



GEAR

GENERAL ENGINEERING
ACADEMIC REQUIREMENTS

COLLEGE OF ENGINEERING
UC SANTA BARBARA

2010-2011

About the Cover

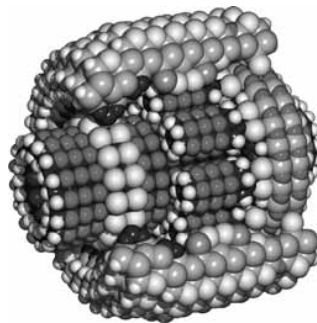
The image shown opposite page left (and as part of the cover collage) is a microelectromechanical ratcheting system that was fabricated by Sandia National Laboratories in Albuquerque, New Mexico using new advanced five-level polysilicon surface micromachining. Twenty of these gears fit on a period in a newspaper sentence. The image shown opposite middle (and also on the cover) depicts a planetary gear and was modeled and designed computationally by K. E. Drexler of the Institute for Molecular Manufacturing and Ralph C. Merkle of Xerox PARC. Planetary gears convert shaft power from one angular frequency to another.

UCSB engineering has extensive computational and micro-machining capabilities in its computer laboratories and clean rooms. Scientists and engineers across all disciplines work together designing and inventing new ways to solve today's problems.

GEAR

General Engineering Academic Requirements

2010-2011



College of Engineering • University of California • Santa Barbara

Volume 1, June 2010

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UNDERGRADUATE STUDIES OFFICE**

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

Message from the Associate Dean



Welcome to the College of Engineering at UC Santa Barbara. There are many reasons we are one of the top engineering schools in the nation. We bring together an amazing group of faculty at the top of their fields. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. A high percentage of the faculty has been elected to the prestigious National Academy of Sciences and National Academy of Engineering. We have five Nobel Prize winners on this campus, four of whom are faculty in engineering and the sciences. We're also home to an amazing group of smart, accomplished, high-energy students. These more than 1,200 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 espe-

cially 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 in 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.

A handwritten signature in black ink that reads "Glenn E. Beltz". The signature is written in a cursive, flowing style with a long horizontal line extending to the right.

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 1,200 undergraduate students and 700 graduate students with a full-time, permanent faculty of 138. This results in an excellent student to faculty ratio and a strong sense of community in the college.

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

The college offers the bachelor of science degree in five disciplines: chemical engineering, computer engineering, computer science, electrical engineering, and mechanical engineering. The undergraduate programs in chemical, computer, electrical, and mechanical engineering are accredited by the Engineering Accreditation Commission of ABET and the computer science bachelor of science program is accredited by the Computing Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone (410) 347-7700.

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

The Office of Undergraduate Studies in Harold Frank Hall, Room 1006, provides academic advising for all undergraduates in the college. Faculty and academic advisors for the individual majors are also provided by the respective departments. This publication contains detailed information about the various programs and schedules and is published yearly. Copies may be obtained by writing to the College of Engineering, Harold Frank Hall, Room 1006, University of California, Santa Barbara, California 93106-5130. Alternatively, it is available on the web at: www.engineering.ucsb.edu/current_undergraduates.

Mission Statement

The mission of the College of Engineering is to provide its students a firm grounding in scientific and mathematical fundamentals; experience in analysis,

synthesis, and design of engineering systems; and exposure to current engineering practice and cutting edge engineering research and technology. A spirit of entrepreneurship in education, scholarly activity and participation in engineering practice infuses UCSB's College of Engineering.

College of Engineering Honors Program

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

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

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

Graduating with Honors Program Designation and to be listed as such in the Commencement Book, students must complete 6.0 total Honors units during their junior and senior years; comprised of coursework from departmental 196, 197, 199 or graduate level courses with grades of B or higher, complete a total of 10 hours of community service and maintain a 3.5 or higher cumulative GPA at the end of each Spring quarter.

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

Dean's Honors

The College of Engineering gives public recognition to its outstanding undergraduate students by awarding Dean's Honors at the end of each regular academic term to students who have earned a 3.5

grade-point average for the quarter and have completed a program of 12 or more letter-graded units. (Grades of Incomplete or Not Passed automatically disqualify students for eligibility for Dean's Honors.) The Dean's Honors List is posted quarterly, and the award is noted quarterly on the student's permanent transcript.

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

Tau Beta Pi

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

Education Abroad Program (EAP)

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

Student Organizations

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

- American Institute of Chemical Engineers
- American Society of Mechanical Engineers
- Association for Computing Machinery
- Engineering Student Council
- Engineers without Borders
- Institute of Electrical and Electronics Engineers
- Los Ingenieros (Mexican-American Engineering Society/Society of Hispanic Professional Engineers)
- National Society of Black Engineers
- Society for Advancement of Chicano and Native Americans in Science
- Society of Women Engineers
- Student Entrepreneurship Association
- Women in Science and Engineering
- Women in Software and Hardware

Change of Major and Change of College

Current UCSB students in a non-engineering major, as well as students wishing to change from one engineering major to another, are welcome to apply after the satisfactory completion of a pre-defined set of coursework (see below).

Students who have completed more than 105 units will not be considered for a change of major/change of college in engineering or computer science unless they can demonstrate that they will be able to complete all the degree requirements for the proposed program without exceeding 215 total units.

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

Computer Engineering. Students may petition to enter the Computer Engineering pre-major at any time Option 1 below has been met, or they may petition to enter the full major when the requirements in Option 2 have been met.

Option 1:

1. An overall UCSB grade point average of at least 3.0; AND
2. Satisfactory completion at UCSB of at least four core classes required as preparation for the Computer Engineering major with a grade point average of at least 3.0 in all core classes completed. The core classes are Mathematics 3A, 3B, 3C, 5A; Computer Science 16, 24, 32, 40; Electrical and Computer Engineering 2A, 2B, 2C, 15A, 15B. Once approved for the Computer Engineering pre-major, the student must meet the requirements for advancing to the full major.

Option 2:

1. An overall UCSB grade point average of at least 3.0; AND
2. Satisfactory completion at UCSB of at least six of the core classes with a grade point average of at least 3.0. If the student has not attained the minimum 3.0 grade point average with the first six core classes completed, all core classes subsequently completed will be included in the grade point average computation; OR
3. Satisfactory completion of all thirteen core classes with a University of California grade point average of at least 2.75.

Computer Science. Students planning to enter the pre-computer science program must complete at least 16 units of pre-major coursework at UCSB, including 8 units in computer science, with at least a

3.0 grade point average for all pre-major courses completed with the University of California. Students who have completed the entire computer science pre-major with at least a 2.75 University of California grade point average will be admitted to full major standing upon petition whether or not they have been officially declared pre-majors. Petitions for changing to the pre-computer science or computer science majors may be filed any time upon meeting the above requirements.

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

1. An overall UCSB grade point average of at least 3.0.
2. Satisfactory completion at UCSB, with a grade point average of 3.0 or better, of at least five classes, including at least two mathematics classes, from the following: Mathematics 5A-B-C, ECE 2A-B-C, ECE 15A. The calculation of the minimum GPA will be based on all classes completed from this list at the time of petitioning.

Mechanical Engineering. Before petitioning for a change of major to mechanical engineering, six (6) of the following core courses or their UC equivalents must be completed: Math 3A-B-C; Math 5A-B-C; Physics 1-2; ME 14-15 (at least one of the 6 courses must include ME 14 or ME 15). Acceptance into the major will be based on UC grade point averages, applicable courses completed, and space availability.

Degree Requirements

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

General University Requirements

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

College General Education Requirements

All students must satisfy the general education requirements for the College of Engineering. These requirements are described on pages 8 and includes a listing of courses which meet each requirement.

Major Degree Requirements

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

Advanced Placement Credit

Students who complete special advanced placement courses in high school and who earn scores of 3, 4, or 5 on the College Board Advanced Placement taken before high school graduation will receive 2, 4, or 8 units of credit toward graduation at UCSB for each such test completed with the required scores, provided scores are reported to the Office of Admissions. The specific unit values assigned to each test, course equivalents, and the applicability of this credit to the General Education requirements, are presented in the chart on page 7.

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

International Baccalaureate Credit

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

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

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

Students must obtain the approval of the dean of engineering to deviate from these requirements. Approval normally will be granted only in the case of medical disability, severe personal problems, or accident.

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.

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

Computer Engineering. A combined B.S./M.S. program in Computer Engineering provides an opportunity for outstanding undergraduates to earn both degrees in five years. The M.S. degree will be earned in either the Department of Computer Science or the Department of Electrical and Computer Engineering, while the B.S. degree is earned in Computer Engineering. Additional information about this program is available from the Undergraduate Studies Office and interested students should contact the Office early in their junior year, because the junior year class schedule will be different from other undergraduates. Transfer students should notify the Office of their interest in the program at the earliest possible opportunity. In addition to fulfilling undergraduate degree requirements, B.S./M.S. degree candidates must meet Graduate Division degree requirements, including university requirements for academic residence and units of coursework as described in the *UCSB General Catalog*.

Computer Science. A combined B.S./M.S. program in computer science provides an opportunity for outstanding undergraduates to earn both degrees in five years. Additional information about this program is available from the computer science graduate program assistant or online at: www.cs.ucsb.edu/undergraduate/. Interested students may apply after completing at least 3 but no more than 8 upper division computer science courses. In addition to fulfilling undergraduate degree requirements, B.S./M.S. degree candidates must meet Graduate Division degree requirements, including university requirements for academic residence and units of coursework.

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

Materials. A combined B.S. Engineering/M.S. Materials program provides an opportunity for outstanding undergraduates in chemical, electrical, or mechanical engineering to earn both of these degrees in five years. This program enables students to develop all of the requisite knowledge in their core engineering disciplines and to

complement this with a solid background in materials. This combination provides highly desirable training from an industrial employment perspective and capitalizes on the strengths of our internationally renowned materials department.

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

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://www.cs.berkeley.edu/~aiken/moss.html>).

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.

College Board Advanced Placement Credit/General Education Program

Advanced Placement Exam with score of 3, 4, or 5	Units Awarded	General Education Course Credit	UCSB Course Equivalent (You may not enroll in these courses for credit at UCSB)
Art History	8	F: 1 course	Art History 1
*Art Studio 2D Design Portfolio	8	none	Art Studio 18
*Art Studio 3D Design Portfolio	8	none	
*Art Studio Drawing Portfolio	8	none	
Biology	8	C: 1 course	EEMB 20, MCDB 20, Natural Science 1C
Chemistry	8	C: 1 course#	Natural Science 1B
Chinese Language & Culture			
<i>With score of 3</i>	8	H: 1 course	
<i>With score of 4</i>	8	H: 1 course	
<i>With score of 5</i>	8	H: 1 course	
Comparative Government and Politics	4	D: 1 course	
+Computer Science A	2	none	
+Computer Science AB	4	C: 1 course#	Computer Science 8
Economics – Macroeconomics	4	D: 1 course	
Economics – Microeconomics	4	D: 1 course	
*English – Composition and Literature or Language and Composition			
<i>With score of 3</i>	8	Entry Level Writing Req.	Writing 1, 1E, 1LK
<i>With score of 4</i>	8	Writing 2	Writing 1, 1E, 1LK, 2, 2E, 2LK
<i>With score of 5</i>	8	Writing 2, 50	Writing 1, 1E, 1LK, 2, 2E, 2LK, 50, 50E, 50LK
Environmental Science	4	C: 1 course	Environmental Studies 2
European History	8	E: 1 course	no equivalent
French Language			
<i>With score of 3</i>	8	H: 1 course	French 1-3
<i>With score of 4</i>	8	H: 1 course	French 1-4
<i>With score of 5</i>	8	H: 1 course	French 1-5
French Literature			
<i>With score of 3</i>	8	H: 1 course	French 1-5
<i>With score of 4 or 5</i>	8	H: 1 course	French 1-6
German Language			
<i>With score of 3</i>	8	H: 1 course	German 1-3
<i>With score of 4 or 5</i>	8	H: 1 course	German 1-4
Human Geography	4	none	no equivalent
Italian Language & Culture			
<i>With score of 3</i>	8	H: 1 course	Italian 1-3
<i>With score of 4</i>	8	H: 1 course	Italian 1-5
<i>With score of 5</i>	8	H: 1 course	Italian 1-6
Japanese Language & Culture			
<i>With score of 3</i>	8	H: 1 course	
<i>With score of 4</i>	8	H: 1 course	
<i>With score of 5</i>	8	H: 1 course	
Latin: Vergil	4	H: 1 course	Latin 1-3
Latin: Literature	4	H: 1 course	Latin 1-3
*Mathematics – Calculus AB (or AB subscore of BC exam)	4	C: 1 course#	Mathematics 3A, 15, 34A, or equivalent
*Mathematics – Calculus BC	8	C: 2 courses	Mathematics 3A, 3B, 15, 34A, 34B, or equivalent
Music – Theory	8	F: 1 course	Music 11
*Physics – B	8	C: 1 course#	Physics 10, Natural Science 1A
*Physics – C (Mechanics)	4	C: 1 course#	Physics 6A
*Physics – C (Electricity & Magnetism)	4	C: 1 course#	Physics 6B
Psychology	4	D: 1 course	Psychology 1
Spanish Language			
<i>With score of 3</i>	8	H: 1 course	Spanish 1-3
<i>With score of 4</i>	8	H: 1 course	Spanish 1-4
<i>With score of 5</i>	8	H: 1 course	Spanish 1-5
Spanish Literature			
<i>With score of 3</i>	8	H: 1 course	Spanish 1-5
<i>With score of 4 or 5</i>	8	H: 1 course	Spanish 1-6
Statistics	4	C: 1 course#	Communication 87, EEMB 30, Geography 17 PSTAT 5AA-ZZ, Psychology 5, Sociology 3
U.S. Government and Politics	4	D: 1 course	Political Science 12
U.S. History	8	D: 1 course	no equivalent
World History	8	none	no equivalent

* A maximum of 8 units EACH in art studio, English, mathematics, and physics is allowed.

Also satisfies the quantitative relationship requirement in Area C.

+ Maximum credit for computer science exams is 4 units.

† Consult the mathematics department about optional higher placement in calculus.

• If you received a score of 5 on Mathematics-Calculus AB, see www.math.ucsb.edu/ugrad/placement.php

General University Requirements

UC Entry Level Writing Requirement

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

1. by achieving a score of 680 or higher on the SAT II: Subject Test in Writing;
2. by achieving a score of 680 or higher on the Writing Section of the SAT Reasoning Test;
3. by achieving a score of 30 or better on the ACT Combined English/Writing test;
4. by achieving a score of 3 or higher on the College Board Advanced Placement Examination in English Composition and Literature or English Language and Composition;
5. by passing the UC systemwide Analytical Writing Placement Examination while in high school;
6. by achieving a score of 6 or higher on the International Baccalaureate (standard level) English A1 Examination.
7. by achieving a score of 5 or higher on the International Baccalaureate (higher level) English A Examination;
8. by entering the university with transcripts showing the completion of an acceptable 3-semester unit or 4-quarter unit course in English composition equivalent to Writing 2 at UCSB, with a grade of C or better.

Students who have not taken the Analytical Writing Placement examination and who have not met the UC Entry Level Writing Requirement in one of the other ways listed above will be required to take the examination during their first quarter at UCSB (check with Writing Program for examination time and location). An appropriate score on the examination will satisfy the requirement. Only one UC examination may be taken – either the systemwide Entry Level Examination while in high school or the examination given at UCSB; and neither may be repeated.

Students who enter UCSB without having fulfilled the university's Entry Level Writing requirement and (if they have not previously taken the systemwide examination) who do not achieve an appropriate score on the examination given on campus must enroll in Writing 1, 1E or Linguistics 12 within their first year at UCSB. A grade of C or higher is needed to satisfy the requirement. Students who earn a grade of C- or lower in will be required to repeat the course in successive quarters

until the requirement is satisfied.

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

American History and Institutions Requirement

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

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

Anthropology 131
 Art History 121A-B-C, 136H
 Asian American Studies 1, 2
 Black Studies 1, 6, 20, 60A-B, 103, 121, 137E, 169AR-BR-CR
 Chicano Studies 1A-B-C, 144, 168A-B, 174, 188A-B-C
 Economics 113A-B, 119
 English 133AA-ZZ, 134AA-ZZ, 137A-B, 138C, 191
 Environmental Studies 173
 Feminist Studies 155A, 159B-C
 History 11A, 17A-B-C, 17AH-BH-CH, 105A, 159B-C, 160A-B, 161A-B, 164C, 164IA-IB, 164PR, 165, 166A-B-C-LB, 167A-B-C, 168A-B, 169AR-BR-CR, 169M, 172A-B, 173A-B-S-T, 175A-B, 176A-B, 177, 178A-B, 179A-B
 Military Science 27
 Political Science 12, 115, 127, 151, 152, 153, 155, 157, 158, 162, 165,

167, 168, 174, 176, 180, 185
 Religious Studies 7, 14, 61A-B, 114B, 151A-B, 152
 Sociology 137E, 140, 144, 155A, 157
 Theater 180A-B

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

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

College of Engineering General Education Requirements

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

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

It should be noted that for College of Engineering transfers who completed IGETC (Intersegmental General Education Transfer Curriculum), it may be used to substitute for the lower division general education and breadth requirements only. To complete the depth and writing requirements, those students will still be required to complete at least two upper division general education courses from General Subject Areas D, E, F, G, or H at UCSB after transfer (unless the student completed a year-long

sequence equivalent to one of the Depth Requirement sequences as part of the IGETC program).

Students who have questions about the General Education requirements should consult with the advisors in College of Engineering Office of Undergraduate Studies.

GENERAL SUBJECT AREA REQUIREMENTS

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

I. Area A: English Reading and Composition

Computer Science students must complete Writing 2 and Writing 50 or 109ST.

All other engineering majors are required to complete Writing 2E and Writing 50E during their first year at UCSB. Students that are unable to meet this requirement should consult with the College of Engineering Office of Undergraduate Studies.

NOTE: Students must complete the UC Entry Level Writing Requirement before enrolling in courses that fulfill the Area A requirement of the General Education program. Please refer to page 8 of this publication or the UCSB General Catalog for a list of ways to satisfy the UC Entry Level Writing requirement.

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

At least 6 courses must be completed in these areas:

Areas D and E: A minimum of 2 courses must be completed in areas D and E.

Areas F and G: A minimum of 2 courses must be completed in areas F and G.

The general provisions relating to General Education requirements, as listed on page 9, must be followed when completing courses in Areas D, E, F, G, and H.

A complete listing of courses, which will satisfy all these requirements starts on page 10.

SPECIAL SUBJECT AREA REQUIREMENTS

In the process of fulfilling the General Education General Subject Areas D

through H requirements, students must complete the following Special Subject Area requirements:

- 1. Writing Requirement.** At least four designated General Education courses that meet the following criteria: (1) the courses require one to three papers totaling at least 1,800 words, exclusive of elements such as footnotes, equations, tables of contents, or references; (2) the required papers are independent of or in addition to written examinations; and (3) the paper(s) is a significant consideration in the assessment of student performance in the course. Courses marked with an asterisk (*) on the lists in this document apply to this requirement. The writing requirement may be met only with designated UCSB courses.

NOTES: ENGR 101 and ENGR 103 may be used as a writing requirement class, even by those students for whom ENGR 101 is required.

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

- 2. Depth Requirement.** At least two upper division General Education courses from two separate departments, in each of which a student has already successfully completed one General Education course. (Alternatively, this entire depth requirement may be satisfied by completion of one of the following sequences: Chicano Studies 1A-B-C, Comparative Literature 30A-B-C, French 50AX-BX-CX, History 2A-B-C, History 2AH-BH-CH, History 4A-B-C, History 4AH-BH-CH, History 17A-B-C, History 17AH-BH-CH, Philosophy 20A-B-C, Religious Studies 80A-B-C or any three courses from Art History 6A-B-C-D-DS-DW-E-F-G-H-K. Students selecting this option must complete all three courses in the sequence. Selection of this option does not change the number of courses required.)

Only courses from General Subject Areas D, E, F, G, or H may be used to meet this requirement.

- 3. Ethnicity Requirement.** At least one course that focuses on the history and the cultural, intellectual, and social experience of one of the following groups: Native Americans, African Americans, Chicanos/Latinos, or Asian Americans. Alternatively, students may take a course that provides a comparative and integrative context for understanding the experience of oppressed and excluded racial minorities in the United States. Courses that meet this requirement are marked

with an ampersand (&) on the lists in this document.

4. European Traditions Requirement.

At least one course that focuses on European cultures or cultures within the European Tradition. Courses that meet this requirement are marked with a caret (^) on the lists in this document.

Other Regulations:

- No more than two courses from the same department may apply to the General Education areas D, E, F, G, and H. (Except if a student completes one of the specific course sequences, such as History 4A-B-C, listed above for the depth requirement.)
- A course listed in more than one general subject area can be applied to only one of these areas. (Example: Art History 6A cannot be applied to both areas E and F.) However, a course can be applied towards a single general subject area and any special subject areas which that course fulfills. (Example: Asian American Studies 5 can be applied to the Writing and Ethnicity requirements in addition to the Area G requirement.)
- Some courses taken to satisfy the General Education requirements may also be applied simultaneously to the American History and Institutions requirement. Such courses must be on the list of approved General Education courses and on the list of approved American History and Institutions courses.
- Courses taken to fulfill a General Education requirement may be taken on a P/NP basis, if the course is offered with that grading option (refer to GOLD for the grading option for a particular course).



GENERAL EDUCATION COURSES

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

AREA A – ENGLISH READING AND COMPOSITION

2 courses required

Writing 2 or 2E and Writing 50, 50E or 109ST are required, and must be taken for letter grades.

AREAS D AND E – SOCIAL SCIENCES, CULTURE & THOUGHT

2 course minimum

Area D: Social Sciences

Objective: To provide an understanding of what determines or influences the behavior and beliefs of individuals and groups.

Anthropology 2	Introductory Cultural Anthropology
* Anthropology 3	Introductory Archaeology
Anthropology 3SS	Introduction to Archaeology
Anthropology 7	Introduction to Biosocial Anthropology
Anthropology 25	Violence and the Japanese State (Same as JAPAN 25)
Anthropology 109	Human Universals
Anthropology 110	Technology and Culture
* Anthropology 122	Anthropology of World Systems
Anthropology 130A-B	Third World Environments
@ 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 and Present
Anthropology 142	Peoples and Cultures of India
Anthropology 156	Understanding Africa
* Anthropology 176	Representations of Sexuality in Modern Japan
@& Asian American Studies 1	Introduction to Asian American History, 1850-Present
@& Asian American Studies 2	American Migration since 1965
& Asian American Studies 3	Asian American Personality and Identity
& Asian American Studies 6	Sociology of Asian America
& Asian American Studies 8	Introduction to Asian American Gender and Sexuality
& 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 131	Asian American Women's History
&* Asian American Studies 136	Asian American Families
&* Asian American Studies 137	Multicultural Asian Americans
@&* Black Studies 1	Introduction to Afro-American Studies
& Black Studies 4	Critical Introduction to Race and Racism
@&* Black Studies 6	The Civil Rights Movement
& Black Studies 15	The Psychology of Blacks
@&* Black Studies 20	Introduction to Afro-American Politics
Black Studies 100	Africa and United States Policy
* Black Studies 102	Black Radicals and the Radical Tradition
@&* Black Studies 103	The Politics of Black Liberation-The Sixties
@& Black Studies 121	The Black Family in the United States
& Black Studies 122	The Education of Black Children
* Black Studies 124	Housing, Inheritance and Race
* Black Studies 125	Queer Black Studies
&* Black Studies 160	Analyses of Racism and Social Policy in the U.S.

@&* Black Studies 169AR-BR-CR	Afro-American History (Same as HIST 169AR-BR-CR)
* Black Studies 171	Africa in Film
@&* Chicano Studies 1A-B-C	Introduction to Chicano/a Studies
Chicano Studies 114	Cultural and Critical Theory
& Chicano Studies 137	Chicana/o Oral Traditions
& Chicano Studies 140	The Mexican Cultural Heritage of the Chicano
@&* Chicano Studies 144	The Chicano Community (Same as SOC 144)
& Chicano Studies 151	De-Colonizing Feminism
& Chicano Studies 155W	La Chicana: Mexican Women in the U.S.
@& Chicano Studies 168A-B	History of the Chicano (Same as HIST 168A-B)
&* Chicano Studies 172	Law and Civil Rights
& Chicano Studies 173	Immigrant Labor Organizing
@& Chicano Studies 174	Chicano/a Politics (Same as POL S 174)
&* Chicano Studies 175	Comparative Social Movements
Chicano Studies 176	Theories of Social Change and Chicano Political Life
& Chicano Studies 178A	Global Migration, Transnationalism in Chicano/a Contexts
* Chicano Studies 179	Democracy and Diversity
& Chicano Studies 189B	The Global Underground
Chicano Studies 189C	Cultures of Globalization
* Communication 1	Introduction to Communication
* Comparative Literature 119	Psychoanalytic Theory
East Asian Cultural Studies 189A	Vietnamese History (Same as HIST 189A)
Economics 1	Principles of Economics - Micro
Economics 2	Principles of Economics - Macro
Economics 109	Introduction to Economics
* Environmental Studies 1	Introduction to Environmental Studies
Environmental Studies 130A-B	Third World Environments
Environmental Studies 132	Human Behavior and Global Environment
* Feminist Studies 20 or 20H	Women, Society and Culture
* Feminist Studies 30 or 30H	Women, Development, and Globalization
* Feminist Studies 50 or 50H	Global Feminisms and Social Justice
@* Feminist Studies 60 or 60H	Women of Color: Race, Class and Ethnicity
* Feminist Studies 117C	Women, the Family, and Sexuality in the Middle Ages (Same as HIST 117C & ME ST 100A)
&* Feminist Studies 153	Women and Work (Same as SOC 153)
@* Feminist Studies 159B-C	Women in American History (Same as HIST 159B-C)
Geography 2	World Regions
Geography 5	People, Place and Environment
Geography 20	Geography of Surfing
Geography 108	Urban Geography
Geography 150	Geography of the United States
* Global Studies 1	Global History, Culture, and Ideology
* Global Studies 2	Global Socioeconomic and Political Processes
* History 7	Great Issues in the History of Public Policy
@&* History 11A	History of America's Racial and Ethnic Minorities
@* History 17A-B-C	The American People
@* History 17AH-BH-CH	The American People (Honors)
History 82	Anthropology of Korea (Same as KOR 82)
@ History 105A	The Atomic Age
* History 117A	Towns, Trade, and Urban Culture in the Middle Ages
* History 117C	Women, the Family, and Sexuality in the Middle Ages (Same as FEMST 117C & ME ST 100A)
&* History 131 F	Anti-Semite and Jew in Modern Europe and America: 1870 to Present
History 138B	The Vietnam Wars
@* History 159B-C	Women in American History (Same as FEMST 159B-C)
@& History 161A-B	Colonial and Revolutionary America
@* History 167B	Development of American Industrial Society 1860-Present
@& History 167C	History of American Labor
* History 167CA-CB-CP	History of American Working Class
@& History 168A-B	History of the Chicanos (Same as CH ST 168A-B)
@&* History 169AR-BR-CR	Afro-American History (Same as BL ST 169AR-BR-CR)
@* History 172A-B	Politics and Public Policy in the United States

* This course applies toward the writing requirement.

& This course applies toward the ethnicity requirement.

@ This course applies toward the American History & Institutions requirement.

^ This course applies toward the European Traditions requirement.

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French 40X	Memory: Bridging the Humanities and Neuroscience (Same as C LIT 27 & MCDB 27)	Political Science 187	Classical Political Theory
*^ French 50AX-BX-CX	Tales of Love	Political Science 188	Modern Political Theory
French 70AX	A Visual History of France	Political Science 189	Recent and Contemporary Political Theory
* French 149C	Reading Paris (1830-1890)	* Portuguese 125A	Culture and Civilization of Portugal
* French 154F	Time Off in Paris	* Portuguese 125B	Culture and Civilization of Brazil
French 154G	Post-Colonial Cultures (Same as C LIT 171)	* Religious Studies 1	Introduction to the Study of Religion
* French 155D	Citoyennes! Women and Politics in Modern France (Same as FEMST 171CN)	* Religious Studies 3	Introduction to Asian Religious Traditions (Same as EACS 3)
* German 43A	Dreaming Revolutions: Introduction to Marx, Nietzsche and Freud	* Religious Studies 4	Introduction to Buddhism
* German 43C	Germany Today	* Religious Studies 5	Introduction to Judaism, Christianity, and Islam
* German 116A	Representations of the Holocaust (Same as C LIT 122A)	Religious Studies 6	Islam and Modernity
* German 164I	Modern Autobiography and Memoir: Texts and Contents	Religious Studies 12	Religious Approaches to Death
* Global Studies 1	Global History, Culture, and Ideology	* Religious Studies 19	The Gods and Goddesses of India
*^ History 2A-B-C	World History	Religious Studies 20	Indic Civilization
*^ History 2AH-BH-CH	World History (Honors)	* Religious Studies 21	Zen
*^ History 4A-B-C	Western Civilization	* Religious Studies 43	Origins: A Dialogue Between Scientists and Humanists (Same as PHYS 43)
^ History 4AH-BH-CH	Western Civilization (Honors)	@& Religious Studies 61A-B	Survey of Afro-American Religious Traditions (Same as BL ST 60A-B)
* History 8	Introduction to History of Latin America	* Religious Studies 70	Topics in Religious Experience
*^ History 33D	The Holocaust: Interdisciplinary Perspectives	& Religious Studies 71	Introduction to Asian American Religions
* History 46	Survey of Middle Eastern History	*^ Religious Studies 80A-B-C	Religion and Western Civilization
* History 49A-B	Survey of African History	* Religious Studies 116A	The New Testament and Early Christianity
* History 80	East Asian Civilization (Same as EACS 80)	&* Religious Studies 123	Asian American Religions (Same as AS AM 161)
* History 84	China and the West	* Religious Studies 126	Roman Catholicism Today
* History 87	Japanese History through Art and Literature	* Religious Studies 130	Judaism
* History 106A	The Origins of Western Science, Antiquity to 1500 (Same as ENV S 108A)	* Religious Studies 136	Creation Myths
* History 106B	The Scientific Revolution, 1500 to 1800	* Religious Studies 138B	Catholic Practices & Global Cultures
* History 106C	History of Modern Science	* Religious Studies 150	American Spiritualities
History 107B	History of the Biological Sciences: Circa 1600 to 1800	Religious Studies 162C	Sikhism
History 107C	The Darwinian Revolution and Modern Biology (Same as ENV S 107C)	* Religious Studies 162E	Indian Civilization
* History 107E	History of Animal Use in Science (Same as ENV S 107E)	* Religious Studies 164A	Buddhist Traditions in South Asia
* History 113B	Roman History	Religious Studies 164B	Buddhist Traditions in East Asia
* History 114B-C-D	History of Christianity	* Religious Studies 183	Quest for Narrative in Late Imperial China
* History 133A	Nineteenth Century Germany	Slavic 33	Russian Culture
* History 133B-C	Twentieth Century Germany	Slavic 130D	Russian Art
*^ History 133D	The Holocaust in German History	Spanish 153	Basque Studies
* History 143	The Nile Quest	Spanish 177	Spanish-American Thought
* History 144	Resistance in African History		
* History 182A-B	Korean History and Civilization (Same as KOR 182A-B)		
* History 185A-B	Modern China		
* History 187A-B-C	Modern Japan		
History 188T	Modernity and the Masses of Taisho Japan (Same as JAPAN 164)		
* History 189E	History of the Pacific		
Italian 20X	Introduction to Italian Culture	Art History 1	Introduction to Art
Italian 138AA-AX-CX-D-DX	Cultural Representations in Italy	* Art History 5A	Introduction to Architecture and the Environment
* Italian 144AX	Gender and Sexuality in Italian Culture	*^ Art History 6A	Art Survey I: Ancient Art-Medieval Art
Japanese 164	Modernity and the Masses of Taisho Japan (Same as HIST 188T)	*^ Art History 6B	Art Survey II: Renaissance Art-Baroque Art
* Korean 182A-B	Korean History and Civilization (Same as HIST 182A-B)	*^ Art History 6C	Art Survey III: Modern-Contemporary Art
* Latin American & Iberian Studies 101	Interdisciplinary Approaches to History and Societies of Latin America	* Art History 6D	Survey: Asian Art
* Linguistics 30	The Story of English	* Art History 6DS	Survey: History of Art in China
Linguistics 50	Language and Power	* Art History 6DW	Survey: Art of Japan and Korea
Middle East Studies 45	Introduction to Islamic & Near East Studies	Art History 6E	Survey: Arts in Africa, Oceania, and Native North America
Molecular, Cellular & Developmental Biology 27	Memory: Bridging the Humanities and Neuroscience (Same as C LIT 27 & FR 40X)	* Art History 6F	Survey: Architecture and Planning
* Philosophy 1	Short Introduction to Philosophy	* Art History 6G	Survey: History of Photography
Philosophy 3	Critical Thinking	* Art History 6H	Pre-Columbian Art
Philosophy 4	Introduction to Ethics	* Art History 6K	Islamic Art and Architecture
*^Philosophy 20A-B-C	History of Philosophy	Art History 101A	Archaic Greek Art (750 to 480 BCE)
* Philosophy 100A	Ethics	Art History 101B	Classical Greek Art (480 to 320 BCE)
* Philosophy 100B	Theory of Knowledge	Art History 101C	Hellenistic Greek Art
* Philosophy 100C	Philosophy of Language	Art History 101D	Ancient Egyptian Art
* Philosophy 100D	Philosophy of Mind	Art History 103A	Roman Architecture
* Philosophy 100E	Metaphysics	Art History 103B	Roman Art: From the Republic to Empire (509 BC to AD 337)
* Philosophy 112	Philosophy of Religion	Art History 103C	Greek Architecture
* Physics 43	Origins: A Dialogue Between Scientists and Humanists (Same as RG ST 43)	Art History 105B	Medieval Art: Byzantine

AREA F AND G – ARTS AND LITERATURE

2 courses minimum

Area F: Arts

Objective: To develop an appreciation of the arts through historical study, analysis of master works, and aesthetically creative activity.

Art History 1	Introduction to Art
* Art History 5A	Introduction to Architecture and the Environment
*^ Art History 6A	Art Survey I: Ancient Art-Medieval Art
*^ Art History 6B	Art Survey II: Renaissance Art-Baroque Art
*^ Art History 6C	Art Survey III: Modern-Contemporary Art
* Art History 6D	Survey: Asian Art
* Art History 6DS	Survey: History of Art in China
* Art History 6DW	Survey: Art of Japan and Korea
Art History 6E	Survey: Arts in Africa, Oceania, and Native North America
* Art History 6F	Survey: Architecture and Planning
* Art History 6G	Survey: History of Photography
* Art History 6H	Pre-Columbian Art
* Art History 6K	Islamic Art and Architecture
Art History 101A	Archaic Greek Art (750 to 480 BCE)
Art History 101B	Classical Greek Art (480 to 320 BCE)
Art History 101C	Hellenistic Greek Art
Art History 101D	Ancient Egyptian Art
Art History 103A	Roman Architecture
Art History 103B	Roman Art: From the Republic to Empire (509 BC to AD 337)
Art History 103C	Greek Architecture
Art History 105B	Medieval Art: Byzantine

* This course applies toward the writing requirement.
& This course applies toward the ethnicity requirement.

@ This course applies toward the American History & Institutions requirement.
^ This course applies toward the European Traditions requirement.

Art History 105C	Medieval Architecture: From Constantine to Charlemagne	Art History 134A	Buddhist Art
Art History 105E	The Origins of Romanesque Architecture	Art History 134B	Early Chinese Art
Art History 105F	Medieval Art: Romanesque	Art History 134C	Chinese Painting
Art History 105G	Late Romanesque and Gothic Architecture	Art History 134D	Art and Modern China
Art History 105H	Medieval Art: Gothic	Art History 134E	The Art of the Chinese Landscape
Art History 105J	Gothic Painting 1200-1400	Art History 134F	The Art of Japan
Art History 105L	Art and Society in Late Medieval Tuscany	Art History 134G	Japanese Painting
Art History 107A	Painting in Fifteenth-Century Netherlands	Art History 134H	Ukiyo-e: Pictures of the Floating World
Art History 107B	Painting in Sixteenth-Century Netherlands	Art History 136A	Nineteenth-Century Architecture
Art History 109A	Italian Renaissance Art 1400-1500	Art History 136B	Twentieth-Century Architecture
Art History 109B	Italian Renaissance Art 1500-1600	Art History 136E	Modern Design
Art History 109C	Art as Technique, Labor, and Idea in Renaissance Italy	@ Art History 136H	Housing American Cultures
Art History 109D	Art and the Formation of Social Subjects in Early Modern Italy	Art History 136I	The City in History
Art History 109E	Michelangelo	Art History 136J	Landscape of Colonialism
Art History 109F	Italian Journeys	Art History 136M	Revival Styles in Southern California Architecture
Art History 109G	Leonardo Da Vinci: Art, Science and Technology in Early Modern Italy	Art History 136O	Sustainable Architecture: History and Aesthetics
Art History 109H	Art and Moral Values	Art History 136Y	Modern Architecture in Southern California
Art History 111A	Seventeenth-Century Visual Culture in Northern Europe	Art History 138B	Contemporary Photography
Art History 111B	Dutch Art in the Age of Rembrandt	Art History 138C	Social Documentary Photography
Art History 111C	Dutch Art in the Age of Vermeer	Art History 138D	History of Photography
Art History 111E	Gender and Power in Sixteenth- and Seventeenth-Century European Art	Art History 140A	Portraiture
Art History 111F	Rethinking Rembrandt	Art History 140B	Landscape Painting and Design
Art History 113A	Seventeenth-Century Art in Southern Europe	Art History 140E	Landscape Design History
Art History 113B	Seventeenth-Century Art in Italy	Art History 141D	Birth of the Modern Museum
Art History 113D	Architecture in Early Modern Italy	Art History 143B	Feminism and Art History
Art History 113F	Bernini and the Age of the Baroque	Art History 143C	Gender and Representation
Art History 115B	Eighteenth-Century Art 1750-1810	Art History 144A	The Avant-Garde in Russia
Art History 115C	Eighteenth-Century British Art and Culture	Art History 144C	Contemporary Art in Russia and Eastern Europe (Same as SLAV 130C)
Art History 115D	Eighteenth-Century Art in Italy: The Age of the Grand Tour	Art History 144D	Russian Art
Art History 117A	Nineteenth-Century Art 1800-1848	Art History 184B	The History of Rome: Image and Ideology
Art History 117B	Nineteenth-Century Art 1848-1900	Art History 184C	The Palace and Villa in Early Modern Europe
Art History 117C	Nineteenth-Century British Art and Culture	* Art Studio 1A	Visual Literacy
Art History 117D	Nineteenth-Century French Art 1800 to 1900	Art Studio 7A	The Intersections of Art and Life
Art History 117F	Impressionism and Post-Impressionism	Art Studio 125	Art Since 1950
Art History 119A	Art in the Modern World	&* Asian American Studies 4	Introduction to Asian American Popular Culture
Art History 119B	Contemporary Art	& Asian American Studies 118	Asian Americans in Popular Culture
Art History 119C	Expressionism to New Objectivity, Early Twentieth-Century German Art	& Asian American Studies 120	Asian American Documentary
Art History 119D	Art in the Post-Modern World	& Asian American Studies 127	Asian American Film, Television, and Digital Media
Art History 119E	Early Twentieth-Century European Art 1900-1945	& Asian American Studies 140	Theory & Production of Social Experience
Art History 119F	Art of the Postwar Period 1945-1968	& Asian American Studies 146	Racialized Sexuality on Screen and Scene
Art History 119G	Critical Approaches to Visual Culture	& Asian American Studies 170KK	Special Topics in Asian American Studies
@ Art History 121A	American Art from the Revolution to Civil War: 1700-1860	&* Black Studies 14	History of Jazz
@ Art History 121B	Reconstruction, Renaissance, and Realism in American Art 1860-1900	& Black Studies 142	Music in Afro-American Culture: U.S.A.
@ Art History 121C	Twentieth-Century American Art: Modernism and Pluralism 1900-Present	& Black Studies 161	Third-World Cinema
& Art History 121D	African-American Art and the African Legacy	* Black Studies 162	African Cinema
Art History 121E	American Things: Material Culture and Popular Art	&* Black Studies 170	Afro-Americans in the American Cinema
& Art History 121F	History of Native Art and Architecture in North America	* Black Studies 171	Africa in Film
Art History 123A	Modern Latin American Art	&* Black Studies 172	Contemporary Black Cinema
Art History 123C	Modern Art of Mexico	Chicano Studies 119	Mesoamerican Art and Artists
& Art History 125A	Chicano Art: Symbol and Meaning	& Chicano Studies 125B	Contemporary Chicano and Chicana Art
Art History 127A-B	African Art	& Chicano Studies 138	Barrio Popular Culture
* Art History 130A	Pre-Columbian Art of Mexico	& Chicano Studies 148	Chicana Art and Feminism
* Art History 130B	Pre-Columbian Art of the Maya	@ Chicano Studies 188C	Chicano Theater Workshop
* Art History 130C	The Arts of Spain and New Spain	* Chinese 40	Popular Culture in Modern Chinese Societies
* Art History 130D	Pre-Columbian Art of South America	Chinese 141	China in Transition Through Films
Art History 132A	Mediterranean Cities	* Chinese 170	New Taiwan Cinema
Art History 132B	The "Masterpiece" in Islamic Art and Architecture	*^ Classics 102	Greek Tragedy in Translation
Art History 132C	Architecture and Ideology from Constantine to Suleyman the Magnificent	^ Classics 165	Greek Painting
Art History 132D	Islamic Architecture 650-1400	^ Classics 170	Pompeii
Art History 132E	Islamic Architecture 1400-Modern	Dance 35	History and Appreciation of World Dance
Art History 132I	Art of Empire	* Dance 36	History of Modern Dance
		Dance 45	History and Appreciation of Dance
		* Dance 145A-B-M	Studies in Dance History
		* Dance 145W	Women in Dance
		Dance 146	Multicultural Dance
		* Film Studies 46	Introduction to Cinema
		* Film Studies 120	Japanese Cinema (Same as JAPAN 159)
		Film Studies 121	Chinese Cinema
		* Film Studies 122AZ	Topics in National Cinema
		* Film Studies 124	Indian Cinema
		* Film Studies 125B	Documentary Film
		* Film Studies 126	Cuban Cinema
		&* Film Studies 127	Latin American Cinema
		* Film Studies 127M	Mexican Film and Cinema

* This course applies toward the writing requirement.

& This course applies toward the ethnicity requirement.

@ This course applies toward the American History & Institutions requirement.

^ This course applies toward the European Traditions requirement.

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* Film Studies 134	French and Francophone Cinema	Chinese 148	Historic Lives
* Film Studies 136	British Cinema	^ Classics 36	Ancient Epic
* Film Studies 144	The Horror Film (Same as GER 183)	^ Classics 37	Greek Literature in Translation
* Film Studies 163	Women and Film: Feminist Perspectives	*^ Classics 38	Latin Literature in Translation
Film Studies 169	Film Noir	*^ Classics 39	Women in Classical Literature
Film Studies 175	Experimental Film	^ Classics 40	Greek Mythology
* Film Studies 178Z	Technology and Cinema (Same as FR 156D)	*^ Classics 102	Greek Tragedy in Translation
* French 156A	French Cinema: History and Theory	*^ Classics 109	Viewing the Barbarian: Representations of Foreign Peoples in Greek Literature
* French 156B	French and Francophone Cinema	*^ Classics 110	From Homer to Harlequin: Masculine, Feminine, and the Romance
* French 156C	Modern Images of the Middle Ages: The Intersection of Text, History, and Film	^ Classics 120	Greek and Latin Lyric Poetry
* French 156D	Technology and Cinema (Same as FLMST 178Z)	^ Classics 130	Comedy and Satire in Translation
* General Education 1FW	General Education Seminar for Freshmen	*^ Classics 175	Ancient Theories of Literature
* German 55A-B	Contemporary German Pop Culture	*^ Comparative Literature 30A-B-C	Major Works of European Literature
* German 183	The Horror Film (Same as FLMST 144)	* Comparative Literature 31	Major Works of Asian Literatures
Italian 124X	Italian Theatre	* Comparative Literature 32	Major Works of Middle Eastern Literatures
Italian 178B	Italian Cinema	* Comparative Literature 33	Major Works of African Literatures (Same as BL ST 33)
Italian 179X	Fiction and Film in Italy	* Comparative Literature 34	Literature of the Americas
* Italian 180Z	Italian Cinema	Comparative Literature 100	Introduction to Comparative Literatures
Japanese 149	Traditional Japanese Drama	* Comparative Literature 107	Voyages to the Unknown
* Japanese 159	Japanese Cinema (Same as FLMST 120)	* Comparative Literature 113	Trauma, Memory, Historiography
Music 11	Fundamentals of Music	* Comparative Literature 115	Introduction to Folk Tales
* Music 15	Music Appreciation	Comparative Literature 117A-B	European Romanticism
Music 17	World Music	* Comparative Literature 122A	Representations of the Holocaust (Same as GER 116A)
* Music 114	Music and Popular Culture in America	* Comparative Literature 122B	Holocaust in France (Same as FR 154E)
* Music 115	Symphonic Music	* Comparative Literature 128A	Children's Literature
Music 116	American Music History: From the Colonial Period to the Present	* Comparative Literature 128B	Representing Childhood
* Music 118A	History and Literature of Great Composers in Western Music	* Comparative Literature 146	Robots
* Music 119A	Music and Politics	* Comparative Literature 153	Border Narratives
* Philosophy 136	Aesthetics	* Comparative Literature 154	Science Fiction in Eastern Europe
Slavic 130A	The Avantgarde in Russia	* Comparative Literature 161	Literature of Central Europe
Slavic 130C	Contemporary Art in Russia and Eastern Europe (Same as ARTHI 144C)	Comparative Literature 171	Post-Colonial Cultures (Same as FR 154G)
Slavic 130D	Russian Art	* Comparative Literature 179B	Mysticism
Slavic 130E	Masters of Soviet Cinema	* Comparative Literature 179C	Mediatechnology (Same as GER 179C)
Spanish 126	Spanish Cinema	Comparative Literature 186EE	Interdisciplinary Comparative Literature Studies
* Theater 2	Performance in Global Contexts	* Comparative Literature 187	Strauss and Hofmannsthal
* Theater 3	Life of the Theater	Comparative Literature 191	Fantasy and the Fantastic (Same as FR 153D)
* Theater 5	Introduction to Acting	* English 15	Introduction to Shakespeare
* Theater 7	Performance of the Human Body	* English 21	Introduction to Narrative
*^ Theater 8	European Theater History	* English 25	Introduction to Literature and the Culture of Information
* Theater 9	Playwriting	* English 35	Introduction to Literature and the Environment
@ Theater 180A-B	American Drama	&* English 38A	Introduction to African American Literature
* Theater 180C	Contemporary American Drama and Theater	&* English 50	Introduction to U.S. Minority Literature
&* Theater 180E	Culture Clash: Studies in U.S. Latino Theater	* English 65MM	Topics in Literature
* Theater 180G	Race, Gender, and Performance	* English 101	English Literature from the Medieval Period to 1650
Theater 181S	National Studies in Spanish Theater and Drama	* English 102	English and American Literature from 1650 to 1789
* Theater 182A	Ancient Theater and Drama	* English 103A	American Literature from 1789 to 1900
* Theater 182M	Modern Theater and Drama	* English 103B	British Literature from 1789 to 1900
* Theater 182MC	Modern Contemporary	* English 104A	American Literature from 1900 to Present
* Theater 182N	Neoclassical Theater and Drama	* English 104B	British Literature from 1900 to Present
* Theater 182RM	Romantic Theater and Drama	* English 105A	Shakespeare: Poems and Earlier Plays
* Theater 184CA	Contemporary African Theater and Performance	* English 105B	Shakespeare: Later Plays
* Theater 188S	Shakespeare on Film and Stage	* English 113AA-ZZ	Literary Theory and Criticism
		* English 114AA-ZZ	Women and Literature
		&* English 114BW	Black Women Authors
		&* English 114NW	Native American Women Authors
		* English 115	Medieval Literature
		* English 116A	Biblical Literature: The Old Testament
		* English 116B	Biblical Literature: The New Testament
		* English 119	Studies in Medieval Literature
		* English 119X	Medieval Literature in Translation
		* English 120	Modern Drama
		* English 121	The Art of Narrative
		* English 122AA-ZZ	Cultural Representations
		&* English 122BP	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-C	Survey of British Fiction
		* English 128AA-ZZ	Literary Genres

AREA G: LITERATURE

Objective: To develop an appreciation of literature through historical study, analysis of master works, and aesthetically creative activity.

&* Asian American Studies 5	Introduction to Asian American Literature
* Black Studies 33	Major Works of African Literatures (Same as C LIT 33)
&* Black Studies 38A-B	Introduction to Afro-American Literature
* Black Studies 127	Black Women Writers
* Black Studies 130A	Negritude and African Literature
* Black Studies 130B	The Black Francophone Novel
&* Chicano Studies 152	Postcolonialism
&* Chicano Studies 180	Survey of Chicano Literature
&* Chicano Studies 181	The Chicano Novel
&* Chicano Studies 184A	Chicana Writers
Chinese 110A	Classics of Ancient China
* Chinese 112A	Major Movements in Modern Chinese Literature
Chinese 115A	Imagism, Haiku, and Chinese Poetry
* Chinese 139	Boundaries of the Self in Late Imperial Chinese Literature

* This course applies toward the writing requirement.
 & This course applies toward the ethnicity requirement.

@ This course applies toward the American History & Institutions requirement.
 ^ This course applies toward the European Traditions requirement.

* English 131AA-ZZ	Studies in American Literature	Korean 113	Korean Literature Survey
@ * English 133AA-ZZ	Studies in American Regional Literature	* Latin American & Iberian Studies 102	Interdisciplinary Approaches to the Cultures, Languages and Literature
@& * English 134AA-ZZ	Literature of Cultural and Ethnic Communities in the United States	* Medieval Studies 100B	Literature of Chivalry
@ * English 137A-B	Poetry in America	* Music 187	Strauss and Hofmannsthal
@ * English 138C	Prose Narrative in America Since 1917	Portuguese 115AA-ED-EO	Brazilian Literature
* English 140	Contemporary American Literature	* Portuguese 120AA-ZZ	Portuguese Literature in English Translation
* English 150	Anglo-Irish Literature	* Religious Studies 114X	Dante's "Divine Comedy"
* English 152A	Chaucer: Canterbury Tales	Religious Studies 129	Religions of the Ancient Near East
* English 156	Literature of Chivalry	* Religious Studies 189C	Critical Readings in Modern Arabic Literature in Translation
* English 157	English Renaissance Drama	Slavic 117F	Chekhov
* English 162	Milton	* Slavic 117G	Dostoevsky
* English 165AA-ZZ	Topics in Literature	* Slavic 117H	Tolstoy
* English 172	Studies in the Enlightenment	Slavic 123A-B	Nineteenth Century Russian Literature
* English 179	British Romantic Writers	Slavic 123C-D	Twentieth Century Russian Literature
* English 180	The Victorian Era	* Slavic 151C	Literature of Central Europe
* English 181	Studies in the Nineteenth Century	* Slavic 164A	Death and Its Representations
* English 184	Modern European Literature	* Slavic 164B	Science Fiction in Eastern Europe
* English 185	Modernism in English	* Slavic 164C	Women in Russian Literature
* English 187AA-ZZ	Studies in Modern Literature	* Spanish 115B	Masterpieces of Spanish Literature (in English Translation)
* English 189	Contemporary Literature	* Spanish 120A-B	Contemporary Spanish American Fiction in English Translation
* English 190AA-ZZ	World Literature in English	& * Spanish 135	Survey of Chicano Literature
@& * English 191	Afro-American Fiction and Criticism, 1920s to Present	* Spanish 142A-B	Don Quixote in English Translation
* English 192	Science Fiction	& * Spanish 179	Chicano Novel
* English 193	Detective Fiction		
* Environmental Studies 122LE	Cultural Representations: Literature and the Environment		
* Environmental Studies 122NE	Cultural Representations of Nature and the Environment (Same as ENGL 122NE)		
* Environmental Studies 160	American Environmental Literature		
* Feminist Studies 40 or 40H	Women, Representation, and Cultural Production		
* Feminist Studies 171CN	Citoyennes! Women and Politics in Modern France (Same as FR 155D)		
* French 145X	Irony in the Renaissance		
* French 153A	Medieval Literature in Translation		
* French 153B	French Theater in Translation		
* French 153C	Autobiography		
French 153D	Fantasy and the Fantastic (Same as C LIT 191)		
* French 153E	The Power of Negative Thinking: Sartre, Adorno, and Marcuse		
* French 153F	Existentialist Literature in Translation		
* French 154A	Voyages to the Unknown		
* French 154D	Torture		
* French 154E	Holocaust in France (Same as C LIT 122B)		
* French 154F	Time Off in Paris		
French 154G	Post-Colonial Cultures (Same as C LIT 171)		
* French 155A	Women in the Middle Ages		
French 155B	Women on Trial		
French 155C	French and Francophone Women Writers		
* French 155D	Citoyennes! Women and Politics in Modern France (Same as FEMST 171CN)		
* German 43B	German Childhood and Youth		
* German 116A	Representations of the Holocaust (Same as C LIT 122A)		
* German 138	Psy Fi: German Science Fiction		
* German 143	The Superhuman		
* German 151C	Literature of Central Europe		
* German 164E-F-G	German Writers in German Language		
* German 164I	Modern Autobiography and Memoir		
German 166	Grimm		
* German 179B	Mysticism		
* German 179C	Mediatechnology (Same as C LIT 179C)		
* German 182	Vampirism in German Literature and Beyond		
* German 187	Satan in German Literature and Beyond		
Global Studies 101	Global Literatures		
* Italian 114X	Dante's "Divine Comedy"		
* Italian 138AX	Cultural Representations in Italy		
* Italian 142X	Women in Italy		
* Italian 144AX	Gender and Sexuality in Italian Culture		
* Italian 163X	Early Modern Epic		
Italian 179X	Fiction and Film in Italy		
* Japanese 110A-B-C	Survey of Japanese Literature		
* Japanese 112	Survey of Modern Japanese Literature		
Japanese 115	Topics in Twentieth-Century Japanese Literature		
		* Chinese 124A-B	Readings in Modern Chinese Literature
		* Chinese 132A	Special Topics in Classical Chinese Poetry
		Chinese 142	Tang Poetry
		French 101A-B-C	Introduction to Literary and Cultural Analysis
		* French 147A	Renaissance Poetry
		* French 147B	French Theater
		* French 148C	Women in the Middle Ages
		* French 148E	The Age of Louis XIV
		French 149B	The Politics of Paradise
		* French 149C	Paris in Nineteenth-Century Literature & Art
		* French 149D	Post-War Avant-Gardes
		* French 149E	Belgian Literature in French
		* German 115A-B-C	Survey of German Literature
		^ Greek 100	Introduction to Greek Prose
		^ Greek 101	Introduction to Greek Poetry
		* Hebrew 114A-B-C	Modern Hebrew Prose and Poetry
		Italian 101	Advanced Reading and Composition: Modern Italy
		Italian 102	Advanced Reading and Composition: Medieval and Renaissance Italy
		Italian 111	Italian Short Fiction
		Italian 126A-AA-AB-BB	Literature in Italian
		^ Latin 100	Introduction to Latin Prose
		^ Latin 101	Introduction to Latin Poetry
		Portuguese 105A-B-C	Survey of Portuguese Literature
		Portuguese 106A-B-C	Survey of Brazilian Literature
		Religious Studies 129	Religions of the Ancient Near East
		Spanish 30	Introduction to Hispanic Literature
		Spanish 102L	Introduction to Hispanic Literary Studies
		Spanish 131	Spanish Golden Age Poetry I
		Spanish 137A-B	Golden Age Drama
		Spanish 138	Contemporary Mexican Literature
		Spanish 140A-B	Cervantes: Don Quixote
		Spanish 174	Hispanic Novel and Cinema

Literature Courses Taught in the Original Languages

Area H: Foreign Language

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

Chinese 2-3	Elementary Modern Chinese
Chinese 2H-3H	First Year Chinese Heritage
Chinese 4-5-6	Intermediate Modern Chinese
Chinese 4H-5H	Second Year Chinese Heritage
French 2-3	Elementary French
French 4-5-6	Intermediate French
French 6GS	Intermediate French for Global Studies and Political Science

* This course applies toward the writing requirement.
 & This course applies toward the ethnicity requirement.

@ This course applies toward the American History & Institutions requirement.
 ^ This course applies toward the European Traditions requirement.

German 2-3	Elementary German	* Chinese 132B	Special Topics in Modern Chinese Poetry
German 4-5-6	Intermediate German	* Chinese 150	The Language of Vernacular Chinese Literature
German 95B-C	Yiddish	* Chinese 166A	Religion in Chinese Culture
Greek 2-3	Elementary Greek	* Chinese 166B	Taoist Traditions in China
Greek 12-13	Modern Greek	* Chinese 166C	Confucian Tradition: The Classical Period
Hebrew 2-3	Elementary Hebrew	* Chinese 166E	The Flowering of Chinese Buddhism
Hebrew 4-5-6	Intermediate Modern Hebrew	* Communication 130	Political Communication
Italian 2-3	Elementary Italian	* Communication 137	Global Communication, International Relations and the Media
Italian 4-5-6	Intermediate Italian	* Communication 150	Group Communication in Multiple Contexts
Japanese 2-3	First Year Japanese	* Communication 153	Communication and Global Advocacy Networks
Japanese 4-5-6	Second Year Japanese	* Comparative Literature 36	Global Humanities: The Politics and Poetics of Witnessing
Korean 2-3	First Year Korean	* Comparative Literature 124	Old Comedy/New Comedy
Korean 2H-3H	First Year Korean Heritage	* Comparative Literature 170	Literary Translation: Theory and Practice
Korean 4-5-6	Second Year Korean	* Counseling, Clinical & School Psychology 101	The Introduction to Applied Psychology
Korean 4NH-5NH-6NH	Second Year Korean Heritage	* East Asian Cultural Studies 161B	Buddhist Meditation Traditions
Latin 2	Elementary Latin	* East Asian Cultural Studies 178	The Body Religious in Chinese Culture
Latin 3	Intermediate Latin	* Economics 113A-B	Economic History of the United States
Portuguese 2-3	Elementary Portuguese	* Economics 117A	Law and Economics
Portuguese 4-5-6	Intermediate Portuguese	@ Economics 119	United States Business History
Religious Studies 10B-C	Elementary Arabic	* Education 20	Introduction to the University Experience
Religious Studies 10D-E-F	Intermediate Arabic	* EEMB 124	Biochemical Ecology
Religious Studies 11B-C	Elementary Hindi	* EEMB 127	Plant Biology and Biodiversity
Religious Studies 11D-E-F	Intermediate Hindi	* EEMB 134	Biology of Seaweeds and Phytoplankton
Religious Studies 17B-C	Introduction to Biblical Hebrew	* EEMB 135	Evolutionary Ecology
Religious Studies 30B-C	Elementary Tibetan	* EEMB 138	Ethnology and Behavioral Ecology
Religious Studies 30D-E-F	Intermediate Tibetan	* EEMB 142BL	Chemical and Physical Methods of Aquatic Environments
Religious Studies 57B-C	Elementary Persian	* EEMB 142CL	Methods of Aquatic Biology
Religious Studies 57D-E-F	Intermediate Persian	* EEMB 147	Biology of Coral Reefs
Religious Studies 60B-C	Elementary Punjabi	* EEMB 149	Mariculture for the Twenty-first Century
Religious Studies 60D-E-F	Intermediate Punjabi	* EEMB 179	Modeling Environmental and Ecological Change
Religious Studies 122B-C	Syriac	* Engineering 101	Ethics in Engineering
Religious Studies 159B-C	Elementary Sanskrit	* Engineering 103	Advanced Engineering Writing
Slavic 2-3	Elementary Russian	* Environmental Studies 2	Introduction to Environmental Science
Slavic 4-5-6	Intermediate Russian	* Environmental Studies 20	Introduction to Shoreline and Watershed Issues, Policy and Research
Spanish 2-3	Elementary Spanish	* Environmental Studies 110	Disease and the Environment
Spanish 2SS-3SS	Intensive Elementary Spanish	* Environmental Studies 143	Endangered Species Management
Spanish 4-5-6	Intermediate Spanish	* Environmental Studies 146	Animals in Human Society: Ethical Issues of Animal Use
Spanish 4SS-5SS-6SS	Intensive Intermediate Spanish	* Environmental Studies 161	Environmental Journalism: A Survey

Special Subject Area Supplementary List of Courses

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

* Anthropology 116A	Myth, Ritual, and Symbol	* Environmental Studies 161	Environmental Journalism: A Survey
* Anthropology 116B	Anthropological Approaches to Religion	* Environmental Studies 173	American Environmental History
* Anthropology 142B	Contemporary Issues in South Asia	@ &* Feminist Studies 80 or 80H	Introduction to LGBTQ Studies
* Anthropology 143	Introduction to Contemporary Social Theory	&* Feminist Studies 142	Black Women Filmmakers
& Anthropology 148A	Comparative Ethnicity	* Feminist Studies 150	Sex, Love, and Romance
* Anthropology 170	Anthropological Approaches to Law	* Feminist Studies 154A	Sociology of the Family
* Anthropology 172	Colonialism and Culture	@ Feminist Studies 155A	Women in American Society
* Art History 186AA-ZZ	Seminar in Advanced Studies in Art History	* Feminist Studies 162	Critical LGBTQ Studies
& Asian American Studies 100CC	Filipino Americans	* Film Studies 101A-B-C	History of Cinema
& Asian American Studies 100DD	Korean Americans	* Film Studies 146	Advanced Film Analysis
& Asian American Studies 113	The Asian American Movement	* Film Studies 191	Film Criticism
&* Asian American Studies 121	Asian American Autobiographies and Biographies	* Geography 8	Living with Global Warming
&* Asian American Studies 122	Asian American Fiction	* Geography 148	California
& Asian American Studies 124	Asian American Literature in Comparative Frameworks	* Geography 180	Geography of the Information Society
&* Asian American Studies 128	Writings by Asian American Women	* Geology 4S or 4W	Introduction to Oceanography
* Asian American Studies 134	Asian American Men and Contemporary Men's Issues	* Geology 6	Mountains, Boots and Backpacks: Field Study of the High Sierra
& Asian American Studies 148	Introduction to Video Production	* Geology 10	Antarctica: The Last Place on Earth
& Asian American Studies 149	Screenwriting	* Geology 104A	Field Studies in Geological Methods
& Asian American Studies 170RR	Special Topics in Asian American Studies	* Geology 104B	Field Methods
* Black Studies 45	Black Arts Expressions	* Geology 117	Earth Surface Processes and Landforms
@ Black Studies 137E	Sociology of the Black Experience	* Geology 123	The Solar System
& Chicano Studies 139	Chicana/o Native American Heritage	* Geology 130	Global Warming - Science and Society
&* Chicano Studies 154F	The Chicano Family	* History 6	Historical Reasoning
& Chicano Studies 168E	History of the Chicano Movement	* History 56	Introduction to Mexican History
& Chicano Studies 168F	Racism in American History	* History 113A	Roman History
& Chicano Studies 171	The Brown/Black Metropolis: Race, Class, & Resistance in the City	* History 123A	Europe in the Nineteenth Century
@ Chicano Studies 188A-B	Chicano Theater	* History 123B	Europe in War and Revolution
& Chicano Studies 189	Immigration and the US Border	* History 123C	Europe Since Hitler
		* History 123F	Twentieth-Century Europe: History and Fiction
		* History 153	Comparative Seaborne Empires 1415 to 1825

* This course applies toward the writing requirement.
 & This course applies toward the ethnicity requirement.

@ This course applies toward the American History & Institutions requirement.
 ^ This course applies toward the European Traditions requirement.

* History 155A-B	History of Portugal	* Psychology 140	Social Influence
* History 155E	Portugal Overseas	* Psychology 143S	Seminar in Social Development
* History 156A	History of Mexico	* Religious Studies 22	Religious Narratives and Paintings of Japan
* History 156I	Indians of Mexico	* Religious Studies 106	Modernity and the Process of Secularization
* History 157A-B	History of Brazil	&* Religious Studies 110D	Ritual Art and Verbal Art of the Pacific Northwest
@& History 160A-B	The American South		Religion and Healing in Native America
@ History 164C	Civil War and Reconstruction	&* Religious Studies 114D	Shugendo: Japanese Mountain Religion
@&* History 164IA-IB	American Immigration	& Religious Studies 124	The History of Religions in Aztlan
@ History 164PR	Proseminar of the History of America's Racial Minorities	* Religious Studies 127B	Christian Thought and Cultures of the Middle Ages
@ History 165	America in the Gilded Age, 1876 to 1900		The History of Anti-Semitism
@ History 166A-B-C	United States in the Twentieth Century	&* Religious Studies 131F	Introduction to Rabbinic Literature
@ History 167A	Rise of the American Marketplace	* Religious Studies 131J	Islamic Traditions
& History 168E	History of the Chicano Movement	* Religious Studies 140A	Religion, Politics, and Society in the Persian Gulf Region
& History 168F	Racism in American History	* Religious Studies 140C	Islamic Mysticism and Religious Thought
&* History 168M	Middle Eastern Americans	& Religious Studies 140E	Islam in America
&* History 168N	Interracial Intimacy	* Religious Studies 141C	Sociology of Religion: Church and State Relations
@ History 169M	History of Afro-American Thought	* Religious Studies 145	Patterns in Comparative Religion
@ History 173A-B	American Intellectual History	* Religious Studies 161B	Buddhist Meditation Traditions
@ History 173S	American Popular Cultural History	* Religious Studies 163	Images of Japan: The Ideology of Representation
@ History 173T	American Environmental History		Religion in Chinese Culture
@ History 176A-B	The American West	* Religious Studies 166A	Taoist Traditions of China
@ History 177	History of California	* Religious Studies 166B	Confucian Traditions: The Classical Period
@ History 178A-B	American Urban History	* Religious Studies 166C	The Flowering of Chinese Buddhism
@&* History 179A	Native American History to 1838	* Religious Studies 166E	Religion in Japanese Culture
@& History 179B	Native American History, 1838 to Present	* Religious Studies 167A-B	Shinto
* Japanese 22	Religious Narratives and Paintings of Japan	* Religious Studies 167D	The Body Religious in Chinese Culture
* Japanese 119	Shugendo: Japanese Mountain Religion	* Religious Studies 178	History of Arabic Literature in Translation
* Japanese 167A-B	Religion in Japanese Culture	* Religious Studies 189A	Critical Readings in Medieval Arabic Literature in Translation
* Japanese 167D	Shinto	* Religious Studies 189B	Religion and Ecology of the Americas
* Latin American and Iberian Studies 10	Introduction to the Latin American and Iberian World		Interethnic Relations
* Latin American and Iberian Studies 100	Introduction to Latin American and Iberian Studies	&* Religious Studies 193	Development and its Alternatives
* Latin American and Iberian Studies 194RR	Special Topics in Latin American and Iberian Studies	* Sociology 128	Development and Social Change in Latin America
* Law and Society 120	Anthropological Approaches to Law	* Sociology 130	Development and Social Change in the Middle East
* Law and Society 124	Capitalism and Racism	* Sociology 130LA	The Sociology of Revolutions
* Linguistics 113	Introduction to Semantics		Radical Social Change
* Linguistics 114	Advanced Phonology		Sociology of the Black Experience
* Linguistics 131	Sociolinguistics	* Sociology 130ME	Black and White Relations
* Linguistics 137	Introduction to First Language Acquisition		Aging in American Society
* Linguistics 138	Language Socialization	* Sociology 134R	Sociology of the Family
* Materials 10	Materials in Society: The Stuff of Dreams	* Sociology 134RC	The Chicano Family
* MCDB 138	Medical Immunology	@&* Sociology 137E	Women in American Society
* MCDB 149	Mariculture for the 21st Century	& Sociology 139A	Contemporary U.S. Women's Movements
&* Military Science 12	Women and Minorities in the Military	@ Sociology 140	Chicanas and Mexican Women in Contemporary Society
* Music 12	Introduction to Music Literature	* Sociology 154A	Radicalism in Contemporary Life
* Music 112AB-C-D-E-F	History of Music	&* Sociology 154F	Sociology of Deviant Behavior
* Philosophy 7	Biomedical Ethics	@ Sociology 155A	Sociology of AIDS
* Physics 13AH	Honors Experimental Physics	&* Sociology 155M	Spanish in the United States: The Language and Its Speakers
* Physics 128AL-BL	Advanced Experimental Physics	& Sociology 155W	Introduction to Communication Disorders
* Political Science 6	Introduction to Comparative Politics		Asian American Theater
* Political Science 7	Introduction to International Relations	@ Sociology 157	Theory
@ * Political Science 127	American Foreign Policy	* Sociology 170	Tutoring Writing
* Political Science 129	The United States, Europe, and Asia in the Twenty-First Century	* Sociology 176A	Writing Creative Nonfiction
@ Political Science 152	American Political Parties	& Spanish 109	Applying Business Communication Concepts Through Internships
@ Political Science 153	Political Interest Groups		Magazine Writing for Publication
@ Political Science 157	The American Presidency	* Speech & Hearing Sciences 50	Writing in New Media
@ Political Science 158	Power in Washington	& Theater 180F	Rhetoric and Writing
@ Political Science 162	Urban Government and Politics	* Theater 185TH	Advanced Legal Writing
@ Political Science 165	Criminal Justice	* Writing 60	Professional Communications in Marketing and Public Relations
@ Political Science 167	Constitutional Law: The Bill of Rights	* Writing 105CN	
@ Political Science 168	Constitutional Law: Civil Rights	* Writing 105IN	
@ Political Science 176	Black Politics in America		
@ Political Science 180	Bureaucracy and Public Policy	* Writing 105MW	
@ * Political Science 185	Government and the Economy	* Writing 105NM	
* Psychology 90A-B-C	First-Level Honors Seminar	* Writing 105RW	
* Psychology 110L	Laboratory in Perception	* Writing 110L	
* Psychology 111L	Laboratory in Biopsychology	* Writing 110MK	
* Psychology 112L	Laboratory in Social Behavior		
* Psychology 114L	Laboratory in Personality		
* Psychology 116L	Laboratory in Animal Learning		
* Psychology 117L	Laboratory in Human Memory and Cognition		
* Psychology 118L	Laboratory in Attention		
* Psychology 120L	Advanced Research Laboratory		
* Psychology 135A-B-C	Field Experience in Psychological Settings		

* This course applies toward the writing requirement.

& This course applies toward the ethnicity requirement.

@ This course applies toward the American History & Institutions requirement.

^ This course applies toward the European Traditions requirement.

CHECKLIST OF GENERAL UNIVERSITY AND GENERAL EDUCATION REQUIREMENTS

GENERAL UNIVERSITY REQUIREMENTS

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

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

American History and Institutions* – (Refer to page 10 for the list of acceptable courses.)

One course _____ or Advanced Placement _____ or International waiver _____

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

GENERAL EDUCATION REQUIREMENTS

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

General Subject Areas

1. Area A: English Reading and Composition

Writing 2 or 2E _____ and Writing 50, 50E or 109ST _____

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

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

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

Special Subject Areas

In the process of fulfilling the G.E. General Subject Area requirements, students must fulfill the following Special Subject Area requirements, as outlined on page 9. **Only approved courses can be used to fulfill these requirements.**

a. Writing Requirement

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

b. Depth Requirement – Choose one of the following options:

Option 1: At least two upper division courses from two separate departments, in each of which a course has already been completed. (**Only courses from Areas D, E, F, G or H may be used towards this requirement.**)

Course 1 (Lower or Upper Division) Course 2 (Upper Division)

Department 1 _____

Department 2 _____

Option 2: Complete a Three Course Sequence from the list on page 9.

c. Ethnicity Requirement – (1 course) _____

d. European Traditions Requirement – (1 course) _____

Chemical Engineering

Department of Chemical Engineering,
Engineering II, Room 3357;
Telephone (805) 893-3412
Web site: www.chemengr.ucsb.edu

Chair: *Michael Doherty*
Vice-Chair: *Susannah Scott*

Faculty

Bradley Chmelka, Ph.D., UC Berkeley, Professor (self-assembled materials, heterogeneous catalysis, surfactants and polymers, porous and composite solids, magnetic resonance)

Patrick S. Daugherty, Ph.D., University of Texas at Austin, Associate Professor (protein engineering and design, combinational molecular biology, gene targeting, viral vector engineering)

Michael F. Doherty, Ph.D., Cambridge University, Professor (process design and synthesis, separations, crystal engineering)

Francis J. Doyle III, Ph.D., California Institute of Technology, Mellichamp Professor of Process Control (process control, systems biology, nonlinear dynamics)

Glenn Fredrickson, Ph.D., Stanford University, Professor (polymer theory, block copolymers, phase transitions, statistical mechanics, glass transitions, composite media)

Michael J. Gordon, Ph.D., California Institute of Technology, Assistant Professor (surface physics, scanning probe microscopy, nanoscale materials, plasmonics, laser spectroscopy)

Jacob Israelachvili, Ph.D., University of Cambridge, Professor (surface and interfacial phenomena, adhesion, colloidal systems, surface forces, bio-adhesion, friction) *1

Edward J. Kramer, Ph.D., Carnegie Mellon University, Professor (microscopic fundamentals of fracture polymers, diffusion in polymers, and polymer surfaces, interfaces and thin films) *1

L. Gary Leal, Ph.D., Stanford University, Schlinger Distinguished Professor in Chemical Engineering (fluid mechanics, physics of complex fluids, rheology)

Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor (structural materials, mechanical properties) *2

Eric McFarland, Ph.D., Massachusetts Institute of Technology, M.D., Harvard, Professor (energy production, catalysis, reaction engineering, charge and energy transfer)

Samir Mitragotri, Ph.D., Massachusetts Institute of Technology, Professor (drug delivery and diagnostics, bio-membrane transport, membrane biophysics, biomedical ultrasound)

Baron G. Peters, Ph.D., UC Berkeley, Assistant Professor (molecular simulation, chemical kinetics, catalytic reaction mechanisms, nucleation, electron transfer)

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

M. Scott Shell, Ph.D. Princeton, Assistant Professor (molecular simulation, statistical mechanics, complex materials, protein biophysics)

Todd M. Squires, Ph.D., Harvard, Associate Professor (fluid mechanics, microfluidics, microrheology, complex fluids)

Theofanis G. Theofanous, Ph.D., University of Minnesota, Professor, Center for Risk Studies and Safety Director (transport phenomena in multiphase systems, risk analysis) *2

Joseph Zasadzinski, Ph.D., University of Minnesota, Professor (surface and interfacial phenomena, high resolution microscopy, biomaterials)

*1 Joint appointment with Materials.

*2 Joint appointment with Mechanical Engineering.

*3 Joint appointment with Chemistry and Biochemistry.

Emeriti Faculty

Sanjoy Banerjee, Ph.D., University of Waterloo, Professor Emeritus (transport processes, multiphase systems, process safety) *2

Owen T. Hanna, Ph.D., Purdue University, Professor Emeritus (theoretical methods)

Duncan A. Mellichamp, Ph.D., Purdue University, Professor Emeritus (process dynamics and control, digital computer control)

Robert G. Rinker, Ph.D., California Institute of Technology, Professor Emeritus (chemical kinetics, reaction engineering, catalysis)

Orville C. Sandall, Ph.D., UC Berkeley, Professor Emeritus (transport of mass, energy, and momentum; separation processes)

Dale E. Seborg, Ph.D., Princeton University, Professor Emeritus (process dynamics and control, monitoring and fault detection, system identification)

Affiliated Faculty

Song-I Han, Ph.D. (Chemistry)

G. Robert Odette, Ph.D. (Materials, Mechanical Engineering)

Philip Alan Pincus, Ph.D. (Materials)

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

The Department of Chemical Engineering offers the B.S., M.S., and Ph.D. degrees in chemical engineering. The B.S. degree is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD, 21202-4012 – telephone: (410) 347-7700.

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

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

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

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

Mission Statement

The program in Chemical Engineering has a dual mission:

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

Educational Objectives for the Undergraduate Program

- We expect our graduates to become innovative, competent, contributing engineers in the process industries.
- We expect our graduates to demonstrate their flexibility and adaptability in the workplace, so that they remain effective engineers, take on new responsibilities, and assume leadership roles.
- We expect at least an average of 15% of our graduates to continue their education by obtaining advanced degrees.

Program Outcomes

Upon graduation, graduates of the Chemical Engineering program at UCSB are expected to have:

1. Fundamentals – the fundamental knowledge of mathematics, computing, science, and engineering needed to practice chemical engineering and the ability to apply this knowledge to identify, formulate, and solve chemical engineering problem;
2. Laboratory – the ability to design and conduct experiments and to analyze and interpret data;
3. Design – the ability to design a system, component, or process to meet desired specifications; ability to use modern engineering tools necessary for engineering practice;
4. Advanced Training – beyond the basic fundamentals in at least one area of chemical engineering as preparation for a continuing process of lifelong learning;
5. Teamwork/Communication – the ability to function productively in multidisciplinary teams working towards common goals; the ability to communicate effectively through written reports and oral presentations;
6. Engineering & Society – the broad education necessary to understand the impact of engineering solutions in a global/societal context; a knowledge of contemporary issues; an understanding of professional and ethical responsibility; a recognition of the need for and the ability to engage in lifelong learning.

Undergraduate Program

Bachelor of Science—Chemical Engineering

A minimum of 194 units is required for graduation. A complete list of requirements for the major can be found on page 42. Schedules should be planned to meet both General Education and major requirements. Courses required for the major, inside or outside of the Department of Chemical Engineering, cannot be taken for the pass/not pass grading option. They must be taken for letter grades.

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

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

Chemical Engineering Courses

LOWER DIVISION

1A. Engineering and the Scientific Method (1) STAFF

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

10. Introduction to Chemical Engineering (3) DAUGHERTY, GORDON

Prerequisites: Chemistry 1A-B-C of 2A-B-C; Mathematics 3A-B-C; and, Engineering 3. Chemical Engineering majors only.

Elementary principles of chemical engineering. The major topics discussed include material and energy balances, stoichiometry, and thermodynamics.

55. Chem-E-Car Activity (1) STAFF

Prerequisite: Chem 1C and 1CL.

Students apply chemistry and engineering knowledge to design a model-scale, chemically powered car with chemically actuated brakes. The cars represent UCSB at American Institute of Chemical Engineering meetings. Grading is based on participation, design creativity, and car performance.

99. Introduction to Research (1-3) STAFF

Prerequisites: consent of instructor and undergraduate advisor.

May be repeated for credit to a maximum of 6 units. Students are limited to 5 units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined.

Directed study, normally experimental, to be arranged with individual faculty members. Course offers exceptional students an opportunity to participate in a research group.

UPPER DIVISION

102. Biomaterials and Biosurfaces (3) ISRAELACHVILI

Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology.

Not open for credit to students who have completed Chemical Engineering 121.

Fundamentals of natural and artificial biomaterials and biosurfaces with emphasis on molecular level structure and function and the interactions of biomaterials and surfaces with the body. Design issues of grafts and biopolymers. Basic biological and biochemical systems reviewed for nonbiologists.

110A. Chemical Engineering Thermodynamics (3) SHELL

Prerequisite: Chemical Engineering 10; Mathematics 5A; Engineering majors only.

Use of the laws of thermodynamics to analyze processes encountered in engineering practice, including cycles and flows. Equations-of-state for describing properties of fluids and mixtures. Applications, including engines, turbines, refrigeration and power plant cycles, phase equilibria, and chemical-reaction equilibria.

110B. Chemical Engineering Thermodynamics (3) STAFF

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

Extension of Chemical Engineering 110A to cover mixtures and multiphase equilibrium. Liquid-

vapor separations calculations are emphasized. Introduction to equations of state for mixtures.

119. Current Events in Chemical Engineering (1) STAFF

Prerequisites: Chemical Engineering 110A-B.

Assigned readings in technical journals on current events of interest to chemical engineers. Student groups present oral reports on reading assignments pertaining to new technologies, discoveries, industry challenges, society/government issues, professional and ethical responsibilities.

120A. Transport Processes (4) SQUIRES, MITAGOTRI

Prerequisites: Mathematics 5A-B-C.

Introductory course in conceptual understanding and mathematical analysis of problems in fluid dynamics of relevance to Chemical Engineering. Emphasis is placed on performing microscopic and macroscopic mathematical analysis to understand fluid motion in response to forces.

120B. Transport Processes (3) STAFF

Prerequisite: Chemical Engineering 120A; Mathematics 5A-B-C and Physics 4.

Introductory course in the mathematical analysis of conductive, convective and radioactive heat transfer with practical applications to design of heat exchange equipment and use.

120C. Transport Processes (3) PETERS

Prerequisite: Chemical Engineering 120B, Mathematics 5A-B-C and Physics 4.

Introductory course in the fundamentals of mass transfer with applications to the design of mass transfer equipment.

121. Colloids and Biosurfaces (3) ISRAELACHVILI

Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology.

Not open for credit to students who have completed Chemical Engineering 102.

Basic forces and interactions between atoms, molecules, small particles and extended surfaces. Special features and interactions associated with (soft) biological molecules, biomaterials and surfaces: lipids, proteins, fibrous molecules (DNA), biological membranes, hydrophobic and hydrophilic interactions, bio-specific and non-equilibrium interactions.

124. Advanced Topics in Transport Phenomena/Safety (3) THEOFANOUS

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

Same course as ME 124.

Hazard identification and assessments, runaway reactions, emergency relief. Plant accidents and safety issues. Dispersion and consequences of releases.

125. Principles of Bioengineering (3) MITRAGOTRI

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

128. Separation Processes (3) SCOTT

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

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

132A. Analytical Methods in Chemical Engineering (4) FREDRICKSON, GORDON

Prerequisites: Mathematics 5A-B.

Develop analytical tools to solve elementary partial differential equations and boundary value problems. Separation of variables, method of

characteristics, Sturm-Liouville theory, generalized Fourier analysis, and computer math tools.

132B. Computational Methods in Chemical Engineering

(3) FREDRICKSON

Prerequisite: Mathematics 5A-B-C.

Numerical methods for solution of linear and nonlinear algebraic equations, optimization, interpolation, numerical integration and differentiation, initial-value problems in ordinary and partial differential equations, and boundary-value problems. Emphasis on computational tools for chemical engineering applications.

132C. Statistical Methods in Chemical Engineering

(3) PETERS

Prerequisites: Mathematics 5A-B-C.

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.

136. Introduction to Multiphase Flows

(3) THEOFANOUS

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

Same course as ME 136.

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

138. Risk Assessment and Management

(3) THEOFANOUS

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

Same course as ME 138.

Conceptual foundations of risk and its utility for decision making. Determinism, statistical inference, and uncertainty. Formulation of safety goals and approaches to risk management. Generalized methodology and tools for assessing risks in the industrial, ecological, and public health context.

140A. Chemical Reaction Engineering

(3) MCFARLAND, SCOTT

Prerequisites: Chemical Engineering 110A and 120A-B.

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

140B. Chemical Reaction Engineering

(3) CHMELKA, MCFARLAND

Prerequisites: Chemical Engineering 110A, 120A-B and 140A.

Thermodynamics, kinetics, mass and energy transport considerations associated with complex homogeneous and heterogeneous reacting systems. Catalysts and catalytic reaction rates and mechanisms. Adsorption and reaction at solid surfaces, including effects of diffusion in porous materials. Chemical reactors using heterogeneous catalysts.

141. The Science and Engineering of Energy Conversion

(3) MCFARLAND

Prerequisite: Chemical Engineering 110A and 140A.

Equivalent upper-division coursework in thermodynamics and kinetics from outside of department will be considered.

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

152A. Process Dynamics and Control

(4) DOYLE

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

Development of theoretical and empirical models for chemical and physical processes, dynamic behavior of processes, transfer function and block diagram representation, process instrumentation, control system design and analysis, stability analysis, computer simulation of controlled processes.

152B. Advanced Process Control

(3) DOYLE

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) DOYLE

Prerequisite: Chemical Engineering 170 and Mathematics 5A-B-C.

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

160. Introduction to Polymer Science

(3) KRAMER

Prerequisite: Chemistry 109A-B.

Same course as Materials 160.

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

170. Molecular and Cellular Biology for Engineers

(3) SHELL

Prerequisite: Chemical Engineering 120A-B-C, 140A and Chemistry 109C. Not open for credit to students who have completed Ch E 172.

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

171. Introduction to Biochemical Engineering

(3) DAUGHERTY

Prerequisite: Chemical Engineering 170.

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

180A. Chemical Engineering Laboratory

(3) STAFF

Prerequisites: Chemical Engineering 110A and 120A-B.

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

180B. Chemical Engineering Laboratory

(3) STAFF

Prerequisites: Chemical Engineering 120C, 128, 140A, and 152A.

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

184A. Design of Chemical Processes

(3) DOHERTY

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

Application of chemical engineering principles to plant design. Conceptual design of chemical processes. Flowsheeting methods. Engineering cost principles and economic aspects.

184B. Design of Chemical Processes

(3) DOHERTY

Prerequisites: Chemical Engineering 184A.

The solution to comprehensive plant design problems. Use of computer process simulators. Optimization of plant design, investment and operations.

194. Group Studies for Advanced Students

(1-4) STAFF

Prerequisites: consent of instructor. Limited to majors in the College of Engineering.

Check with department for quarters offered.

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

196. Undergraduate Research

(2-4) STAFF

Prerequisite: Upper-division standing, completion of 2 upper-division courses in Chemical Engineering; consent of the instructor.

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

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

198. Independent Studies in Chemical Engineering

(1-5) STAFF

Prerequisites: consent of instructor; upper-division standing; completion of two upper-division courses in chemical engineering.

Must have a minimum 3.0 grade-point-average for the preceding three quarters. May be repeated up to twelve units. Students are limited to five units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined.

Directed individual studies.

GRADUATE COURSES

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



Computer Engineering

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

Director: Frederic T. Chong
Vice Director: Patrick Yue

Faculty

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

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

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

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

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, Professor (design automation, VLSI testing, design synthesis, design verification, algorithms)

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

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

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

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

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

Behrooz Parhami, Ph.D., UC Los Angeles,

Professor (parallel architectures and algorithms, computer arithmetic, computer design, dependable and fault-tolerant computing)

Volkan Rodoplu, Ph.D., Stanford University, Associate Professor (wireless networks, energy-efficient and device-adaptive communications)

Tim Sherwood, Ph.D., UC San Diego, Associate 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, Assistant 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)

Patrick Yue, Ph.D., Stanford University, Professor (high-speed CMOS IC design, cell-based RF CAD methodology and integrated biomedical sensors)

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

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

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

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

The Computer Engineering program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700.

Mission Statement

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

Educational Objectives

The Computer Engineering Program seeks to produce graduates who:

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

Program Outcomes

Upon completion of this program, students will have:

- 1) Acquired strong basic knowledge and skills in those fundamental areas of mathematics, science, and engineering necessary to facilitate specialized professional training at an advanced level. Developed a recognition of the need for and the ability to engage in lifelong learning.
- 2) Experienced in-depth training in state-of-the-art specialty areas in computer engineering.
- 3) Benefited from hands-on, practical laboratory experiences where appropriate throughout the program. The laboratory experiences will be closely integrated with coursework and will make use of up-to-date instrumentation and computing facilities. Students will have completed both hardware-oriented and software-oriented assignments.
- 4) Experienced design-oriented challenges that exercise and integrate skills and knowledge acquired during their course of study. These challenges may include design of components or subsystems with performance specifications. Gradu-

ates 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.

Admission to the Major

Requirements for Advancing to the Computer Engineering Major from the Pre-Major

Students intending to major in computer engineering should declare the pre-major when applying for admission to the university. It is strongly recommended that incoming freshmen with no prior programming experience take Computer Science 8 before taking Computer Science 16.

Students may petition to advance from the computer engineering pre-major to the computer engineering major when they have met either of the following requirements:

Option A: Satisfactory completion at UCSB of at least six core classes required as preparation for the computer engineering major with a grade-point-average of at least 3.0. The core classes are: Mathematics 3A, 3B, 3C, 5A; Computer Science 16, 24, 32, 40; Electrical and Computer Engineering 2A, 2B, 2C, 15A, 15B. If the student has not attained the minimum 3.0 grade-point-average with the first six core classes completed, all core classes subsequently completed will be included in the grade-point-average computation.

Option B: Satisfactory completion of all thirteen core classes with a University of California grade-point-average of at least 2.75.

Undergraduate Program

Bachelor of Science—Computer Engineering

A minimum of 189 units is required for graduation. A complete list of requirements for the major can be found on page 44. Schedules should be planned to meet both General Education and major requirements.

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

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

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

The upper-division requirements consist of a set of required courses and a minimum of 40 units (10 classes) of additional departmental elective courses comprised of at least two sequences chosen from a set of eight specialty sequences. Each sequence must consist of two or more courses taken from the same course/sequence group. The department electives must also include a capstone design project (CMPSC 189A-B/ECE 189A-B). Upper-division courses required for the major are: Computer Science 130A, 170; ECE 152A-B, 154, either ECE 139 or PSTAT 120A; Engineering 101.

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

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

- Computer-Aided Design (CAD): ECE 156A-B
- Computer Systems Design: ECE/CMPSC 153A, ECE 153B
- Computer Networks: ECE 155A/CMPSC 176A, ECE 155B/CMPSC 176B
- Distributed Systems: ECE 151/CMPSC 171 and one or both of the Computer Networks courses
- Programming Languages: CMPSC 160, 162
- Real-Time Computing & Control: ECE 147A-B, 157
- Multimedia: ECE 178, ECE/CMPSC 181B, ECE 160/CMPSC 182
- VLSI: ECE 124A, 124D
- Signal Processing: ECE 130A-B

Satisfactory Progress and Prerequisites

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

Computer Engineering Courses

See listings for Computer Science starting on page 26 and Electrical and Computer Engineering starting on page 30.



Computer Science

Department of Computer Science,
Harold Frank Hall, Room 2104;
Telephone (805) 893-4321
Web site: www.cs.ucsb.edu

Chair: *Amr El Abbadi*
Vice Chair: *Elizabeth Belding*

Faculty

Divyakant Agrawal, Ph.D., State University of New York at Stony Brook, 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)

Elizabeth Belding, Ph.D., University of California, Santa Barbara, Professor (mobile wireless networking, deployment and monitoring, network adaptability, wireless networks for developing regions)

Tevfik Bultan, Ph.D., University of Maryland, College Park, Professor (model checking, concurrency, web services, static analysis, software engineering)

Peter R. Cappello, Ph.D., Princeton University, Professor (Java-centric cluster and multithread computing, parallel processing, multiprocessor scheduling, market-based resource allocation)

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

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

C. Michael Costanzo, Ph.D., University of California, Santa Barbara, Lecturer

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, Professor (information systems, databases, fault-tolerant distributed systems)

Diana Franklin, Ph.D., University of California, Davis, Lecturer SOE (computer architecture, embedded systems, architectural support for reliability, undergraduate teaching methods for diverse populations)

Frederic Gibou, Ph.D., University of California, Los Angeles, Associate Professor (computational mathematics, modeling and simulations - materials science, multiphase flows; level-set methods, ghost-fluid methods, and interface problems; and image segmentation with applications to radiotherapy treatment planning and civil engineering)*²

John R. Gilbert, Ph.D., Stanford University, Professor (combinatorial scientific computing, tools and software for computational science and engineering, numerical linear algebra, smart matter and systemic MEMS, distributed sensing and control)

Teofilo Gonzalez, Ph.D., University of Minnesota, Professor (multimessage multicasting, VLSI placement and routing algorithms, scheduling theory; design and analysis of algorithms)

Ben Hardekopf, Ph.D., University of Texas at Austin, Assistant Professor (programming Languages and systems)

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

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, secure mobile computing)

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

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

Linda R. Petzold, Ph.D., University of Illinois at Urbana-Champaign, Professor (computational science and engineering, multiscale numerical simulation, systems biology)*²

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

Ambuj Singh, Ph.D., University of Texas at Austin, Professor (bioinformatics, databases, parallel and distributed systems)*³

Jianwen Su, Ph.D., University of Southern California, Professor (database systems and applications, web services)

Subhash Suri, Ph.D., Johns Hopkins University, Professor (algorithms, internet computing, computational geometry)

Matthew Turk, Ph.D., Massachusetts Institute of Technology, Professor (computer vision, human computer interaction, perceptual user interfaces, imaging systems)

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

Giovanni Vigna, Ph.D., Politecnico di Milano, Professor (computer and network security, network models and protocols, mobile code languages and systems, mobile agent security)

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

Richard Wolski, Ph.D., University of California, Davis/Livermore, Professor (distributed systems, computational grid computing, on-line performance forecasting)

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

Tao Yang, Ph.D., Rutgers University, Professor (parallel and distributed systems, high performance scientific computing, cluster-based network services, Internet search)

Ben Zhao, Ph.D., University of California, Berkeley, Associate Professor (large-scale distributed systems, security and privacy, overlay and peer-to-peer networks, mobile and wireless networks)

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

Emeriti Faculty

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

Marvin Marcus, Ph.D., University of California, Berkeley, Professor Emeritus (linear and multilinear algebra, scientific computation, numerical algorithms)

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

Roger C. Wood, Ph.D., University of California, Los Angeles, Professor Emeritus (computer system modeling, design and analysis, computer architecture)*⁶

*¹ Joint appointment with College of Creative Studies.

*² Joint appointment with Mechanical Engineering.

*³ Joint appointment with Biomolecular Science & Engineering.

*⁴ Joint appointment with Geography.

*⁵ Joint appointment with Physics.

*⁶ Joint appointment with Electrical & Computer Engineering

Affiliated Faculty

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

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

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

Martin Raubal, Ph.D. (Geography)

The Department of Computer Science offers programs leading to the degrees of bachelor of arts and bachelor of science in computer science, and the M.S. and Ph.D. in computer science. The B.A. is a College of Letters and Science major; the B.S. is a College of Engineering major. The B.S. degree program in computer science is accredited by the Computing Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 -telephone: (410) 347-7700.

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

Additional computing facilities are available for graduate students in the Graduate Student Laboratory. Students working with faculty have access to the specialized research facilities within the Department of Computer Science.

The undergraduate major in computer science has a dual purpose: to prepare students for advanced studies and research and to provide training for a variety of careers in business, industry, and government.

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

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.

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. Baccalaureate graduates, ready for immediate employment, are trainable for most computer science positions in government and a wide range of industries. Outstanding graduates interested in highly technical careers, research, and/or academia, should be prepared to further their education in graduate school.

The primary computer science departmental emphasis is on 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:

- a. An ability to apply knowledge of computing and mathematics appropriate to computer science.
- b. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.
- c. An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.
- d. An ability to function effectively on teams to accomplish a common goal.
- e. An understanding of professional, ethical, and social responsibilities.
- f. An ability to communicate effectively.
- g. An ability to analyze the impact of computing on individuals, organizations, and society, including ethical, legal, security, and global policy issue.
- h. Recognition of the need for and an ability to engage in continuing professional development.
- i. An ability to use current techniques, skills, and tools necessary for computing practice.
- j. 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.
- k. An ability to apply design and development principles in the construction of software systems of varying complexity.

Admission to the Major

Students intending to major in computer science should declare a computer science pre-major when applying for admission to the university.

Computer Science majors and pre-majors have priority when registering in all Computer Science courses. Students who declare the computer science pre-major or major are responsible for satisfying major requirements in effect at the time of their declaration. When students have completed the required pre-major courses, they must petition to change from pre-major to major status. Students cannot be accepted into the computer science major unless they have successfully completed the computer science preparation for the major courses.

Courses required for the pre-major or major, lower- or upper-division, inside or outside of the Department of Computer Science, must be taken for letter grades.

Undergraduate Program

Bachelor of Science— Computer Science

A minimum of 184 units is required for graduation. A complete list of requirements for the major can be found on page 46. Schedules should be planned to meet both General Education and major requirements.

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

Students applying for major status in the BS program who have completed more than 105 units will **not** be considered for a change of major/change of college unless they can demonstrate that they will be able to complete all of the degree requirements for the proposed program without exceeding 215 units.

Students may petition to enter the computer science pre-major at any time **Option A** below has been met, or they may petition to enter the full major when **Option B** has been met.

Option A: Satisfactory completion at UCSB of at least four 4-unit courses required for the computer science preparation for the major, including at least two computer science courses, with a University of California grade point average of at least 3.0 in all the preparation for the major courses taken.

Option B: Satisfactory completion of all the preparation for the major requirements with a University of California grade point average of at least 2.75.

Please note: Pre-major status does not guarantee admission to major status. To be admitted to the major, the student must complete the pre-major courses with a minimum grade point average of 2.75. All courses required for the preparation for the major must be taken for a letter grade. No exceptions will be made to the minimum 2.75 GPA rule.

At least 20 units of major field electives are required. Prior approval of these electives must be obtained from the faculty advisor. Lists of approved major field electives and science electives are available in the computer science office and on the web at: www.cs.ucsb.edu/undergraduate

Bachelor of Arts— Computer Science

The College of Letters and Science offers a bachelor of arts degree in computer science, with emphases in computational biology, computational economics, and computational geography. For information about this major, refer to the College of Letters and Science section of the *UCSB General Catalog*.

Computer Science Courses

LOWER DIVISION

1. Seminar on the Field of Computer Science

(1) FRANKLIN

Overviews the potential of, and opportunities available from, the field of computer science. Topics include an overview of how computers work and the interesting ways in which computers can be applied to solve important and high-impact technological, social, and cutting-edge research problems.

8. Introduction to Computer Science

(4) CONRAD, FRANKLIN

Not open for credit to students who have completed Computer Science 5, Computer Science 10, Computer Science 16, or Engineering 3.

Introduction to computer program development for students with little to no programming experience. Basic programming concepts, variables and expressions, data and control structures, algorithms, debugging, program design, and documentation.

11AA-ZZ. Programming Language Laboratory

(1) FRANKLIN

Different sections may be repeated. Sections not always offered.

Recommended preparation: knowledge of at least one programming language.

A self-paced course to allow a student who already possesses a working knowledge of at least one programming language an opportunity to learn other languages of interest.

16. Problem Solving with Computers I

(4) CONRAD, KRINTZ

Prerequisite: Math 3A

Recommended Preparation: Students with no experience with computer programming are encouraged to take Computer Science 5 or 8 before Computer Science 16.

Not open for credit to students who have completed Computer Science 10.

Fundamental building blocks for solving problems using computers. Topics include basic computer organization and programming constructs: memory CPU, binary arithmetic, variables, expressions, statements, conditionals, iteration, functions, parameters, recursion, primitive and composite data types, and basic operating system and debugging tool.

24. Problem Solving with Computers II

(4) FRANKLIN, COSTANZO

Prerequisite: Computer Science 16 or Engineering 3; and Mathematics 3B.

Not open for credit to students who have completed Computer Science 12 or 20.

Repeat Comments: Course counts as legal repeat of Computer Science 12.

Intermediate building blocks for solving problems using computers. Topics include data structures, object-oriented design and development, algorithms for manipulating these data structures and their runtime analyses. Data structures introduced include stacks, queues, lists, trees, and sets.

32. Object Oriented Design and Implementation

(4) HOLLERER

Prerequisite: Computer Science 24

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

Repeat Comments: Computer Science 32 is a legal repeat for Computer Science 60

Advanced topics in object-oriented computing. Topics include encapsulation, data hiding, inheritance, polymorphism, compilation, linking and loading, memory management, and debugging; recent advances in design and development tools, practices, libraries, and operating system support.

40. Foundations of Computer Science

(4) VAN DAM, SU

Prerequisites: Computer Science 10 or 12; and Mathematics 3C.

Propositional predicate logic, set theory, functions and relations, counting, mathematical induction and recursion (generating functions).

48. Computer Science Project

(4) CAPPELLO

Prerequisite: Computer Science 32

Team-based project development. Topics include software engineering and professional development practices, interface design, advanced library support; techniques for team-oriented design and development, testing and test-driven development, and software reliability and robustness. Students present and demonstrate their final projects.

56. Advanced Applications Programming

(4) CONRAD

Prerequisites: Computer Science 24.

Recommended Preparation: Students are encouraged to complete Computer Science 32 prior to enrolling in Computer Science 56.

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

Advanced application programming using a highlevel, virtual-machine-based language. Topics include generic programming, exception handling, programming language implementation; automatic memory management, and application development, management, and maintenance tools; event handling, concurrency and threading, and advanced library use.

64. Computer Organization and Logic Design

(4) ZHENG, FRANKLIN

Prerequisite: Engineering 3 or Computer Science 8 or Computer Science 16; and Mathematics 3C.

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

Repeat Comments: Course counts as a legal repeat of CMPS 30.

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

95AA-ZZ. Undergraduate Seminar in Computer Science

(1-4) STAFF

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

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

UPPER DIVISION

111. Introduction to Computational Science

(4) PETZOLD

Prerequisites: Mathematics 5B; and, Computer Science 12 or 60.

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.

123. Overview of Computer Systems: Hardware and Software

(4) EL ABBADI

Prerequisites: Computer Science 20 and 60.

Not open for credit to students who have completed Computer Science 30 or Computer Science 170.

Basic computer architecture: CPU, memory, I/O. Basic operating systems concepts: processes, synchronization, memory management, virtual memory, file systems.

130A. Data Structures and Algorithms I

(4) GONZALEZ, SURI

Prerequisites: Computer Science 20, 40 and 60; PSTAT 120 or ECE 139; open to computer science, computer engineering, and electrical engineering majors only.

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

130B. Data Structures and Algorithms II

(4) GONZALEZ, SURI

Prerequisite: Computer Science 130A.

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

138. Automata and Formal Languages

(4) EGECIOGLU

Prerequisite: Computer Science 40; open to computer science and computer engineering majors only.

Not open for credit to students who have completed Computer Science 136.

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

140. Parallel Scientific Computing

(4) GILBERT

Prerequisites: Mathematics 5B and Computer Science 20; and, Computer Science 12 or 60.

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

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

153A. Hardware/Software Interface

(4) KRINTZ

Prerequisite: Computer Science 130A with a minimum grade of C-.

Same course as ECE 153A.

The study of the structures employed at the interface of hardware and software in modern computing systems. Instruction set architecture (ISA) design trade-offs, operating system and hardware support for input/output devices (memory-mapping, interrupts, device drivers). Operating system and real-time system scheduling of tasks. Low level software and program support infrastructures (virtualization, compilation, optimization, emulation/simulation, debugging).

154. Computer Architecture

(4) SHERWOOD, CHONG

Prerequisite: ECE 152A.

Not open for credit to students who have received credit for ECE 154.

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

160. Translation of Programming Languages

(4) SHERWOOD, BULTAN

Prerequisites: Computer Science 30 or 123; Computer Science 130A; and Computer Science 136 or 138; open to computer science and computer engineering majors only.

Study of the structure of compilers. Topics include: lexical analysis; syntax analysis including LL and LR parsers; type checking; run-time

environments; intermediate code generation; and compiler-construction tools.

162. Programming Languages

(4) HARDEKOPF, KRINTZ

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

Concepts of programming languages: scopes, parameter passing, storage management; control flow, exception handling; encapsulation and modularization mechanism; reusability through genericity and inheritance; type systems; procedural, object-oriented, functional, and logic programming languages.

165A. Artificial Intelligence

(4) TURK

Prerequisite: Computer Science 130A

Introduction to the field of artificial intelligence which attempts to understand and build intelligent systems. Topics include AI programming languages, search, knowledge representation and reasoning, planning, perception, and intelligent agents.

165B. Machine Learning

(4) SINGH

Prerequisite: Computer Science 130A.

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

167. Introduction to Bioinformatics

(4) SINGH

Prerequisite: Computer Science 130B.

Not open to students who have completed Computer Science 190

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

170. Operating Systems

(4) KRUEGEL, ZHAO

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 170.

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

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

172. Software Engineering

(4) BULTAN

Prerequisites: Computer Science 130A; open to computer science majors only.

Not open for credit to students who have completed Computer Science 189A.

Recommended preparation: Computer Science 130B.

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

174A. Fundamentals of Database Systems

(4) SU

Prerequisite: Computer Science 130A.

Database system architectures, relational data model, relational algebra, relational calculus, SQL,

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

174B. Design and Implementation Techniques of Database Systems

(4) SU, YAN

Prerequisite: Computer Science 130B.

Queries and processing, optimizer, cost models, execution plans, rewriting rules, access methods, spatial indexing, transactions, ACID properties, concurrency control, serializability, two-phase locking, timestamping, logging, checkpointing, transaction abort and commit, crash recovery; distributed databases.

176A. Introduction to Computer Communication Networks

(4) ALMEROOTH, BELDING

Prerequisites: PSTAT 120A or ECE 139; open to computer science, computer engineering, and electrical engineering majors only.

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

Recommended preparation: PSTAT 120B.

Basic concepts in networking, the OSI model, error detection codes, flow control, routing, medium access control, and high-speed networks.

176B. Network Computing

(4) ZHAO, VIGNA

Prerequisite: Computer Science 176A.

Not open for credit to students who have completed ECE 155B or 194W.

Focus on networking technologies used in the Internet. The OSI model is used as a guide for exploring and understanding how the Internet works. Topics include snooping packets in the network, socket programming, and implementing application-layer protocols.

176C. Advanced Topics in Internet Computing

(4) BELDING, ZHENG

Prerequisite: Computer Science 176B.

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

177. Computer Security

(4) KEMMERER

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

Introduction to the basics of computer security and privacy. Analysis of technical difficulties of producing secure computer information systems that provide guaranteed controlled sharing. Examination and critique of current systems, methods, certification.

178. Introduction to Cryptography

(4) EGECIOGLU

Prerequisites: Computer Science 10 and PSTAT 120A or 121A or equivalent courses.

An introduction to the basic concepts and techniques of cryptography and cryptanalysis. Topics include: The Shannon Theory, classical systems, the Enigma machine, the data encryption standard, public key systems, digital signatures, file security.

180. Computer Graphics

(4) WANG

Prerequisite: Computer Science 130B or consent of instructor.

Overview of OpenGL graphics standard, OpenGL state machine, other 3D graphics libraries, 3D graphics pipeline, 3D transformations and clipping, color model, shading model, shadow algorithms, texturing, curves and curved surfaces, graphics hardware, interaction devices and techniques.

181B. Introduction to Computer Vision

(4) WANG, TURK

Prerequisite: Upper-division standing.

Same course as ECE 181B.

Overview of computer vision problems and techniques for analyzing the content images

and video. Topics include image formation, edge detection, image segmentation, pattern recognition, texture analysis, optical flow, stereo vision, shape representation and recovery techniques, issues in object recognition, and case studies of practical vision systems.

182. Multimedia Computing

(4) ALMEROOTH, ZHENG

Not open for credit to students who have completed ECE 160.

Introduction to multimedia and applications. Topics include streaming media, conferencing, webcasting, digital libraries, multimedia system architectures, standards (including JPEG and MPEG), and multimedia storage and retrieval. A key emphasis is on using the Internet for delivery of multimedia data.

185. Human-Computer Interaction

(4) HOLLERER

Prerequisite: open to computer science, computer engineering, and electrical engineering majors.

Recommended preparation: proficiency in the Java/C++ programming language, some experience with user interface programming

The study of human-computer interaction enables system architects to design useful, efficient, and enjoyable computer interfaces. This course teaches the theory, design guidelines, programming practices, and evaluation procedures behind effective human interaction with computers.

186. Theory of Computation

(4) IBARRA

Prerequisite: Computer Science 138; open to computer science majors only.

Not open for credit to students who have completed Mathematics 150A.

Turing machines; computability and unsolvability; computational complexity; intractability and NP-completeness.

189A. Senior Computer Systems Project

(4) BULTAN

Prerequisite: senior standing in Computer Engineering, Electrical Engineering, or Computer Science; consent of instructor.

Not open for credit to students who have completed Computer Science 172.

Student groups design a significant computer-based project. Groups work independently with interaction among groups via interface specifications and informal meetings.

189B. Senior Computer Systems Project

(4) BULTAN

Prerequisite: CMPSC 172 or CMPSC 189A; Senior standing in computer engineering, computer science, or electrical engineering; consent of instructor.

Not open for credit to students who have completed ECE 189A or ECE 189B.

Student groups design a significant computer-based project. Multiple groups may cooperate toward one large project. Each group works independently; interaction among groups is via interface specifications and informal meetings. Project for course may be different from that in first course.

190AA-ZZ. Special Topics in Computer Science

(4) STAFF

Prerequisite: consent of instructor.

May be repeated with consent of the department chair.

Courses provide for the study of topics of current interest in computer science.

- A. Foundations
- B. Software Systems
- C. Programming languages and software engineering
- D. Information management
- E. Architecture
- F. Networking
- G. Security
- H. Scientific computing
- I. Intelligent and interactive systems
- N. General

192. Projects in Computer Science

(4) STAFF

Prerequisite: consent of instructor.

Students must have a minimum 3.0 GPA. May be repeated with consent of the department chair but only 4 units may be applied to the major.

Projects in computer science for advanced undergraduate students.

193. Internship in Industry**(1-4) STAFF**

Prerequisites: consent of instructor and department chair.

Not more than 4 units per quarter; may not be used as a field elective and may not be applied to science electives. May be repeated with faculty/chair approval to a maximum of 4 units.

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

196. Undergraduate Research**(2-4) STAFF**

Prerequisites: upper-division standing, consent of the instructor.

Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated for up to 12 units. No more than 4 units may be applied to departmental electives.

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

199. Independent Studies in Computer Science**(1-4) STAFF**

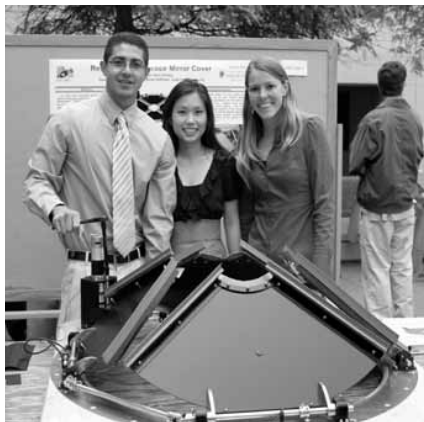
Prerequisites: upper-division standing; must have completed at least two upper-division courses in computer science.

Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated with consent of chair. Students are limited to 5 units per quarter and 30 units total in all 198/199 courses combined.

Independent study in computer science for advanced students.

GRADUATE COURSES

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



Electrical & Computer Engineering

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

Chair: Jerry Gibson

Vice Chair: Joao Hespanha

Faculty

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

Daniel J. Blumenthal, Ph.D., University of Colorado at Boulder, Professor (fiber-optic networks, wavelength and subcarrier division multiplexing, photonic packet switching, signal processing in semiconductor optical devices, wavelength conversion, microwave photonics)

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

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

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)

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

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

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

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

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

Steven P. DenBaars, Ph.D., University of

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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, Professor (digital signal processing: intelligent human-machine interaction, digital signal processing, speech processing and recognition; telecommunications)

Volkan Rodoplu, Ph.D., Stanford University, Associate Professor (wireless networks, energy-efficient and device-adaptive communications)

Mark J.W. Rodwell, Ph.D., Stanford University, Professor, Director of Compound Semiconductor Research Laboratories, Director of National Nanofabrication Users Network (heterojunction bipolar transistors, high frequency integrated circuit design, electronics beyond 100 GHz)

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

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

Roy Smith, Ph.D., California Institute of Technology, Professor (robust control with an emphasis on the modeling, identification, and control of uncertain systems, applications and experimental work including process control, flexible structures, automotive systems, semiconductor manufacturing, levitated magnetic bearings and dynamic aeromaneuvering of interplanetary spacecraft)

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

Andrew Teel, Ph.D., UC Berkeley, Professor (control design and analysis for nonlinear dynamical systems, input-output methods, actuator nonlinearities, applications to aerospace problems)

Luke Theogarajan, Ph.D., Massachusetts Institute of Technology, Assistant Professor (low-power analog VLSI, biomimetic nanosystems, neural prostheses, biosensors, block co-polymer synthesis, self-assembly, and microfabrication)

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

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

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

Patrick Yue, Ph.D., Stanford University,

Professor (high-speed CMOS IC design, cell-based RF CAD methodology and integrated biomedical sensors)

Emeriti Faculty

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

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

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

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

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

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

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

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

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

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

Roger C. Wood, Ph.D., UC Los Angeles, Professor Emeritus (computer system modeling, design, and analysis, computer architecture, and instructional use of computers) *2

*1 Joint appointment with Materials.

*2 Joint appointment with Computer Science.

Affiliated Faculty

David Awschalom, Ph.D. (Physics)

Elizabeth Belding, Ph.D. (Computer Science)

Francesco Bullo, Ph.D. (Mechanical Engineering)

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

Oscar Ibarra, Ph.D., (Computer Science)

Mustafa Khammash, Ph.D. (Mechanical Engineering)

Chandra Krintz, Ph.D. (Computer Science)

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

Shuji Nakamura, Ph.D. (Materials)

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

Tim Sherwood, Ph.D. (Computer Science)

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, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700. It is one of the degrees recognized in all fifty states as leading to eligibility for registration as a professional engineer.

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

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

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College of Engineering, as well as advisors in the department. Students who plan to change 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 California's high schools and for postgraduate students, both domestic and international. The department has a dual mission:

- *Education:* We will develop and produce excellent electrical and computer engineers who will support the high-tech economy of California and the nation. This mission requires that we offer a balanced and timely education that includes not only strength in the fundamental principles but also experience with the practical skills that are needed to contribute to the complex technological infrastructure of our society. This approach will enable each of our graduates to continue learning throughout an extended career.
- *Research:* We will develop relevant and innovative science and technology through our research that addresses the needs of industry, government and the scientific community. This technology can be transferred through our graduates, through industrial affiliations, and through publications and presentations.

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

Educational Objectives

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

1. We expect our graduates to make positive contributions to society in fields including, but not limited to, engineering.
2. We expect our graduates to have acquired the ability to be flexible and adaptable, showing that their educational background has given them the foundation needed to remain effective, take on new responsibilities and assume leader-

ship roles.

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

Program Outcomes

The EE program expects our students upon graduation to have:

1. Acquired strong basic knowledge and skills in those fundamental areas of mathematics, science, and electrical engineering that are required to support specialized professional training at the advanced level and to provide necessary breadth to the student's overall program of studies. This provides the basis for lifelong learning.
2. Experienced in-depth training in state-of-the-art specialty areas in electrical engineering. This is implemented through our senior electives. Students are required to take two sequences of at least two courses each at the senior level.
3. Benefited from imaginative and highly supportive laboratory experiences where appropriate throughout the program. The laboratory experience will be closely integrated with coursework and will make use of up-to-date instrumentation and computing facilities. Students should experience both hardware-oriented and simulation-oriented exercises.
4. Experienced design-oriented challenges that exercise and integrate skills and knowledge acquired in several courses. These may include design of components or subsystems with performance specifications. Graduates should be able to demonstrate an ability to design and conduct experiments as well as analyze the results.
5. Learned to function well in teams. Also, students must develop communication skills, written and oral, both through team and classroom experiences. Skills including written reports, webpage preparation, and public presentations are required.
6. Completed a well-rounded and balanced education through required studies in selected areas of fine arts, humanities, and social sciences. This provides for the ability to understand the impact of engineering solutions in a global and societal context. A course in engineering ethics is also required of all undergraduates.

Undergraduate Program

Bachelor of Science—Electrical Engineering

A minimum of 193 units is required for graduation. A complete list of requirements for the major can be found on page 48. Schedules should be planned to meet both General Education and major requirements.

The department academic advisor can suggest a recommended study plan for electrical engineering freshmen and sophomores. Each student is assigned a departmental faculty advisor who must be

consulted in planning the junior and senior year programs.

The required 32 units (8 courses) of departmental electives are taken primarily in the senior year, and they permit students to develop depth in specialty areas of their choice. A student's elective course program must be approved by a departmental faculty advisor. The advisor will check the program to ensure satisfaction of the departmental requirements. A wide variety of elective programs will be considered acceptable.

Three matters should be noted: (1) students who fail to attain a grade-point average of at least 2.0 in the major may be denied the privilege of continuing in the major, (2) a large majority of electrical and computer engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite courses means receiving a grade of C- or better in prerequisite courses except for Mathematics 3A-B-C and Mathematics 5A and 5B which require a grade of C or better to apply these courses as prerequisites, (3) courses required for the pre-major or major, inside or outside of the Department of Electrical Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.

Bachelor of Science—Computer Engineering

This major is offered jointly by the Department of Computer Science and the Department of Electrical and Computer Engineering. For information about this major, see page 22.

Electrical & Computer Engineering Courses

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

LOWER DIVISION

1. Ten Puzzling Problems in Computer Engineering

(1) PARHAMI

Prerequisite: open to pre-computer engineering only. *Seminar, 1 hour.*

Gaining familiarity with, and motivation to study, the field of computer engineering, through puzzle-like problems that represent a range of challenges facing computer engineers in their daily problem-solving efforts and at the frontiers of research.

2A. Circuits, Devices, and Systems

(5) YORK

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

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

2B. Circuits, Devices, and Systems

(5) YORK

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

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

2C. Circuits, Devices, and Systems

(5) YORK

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

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

4. Design Project for Freshmen

(4) STAFF

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

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

15A. Fundamentals of Logic Design

(3) MAREK-SADOWSKA

Prerequisites: ECE 2A with a minimum grade of C-; 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.

15B. Computer Organization

(3) STAFF

Prerequisites: ECE 15A with a minimum grade of C-; open to electrical engineering, computer engineering, and pre-computer engineering majors only.

Not open for credit to students who have completed Computer Science 30 or ECE 15. *Lecture, 3 hours; discussion, 1 hour.*

Basic memory and processor organization, instruction set architecture, assembly language programming, number systems, arithmetic, data transfer and control flow instructions, procedures, memory management, program execution.

94AA-ZZ. Group Studies in Electrical and Computer Engineering

(1-4) STAFF

Prerequisite: consent of instructor.

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

UPPER DIVISION**121A-B. The Practice of Science**

(3-4) HU, AWSCHALOM

Prerequisites: consent of instructor (for 121A); ECE 121A or Physics 121A; consent of instructor (for 121B).

Same course as Physics 121A-B. *Lecture, 3 hours (for 121A); Lecture, 4 hours (for 121B).*

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

124A. VLSI Principles

(4) BANERJEE

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

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

124B. Integrated Circuit Design and Fabrication

(4) BOWERS

Prerequisite: ECE 132 with a minimum grade of C-. *Lecture, 4 hours; laboratory, 3 hours.*

Theory, fabrication, and characterization of solid state devices including P-N junctions, capacitors, bipolar and MOS devices. Devices are fabricated using modern VLSI processing techniques including lithography, oxidation, diffusion, and evaporation. Physics and performance of processing steps are discussed and analyzed.

124C. Integrated Circuit Design and Fabrication

(4) BOWERS

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

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

124D. VLSI Architecture and Design

(4) BREWER

Prerequisite: ECE 124A with a minimum grade of C-. *Lecture, 3 hours; laboratory, 2 hours.*

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

125. High Speed Digital Integrated Circuit Design

(4) BANERJEE

Prerequisite: ECE 124A or 137A with a minimum grade of C- in either. *Lecture, 4 hours.*

Advanced digital VLSI design: CMOS scaling, nanoscale issues including variability, thermal management, interconnects, reliability; non-clocked, clocked and self-timed logic gates; clocked storage elements; high-speed components, PLLs and DLLs; clock and power distribution; memory systems; signaling and I/O design; low-power design.

130A. Signal Analysis and Processing

(4) MADHOW

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

Analysis of continuous time linear systems in the time and frequency domains. Superposition and convolution. Bilateral and unilateral Laplace transforms. Fourier series and Fourier transforms. Filtering, modulation, and feedback.

130B. Signal Analysis and Processing

(4) CHANDRASEKARAN

Prerequisite: ECE 130A with a grade of C- or better; open to EE and computer engineering majors only. *Lecture, 3 hours; discussion, 2 hours.*

Analysis of discrete time linear systems in the time and frequency domains. Z transforms, Discrete Fourier transforms. Sampling and aliasing.

130C. Signal Analysis and Processing

(4) CHANDRASEKARAN

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

Basic techniques for the analysis of linear models in electrical engineering: Gaussian elimination,

vector spaces and linear equations, orthogonality, determinants, eigenvalues and eigenvectors, systems of linear differential equations, positive definite matrices, singular value decomposition.

132. Introduction to Solid State Electronic Devices

(4) MISHRA

Prerequisites: Physics 4 or 24 with a minimum grade of C-; Mathematics 5A with a minimum grade of C; and ECE 2A-B (may be taken concurrently) with a minimum grade of C- in both; open to EE and computer engineering majors only. *Lecture, 3 hours; discussion, 2 hours.*

Electrons and holes in semiconductors; doping (P and N); state occupation statistics, transport properties of electrons and holes; P-N junction diodes; I-V, C-V, and switching properties of P-N junctions; introduction of bipolar transistors, MOSFET's and JFET's.

134. Introduction to Fields and Waves

(4) DAGLI, YORK

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

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

135. Optical Fiber Communication

(4) DAGLI

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

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

137A. Circuits and Electronics I

(4) RODWELL

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

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

137B. Circuits and Electronics II

(4) RODWELL

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

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

139. Probability and Statistics

(4) ILTIS

Prerequisite: Open to Electrical Engineering, Computer Engineering and pre-Computer Engineering majors only. *Lecture, 3 hours; discussion, 2 hours.*

Fundamentals of probability, conditional probability, Bayes rule, random variables, functions of random variables, expectation and high-order moments, Markov chains, hypothesis testing.

140. Random Processes for Engineering

(4) ILTIS

Prerequisites: ECE 130A-B and 139 each with a minimum grade of C-; open to EE majors only. *Lecture, 3 hours; discussion, 2 hours.*

Random processes, characteristic functions, central limit theorem, spectral analysis, linear systems with random inputs, representation of bandlimited processes, Poisson process, simple queueing systems.

141A. Introduction To Nanoelectromechanical and Microelectromechanical Systems(NEMS/MEMS)

(3) PENNATUR, TURNER

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

Same course as ME 141A. Lecture, 3 hours.

Introduction to nano- and microtechnology. Scaling laws and nanoscale physics are stressed. Individual subjects at the nanoscale including materials, mechanics, photonics, electronics, and fluidics will be described, with an emphasis on differences of behavior at the nanoscale and real-world examples.

141B. MEMS: Processing and Device Characterization**(4) PENNATHUR, TURNER**

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

Same course as ME 141B. Lecture, 2 hours; laboratory, 6 hours.

Lectures and laboratory on semiconductor-based processing for MEMS. Description of key equipment and characterization tools used for MEMS and design, fabrication, characterization and testing of MEMS. Emphasis on current MEMS devices including accelerometers, comb drives, micro-reactors and capacitor-actuators.

141C. Introduction to Microfluidics and BioMEMS**(3) MEINHART**

Prerequisite: ME 141A or ECE 141A; open to ME and EE majors only.

Same course as ME 141C. Lecture, 3 hours.

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

144. Electromagnetic Fields and Waves**(4) YORK**

Prerequisite: ECE 134 with a minimum grade of C-. Lecture, 3 hours; laboratory, 3 hours.

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

145A. Communication Electronics**(5) RODWELL**

Prerequisites: ECE 137A-B with a minimum grade of C- in both. Lecture, 3 hours; laboratory, 6 hours.

RF/Microwave circuits. Transistor, transmission-line, and passive element characteristics. Transmission-line theory and impedance matching. Amplifier design for maximum available gain. Amplifier stability. Gain compression and power limits. Introduction to noise figure, and to intermodulation distortion.

145B. Communication Electronics II**(5) YUE**

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 implementation. On-chip passive components. LNAs. PAs. T/R switches. Mixers. VCOs. Poly-phase filters. Radio link budget. Analog and digital modulation schemes. Introduction to receiver architectures. I&Q modulation. Image-reject architectures.

145C. Communication Electronics III**(5) YUE**

Prerequisites: ECE 137B with a minimum grade of C-. Lecture, 4 hours.

Modern wireless communication standards. Cellular phone. Wireless LAN. Introduction to multi-access techniques. Advanced modulation schemes. Interference and distortion. Modern transceiver architectures. Direct conversion vs. low IF vs. superheterodyne. Sub-sampling receiver. Direct polar modulator. Frequency synthesis using PLL.

146A. Analog Communication Theory and Techniques**(5) ILTIS**

Prerequisites: ECE 130A-B with a minimum grade of C- in both; open to EE majors only. Lecture, 3 hours; laboratory, 6 hours.

Modulation theory, AM, FM, PM, and analog pulse modulation and demodulation techniques. System noise and performance calculations.

146B. Digital Communication Theory and Techniques**(5) SHYNK**

Prerequisites: ECE 130A-B, 140 and 146A with minimum grades of C-; open to EE majors only. Lecture, 3 hours; laboratory, 6 hours.

Elements of source coding: quantization, pulse code modulation, delta modulation. Introduction to digital modulation over baseband and passband channels: linear modulation, Nyquist criterion for intersymbol interference avoidance, orthogonal modulation. Optimal reception of signals in Additive White Gaussian Noise: detection theory basics, signal space concepts, geometry of maximum likelihood receivers. Performance analysis of optimal receivers: error probability as a function of E_b/N_0 , union bound, nearest neighbors approximation. Link design: power-bandwidth tradeoffs, link budget analysis.

147A. Feedback Control Systems - Theory and Design**(5) TEEL, SMITH**

Prerequisites: ECE 130A-B-C with a minimum grade of C- in each; open to EE and computer engineering majors only. Lecture, 3 hours; laboratory, 6 hours.

Feedback systems design, specifications in time and frequency domains. Analysis and synthesis of closed loop systems. Computer aided analysis and design.

147B. Digital Control Systems - Theory and Design**(5) SMITH, TEEL**

Prerequisite: ECE 147A with a minimum grade of C-; open to EE and computer engineering majors only. Lecture, 3 hours; laboratory, 6 hours.

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

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

A sequence of engineering applications of signal analysis and processing techniques; in communications, image processing, analog and digital filter design, signal detection and parameter estimation, holography and tomography, Fourier optics, and microwave and acoustic sensing.

149. Active and Passive Network Synthesis**(4) ILTIS**

Prerequisite: Upper-division standing; open to EE majors only.

Designed for juniors to take right after ECE 130AB.

Combines the areas of electronics and network theory in the subject of passive and active network design. Topics include passive synthesis, optimization techniques, approximations to ideal filters, distributed networks, sensitivity and the modern design techniques, and applications of active filters.

151. Distributed Systems**(4) MELLIAR-SMITH**

Prerequisite: Computer Science 170 with a minimum

grade of C-.

Not open for credit to students who have completed Computer Science 171. Lecture, 3 hours; discussion, 1 hour.

Distributed systems architecture, distributed programming techniques, message passing, remote procedure calls, group communication and membership, naming, asynchrony, causality, consistency, fault-tolerance and recovery, resource management, scheduling, monitoring, testing and debugging.

152A. Digital Design Principles**(5) RODOPLU**

Prerequisites: ECE 15 or 15A or Computer Science 30 with a minimum grade of C- in each course; open to electrical engineering, computer engineering, and computer science majors only. Lecture, 3 hours; laboratory, 6 hours.

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

152B. Digital Design Methodologies**(5) CHENG**

Prerequisites: ECE 152A with a minimum grade of C-; open to EE, computer engineering, and computer science majors only. Lecture, 3 hours; discussion, 6 hours.

Design methodologies of digital systems, the register and processor levels. Design of functional subsystems, including arithmetic processors, hardwired and microprogrammed control units, memory systems, and bussing systems. System organization including communication, input/output systems, and multiple CPU systems.

153A. Hardware/Software Interface**(4) BREWER, KRINTZ**

Prerequisite: Upper division standing in Computer Engineering, Computer Science or Electrical Engineering.

Same course as Computer Science 153A.

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

153B. Sensor and Peripheral Interface Design**(4) BUTNER**

Prerequisites: ECE 152B and 153A with a minimum grade of C- in both. Lecture, 3 hours; laboratory, 3 hours.

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

154. Introduction to Computer Architecture**(4) PARHAMI**

Prerequisite: ECE 152A with a minimum grade of C-; open to EE, computer engineering, and computer science majors only.

Not open for credit to students who have completed Computer Science 154. Lecture, 3 hours; discussion, 1 hour.

The computer design space. Methods of performance evaluation. Machine instructions and assembly language. Variations in instruction set architecture. Design of arithmetic/logic units. Data path and control unit synthesis. Pipelining and multiple instruction issue. Hierarchical memory systems. Input/output and interfacing. High-performance systems, including multiprocessors and multicomputers.

155A. Introduction to Computer Networks**(4) MOSER**

Prerequisite: ECE 154 with a minimum grade of C-; and, Computer Science 12 or 60 with a minimum grade of C-.

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

155. *Lecture, 3 hours; discussion, 1 hour.*

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

155B. Network Computing

(4) MOSER

Prerequisites: ECE 155A with a minimum grade of C-; and, Computer Science 5JA or 10 or 11JA with a minimum grade of C-.

Not open for credit to students who have completed Computer Science 176B or ECE 194W. Lecture, 3 hours; discussion, 1 hour.

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

156A. Digital Design with VHDL and Synthesis

(4) WANG

Prerequisite: ECE 152A with a minimum grade of C-. Lecture, 3 hours; laboratory, 3 hours.

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

156B. Computer-Aided Design of VLSI Circuits

(4) WANG

Prerequisite: ECE 156A with a minimum grade of C-. Lecture, 3 hours; laboratory, 3 hours.

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

158. Digital Signal Processing

(4) GIBSON

Prerequisites: ECE 130A-B with a minimum grade of C- in both; open to EE majors only.

Lecture, 3 hours; laboratory, 3 hours.

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

160. Multimedia Systems

(4) MELLIER-SMITH

Prerequisites: upper-division standing; open to EE, computer engineering, computer science, and creative studies majors only. Lecture, 3 hours; laboratory, 3 hours.

Introduction to multimedia and applications, including WWW, image/video databases and video streaming. Covers media content analysis, media data organization and indexing (image/video databases), and media data distribution and interaction (video-on-demand and interactive TV).

162A. The Quantum Description of Electronic Materials

(4) BOWERS

Prerequisites: ECE 130A-B and 134 with a minimum grade of C- in all; open to EE and materials majors only.

Same course as Materials 162A. Lecture, 4 hours.

Electrons as particles and waves, Schrodinger's equation and illustrative solutions. Tunnelling. Atomic structure, the exclusion principle and the periodic table. Bonds. Free electrons in metals, periodic potentials and energy bands.

162B. Fundamentals of the Solid State

(4) COLDREN

Prerequisite: ECE 162A with a minimum grade of C-; open to EE and materials majors only.

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

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.

162C. Optoelectronic Materials and Devices

(4) COLDREN

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

Optical transitions in solids. Direct and indirect gap semiconductors. Luminescence. Excitons and photons. Fundamentals of optoelectronic devices: semiconductor lasers, LED's photoconductors, solar cells, photo diodes, modulators. Photoemission. Integrated circuits.

178. Introduction to Digital Image and Video Processing

(4) MANJUNATH

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.

181A. Introduction to Robotics: Robot Mechanics

(4) PADEN

Same course as ME 170A.

Recommended preparation: ME 16. Lecture, 3 hours; laboratory, 3 hours.

Overview of robot kinematics and dynamics. Structure and operation of industrial robots. Robot performance: work space, velocity, precision, payload. Comparative discussion of robot mechanical designs. Actuators. Robot coordinate systems. Kinematics of position. Dynamics of manipulators. (S; may not be offered every year)

181B. Introduction to Computer Vision

(4) MANJUNATH

Prerequisite: Upper-division standing.

Same course as Computer Science 181B.

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

181C. Introduction to Robotics: Robot Control

(4) PADEN

Prerequisite: ECE 2A-B-C with a minimum grade of C-; or ME 104.

Same course as ME 170C. Lecture, 2 hours; laboratory, 4 hours.

Overview of robot control technology from open-loop manipulators and sensing systems, to single-joint servovalves and servomotors, to integrated adaptive force and position control using feedback from machine vision and touch sensing systems. Design emphasis on accurate tracking accomplished with minimal algorithm complexity. (F; may not be offered every year)

183. Nonlinear Phenomena

(4) TEEL

Prerequisites: Physics 105A or ME 163 or upper-division standing in EE.

Same course as Physics 106 and ME 169. Not open for credit to students who have completed ECE 163C. Lecture, 3 hours; discussion, 1 hour.

An introduction to nonlinear phenomena. Flows and bifurcations in one and two dimensions, chaos, fractals, strange attractors. Applications to physics, engineering, chemistry, and biology.

188A. Senior Electrical Engineering Project

(4) STAFF

Prerequisites: Consent of instructor; completion of at least four required upper division Electrical Engineering courses with a 3.0 GPA or higher.

Student groups design a significant project based on the knowledge and skills acquired in earlier

coursework and integrate their technical knowledge through a practical design experience. The project is evaluated through written reports, oral presentations, and demonstrations of performance.

188B. Senior Electrical Engineering Project

(4) STAFF

Prerequisites: ECE 188A with a minimum grade of C-.

Student groups design a significant project based on the knowledge and skills acquired in earlier coursework and integrate their technical knowledge through a practical design experience. The project is evaluated through written reports, oral presentations, and demonstrations of performance.

189A-B. Senior Computer Systems Project

(4-4) BUTNER

Prerequisite: consent of instructor; senior standing in computer engineering, computer science, or EE.

Not open for credit to students who have completed Computer Science 189.

Student groups design a significant computer-based project. Groups work independently with interaction among groups via interface specifications and informal meetings.

192. Projects in Electrical and Computer Engineering

(4) STAFF

Prerequisite: consent of instructor. Discussion, 2 hours; laboratory, 6 hours.

Projects in electrical and computer engineering for advanced undergraduate students.

193. Internship in Industry

(1-8) STAFF

Prerequisite: consent of department.

Must have a 3.0 grade-point-average. May not be used as departmental electives. May be repeated to a maximum of 12 units. Field, 1-8 hours.

Special projects for selected students. Offered in conjunction with engineering practice in selected industrial and research firms, under direct faculty supervision.

194AA-ZZ. Special Topics in Electrical and Computer Engineering

(1-5) STAFF

Prerequisite: consent of instructor. Variable hours.

Group studies intended for small number of advanced students who share an interest in a topic not included in the regular departmental curriculum. Topics covered include (check with department for quarters offered):

- A. Circuits
- AA. Micro-Electro-Mechanical Systems
- B. Systems Theory
- BB. Computer Engineering
- C. Communication Systems
- D. Control Systems
- E. Signal Processing
- F. Solid State
- G. Fields and Waves
- H. Quantum Electronics
- I. Microwave Electronics
- J. Switching Theory
- K. Digital Systems Design
- L. Computer Architecture
- M. Computer Graphics
- N. Pattern Recognition
- O. Microprocessors and Microprocessor-based Systems
- P. Simulation
- Q. Imaging Systems and Image Processing
- R. General
- S. Speech
- T. Robot Control
- U. Optoelectronics
- V. Scientific Computation
- W. Computer Network
- X. Distributed Computation
- Y. Numerical Differential Equations
- Z. Nanotechnology

196. Undergraduate Research

(2-4) STAFF

Prerequisites: upper-division standing; consent of instructor.

Must have a minimum 3.0 grade-point average

for the preceding three quarters. May be repeated for up to 12 units. Not more than 4 units may be applied to departmental electives.

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

199. Independent Studies in Electrical and Computer Engineering (1-5) STAFF

Prerequisites: upper division standing; completion of two upper-division courses in electrical and computer engineering; consent of instructor.

Must have a minimum 3.0 grade-point average for the preceding three quarters. Students are limited to five units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined.

Directed individual study, normally experimental.

GRADUATE COURSES

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



Engineering Sciences

Engineering Sciences, Office of the Associate Dean for Undergraduate Studies, Harold Frank Hall, Room 1006; Telephone (805) 893-2809
Web site: www.engr.ucsb.edu/current_undergraduates/engr_sci/

Chair & Associate Dean for Undergraduate Studies: Glenn E. Beltz
Director, Technology Management Programs: Gary S. Hansen

Faculty

Glenn E. Beltz, Ph.D., Harvard, Professor

* Gary S. Hansen, Ph.D., University of Michigan, Associate Professor

* David Seibold, Ph.D., Michigan State University, Professor

* Technology Management Program faculty

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

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

Engineering Sciences Courses

LOWER DIVISION

3. Introduction to Programming for Engineers (3) STAFF

Prerequisites: Open to chemical engineering, electrical engineering, and mechanical engineering majors only.

General philosophy of programming for engineering majors. Students will be introduced to a modern programming language or software package. Specific areas of study will include algorithms, basic decision structures, arrays, matrices, and graphing. Engineering applications will be emphasized. (F, S, M).

10H. Engineering Honors Seminar (1) BELTZ

Prerequisites: enrollment in College of Engineering Honors Program; lower-division standing.

An interdisciplinary examination of selected topics, texts, theories, and/or methods in engineering. Particular course focus is determined by the instructor(s) each time the course is offered.

99. Introduction to Research (1-3) STAFF

Prerequisite: Consent of instructor.

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

UPPER DIVISION

101. Ethics in Engineering (3) STAFF

Prerequisite: senior standing in engineering.

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

102AA-ZZ. Special Topics in Engineering, Business, and Society (1) STAFF

Prerequisites: Upper-division standing.

May be repeated for credit if there is no duplication of course content.

A series of weekly lectures given by university staff and outside experts in all fields of new technology management.

103. Advanced Engineering Writing (4) STAFF

Prerequisites: Writing 50 or 50E; upper-division standing.

Practice in the forms of communication—contractual reports, proposals, conference papers, oral presentations, business plans—that engineers and entrepreneurial engineers will encounter in professional careers. Focus is on research methods, developing a clear and persuasive writing style, and electronic document preparation.

160. Science for the Public (1-4) STAFF

Prerequisite: consent of instructor.

Same course as Physics 160K. Open to graduate students in science and engineering disciplines and to undergraduate science and engineering majors. May be repeated for credit to a maximum of 12 units, but only 4 units may be applied to the major.

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

177. Art and Science of Aerospace Culture (4) STAFF

Prerequisites: upper-division standing; consent of instructor.

Same course as Art Studio 177.

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

182. Introduction to Health Care and Biomedical Technology (3) STAFF

Prerequisite: upper-division standing.

Same course as MCDB 182.

Course offered in conjunction with Sansum-Santa Barbara Clinic and Cottage Hospitals and involves a series of lecture/discussions dealing with various aspects of health delivery and modern biotechnology. Students spend time working with a

physician or medical research scholar.

185A. The Art of the CEO: Business Skills for Future Leaders

(4) HANSEN

Prerequisite: Writing 2 or 2E; and,

Writing 50 or 50E or 109AA-ZZ; senior standing.

An introductory business course in strategic thinking, negotiations, marketing, finance and modeling skills that prepare engineering, science and non-technical students for successful entry into business. Class uses case studies, lectures, and computer simulation.

185B. New Venture Creation: Entrepreneurship

(4) HANSEN

Prerequisite: Writing 2 or 2E; and, Writing 50 or 50E or 109AA-ZZ; senior standing.

Overview of the new venture creation process. Analysis of new business opportunities, development of new business value propositions, team building, venture financing, new venture planning, managing and protecting intellectual property, business formation, and other topics relevant to the entrepreneurial process.

185C. Business Planning for New Technology Ventures

(4) HANSEN

Prerequisite: Engineering 185A; and, Engineering 185B or 185D; senior standing.

Analysis and creation of a business plan for a new business venture including demand forecasting, financial modeling, selling of the new business idea, and other issues for current business conditions.

185D. New Product Development

(4) BOWERS

Prerequisite: senior standing.

New product development requires technical and non-technical business persons to work across disciplines. Instruction is provided in a wide range of topics concerning customer driven product innovation. Students learn new product development processes, tools, techniques and organizational structures.

185F. Business Skills: Asia: New Opportunities for Technology Businesses

(4) STAFF

Prerequisite: Upper-division standing.

Use analytical frameworks for assessing technology business environments and sustainability within Asia. Establish historical context; governmental structures, policy and influence; capability investments and yield by local and foreign companies; operating models in leveraging Asian economies' resources and related experiences.

191AA-ZZ. Professional Seminar in New Technology Management

(2) STAFF

Prerequisite: Upper-division standing.

May be repeated for credit if there is no duplication of course content.

Courses provide for the study of topics of current interest in the areas of entrepreneurship, business, engineering management, ethics, social, political, and other issues related to the successful practice of engineering.

192A. Entrepreneurial Opportunities in Healthcare and Life Sciences

(2) STAFF

Prerequisite: senior standing.

Not open for credit to students who have completed Engineering 191F.

Expert guest lecturers address current products and services. Students address the identification of market opportunities with an appreciation of the needs and requirements of the healthcare industry.

192B. Designing Solutions for Healthcare and Life Sciences Opportunities

(2) STAFF

Prerequisite: senior standing.

Students identify specific solutions for business opportunities in the healthcare industry considering technological and market feasibility. Interaction with healthcare professionals and industry executives.

192C. Critical Issues in Early Stage

Healthcare and Life Science Companies

(2) STAFF

Prerequisite: senior standing.

Course includes visiting speakers and field visits to facilitate learning about the critical issues in early stage, life science related companies.

193A. Entrepreneurial Opportunities in IT and Telecom

(2) STAFF

Prerequisite: Upper-division standing.

This course is intended for students with an interest in the identification of new products and services in the IT and Telecom environment. The course involves interaction with industry professionals and executives.

193B. Designing Solutions for IT and Telecom

(2) STAFF

Prerequisite: Upper-division standing.

Students design specific solutions for business opportunities in the IT and Telecom industry considering technological and market feasibility.

193C. Critical Issues in Early Stage IT and Telecom Companies

(2) STAFF

Prerequisite: Upper-division standing.

Course includes visiting speakers and field visits to facilitate learning about the critical issues in early stage Telecom related companies.

199. Independent Studies in Engineering

(1-5) STAFF

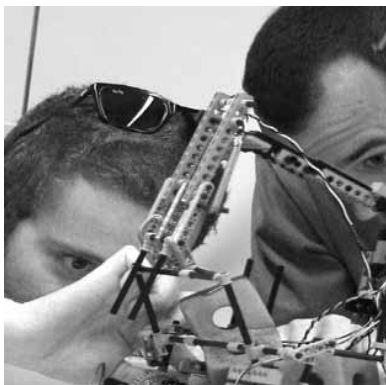
Prerequisite: Upper-division standing; consent of instructor.

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

Directed individual study.

GRADUATE COURSES

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



Materials

Department of Materials
Engineering II, Room 1355;
Telephone (805) 893-4362

Web site: www.materials.ucsb.edu

Chair: James S. Speck

Associate Chair: Francis W. Zok

Faculty

Guillermo C. Bazan, Ph.D., Massachusetts Institute of Technology, Professor (polymer synthesis, photophysics) *5

Michael Chabiny, 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)

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

Steven P. DenBaars, Ph.D., University of Southern California, Professor (metalorganic chemical vapor deposition (MOCVD) of semiconductors, IR to blue lasers and LEDs, high power electronic materials and devices) *1

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

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

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

Edward J. Kramer, Ph.D., Carnegie Mellon University, Professor (fracture and diffusion in polymers; polymer surfaces, interfaces, and thin films) *3

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

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, Professor (mechanics of materials, fracture mechanics, plasticity, computational mechanics, process modeling) *2

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

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

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

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

Philip A. Pincus, Ph.D., UC Berkeley, Professor (theoretical aspects of self-assembled biomolecular structures, membranes, polymers, and colloids) *4

Cyrus R. Safinya, Ph.D., Massachusetts Institute of Technology, 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)

Ram Seshadri, Ph.D., Indian Institute of Science, Professor (inorganic materials, preparation and magnetism of bulk solids and nanoparticles, patterned materials)

Hyongsuk (Tom) Soh, Ph.D., Stanford, Associate Professor (directed evolution of biological molecules, supramolecular assemblies, integrated biosensors) *2

Nicola A. Spaldin, Ph.D., UC Berkeley, Professor (computational electronic and magnetic materials)

James S. Speck, Sc.D., Massachusetts Institute of Technology, Professor (nitride semiconductors, III-V semiconductors, ferroelectric and high-K films, microstructural evolution, extended defects, transmission electron microscopy, x-ray diffraction)

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

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

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

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

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

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

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

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

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

*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

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

Joseph A. N. Zasadzinski, Ph.D. (Chemical Engineering)

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

The department has major research groups working on a wide range of advanced inorganic and organic materials, including advanced structural alloys, ceramics and polymers; high performance composites; thermal barrier coatings and

engineered surfaces; organic, inorganic and hybrid semiconductor and photonic material systems; catalysts and porous materials, magnetic, ferroelectric and multiferroic materials; biomaterials and biosurfaces, including biomedically relevant systems; colloids, gels and other complex fluids; lasers, LEDs and optoelectronic devices; packaging systems; microscale engineered systems, including MEMS. The groups are typically multidisciplinary involving faculty, postdoctoral researchers and graduate students working on the synthesis and processing, structural characterization, property evaluation, microstructure-property relationships and mathematical models relating micromechanisms to macroscopic behavior.

Materials Courses

LOWER DIVISION

10. Materials in Society, the Stuff of Dreams (4) STAFF

Not open to engineering, pre-computer science, or computer science majors. Lecture, 3 hours; discussion 1 hour.

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) SESHADRI, SPALDIN

Prerequisites: Chemistry 1A-B; Physics 4; and, Mathematics 5A-B-C. Lecture, 3 hours.

An introduction to materials in modern technology. The internal structure of materials and its underlying principles: bonding, spatial organization of atoms and molecules, structural defects. Electrical, magnetic and optical properties of materials, and their relationship with structure.

100B. Structure and Properties II

(3) STEMMER, ZOK

Prerequisite: Materials 100A.

Not open for credit to students who have completed Materials 101. Lecture, 3 hours.

Mechanical properties of engineering materials and their relationship to bonding and structure. Elastic, flow, and fracture behavior; time dependent deformation and failure. Stiffening, strengthening, and toughening mechanisms. Piezoelectricity, magnetostriction and thermo-mechanical interactions in materials.

100C. Fundamentals of Structural Evolution

(3) LEVI, ODETTE, ZOK

Prerequisites: Materials 100A or ECE 132; and, Materials 100B or Chemical Engineering 185 or ME 180. Lecture, 3 hours.

An introduction to the thermodynamic and kinetic principles governing structural evolution in materials. Phase equilibria, 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

Prerequisite: upper-division standing.

Not open for credit to students who have completed Materials 100B. Students interested in following the BS Engineering/MS Materials program should not take this course.

Introduction to the structure of engineering materials and its relationship with their mechanical

properties. Structure of solids and defects. Concepts of microstructure and origins. Elastic, plastic flow and fracture properties. Mechanisms of deformation and failure. Stiffening, strengthening, and toughening mechanisms.

135. Biophysics and Biomolecular Materials

(3) SAFINYA

Prerequisites: Physics 5 or 6C or 25.

Same course as Physics 135.

Structure and function of cellular molecules (lipids, nucleic acids, proteins, and carbohydrates). Genetic engineering techniques of molecular biology. Biomolecular materials and biomedical applications (e.g., bio-sensors, drug delivery systems, gene carrier systems).

160. Introduction to Polymer Science

(3) KRAMER

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. (F)

162B. Fundamentals of the Solid State

(4) COLDREN, PETROFF

Prerequisites: ECE 162A with a minimum grade of C-; open to EE and materials majors only.

Same course as ECE 162B.

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) LEVI, ODETTE

Prerequisite: Materials 100B or 101.

Same course as ME 185. Lecture, 3 hours.

Introduces the student to the main families of materials and the principles behind their development, selection, and behavior. Discusses the generic properties of metals, ceramics, polymers, and composites more relevant to structural applications. The relationship of properties to structure and processing is emphasized in every case.

186. Manufacturing and Materials

(3) LEVI

Prerequisites: ME 15 and 151C; and, Materials 100B or 101.

Same course as ME 186. Lecture, 3 hours.

Introduction to the fundamentals of common manufacturing processes and their interplay with the structure and properties of materials as they are transformed into products. Emphasis on process understanding and the key physical concepts and basic mathematical relationships involved in each of the processes discussed.

188. Topics in Materials

(2) 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: *Kimberly Turner*

Vice Chairs: *Jeffrey M. Moehlis*

Faculty

Bassam Bamieh, Ph.D., Rice University, Professor (control systems design with applications to fluid flow problems)

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

Glenn E. Beltz, Ph.D., Harvard, Professor (solid mechanics, materials, aeronautics, engineering education)

Ted D. Bennett, Ph.D., UC Berkeley, Associate Professor (thermal science, laser processing)

David Bothman, B.S., UC San Diego, Lecturer

Francesco Bullo, Ph.D., California Institute of Technology, Professor (motion planning and coordination, control systems, distributed and adaptive algorithms)

David R. Clarke, Ph.D., University of Cambridge, Professor (electrical ceramics, thermal barrier coatings, piezospectroscopy, mechanics of microelectronics) *3

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

Gary S. Hansen, Ph.D., University of Michigan, Associate Professor (technology management program)

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

Mustafa Khammash, Ph.D., Rice University, Professor (robust analysis and synthesis of control systems and controls in biological systems)

Rouslan Krechetnikov, Ph.D., Moscow Institute of Physics & Technology, Assistant Professor (fluid mechanics, complex fluid interfaces, analytical mechanics, dynamical systems, stability theory, applied mathematics)

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

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

Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor (mechanical properties of structural materials, environmental effects, structural reliability) *1

Eric F. Matthys, Ph.D., California Institute of Technology, Professor (heat transfer, fluid mechanics, rheology)

Robert M. McMeeking, Ph.D., Brown University, Professor (mechanics of materials, fracture mechanics, plasticity, computational mechanics) *3

Eckart Meiburg, Ph.D., University of Karlsruhe, Professor (computational fluid dynamics, fluid mechanics)

Carl D. 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, Associate Professor (nonlinear dynamics, fluid mechanics, biological dynamics, applied mathematics)

G. Robert Odette, Ph.D., Massachusetts Institute of Technology, Professor (deformation and fracture, high performance materials for use in severe environments) *3

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

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

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

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

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

Kimberly L. Turner, Ph.D., Cornell University, Professor (microelectromechanical systems, dynamics, solid mechanics, measurement and characterization of microsystems motion and device parameters)

Megan Valentine, Ph.D., Harvard University, Assistant Professor (single-molecule biophysics, cell mechanics, motor proteins, biomaterials)

Henry T. Yang, Ph.D., Cornell University, Professor (aerospace structures, structural dynamics and stability, transonic flutter and aeroelasticity, intelligent manufacturing systems)

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

Emeriti Faculty

John C. Bruch, Jr., Ph.D., Stanford University, Professor Emeritus (applied mathematics, numerical solutions and analysis)

Roy S. Hickman, Ph.D., UC Berkeley,

Professor Emeritus (fluid mechanics, physical gas dynamics, computer-aided design)

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

Frederick A. Leckie, Ph.D., Stanford University, Professor Emeritus (mechanics of materials, engineering design)

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

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

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

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

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

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

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

*1 Joint appointment with Chemical Engineering.

*2 Joint appointment with Computer Science.

*3 Joint appointment with Materials.

Affiliated Faculty

Paul J. Atzberger (Mathematics)

Hector Cenicerros (Mathematics)

Patricia Holden (Bren School of Environmental Science and Management)

Arturo Keller (Bren School of Environmental Science and Management)

Gary Leal (Chemical Engineering)

Sally MacIntyre (Ecology, Evolution & Marine Biology)

The undergraduate program in mechanical engineering is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD, 21202-4012 – telephone: (410) 347-7700. We offer a balanced curriculum of theory and application, involving: preparation in basic science, math, computing and writing; a comprehensive set of engineering science and laboratory courses; and a series of engineering design courses starting in the freshman year and concluding with a three course sequence in the senior year. Our students gain hands-on expertise with state-of-the art tools of computational de-

sign, analysis, and manufacturing that are increasingly used in industry, government, and academic institutions. In addition, the Department has a 15-unit elective program that allows students to gain depth in specific areas of interest, while maintaining appropriate breadth in the basic stem areas of the discipline. All students participate in a widely recognized design project program which includes projects sponsored by industry, UCSB researchers, as well as intercollegiate design competitions. The project program has been expanded to emphasize entrepreneurial product-oriented projects.

Mission Statement

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

Educational Objectives for the Undergraduate Program

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

- Successfully practice in either the traditional or the emerging technologies comprising mechanical engineering;
- Are successful in a range of engineering graduate programs including those in mechanical, environmental and materials engineering;
- Have a solid background in the fundamentals of engineering allowing them to pass the Fundamentals of Engineering examination;
- Are active in professional societies.

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

Program Outcomes

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

1. Should possess a solid foundation in, and be able to apply the principles of, mathematics, science, and engineering to solve problems and have the ability to learn new skills relevant to his/her chosen career.
2. Have the ability to conduct and analyze data from experiments in dynamics, fluid dynamics, thermal science and materi-

als, and should have been exposed to experimental design in at least one of these areas.

3. Should have experienced the use of current software in problem solving and design.
4. Should demonstrate the ability to design useful products, systems, and processes.
5. Should be able to work effectively on teams.
6. Should have an understanding of professional and ethical responsibilities.
7. Should be able to write lab reports and design reports and give effective oral presentations.
8. Should have the broad background in the humanities and the social sciences, which provides an awareness of contemporary issues and facilitates an understanding of the global and societal impact of engineering problems and solutions.
9. Should be members of the American Society of Mechanical Engineers.

Undergraduate Program

Bachelor of Science— Mechanical Engineering

A minimum of 190 units is required for graduation. A complete list of requirements for the major can be found on page 50. Schedules should be planned to meet both General Education and major requirements.

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

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

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

Research Opportunities

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

Mechanical Engineering Courses

LOWER DIVISION

6. Basic Electrical and Electronic Circuits

(4) KHAMMASH, SOH

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

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

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

10. Engineering Graphics: Sketching, CAD, and Conceptual Design

(4) LAGUETTE

Prerequisite: ME majors only.

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

11. Introductory Concepts in Mechanical Engineering

(1) BOTHMAN, FIELDS, BELTZ

Prerequisite: lower-division standing.

The theme question of this course is "What do mechanical engineers do?" Survey of mechanical and environmental engineering applications. Lectures by mechanical engineering faculty and practicing engineers.

12. Manufacturing Processes

(1) STAFF

Prerequisite: ME majors only.

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

12S. Introduction to Machine Shop

(1) BOTHMAN

Prerequisite: ME majors only.

Basic machine shop skills course. Students learn to work safely in a machine shop. Students are introduced to the use of hand tools, the lathe, the milling machine, drill press, saws, and precision measuring tools. Students apply these skills by completing a project.

14. Statics

(4) BELTZ, MILSTEIN, TURNER

Prerequisite: Physics 1 and Mathematics 3B; open to ME majors only.

Introduction to applied mechanics. Forces, moments, couples, and resultants; vector algebra; construction of free body diagrams; equilibrium in 2- and 3- dimensions; analysis of frames, machines, trusses and beams; distributed forces; friction.

15. Strength of Materials

(4) BELTZ, MILSTEIN, KEDWARD

Prerequisites: ME 14; open to mechanical engineering majors only.

Properties of structural materials, including Hooke's law and behavior beyond the elastic limit. Concepts of stress, strain, displacement, force, force systems, and multiaxial stress states. Design applications to engineering structures, including problems of bars in tension, compression, and torsion, beams subject to flexure, pressure vessels, and buckling.

16. Engineering Mechanics: Dynamics

(4) TURNER, BAMIEH

Prerequisites: Physics 2; ME 14; and, Mathematics 5C; (may be taken concurrently); open to ME majors only.

Not open for credit to students who have completed ME 163A.

Vectorial kinematics of particles in space, orthogonal coordination systems. Relative and constrained motions of particles. Dynamics of particles and systems of particles, equations of motion, energy and momentum methods. Collisions. Planar kinematics and kinetics of rigid bodies. Energy and momentum methods for analyzing rigid body systems. Moving frames and relative motion.

17. Mathematics of Engineering

(3) MOEHLIS, GIBOU

Prerequisite: Engineering 3; Mathematics 5B (may be taken concurrently); open to ME majors only.

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

95. Introduction to Mechanical Engineering

(1-4) STAFF

Prerequisite: consent of instructor.

May be repeated for credit to a maximum of 6 units.

Participation in projects in the laboratory or machine shop. Projects may be student- or faculty-originated depending upon student interest and consent of faculty member.

97. Mechanical Engineering Design Projects

(1-4) STAFF

Prerequisite: consent of instructor.

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

Course offers students opportunity to work on established departmental design projects. P/ NP grading, does not satisfy technical elective requirement.

99. Introduction to Research

(1-3) STAFF

Prerequisite: consent of instructor.

May be repeated for maximum of 6 units, variable hours.

Directed study to be arranged with individual faculty members. Course offers exceptional students an opportunity to participate in a research group.

UPPER DIVISION

100. Professional Seminar

(1) STAFF

Prerequisite: undergraduate standing.

May be repeated for up to 3 units. May not be used as a departmental elective.

A series of weekly lectures given by university staff and outside experts in all fields of mechanical and environmental engineering.

104. Mechatronics

(3) BAMIEH, PADEN

Prerequisites: ME 6; open to ME majors only.

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

105. Mechanical Engineering Laboratory

(4) BENNETT, MATTHYS, VALENTINE

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

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

106A. Advanced Mechanical Engineering Laboratory

(3) KHAMMASH, BAMIEH

Prerequisite: ME 155A.

An advanced lab course with experiments in dynamical systems and feedback control design. Students design, troubleshoot, and perform detailed, multi-session experiments.

106B. Mechanics, Materials and Structures Laboratory

(3) ZOK

Prerequisites: ME 15; ME 154; ME 156A; and Materials 100B or 101.

Experiments on mechanical behavior of materials and structures. Assessment of analytical and finite element methods for mechanical design, with applications to optimization of lightweight structures.

106C. Advanced Thermo/Fluids Laboratory

(3) BENNETT

Prerequisite: ME 105 and 151A-B, ME 151C (may be concurrent) and ME 152A-B

Perform thermo/fluid experiments that emphasize elements of thermodynamics, heat transfer, and fluid mechanics. This laboratory course stresses critical thinking skills required to construct and perform experiments independently, and to investigate physical phenomena experimentally.

110. Aerodynamics and Aeronautical Engineering

(3) BELTZ, MEINHART

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 Conversion

(3) MATTHYS

Prerequisite: ME 151C and 152; or, Chemical Engineering 110B and 120A.

Overview of energy usage and production from prehistory to present times (technical, environmental, and societal issues). Technical analysis of the modern means of energy production (fossil, nuclear, hydro, wind, solar, geothermal, biomass, etc.): operating principles, hardware, engineering issues, environmental impact, etc.

114. Water Supply and Pollution Control

(3) STAFF

Prerequisite: ME 152A or Chemical Engineering 120A.

Water supply and quality requirements for domestic, industrial, agricultural, and recreational uses. Properties of natural surface and groundwaters. Pollutants in surface and groundwaters. Transport and fates of waterborne pollutants. Water and sewage treatment processes. Waste water reclamation. Water quality management in ground and surface water environments.

119. Introduction to Coastal Engineering

(3) STAFF

Prerequisite: ME 152A.

Quantitative description of waves and tides: refraction, shoaling, nearshore circulation. Sediment characteristics and transport; equilibrium beach profile; shoreline protection.

124. Advanced Topics in Transport Phenomena/Safety

(3) THEOFANOUS

Prerequisites: Chemical Engineering 120A-B-C, or ME 151A-B and ME 152A.

Same course as Chemical Engineering 124. Hazard identification and assessments, runaway reactions, emergency relief. Plant accidents and safety issues. Dispersion and consequences of releases.

125AA-ZZ. Special Topics in Mechanical Engineering

(3) STAFF

Prerequisite: Consent of instructor.

May be repeated for credit to a maximum of 12 units provided letter designations are different. Students are advised to consult their faculty advisor before making their course selection.

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

mechanical engineering.

128. Design of Biomedical Devices

(3) LAGUETTE

Prerequisite: Mechanical Engineering 10, 14, 15, 16, and 153; open to ME majors only.

Introductory course addresses the challenges of biomedical device design, prototyping and testing, material considerations, regulatory requirements, design control, human factors and ethics.

134. Advanced Thermal Science

(3) MATTHYS, YUEN

Prerequisite: ME 151C.

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

136. Introduction to Multiphase Flows

(3) THEOFANOUS

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

Same course as Chemical Engineering 136.

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

138. Risk Assessment and Management

(3) THEOFANOUS

Prerequisites: ME 151B and 152A, or Chemical Engineering 120A-B-C.

Same course as Chemical Engineering 138.

Conceptual foundations of risk and its utility for decision making. Determinism, statistical inference, and uncertainty. Formulation of safety goals and approaches to risk management. Generalized methodology and tools for assessing risks in the industrial, ecological, and public health context.

140A. Numerical Analysis in Engineering

(3) MOEHLIS, GIBOU, MEIBURG

Prerequisites: ME 17 or Chemical Engineering 132A; open to ME and Chemical Engineering majors only.

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

140B. Theoretical Analysis in Mechanical Engineering

(3) MOEHLIS, GIBOU, MEIBURG

Prerequisites: ME 140A; open to ME and Chemical Engineering majors only.

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

141A. Introduction to Nanoelectromechanical and Microelectromechanical systems (NEMS/ MEMS)

(3) TURNER, PENNATHUR

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

Same course as ECE 141A.

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) TURNER, PENNATHUR

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

Same course as ECE 141B.

Lectures and laboratory on semiconductor-based

processing for MEMS. Description of key equipment and characterization tools used for MEMS and design, fabrication, characterization and testing of MEMS. Emphasis on current MEMS devices including accelerometers, comb drives, micro-reactors and capacitor-actuators.

141C. Introduction to Microfluidics and BioMEMS

(3) MEINHART

Prerequisite: ME 141A or ECE 141A; open to ME and EE majors only.

Same course as ECE 141C.

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

146. Molecular and Cellular Biomechanics

(3) VALENTINE

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

151A. Thermosciences 1

(4) MATTHYS

Prerequisite: Physics 2; ME 14; and, Mathematics 5C.

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

151B. Thermosciences 2

(4) MATTHYS

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) MATTHYS

Prerequisites: ME 151B and 152B; open to ME majors only.

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

152A. Fluid Mechanics

(4) MATTHYS, MEINHART

Prerequisite: Mathematics 5C and ME 16.

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

152B. Fluid Mechanics

(3) MEINHART, PENNATHUR

Prerequisite: ME 152A; open to ME majors only.

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

153. Introduction to Mechanical Engineering Design

(3) BELTZ, TURNER, KEDWARD, LAGUETTE

Prerequisites: ME 10 and 16; open to ME majors only.

Design methods. Creative thinking. Introduction to manufacturing processes, design for manufacturing. Project planning and teamwork. Applications of engineering software. Application of engineering principles to practical problem solving. Codes and standards. Engineering ethics.

154. Design and Analysis of Structures

(3) MCMEEKING, KEDWARD, SHUGAR

Prerequisites: ME 15 and 16; open to ME majors only.

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

155A. Control System Design

(3) BAMIEH, ASTROM, BULLO

Prerequisite: ME 17; ME 140A (may be taken concurrently); and ME 163.

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

155B. Control System Design

(3) PADEN

Prerequisite: ME 155A.

Dynamic system modeling using state-space methods, controllability and observability, state-space methods for control design including pole placement, and linear quadratic regulator methods. Observers and observer-based feedback controllers. Sampled-data and digital control. Laboratory exercises using MATLAB for simulation and control design.

156A. Mechanical Engineering Design - I

(3) TURNER, LUCAS

Prerequisite: ME 151C (may be concurrent), 152B, 153 and 154; and MATRL 101 or 100B; open to ME majors only

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

156B. Mechanical Engineering Design II

(3) KEDWARD

Prerequisites: ME 156A; open to ME majors only.

Machine elements including gears, bearings, and shafts. Joint design and analysis: bolts, rivets, adhesive bonding and welding. Machine dynamics and fatigue. Design for reliability and safety. Codes and standards. Topics covered are applied in practical design projects.

158. Computer Aided Design and Manufacturing

(3) BOTHMAN

Prerequisites: ME 10 and 156A; open to ME majors only.

Engineering applications using advanced 3-D CAD software for plastic part designs and tooling. Topics include an overview of the design for injection molded plastic parts, material selections and electronic tooling design via CAD and CNC system software. Emphasis is put into final design projects that are designed to be functional, manufacturable, and esthetically pleasing.

162. Introduction to Elasticity

(3) MCMEEKING, BELTZ

Prerequisites: ME 15 and 140A.

Equations of equilibrium, compatibility, and boundary conditions. Solutions of two-dimensional problems in rectangular and polar coordinates. Eigen-solutions for the Wedge and Williams' solution for cracks. Stress intensity factors. Extension, torsion, and bending. Energy theorems. Introduction to wave propagation in elastic solids.

163. Engineering Mechanics: Vibrations

(3) MEZIC, BULLO

Prerequisites: ME 16; open to ME majors only.

Not open for credit to students who have completed ME 163B.

Topics relating to vibration in mechanical systems; exact and approximate methods of analysis, matrix methods, generalized coordinates and Lagrange's equations, applications to systems. Basic feedback systems and controlled dynamic behavior.

166. Advanced Strength of Materials

(3) TURNER, KEDWARD

Prerequisite: ME 15.

Analysis of statically determinate and indeterminate systems using integration, area moment, and energy methods. Beams on elastic foundations, curved beams, stress concentrations, fatigue, and theories of failure for ductile and brittle materials. Photoelasticity and other experimental

techniques are covered, as well as methods of interpreting in-service failures.

167. Structural Analysis

(3) YANG

Prerequisites: ME 15 or 165; and ME 140A.

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) MEZIC, KHAMMASH

Prerequisites: Physics 105A or ME 163; or upper-division standing in ECE.

Same course as ECE 183 and Physics 106. Not open for credit to students who have completed ME 163C.

An introduction to nonlinear phenomena. Flows and bifurcation in one and two dimensions, chaos, fractals, strange attractors. Applications to physics, engineering, chemistry, and biology.

170A. Introduction to Robotics: Robot Mechanics

(4) PADEN, BULLO

Same course as ECE 181A.

Recommended preparation: ME 16.

Overview of robot kinematics and dynamics. Structure and operation of industrial robots. Robot performance: workspace, velocity, precision, payload. Comparative discussion of robot mechanical designs. Actuators. Robot coordinate systems. Kinematics of position. Dynamics of manipulators.

170C. Introduction to Robotics: Robot Control

(4) PADEN

Prerequisites: ECE 2A-B-C with a minimum grade of C-; or ME 104.

Same course as ECE 181C.

Overview of robot control technology from open-loop manipulators and sensing systems, to single-joint servovalves and servomotors, to integrated adaptive force and position control using feedback from machine vision and touch sensing systems. Design emphasis on accurate tracking accomplished with minimal algorithm complexity.

173. Control Systems Synthesis

(3) BAMIEH

Prerequisite: ME 155A.

Not open for credit to students who have completed ECE 147A.

Pole-placement, observer design, observer-based compensation, frequency and time-domain techniques, internal model principle, linear quadratic regulators, modeling uncertainty in signals and systems, robust stability and performance, synthesis for robustness.

185. Materials in Engineering

(3) LEVI, ODETTE

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.

186. Manufacturing and Materials

(3) LEVI, ODETTE

Prerequisites: ME 15 and 151C; and, Materials 100B or 101.

Same course as Materials 186.

Introduction to the fundamentals of common manufacturing processes and their interplay with the structure and properties of materials as they are transformed into products. Emphasis on process understanding and the key physical concepts and basic mathematical relationships involved in each of the processes discussed.

189A-B-C. Capstone Mechanical Engineering Design Project

(2-2-2) LAGUETTE

Prerequisites: ME 153; and ME 156A (may be taken concurrently).

A three-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.

Students work in teams under the direction of a faculty advisor to tackle an engineering design project. Engineering communication, such as reports and oral presentations are covered. Course emphasizes practical, hands-on experience, and integrates analytical and design skills acquired in the companion ME 156 courses.

193. Internship in Industry

(1) STAFF

Prerequisite: consent of instructor and prior departmental approval needed.

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

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

197. Independent Projects in Mechanical Engineering Design

(1-4) STAFF

Prerequisites: ME 16; consent of instructor.

May be repeated for a maximum of 12 units, variable hours. No more than 4 units may be used as departmental electives.

Special projects in design engineering. Course offers motivated students opportunity to synthesize academic skills by designing and building new machines.

199. Independent Studies in Mechanical Engineering

(1-5) STAFF

Prerequisites: consent of instructor; upper-division standing; completion of two upper-division courses in Mechanical Engineering.

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

Directed individual study.

GRADUATE COURSES

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



CHEMICAL ENGINEERING 2010-11

	Units		Units
PREPARATION FOR THE MAJOR	80	UNIVERSITY REQUIREMENTS	
CH E 1A.....	1	American History and Institutions – (one 4-unit course, may be counted as G.E. if selected from approved list)	
CH E 10.....	3	_____	
CHEM 1A, 1B, 1C or 2A, 2B, 2C.....	9	UC Entry Level Requirement: English Composition	
CHEM 1AL, 1BL, 1CL or 2AC, 2BC, 2CC.....	6	<i>Must be fulfilled within three quarters of matriculation</i>	
CHEM 6AL-BL.....	6	Satisfied by: _____	
CHEM 109A-B-C.....	12		
ENGR 3.....	3		
MATH 3A-B-C, 5A-B-C.....	24		
PHYS 1, 2, 3, 3L, 4, 4L.....	16		
UPPER DIVISION MAJOR	78	GENERAL EDUCATION	
CH E 110A-B.....	6	General Subject Areas	
CH E 119.....	1	Area A: English Reading & Comprehension – (2 courses required)	
CH E 120A-B-C.....	10	A-1: _____ A-2: _____	
CH E 128.....	3	Areas D & E: Social Sciences, Culture and Thought	
CH E 132A-B-C.....	10	(2 courses minimum)	
CH E 140A-B.....	6	_____	
CH E 152A.....	4	Areas F & G: The Arts, Literature	
CH E 170.....	3	(2 courses minimum)	
CH E 180A-B.....	6	_____	
CH E 184A-B.....	6	2 additional courses from Areas D, E, F, G, or H	
CHEM 113B-C.....	8	_____	
MATRL 101 or MATRL 100B *.....	3		
* see note on next page		Special Subject Areas	
Technical Elective requirement.....	12	Depth: _____	
<i>Prior approval of the student's technical electives must be obtained from the department faculty adviser.</i>		_____	
Approved Technical Elective Requirement classes:		Ethnicity (1 course): _____	
CH E 102 CHEM 142A-B-C MCDB 111		European Traditions (1 course): _____	
CH E 121 CHEM 145 MCDB 126A-B-C		Writing (4 courses required):	
CH E 124 CHEM 147 MCDB 133		_____	
CH E 125 CHEM 150 MCDB 138		_____	
CH E 136 ECE 130A-B-C ME 110			
CH E 138 ECE 183 ME 112			
CH E 141 ENGR 101 ME 114			
CH E 152B ENGR 103 ME 119			
CH E 154 ENGR 185A-B-C-D ME 128			
CH E 160 ENV S 105 ME 134			
CH E 171 MATH 122A-B ME 169			
CH E 198 MATRL 100A,C ME 185			
CHEM 115A-B-C MATRL 160 PHYS 123A-B			
CHEM 123 MATRL 185 PHYS 127AL			
CHEM 126 MCDB 101A-B PHYS 127BL			
Technical electives taken:			

Courses required for the major, inside or outside of the Department of Chemical Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.			
		NON-MAJOR ELECTIVES	36
		General Education and Free Electives taken:	

		TOTAL UNITS REQUIRED FOR GRADUATION 194	

CHEMICAL ENGINEERING 2010-11

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
CH E 1A	1	CHEM 1B or 2B	3	CHEM 1C or 2C	3
CHEM 1A or 2A	3	CHEM 1BL or 2BC	2	CHEM 1CL or 2CC	2
CHEM 1AL or 2AC	2	MATH 3B	4	MATH 3C	4
ENGR 3 or G.E. Elective	3	PHYS 1	4	PHYS 2	4
MATH 3A	4	WRIT 2E or 50E	4	WRIT 50E or G.E. Elective	4
WRIT 1E or 2E	4			or ENGR 3	
TOTAL	17		17		17

SOPHOMORE YEAR

FALL	units	WINTER	units	SPRING	units
CH E 10	3	CH E 110A	3	CH E 110B	3
CHEM 109A	4	CHEM 6AL	3	CHEM 6BL	3
MATH 5A	4	CHEM 109B	4	CHEM 109C	4
PHYS 3	3	MATH 5B	4	MATH 5C	4
PHYS 3L	1	PHYS 4	3	G.E. Elective	4
		PHYS 4L	1		
TOTAL	15		18		18

JUNIOR YEAR

FALL	units	WINTER	units	SPRING	units
CH E 119	1	CH E 120B	3	CH E 120C	3
CH E 120A	4	CH E 132C	3	CH E 140A	3
CH E 128	3	CHEM 113B	4	CH E 180A	3
CH E 132A	4	MATRL 101 or MATRL 100B*	3	CHEM 113C	4
G.E. Elective	4	G.E. Elective	3	Technical or Free Elective	3
TOTAL	16		16		16

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
CH E 132B	3	CH E 180B	3	CH E 184B	3
CH E 140B	3	CH E 184A	3	G.E. Elective	4
CH E 152A	4	G.E. Elective	4	Technical or Free Electives	7
CH E 170	3	Technical or Free Electives	4		
Technical or Free Elective	3				
TOTAL	16		14		14

* if applying to the BS/MS Materials program, juniors must take MATRL 100A in fall, MATRL 100B in winter, and MATRL 100C in spring.

COMPUTER ENGINEERING 2010-11

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
CHEM 1A or 2A	3	ECE 15A or Math, Science, or Engr. Elective	3/4	CMPSC 16	4
CHEM 1AL or 2AC	2	MATH 3B	4	ECE 1	1
MATH 3A	4	PHYS 1	4	MATH 3C	4
G.E. Elective or CMPSC 8*	4	WRIT 2E or 50E	4	PHYS 2	4
WRIT 1E or 2E	4			WRIT 50E or G.E. Elective	4
TOTAL	17		15/16		17

SOPHOMORE YEAR

FALL	units	WINTER	units	SPRING	units
CMPSC 40	4	CMPSC 24	4	CMPSC 32	4
ECE 2A	5	ECE 2B	5	ECE 2C	5
MATH 5A	4	ECE 15A or Math, Science, or Engr. Elective	3/4	ECE 152A	5
PHYS 3	3	PHYS 4	3	ECE 139 or PSTAT 120A**	4
PHYS 3L	1	PHYS 4L	1		
TOTAL	17		16/17		18

JUNIOR YEAR

FALL	units	WINTER	units	SPRING	units
ECE 154	4	CMPSC 130A	4	CMPSC 170	4
G.E. or Free Electives	8	CMPEN Elective	4	ECE 152B	5
CMPEN Elective	4	G.E. or Free Electives	8	G.E. or Free Elective	4
TOTAL	16		16		13

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
CMPEN Electives	12	CMPEN Electives	8	CMPEN Electives	12
Free Elective	4	ENGR 101	3		
		Free Elective	4		
TOTAL	16		15		12

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

** PSTAT 120A is offered each quarter. ECE 139 is offered only in spring quarter, and is better suited for future upper division electives for the Computer Engineering major.

COMPUTER SCIENCE 2010-11

PREPARATION FOR THE MAJOR	Units
CMPSC 16	4
CMPSC 24	4
CMPSC 32	4
CMPSC 40	4
CMPSC 48	4
CMPSC 56	4
CMPSC 64	4
MATH 3A-B-C, 5A-B	20
PSTAT 120A	4

UPPER DIVISION MAJOR	Units
CMPSC 111 or 140	4
CMPSC 130A-B	8
CMPSC 138	4
CMPSC 154/ECE 154	4
CMPSC 160	4
CMPSC 162	4
CMPSC 170	4
ECE 152A	5
ENGR 101	3
PSTAT 120B	4

Major Field Electives 20
 selected from the following list (at least 8 units must be CMPSC courses)

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

CMPSC/MATH 109A-B-C	CMPSC 178	ECE 130A-B-C
CMPSC 111 ¹	CMPSC 180	ECE 140
CMPSC 140 ¹	CMPSC 181B/ECE 181B	ECE 152B
CMPSC/ECE 153A	CMPSC 182/ECE160	ECE 153B
CMPSC 165A-B	CMPSC 185	MATH 108A-B
CMPSC 167	CMPSC 186	MATH 119A-B
CMPSC 171/ECE 151	CMPSC 189 A-B	MATH 124A-B
CMPSC 172	CMPSC 190 AA-ZZ	PSTAT 122
CMPSC 174A-B	CMPSC 192 ²	PSTAT 130
CMPSC 176A-B-C	CMPSC 196 ²	PSTAT 132C
CMPSC 177		

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

Major Field Electives taken:

SCIENCE COURSES	Units
PHYS 1, 2, 3, 3L	12
Science Electives (see Dept. for list)	8
Science Electives taken:	_____

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

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

GENERAL EDUCATION	Units
General Subject Areas	
Area A: English Reading & Comprehension – (2 courses required)	_____
A-1: _____ A-2: _____	_____
Areas D & E: Social Sciences, Culture and Thought (2 courses minimum)	_____
Areas F & G: The Arts, Literature (2 courses minimum)	_____
2 additional courses from Areas D, E, F, G, or H	_____

Special Subject Areas	Units
Depth:	_____
Ethnicity (1 course):	_____
European Traditions (1 course):	_____
Writing (4 courses required):	_____

NON-MAJOR ELECTIVES	Units
General Education and Free Electives taken:	_____
_____	_____
_____	_____
_____	_____
_____	_____

TOTAL UNITS REQUIRED FOR GRADUATION 184

COMPUTER SCIENCE 2010-11

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
G.E. Elective or CMPSC 8*	4	CMPSC 16	4	CMPSC 24	4
MATH 3A	4	MATH 3B	4	MATH 3C	4
WRIT 1, 2, or G.E. Elective	4	PHYS 1	4	PHYS 2	4
G.E. Elective	4	WRIT 1, 2, or G.E. Elective	4	Science or Free Elective	4
TOTAL	16		16		16

SOPHOMORE YEAR

FALL	units	WINTER	units	SPRING	units
CMPSC 32	4	CMPSC 48	4	CMPSC 64	4
CMPSC 40	4	CMPSC 56	4	PSTAT 120A	4
MATH 5A	4	MATH 5B	4	G.E. Elective	4
PHYS 3	3	G.E. Elective	4	Science or Free Elective	4
PHYS 3L	1				
TOTAL	16		16		16

JUNIOR YEAR

FALL	units	WINTER	units	SPRING	units
CMPSC 130A	4	CMPSC 130B	4	CMPSC / ECE 154	4
CMPSC 138	4	ECE 152A	5	PSTAT 120B	4
G.E. Elective	4	Free Elective	3	Field or Free Elective	4
Science or Free Elective	4	G.E. Elective	4	G.E. Elective	4
TOTAL	16		16		16

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
CMPSC 111 **	4	CMPSC 160	4	Field or Free Elective	4
CMPSC 170	4	CMPSC 162	4	Field or Free Elective	4
Field or Free Elective	4	ENGR 101	3	G.E. or Free Elective	5
		Field or Free Elective	4		
TOTAL	12		15		13

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

** or you may take CMPSC 140 in winter quarter to satisfy this requirement.

ELECTRICAL ENGINEERING 2010-11

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
CHEM 1A or 2A	3	CHEM 1B or 2B	3	CMPSC 16	4
CHEM 1AL or 2AC	2	CHEM 1BL or 2BC	2	MATH 3C	4
ENGR 3	3	MATH 3B	4	PHYS 2	4
MATH 3A	4	PHYS 1	4	WRIT 50E or G.E.	4
WRIT 1E or 2E	4	WRIT 2E or 50E	4		
TOTAL	16		17		16

SOPHOMORE YEAR

FALL	units	WINTER	units	SPRING	units
ECE 2A	5	ECE 2B	5	CMPSC 24	4
MATH 5A	4	ECE 15A	3	ECE 2C	5
PHYS 3	3	MATH 5B	4	MATH 5C	4
PHYS 3L	1	PHYS 4	3	PHYS 5	3
		PHYS 4L	1	PHYS 5L	1
TOTAL	13		16		17

JUNIOR YEAR

FALL	units	WINTER	units	SPRING	units
ECE 130A	4	ECE 130B	4	ECE 137B	4
ECE 132	4	ECE 137A	4	ECE 139*	4
ECE 134	4	ECE Elective	4	ECE 152A**	5
G.E. or Free Elective	4	G.E. or Free Elective	4	G.E. or Free Elective	4
TOTAL	16		16		17

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
ECE Electives	12	ECE Electives	8	ECE Electives	8
G.E. or Free Elective	4	G.E. or Free Electives	8	ENGR 101	3
				G.E. or Free Electives	6
TOTAL	16		16		17

* ECE 139 may also be taken in the spring quarter of the sophomore year.

** ECE 152A may also be taken in the spring quarter of the sophomore year.

MECHANICAL ENGINEERING 2010-11

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
CHEM 1A or 2A	3	CHEM 1B or 2B	3	MATH 3C	4
CHEM 1AL or 2AC	2	CHEM 1BL or 2BC	2	ME 10	4
ENGR 3 or G.E. Elective	3/4	MATH 3B	4	PHYS 2	4
MATH 3A	4	PHYS 1	4	WRIT 50E, ENGR 3, or	3/4
WRIT 1E or 2E	4	WRIT 2E or 50E	4	G.E. Elective	
TOTAL	16/17		17		15/16

SOPHOMORE YEAR

FALL	units	WINTER	units	SPRING	units
MATH 5A	4	MATH 5B	4	MATH 5C	4
ME 14	4	ME 6	4	ME 16	4
PHYS 3	3	ME 15	4	ME 17	3
PHYS 3L	1	PHYS 4	3	G.E. Elective	4
G.E. Elective	4	PHYS 4L	1		
TOTAL	16		16		15

JUNIOR YEAR

FALL	units	WINTER	units	SPRING	units
ME 104	3	MATRL 101 or	3	ME 105	4
ME 140A	3	MATRL 100B*		ME 153	3
ME 151A	4	ME 151B	4	ME 151C	3
ME 152A	4	ME 152B	3	ME 155A	3
G.E. or Free Elective	4	ME 163	3	G.E. or Free Elective	4
		G.E. or Free Elective	4		
TOTAL	18		17		17

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
ME 154	3	ME 156B	3	ME 189C	2
ME 156A	3	ME 189B	2	Departmental Electives	6
ME 189A	2	Departmental Electives	6	G.E. or Free Electives	4
Departmental Electives	3	G.E. or Free Elective	4		
G.E. or Free Elective	4				
TOTAL	15		15		12

* if applying to the BS/MS Materials program, juniors must take MATRL 100A in fall, MATRL 100B in winter, and MATRL 100C in spring.

Additional Resources and Information

Gaucha On-Line Data (GOLD) – student record, class registration, degree audits—<https://my.sa.ucsb.edu/gold>

UMAIL – campus email for official notifications—<http://www.umail.ucsb.edu>

Schedule of Classes information – quarterly calendar and information—<http://www.registrar.ucsb.edu>

General Catalog for UCSB – academic requirements for all campus majors—<http://my.sa.ucsb.edu/Catalog/>

Summer Sessions – Summer programs and course offerings—<http://www.summer.ucsb.edu>

Tutoring – course-specific tutoring and academic skills development—<http://www.clas.ucsb.edu>

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

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

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

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

		Phone	Email	Location
College Advising staff		(805) 893-2809	coe-info@enr.ucsb.edu	Frank Hall, Rm. 1006
Departmental Advisors:				
Chemical Engineering	Laura Crowover	893-8671	cheugrads@enr.ucsb.edu	Engr.II, Rm. 3335
Computer Engineering	Jaima Dillard	893-8292	ugradinfo@ece.ucsb.edu	Trailer 380, Rm. 101
Computer Science	Benji Dunson	893-4321	ugradv@cs.ucsb.edu	Frank Hall, Rm. 2104
Electrical Engineering	Jaima Dillard	893-8292	ugradinfo@ece.ucsb.edu	Trailer 380, Rm. 101
Mechanical Engineering	Suzi See	893-8198	meugrad@enr.ucsb.edu	Engr.II, Rm. 2335



2010-11 Academic Calendar

Note: Dates subject to change without notice.

	Fall 2010	Winter 2011	Spring 2011
Registration begins	May 13, 2010	October 23, 2010	February 2, 2011
Quarter begins	September 18-19, 2010	January 3, 2011	March 28, 2011
Convocation	September 20, 2010		
Pre-instruction Activities	September 20-22, 2010	January 3, 2011	March 28, 2011
First day of instruction	September 23, 2010	January 3, 2011	March 28, 2011
Last day of instruction	December 3, 2010	March 11, 2011	June 3, 2011
Final examinations	December 6-11, 2010	March 14-19, 2011	June 4-10, 2011
Quarter ends	December 11, 2010	March 19, 2011	June 10, 2011
Commencement			June 11-12, 2011

Summer Sessions 2011

Registration begins: April 4, 2011
First day of instruction: June 20, 2011

2010-11 Campus Holidays

Labor Day: Monday, September 6, 2010
Veterans' Day: Thursday, November 11, 2010
Thanksgiving: Thursday & Friday, November 25 & 26, 2010
Christmas: Friday & Monday, December 24 & 27, 2010
New Year: Thursday & Friday, December 30 & 31, 2010
Martin Luther King, Jr.'s Birthday: Monday, January 17, 2011
Presidents' Holiday: Monday, February 21, 2011
Cesar Chavez Holiday: Friday, March 25, 2011
Memorial Day: Monday, May 30, 2011
Independence Day: Monday, July 4, 2011

GEAR **General Engineering Academic Requirements** **2010-11**

*For additional information, please contact the
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University of California
Santa Barbara, CA 93106-5130*

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EQUAL OPPORTUNITY AND NONDISCRIMINATION

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

¹ Pregnancy includes pregnancy, childbirth, and medical conditions related to pregnancy or childbirth.

Produced by the College of Engineering, Student Advising Division

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