergraduate Program

Bachelor of Science—Chemical Engineering

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

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

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

Chemical Engineering Courses

LOWER DIVISION

5. Introduction to Chemical Engineering Design
(3) 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. Introduction to Chemical Engineering
(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-I; 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.

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

120B. Transport Processes
(3) HELGESON, CHMELKA
Prerequisite: Chemical Engineering 10 with 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, SQUIRES
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 120A.
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.

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

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

128. Separation Processes
(3) SCOTT, CHMELKA
Prerequisites: Chemical Engineering 10 and 110A-B; open to College of Engineering majors only.
Basic principles and design techniques of equilibrium-stage separation processes. Emphasis is placed on binary distillation, liquid-liquid extraction, and multicomponent distillation.

132A. Analytical Methods in Chemical Engineering
(4) FREDRICKSON, GORDON
Prerequisites: Engineering 3, Mathematics 4B or 4BI, Mathematics 6A or 6AI-6B.
Develop analytical tools to solve elementary partial differential equations and boundary value problems. Separation of variables, Laplace transforms, Sturm- Liouville theory, generalized Fourier analysis, and computer math tools.

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

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

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

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

141. The Science and Engineering of Energy Conversion
(3) MCFARLAND
Prerequisite: Chemical Engineering 110A and 140A.
Equivalent upper-division coursework in thermodynamics and kinetics from outside of department will be considered.
Framework for understanding the energy supply issues facing society with a focus on the scientific, 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 catalysts. Correlations and theoretical approaches in chemical engineering catalysis.

152A. Process Dynamics and Control
(4) CHMELKA, CHRISTOPHER
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 systems, 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 feedforward control, cascade control, enhanced single- loop strategies, and model predictive control. Analysis of multi-loop control systems. Introduction to on-line optimization.

154. Engineering Approaches to Systems Biology
(3) STAFF
Prerequisite: Chemical Engineering 170 or Chemical Engineering 107; Mathematics 4B or 4BI; Mathematics 6A or 6AI and Mathematics 6B.
Applications of engineering tools and methods to solve problems in systems biology. Emphasis is placed on integrative approaches that address multi-scale and multi-rate phenomena in biological regulation, modeling, optimization, and sensitivity analysis tools are introduced.

160. Introduction to Polymer Science
(3) SEGALMAN
Prerequisite: Chemical Engineering 110A or Chemistry 113A or equivalent.
Same course as Material 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. Mechatronics and Instrumentation for Chemical Engineers
(3) GORDAN
Prerequisite: Engineering 3 and Chemical Engineering 110A and 110B or consent of instructor
Recommended Preparation: Chemical Engineering 120A and B and Chemical Engineering 132A and B.
Enrollment Comments: Concurrently offered with Chemical Engineering 266.
Introduction to electromechanical systems and instrumentation used in Chemical Engineering. Fundamentals of transducers, sensors and actuators; interfacing and controlling hardware with software (Labview & 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 170 or Chemical Engineering 107 or MCB 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 170 or Chemical Engineering 107 or MCB 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) O'MALLEY
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 120B.
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, 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

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

198. Independent Studies in Chemical Engineering
(1-4) STAFF
Prerequisites: consent of instructor; upper-division standing; completion of two upper-division courses in chemical engineering.
Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated up to twelve units. Students are limited to five units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined.
Directed individual studies.

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

Computer Engineering

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

Faculty
Kauat Boanee, 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. Brewr, Ph.D., University of Illinois at Urbana-Champaign, Professor (VLSI and computer-aided 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)
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)

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/CIL, efficient mobile program transfer formats)
Behroz Parhami, Ph.D., UC Los Angeles, Professor (parallel architectures and algorithms, computer arithmetic, computer design, dependable and fault-tolerant computing)
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)
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)
Yuan Xie, Ph.D., Princeton University, Professor (EDA, VLSI design, computer architecture, embedded systems, high-performance computing)
Zheng Zhang, Ph.D., Massachusetts Institute of Technology, Assistant Professor (Design Automation Algorithms for VLSI/ MEMS/Photonics; Uncertainty Quantification and Data Analysis; Modeling and Control for Robotic and Autonomous Systems; Computation for Biomedical Imaging)

The Computer Engineering major’s objective is to educate broadly based engineers with an understanding of digital electronics, computer architecture, system software and integrated circuit design. These topics bridge traditional electrical engineering and computer science curricula. The Computer Engineering degree program is conducted jointly with faculty from the Department of Computer Science and the Department of Electrical and Computer Engineering. Computer engineers emerging from this program will be able to design and build integrated digital hardware and software systems in a wide range of applications areas. Computer engineers will seldom work alone and thus teamwork and project management skills are also emphasized. The undergraduate major in Computer Engineering prepares students for a wide range of positions in business, government and private industrial research, development and manufacturing organizations.

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College of Engineering, as well as advisors in the department. Faculty advisors are also available to help with academic program planning. Students who hope to change to this major should consult the department advisor.


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

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

Program Outcomes
Upon completion of this program, students will have:
1) Acquired strong basic knowledge and skills in those fundamental areas of mathematics, science, and engineering necessary to facilitate specialized profes-
sional training at an advanced level. Developed a recognition of the need for and the ability to engage in lifelong learning.

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

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

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

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

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

Undergraduate Program

Bachelor of Science—Computer Engineering

A minimum of 191 units is required for graduation. A complete list of requirements for the major can be found on page 48. Schedules should be planned to meet both General Education and major requirements.

The curriculum contains a core required of all computer engineers, a choice of at least 48 units of senior year elective courses including completion of two out of ten elective sequences and a senior year capstone design project.

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

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

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

Computer Science

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

Faculty

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

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

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

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)

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

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

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

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

Yufei Ding, Ph.D., North Carolina State University, Assistant Professor (high-level computer science education, theoretical computer science, quantum computation)

Satisfactory Progress and Prerequisites

A majority of Computer Science and Electrical and Computer Engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite classes requires a grade of C or better in Mathematics 3A-B 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.
large-scale program optimizations, high-performance domain-specific languages, heterogeneous massively parallel computing, high-performance machine learning, and quantum computing)

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

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

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

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

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

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 Hardekoepf, 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, PhD., University of Arizona, Lecturer Potential SOE

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)

Daniel Lokshtanov, PhD., University of Bergen, Associate Professor (algorithms, theory of computing)

Diba Mirza, PhD., University of California, San Diego, Lecturer PSOE

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)

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)

Misha Sra, Ph.D, Massachusetts Institute of Technology, John and Eileen Gerngross 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)

Richert K. Wang, Ph.D., University of California, Irvine, Lecturer Potential SOE

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

Yuxiang 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)

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

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

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

Emeriti Faculty

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

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

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

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

Alan G. Konheim, Ph.D., Cornell University, 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)

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

Francesco Bullo, Ph.D. (Mechanical Engineering)

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

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

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

Yasamin Mostofi, Ph.D. (Electrical and Computer Engineering)

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

Yuan Xie, Ph.D. (Electrical and Computer Engineering)

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

The Department of Computer Science offers programs leading to the degree of Bachelor of Science in computer science, and the M.S. and Ph.D. in computer science. One of the most important assets of the Computer Science program at UCSB is the wealth of "hands-on" opportunities for students. UCSB has excellent computer facilities. Campus Instructional Computing makes accounts available to all students. Computer Science majors and premajors use the workstations in the Computer Science Instructional Lab and Engineering Computing Infrastructure computing facilities. Students doing special projects can gain remote access to machines at the NSF Supercomputing Centers.

Additional computing facilities are available for graduate students in the Graduate Student Laboratory. Students working with faculty have access to further specialized research facilities within the Department of Computer Science. The undergraduate major in computer science has a dual purpose: to prepare students for advanced studies and research and to provide training for a variety of careers in business, industry, and government.

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College of Engineering, as well as advisors in the department. A faculty advisor is also available to each undergraduate class for further academic program planning.

Program Goals for Undergraduate Programs

The goal of the computer science undergraduate program is to prepare future generations of computer professionals for long-term careers in research, technical development, and applications. Graduates of the B.S. program that wish to seek immediate employment are prepared for a wide range of computer science positions in industry and government. Outstanding graduates interested in highly technical careers, research, and/or academia, might consider furthering their education in graduate school.

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

Program Outcomes for Undergraduate Programs

The program enables students to achieve, by the time of graduation:

1. An ability to apply knowledge of computing and mathematics appropriate to computer science.
2. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.
3. An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.
4. An ability to function effectively on teams to accomplish a common goal.
5. An understanding of professional, ethical, and social responsibilities.
6. An ability to communicate effectively.
7. An ability to analyze the impact of computing on individuals, organizations, and society, including ethical, legal, security, and global policy issue.
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) KHARTONOVA, MIRZA, MATNI
   Not open for credit to students who have completed Computer Science 16 or Engineering 3.
   Legal repeat for CMPSC 5AA-ZZ.
   Introduction to computer program development for students with little to no programming experience. Basic programming concepts, variables and expressions, data and control structures, algorithms, debugging, program design, and documentation.

16. Problem Solving with Computers I
   (4) KHARTONOVA, MIRZA
   Prerequisite: Math 3A with a grade of C or better
   Introduction to programming and problem solving. Computer organization and programming constructs: memory CPU, binary arithmetic, variables, expressions, statements, conditionals, iteration, functions, parameters, recursion, primitive and composite data types, and basic operating system and debugging tool.

24. Problem Solving with Computers II
   (4) AGRAWAL, MIRZA
   Prerequisite: Computer Science 16 with a grade of C or better
   Advanced topics in object-oriented computing. Topics include encapsulation, data hiding, inheritance, polymorphism, compilation, linking and loading, memory management, and debugging; recent advances in design and development tools, practices, libraries, and operating system support.

32. Object Oriented Design and Implementation

   (4) WANG, R.
   Prerequisite: Computer Science 24 with a grade of C or better
   Computer Science 32 is a legal repeat for Computer Science 60.
   Introduction to the theoretical underpinnings of computer science. Topics include propositional predicate logic, set theory, functions and relations, counting, mathematical induction and recursion (generating functions).

64. Computer Organization and Logic Design
   (4) MATNI
   Prerequisite: Computer Science 16 with a grade of C or better
   Computer Science 16 with a grade of C or better
   Not open for credit to students who have completed ECE 15 or ECE 15B or Computer Science 30.
   Course counts as a legal repeat of CMPSC 30.
   Assembly language programming and advanced computer organization; Digital logic design topics including gates, combinational circuits, flip-flops, and the design and analysis of sequential circuits.

99. Independent Studies in Computer Science
   (1-4) STAFF
   Must have a minimum 3.0 grade point average.
   May be repeated. Students are limited to 5 units per quarter and 30 units total in all 99/198/199 courses combined.
   Independent studies in computer science for advanced students.
111. Introduction to Computational Science
(4) GILBERT, MATNI
Prerequisite: Mathematics 5A or 4B with a grade of C or better; Mathematics 5B or 6A with a grade of C or better; Computer Science 24 with a grade of C or better.
Not open for credit to students who have completed Computer Science 110A.
Introduction to computational science, emphasizing basic numerical algorithms and the informed use of mathematical software. Matrix computation, systems of linear and nonlinear equations, interpolation and zero finding, differential equations, numerical integration. Students learn and use the Matlab language and their applications.

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

130B. Data Structures and Algorithms II
(4) LOKSHANTOV, 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, branch and bound, backtracking, and local search. Applications of techniques to problems from several disciplines. NP - completeness.

138. Automata and Formal Languages
(4) EUGICIGOF
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 or 5A with a grade of C or better; Mathematics 6A or 5B with a grade of C or better; Computer Science 130A.
Not open for credit to students who have completed Computer Science 110B.
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.
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) KRINTZ
Prerequisite: Upper-division standing in computer science, computer engineering, or electrical engineering.
Same course as ECE 153A.
Issues in interfacing computing systems and software to practical I/O interfaces. Rapid response, real-time events and management of tasks, threads, and scheduling required for efficient design of embedded software and systems. Techniques for highly constrained systems.

154. Computer Architecture
(4) MATNI
Prerequisite: Computer Science 32 with a grade of C or better; Computer Science 48 with a grade of C or better, and Computer Science 64 with a grade of C or better.
Not open for credit to students who have completed Computer Science 20.
Introduction to the architecture of computer systems. Topics include: central processing units, memory system, communication 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; computer science or computer engineering majors only.
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 software, 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) SING, HARKOFF
Prerequisite: Computer Science 48 or Electrical Engineering 154 or Electrical Engineering 154A; Computer Science 130A; and Computer Science 138; open to computer science and computer engineering majors only.
The study of compilers. Topics include: lexical analysis; syntax analysis including LL and LR parsers; type checking; run-time environments; intermediate code generation; and compiler-construction tools.

162. Programming Languages
(4) HARKOFF, 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; programmability through generative and inheritance; type systems; programming paradigms (imperative, object-oriented, functional, and others). Emerging programming languages and their development infrastructures.

165A. Artificial Intelligence
(4) WANG, Y., 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, probabilistic reasoning, and applications of AI.

165B. Machine Learning
(4) WANG, W., DAI
Prerequisite: Computer Science 130A.
Covers the most important techniques of machine learning (ML) and includes discussions of: well-posed learning problems; artificial neural networks; concept learning and specific ordering; decision tree learning; genetic algorithms; Bayesian learning; analytical learning; and others.

170. Operating Systems
(4) WOLSKA, 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 call, communication, naming and membership problems, asynchrony, logical time, consistency, fault-tolerance, and recovery.

172. Software Engineering
(4) BULTRAN
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 learn, 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 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 normalizing preserving decompositions, Boyce-Codd and Third Normal Forms.

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

176A. Introduction to Computer Communication Networks
(4) BLEDING
Prerequisite: CMPSC 32 with a grade of C or better; PSTAT 120A or ECE 139; open to computer science, electrical engineering, and computer engineering majors only.
Not open for credit to students who have completed Computer Science 176 or ECE 155 or ECE 155A.
Recommended preparation: PSTAT 120B.
Basic concepts in networking, the OSI model, error detection codes, flow control, routing, medium access control, and high-speed networks.

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

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

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

178. Introduction to Cryptography
(4) ANANTH
Prerequisite: Computer Science 24 and Computer Science 40 with a grade of C or better; and PSTAT 120A or 121A or ECE 139 or permission of instructor.
An introduction to the basic concepts and techniques of cryptography and cryptanalysis. Topics include: The Shannon Theory, classical systems, the Enigma machine, the data encryption standard, public key systems, digital signatures, file security.

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

181. Introduction to Computer Vision
(4) WANG Y.F.
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 and Computer Science 190A.
An introduction to programming mobile computing devices. Students will learn about and study the shift in software development from desktop to mobile device applications. Topics will include software engineering and design practices, advances in programming practice, and support tools for mobile application development and testing. Students will develop and deploy mobile applications as part of their course work.

185. Human-Computer Interaction
(4) HOLLERER
Prerequisite: Upper-division standing in computer science, computer engineering, or electrical engineering majors.
Recommended preparation: Students are strongly encouraged to complete Computer Science 56 prior to enrolling in Computer Science 185. Proficiency in the Java/C++ programming language, some experience with user interface programming.
The study of human-computer interaction enables system architects to design useful, efficient, and enjoyable computer interfaces. This course covers 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 56; Senior standing in computer engineering, computer science, or electrical engineering; consent of instructor.
Not open for credit to students who have completed Computer Science 172 or ECE 189A.
Student groups design a significant computer-based project. Multiple groups may cooperate toward one large project. Each group works independently; interaction among groups is via interface specifications and informal meetings. Project for follow-up course may be different.

189B. Senior Computer Systems Project
(4) BULTAN, KRINTZ
Prerequisite: CMPSC 189A; Senior standing in computer engineering, computer science, or electrical engineering; consent of instructor.
Not open for credit to students who have completed ECE 189A or ECE 189B.
Student groups design a significant computer-based project. Multiple groups may cooperate toward one large project. Each group works independently; interaction among groups is via interface specifications and informal meetings. Project for 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 8 units with consent of the department chair but only 4 units may be applied to the major.
Projects in computer science for advanced undergraduate students.

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

196. Undergraduate Research
(2-4) STAFF
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.

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 for this major can be found in the UCSB General Catalog.
and electronic devices and integrated circuits, fiber optic communication, semiconductors, laser physics and mode-locking phenomena, compound semiconductor materials and processing)

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

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

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

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

Nadir Dagli, Ph.D., Massachusetts Institute of Technology, Professor (design, fabrication, and modeling of photonic integrated circuits, ultrafast electrooptic modulators, solid state microwave and millimeter wave devices; experimental study of ballistic transport in quantum confined structures)

Steven P. DenBaars, Ph.D., University of Southern California, Distinguished Professor (metalorganic vapor phase epitaxy, optoelectronic materials, compound semiconductors, indium phosphide and gallium nitride, photonic devices)

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 (Low power hardware design, Multi-antenna wireless communications, Transmit beam forming, Vector quantization, Performance analysis of communication systems)

Jonathan Klimkin, Ph.D., UC Santa Barbara, Associate Professor (Integrated Photonics, Silicon Photonics, Optical Communications, Nanophotonics, 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 imaging, 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, Assistant Professor (Feedback Control and Systems Theory; Game Theoretic Methods for Coordination of Large Scale Distributed Systems; Application to Distributed Traffic Routing, Dynamic Resource Allocation, Queuing Systems, and Sensor Networks)

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

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

Ramin 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 (Compound Semiconductor Research Laboratories, Director of National Nanofabrication Users Network (heterojunction bipolar transistors, high frequency integrated circuit design, electronics beyond 100 GHz))

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

Loai Salem, PhD, UC San Diego (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, Assistant Professor (nanophotonics, organic optoelectronics, plasmonics, metamaterials)

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

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

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)

Christos Thrampoulidis, PhD, Caltech, Assistant Professor (high-dimensional inference, statistical signal-processing optimization, compressed sensing, learning theory)

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 (design verification, testing, computer-aided design of microprocessors)

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

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

Zheng Zhang, Ph.D., Massachusetts Institute of Technology, Assistant Professor (Photonics, 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, design 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 (computation theory, signal processing in radar and digital communication systems; digital image processing)

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

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

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

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

Stephen L. 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. Mathaei, 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 Mellar-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-aided design, fault-tolerance, formal specification and verification, performance evaluation)

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

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

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

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

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

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

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

*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 Engineering)

Shuji Nakamura, Ph.D. (Materials Engineering)

Tim Sherwood, Ph.D. (Computer Science)

William Wang, Ph.D. (Computer Science)

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

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

The undergraduate major in Electrical Engineering prepares students for a wide range of positions in business, government, and private industrial research, development, and manufacturing organizations.

Students who complete a major in electrical engineering may be eligible to pursue a California teaching credential. Interested students should consult the credential advisor in the Graduate School of Education.

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

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

Mission Statement

The Department of Electrical and Computer Engineering seeks to provide a comprehensive, rigorous and accredited educational program for the graduates of Cali-
The educational objectives of the Electrical Engineering Program identify what we hope that our graduates will accomplish within a few years after graduation.

1. We expect our graduates to make positive contributions to society in fields including, but not limited to, engineering.
2. We expect our graduates to have acquired the ability to be flexible and adaptable, showing that their educational background has given them the foundation needed to remain effective, take on new responsibilities and assume leadership roles.
3. We expect some of our graduates to pursue their formal education further, including graduate study for master’s and doctoral degrees.

Program Outcomes

The EE program expects our students upon graduation to have:

1. Acquired strong basic knowledge and skills in those fundamental areas of mathematics, science, and electrical engineering that are required to support specialized professional training at the advanced level and to provide necessary breadth to the student’s overall program of studies. This provides the basis for lifelong learning.
2. Experienced in-depth training in state-of-the-art specialty areas in electrical engineering. This is implemented through our senior electives. Students are required to take two sequences of at least two courses each at the senior level.
3. Experienced design-oriented challenges that exercise and integrate skills and knowledge acquired in several courses. These may include design of components or subsystems with performance specifications. Graduates should be able to demonstrate an ability to design and conduct experiments as well as analyze the results.
4. Completed a well-rounded and balanced education through required studies in selected areas of fine arts, humanities, and social sciences. This provides for the ability to understand the impact of engineering solutions in a global and societal context. A course in engineering ethics is also required of all undergraduates.

Undergraduate Program

Bachelor of Science—Electrical Engineering

A minimum of 189 units is required for graduation. A complete list of requirements for the major can be found on page 52. Schedules should be planned to meet both General Education and major requirements.

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

The required 32 units (8 courses) of departmental electives are taken primarily in the senior year, and they permit students to develop depth in specialty areas of their choice. The 32 units of departmental electives must include at least 2 sequences, one of which must be an approved EE Senior Capstone Design/Project course sequence. A student’s elective course program must be approved by a departmental faculty advisor. The advisor will check the program to ensure satisfaction of the departmental requirements. A wide variety of elective programs will be considered acceptable.

Three matters should be noted: (1) students who fail to attain a grade-point average of at least 2.0 in the major may be denied the privilege of continuing in the major. (2) A 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

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

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

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 signal systems. Specific areas will include 1-D and 2-D signal processing, basic transforms and applications.

5. Introduction to Electrical & Computer Engineering

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 Electric 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

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 engineering and computer engineering majors. Lecture: 3 hours

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

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

10AL. Foundations of Analog and Digital Circuits and Systems (3) STAFF
Prerequisite: ECE 10A with a C- or better grade. Lecture: 3 hours
Not open for credit to those who have received a C- or higher in ECE 2B.

The objective of the course is to introduce the MOSFET behavior of digital logic and analog circuit design. The course will cover the CMOS digital design and its controlled logic design. Topics discussed will be introduced to the concepts discussed in ECE 10B. The lab will utilize the MOSFET to introduce students to the characteristics of digital logic gates.

10BL. Foundations of Analog and Digital Circuits and Systems Lab (2) STAFF
Prerequisite: ECE 10B with a C- or better grade. Laboratory: 4 hours
Not open for credit to 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, circuit simulation and design tools, 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 to those who have received a C- or higher in ECE 2B.

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. (S)

10CL. Foundations of Analog and Digital Circuits and Systems Lab (2) STAFF
Prerequisite: ECE 10C with a C- or better grade. Laboratory: 4 hours
Not open for credit to 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 propagation 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 and Computer Engineering majors only.
Projects in electrical and computer engineering for advanced undergraduate students.

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

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 research seminar, and prepare at least one written report on their research.

UPPER DIVISION

120A. Integrated Circuit Design and Fabrication (4) BEN-YAACOV
Prerequisite: ECE 132 with a minimum grade of C-.
Lecture: 3 hours; Laboratory: 3 hours
Not open for credit to 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 124B.

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

122A. VLSI Principles (4) BANERJEE
Prerequisite: ECE 152A with a minimum grade of C-.
Lecture: 3 hours; Laboratory: 3 hours
Not open for credit to 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 characterization: delay, noise margins, and power dissipation; combinational and sequential circuits; arithmetic operations and memories.

122B. VLSI Architecture and Design (4) BREWER
Prerequisite: ECE 122A or ECE 123 or ECE 122A with a minimum grade of C-
Lecture: 3 hours; Laboratory: 2 hours
Not open for credit to those who have taken ECE 124D.

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

123. High-Performance Digital Circuit Design (4) THEOGARAJAN
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 to 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 management, interconnects, reliability; non-clocked, clocked and self-timed logic gates; clocked storage elements; high-speed components, PLLs and DLLs; clock and power distribution; memory systems; signal integrity and I/O design, low-power design.

130A. Signal Analysis and Processing (4) STAFF
Prerequisite: Mathematics 4B or 5A with a minimum grade of C and ECE 2B or ECE 10B & ECE 10BL with a minimum grade of C- in each.
Laboratory: 4 hours.
Advanced continuous and discrete time linear systems in the time and frequency domains. Fourier transforms, Laplace transforms, Sampling and aliasing.

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

130C. Signal Analysis and Processing (4) CHANDRASEKARAN
Prerequisite: ECE 130-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, 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 5A with a minimum grade of C- and, ECE 10A-B and ECE 10AL-BL or ECE 2A-B (may be taken concurrently) with a minimum grade of C- in each; open to EE and computer engineering majors only.
Laboratory: 3 hours; Discussion: 2 hours.
Analysis of solid state electronic devices: Basic semiconductor physics and properties of electrons and holes; P-N junction diodes; I-V; C-V, and switching properties of P-N junctions; introduction of bipolar transistors, MOSFETs and JFETs.

134. Introduction to Fields and Waves (4) DAGLI YORK
Prerequisite: Physics 3 or 23 with a minimum grade of C-; Mathematics 4B or 4BI or 5A and Mathematics 5C or 6B with a minimum grade of C- in each; 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. Waves on transmission-lines, elements of 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) ROODWELL
Prerequisites: ECE 10A-B-C and ECE 10AL-BL-CL or ECE 2A-B-C, 130A, and 132 with a minimum grade of C- in all; open to EE majors only. Lecture, 3 hours, laboratory, 3 hours.

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

137B. Circuits and Electronics II
(4) ROODWELL
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. Transistor 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 high-order moments. Markov chains, hypothesis testing.

141A. Introduction To Nanoelectromechanical and Microelectromechanical Systems(NEMS/MEMS)
(3) PENNATHUR
Prerequisites: ME 16 & 17, ME 152A, ME 151A (may be concurrent); or, ECE 130A and 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.

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)

141C. Introduction to Microfluidics and BioMEMS
(3) MENHART
Prerequisites: ME 141A or ECE 141A; open to ME and EE majors only.

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

142. Introduction to Power Electronics
(4) MISHRA
Prerequisites: ECE 132, ECE 134, and ECE 137A with a minimum grade of C- in all; open to EE majors only. Lecture, 3 hours; laboratory, 2 hours.

An introduction to modern switched-mode power electronics and associated devices. Covers modern converter/inverter topologies for the control and conversion of electrical power with high efficiency with applications in power supplies, renewable energy systems, lighting, electric/hybrid vehicles, and motor drivers.

144. Electromagnetic Fields and Waves
(4) KLAMKIN
Prerequisite: ECE 134 with a minimum grade of C-. Lecture, 3 hours; laboratory, 3 hours.

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

145A. Communication Electronics
(5) ROODWELL
Prerequisites: ECE 137A-B with a minimum grade of C- in both. Lecture, 3 hours; laboratory, 6 hours.


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

RF models for CMOS and BJT. Discrete vs. IC implementations in passive components. LNA’s, PAs, T/R switches, Mixers, VCOs. Phase filters Radio link budget. Analog and digital modulation schemes. Introduction to receiver architectures. IQ modulation. Image-reject architectures.

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


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
Prerequisites: ECE 130A-B 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, 6 hours.

Analysis of sampled data feedback systems; state space description of linear systems; observability, controllability, pole assignment, state feedback, observers. Design of digital control systems. (W)

147C. Control System Design Project
(5) HESPANHA
Prerequisite: ECE 147A or ME 155B or ME 173 with a minimum grade of C-. Lecture, 3 hours; laboratory, 6 hours.

Students are required to design, implement, and document a significant control systems project. The project is implemented in hardware or in high-fidelity numerical simulators. Lectures and laboratories cover special topics related to the practical implementation of control systems.

148. Applications of Signal Analysis and Processing
(4) LEE
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
(6) STAFF
Prerequisite: Probability: 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, camera, 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.

Design of synchronous digital systems: timing diagrams, propagation delay, latches and flip-flops, shift registers and counters, Mealy/Moore finite state machines, Verilog, 2-phase clocking, timing analysis, CMOS implementation, S-, RAM, RAM-based designs, ASM charts, state minimization.

153A. Hardware/Software Interface
(4) KIRNTZ
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
154A. Introduction to Computer Architecture (4) PARKHAI
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 maps, arrays, pointers; Procedure calls; Number formats; Simple ALUs; Data path, control, microprogram; Buses, I/O programming, interrupts; Pipelined data paths and control schemes.

154B. Advanced Computer Architecture (4) STRUKOV
Prerequisite: ECE 154A with a 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, multithreading, VLIW; Vector and array processing, multi-/many-core chips; Cache and virtual memory; Disk arrays, shared memory; 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 152A 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) for the 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 CMPSC 182.
Introduction to multimedia and applications, including WWW, image/video databases and video streaming. Concepts and methods in multimedia 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. Tunneling, 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) BYL
Prerequisites: open to EE, computer engineering, and computer science majors with upper-division standing. Lecture, 3 hours; discussion, 1 hour.
Basic concepts in image and video processing.
Topics include image formation and sampling, image transforms, image enhancement, and image and video compression including JPEG and MPEG coding standards.

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

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

181. Introduction to Computer Vision (4) MANJUNATH
Prerequisite: Upper-division standing in Electrical Engineering, Computer Engineering, Computer Science, Chemical Engineering or Mechanical Engineering. Lecture: 3 hours; Discussion: 1 hour.
Same course as Computer Science 181B.
Repeat Comments: Not open for credit to students who have completed ECE/CMPS 181B with a grade of C or better. ECE/CMPS 181 is a legal repeat of ECE/CMPS 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.

188A. Senior Electrical Engineering Project (3) BEN YAACOV
Prerequisite: ECE 130A and ECE 130B with a C-grade or better in both; or ECE 137A and ECE 137B with a C- or better in both.
Student groups design a significant project based on the knowledge and skills acquired in earlier coursework and integrate their technical knowledge through a practical design experience. The project is evaluated through written reports, oral presentations, and demonstrations of performance.

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

189A. Senior Computer Systems Project (3) ISUKAPALLI
Prerequisite: ECE 153B; senior standing. ECE 153B; Computer Engineering, Computer Science or EE.
Lecture: 3 hours; Laboratory: 3 hours.
Not open for credit to students who have completed Computer Science 189A-B.
Student groups design a significant computer-based project. The focus will be on designing a significant project based on the knowledge and skills acquired in earlier coursework. Groups work independently with interaction among groups via interface specifications and informal meetings.
199. Independent Studies in Electrical and Computer Engineering

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

GRADUATE COURSES

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

Engineering Sciences

Engineering Sciences, Office of Associate Dean for Undergraduate Studies, Harold Frank Hall, Room 1006; Telephone (805) 893-2809

Web site: 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 education 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

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

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

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)

103. Advanced Engineering Writing

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

Prerequisite: consent of instructor.

Same course as Physics 160K. Open to graduate students in science and engineering disciplines and to undergraduate science and engineering majors.

Provides experience in communicating science and technology to nonspecialists. The major components of the course are field work in mentoring, a bimonthly seminar, presentations to precollege students and to adult nonscientists, and end-of-term research papers.
Materials

Department of Materials Engineering II, Room 1355; Telephone (805) 893-4601
Web site: www.materials.ucsb.edu
Chair: Michael L. Chabinyc
Vice Chair: Stephen Wilson

Faculty

Christopher M. Bates, PhD, University of Austin Texas, Assistant Professor (polymer mrosucture and dynamics, energy storage, and crystallization)

Guillermo C. Bazan, Ph.D., Massachusetts Institute of Technology, Distinguished Professor (polymer synthesis, photochemistry)"5

Matthew R. Begley, Ph.D., University of California, Santa Barbara, Professor (mechanics of materials with applications to multilayered devices such as microfluidics, MEMS and protective coatings)

Irene J. 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)

Raphaëlle J. Clément, PhD, University of Cambridge, Assistant Professor (energy storage and conversion using batteries and photoelectrochemical cells, characterization of inorganic (photo)electrochemical materials using magnetic resonance techniques and first principles calculations).

Steven P. DenBaars, Ph.D., University of Southern California, Distinguished Professor (growth and electronic properties of compound 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. Polllock, 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 correlated electrons, nonlinear optical spectroscopy, angle-resolved photoemission spectroscopy)

Craig Hawker, Ph.D., University of Cambridge, Distinguished Professor, Director of Materials Research Laboratory (synthetic polymer chemistry, nanotechnology, materials science)"5

Carlos G. Levi, Ph.D., University of Illinois at Urbana-Champaign, Professor (materials processing, and microstructure evolution, coatings, composites, functional inorganics)"2

Robert M. McMeeking, Ph.D., Brown University, Distinguished Professor (mechanics of materials, fracture mechanics, plasticity, computational mechanics, process modeling)"2

Kunal Mukherjee, PhD, Massachusetts Institute of Technology, Assistant Professor (growth and electronic properties of compound semiconductors for optoelectronic, imaging, and energy conversion devices)

Shuji Nakamura, Ph.D., University of Toyota, Creen Professor of Solid State Lighting and Displays (gallium nitride, blue lasers, white LEDs, solid state illumination, bulk GaN substrates)

Chris Palmstrom, Ph.D., University of Leeds, Distinguished Professor (atomic level control of interfacial phenomena, in-situ STM, surface and thin film analysis, metallization of semiconductors, disimilar materials epitaxial growth, molecular beam and chemical beam epitaxial growth of metallic compounds)"1

Interdisciplinary course/seminar/practice for 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 188AB, 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 (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 188AB, 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 (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 188AB, 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 (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.
semiconductors, ferroelectric and high-K films, microstructural evolution, extended defects, transmission electron microscopy, x-ray diffraction)

Susanne Stegger, Ph.D., University of Stuttgart, Professor (functional oxide thin films, structure-property relationships, scanning transmission electron microscopy and spectroscopy)

Galen Stucky, Ph.D., Iowa State University, Distinguished Professor (biomaterials, composites, materials synthesis, electro-optical materials catalysis) 5

Chris Van de Walle, Ph.D., Stanford University, Distinguished Professor (novel electronic 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; mechanical methods development, electrochemical energy storage materials, high temperature structural materials corrosion)

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

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

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

Emeriti Faculty

Anthony K. Cheetham, Ph.D., Oxford University, Professor Emeritus (catalysis, optical materials, X-ray, neutron diffraction) 5

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

Larry A. Coldren, Ph.D., Stanford University, Kavli Professor in Optoelectronics and Sensorics, Director of Optoelectronic 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, biofouling and interactions) 3

Herbert Kroemer, Dr. rer. nat., University of Göttingen, Donald W. Whittaker 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, polymeric chemistry of fullerenes, and design and preparation of self-penetrating polymers) 1

*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 and biosurfaces, including biomedically relevant systems; colloids, gels and other complex fluids; lasers, LEDs and optoelectronic devices; packaging systems; microscale engineered systems, including MEMS. The groups are typically multidisciplinary involving faculty, postdoctoral researchers and graduate students working on the synthesis and processing, structural characterization, property evaluation, microstructure-property relationships and mathematical models relating micromechanisms to macroscopic behavior.

Materials Courses

LOWER DIVISION

10. Materials in Society, the Stuff of Dreams

(4) STEMMER

Prerequisites: Not open to engineering, precomputer 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


100B. Structure and Properties II

(3) STAFF

Prerequisite: Materials 100A. Students who take Matrl 101 & 100B will only receive major credit for one of these courses. Lecture, 3 hours.


100C. Fundamentals of Structural Evolution

(3) STAFF

Prerequisite: Materials 100A and Materials 100B.

An introduction to the thermodynamic and kinetic principles governing structural evolution in materials. Phase equilibrium, diffusion and structural transformations. Metastable structures in materials. Self-assembling systems. Structural control through processing and/or imposed fields. Environmental effects on structure and properties.

101. Introduction to the Structure and Properties of Materials

(3) STAFF
the processes discussed. The structure and properties of materials as they are developed, selection, and behavior. Discusses the generic properties of metals, ceramics, polymers, and composites more relevant to structural properties to control 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) SAFINYA
Prerequisites: Physics 5 or 6C or 25. Same course as Physics 135. Structure and function of cellular molecules (lipids, nucleic acids, proteins, and carbohydrates). Genetic engineering techniques of molecular biology. Biomolecular materials and biomedical applications (e.g., bio-sensors, drug delivery systems, gene carrier systems).

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

162A. The Quantum Description of Electronic Materials (4) STAFF
Prerequisites: ECE 130A-B and 134 with a minimum grade of C- in all; open to EE and Materials majors only. Same course as ECE 162A. Electrons as particles and waves, Schrodinger’s equation and illustrative solutions. Tunneling, Atomic structure, the Exclusion Principle and the periodic table. Bonds. Free electrons in metals. Periodic potentials and energy bands. (W)

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. Crystal lattices and the structure of solids, with emphasis on semiconductors. Lattice vibrations, electronic states and energy bands. Electrical and thermal conduction. Dielectric and optical properties. Semiconductor devices: Diffusion, P-N junctions and diode behavior.

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 course.

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) BÉGLEY
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 stages for one of these processes. A brief description of the physics of photopolymerization, extrusion, selective laser melting and e-beam melting fabrication.

188. Topics in Materials (R) 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: Frederic Gibou
Vice Chair: Jeffrey Moehlis

Faculty
Bassam Bamieh, Ph.D., Rice University, Professor (control systems design with applications to fluid flow problems)
Matthew R. Begley, Ph.D., University of California, Santa Barbara, Professor (mechanics of materials with applications to multilayered devices such as microfluidics, MEMS and protective coatings)
Glenn E. Beltz, Ph.D., Harvard, Professor (solid mechanics, materials, aeronautics, engineering education)
Ted D. Bennett, Ph.D., UC Berkeley, Associate Professor (thermodynamic, 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 Camps, 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)
Emile Dresaire, 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, Assistant Professor (nanoscale energy transport and its application to sustainable energy technologies)
Paolo Luzzatto-Fegiz, PhD, Cornell University, Assistant Professor (fluid mechanics, wind energy and instrument development)
Eric F. Mattheys, Ph.D., California Institute of Technology, Professor (heat transfer, fluid mechanics, rheology)
Robert M. McMeeking, Ph.D., Brown University, Distinguished Professor (mechanics of materials, fracture mechanics, plasticity, computational mechanics) 3

Eckart Meiburg, Ph.D., University of Karlsruhe, Distinguished Professor (computational fluid dynamics, fluid mechanics)
Carl D. Meinhart, Ph.D., University of Illinois at Urbana-Champaign, Professor (wall turbulence, microfluidics, flows in complex geometries)

Igor Mezic, Ph.D., California Institute of Technology, Professor (applied mechanics, non-linear dynamics, fluid mechanics, applied mathematics)

Jeffrey M. Moehlis, Ph.D., University of California, Berkeley, Professor (nonlinear dynamics, fluid mechanics, biological dynamics, applied mathematics)

Sumita Pennathur, Ph.D., Stanford University, Associate Professor (application of microfabrication techniques and micro/nanoscale flow phenomena)

Linda R. Petzold, Ph.D., University of Illinois at Urbana-Champaign, Distinguished Professor, Director of Computational Science and Engineering Graduate Emphasis (computational science and engineering; systems biology) 1

Beth Fruitt, 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, Lecturer Potential SOE (mechanical and product design, engineering
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 microelectro-mechanical systems; dynamics and controls and related areas of sensors, actuators and instrumentation; advanced composite materials and smart structures; computation, simulation and information science; advanced energy and transportation systems; and environmental monitoring, modeling and remediation.

Student Outcomes
Upon graduation, students in the mechanical engineering B.S. degree program:
1. Should possess a solid foundation in, and be able to apply the principles of, mathematics, science, and engineering
2. Are successful in a range of engineering projects sponsored by industry, UCSB researchers, as well as intercollegiate design competitions. The project program has been expanded to emphasize entrepreneurial product-oriented projects.
3. Should have experienced the use of current software in problem solving and design.
4. Should demonstrate the ability to design useful products, systems, and processes.
5. Be able to work effectively on multidisciplinary teams.
6. Should have an understanding of professional and ethical responsibilities.
7. Should be able to write lab reports and design reports and give effective oral presentations.
8. Should have the broad background in the humanities and the social sciences, which provides an awareness of
contemporary issues and facilitates an understanding of the global and societal impact of engineering problems and solutions.

9. Be a member of or participate in a professional society.

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. Not open for credit to students who have completed ECE 2A or 2B, or ECE 6A or 6B, or ECE 10A and 10AL, or ECE 10B or 10BL.

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

Prerequisite: ME majors only. Processes used to convert raw material into finished objects. An 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 resultant vectors; vector algebra; construction of free body diagrams; equilibrium in 2- and 3-dimensional analysis; analysis of frames, machines, trusses and beams; distributed forces; friction.

15. Strength of Materials

Prerequisite: ME 14 with a minimum grade of C-; open to mechanical engineering majors only.

Properties of structural materials, including Hook’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 subjected to flexure, pressure vessels, and buckling.


Prerequisite: Physics 2; ME 14 with a minimum grade of C-; and, Mathematics 6B; (may be taken concurrently); open to ME majors only.


17. Mathematics of Engineering

Prerequisite: ME majors only. Introduction to basic numerical and analytical methods, with implementation using MATLAB. Topics include root finding, linear algebraic equations, introduction to matrix algebra, determinants, inverses and eigenvalues, curve fitting and interpolation, and numerical differentiation and integration. (S, M)

95. Introduction to Mechanical Engineering

Prerequisite: consent of instructor.

May be repeated for credit to a maximum of 6 units. Participation in projects in the laboratory or machine shop. Projects may be student- or faculty-originated depending upon student interest and consent of faculty member.

97. Mechanical Engineering Design Projects

Prerequisite: consent of instructor.

May be repeated for maximum of 12 units, variable hours. Course offers students opportunity to work on established departmental design projects. P/ NP grading, does not satisfy technical elective requirement.

99. Introduction to Research

Prerequisite: consent of instructor.

May be repeated for 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

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

Prerequisites: ME 151C and ME 152B; or consent by instructor.


104. Mechatronics

Prerequisites: ME 6; open to ME majors only.

Introduction to 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

Prerequisites: ME 151B, 152B, 163; and, Materials 101 or 100B.

Introduction to fundamental engineering laboratory measurement techniques and report writing skills. Experiments from thermosciences, fluid mechanics, mechanics, materials science and environmental engineering. Introduction to modern data acquisition and analysis techniques. (S)

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.

112. Energy

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 their implications.

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

125A-22. 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, theological mechanics, thermal sciences, and recent developments in mechanical engineering.

128. Design of Biomedical Devices
(3) LAGUETTE
Prerequisite: Mechanical Engineering 10, 14, 15, 16, and 153; open to ME majors only.

Course materials fee may be required. Introductory course addresses the challenges of biomedical device design, prototyping and testing, material considerations, regulatory requirements, design control, human factors and ethics.

134. Advanced Thermal Science
(3) MATTHYS
Prerequisite: ME 151C.

This class will address advanced topics in fluid mechanics, heat transfer, and thermodynamics. Topics of interest may include combustion, phase change, experimental techniques, materials processing, manufacturing, engines, HVAC, non-Newtonian fluids, etc.

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

Numerical analysis and analytical solutions of problems described by linear and nonlinear differential equations with an emphasis on MATLAB. First and second order differential equations; systems of differential equations; linear algebraic equations, matrices and eigenvalues; boundary value problems; finite differences. (F)

140B. Theoretical Analysis in Mechanical Engineering
(3) MOERLIS, GIBOU, MEIBURG
Prerequisites: ME 140A

Analysis of engineering problems formulated in terms of partial differential equations. Solutions of these mathematical models by means of analytical and numerical methods. Physical interpretation of the results.

141A. Introduction to Nano- and Electromechanical 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) VALENTINE

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

147. Mechatronics Using Labview
(3) HARE
Prerequisite: Engineering 3; and 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) BENNETT, MEINHART
Prerequisite: Physics 2; ME 14 with a minimum grade of C-; and, Mathematics 6B.

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

151B. Thermosciences 2
(4) BENNETT, LIAO
Prerequisite: ME 151A and 152A.

Introduction to heat transfer processes, steady and unsteady state conduction, multidimensional analysis. Introduction to convective heat transfer. (W)

151C. Thermosciences 3
(3) BENNETT, SAURET
Prerequisites: ME 151B and 152B; open to ME majors only.

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

152A. Fluid Mechanics
(4) CAMPAS, MEINHART
Prerequisite: Mathematics 6B; and ME 16 with a minimum grade of C-

Introduction to the fundamental concepts in fluid mechanics and basic fluid properties. Basic equations of fluid flow. Dimensional analysis and similarity. Hydrodynamics. (F)

152B. Fluid Mechanics
(3) LUZZATTO
Prerequisite: ME 152A; open to ME majors only.

Incompressible viscous flow. Boundary-layer theory. Introductory considerations for one-dimensional compressible flow. (W)

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

Course materials fee required.

Design of systems using mechanics, stress analysis and finite elements. Statistical problems in manufacturing and reliability. Ethics. One paper design project plus the ASME student design project.

154. Design and Analysis of Structures
(3) McMEEKING, BEGLEY, BEYERLEIN
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 methods, deflection method, displacement method and virtual work. Topics include applications to bars, beams, trusses, frames, and solids.

155A. Control System Design
(3) YOUNG, BAMIÉH
Prerequisite: ME 17 with a minimum grade of C-; and ME 163.

The discipline of control and its application. Dynamics and feedback. The mathematical models: transfer functions and state space descriptions. Simple control design (PID). Assessment of a control problem, specification and limitations, codesign of system and control.

155B. Control System Design
(3) BAMIÉH
Prerequisite: ME 15A.

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) BAMIÉH
Prerequisite: ME 15A. 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
Prerequisites: ME 156A; open to ME majors only.


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

May not be taken for additional credit 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 selects a project area 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) MCEEEKING, BELTZ  
Prerequisites: ME 15 and 140A.  

(3) MEZIC  
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 W 167.

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) MOENLIS  
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.

170. 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 design problems through 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) LEVY  
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) BEGLEY  
Prerequisite: 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 156A. Quarters usually offered: Fall, A-3-quarter sequence with grades issued for each quarter.

Students may not concurrently enroll in ME 197 and ME 189A-B-C with the same design project.  
Course can only be repeated as a full sequence.

189B. Capstone Mechanical Engineering Design Project  
(3) SUSKO  
Prerequisite: ME 189A.  
Course materials fee required.

Designed for majors. Concurrently offered with ME 156B. Quarters usually offered: Winter. A-3-quarter sequence with grades issued for each quarter.

Students may not concurrently enroll in ME 197 and ME 189A-B-C with the same design project.  
Course can only be repeated as a full sequence.

189C. Capstone Mechanical Engineering Design Project  
(3) SUSKO  
Prerequisite: ME 189A, B.  
Course materials fee required.

Designed for majors. Quarters usually offered: Spring. A-3-quarter sequence with grades issued for each quarter.

Students may not concurrently enroll in ME 197 and ME 189A-B-C with the same design project.  
Course can only be repeated as a full sequence.

193. Internship in Industry  
(1) STAFF  
Prerequisite: consent of instructor and prior departmental approval needed.

Cannot be used as a departmental elective. May be repeated to a maximum of 2 units.

Students obtain credit for a mechanical engineering related internship and/or industrial experience under faculty supervision. A 6-10 page written report is required for credit.

197. Independent Projects in Mechanical Engineering  
(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  
(1-4) STAFF  
Prerequisites: consent of instructor; upper-division standing; completion of two upper-division courses in Mechanical Engineering.

Students must have a minimum of 3.0 grade-point average for the preceding three quarters and are limited to 5 units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined. No more than 4 units may be used as departmental electives. May be repeated to 12 units.

Directed individual study.

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

Technology Management Program
Phelps Hall, Room 2219
Telephone (805) 893-2729
Web site: www.tmp.ucsb.edu

Chair: Kyle Lewis

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

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

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

122. Entrepreneurship (4) STAFF
   Prerequisite: TMP 120 with grade of B- or better, and upper division standing

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

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

127. Understanding and Managing Technology Organizations (4) STAFF
   Prerequisite: TMP 120 with a grade of B- or better and upper division standing.
   Participating in, managing, and leading successful careers, teams, and organizations.

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 (5) 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 2020-21

### PREPARATION FOR THE MAJOR

<table>
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### UNIVERSITY REQUIREMENTS

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

**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

... 187

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

Technical electives taken:

- ____________________________

- ____________________________

- ____________________________

To satisfy major requirements, courses taken inside or outside the Department of Chemical Engineering, must be taken for a letter grade.
### CHEMICAL ENGINEERING 2020-21

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>
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<tr>
<th>FALL</th>
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**TOTAL** 16 17 16

#### SOPHOMORE YEAR

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<td>CH E 132A</td>
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<td>CHEM 6BL</td>
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<td>MATH 6B</td>
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**TOTAL** 15 17 18

#### JUNIOR YEAR

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<td>CH E 132C</td>
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<td>CHEM 113C</td>
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**TOTAL** 14 16 17

#### SENIOR YEAR

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<td>CH E 184B</td>
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</table>

**TOTAL** 14 13 14

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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 100B)
# Computer Engineering 2020-21

## Preparation for the Major

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Units</th>
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<td>CHEM 1A, TAL or 2A, 2AC</td>
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<tr>
<td>CMPSC 16</td>
<td>4</td>
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<tr>
<td>CMPSC 24</td>
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<td>CMPSC 32</td>
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<td>CMPSC 40</td>
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<tr>
<td>ECE 1A-1B</td>
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<tr>
<td>ECE 10A, 10AL, 10B, 10BL, 10C, 10CL</td>
<td>15</td>
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<td>ECE 15A</td>
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<td>MATH 3A-B, 4A-B</td>
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## Upper Division Major

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<td>CMPSC 130A</td>
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<td>ECE 139 or PSTAT 120A</td>
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<tr>
<td>ECE 152A</td>
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<td>ECE 154A</td>
<td>4</td>
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<tr>
<td>ENGR 101</td>
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</tr>
<tr>
<td>CMPSC 189 A-B / ECE 189 A-B-C</td>
<td>8-12</td>
</tr>
</tbody>
</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.

| CMPSC 130B | ECE 130A-B-C |
| CMPSC 138 | ECE 147A-B |
| CMPSC 153A/ECE 153A | ECE 149 |
| CMPSC 160 | ECE 150 |
| CMPSC 162 | ECE 153B |
| CMPSC 165A-B | ECE 154B |
| CMPSC 170 | ECE 157A-B |
| CMPSC 171 | ECE 160 |
| CMPSC 174A | ECE 178 |
| CMPSC 176A-B | ECE 179D, 179P |
| CMPSC 176C | ECE 194AA-194ZZ (except 194R) |
| CMPSC 177 | |
| CMPSC 178 | |
| CMPSC 181/ECE 181 | |
| ECE 122A-B | |
| ECE 123 | |

Computer Engineering electives taken:

\[
\text{MATH, SCIENCE, ENGR, ELECTIVE} \quad 4
\]

(See ECE Dept. student office for the approved list)

Elective taken:

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

## Total Units Required for Graduation

191
# COMPUTER ENGINEERING 2020-21

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>
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**TOTAL** 17 17 17

## SOPHOMORE YEAR

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<th>FALL</th>
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**TOTAL** 17 18 18

## JUNIOR YEAR

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

**TOTAL** 16 16 12

## SENIOR YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>units</th>
<th>WINTER</th>
<th>units</th>
<th>SPRING</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 189A*/CMPSC&lt;sup&gt;+&lt;/sup&gt; 189A</td>
<td>4</td>
<td>ECE 189B/ CMPSC 189B</td>
<td>4</td>
<td>ECE 189C or CMPEN Elect.</td>
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</tr>
<tr>
<td>CMPEN Electives</td>
<td>8</td>
<td>ENGR 101&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3</td>
<td>CMPEN Elective</td>
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<tr>
<td>G.E.</td>
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<td>G.E.</td>
<td>4</td>
<td>G.E.</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>CMPEN Elective</td>
<td>4</td>
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<td></td>
</tr>
</tbody>
</table>

**TOTAL** 16 15 12

---

1. CMPSC 8 may be used to satisfy the Math, Science, Engineering Elective requirement.
2. PSTAT 120A is offered each quarter. ECE 139 is offered only in spring quarter, and is better suited for future upper division electives for the Computer Engineering major.
3. ENGR 101 may be taken any quarter of senior year.
4. ECE 189A-B-C is taken fall, winter, and spring quarters. Prerequisite to ECE 189A is ECE 153B, taken winter of junior year.
5. CMPSC 189A-B is taken fall and winter quarters. Prerequisite to CMPSC 189A is CMPSC 156.
## COMPUTER SCIENCE 2020-21

### PREPARATION FOR THE MAJOR

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMPSC 16</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 24</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 32</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 40</td>
<td>5</td>
</tr>
<tr>
<td>CMPSC 64</td>
<td>4</td>
</tr>
<tr>
<td>MATH 3A-B, 4A-B, 6A</td>
<td>20</td>
</tr>
<tr>
<td>PSTAT 120A</td>
<td>4</td>
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<tr>
<td>PHYS 1, 2, 3, 3L</td>
<td>12</td>
</tr>
</tbody>
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### UPPER DIVISION MAJOR

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>CMPSC 111 or 140</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 130A-B</td>
<td>8</td>
</tr>
<tr>
<td>CMPSC 138</td>
<td>4</td>
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<tr>
<td>CMPSC 148 or 156 or 172</td>
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</tr>
<tr>
<td>CMPSC 154</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 160 or 162</td>
<td>4</td>
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<tr>
<td>CMPSC 170</td>
<td>4</td>
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<tr>
<td>ENGR 101</td>
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</tr>
<tr>
<td>PSTAT 120B</td>
<td>4</td>
</tr>
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</table>

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.

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>CMPSC 111^1</td>
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</tr>
<tr>
<td>CMPSC 140^1</td>
<td></td>
</tr>
<tr>
<td>CMPSC/ECE 153A</td>
<td></td>
</tr>
<tr>
<td>CMPSC 160^2</td>
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<tr>
<td>CMPSC 165A-B</td>
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</tr>
<tr>
<td>CMPSC 171/ECE 151</td>
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<tr>
<td>CMPSC 174A-B</td>
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<tr>
<td>CMPSC 176A-B-C</td>
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<tr>
<td>CMPSC 177</td>
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<tr>
<td>CMPSC 178</td>
<td></td>
</tr>
</tbody>
</table>

^1 CMPSC 111 or CMPSC 140 can be used as an elective if not taken as a major course.

^2 CMPSC 160 or CMPSC 162 can be used as an elective if not taken as a major course.

^3 Three units maximum from CMPSC 192 and CMPSC 196 combined; only for students with GPA of 3.0 or higher.

^4 Only for students who have met the requirements. Please see department advisor for more information.

### SCIENCE COURSES

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Science Electives (see Dept. for list)</td>
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Science Electives taken:

<table>
<thead>
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<th>Course</th>
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</thead>
</table>

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

### UNIVERSITY REQUIREMENTS

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

#### General Subject Areas

<table>
<thead>
<tr>
<th>Area</th>
<th>(2 courses minimum)</th>
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</thead>
<tbody>
<tr>
<td>A-1: English Reading &amp; Comprehension</td>
<td>(2 courses minimum)</td>
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<tr>
<td>A-2:</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Area</th>
<th>(1 course minimum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D: Social Science</td>
<td></td>
</tr>
<tr>
<td>E: Culture and Thought</td>
<td></td>
</tr>
<tr>
<td>F: The Arts</td>
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</tr>
<tr>
<td>G: Literature</td>
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</tbody>
</table>

#### Special Subject Areas

<table>
<thead>
<tr>
<th>Subject</th>
<th>(1 course)</th>
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<tr>
<td>Ethnicity</td>
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</tr>
<tr>
<td>European Traditions</td>
<td></td>
</tr>
<tr>
<td>or World Cultures</td>
<td></td>
</tr>
<tr>
<td>Writing</td>
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Free Electives taken:

<table>
<thead>
<tr>
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### NON-MAJOR ELECTIVES

Free Electives taken:

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

TOTAL UNITS REQUIRED FOR GRADUATION ...... 184
# COMPUTER SCIENCE 2020-21

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>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FALL</td>
<td>G.E. Elective or CMPSC 8&lt;sup&gt;1&lt;/sup&gt; 4</td>
</tr>
<tr>
<td></td>
<td>MATH 3A 4</td>
</tr>
<tr>
<td></td>
<td>WRIT 1, 2, or G.E. Elective 4/5</td>
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<td></td>
<td>G.E. Elective 4</td>
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## SOPHOMORE YEAR

<table>
<thead>
<tr>
<th>Units</th>
<th>Description</th>
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<tbody>
<tr>
<td>FALL</td>
<td>CMPSC 32 4</td>
</tr>
<tr>
<td></td>
<td>CMPSC 40 5</td>
</tr>
<tr>
<td></td>
<td>MATH 4B 4</td>
</tr>
<tr>
<td></td>
<td>PHYS 3 3</td>
</tr>
<tr>
<td></td>
<td>PHYS 3L 1</td>
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<tr>
<td></td>
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<td>TOTAL 17</td>
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## JUNIOR YEAR

<table>
<thead>
<tr>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
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<td>CMPSC 138 4</td>
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<td>Field Elective 4</td>
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<td>Science or Free Elective 4</td>
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## SENIOR YEAR

<table>
<thead>
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<th>Units</th>
<th>Description</th>
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<tr>
<td></td>
<td>CMPSC 160&lt;sup&gt;2&lt;/sup&gt; 4</td>
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<tr>
<td></td>
<td>Field or Free Elective 4</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

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 2020-21**

<table>
<thead>
<tr>
<th>PREPARATION FOR THE MAJOR</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1A, 1AL or 2A, 2AC</td>
<td>5</td>
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<tr>
<td>CMPSC 16</td>
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<tr>
<td>ECE 5</td>
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<tr>
<td>ECE 10A, 10AL, 10B, 10BL, 10C, 10CL</td>
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</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>
<td>PHYS 1, 2, 3, 3L, 4, 4L, 5, 5L</td>
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<table>
<thead>
<tr>
<th>UNIVERSITY REQUIREMENTS</th>
<th>Units</th>
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<tr>
<td>UC Entry Level Requirement: English Composition</td>
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<tr>
<td>Must be fulfilled within three quarters of matriculation</td>
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<tr>
<td>American History and Institutions – (one 4-unit course, may be counted as G.E. if selected from approved list)</td>
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<table>
<thead>
<tr>
<th>GENERAL EDUCATION</th>
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<tbody>
<tr>
<td><strong>General Subject Areas</strong></td>
<td></td>
</tr>
<tr>
<td>Area A: English Reading &amp; Comprehension – (2 courses required)</td>
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</tr>
<tr>
<td>A-1:</td>
<td>A-2:</td>
</tr>
<tr>
<td>Area D: Social Science</td>
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</tr>
<tr>
<td>(2 courses minimum)</td>
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</tr>
<tr>
<td>Area E: Culture and Thought</td>
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</tr>
<tr>
<td>(2 courses minimum)</td>
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</tr>
<tr>
<td>Area F: The Arts</td>
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</tr>
<tr>
<td>Area G: Literature</td>
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</tr>
<tr>
<td>(1 course minimum)</td>
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</tr>
<tr>
<td>(1 course minimum)</td>
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</table>

<table>
<thead>
<tr>
<th>Special Subject Areas</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity (1 course):</td>
<td></td>
</tr>
<tr>
<td>European Traditions or World Cultures (1 course):</td>
<td></td>
</tr>
<tr>
<td>Writing (4 courses required):</td>
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</table>

<table>
<thead>
<tr>
<th>NON-MAJOR ELECTIVES</th>
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</thead>
<tbody>
<tr>
<td>Free Electives taken:</td>
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<table>
<thead>
<tr>
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<td></td>
<td>189</td>
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</table>

To satisfy major requirements, courses taken inside or outside the Department of Electrical and Computer Engineering, must be taken for a letter grade.
# ELECTRICAL ENGINEERING 2020-21

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>CHEM 1A or 2A</td>
<td>3</td>
<td>MATH 3B</td>
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<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>
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<td>ECE 5</td>
<td>4</td>
<td>WRIT 50E or G.E.</td>
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</tr>
<tr>
<td>MATH 3A</td>
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<td>WRIT 2E or 50E</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>WRIT 1E or 2E</td>
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<td><strong>TOTAL</strong></td>
<td>17</td>
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## SOPHOMORE 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>ECE 10A</td>
<td>3</td>
<td>ECE 10B</td>
<td>3</td>
<td>ECE 10C</td>
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<td>ECE 10AL</td>
<td>2</td>
<td>ECE 10BL</td>
<td>2</td>
<td>ECE 10CL</td>
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<tr>
<td>MATH 4B</td>
<td>4</td>
<td>ECE 15A</td>
<td>4</td>
<td>MATH 6B</td>
<td>4</td>
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<td>PHYS 3</td>
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<td>MATH 6A</td>
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<td>PHYS 5L</td>
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<td>17</td>
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## JUNIOR 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>ECE 130A</td>
<td>4</td>
<td>ECE 130B</td>
<td>4</td>
<td>ECE 137B</td>
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<td>ECE 132</td>
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<td>ECE 137A</td>
<td>4</td>
<td>ECE 139(^1)</td>
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</tr>
<tr>
<td>ECE 134</td>
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<td>ECE Elective</td>
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<td>ECE 152A(^2)</td>
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<td>G.E.</td>
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<td><strong>TOTAL</strong></td>
<td>16</td>
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<td>16</td>
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## SENIOR YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>units</th>
<th>WINTER</th>
<th>units</th>
<th>SPRING</th>
<th>units</th>
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</thead>
<tbody>
<tr>
<td>ECE 188A</td>
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<td>ECE 188B</td>
<td>3</td>
<td>ECE 188C</td>
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<td>ECE Electives</td>
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<td>ECE Electives</td>
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<tr>
<td>G.E.</td>
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<td>G.E.</td>
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<td>Free Elective(^4)</td>
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<td>ENGR 101(^3)</td>
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<td></td>
<td>18</td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

---

1 ECE 139 may also be taken in the spring quarter of the sophomore year.
2 ECE 152A may also be taken in the spring quarter of the sophomore year.
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.
## PREPARATION FOR THE MAJOR

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>ENGR 3</td>
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<tr>
<td>MATH 3A-B, 4A-B, 6A-B</td>
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</tr>
<tr>
<td>ME 6</td>
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</tr>
<tr>
<td>ME 10</td>
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<tr>
<td>ME 12S</td>
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</tr>
<tr>
<td>ME 14</td>
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</tr>
<tr>
<td>ME 15</td>
<td>4</td>
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<td>ME 16</td>
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**Units:** 77

## UNIVERSITY REQUIREMENTS

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

## GENERAL EDUCATION

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

<table>
<thead>
<tr>
<th>A-1</th>
<th>A-2</th>
</tr>
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</table>

### Area D: Social Science (2 courses minimum)

<table>
<thead>
<tr>
<th>Area D: Social Science</th>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>(2 courses minimum)</td>
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</table>

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

<table>
<thead>
<tr>
<th>Area E: Culture and Thought</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>(2 courses minimum)</td>
<td></td>
</tr>
</tbody>
</table>

### Area F: The Arts (1 course minimum)

<table>
<thead>
<tr>
<th>Area F: The Arts</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1 course minimum)</td>
<td></td>
</tr>
</tbody>
</table>

### Area G: Literature (1 course minimum)

<table>
<thead>
<tr>
<th>Area G: Literature</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1 course minimum)</td>
<td></td>
</tr>
</tbody>
</table>

## Special Subject Areas

### Ethnicity (1 course):

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>(1 course)</td>
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</tbody>
</table>

### European Traditions or World Cultures (1 course):

<table>
<thead>
<tr>
<th>European Traditions or World Cultures</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1 course)</td>
<td></td>
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</tbody>
</table>

### Writing (4 courses required):

<table>
<thead>
<tr>
<th>Writing</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>(4 courses required)</td>
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</tbody>
</table>

## NON-MAJOR ELECTIVES

### Free Electives taken:

<table>
<thead>
<tr>
<th>Free Electives taken</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

**TOTAL UNITS REQUIRED FOR GRADUATION:** 180

---

To satisfy major requirements, courses taken inside or outside the Department of Mechanical Engineering, must be taken for a letter grade.
# MECHANICAL ENGINEERING 2020-21

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>CHEM 1A or 2A</td>
<td>3</td>
<td>CHEM 1B or 2B</td>
<td>3</td>
<td>MATH 4A</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 1AL or 2AC</td>
<td>2</td>
<td>CHEM 1BL or 2BC</td>
<td>2</td>
<td>ME 10</td>
<td>4</td>
</tr>
<tr>
<td>MATH 3A</td>
<td>4</td>
<td>MATH 3B</td>
<td>4</td>
<td>ENGR 3</td>
<td>3</td>
</tr>
<tr>
<td>ME 12S(^1)</td>
<td>1</td>
<td>PHYS 1</td>
<td>4</td>
<td>PHYS 2</td>
<td>4</td>
</tr>
<tr>
<td>WRIT 1E or 2E</td>
<td>4</td>
<td>WRIT 2E or 50E</td>
<td>4</td>
<td>WRIT 50E or G.E. Elective</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>14</strong></td>
<td><strong>17</strong></td>
<td></td>
<td><strong>19</strong></td>
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## SOPHOMORE 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>MATH 4B</td>
<td>4</td>
<td>MATH 6A</td>
<td>4</td>
<td>MATH 6B</td>
<td>4</td>
</tr>
<tr>
<td>ME 14</td>
<td>4</td>
<td>ME 6</td>
<td>4</td>
<td>ME 16</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 3</td>
<td>3</td>
<td>ME 15</td>
<td>4</td>
<td>ME 17</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 3L</td>
<td>1</td>
<td>PHYS 4</td>
<td>3</td>
<td>G.E. Elective</td>
<td>4</td>
</tr>
<tr>
<td>G.E. Elective</td>
<td>4</td>
<td>PHYS 4L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16</strong></td>
<td><strong>16</strong></td>
<td></td>
<td><strong>15</strong></td>
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</tbody>
</table>

## JUNIOR YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>units</th>
<th>WINTER</th>
<th>units</th>
<th>SPRING</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 151A</td>
<td>4</td>
<td>MATRL 101 or</td>
<td>3</td>
<td>ME 104</td>
<td>4</td>
</tr>
<tr>
<td>ME 152A</td>
<td>4</td>
<td>MATRL 100B(^2)*</td>
<td>3</td>
<td>ME 153</td>
<td>3</td>
</tr>
<tr>
<td>G.E. or Free Elective</td>
<td>4</td>
<td>ME 151B</td>
<td>4</td>
<td>ME 151C</td>
<td>3</td>
</tr>
<tr>
<td>G.E. or Free Elective</td>
<td>4</td>
<td>ME 152B</td>
<td>3</td>
<td>ME 155A</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ME 163</td>
<td></td>
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<td></td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>13</strong></td>
<td></td>
<td><strong>13</strong></td>
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</table>

## SENIOR YEAR

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

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

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

\(^3\)Course availability may vary. If using ME 154, ME 157, or ME 167 to satisfy requirement, students may not count the course as an Engineering Elective. 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 100B)
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.cla.ucsb.edu

Education Abroad Program – EAP options for engineering students—email: eap@engineering.ucsb.edu

College Honors Program – program information and opportunities—email: honors@engineering.ucsb.edu

Advising Staff

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

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

<table>
<thead>
<tr>
<th>College Advising staff</th>
<th>Phone</th>
<th>Email</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Engineering</td>
<td>(805) 893-2809</td>
<td><a href="mailto:cheugrads@engr.ucsb.edu">cheugrads@engr.ucsb.edu</a></td>
<td>Engr.II, Rm. 3357</td>
</tr>
<tr>
<td>Computer Engineering</td>
<td>893-8671</td>
<td><a href="mailto:ugrad-advisor@ece.ucsb.edu">ugrad-advisor@ece.ucsb.edu</a></td>
<td>Trailer 380, Rm. 101</td>
</tr>
<tr>
<td>Computer Science</td>
<td>893-8292</td>
<td><a href="mailto:ugradhelp@cs.ucsb.edu">ugradhelp@cs.ucsb.edu</a></td>
<td>Harold Frank Hall, Rm. 2104</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>893-8292</td>
<td><a href="mailto:ugrad-advisor@ece.ucsb.edu">ugrad-advisor@ece.ucsb.edu</a></td>
<td>Trailer 380, Rm. 101</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>893-8198</td>
<td><a href="mailto:meugrad@engr.ucsb.edu">meugrad@engr.ucsb.edu</a></td>
<td>Engr.II, Rm. 2355</td>
</tr>
<tr>
<td>Technology Management</td>
<td>893-2729</td>
<td><a href="mailto:tmp@tmp.ucsb.edu">tmp@tmp.ucsb.edu</a></td>
<td>Phelps 1333</td>
</tr>
<tr>
<td>Program</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Policy on Academic Conduct

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

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

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

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

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

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

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

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