GEAR

General **E**ngineering **A**cademic **R**equirements

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College of Engineering
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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 faculty, the members of which are highly acclaimed in the scientific communities in which they work. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. A high percentage of the faculty has been elected to the prestigious National Academy of Sciences and National Academy of Engineering. We have five Nobel Prize winners on this campus, four of whom are faculty in engineering and the sciences. We're also home to an amazing group of smart, accomplished, high-energy students. These more than 1,350 undergraduates, pursuing a variety of interests, contribute greatly to the quality of the learning environment as well as to the overall richness of campus life.

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

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

As part of the prestigious and well-established University of California system, we have the resources as well as the breadth and depth of talent to pursue new fields of scientific inquiry. We also bring an entrepreneurial attitude to our research, focusing on applications as much as discovery.
Our leading programs in areas as diverse as biotechnology, communications, computer security, materials, nanotechnology, networking, and photonic devices attest to the success of this approach.

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

Glenn E Beltz

Glenn Beltz
Associate Dean for
Undergraduate Studies

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College of Engineering

The College of Engineering at UCSB is noted for its excellence in teaching, research, and service to the community. The college has an enrollment of approximately 1,350 undergraduate students and 750 graduate students with a full-time, permanent faculty of 129. This results in an excellent student to faculty ratio and a strong sense of community in the college.

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

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

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

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

Mission Statement

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

College of Engineering Honors Program

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

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

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

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

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

Dean's Honors

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

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

Tau Beta Pi

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

Education Abroad Program (EAP)

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

Student Organizations

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

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

Change of Major and Change of College

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

Students who enter UCSB as transfer students will not be able to change to or add an engineering major, if not initially accepted into one. Students who began as freshmen who plan to enter an engineering major or to change from one engineering major to another will be expected to complete at least 30 units at UCSB before petitioning for a change of major and usually must satisfy the prerequisites of the prospective major. Students who have completed more than 105 units will not be considered for a change of major/change of college in engineering or computer science unless they can demonstrate that they will be able to complete all the degree requirements without exceeding 215 total units.

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

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

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

1. An overall UCSB grade point average of at least 3.0.
2. Satisfactory completion at UCSB, with a grade point average of 3.0 or better, of any five classes, including at least two Electrical & Computer Engineering (ECE) classes and two Computer Science (CMPSC) classes, from the following: Math 4B or 5A, ECE 2A-B-C, ECE 15A, CMPSC 16, 24, 32, 40.

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

1. An overall UCSB grade point average of at least 2.0;
2. Satisfactory completion (preferably at UCSB), with a grade of B or better in Computer Science 16, 24, and 40;
3. Satisfactory completion (preferably at UCSB) with a grade of C or better in Math 3A and 3B; Math 3C or 4A; and Math 4B or 5A.

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

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

1. An overall UCSB grade point average of at least 3.0.
2. Satisfactory completion at UCSB, with a grade point average of 3.0 or better, of at least five classes, including at least two mathematics classes, from the following: Math 4B or 5A, Math 5B or 6A, Math 5C or 6B, ECE 2A-B-C, ECE 15A. The calculation of the minimum GPA will be based on all classes completed from this list at the time of petitioning.

Mechanical Engineering. Before petitioning for a change of major to mechanical engineering, six (6) of the following core courses or their UC equivalents must be completed: Math 3A-B; Math 3C or 4A; Math 5A or 4B; Math 5B-C or 6A-B; Physics 1-2; ME 14-15 (at least one of the 6 courses must include ME 14 or ME 15). Acceptance into the major will be based on UC grade point averages, applicable courses completed, and space availability. All students considering changing into Mechanical Engineering are required to meet with the ME Academic Advisor.

Degree Requirements

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

General University Requirements

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

College General Education Requirements

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

Major Degree Requirements

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

Advanced Placement Credit

Students who complete special advanced placement courses in high school and who earn scores of 3, 4, or 5 on the College Board Advanced Placement taken before high school graduation will receive 2, 4, or 8 units of credit toward graduation at UCSB for each such test completed with the required scores, provided scores are reported to the Office of Admissions. The specific unit values assigned to each test, course equivalents, and the applicability of these credits to the General Education requirements are presented in the chart on page 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 on page 6.

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 what is prescribed by the prevailing academic Senate regulation regarding Minimum Cumulative Progress. At least three-fourths of the minimum number of academic units passed must include courses prescribed for the major.

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

Students must obtain the approval of the dean of engineering to deviate from these requirements. Approval normally will be granted only in cases of medical disability, severe personal problems, or accidents. Students enrolled in dual-degree programs must submit their proposed programs of study to the Associate Dean for Undergraduate Studies in the College of Engineering for approval. The individual programs must contain comparable standards of minimal academic progress.

215–Unit and Quarter Enrollment Limitations

The college expects students to graduate with no more than 215 units. College credit earned before high school graduation does not count toward the 215-unit maximum. This includes credit for Advanced Placement and International Baccalaureate examinations, and also college or university credit earned while still in high school.

Students who are admitted as freshmen and remain continuously enrolled will be assessed after 12 regular quarters at UCSB, and transfer students admitted as juniors will be assessed after 9 regular quarters at UCSB, irrespective of whether they earn more than 215 units during that period. Summer session does not count as a regular quarter in this calculation, but units earned in summer session do apply toward the 215-unit maximum.

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

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

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

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

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

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

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

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

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

International Baccalaureate Higher Level Exam
(With Score of 5 or Higher)

Exam	Units	GE Credit	UCSB Equivalent
Biology	8	C: 1 course	MCDB 20/EEMB 20
Business & Management	8	None	None
Chemistry	8	C: 1 course#	Natural Science 1B
Computer Science	8	C: 1 course#	Computer Science 5NM
Design Technology	8	None	None
Economics	8	D: 2 courses	Econ 1,2
English (A1 level)			
Score of 5	8	Entry Level Writing	Writing 1, 1E, 1LK
Score of 6	8	Writing 2	Writing 1, 1E, 1LK, 2, 2E, 2LK
Score of 7	8	Writing 2, 50	Writing 1, 1E, 2, 2E, 50, 50E
Foreign Languages	8	B	Levels 1-6
Geography	8	D: 1 course	None
History of Africa	8	E: 1 course+	None
History of the Americas	8	E: 1 course	None
History of East/South Asia	8	E: 1 course+	None
History of Europe	8	E: 1 course^	History 4C
History of S. Asia/Middle East	8	E: 1 course+	None
Islamic History	8	E: 1 course+	None
Math	8	C: 1 course#	None
Music	8	F: 1 course	None
Philosophy	8	E: 1 course	None
Physics	8	C: 1 course#	Natural Science 1A, Physics 10
Psychology	8	D: 1 course	None
Social & Cultural Anthro.	8	D: 1 course	Anthropology 2
Theater	8	F: 1 course	None
Visual Arts	8	F: 1 course	None

course also satisfies the Quantitative Relationships Requirement
+ course also satisfies the World Cultures Requirement
^ course also satisfies the European Traditions Requirement

College Board Advanced Placement Credit

Advanced Placement Exam with score of 3, 4, or 5	Units Awarded	General Ed. 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			
With score of 3	8	H: 1 course	
With score of 4	8	H: 1 course	
With score of 5	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			
With score of 3	8	Entry Level Writing	Writing 1, 1E, 1LK
With score of 4	8	Writing 2	Writing 1, 1E, 1LK, 2, 2E, 2LK
With score of 5	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			
With score of 3	8	H: 1 course	French 1-3
With score of 4	8	H: 1 course	French 1-4
With score of 5	8	H: 1 course	French 1-5
French Literature			
With score of 3	8	H: 1 course	French 1-5
With score of 4 or 5	8	H: 1 course	French 1-6
German Language			
With score of 3	8	H: 1 course	German 1-3
With score of 4	8	H: 1 course	German 1-4
With score of 5	8	H: 1 course	German 1-5
Human Geography	4	none	no equivalent
Italian Language & Culture			
With score of 3	8	H: 1 course	Italian 1-3
With score of 4	8	H: 1 course	Italian 1-5
With score of 5	8	H: 1 course	Italian 1-6
Japanese Language & Culture			
With score of 3	8	H: 1 course	
With score of 4	8	H: 1 course	
With score of 5	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 and 6AL
*Physics – C (Electricity & Magnetism)	4	C: 1 course#	Physics 6B and 6BL
Psychology	4	D: 1 course	Psychology 1
Spanish Language			
With score of 3	8	H: 1 course	Spanish 1-3
With score of 4	8	H: 1 course	Spanish 1-4
With score of 5	8	H: 1 course	Spanish 1-5
Spanish Literature			
With score of 3	8	H: 1 course	Spanish 1-5
With score of 4 or 5	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

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

General University Requirements

UC Entry Level Writing Requirement

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

1. by achieving a score of 680 or higher on the 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, 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, 168A-B, 169AR-BR-CR, 169M, 172A-B, 173T, 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, 107T, or 109ST.

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

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

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

At least 6 courses must be completed in these areas:

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

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

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

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

SPECIAL SUBJECT AREA REQUIREMENTS

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

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

   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. **<u>Depth Requirement</u>.** At least two upper division General Education courses from two separate departments, in each of which a student has already successfully completed one General Education course.

   Alternatively, this entire depth requirement may be satisfied by option 2, completion of one of the following sequences: Chicano Studies 1A-B-C, Comparative Literature 30A-B-C, French 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.

   Option three is to complete an approved minor or double major, in a discipline encompassed by areas D, E, F, or G. This can be done by petition only, and petitions must be submitted at least three quarters in advance of the student's expected graduation date.

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

   Starting Fall 2012, students have the option of fulfilling the depth requirement by completting an approved minor or double major, in a discipline encompassed by areas D, E, F, or G, listed below.

Approved Minors

- American Indian and Indigenous Studies (Religious Studies)
- Anthropology
- Art History
- Asian American Studies
- Black Studies
- Chinese
- Classics
- Comparative Literature
- English
- Feminist Studies
- French
- German Studies
- Global Peace and Security
- History
- Italian Studies
- Japanese
- Jewish Studies (Religious Studies)
- Labor Studies (History)
- Latin American and Iberian Studies
- Lesbian, Gay, Bisexual, Transgender, and Queer Studies (Feminist Studies)
- Linguistics
- Music
- Philosophy
- Portuguese
- Russian
- Sociocultural Linguistics
- Spanish
- Theatre
- Theatre - Production and Design
- Women, Culture, and Development (Global Studies)

3. **<u>Ethnicity Requirement</u>.** Objective: To learn to identify and understand the philosophical, intellectual, historical, and/or cultural experiences of HISTORICALLY oppressed and excluded racial minorities in the United States. At least one course that focuses on the history and the cultural, intellectual, and social experience of one of the following groups: Native Americans, African Americans,

Chicanos/Latinos, or Asian Americans. Alternatively, students may take a course that provides a comparative and integrative context for understanding the experience of oppressed and excluded racial minorities in the United States. Courses that meet this requirement are marked with an ampersand (&) on the lists in this document.

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

Other Regulations:

- No more than two courses from the same department may apply to the General Education areas D, E, F, G, and H. (Except if a student completes one of the specific course sequences, such as History 4A-B-C, listed above for the depth requirement.)
- A course listed in more than one general subject area can be applied to only one of these areas. (Example: Art History 6A cannot be applied to both areas E and F.) However, a course can be applied towards a single general subject area and any special subject areas which that course fulfills. (Example: Asian American Studies 4 can be applied to the Writing and Ethnicity requirements in addition to the Area Frequirement.)
- 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

Objective: To learn to analyza purposes, audiences, ad contexts for writing through study of and practice with writing.
2 courses required
Writing 2 or 2E and Writing 50, 50E, 107T or 109ST are required, and must be taken for letter grades.

Areas D and E – Social Sciences, Culture & Thought

2 course minimum

Area D: Social Sciences

Objective: To apply perspectives, theories, and methods of social science research to understand what motivates, influences, and/or determines the behaviors of individuals, groups, and societies. Area D courses are based upon systematic studies of human behavior which may include observation, experimentation, deductive reasoning, and quantatative analysis.

	Course	Title
	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 103A	Anthropology of China
	Anthropology 103B	Anthropology of Japan
	Anthropology 103C	Anthropology of Korea
	Anthropology 109	Human Universals
	Anthropology 110	Technology and Culture
*	Anthropology 122	Anthropology of World Systems
	Anthropology 130A-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
&	Anthropology 191	Indigenous Movements in Asia
@&	Asian American Studies 1	Introduction to Asian American History, 1850-Present
@&	Asian American Studies 2	American Migration since 1965
&	Asian American Studies 3	Asian American Personality and Identity
&	Asian American Studies 6	Sociology of Asian America
&	Asian American Studies 7	Asian American Globalization
&	Asian American Studies 8	Introduction to Asian American Gender and Sexuality
&	Asian American Studies 100AA	Chinese Americans
&*	Asian American Studies 100FF	South Asian Americans
&	Asian American Studies 107	Third World Social Movements
&	Asian American Studies 109	Asian American Women and Work
&*	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 132	South Asian Women in Diapora
&*	Asian American Studies 136	Asian American Families
&*	Asian American Studies 137	Multiethnic Asian Americans
&	Asian American Studies 165	Ethnographies of Asian Americans
@&*	Black Studies 1, 1H	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 100	Africa and United States Policy
&*	Black Studies 102	Black Radicals and the Radical Tradition
@&*	Black Studies 103	The Politics of Black Liberation-The Sixties
&	Black Studies 122	The Education of Black Children
*	Black Studies 124	Housing, Inheritance and Race
*	Black Studies 125	Queer Black Studies
&*	Black Studies 129	The Urban Dilemma
&*	Black Studies 131	Race and Public Policy
&*	Black Studies 160	Analyses of Racism and Social Policy in the U.S.
@&*	Black Studies 169AR-BR-CR	Afro-American History (Same as HIST 169AR-BR-CR)
*	Black Studies 171	Africa in Film
*	Black Studies 174	From Plantations to Prisons
@&*	Chicano Studies 1A-B-C	Introduction to Chicano/a Studies
	Chicano Studies 114	Cultural and Critical Theory
&	Chicano Studies 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 187	Language, Power, and Learning
&	Chicano Studies 189B	The Global Underground
	Chicano Studies 189C	Cultures of Globalization
*	Communication 1	Introduction to Communication
	East Asian Cultural Studies 40	Gender and Sexuality in Modern Asia
	East Asian Cultural Studies 103A	Anthropology of China
	East Asian Cultural Studies 103B	Anthropology of Japan
	East Asian Cultural Studies 103C	Anthropology of Contemporary Korea
	East Asian Cultural Studies 140	Indigenous Movements in Asian
	East Asian Cultural Studies 186	The Invention of Tradition in Contemporary East Asia
	East Asian Cultural Studies 189A	Vietnamese History (Same as HIST 189A)
	Economics 1	Principles of Economics - Micro
	Economics 2	Principles of Economics - Macro
	Economics 9	Introduction to Economics
&*	Education 187	Language, Power, and Learning
	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
	Global Studies 11	Introduction to Law and Society
*	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 159B-C	Women in American History (Same as FEMST 159B-C)
@&	History 161A-B	Colonial and Revolutionary America
*	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
@	History 175A-B	American Cultural History
*	History 188S	Representations of Sexuality in Modern Japan
	History 189A	Vietnamese History (Same as EACS 189A)
*	Italian 161AX	The European Union
	Japanese 25	Violence and the Japanese State (Same as ANTH 25)
	Japanese 63	Sociology of Japan
*	Japanese 162	Representations of Sexuality in Modern Japan
	Korean 82	Anthropology of Korea (Same as HIST 82)
	Linguistics 20	Language and Linguistics
*	Linguistics 70	Language in Society
	Linguistics 130	Language as Culture
*	Linguistics 132	Language, Gender, and Sexuality

* 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.

&*	Linguistics 136	African American Language and Culture
*	Linguistics 170	Language in Social Interaction
&*	Linguistics 180	Language in American Ethnic Minorities
&*	Linguistics 187	Language, Power, and Learning
*	Medieval Studies 100A	Women, the Family and Sexuality in the Middle Ages
@ *	Military Science 27	American Military History and the Evolution of Western Warfare
*	Music 175E	Music Cultures of the World: China
*	Music 175F	Music Cultures of the World: Middle East
*	Music 175G	Music Cultures of the World: India
	Music 175I	Music Cultures of the World: Indonesia
*	Political Science 1	Introduction to Political Philosophy
@ *	Political Science 12	American Government and Politics
*	Political Science 114	Democracy and Diversity
@ *	Political Science 115	Courts, Judges and Politics
*	Political Science 121	International Politics
*	Political Science 136	Government and Politics of China
*	Political Science 145	The European Union
	Political Science 150A	Politics of the Middle East
@	Political Science 151	Voting and Elections
@ *	Political Science 155	Congress
	Political Science 171	Politics and Communication
@&	Political Science 174	Chicano/a Politics (Same as CH ST 174)
	Psychology 1	Introduction to Psychology
	Psychology 102	Introduction to Social Psychology
	Psychology 103	Introduction to Psychopathology
	Psychology 105	Developmental Psychology
	Psychology 107	Introduction to Perception
	Psychology 108	Introduction to Cognitive Psychology
@ *	Religious Studies 7	Introduction to American Religion
@&*	Religious Studies 14	Introduction to Native American Religious Studies
*	Religious Studies 15	Religion and Psychology
	Religious Studies 35	Introduction to Religion and Politics
	Religious Studies 40	Religion and Society
@&*	Religious Studies 114B	Religious Traditions of the Southwest
	Religious Studies 115A	Literature and Religion of the Hebrew Bible/ Old Testament
	Religious Studies 131H	Politics and Religion in the City: Jerusalem
*	Religious Studies 136	Creation Myths
*	Religious Studies 141A-B	Sociology of Religion
*	Religious Studies 147	Religion and the American Experience
@ *	Religious Studies 151A-B	Religion in American History
@	Religious Studies 152	Religion in America Today
&*	Religious Studies 162F	South Asians in the U.S.
*	Slavic 152A	Slavic and East European Folklore
*	Slavic 152B	Language and Cultural Identity
*	Slavic 152C	Ideology and Representation
	Sociology 1	Introduction to Sociology
	Sociology 131	Political Sociology
*	Sociology 134	Social Movements
@&*	Sociology 144	The Chicano Community (Same as CH ST 144)
	Sociology 152A	Sociology of Human Sexuality
&*	Sociology 153	Women and Work (Same as FEMST 153)
*	Spanish 178	Mexican Culture
	Theater 65	Public Speaking

AREA E: CULTURE AND THOUGHT

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

*	Anthropology 138TS	Archaeology of Egypt
	Anthropology 176TS	Ancient Egyptian Religion
*^	Art History 6A-B-C	Art Survey
	Art History 109G	Leonardo Da Vinci: Art, Science, and Technology in Early Modern Italy
	Art History 130E	Art and Empire in the Americas: Aztec, Inca, Spanish
	Art History 136I	The City in History
	Art History 144D	Russian Art
&	Asian American Studies 71	Introduction to Asian American Religions
&	Asian American Studies 138	Asian American Sexualities
&*	Asian American Studies 161	Asian American Religions (Same as RG ST 123)
	Black Studies 3	Introduction to African Studies
*	Black Studies 5	Blacks and Western Civilization
*	Black Studies 7	Introduction to Caribbean Studies
*	Black Studies 49A-B	Survey of African History
&*	Black Studies 50	Blacks in the Media
@&*	Black Studies 60A-B	Survey of Afro-American Religious Traditions (Same as RG ST 61A-B)
*	Black Studies 104	Black Marxism
*	Black Studies 130A	Negritude and African Literature
	Black Studies 130B	The Black Francophone Novel
	Chicano Studies 13	Critical Introduction to Ancient Mesoamerica
	Chinese 148	Historic Lives
	Chinese 158	Problem of Love
*	Chinese 183	The Quest for Narrative in Late Imperial China (Same as C LIT 183)
*	Chinese 185A-B	Modern China
^	Classics 50	Introduction to Classical Archaeology
^	Classics 80A	Greek Civilization
^	Classics 80B	Roman Civilization
^	Classics 101	The Greek Intellectual Experience: From Poetry to Philosophy
*^	Classics 106	Magic and Medicine in Ancient Greece
^	Classics 108	Pagan Religion and Cult in Ancient Rome
	Classics 115	Marriage in the Ancient World
^	Classics 150	The Fall of the Ancient Republic: Cicero, Caesar, and Rome
^	Classics 160	Greek Cities and Sanctuaries
*^	Classics 171	Artifact and Text: The Archaeology and Literature of Early Greece
	Comparative Literature 27	Memory: Bridging the Humanities and Neurosciences (Same as FR 40X & MCDB 27)
*^	Comparative Literature 30A-B-C	Major Works of European Literature
*	Comparative Literature 35	The Making of the Modern World
*	Comparative Literature 113	Trauma, Memory, Historiography
*	Comparative Literature 119	Psychoanalytic Theory
*	Comparative Literature 122A	Representations of the Holocaust (Same as GER 116A)
	Comparative Literature 171	Post Colonial Cultures (Same as FR 154G)
*	Comparative Literature 183	The Quest for Narrative in Late Imperial China (Same as CHIN 183)
*	Comparative Literature 186RR	Romantic Revolutions: Philosophy, History, and the Arts in Europe
*	East Asian Cultural Studies 3	Introduction to Asian Religious Traditions (Same as RG ST 3)
*	East Asian Cultural Studies 4A-B	East Asian Traditions
*	East Asian Cultural Studies 5	Introduction to Buddhism
*	East Asian Cultural Studies 21	Zen
*	East Asian Cultural Studies 80	East Asian Civilization (Same as HIST 80)
	East Asian Cultural Studies 164B	Buddhist Traditions in East Asia
*	Environmental Studies 3	Introduction to the Social and Cultural Environment
	Environmental Studies 107C	The Darwinian Revolution and Modern Biology (Same as HIST 107C)
*	Environmental Studies 107E	History of Animal Use in Science (Same as HIST 107E)
*	Feminist Studies 171CN	Citoyennes! Women and Politics in Modern France (Same as FR 155D)
	French 40X	Memory: Bridging the Humanities and Neuroscience (Same as C LIT 27 & MCDB 27)
^	French 50AX-BX-CX	Tales of Love
	French 70AX	A Visual History of France
*	French 149C	Reading Paris (1830-1890)
*	French 154F	Time Off in Paris
	French 154G	Post-Colonial Cultures (Same as C LIT 171)
*	French 155D	Citoyennes! Women and Politics in Modern France (Same as FEMST 171CN)
*	German 43A	Dreaming Revolutions: Introduction to Marx, Nietzsche and Freud
*	German 43C	Germany Today
*^	German 111	Contemporary German Art and Politics
*^	German 112	Introduction to German Culture
*	German 116A	Representations of the Holocaust (Same as C LIT 122A)
*	German 164I	Modern Autobiography and Memoir: Texts and Contents
*	Global Studies 1	Global History, Culture, and Ideology

* 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 2A-B-C	World History
*^ History 2AH-BH-CH	World History (Honors)
*^ History 4A-B-C	Western Civilization
*^ History 4AH-BH-CH	Western Civilization (Honors)
* History 8	Introduction to History of Latin America
*^ History 33D	The Holocaust: Interdisciplinary Perspectives
* History 46	Survey of Middle Eastern History
* History 49A-B	Survey of African History
* History 80	East Asian Civilization (Same as EACS 80)
* History 87	Japanese History through Art and Literature
* History 106A	The Origins of Western Science, Antiquity to 1500 (Same as ENV S 108A)
* History 106B	The Scientific Revolution, 1500 to 1800
* History 106C	History of Modern Science
History 107B	History of Biological Sciences: Circa 1600 to 1800
History 107C	The Darwinian Revolution and Modern Biology Same as ENV S 107C)
* History 107E	History of Animal Use in Science (Same as ENV S 107E)
* History 114B-C-D	History of Christianity
History 133A	Nineteenth Century Germany
History 133B-C	Twentieth Century Germany
^ History 133D	The Holocaust in German 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
Italian 138AA-CX-D-DX-EX-FX	Cultural Representations in Italy
* Italian 138AX	Cultural Representations in Italy
* Italian 144AX	Gender and Sexuality in Italian Culture
^ Italian 189A	Italy Mediterranean
Japanese 164	Modernity and the Masses of Taisho Japan (Same as HIST 188T)
* Korean 182A-B	Korean History and Civilization (Same as HIST 182A-B)
* Latin American & Iberian Studies 101	Interdisciplinary Approaches to History and Societies of Latin America
* Linguistics 30	The Story of English
Linguistics 50	Language and Power
Linguistics 80	Endangered Languages
Middle East Studies 45	Introduction to Islamic & Near East Studies
Molecular, Cellular & Developmental Biology 27	Memory: Bridging the Humanities and Neuroscience (Same as C LIT 27 & FR 40X)
* Philosophy 1	Short Introduction to Philosophy
Philosophy 3	Critical Thinking
* Philosophy 4	Introduction to Ethics
*^Philosophy 20A-B-C	History of Philosophy
* Philosophy 100A	Ethics
* Philosophy 100B	Theory of Knowledge
* Philosophy 100C	Philosophy of Language
* Philosophy 100D	Philosophy of Mind
* Philosophy 100E	Metaphysics
* Philosophy 112	Philosophy of Religion
* Physics 43	Origins: A Dialogue Between Scientists and Humanists (Same as RG ST 43)
Political Science 187	Classical Political Theory
Political Science 188	Modern Political Theory
Political Science 189	Recent and Contemporary Political Theory
* Portuguese 125A	Culture and Civilization of Portugal
* Portuguese 125B	Culture and Civilization of Brazil
* Religious Studies 1	Introduction to the Study of Religion
* Religious Studies 3	Introduction to Asian Religious Traditions (Same as EACS 3)
* Religious Studies 4	Introduction to Buddhism
* Religious Studies 5	Introduction to Judaism, Christianity, and Islam
Religious Studies 6	Islam and Modernity
Religious Studies 12	Religious Approaches to Death
* Religious Studies 19	The Gods and Goddesses of India
Religious Studies 20	Indic Civilization
* Religious Studies 21	Zen
Religious Studies 25	Global Catholicism
Religious Studies 31	Religions of Tibet
^ Religious Studies 34	Saints and Miracles in the Catholic Tradition
* Religious Studies 43	Origins: A Dialogue Between Scientists and Humanists (Same as PHYS 43)
& Religious Studies 71	Introduction to Asian American Religions
*^ Religious Studies 80A-B-C	Religion and Western Civilization
* Religious Studies 116A	The New Testament and Early Christianity
&* Religious Studies 123	Asian American Religions (Same as AS AM 161)
* Religious Studies 126	Roman Catholicism Today
* Religious Studies 130	Judaism
* Religious Studies 136	Creation Myths
* Religious Studies 138B	Catholic Practices & Global Cultures
* Religious Studies 150	American Spiritualities
Religious Studies 162C	Sikhism
* Religious Studies 162E	Indian Civilization
* Religious Studies 164A	Buddhist Traditions in South Asia
Religious Studies 164B	Buddhist Traditions in East Asia
* Religious Studies 183	Quest for Narrative in Late Imperial China
Slavic 33	Russian Culture
Slavic 130D	Russian Art
Spanish 153	Basque Studies
Spanish 177	Spanish-American Thought

Area F and G – Arts and Literature

2 courses minimum

Area F: Arts

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

Art 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 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 101B	Classical Greek Art (480 to 320 BCE)
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 105C	Medieval Architecture: From Constantine to Charlemagne
Art History 105E	The Origins of Romanesque Architecture
Art History 105G	Late Romanesque and Gothic Architecture
Art History 105L	Art and Society in Late Medieval Tuscany
Art History 107A	Painting in Fifteenth-Century Netherlands
Art History 107B	Painting in Sixteenth-Century Netherlands
Art History 109A	Italian Renaissance Art 1400-1500
Art History 109B	Italian Renaissance Art 1500-1600
Art History 109C	Art as Technique, Labor, and Idea in Renaissance Italy
Art History 109D	Art and the Formation of Social Subjects in Early Modern Italy
Art History 109E	Michelangelo
Art History 109F	Italian Journeys
Art History 109G	Leonardo Da Vinci: Art, Science and Technology in Early Modern Italy
Art History 109H	Art and Moral Values
Art History 111B	Dutch Art in the Age of Rembrandt
Art History 111C	Dutch Art in the Age of Vermeer
Art History 111E	Gender and Power in Sixteenth- and Seventeenth-Century European Art
Art History 111F	Rethinking Rembrandt
Art History 113A	Seventeenth-Century Art in Southern Europe
Art History 113B	Seventeenth-Century Art in Italy

* 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 113D	Architecture in Early Modern Italy
	Art History 113F	Bernini and the Age of the Baroque
	Art History 115B	Eighteenth-Century Art 1750-1810
	Art History 115C	Eighteenth-Century British Art and Culture
	Art History 115D	Eighteenth-Century Art in Italy: The Age of the Grand Tour
	Art History 117A	Nineteenth-Century Art 1800-1848
	Art History 117B	Nineteenth-Century Art 1848-1900
	Art History 117C	Nineteenth-Century British Art and Culture
	Art History 117D	Nineteenth-Century French Art 1800 to 1900
	Art History 117F	Impressionism and Post-Impressionism
	Art History 119A	Art in the Modern World
	Art History 119B	Contemporary Art
	Art History 119C	Expressionism to New Objectivity, Early Twentieth-Century German Art
	Art History 119D	Art in the Post-Modern World
	Art History 119E	Early Twentieth -Century European Art 1900-1945
	Art History 119F	Art of the Postwar Period 1945-1968
	Art History 119G	Critical Approaches to Visual Culture
@	Art History 121A	American Art from the Revolution to Civil War: 1700-1860
@	Art History 121B	Reconstruction, Renaissance, and Realism in American Art 1860-1900
@	Art History 121C	Twentieth-Century American Art: Modernism and Pluralism 1900-Present
&	Art History 121D	African-American Art and the African Legacy
	Art History 121E	American Things: Material Culture and Popular Art
&	Art History 121F	History of Native Art and Architecture in North America
	Art History 123A	Modern Latin American Art
&	Art History 125A	Chicano Art: Symbol and Meaning
	Art History 127A-B	African Art
*	Art History 130A	Pre-Columbian Art of Mexico
*	Art History 130B	Pre-Columbian Art of the Maya
	Art History 130C	The Arts of Spain and New Spain
	Art History 130D	Pre-Columbian Art of South America
	Art History 132A	Mediterranean Cities
	Art History 132B	The "Masterpiece" in Islamic Art and Architecture
	Art History 132C	Architecture and Ideology from Constantine to Suleyman the Magnificent
	Art History 132D	Islamic Architecture 650-1400
	Art History 132E	Islamic Architecture 1400-Modern
	Art History 132I	Art of Empire
	Art History 134A	Buddhist Art
	Art History 134B	Early Chinese Art
	Art History 134C	Chinese Painting
	Art History 134D	Art and Modern China
	Art History 134E	The Art of the Chinese Landscape
	Art History 134F	The Art of Japan
	Art History 134G	Japanese Painting
	Art History 134H	Ukiyo-e: Pictures of the Floating World
	Art History 136A	Nineteenth-Century Architecture
	Art History 136B	Twentieth-Century Architecture
	Art History 136E	Modern Design
@	Art History 136H	Housing American Cultures
	Art History 136I	The City in History
	Art History 136J	Landscape of Colonialism
*^	Art History 136K	Modern Architecture in Early Twentieth-Century Europe
*^	Art History 136L	From Modernism to Postmodernism in European Architecture
	Art History 136M	Revival Styles in Southern California Architecture
	Art History 136O	Sustainable Architecture: History and Aesthetics
	Art History 136Y	Modern Architecture in Souther California
	Art History 138B	Contemporary Photography
	Art History 138C	Social Documentary Photography
	Art History 138D	History of Photography
	Art History 140A	Portraiture
	Art History 140E	Landscape Design History
	Art History 141D	Birth of the Modern Museum
	Art History 143C	Gender and Representation
	Art History 144A	The Avant-Garde in Russia
	Art History 144C	Contemporary Art in Russia and Eastern Europe (Same as SLAV 130C)
	Art History 144D	Russian Art
	Art History 184B	The History of Rome: Image and Ideology
	Art History 184C	The Palace and Villa in Early Modern Europe
*	Art Studio 1A	Visual Literacy
	Art Studio 7A	The Intersections of Art and Life
	Art Studio 125	Art Since 1950
&*	Asian American Studies 4	Introduction to Asian American Popular Culture
&	Asian American Studies 118	Asian Americans in Popular Culture
&	Asian American Studies 120	Asian American Documentary
&	Asian American Studies 127	Asian American Film, Television, and Digital Media
&	Asian American Studies 140	Theory & Production of Social Experience
&	Asian American Studies 146	Racialized Sexuality on Screen and Scene
&	Asian American Studies 170KK	Special Topics in Asian American Studies
&*	Black Studies 14	History of Jazz
*	Black Studies 45	Black Arts Expressions
&	Black Studies 142	Music in Afro-American Culture: U.S.A.
*	Black Studies 153	Black Popular Music in America
	Black Studies 161	Third-World Cinema
*	Black Studies 162	African Cinema
&*	Black Studies 170	Afro-Americans in the American Cinema
*	Black Studies 171	Africa in Film
&*	Black Studies 172	Contemporary Black Cinema
	Black Studies 175	Black Diaspora Cinema
	Chicano Studies 119	Mesoamerican Art and Artists
&	Chicano Studies 125B	Contemporary Chicano and Chicana Art
&	Chicano Studies 138	Barrio Popular Culture
&	Chicano Studies 148	Chicana Art and Feminism
@&	Chicano Studies 188C	Chicano Theater Workshop
*	Chinese 40	Popular Culture in Modern Chinese Societies
	Chinese 141	China in Transition Through Films
*	Chinese 170	New Taiwan Cinema
*^	Classics 102	Greek Tragedy in Translation
^	Classics 165	Greek Painting
^	Classics 170	Pompeii
	Dance 35	History and Appreciation of World Dance
*	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 122AA-ZZ	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
*	Film Studies 134	French and Francophone Cinema
*	Film Studies 136	British Cinema
*	Film Studies 144	The Horror Film (Same as GER 183)
*	Film Studies 163	Women and Film: Feminist Perspectives
	Film Studies 169	Film Noir
	Film Studies 175	Experimental Film
*	Film Studies 178Z	Technology and Cinema (Same as FR 156D)
*	French 156A	French Cinema: History and Theory
*	French 156B	French and Francophone Cinema
*	French 156C	Modern Images of the Middle Ages: The Intersection of Text, History, and Film
*	French 156D	Technology and Cinema (Same as FLMST 178Z)
*	General Education 1FW	General Education Seminar for Freshmen
*	German 55A-B	Contemporary German Pop Culture
*	German 183	The Horror Film (Same as FLMST 144)
	Italian 124X	Italian Theatre
	Italian 178B	Italian Cinema
	Italian 179X	Fiction and Film in Italy
*	Italian 180Z	Italian Cinema
	Japanese 149	Traditional Japanese Drama
*	Japanese 159	Japanese Cinema (Same as FLMST 120)
	Music 11	Fundamentals of Music
*	Music 15	Music Appreciation

* This course applies toward the writing requirement.
& This course applies toward the ethnicity requirement.
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^ This course applies toward the European Traditions requirement.

	Music 17	World Music
*	Music 114	Music and Popular Culture in America
*	Music 115	Symphonic Music
	Music 116	American Music History: Colonial to Present
*	Music 118A	History and Literature of Great Composers in Western Music
*	Music 119A	Music and Politics
	Music 119B	Music in Political Films
*	Philosophy 136	Aesthetics
	Slavic 130A	The Avantgarde in Russia
	Slavic 130B	Russian Cinema
	Slavic 130C	Contemporary Art in Russia and Eastern Europe (Same as ARTHI 144C)
	Slavic 130D	Russian Art
	Slavic 130E	Masters of Soviet Cinema
	Spanish 126	Spanish Cinema
	Theater 2A-B	Performance in Global Contexts
*^	Theater 2C	Performance in Global Contexts: Europe
*	Theater 3	Life of the Theater
	Theater 5	Introduction to Acting
*	Theater 7	Performance of the Human Body
*^	Theater 8	European Theater History
*	Theater 9	Playwriting
	Theatre 143	The People's Voice
@ *	Theater 180A-B	American Drama
*	Theater 180C	Contemporary American Drama and Theater
&*	Theater 180E	Culture Clash: Studies in U.S. Latino Theater
&*	Theater 180G	Race, Gender, and Performance
	Theater 181S	National Studies in Spanish Theater and Drama
*	Theater 182A	Ancient Theater and Drama
*	Theater 182M	Modern Theater and Drama
*	Theater 182MC	Modern Contemporary
*	Theater 182N	Neoclassical Theater and Drama
*	Theater 182RM	Romantic Theater and Drama
&*	Theater 184AA	African American Performance
*	Theater 184CA	Contemporary African Theater and Performance
*	Theater 188S	Shakespeare on Film and Stage

Area G: Literature

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

&	Asian American Studies 5	Introduction to Asian American Literature
*	Asian American Studies 122	Asian American Fiction
*	Asian American Studies 128	Writings by Asian American Women
*	Black Studies 33	Major Works of African Literatures (Same as C LIT 33)
&*	Black Studies 38A-B	Introduction to Afro-American Literature
*	Black Studies 126	Comparative Black Literatures
&*	Black Studies 127	Black Women Writers
*	Black Studies 130A	Negritude and African Literature
	Black Studies 130B	The Black Francophone Novel
&*	Chicano Studies 152	Postcolonialism
&*	Chicano Studies 180	Survey of Chicano Literature
&*	Chicano Studies 181	The Chicano Novel
&*	Chicano Studies 184A	Chicana Writers
	Chinese 110A	Classics of Ancient China
*	Chinese 112A	Major Movements in Modern Chinese Literature
	Chinese 115A	Imagism, Haiku, and Chinese Poetry
*	Chinese 124A-B	Readings in Modern Chinese Literature
*	Chinese 132A	Classical Chinese Poetry
*	Chinese 139	Boundaries of the Self in Late Imperial Chinese Literature
	Chinese 142	Tang Poetry
	Chinese 148	Historic Lives
^	Classics 36	Ancient Epic
^	Classics 37	Greek Literature in Translation
*^	Classics 38	Latin Literature in Translation
*^	Classics 39	Women in Classical Literature
^	Classics 40	Greek Mythology
*^	Classics 102	Greek Tragedy in Translation
*^	Classics 109	Viewing the Barbarian: Representations of Foreign Peoples in Greek Literature
*^	Classics 110	From Homer to Harlequin: Masculine, Feminine, and the Romance
^	Classics 120	Greek and Latin Lyric Poetry
^	Classics 130	Comedy and Satire in Translation
*^	Classics 175	Ancient Theories of Literature
*^	Comparative Literature 30A-B-C	Major Works of European Literature
*	Comparative Literature 31	Major Works of Asian Literatures
*	Comparative Literature 32	Major Works of Middle Eastern Literatures
*	Comparative Literature 33	Major Works of African Literatures (Same as BL ST 33)
*	Comparative Literature 34	Literature of the Americas
*	Comparative Literature 100	Introduction to Comparative Literatures
*	Comparative Literature 107	Voyages to the Unknown
*	Comparative Literature 113	Trauma, Memory, Historiography
	Comparative Literature 117A-B	European Romanticism
*	Comparative Literature 122A	Representations of the Holocaust (Same as GER 116A)
*	Comparative Literature 122B	Holocaust in France (Same as FR 154E)
*	Comparative Literature 126	Comparative Black Literatures
*	Comparative Literature 128A	Children's Literature
*	Comparative Literature 128B	Representing Childhood
*	Comparative Literature 133	Transpacific Literature
*	Comparative Literature 146	Robots
&*	Comparative Literature 153	Border Narratives
*	Comparative Literature 154	Science Fiction in Eastern Europe
*	Comparative Literature 161	Literature of Central Europe
	Comparative Literature 171	Post-Colonial Cultures (Same as FR 154G)
*	Comparative Literature 179B	Mysticism
*	Comparative Literature 179C	Mediatechnology (Same as GER 179C)
	Comparative Literature 186AD	Adultery in the Novel
	Comparative Literature 186EE	Interdisciplinary Comparative Literature
*	Comparative Literature 187	Strauss and Hofmannsthal
	Comparative Literature 188	Narrative Studies
*	Comparative Literature 189	Narrative in the First Person
	Comparative Literature 191	Fantasy and the Fantastic (Same as FR 153D)
*	English 15	Introduction to Shakespeare
*	English 21	Introduction to Narrative
*	English 25	Introduction to Literature and the Culture of Information
*	English 35	Introduction to Literature and the Environment
&*	English 38A-B	Introduction to African American Literature
&*	English 50	Introduction to U.S. Minority Literature
*	English 65AA-ZZ	Topics in Literature
*	English 101	English Literature from the Medieval Period to 1650
*	English 102	English and American Literature from 1650 to 1789
*	English 103A	American Literature from 1789 to 1900
*	English 103B	British Literature from 1789 to 1900
*	English 104A	American Literature from 1900 to Present
*	English 104B	British Literature from 1900 to Present
*	English 105A	Shakespeare: Poems and Earlier Plays
*	English 105B	Shakespeare: Later Plays
*	English 113AA-ZZ	Literary Theory and Criticism
*	English 114AA-ZZ	Women and Literature
&*	English 114BW	Black Women Authors
&*	English 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
*	English 131AA-ZZ	Studies in American Literature
@ *	English 133AA-ZZ	Studies in American Regional Literature
@&*	English 134AA-ZZ	Literature of Cultural and Ethnic Communities in the United States
@ *	English 137A-B	Poetry in America
@ *	English 138C	Prose Narrative in America Since 1917
*	English 140	Contemporary American Literature

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*	English 150	Anglo-Irish Literature
*	English 152A	Chaucer: Canterbury Tales
*	English 156	Literature of Chivalry
*	English 157	English Renaissance Drama
*	English 162	Milton
*	English 165AA-ZZ	Topics in Literature
*	English 170CM,IM,LM,MT	Studies in Literature and the Mind
*	English 172	Studies in the Enlightenment
*	English 179	British Romantic Writers
*	English 180	The Victorian Era
*	English 181, 181MT	Studies in the Nineteenth Century
*	English 184	Modern European Literature
*	English 185	Modernism in English
*	English 187AA-ZZ	Studies in Modern Literature
*	English 189	Contemporary Literature
*	English 190AA-ZZ	World Literature in English
@&*	English 191	Afro-American Fiction and Criticism, 1920s to Present
*	English 192	Science Fiction
*	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 101A-B-C	Literary and Cultural Analysis
*	French 147A	French and Francophone Poetry
*	French 147B	French and Francophone Theater
*	French 148C	Women in the Middle Ages
*	French 148E	The Age of Louis XIV
	French 149B	The Politics of Paradise
*	French 149C	Reading Paris (1830-1890)
*	French 149D	Post-War Avant-Gardes
*	French 149E	Belgian Literature and Art
*	French 153A	Medieval Literature in Translation
*	French 153B	French Theater in Translation
*	French 153C	Autobiography
	French 153D	Fantasy & the Fantastic (Same as C LIT 191)
*	French 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 Fracophone Women Writers
*	French 155D	Citoyennes! Women and Politics in Modern France (Same as FEMST 171CN)
*	French 156C	Modern Images of the Middle Ages
*	German 43B	German Childhood and Youth
*	German 115A-B-C	Survey of German Literature
*	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
^	Greek 100	Introduction To Greek Prose
^	Greek 101	Introduction To Greek Poetry
*	Hebrew 114A-B-C	Readings in Modern Hebrew Prose and Poetry
	Italian 101	Modern Italy
	Italian 102	Medieval and Renaissance Italy
	Italian 111	Italian Short Fiction
*	Italian 114X	Dante's "Divine Comedy"
	Italian 126AA-ZZ	Literature in Italian
*	Italian 138AX	Cultural Representations in Italy
*	Italian 142X	Women in Italy
*	Italian 144AX	Gender and Sexuality in Italian Culture
*	Italian 163X	Early Modern Epic
	Italian 179X	Fiction and Film in Italy
*	Japanese 80	Masterpieces in Japanese Literature
*	Japanese 112	Survey of Modern Japanese Literature
	Japanese 115	Twentieth-Century Japanese Literature
	Korean 113	Korean Literature Survey
^	Latin 100	Introduction To Latin Prose
^	Latin 101	Introduction To Latin Poetry
*	Latin American & Iberian Studies 102	Interdisciplinary Approaches to the Cultures, Languages and Literature
*	Medieval Studies 100B	Literature of Chivalry
*	Music 187	Strauss and Hofmannsthal
	Portuguese 105A-B-C	Survey of Portuguese Literature
	Portuguese 106A-B-C	Survey of Brazilian Literature
	Portuguese 115AA-ED-EO	Brazilian Literature
*	Portuguese 120AA-ZZ	Portuguese Literature in English Translation
*	Religious Studies 114X	Dante's "Divine Comedy"
	Religious Studies 129	Religions of the Ancient Near East
*	Religious Studies 189C	Modern Arabic Literature in Translation
	Slavic 117F	Chekhov
*	Slavic 117G	Dostoevsky
*	Slavic 117H	Tolstoy
	Slavic 123A-B	Nineteenth Century Russian Literature
	Slavic 123C-D	Twentieth Century Russian Literature
*	Slavic 151C	Literature of Central Europe
*	Slavic 164A	Death and Its Representations
*	Slavic 164B	Science Fiction in Eastern Europe
*	Slavic 164C	Women in Russian Literature
	Spanish 30	Introduction to Hispanic Literature
	Spanish 102L	Introduction to Hispanic Literary Studies
*	Spanish 115B	Masterpieces of Spanish Literature
*	Spanish 120A-B	Contemporary Spanish American Fiction in English Translation
	Spanish 131	Spanish Golden Age Poetry
&*	Spanish 135	Survey of Chicano Literature
	Spanish 137A-B	Golden Age Drama
	Spanish 138	Contemporary Mexican Literature
	Spanish 140A-B	Cervantes: Don Quijote
*	Spanish 142A-B	Don Quixote in English Translation
	Spanish 174	The Hispanic Novel and Cinema
&*	Spanish 179	Chicano Novel

Literature Courses Taught in the Original Language

*	Chinese 124A-B	Readings in Modern Chinese Literature
*	Chinese 132A	Special Topics in Classical Chinese Poetry
	Chinese 142	Tang Poetry
	French 101A-B-C	Introduction to Literary and Cultural Analysis
*	French 147A	Renaissance Poetry
*	French 147B	French Theater
*	French 148C	Women in the Middle Ages
*	French 148E	The Age of Louis XIV
	French 149B	The Politics of Paradise
*	French 149C	Paris in Nineteenth-Century Literature & Art
*	French 149D	Post-War Avant-Gardes
*	French 149E	Belgian Literature in French
*	German 115A-B-C	Survey of German Literature
^	Greek 100	Introduction to Greek Prose
^	Greek 101	Introduction to Greek Poetry
*	Hebrew 114A-B-C	Modern Hebrew Prose and Poetry
	Italian 101	Modern Italy
	Italian 102	Advanced Reading and Composition: Medieval and Renaissance Italy
	Italian 111	Italian Short Fiction
	Italian 126-A-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

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Spanish 102L	Introduction of Hispanic Literature Studies
Spanish 131	Spanish Golden Age Poetry I
Spanish 137A-B	Golden Age Drama
Spanish 138	Contemporary Mexican Literature
Spanish 140A-B	Cervantes: Don Quijote
Spanish 174	Hispanic Novel and Cinema

Area H: Foreign Language

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

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

Special Subject Area Supplementary List of Courses

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

*	Anthropology 116A	Myth, Ritual, and Symbol
*	Anthropology 116B	Anthropological Approaches to Religion
*	Anthropology 142B	Contemporary Issues in South Asia
*	Anthropology 143	Introduction to Contemporary Social Theory
&	Anthropology 148A	Comparative Ethnicity
*	Anthropology 172	Colonialism and Culture
*	Art History 186AA-ZZ	Seminar in Advanced Studies in Art History
&	Asian American Studies 100CC	Filipino Americans
&	Asian American Studies 113	The Asian American Movement
&*	Asian American Studies 121	Asian American Autobiographies and Biographies
&	Asian American Studies 124	Asian American Literature in Comparative Frameworks
*	Asian American Studies 134	Asian American Men and Contemporary Men's Issues
&	Asian American Studies 148	Introduction to Video Production
&	Asian American Studies 149	Screenwriting
@&*	Black Studies 137E	Sociology of the Black Experience
&	Chicano Studies 139	Chicana/o Native American Heritage
&*	Chicano Studies 154F	The Chicano Family
&	Chicano Studies 168E	History of the Chicano Movement
&	Chicano Studies 168F	Racism in American History
&	Chicano Studies 171	The Brown/Black Metropolis: Race, Class, & Resistance in the City
@	Chicano Studies 188A-B	Chicano Theater
&	Chicano Studies 189	Immigration and the US Border
*	Chinese 132B	Special Topics in Modern Chinese Poetry
*	Chinese 150	The Language of Vernacular Chinese Literature
*	Chinese 166A	Religion in Chinese Culture
*	Chinese 166B	Taoist Traditions in China
*	Chinese 166C	Confucian Tradition: The Classical Period
*	Chinese 166E	The Flowering of Chinese Buddhism
*	Communication 130	Political Communication
*	Communication 137	Global Communication, International Relations and the Media
*	Communication 150	Group Communication in Multiple Contexts
*	Communication 153	Communication and Global Advocacy
*	Comparative Literature 36	Global Humanities: The Politics and Poetics of Witnessing
*	Comparative Literature 124	Old Comedy/New Comedy
*	Comparative Literature 170	Literary Translation: Theory and Practice
*	Counseling, Clinical & School Psychology 101	Introduction to Applied Psychology
*	Earth Science 6	Mountains, Boots and Backpacks: Field Study of the High Sierra
*	Earth Science 10	Antarctica: The Last Place on Earth
*	Earth Science 104A	Field Studies in Geological Methods
*	Earth Science 104B	Field Methods
*	Earth Science 117	Earth Surface Processes and Landforms
*	Earth Science 123	The Solar System
*	Earth Science 130	Global Warming - Science and Society
*	East Asian Cultural Studies 178	The Body Religious in Chinese Culture
@	Economics 113A-B	Economic History of the United States
*	Economics 117A	Law and Economics
@	Economics 119	United States Business History
*	Education 20	Introduction to the University Experience
*	Ecology, Evolution, and Marine Biology 124	Biochemical Ecology
*	EEMB 134	Biology of Seaweeds and Phytoplankton
*	EEMB 135	Evolutionary Ecology
*	EEMB 138	Ethology and Behavioral Ecology
*	EEMB 142BL	Chemical and Physical Methods of Aquatic Environments
*	EEMB 142CL	Methods of Aquatic Biology
*	EEMB 147	Biology of Coral Reefs
*	EEMB 149	Mariculture for the Twenty-first Century
*	EEMB 179	Modeling Environmental and Ecological Change
*	English 36	Global Humanities
*	Engineering 101	Ethics in Engineering
*	Engineering 103	Advanced Engineering Writing
*	Environmental Studies 2	Introduction to Environmental Science
*	Environmental Studies 20	Shoreline Issues
*	Environmental Studies 110	Disease and the Environment
*	Environmental Studies 143	Endangered Species Management
*	Environmental Studies 146	Animals in Human Society: Ethical Issues of Animal Use
*	Environmental Studies 161	Environmental Journalism: A Survey
@	Environmental Studies 173	American Environmental History
&*	Environmental Studies 189	Religion and Ecology in the Americas
*	Feminist Studies 80 or 80H	Introduction to LGBTQ Studies
&*	Feminist Studies 142	Black Women Filmmakers
*	Feminist Studies 150, 150H	Sex, Love, and Romance
*	Feminist Studies 154A	Sociology of the Family
@	Feminist Studies 155A	Women in American Society
*	Feminist Studies 162	Critical LGBTQ Studies
*	Film Studies 101A-B-C	History of Cinema
*	Film Studies 146	Advanced Film Analysis
*	Film Studies 191	Film Criticism
*	Geography 8	Living with Global Warming

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*	Geography 148	California
*	Geography 180	Geography of the Information Society
*	History 6	Historical Reasoning
*	History 56	Introduction to Mexican History
*	History 123A	Europe in the Nineteenth Century
*	History 123B	Europe in War and Revolution
*	History 123C	Europe Since Hitler
*	History 140A-B	Early Modern Britain
*	History 153	Comparative Seaborne Empires 1415 to 1825
*	History 155A-B	History of Portugal
*	History 155E	Portugal Overseas
*	History 156A	History of Mexico
*	History 156I	Indians of Mexico
*	History 157A-B	History of Brazil
@&	History 160A-B	The American South
@	History 164C	Civil War and Reconstruction
@& *	History 164IA-IB	American Immigration
@	History 164PR	Proseminar of the History of America's Racial Minorities
@	History 165	America in the Gilded Age, 1876 to 1900
@	History 166A-B-C	United States in the Twentieth Century
@	History 166LB	United States Legal History
&	History 168E	History of the Chicano Movement
&	History 168F	Racism in American History
&*	History 168M	Middle Eastern Americans
&*	History 168N	Interracial Intimacy
@	History 169M	History of Afro-American Thought
@	History 173T	American Environmental History
@	History 176A-B	The American West
@	History 177	History of California
@	History 178A-B	American Urban History
@& *	History 179A	Native American History to 1838
@&	History 179B	Native American History, 1838 to Present
*	Japanese 25	Violence and the State in Japan
*	Japanese 167A	Religion in Japanese Culture
*	Latin American and Iberian Studies 10	Introduction to the Latin American and Iberian World
*	Latin American and Iberian Studies 100	Introduction to Latin American and Iberian Studies
*	Latin American and Iberian Studies 194RR	Special Topics in Latin American and Iberian Studies
*	Linguistics 113	Introduction to Semantics
*	Linguistics 114	Advanced Phonology
*	Linguistics 131	Sociolinguistics
*	Linguistics 137	Introduction to First Language Acquisition
*	Linguistics 138	Language Socialization
*	Materials 10	Materials in Society: The Stuff of Dreams
*	Molecular, Cellular, and Developmental Biology 134H	Animal Virology– Honors
*	Molecular, Cellular, and Developmental Biology 138	Medical Immunology
*	Molecular, Cellular, and Developmental Biology 149	Mariculture for the 21st Century
*	Music 12	Introduction to Music Literature
*	Music 112AB-C-D-E-F	History of Music
*	Philosophy 7	Biomedical Ethics
*	Physics 13AH	Honors Experimental Physics
*	Physics 128AL-BL	Advanced Experimental Physics
*	Political Science 6	Introduction to Comparative Politics
*	Political Science 7	Introduction to International Relations
@ *	Political Science 127	American Foreign Policy
*	Political Science 129	The United States, Europe, and Asia in the Twenty-First Century
@	Political Science 152	American Political Parties
@	Political Science 153	Political Interest Groups
@	Political Science 157	The American Presidency
@	Political Science 158	Power in Washington
@	Political Science 162	Urban Government and Politics
@	Political Science 165	Criminal Justice
@	Political Science 167	Constitutional Law: The Bill of Rights
@	Political Science 168	Constitutional Law: Civil Rights
@	Political Science 176	Black Politics in America
@	Political Science 180	Bureaucracy and Public Policy
@ *	Political Science 185	Government and the Economy
*	Psychology 90A-B-C	First-Level Honors Seminar
*	Psychology 110L	Laboratory in Perception
*	Psychology 111L	Laboratory in Biopsychology
*	Psychology 112L	Laboratory in Social Behavior
*	Psychology 114L	Laboratory in Personality
*	Psychology 116L	Laboratory in Animal Learning
*	Psychology 117L	Laboratory in Human Memory and Cognition
*	Psychology 118L	Laboratory in Attention
*	Psychology 120L	Advanced Research Laboratory
*	Psychology 135A-B-C	Field Experience in Psychological Settings
*	Psychology 143S	Seminar in Social Development
*	Religious Studies 106	Modernity and the Process of Secularization
&*	Religious Studies 110D	Ritual Art and Verbal Art of the Pacific Northwest
&*	Religious Studies 114D	Religion and Healing in Native America
&	Religious Studies 124	The History of Religions in Aztlan
*	Religious Studies 127B	Christian Thought and Cultures of the Middle Ages
&*	Religious Studies 131F	The History of Anti-Semitism
*	Religious Studies 131J	Introduction to Rabbinic Literature
*	Religious Studies 140A	Islamic Traditions
*	Religious Studies 140B	Religion, Politics, and Society in the Persian Gulf Region
*	Religious Studies 140C	Islamic Mysticism and Religious Thought
&	Religious Studies 140E	Islam in America
*	Religious Studies 141C	Sociology of Religion: Church and State Relations
*	Religious Studies 145	Patterns in Comparative Religion
*	Religious Studies 163	Images of Japan: The Ideology of Representation
*	Religious Studies 166A	Religion in Chinese Culture
*	Religious Studies 166B	Taoist Traditions of China
*	Religious Studies 166C	Confucian Traditions: The Classical Period
*	Religious Studies 166E	The Flowering of Chinese Buddhism
*	Religious Studies 167A	Religion in Japanese Culture
*	Religious Studies 178	The Body Religious in Chinese Culture
*	Religious Studies 189A	History of Arabic Literature in Translation
*	Religious Studies 189B	Critical Readings in Medieval Arabic Literature in Translation
&*	Religious Studies 193	Religion and Ecology of the Americas
&*	Sociology 128	Interethnic Relations
*	Sociology 130	Development and its Alternatives
*	Sociology 130LA	Development and Social Change in Latin America
*	Sociology 130ME	Development and Social Change in the Middle East
*	Sociology 134R	The Sociology of Revolutions
*	Sociology 134RC	Radical Social Change
@& *	Sociology 137E	Sociology of the Black Experience
&	Sociology 139A	Black and White Relations
@	Sociology 140	Aging in American Society
*	Sociology 154A	Sociology of the Family
&*	Sociology 154F	The Chicano Family
@	Sociology 155A	Women in American Society
&*	Sociology 155M	Contemporary U.S. Women's Movements
&	Sociology 155W	Chicanas and Mexican Women in Contemporary Society
*	Sociology 156A	Introduction to Women, Culture, and Development
@	Sociology 157	Radicalism in Contemporary Life
*	Sociology 170	Sociology of Deviant Behavior
*	Sociology 176A	Sociology of AIDS
&	Spanish 109	Spanish in the United States: The Language and its Speakers
*	Speech & Hearing Sciences 50	Introduction to Communication Disorders
*	Theater 1	Play Analysis
*	Theater 91	Summer Theater in Orientation
&	Theater 180F	Asian American Theater
*	Theater 185TH	Theory
*	Writing 110L	Advanced Legal Writing
*	Writing 110MK	Professional Communications in Marketing and Public Relations
*	Writing 160	Theory and Practice of Writing Center Consulting

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

CHECKLIST OF GENERAL UNIVERSITY AND GENERAL EDUCATION REQUIREMENTS

GENERAL UNIVERSITY REQUIREMENTS

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

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

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

One course __________ or Advanced Placement ___________ or International waiver ______________

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

GENERAL EDUCATION REQUIREMENTS

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

General Subject Areas

1. Area A: English Reading and Composition

Writing 2 or 2E _______________ and Writing 50, 50E, 107T or 109ST ______________

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

_______________________ ___________________________

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

_______________________ ___________________________

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

_______________________ ___________________________

Special Subject Areas

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

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

_______________________ __________ ______ _____________

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

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

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

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

____________________ ____________________ ____________________

Option 3: Complete an approved minor or double major, see page 9 for more information about this option.

____

c. Ethnicity Requirement – (1 course) ______________________

d. European Traditions Requirement – (1 course)

Chemical Engineering

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

Chair: Michael Doherty
Vice-Chairs: Patrick Daugherty

Faculty

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

Patrick S. Daugherty, Ph.D., University of Texas at Austin, Professor (protein engineering and design, 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, Associate Professor (surface physics, scanning probe microscopy, nanoscale materials, plasmonics, laser spectroscopy)

Matthew E. Helgeson, Ph.D., University of Delaware, Assistant Professor (colloidal thermodynamics and rheology, polymer and surfactant self-assembly, nanomaterials, microfluidics)

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

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

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

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

Eric McFarland, Ph.D., Massachusetts Institute of Technology, 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)

Michelle A. O'Malley, Ph.D., University of Delaware, Assistant Professor (genetic and cellular engineering, membrane protein characterization for drug discovery, protein biophysics, metagenomics, biofuel production)

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

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

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

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

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

Emeriti Faculty

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

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

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

Affiliated Faculty

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

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

Philip Alan Pincus, Ph.D. (Materials)

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

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

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

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

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

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

Mission Statement

The program in Chemical Engineering has a dual mission:

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

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, while recognizing, assessing and mitigating potential hazards; the ability to use modern engineering tools necessary for engineering practice;
4. Advanced Training – knowledge beyond the basic fundamentals in chemical engineering and/or related technical fields as preparation for a continuing process of lifelong learning; a recognition of the need for and the ability to engage in lifelong learning;
5. Teamwork/Communication – the ability to function productively in multidisciplinary teams working towards common goals; the ability to communicate effectively through written reports and oral presentations;
6. Engineering & Society – the broad education necessary to understand the impact of engineering solutions in a global/societal context; a knowledge of contemporary issues; an understanding of professional and ethical responsibility; 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 or 2A-B-C; Mathematics 3A-B and Mathematics 3C or Mathematics 4A; and Engineering 3; chemical engineering majors only.

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

55. Chem-E-Car Activity
(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 or Mathematics 4B; Engineering majors only.

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

110B. Chemical Engineering Thermodynamics
(3) STAFF
Prerequisite: Chemical Engineering 110A; Mathematics 5A or Mathematics 4B; Engineering majors only.

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

119. Current Events in Chemical Engineering
(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 or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.

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

120B. Transport Processes
(3) STAFF
Prerequisite: Chemical Engineering 120A; Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B; and Physics 4.

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

120C. Transport Processes
(3) PETERS
Prerequisite: Chemical Engineering 120B, Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B; and Physics 4.

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

121. Colloids and Biosurfaces
(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 or Mathematics 4B; Mathematics 5B or Mathematics 6A.
Develop analytical tools to solve elementary partial differential equations and boundary value problems. Separation of variables, Laplace transforms, Sturm- Liouville theory, generalized Fourier analysis, and computer math tools.

132B. Computational Methods in Chemical Engineering
(3) FREDRICKSON, GORDON
Prerequisite: Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.
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 or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.
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 homogenous 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 or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.
Applications of engineering tools and methods to solve problems in systems biology. Emphasis is placed on integrative approaches that address multi-scale and multi-rate phenomena in biological regulation. Modeling, optimization, and sensitivity analysis tools are introduced.

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

170. Molecular and Cellular Biology for Engineers
(3) SHELL
Prerequisite: Chemical Engineering 120A-B-C, 140A and Chemistry 109C. Not open for credit to students who have completed Ch E 172.
Introduction to molecular and cellular biology from an engineering perspective. Topics include protein structure and function, transcription, translation, post- translational processing, cellular organization, molecular transport and trafficking, and cellular models.

171. Introduction to Biochemical Engineering
(3) DAUGHERTY
Prerequisite: Chemical Engineering 170.
Introduction to biochemical engineering covering cell growth kinetics, bioreactor design,enzyme processes, biotechnologies for modification of cellular information, and molecular and cellular engineering.

179. Biotechnology Laboratory
(4) DAUGHERTY
Prerequisite: Chemical Engineering 170 or MCDB 1A or Chemistry 142A-B or Consent of Instructor.
Must have an overall grade point average of 3.3 or above.
This course will provide an introduction to theoretical principles and practical methods used in modern biotechnology, genetic engineering, and synthetic biology. Topics will include protein and cellular engineering using recombinant DNA technologies, mutagenesis, library construction, and biosynthetic display technologies.

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

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

184A. Design of Chemical Processes
(3) DOHERTY
Prerequisites: Chemical Engineering 110A-B, 120A-B-C,128, 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
Associate Director: Forrest Brewer

Faculty

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

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

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

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

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

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

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

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)

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

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

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

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

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

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, http://www.abet.org.

Mission Statement

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

Educational Objectives

The Computer Engineering Program seeks to produce graduates who:

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

Program Outcomes

Upon completion of this program, students will have:

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

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

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

Undergraduate Program

Bachelor of Science—Computer Engineering

A minimum of 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,154, 156A; either ECE 139 or PSTAT 120A; Engineering 101.

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

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

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

Satisfactory Progress and Prerequisites

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

Computer Engineering Courses

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

Computer Science

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

Chair: Subhash Suri
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, network performance evaluation, advanced service support, solutions for developing and under-developed regions)

Tevfik Bultan, Ph.D., University of Maryland, College Park, Professor (web software and services, dependability, concurrency, automated verification, static analysis, software engineering)

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

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 LSOE (computer science education, web technologies, computer networks and communication, transport protocols, multimedia computing)*1

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 and data management; distributed systems, cloud computing)

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

Frederic Gibou, Ph.D., University of California, Los Angeles, Professor (High resolution multiscale simulation, scientific computing, tools and software for computational science and engineering, engineering applications)*2

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

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

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

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

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)

Chandra Krintz, Ph.D., University of California, San Diego, Professor (programming language implementations, dynamic and adaptive program analysis and optimization, mobile and distributed programming systems, cloud computing platforms (AppScale))

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

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

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

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

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

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

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

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, intrusion detection, vulnerability, analysis and security testing, web security, malware detection)

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 (cloud computing, high-performance distributed computing, computational grids, and computational economies for resource allocation and scheduling)

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

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

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

Heather Zheng, Ph.D., University of Maryland, College Park, 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

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

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

*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)

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

Mission Statement

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

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

One of the most important aspects of the Computer Science program at UCSB is the wealth of “hands-on” opportunities for students. UCSB has excellent computer facilities. Campus Instructional Computing makes accounts available to all students. Computer Science majors and premajors 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.

Program Goals for Undergraduate Programs

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

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

Program Outcomes for Undergraduate Programs

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

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

Admission to the Major

Students interested in computer science who apply to UCSB should declare the computer science major when they apply. UCSB students in majors other than computer science major can petition to the Department of Computer Science for consideration for admission via change-of-major once they complete the minimum requirements (specified on the departmental web pages) for doing so. Computer Science majors have priority when registering for all Computer Science courses.

Students admitted to the computer science major are responsible for satisfying major requirements in effect when they declare their major. Upper and lower division courses required for the major that are offered by the Department of Computer Science or any other department must be taken for letter grades

Undergraduate Program

Bachelor of Science—Computer Science

A minimum of 184 units is required for graduation. A complete list of requirements for the major can be found on page 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 major when the following requirements are met:

1. An overall UCSB grade point average of at least 2.0,

2. Satisfactory completion (preferably at UCSB), with a grade of B or better of CMPSC 16, 24, and 40,

3. Satisfactory completion (preferably at UCSB) with a grade of C or better of MATH 3A, 3B, 4A, and 4B.

The selection process is highly competitive and these milestones are minimum requirements for consideration, achieving them does not guarantee admission to the Computer Science major. Any petitions denied will be automatically considered a second time in the next quarter. Petitions denied a second time will not be reconsidered.

More information can be found at http://cs.ucsb.edu/undergraduate/admissions/.

Bachelor of Arts—Computer Science

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

Bachelor of Science—Computer Engineering

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

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 10, Computer Science 16, or Engineering 3.

Legal repeat for CMPSC 5AA-ZZ.

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

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 (may be taken concurrently)

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

Legal repeat of CMPSC 10.

Fundamental building blocks for solving problems using computers. Topics include basic computer organization and programming constructs: memory CPU, binary arithmetic, variables, expressions, statements, 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 with a grade of C or better; and Math 3B (may be taken concurrently).

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

Intermediate building blocks for solving problems using computers. Topics include 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 with a grade of C or better.

Computer Science 32 is a legal repeat for Computer Science 60.

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

40. Foundations of Computer Science

(4) VAN DAM, SU

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

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

48. Computer Science Project

(4) CAPPELLO

Prerequisite: Computer Science 32 with a grade of C or better.

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

56. Advanced Applications Programming

(4) CONRAD

Prerequisites: Computer Science 24 with a grade of C or better.

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

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

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

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

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

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

95AA-ZZ. Undergraduate Seminar in Computer Science

(1-4) STAFF

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.

99. Independent Studies in Computer Science

(1-4) STAFF

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

Independent studies in computer science for advanced students.

UPPER DIVISION

111. Introduction to Computational Science

(4) PETZOLD

Prerequisites: Mathematics 6A; and, Computer Science 24 with a grade of C or better.

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

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

130A. Data Structures and Algorithms I

(4) GONZALEZ

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

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

130B. Data Structures and Algorithms II

(4) GONZALEZ, SURI

Prerequisite: Computer Science 130A.

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

138. Automata and Formal Languages

(4) EGECIOGLU

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

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

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

140. Parallel Scientific Computing

(4) GILBERT

Prerequisites: Mathematics 5B; Computer Science 130A.

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

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

153A. Hardware/Software Interface

(4) KRINTZ, BREWER

Prerequisite: Upper-division standing in computer science, computer engineering, or electrical engineering.

Same course as ECE 153A.

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

154. Computer Architecture

(4) SHERWOOD, CHONG

Prerequisite: ECE 152A.

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

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

160. Translation of Programming Languages

(4) SHERWOOD

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

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

162. Programming Languages

(4) HARDEKOPF, KRINTZ

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

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

165A. Artificial Intelligence

(4) TURK

Prerequisite: Computer Science 130A

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

165B. Machine Learning

(4) SINGH

Prerequisite: Computer Science 130A.

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

167. Introduction to Bioinformatics

(4) SINGH

Prerequisite: Computer Science 130B.

Not open to students who have completed Computer Science 190N

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

170. Operating Systems

(4) KRUEGEL, ZHAO

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.

174A. Fundamentals of Database Systems

(4) SU

Prerequisite: Computer Science 130A

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

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

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

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

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

176A. Introduction to Computer Communication Networks
(4) ALMEROTH, BELDING
Prerequisites: PSTAT 120A or ECE 139, CMPSC 32 with a grade of C or better; open to computer science, computer engineering, and electrical engineering majors only.

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

Recommended preparation: PSTAT 120B.

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

176B. Network Computing
(4) ZHAO, VIGNA
Prerequisite: Computer Science 176A.

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

Focus on networking and web technologies used in the Internet. The class covers socket programming and web-based techniques that are used to build distributed applications.

176C. Advanced Topics in Internet Computing
(4) BELDING, ZHENG
Prerequisite: Computer Science 176B.

General overview of 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 24 and Computer Science 40 with a grade of C or better; and PSTAT 120A or 121A or ECE 139 or permission of instructor.

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

180. Computer Graphics
(4) WANG
Prerequisite: Computer Science 130A or consent of instructor.

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

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) ALMEROTH, 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: Upper-division standing in computer science, computer engineering, or electrical engineering majors.

Recommended preparation: Students are strongly encouraged to complete Computer Science 56 prior to enrolling in Computer Science 185. Proficiency in the Java/C++ programming language, some experience with user interface programming.

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

186. Theory of Computation
(4) IBARRA
Prerequisite: Computer Science 138; open to computer science majors only.

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

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

189A. Senior Computer Systems Project
(4) BULTAN
Prerequisite: senior standing in Computer Engineering, Electrical Engineering, or Computer Science; consent of instructor.

Not open for credit to students who have completed Computer Science 172 or ECE 189A.

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

189B. Senior Computer Systems Project
(4) BULTAN
Prerequisite: CMPSC 172 or CMPSC 189A; Senior standing in computer engineering, computer science, or electrical engineering; consent of instructor.

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

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

190AA-ZZ. Special Topics in Computer Science
(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 to a maximum of 8 units with consent of the department chair but only 4 units may be applied to the major.

Projects in computer science for advanced undergraduate students.

193. Internship in Industry
(1-4) STAFF
Prerequisites: consent of instructor and department chair.

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

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

196. Undergraduate Research
(2-4) STAFF
Prerequisites: upper-division standing, consent of the instructor.

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

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

199. Independent Studies in Computer Science
(1-4) STAFF
Prerequisites: upper-division standing; must have completed at least two upper-division courses in computer science.

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

Independent study in computer science for advanced students.

GRADUATE COURSES

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

Electrical & Computer Engineering

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

Chair: Joao Hespanha
Vice Chair: B.S. Manjunath

Faculty

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

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

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

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

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

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

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

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

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

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, Associate 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)

Yasamin Mostofi, Ph.D., Stanford University, Associate Professor (mobile sensor networks, wireless systems, networked control systems)

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

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

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

Mark J.W. Rodwell, Ph.D., Stanford University, Professor, Director of Compound Semiconductor Research 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)

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

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

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

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

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

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

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

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

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

Emeriti Faculty

Steven E. Butner, Ph.D., Stanford University, Professor (computer architecture, VLSI design of CMOS and gallium-arsenide ICs with emphasis on distributed organizations and fault-tolerant structures)

Jorge R. Fontana, Ph.D., Stanford University, Professor Emeritus (quantum electronics, particularly lasers, interaction with charged particles)

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

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

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

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

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

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

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

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

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)

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

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

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

*1 Joint appointment with Materials
*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)

Frederick Chong, Ph.D. (Computer Science)

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

Chandra Krintz, Ph.D. (Computer Science)

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

Shuji Nakamura, Ph.D. (Materials)

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

Tim Sherwood, Ph.D. (Computer Science)

Hyongsok Tom Soh, Ph.D. (Mechanical Engineering)

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

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

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

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

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College of Engineering, as well as advisors in the department. Students who plan to change 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 leadership roles.
3. We expect some of our graduates to pursue their formal education further, including graduate study for master's and doctoral degrees.

Program Outcomes

The EE program expects our students upon graduation to have:

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

Undergraduate Program

Bachelor of Science—Electrical Engineering

A minimum of 194 units is required for graduation. A complete list of requirements for the major can be found on page 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

1A. Computer Engineering Seminar
(1) STAFF
Prerequisite: open to pre-computer engineering and computer engineering majors only. Seminar: 1 hour.
Introductory seminar to expose students to a broad range of topics in Computer Engineering.

1B. Ten Puzzling Problems in Computer Engineering
(1) PARHAMI
Prerequisite: open to pre-computer engineering only. Seminar, 1 hour.
Gaining familiarity with, and motivation to study, the field of computer engineering, through puzzle-like problems that represent a range of challenges facing computer engineers in their daily problem-solving efforts and at the frontiers of research.

2A. Circuits, Devices, and Systems
(5) YORK
Prerequisites: Mathematics 3A-B, and Mathematics 3C or 4A with a minimum grade of C; and, Mathematics 5A with a minimum grade of C (may be taken concurrently); Physics 3 or 23 (may be taken concurrently); open to electrical engineering, computer engineering, and pre-computer engineering majors only. Lecture, 3 hours; laboratory, 4 hours.
Introduction to basic circuit analysis. KCL, KVL, nodal analysis, superposition, independent and dependent sources; diodes and I-V characteristics; basic op-amp circuits; first-order transient analysis; AC analysis and phasors. Introduction to the use of test instruments.

2B. Circuits, Devices, and Systems
(5) YORK
Prerequisites: ECE 2A with a grade of C- or better; open to electrical engineering, computer engineering, and pre-computer engineering majors only. Lecture, 3 hours; laboratory, 4 hours.
Second order circuits. Laplace transform and solution of steady state and transient circuit problems in the s-domain; Bode plots; Fourier series and transforms; filters. Transistor as a switch; load lines; simple logic gates; latches and flip-flops.

2C. Circuits, Devices, and Systems
(5) YORK
Prerequisites: ECE 2B with a grade of C- or better (may be taken concurrently); open to electrical engineering, computer engineering, and pre-computer engineering majors only. Lecture, 3 hours; laboratory, 4 hours.
Two-port network parameters; small-signal models of nonlinear devices; transistor amplifier circuits; frequency response of amplifiers; non-ideal op-amps; modulation, bandwidth, signals; Fourier analysis.

4. Design Project for Freshmen
(4) STAFF
Prerequisites: Mathematics 3A-B and Mathematics 3C or 4A and Physics 1 with minimum grades of C; Engineering 3 with a minimum grade of C-. Lecture, 3 hours; laboratory, 3 hours.
This first course on design gives an intuitive introduction to engineering design. Learn how to take an idea of a system and convert it to a working model. Use hardware and software for building a system.

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

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

UPPER DIVISION

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

121B. The Practice of Science
(4) HU, AWSCHALOM
Prerequisite: ECE 121A or Physics 121A; consent of instructor.
Same course as Physics 121B.

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

123. High-Performance Digital Circuit Design
(4) THEOGARAJAN
Prerequisite: ECE 2A-B-C with a minimum grade of C- in each of those courses; open to both electrical engineering and computer engineering majors only.

Introduction to high-performance digital circuit design techniques. Basics of device physics including deep submicron effects; device sizing and logical effort; Circuit design styles; clocking & timing issues; memory & datapath design; Low-power design; VLSI design flows and associated EDA tools

124A. VLSI Principles
(4) BANERJEE
Prerequisites: ECE 132 (may be taken concurrently) and ECE 152A with a minimum grade of C- in both. Lecture, 3 hours; laboratory, 3 hours.

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

141A. Introduction To Nanoelectro-mechanical 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.

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

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

144. Electromagnetic Fields and Waves
(4) 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) STAFF
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. Polyphase filters Radio link budget. Analog and digital modulation schemes. Introduction to receiver architectures. I&Q modulation. Image-reject architectures.

145C. Communication Electronics III
(5) STAFF
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 Eb/N0, 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 filer design, signal detection and parameter estimation, holography and tomography, Fourier optics, and microwave and acoustic sensing.

149. Active and Passive Network Synthesis
(4) ILTIS
Prerequisite: Upper-division standing; open to EE majors only.

Designed for juniors to take right after ECE 130AB.

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

150. Mobile Embedded Systems
(4) CHENG
Prerequisite: Proficiency in JAVA programming.

Architectures of modern smartphones and their key hardware components including mobile application processors, communications chips, display, touchscreen, graphics, camera, battery, GPS,and various sensors; the OS and software development platform of smartphones; smartphone applications; low power design techniques.

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.

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.

154A. Introduction to Computer Architecture
(4) PARHAMI
Prerequisite: ECE 152A with a minimum grade of C-; open to electrical engineering and computer engineering majors only.

Not open for credit to students who have completed Computer Science 154.

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

154B. Advanced Computer Architecture
(4) STRUKOV
Prerequisite: ECE 154A with a minimum grade of C-; open to electrical engineering and computer engineering majors only.

Not open for credit to students who have completed Computer Science 154.

ISA variations; Pipeline data and control hazards; Fast ALU design; Instruction-level parallelism, multithreading, VLIW; Vector and array processing, multi/many-core chips; Cache and virtual memory; Disk arrays; Shared- and distributed-memory systems, supercomputers; Reconfigurable and application-specific circuits.

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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) MITRA

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) MELLIAR-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.

179D. Introduction to Robotics: Dynamics and Control
(4) BYL

Prerequisites: ECE 130A or ME 155A (may be taken concurrently).

Same course as ME 179D.

Dynamic modeling and control methods for robotic systems. LaGrangian method for deriving equations of motion, introduction to the Jacobian, and modeling and control of forces and contact dynamics at a robotic end effector. Laboratories encourage a problem-solving approach to control.

179P. Introduction to Robotics: Planning and Kinematics
(4) BULLO

Prerequisites: ENGR 3; and either ME 17 or ECE 130C (may be taken concurrently). Not open for credit to student who have completed Mechanical Engineering 170A or ECE 181A.

Same course as ME 179P.

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

181B. Introduction to Computer Vision
(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.

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. Senior Computer Systems Project
(4) BUTNER

Prerequisite: ECE 152B; senior standing in Computer Engineering, Computer Science or EE. Not open for credit to students who have completed Computer Science 189A-B.

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

189B. Senior Computer Systems Project
(4) BUTNER

Prerequisite: ECE 189A; senior standing in Computer Engineering, Computer Science or ECE. Not open for credit to students who have completed Computer Science 189A-B.

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

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 Associate Dean for Undergraduate Studies, Harold Frank Hall, Room 1006;
Telephone (805) 893-2809
Web site: http://engrsci.ucsb.edu

Chair & Associate Dean: Glenn E. Beltz

Faculty

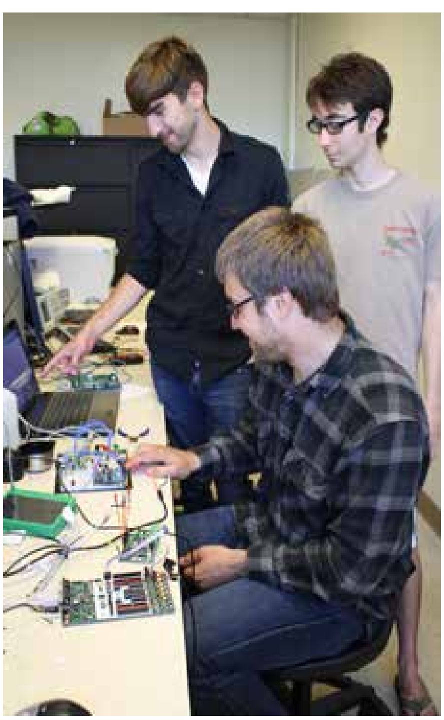
Glenn E. Beltz, Ph.D., Harvard, Professor

Jeffrey M. Moehlis, Ph.D., University of California, Berkeley, Associate Professor

Linda R. Petzold, Ph.D., University of Illinois at Urbana-Champaign, Professor

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

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



Engineering Sciences Courses

LOWER DIVISION

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

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

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

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

UPPER DIVISION

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

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

103. Advanced Engineering Writing
(4) STAFF
Prerequisites: Writing 50 or 50E; upper-division standing.

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

160. Science for the Public
(1-4) STAFF
Prerequisite: consent of instructor.

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

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

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

Same course as Art Studio 177.

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

199. Independent Studies in Engineering
(1-5) STAFF
Prerequisite: Upper-division standing; consent of instructor.

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

Directed individual study.

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: Tresa M. Pollock
Vice Chair: Michael L. Chabinyc

Faculty

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

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

John Bowers, Ph.D., Stanford, Professor (energy efficiency, optical devices and networks, silicon photonics) *1

Michael Chabinyc, Ph.D., Stanford University, Associate Professor (organic semiconductors, thin film electronics, energy conversion using photovoltaics, characterization of thin films of polymers, x-ray scattering from polymers)

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

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

Tresa M. Pollock, Ph.D., Massachusetts Institute of Technology, Professor (mechanical and environmental performance of materials in extreme environments, unique high temperature materials processing paths, ultrafast laser-material interactions, alloy design and 3-D materials characterization)

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

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

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

Anton Van der Ven, Ph.D., Massachusetts Institute of Technology, Associate Professor (equilibrium and non-equilibrium materials properties, combine density functional theory with statistical mechanics to calculate thermodynamic and kinetic properties of new materials)

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)

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

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

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

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

Affiliated Faculty

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

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

Mahn Won Kim, Ph.D. (Physics)

Gary Leal, Ph.D. (Chemical Engineering)

Gene Lucas, Ph.D. (Chemical Engineering)

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

The department has major research groups working on a wide range of advanced inorganic and organic materials, including advanced structural alloys, ceramics and polymers; high performance composites; thermal barrier coatings and engineered surfaces; organic, inorganic and hybrid semiconductor and photonic material systems; catalysts and porous materials, magnetic, ferroelectric and multiferroic materials; biomaterials and biosurfaces, including biomedically relevant systems; colloids, gels and other complex fluids; lasers, LEDs and optoelectronic

devices; packaging systems; microscale engineered systems, including MEMS. The groups are typically multidisciplinary involving faculty, postdoctoral researchers and graduate students working on the synthesis and processing, structural characterization, property evaluation, microstructure-property relationships and mathematical models relating micromechanisms to macroscopic behavior.

Materials Courses

UPPER DIVISION

100A. Structure and Properties I
(3) SESHADRI, SPALDIN
Prerequisites: Chemistry 1A-B; Physics 4; and, Mathematics 5A-B-C. Lecture, 3 hours.
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: Francesco Bullo
Vice Chair: Frederic Gibou

Faculty

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

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

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

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

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

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

Otger Campas, Ph.D., Curie Institute (Paris) and University of Barcelona, Assistant Professor (physical biology, systems biology, quantitative biology, morphogenesis and self-organization of living matter)

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

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

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

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

Eric F. 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, Professor (nonlinear dynamics, fluid mechanics, biological dynamics, applied mathematics)

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

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

Sumita Pennathur, Ph.D., Stanford University, Associate Professor (application of microfabrication techniques and micro/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, Professor (microelectromechanical systems, integrated biosensors, multi-functional biomaterials)

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

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

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

Emeriti Faculty

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

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

Roy S. Hickman, Ph.D., UC Berkeley, Professor Emeritus (fluid mechanics, physical gas dynamics, computer-aided design)

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

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

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

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

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

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

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

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

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

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

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

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

Affiliated Faculty

Paul J. Atzberger (Mathematics)
Katie A. Byl (Electrical and Computer Engineering)
Patricia Holden (Bren School of Environmental Science and Management)
Arturo Keller (Bren School of Environmental Science and Management)
L. Gary Leal (Chemical Engineering

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

Mission Statement

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

Educational Objectives for the Undergraduate Program

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

- 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 materials, and should have been exposed to experimental design in at least one of these areas.
3. Should have experienced the use of current software in problem solving and design.
4. Should demonstrate the ability to design useful products, systems, and processes.
5. Should be able to work effectively on teams.
6. Should have an understanding of professional and ethical responsibilities.
7. Should be able to write lab reports and design reports and give effective oral presentations.
8. Should have the broad background in the humanities and the social sciences, which provides an awareness of contemporary issues and facilitates an understanding of the global and societal impact of engineering problems and solutions.

9. 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) STAFF
Prerequisites: Physics 3-3L; Mathematics 3C or 4A; open to ME majors only.

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

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

10. Engineering Graphics: Sketching, CAD, and Conceptual Design
(4) STAFF
Prerequisite: ME majors only.

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

11. Introductory Concepts in Mechanical Engineering
(1) BOTHMAN, FIELDS, BELTZ
Prerequisite: lower-division standing.

The theme question of this course is "What do mechanical engineers do?" Survey of mechanical and environmental engineering applications. Lectures by mechanical engineering faculty and practicing engineers.

12. Manufacturing Processes
(1) BOTHMAN
Prerequisite: ME majors only.

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

12S. Introduction to Machine Shop
(1) STAFF
Prerequisite: ME majors only.

Basic machine shop skills course. Students learn to work safely in a machine shop. Students are introduced to the use of hand tools, the lathe, the milling machine, drill press, saws, and precision measuring tools. Students apply these skills by completing a project.

14. Statics
(4) BELTZ, SHUGAR, TURNER
Prerequisite: Physics 1 and Mathematics 3B; open to ME majors only.

Introduction to applied mechanics. Forces, moments, couples, and resultants; vector algebra; construction of free body diagrams; equilibrium in 2- and 3- dimensions; analysis of frames, machines, trusses and beams; distributed forces; friction.

15. Strength of Materials
(4) BELTZ, KEDWARD
Prerequisites: ME 14 with a minimum grade of C-; open to mechanical engineering majors only.

Properties of structural materials, including Hooke's law and behavior beyond the elastic limit. Concepts of stress, strain, displacement, force, force systems, and multiaxial stress states. Design applications to engineering structures, including problems of bars in tension, compression, and torsion, beams subject to flexure, pressure vessels, and buckling.

16. Engineering Mechanics: Dynamics
(4) TURNER, MEZIC, BAMIEH
Prerequisites: Physics 2; ME 14 with a minimum grade of C-; and, Mathematics 5C or 6B; (may be taken concurrently); open to ME majors only.

Not open for credit to students who have completed ME 163A.

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 or 6A (may be taken concurrently); open to ME majors only.

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

95. Introduction to Mechanical Engineering
(1-4) STAFF
Prerequisite: consent of instructor.

May be repeated for credit to a maximum of 6 units.

Participation in projects in the laboratory or machine shop. Projects may be student- or faculty-originated depending upon student interest and consent of faculty member.

97. Mechanical Engineering Design Projects
(1-4) STAFF
Prerequisite: consent of instructor.

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

Course offers students opportunity to work on established departmental design projects. P/NP grading, does not satisfy technical elective requirement.

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

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) 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
(3) MATTHYS, MARSCHALL

Prerequisite: Senior Undergraduate or Graduate Student status in the College of Engineering; or consent of Instructor.

Introduction to the field of Energetics. Topics may include energy sources and production, energy usage, renewable technologies, hardware, operating principles, environmental impact, energy reserves, national and global energy budgets, historical perspectives, economics, societal considerations, and others.

119. Introduction to Coastal Engineering
(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.

140A. Numerical Analysis in Engineering
(3) MOEHLIS, GIBOU, MEIBURG

Prerequisites: ME 17 with a minimum grade of C- or Chemical Engineering 132A; open to ME and Chemical Engineering majors only.

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

140B. Theoretical Analysis in Mechanical Engineering
(3) 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 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) 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) BENNETT

Prerequisite: Physics 2; ME 14 with a minimum grade of C-; and, Mathematics 5C or 6B.

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

151B. Thermosciences 2
(4) BENNETT

Prerequisite: ME 151A and 152A.

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

151C. Thermosciences 3
(3) BENNETT

Prerequisites: ME 151B and 152B; open to ME majors only.

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

152A. Fluid Mechanics
(4) MEINHART, PENNATHUR

Prerequisite: Mathematics 5C or 6B; and ME 16 with a minimum grade of C-.

Introduction to the fundamental concepts in fluid mechanics and basic fluid properties. Basic equations of fluid flow. Dimensional analysis and 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

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 with minimum grades of C-; open to ME majors only.

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

155A. Control System Design
(3) BAMIEH, BULLO

Prerequisite: ME 17 with a minimum grade of C-; ME 140A (may be taken concurrently); and ME 163.

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

155B. Control System Design
(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, 152B, and 153; 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, MCMEEKING
Prerequisites: ME 16 with a minimum grade of C-; open to ME majors only.

Not open for credit to students who have completed ME 163B.

Topics relating to vibration in mechanical systems; exact and approximate methods of analysis, matrix methods, generalized coordinates and Lagrange's equations, applications to systems. Basic feedback systems and controlled dynamic behavior.

166. Advanced Strength of Materials
(3) 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
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.

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.

179D. Introduction to Robotics: Dynamics and Control
(4) BYL
Prerequisites: ECE 130A or ME 155A (may be taken concurrently).

Dynamic modeling and control methods for robotic systems. LaGrangian method for deriving equations of motion, introduction to the Jacobian, and modeling and control of forces and contact dynamics at a robotic end effector. Laboratories encourage a problem-solving approach to control.

179L. Introduction to Robotics: Design Laboratory
(4) PADEN
Prerequisites: ENGR 3; and ME 6 or ECE 2A. Not open for credit to student who have completed Mechanical Engineering 170C or ECE 181C.

Design, programming, and testing of mobile robots. Design problems re formulated in terms of robot performance. Students solve electromechanical problems, developing skills in brainstorming, concept selection, spatial reasoning, teamwork and communication. Robots are controlled with micro-controllers using C programming interfaced to senors and motors.

179P. Introduction to Robotics: Planning and Kinematics
(4) BULLO
Prerequisites: Engr 3; and either ME 17 or ECE 130C (may be taken concurrently). Not open for credit to students who have completed ME 170A or ECE 181A.

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

185. Materials in Engineering
(3) LEVI, 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.

ME 189A. Capstone Mechanical Engineering Design Project
(2) LAGUETTE
Prerequisites: ME 153; and ME 156A (may be taken concurrently).

Designed for majors. Concurrently offered with ME 156A. Quarters usually offered: Fall. A 3-quarter sequence with grades issued for each quarter. Students may not concurrently enroll in ME 197 and ME 189A-B-C with the same design project.

Course can only be repeated as a full sequence (189A-B-C).

Students work in teams under the direction of a faculty advisor (and possibly an industrial sponsor) to tackle an engineering design project. Engineering communication, such as reports and oral presentations are covered. Emphasis on practical, hands-on experience, and the integration of analytical and design skills acquired in the companion ME 156 courses.

ME 189B. Capstone Mechanical Engineering Design Project
(2) LAGUETTE
Prerequisite: ME 189A

Designed for majors. Concurrently offered with ME 156B. Quarters usually offered: Winter. A 3-quarter sequence with grades issued for each quarter. Students may not concurrently enroll in ME 197 and ME 189A-B-C with the same design project.

Course can only be repeated as a full sequence (189A-B-C).

Students work in teams under the direction of a faculty advisor (and possibly an industrial sponsor) to tackle an engineering design project. Engineering communication, such as reports and oral presentations, are covered. Course emphasizes practical, hands-on experience, and integrates analytical and design skills acquired in the companion ME 156 courses.

ME 189C. Capstone Mechanical Engineering Design Project
(2) LAGUETTE
Prerequisite: ME 189A,B

Designed for majors. Quarters usually offered: Spring. A 3-quarter sequence with grades issued for each quarter. Students may not concurrently enroll in ME 197 and ME 189A-B-C with the same design project. Course can only be repeated as a full sequence (189A-B-C).

Students work in teams under the direction of a faculty advisor (and possibly an industrial sponsor) to tackle an engineering design project. Engineering communication, such as reports and oral presentations, are covered. Course emphasizes practical, hands-on experience, and integrates analytical and design skills acquired in the companion ME 156 courses.

193. Internship in Industry
(1) STAFF
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.

Technology Management

Technology Management Program
Phelps Hall, Room 1325
Telephone (805) 893-8107
Web site: www.tmp.ucsb.edu

Chair: Robert A. York
Vice Chair: David Seibold

Faculty

John E. Bowers, Ph.D., Stanford University, Professor

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

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

Robert A. York, Ph.D., Cornell University, Professor

Transitioning new technical advances and discoveries into products or services that benefit society requires business and interpersonal skills as well as technical expertise. These include an ability to work effectively in teams, having a sound understanding of organizational behavior and management, technical marketing and communication, basic economics, personnel and project management, and accounting and finance. The Technology Management Program (TMP) provides a solid foundation in these areas to help cultivate managerial and entrepreneurial leadership for technology businesses.

Mission Statement

TMP is a unique educational program that exposes innovative, energetic, and entrepreneurial students to key aspects of technology, business practices, new venture creation, and professional development. Dedicated to the study of management, organizational and entrepreneurial business processes involved in transforming new discoveries in science and engineering into economically productive enterprises, TMP is redefining entrepreneurial education with a comprehensive curriculum for the creation and management of tomorrow's technology ventures.

The Technology Entrepreneurship Professional Certificate

The Technology Entrepreneurship Professional Certificate program provides students a solid foundation in business fundamentals and entrepreneurship as it applies to new technologies and technology-oriented companies. This certificate serves as an official recognition that the student has a solid grounding in fundamental business strategies and models, opportunity recognition and new-venture creation, entrepreneurial marketing and finance, foundations of team building, organization behavior and talent management.

Students will gain an understanding of the wide range of concepts and business principles considered during start-up, growth, and operation of technology-oriented companies. The program provides access to many professionals familiar with the demands of starting new businesses as well as running existing companies. Students will be able to directly apply their knowledge from TEC courses to operate effectively in the business environment or launch a new venture.

TMP also offers an undergraduate Technology Entrepreneurship certificate in partnership with UC Extension.

Technology Management Program Courses

TMP 111. Opportunities and Perspectives in Technology, Business, and Society
(1) STAFF
Prerequisite: Writing 2 with a minimum grade of B; and Writing 50 or equivalent with a minimum grade of B.
Enrollment Comments: Quarters usually offered: Fall, Winter, Spring. "Writing 50 or equivalent" in the prerequisites is intended to include: ENGL 10, WRIT 50, WRIT 105*, WRIT 107* & WRIT 109**

Lecture series where entrepreneurial, technological, business, and governmental leaders share their lessons of experience and discuss current business issues. For anyone interested in entrepreneurship, management, technology development, and commercialization and the impact that innovation has on society.

TMP 120. Business Strategy & Leadership Skills
(4) HANSEN
Prerequisite: Writing 2 with a minimum grade of B-; and, Writing 50 or equivalent with a minimum grade of B-; and upper division standing.

Introduction to critical business principles and practices required by leaders for business success and societal benefit. Students will be exposed to key management theories, models and tools in strategy, finance, accounting, commercialization, marketing, and sales.

TMP 122. Entrepreneurship
(4) STAFF
Prerequisite: Writing 2 with a minimum grade of B- and Writing 50 or equivalent (ENGL 10, WRIT 50, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B-.*

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

TMP 124. Entrepreneurial Marketing
(2) STAFF
(Offered through UC Extension)
Prerequisite: Writing 2 with a minimum grade of B- and Writing 50 or equivalent (ENGL 10, WRIT 50, WRIT 105*, WRIT 107*, or 109*), and upper division standing.*

Introduction to basic marketing concepts and how these concepts can be applied to any organization, particularly technology firms. Additionally, they will be introduced to how management of the marketing function within and organization is critical to the organization's success.

TMP 126. New Venture Finance
(2) STAFF
(Offered through UC Extension)
Recommended Preparation: Economics 3A or equivalent.

Presents the tools necessary for the strategic analysis and understanding of financial information particular to new ventures. Provides insight into how financial information can be used to design optimal financing strategies, prepare valuation models for new ventures, and assist in strategic planning for the venture.

TMP 127. Organization Teams and Talent Management
(3) STAFF
(Offered through UC Extension)
Prerequisite: Writing 2 with a minimum grade of B and Writing 50 with a minimum grade of B or equivalent, upper division standing.

Focuses on the important link between the business and talent strategy including talent value chain, recruitment/selection strategies for rewards/incentives, employee relations, leadership and team formation; conflict resolution, problem solving, and decision-making, importance of organization culture; culture diversity and global village.

TMP 130. Operations Management
(3) STAFF
Prerequisite: Upper Division standing and Writing 2 and Writing 50, with grades of B- or better.

Studies the flow of materials and information necessary to effectively and efficiently supply products and or services to customers. Provides an understanding of the principles of design and management of manufacture, service, and supply chain organizations, business processes and systems.

TMP 131. Introductions to Patents and Intellectual Property
(3) STAFF
Prerequisite: Writing 2 with a minimum grade of B; and Writing 50 or equivalent (ENGL 10, WRIT 50, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B-; and upper division standing.*

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

TMP 132. Business Planning for New Ventures
(4) STAFF
Prerequisite: Engineering 120 or Engineering 122; and Writing 50 or equivalent (ENGL 10, WRIT 50, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B-.*

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.

TMP 134. Selling High Tech Products
(3) STAFF
Prerequisite: Writing 2 with a minimum grade of B; and Writing 50 or equivalent (ENGL 10, WRIT 50, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B-; and upper division standing.*

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

TMP 135. New Product Development
(4) BOWERS
Prerequisite: Upper division 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 skills.

TMP 136. Project Management
(3) STAFF
Prerequisite: Upper division standing.
Introduces the theory, concepts, techniques, vocabulary, and practical knowledge of project management practice. Students will learn about the process groups and knowledge areas comprising PMI's Project Management Body of Knowledge. Provides a framework for conducting projects using project management principles.

TMP 144. Market Research for Business
(3) STAFF
Prerequisite: Writing 2 with a minimum grade of B, and Writing 50 or equivalent with a minimum grade of B; and upper division standing.
Enrollment Comments: Students must have a cumulative 3.0 for the proceeding 3 quarters. Quarters usually offered: Winter, Spring.
Provides a high level introduction to modern marketing research. Course will cover the fundamental principles and techniques for market validation that are critical to launch, grow, and sustain a viable business.

TMP 148A. New Venture Seminar
(3) STAFF
Recommended Preparation: TMP 122, TMP 149, or equivalent.
Enrollment Comments: Quarters usually offered: Winter.
A twice-weekly series of seminars about the creation of sustainable new business ventures from inception to launch. Intended for students participating in the TMP New Venture Competition.

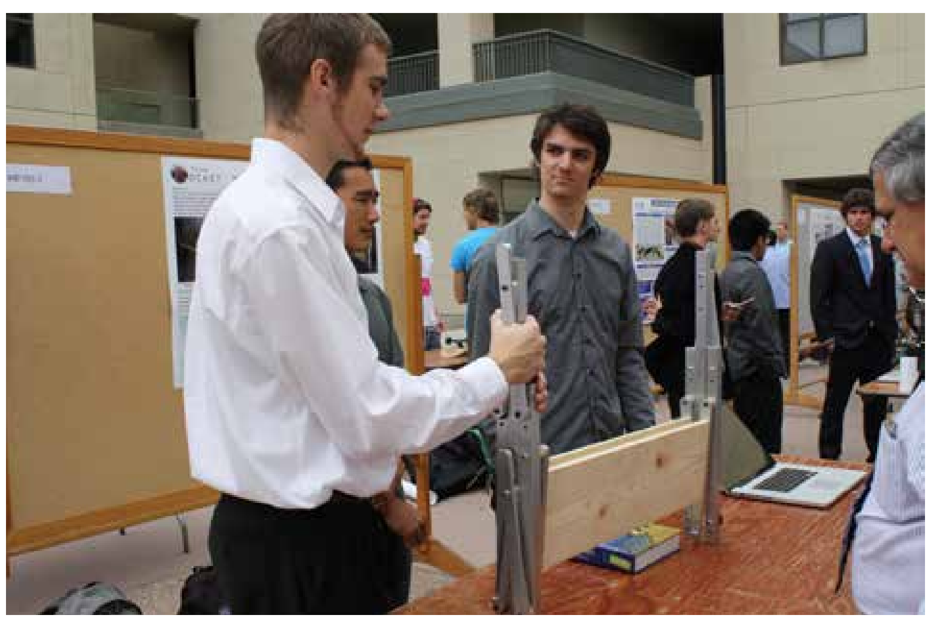
TMP 148B. New Venture Seminar
(3) STAFF
Recommended Preparation: TMP 122, TMP 148A, TMP 149, or equivalent.
Enrollment Comments: Quarters usually offered: Spring.
Continuation of twice-weekly seminar series covering the development of a validated and sustainable new business, with a focus on creating a writing business plan and oral presentation. Intended for students participation in the TMP New Venture Competition finals.

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

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

GRADUATE COURSES

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



CHEMICAL ENGINEERING 2013-14

PREPARATION FOR THE MAJOR	Units 80
CH E 1A	1
CH E 10	3
CHEM 1A, 1B, 1C or 2A, 2B, 2C	9
CHEM 1AL, 1BL, 1CL or 2AC, 2BC, 2CC	6
CHEM 6AL-BL	6
CHEM 109A-B-C	12
ENGR 3	3
MATH 3A-B, 4A-B, 6A-B	24
PHYS 1, 2, 3, 3L, 4, 4L	16

UPPER DIVISION MAJOR	78
CH E 110A-B	6
CH E 119	1
CH E 120A-B-C	10
CH E 128	3
CH E 132A-B-C	10
CH E 140A-B	6
CH E 152A	4
CH E 170	3
CH E 180A-B	6
CH E 184A-B	6
CHEM 113B-C	8
MATRL 101 or MATRL 100B *	3

* see note on next page

Technical Elective requirement 12

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

Approved Technical Elective Requirement classes:

CH E 102	CHEM 126	MCDB 111
CH E 121	CHEM 142A-B-C	MCDB 126A-B-C
CH E 124	CHEM 145	MCDB 133
CH E 125	CHEM 147	MCDB 138
CH E 136	CHEM 150	ME 110
CH E 138	ECE 130A-B-C	ME 112
CH E 141	ECE 183	ME 114
CH E 152B	ENGR 101	ME 119
CH E 154	ENGR 103	ME 128
CH E 160	ENV S 105	ME 134
CH E 171	MATH 122A-B	ME 169
CH E 196[1]	MATRL 100A,C	ME 185
CH E 198[1]	MATRL 160	PHYS 123A-B
CHEM 115A-B-C	MATRL 185	PHYS 127AL
CHEM 123	MCDB 101A-B	PHYS 127BL

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

Technical electives taken:

______________________ ______________________

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

UNIVERSITY REQUIREMENTS (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
Must be fulfilled within three quarters of matriculation

Satisfied by: ______________________________

GENERAL EDUCATION

General Subject Areas

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

A-1: ____________________ **A-2**: ____________________

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

____________________ ____________________

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

____________________ ____________________

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

____________________ ____________________

Special Subject Areas

Depth:

____________________ ____________________
____________________ ____________________

Ethnicity (1 course): ______________________________

European Traditions (1 course): ______________________

Writing (4 courses required):

____________________ ____________________
____________________ ____________________

NON-MAJOR ELECTIVES **36**

General Education and Free Electives taken:

____________________ ____________________
____________________ ____________________
____________________ ____________________
____________________ ____________________
____________________ ____________________
____________________ ____________________

TOTAL UNITS REQUIRED FOR GRADUATION 194

CHEMICAL ENGINEERING 2013-14

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 4A	4
ENGR 3 or G.E. Elective	3/4	PHYS 1	4	PHYS 2	4
MATH 3A	4	WRIT 2E or 50E	4	WRIT 50E or G.E. Elective or ENGR 3	3/4
WRIT 1E or 2E	4				
TOTAL	**17/18**		**17**		**16/17**

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 4B	4	CHEM 109B	4	CHEM 109C	4
PHYS 3	3	MATH 6A	4	MATH 6B	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 2013-14

PREPARATION FOR THE MAJOR	Units 74
CHEM 1A, 1AL or 2A, 2AC	5
CMPSC 16	4
CMPSC 24	4
CMPSC 32	4
CMPSC 40	4
ECE 1A-1B	2
ECE 2A-B-C	15
ECE 15A	4
MATH 3A-B, 4A-B	16
PHYS 1, 2, 3, 3L, 4, 4L	16

UPPER DIVISION MAJOR	68
CMPSC 130A	4
CMPSC 170	4
ECE 139 or PSTAT 120A	4
ECE 152A	5
ECE 154A	4
ECE 156A	4
ENGR 101	3

Computer Engineering electives selected from the following list: 40

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

Must include at least 2 sequences and 8 units of senior computer systems project CMPSC 189 A-B/ECE 189A-B.

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

Computer Engineering electives taken:

MATH, SCIENCE, ENGR. ELECTIVE	4

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

Elective taken: ______________________

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

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
Must be fulfilled within three quarters of matriculation

Satisfied by: ______________________

GENERAL EDUCATION

General Subject Areas

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

A-1: ____________ **A-2**: ____________

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

____________ ____________

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

____________ ____________

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

____________ ____________

Special Subject Areas

Depth:

____________ ____________

____________ ____________

Ethnicity (1 course): ______________________

European Traditions (1 course): ______________________

Writing (4 courses required):

____________ ____________

____________ ____________

NON-MAJOR ELECTIVES	44

General Education and Free Electives taken:

TOTAL UNITS REQUIRED FOR GRADUATION 190

COMPUTER ENGINEERING 2013-14

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
CHEM 1A or 2A	3	ECE 1A	1	CMPSC 16	4
CHEM 1AL or 2AC	2	Math, Science,		ECE 1B	1
MATH 3A	4	or Engr. Elective	4	MATH 4A	4
G.E. Elective or CMPSC 8[1]	4	MATH 3B	4	PHYS 2	4
WRIT 1E or 2E	4	PHYS 1	4	WRIT 50E or G.E. Elective	4
		WRIT 2E or 50E	4		
TOTAL	**17**		**17**		**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 4B	4	ECE 15A	4	ECE 152A	5
PHYS 3	3	PHYS 4	3	ECE 139 or PSTAT 120A[2]	4
PHYS 3L	1	PHYS 4L	1		
TOTAL	**17**		**17**		**18**

JUNIOR YEAR

FALL	units	WINTER	units	SPRING	units
ECE 154A	4	CMPSC 130A	4	CMPSC 170	4
ECE 156A	4	CMPEN Elective	4	CMPEN Elective	4
CMPEN Elective	4	G.E. or Free Electives	8	G.E. or Free Elective	4
G.E. or Free Electives	4				
TOTAL	**16**		**16**		**12**

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**

[1] CMPSC 8 is recommended only for students who do not have prior programming experience, as programming experience is a prerequisite for CMPSC 16.

[2] PSTAT 120A is offered each quarter. ECE 139 is offered only in spring quarter, and is better suited for future upper division electives for the Computer Engineering major.

COMPUTER SCIENCE 2013-14

PREPARATION FOR THE MAJOR	Units 52
CMPSC 16	4
CMPSC 24	4
CMPSC 32	4
CMPSC 40	4
CMPSC 48	4
CMPSC 56	4
CMPSC 64	4
MATH 3A-B, 4A-B, 6A	20
PSTAT 120A	4

UPPER DIVISION MAJOR	64
CMPSC 111 or 140	4
CMPSC 130A-B	8
CMPSC 138	4
CMPSC 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 153B
CMPSC/ECE 153A	CMPSC 182/ECE160	MATH 108A-B
CMPSC 165A-B	CMPSC 185	MATH 119A-B
CMPSC 167	CMPSC 186	MATH 124A-B
CMPSC 171/ECE 151	CMPSC 189 A-B	PSTAT 122
CMPSC 172	CMPSC 190 AA-ZZ	PSTAT 130
CMPSC 174A-B	CMPSC 192[2]	PSTAT 132C
CMPSC 176A-B-C	CMPSC 196[2]	
CMPSC 177		

[1]CMPSC 111 or CMPSC 140 can be used as an elective if not taken as a major course.
[2]Four units maximum from CMPSC 192 and CMPSC 196 combined; only for students with GPA of 3.0 or higher.

Major Field Electives taken:

SCIENCE COURSES	20
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
Must be fulfilled within three quarters of matriculation

Satisfied by: ____________________

GENERAL EDUCATION

General Subject Areas

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

A-1: ____________ **A-2**: ____________

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

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

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

Special Subject Areas

Depth:

Ethnicity (1 course): ____________________

European Traditions (1 course): ____________________

Writing (4 courses required):

NON-MAJOR ELECTIVES	48

General Education and Free Electives taken:

TOTAL UNITS REQUIRED FOR GRADUATION 184

COMPUTER SCIENCE 2013-14

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 4A	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 4B	4	MATH 6A	4	G.E. Elective	4
PHYS 3	3	WRIT 50	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 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 2013-14

PREPARATION FOR THE MAJOR	Units 84
CHEM 1A, 1AL, 1B, 1BL or 2A, 2AC, 2B, 2BC	10
CMPSC 16	4
CMPSC 24	4
ECE 2A-B-C	15
ECE 15A	4
ENGR 3	3
MATH 3A-B, 4A-B, 6A-B.	24
PHYS 1, 2, 3, 3L, 4, 4L, 5, 5L	20

UPPER DIVISION MAJOR	68
ECE 130A-B	8
ECE 132	4
ECE 134	4
ECE 137A-B	8
ECE 139	4
ECE 152A	5
ENGR 101	3

Departmental electives selected from the following list: . . . 32

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

Approved Departmental Electives:

ECE 123	ECE 148	ECE 181B
ECE 124A-B-C-D	ECE 150	ECE 183
ECE 125	ECE 153A-B	ECE 188A-B
ECE 130C	ECE 154A-B	ECE 192 or 196 (4 unit combined max)
ECE 135	ECE 155A-B	ECE 194AA-ZZ(excluding ECE 194R)
ECE 141A-B-C	ECE 156A-B	ENGR 103, TMP 120, TMP 122 (1 course max)
ECE 142	ECE 158	
ECE 144	ECE 160	MATRL 100A, C
ECE 145A-B-C	ECE 162-A-B-C	MATRL 100B or MATRL 101
ECE 146A-B	ECE 178	MATRL 162A-B
ECE 147A-B-C	ECE 179D, P	

Departmental Electives taken:

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

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
Must be fulfilled within three quarters of matriculation

Satisfied by:__________________________

GENERAL EDUCATION

General Subject Areas

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

A-1: ____________________ **A-2**: ____________________

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

____________________ ____________________

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

____________________ ____________________

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

____________________ ____________________

Special Subject Areas

Depth:

____________________ ____________________
____________________ ____________________

Ethnicity (1 course):____________________

European Traditions (1 course):____________________

Writing (4 courses required):

____________________ ____________________
____________________ ____________________

NON-MAJOR ELECTIVES	42

General Education and Free Electives taken:

TOTAL UNITS REQUIRED FOR GRADUATION 194

ELECTRICAL ENGINEERING 2013-14

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 4A	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 4B	4	ECE 15A	4	ECE 2C	5
PHYS 3	3	MATH 6A	4	MATH 6B	4
PHYS 3L	1	PHYS 4	3	PHYS 5	3
		PHYS 4L	1	PHYS 5L	1
TOTAL	**13**		**17**		**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 [1]	4
ECE 134	4	ECE Elective	4	ECE 152A [2]	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**

[1] ECE 139 may also be taken in the spring quarter of the sophomore year.

[2] ECE 152A may also be taken in the spring quarter of the sophomore year.

MECHANICAL ENGINEERING 2013-14

PREPARATION FOR THE MAJOR	Units 76
CHEM 1A, 1AL, 1B, 1BL or 2A, 2AC, 2B, 2BC	10
ENGR 3	3
MATH 3A-B, 4A-B, 6A-B	24
ME 6	4
ME 10	4
ME 14	4
ME 15	4
ME 16	4
ME 17	3
PHYS 1, 2, 3, 3L, 4, 4L	16

UPPER DIVISION MAJOR	70
Third Year	
MATRL 101 or MATRL 100B*	3
ME 104	3
ME 105	4
ME 140A	3
ME 151A-B-C	11
ME 152A-B	7
ME 153	3
ME 155A	3
ME 163	3

* see note on next page

Fourth Year	
ME 154	3
ME 156A-B	6
ME 189A-B-C	6
Engineering Electives	15

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

Approved Engineering Electives:

CHEM 109A	ME 110	ME 155B
CHEM 123	ME 112	ME 158
ECE 147A,C	ME 114	ME 162
ENGR 101	ME 119	ME 166
ENGR 103, TMP 120,	ME 124	ME 167
TMP 122 (max 1 course)	ME 125AA-ZZ	ME 168
ENV S 105	ME 128	ME 169
MATRL 100A	ME 134	ME 173
MATRL 100C	ME 136	ME 179D-L-P
MATRL 186	ME 138	ME 185
MATRL 188	ME 140B	ME 186
ME 106A-B-C	ME 141A-B-C	ME 197[1]
	ME 146	ME 199[1]

[1] Four units maximum from ME 197 and ME 199 combined.

Engineering Electives taken:

____

____

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

UNIVERSITY REQUIREMENTS

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

____

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

Satisfied by: ____________________

GENERAL EDUCATION

General Subject Areas

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

A-1: ____________ **A-2**: ____________

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

____________ ____________

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

____________ ____________

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

____________ ____________

Special Subject Areas

Depth:

____________ ____________

____________ ____________

Ethnicity (1 course): ____________

European Traditions (1 course): ____________

Writing (4 courses required):

____________ ____________

____________ ____________

NON-MAJOR ELECTIVES 44

General Education and Free Electives taken:

TOTAL UNITS REQUIRED FOR GRADUATION 190

MECHANICAL ENGINEERING 2013-14

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
CHEM 1A or 2A	3	CHEM 1B or 2B	3	MATH 4A	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 4B	4	MATH 6A	4	MATH 6B	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

Gaucho On-Line Data (GOLD) – student record, class registration, degree audits—**https://my.sa.ucsb.edu/gold**

UMAIL – campus email for official notifications—**http://www.umail.ucsb.edu**

Schedule of Classes information – quarterly calendar and information—**http://www.registrar.ucsb.edu**

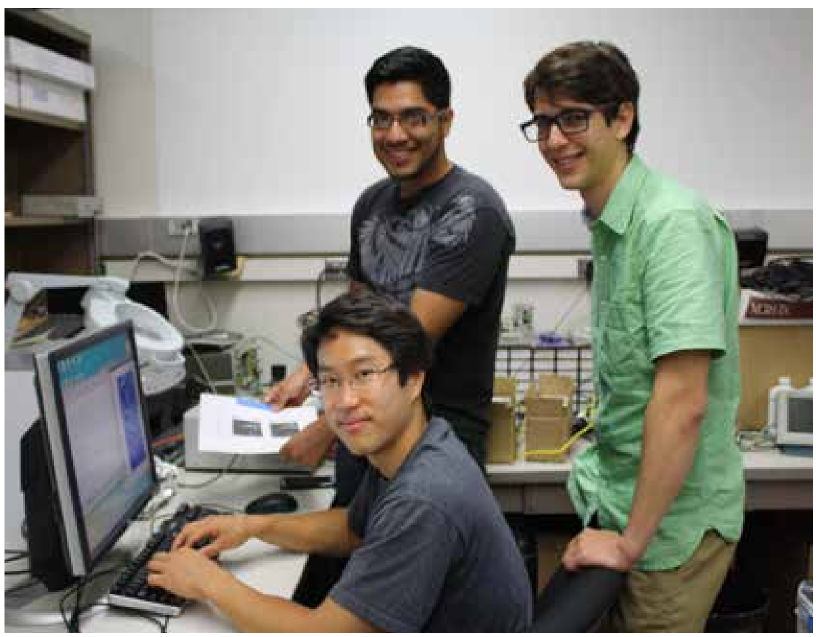
General Catalog for UCSB – academic requirements for all campus majors—**http://my.sa.ucsb.edu/Catalog/**

Summer Sessions – Summer programs and course offerings—**http://www.summer.ucsb.edu**

Tutoring – course-specific tutoring and academic skills development—**http://www.clas.ucsb.edu**

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

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



Advising Staff

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

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

		Phone	Email	Location
College Advising staff		(805) 893-2809	coe-info@engr.ucsb.edu	Frank Hall, Rm. 1006
Departmental Advisors:				
Chemical Engineering	Laura Crownover	893-8671	laura@engr.ucsb.edu	Engr.II, Rm. 3357
Computer Engineering	Alex Reyes	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	Alex Reyes	893-8292	ugradinfo@ece.ucsb.edu	Trailer 380, Rm. 101
Mechanical Engineering	Suzi See	893-8198	meugrad@engr.ucsb.edu	Engr.II, Rm. 2335
Technology Management Program	Diana Doyle	893-2729	ddoyle@tmp.ucsb.edu	Phelps 1333

Notes

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