GEAR

General Engineering Academic Requirements

2021-2022

UC SANTA BARBARA
College of Engineering

2021-2022 Academic Calendar

Note: Dates subject to change without notice.

	Fall 2021	Winter 2022	Spring 2022
Quarter begins	September 19, 2021	January 3, 2022	March 28, 2022
New Student Convocation	September 20, 2021		
Pre–instruction Activities	September 20-22, 2021	January 3, 2022	March 28, 2022
First day of instruction	September 23, 2021	January 3, 2022	March 28, 2022
Last day of instruction	December 3, 2021	March 11, 2022	June 3, 2022
Final examinations	December 4-10, 2021	March 12-18, 2022	June 4-10, 2022
Quarter ends	December 10, 2021	March 18, 2021	June 10, 2022
Commencement			June 11-12, 2022

2021-2022 Campus Holidays Observed

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

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

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

All announcements herein are subject to revision without notice.

EQUAL OPPORTUNITY AND NONDISCRIMINATION

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

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

[1] Pregnancy includes pregnancy, childbirth, and medical conditions related to pregnancy or childbirth.

GEAR

General Engineering Academic Requirements

College of Engineering • University of California • Santa Barbara

Volume 12, Summer 2021

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Requirements and policies in the GEAR are subject to change each academic year.

Message from the Associate Dean

Glenn Beltz, Associate Dean
Photo by Emily Swindle

Welcome to the College of Engineering at UC Santa Barbara. There are many reasons we are one of the top engineering schools in the nation. We bring together an amazing faculty, the members of which are highly acclaimed in the scientific communities in which they work. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. A high percentage of the faculty has been elected to the prestigious National Academy of Sciences and National Academy of Engineering. We have six Nobel Prize winners on this campus, five of whom are faculty in engineering and the sciences. We're also home to an amazing group of smart, accomplished, high-energy students. These more than 1,500 undergraduates, pursuing a variety of interests, contribute greatly to the quality of the learning environment as well as to the overall richness of campus life.

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

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

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

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

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

Glenn Beltz
Associate Dean for
Undergraduate Studies

Table of Contents

Message from the Associate Dean 2

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

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

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

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

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

Additional Resources 56

Academic Year Calendar .... Inside Front Cover

College Policy on Academic Conduct 57

UC **SANTA BARBARA**

College of Engineering

The College of Engineering at UCSB is noted for its excellence in teaching, research, and service to the community. The college has an enrollment of approximately 1,500 undergraduate students and 750 graduate students with a full-time, 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 http://www.abet.org.

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

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

Mission Statement

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

College of Engineering Honors Program

The Honors Program in the College of Engineering is designed to enrich the educational opportunities of its best students. Students in the Honors Program will be encouraged to participate in early experiences in scholarship through special seminars and, in later years, as members of research teams.

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

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

To graduate as an Honors Program Scholar, students must complete 6.0 total Honors units during their junior and senior years; comprised of coursework from departmental 196, 197, 198, 199 courses, graduate level courses (numbered 200-299), or completing courses toward their engineering major through the UC Education Abroad Program with grades of B or higher.

Notes: Capstone participation/courses do not apply to honors credit, nor do graduate courses taken to satisfy requirements for a graduate degree. Paid research positions cannot apply., complete a total of 10 hours of community service for each year they are program members and maintain a 3.5 or higher cumulative GPA at the end of each Spring quarter.

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

Dean's Honors

The College of Engineering gives public recognition to its outstanding undergraduate students by awarding Dean's Honors at the end of each regular academic term to students who have earned a 3.75 grade-point average for the quarter and have completed a program of 12 or more letter-graded units. Grades of Not Passed automatically disqualify students for eligibility for Dean's Honors.The award is noted quarterly on the student's permanent transcript.

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

Tau Beta Pi

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

Education Abroad Program (EAP)

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

Student Organizations

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

- American Indians in Science and Engineering Society
- American Institute of Chemical Engineers
- American Society of Mechanical Engineers
- Association for Computing Machinery
- Coders SB
- Data Science at UCSB
- Engineering Student Council
- Engineers without Borders
- Entrepreneurs Association
- Institute of Electrical and Electronics Engineers
- The Lighthouse Journal
- Los Ingenieros (Mexican-American Engineering Society/Society of Hispanic Professional Engineers)
- Machine Shop Club
- National Society of Black Engineers
- Out in Science, Technology, Engineering, and Mathematicsout in Science, Technology, Engineering, and Mathematics
- Phi Sigma Rho
- Photonics Society at UCSB
- Robotics Club
- SB Hacks
- Society for Advancement of Chicano and Native Americans in Science
- Society of Asian Scientists and Engineers
- Society of Women Engineers
- Theta Tau
- Women in Computer Science
- Women in Science and Engineering
- Women in Software and Hardware

Change of Major and Change of College

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

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

Note: The College of Engineering will not accept students from the College of Creative Studies or the College of Letters and Science after they have completed 105 units, regardless of their expected unit total at graduation. Students must be at or below 105 units at the time required change of major courses are completed.

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

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

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

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

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

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

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

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

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

1. An overall UCSB grade point average of

at least 3.0.

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

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

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

Degree Requirements

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

General University Requirements

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

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

Major Degree Requirements

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

Advanced Placement Credit

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

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

International Baccalaureate Credit

Students who earn scores of 5, 6, or 7 on International Baccalaureate (IB) Higher Level (HL) Examinations taken before high school graduation will receive 8 units of credit toward graduation at UCSB for each such test completed with the required scores, provided official scores are submitted to the Office of Admissions. Students who complete the IB diploma with a score of 30 or above will receive 6 quarter units in addition to the units earned for individual Higher Level exams.

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

Minimal Progress Requirements

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

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

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

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

215–Unit and Quarter Enrollment Limitations

The college expects students to graduate within 12 regular quarters for students who are admitted as freshmen and 9 regular quarters for students admitted as junior transfers and with no more than 215 units. College credit earned before high school graduation does not count toward the 215-unit maximum. This includes credit for Advanced Placement and International Baccalaureate examinations, and also college or university credit earned while still in high school.

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

With the exception of summer sessions,

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

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

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

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

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

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

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

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

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

Five-Year B.S. / M.S. in Mechanical Engineering. A combined B.S./M.S. program in Mechanical Engineering provides an opportunity for outstanding undergraduates to earn both degrees in five years. Additional information about this program is available from the Mechanical Engineering Undergrad Advising office. Interested students should contact the office fall quarter of their junior year. In addition to fulfilling undergraduate degree requirements, B.S./M.S. degree candidates must meet Graduate Division degree requirements, including university requirements for academic residence and units of coursework.

International Baccalaureate Higher Level Examinations

Students who earn scores of 5, 6, or 7 on International Baccalaureate (IB) Higher Level (HL) Examinations taken before high school graduation will receive 8 units of credit toward graduation at UCSB for each such test completed with the required scores, provided official scores are submitted to the Office of Admissions. Students who complete the IB diploma with a score of 30 or above will receive 6 quarter units in addition to the units earned for individual Higher Level exams. The university does not grant credit for Standard Level (SL) exams. The application of this credit to the General Education requirements and course equivalents for these exams are listed below.

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

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

INTERNATIONAL BACCALAUREATE INFORMATION

Exam with score of 5, 6, Or 7	Units	COE GE Credit	UCSB Equivalent Course(s)
Biology	8	none	EEMB 22, MCDB 20
Business Management	8	none	none
Chemistry	8	none	none
Computer Science	8	none	Computer Science 8
Dance	8	none	none
Economics	8	D: 2 courses	Economics 1, 2
English A: Literature or English A: Language And Literature			
Score Of 5	8	Entry Level Writing	Writing 1, 1E
Score Of 6	8	A1	Writing 1, 1E, 2, 2E, 2LK
Score Of 7	8	A1, A2,	Writing 1, 1E, 2, 2E, 2LK, 50, 50E
English B	8	none	none
Film	8	none	none
Geography	8	D: 1 course	none
Global Politics	8	D: 1 course	none
History	8	E: 1 course^	none
History of Africa	8	D: 1 course+	none
History of the Americas	8	D: 1 course	none
History of Asia And Oceania	8	D: 1 course	none
History of Europe and the Middle East	8	D: 1 course^	none
Languages Other Than English	8	none	See department for level placement
Mathematics%	8	none	Mathematics 2A, 2B, 3A, 3B, 34A, 34B, or equivalent
Mathematics, Further%	8	none	none
Mathematics, Analysis & Approaches	8	none	Mathematics 2A, 3A
Music	8	F: 1 course	none
Philosophy	8	E: 1 course	none
Physics	8	none	Physics 10
Social & Cultural Anthropology	8	D: 1 course	Anthropology 2
Theater	8	F: 1 course	none
Visual Arts	8	F: 1 course	none
Psychology	8	D: 1 course	none

^ Course also satisfies the european traditions requirement
+ Course also satisfies the world cultures requirement
% Last Offered Fall 2020

College Board Advanced Placement Credit

Students who earn scores of 3, 4, or 5 on College Board Advanced Placement Examinations taken before high school graduation will receive 2, 4, or 8 units of credit toward graduation at UCSB for each such test completed with the required scores, provided official scores are submitted to the Office of Admissions.

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

Note: Advanced Placement credit earned prior to entering the university will not be counted toward maximum unit limitations either for selection of a major or for graduation.

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)*
2D Art and Design	8	none	none
3D Art and Design	8	none	none
Art History	8	F: 1 course	Art History 1
Biology	8	none	EEMB 22, MCDB 20
Chemistry	8	none	none
Chinese Language and Culture			
With score of 3	8	none	See department for level placement
Comparative Government and Politics	4	D: 1 course	none
+Computer Science A (through S17)	2 or 8+	none	none
With score of 3	8	none	none
With score of 4	8	none	Computer Science 8
With score of 5	8	none	Computer Science 8
Computer Science Principles (effective S17 and S18)			
With score of 3	8	none	none
With score of 4 or 5	8	none	Computer Science 8
Computer Science Principles (effective S19)			
With score of 3	8	none	none
With score of 4 or 5	8	none	Computer Science 4
Drawing	8	none	Art 18
Macroeconomics	4	D: 1 course	none
Microeconomics	4	D: 1 course	none
*English – Composition and Literature or Language and Composition			
With score of 3	8	Entry Level Writing	Writing 1, 1E
With score of 4	8	A1	Writing 1, 1E, 2, 2E, 2LK
With score of 5	8	A1, A2	Writing 1, 1E, 2, 2E, 2LK, 50, 50E
Environmental Science	4	none	Environmental Studies 2
European History	8	E: 1 course	none
French Language and Culture			
With score of 3	8	none	French 1-3
With score of 4	8	none	French 1-4
With score of 5	8	none	French 1-5
German Language and Culture			
With score of 3	8	none	German 1-3
With score of 4	8	none	German 1-4
With score of 5	8	none	German 1-5
Human Geography	4	D: 1 course	Geography 5
Italian Language and Culture			
With score of 3	8	none	Italian 1-3
With score of 4	8	none	Italian 1-5
With score of 5	8	none	Italian 1-6
Japanese Language & Culture			
With score of 3	8	none	See department for level placement
With score of 4	8	none	
With score of 5	8	none	
Latin	8	none	Latin 1-3
*Calculus AB (or AB subscore of BC exam)	4	none	Mathematics 2A, 3A, 34A, or equivalent
*Calculus BC	8	none	Mathematics 2A, 2B, 3A, 3B, 34A, 34B, or equivalent
Music Theory	8	F: 1 course	Music 11
*Physics 1 (effective S'15)	8	none	none
*Physics 2 (effective S'15)	8	none	none
*Physics – B (last offered S'14)	8	none	Physics 10
*Physics – C (Mechanics)	4	none	Physics 6A and 6AL
*Physics – C (Electricity and Magnetism)	4	none	Physics 6B and 6BL
Psychology	4	D: 1 course	Psychology 1
Spanish Language and Culture			
With score of 3	8	none	Spanish 1-3
With score of 4	8	none	Spanish 1-4
With score of 5	8	none	Spanish 1-5

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)*
Spanish Literature and Culture			
With score of 3	8	none	Spanish 1-4
With score of 4	8	none	Spanish 1-5
With score of 5	8	none	Spanish 1-6
Statistics	4	none	Communication 87, PSTAT 5AA-ZZ, Psychology 5
United States Government and Politics	4	D: 1 course	Political Science 12
United States History	8	D: 1 course	none
World History: Modern	8	E: 1 course	none

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

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

A Level Examination Credit

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

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

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

A Level Exam With A Grade of A, B, or C	Units Awarded	General Ed. Credit	UCSB Course Equivalent - *Only for Cambridge International exams taken 2013 or later (You may not enroll in these courses for credit at UCSB)*
Accounting	12		Economics 3A, 3B
Afrikaans	12		
Arabic	12		
Art and Design	12		
Biology	12		
Chemistry	12		
Chinese	12		
Classical Studies	12		
Computer Science	12		Computer Science 8
Computing	12		Computer Science 16
Economics	12	Area D: 2 courses	Economics 1, 2
English – Language	12		
English – Literature	12		
French	12		
Geography	12		
German	12		
Hindi	12		
History	12		
Marathi	12		
Marine Science	12		
Mathematics	12		Mathematics 3A, 3B, 15, 34A, 34B
Mathematics – Further	12		Mathematics 4A, 4B
Music	12		
Physics	12		Physics 6A, 6AL, 6B, 6BL, 6C, 6CL
Portuguese	12		
Psychology	12	Area D: 1 course	Psychology 1, 3, 7
Putonghua	12		
Sociology	12		
Spanish	12		
Tamil	12		
Telugu	12		
Urdu	12		
Urdu – Pakistan only	12		

General University Requirements

UC Entry Level Writing Requirement

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

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

Students who have not met the UC Entry Level Writing Requirement in one of the ways listed above will be required to take a placement exam.

Students who do not achieve an appropriate score on the placement exam to fulfill the Entry Level Writing Requirement must enroll in Writing 1, 1E, or Linguistics 12 within their first year at UCSB.

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

American History and Institutions Requirement

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

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

Anthropology 131
Art History 121A-B-C-E, 136H
Asian American Studies 1, 2
Black Studies 1, 6, 20, 60A-B, 103, 137E, 169AR-BR-CR
Chicano Studies 1A-B-C, 168B, 174, 188C
Economics 113A-B, 119
English 133AA-ZZ, 134AA-ZZ, 191
Environmental Studies 173
Feminist Studies 155A, 159B
History 11A, 17A-B-C, 17AH-BH-CH, 105A, 159B-C, 160A-B, 161A-B, 164C, 164IA-IB, 164PR, 166A-B-C-D-LB, 168A-B-C-D-N-M, 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, 153, 155, 157, 158, 162, 165, 167, 180, 185
Religious Studies 7, 14, 61A-B, 151A-B, 152
Sociology 137E, 140, 144, 155A,
Theater 180A-B

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

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

College of Engineering General Education Requirements

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

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

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

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

GENERAL SUBJECT AREA REQUIREMENTS

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

I. Area A: English Reading and Composition

Two courses must be completed in this area and taken for letter grades. Writing 2 or 2E, and one course from Writing 50, 50E, 105CD, 105CW, 105M, 105PD, 105PS, 105S, 105SW, 107B, 107EP, 107G, 107J, 107L, 107M, 107T, 107WC, 109ED, 109ES, 109HP, or 109ST are required.

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

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

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

At least 6 courses must be completed in these areas:
Area D: A minimum of 2 courses must be completed in Area D.
Area E: A minimum of 2 courses must be completed in Area E.
Area F: A minimum of 1 course must be completed in Area F.
Area G: A minimum of 1 course must be completed in Area G.
The general provisions relating to General Education requirements, as listed on page 12, must be followed when completing courses in Areas D, E, F, and G.
A complete listing of courses, which will satisfy all these requirements starts on page 13.

SPECIAL SUBJECT AREA REQUIREMENTS

In the process of fulfilling the General Education General Subject Areas D through G requirements, students must

complete the following Special Subject Area requirements:

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

   NOTES: ENGR 101 may be used as a writing requirement class, even by those students for whom ENGR 101 is required.
   New transfer students should consult with the College Undergraduate Studies Office regarding this requirement.

2. **Ethnicity Requirement.** Objective: To learn to identify and understand the philosophical, intellectual, historical, and/or cultural experiences of historically oppressed and excluded racial minorities in the United States. At least one course in this area is required. Courses that meet this requirement are marked with an ampersand (&) on the lists in this document.

3. **European Traditions or World Cultures Requirement.**

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

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

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

Other Regulations:

- A course listed in more than one general subject area can be applied to only one of these areas. (Example: Art History 6A cannot be applied to both Areas E and F.) However, a course can be applied towards a single general subject area and any special subject areas which that course fulfills. (Example: Asian American Studies 4 can be applied to the Writing and Ethnicity requirements in addition to the Area F requirement.)
- Some courses taken to satisfy the General Education requirements may also be applied simultaneously to the American History and Institutions requirement. Such courses must be on the list of approved General Education courses and on the list of approved American History and Institutions courses.
- Courses taken to fulfill a General Education requirement may be taken on a P/NP basis, if the course is offered with that grading option (refer to GOLD for the grading option for a particular course).

GENERAL EDUCATION COURSES

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

Area A: English Reading and Composition (2 courses required)

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

Writing 2 or 2E and one course from the following list:
Writing 50 Writing and the Research Process
Writing 50E Writing and the Research Process for Engineers
Writing 105CD Writing with Code
Writing 105CW Writing in Community
Writing 105M Multimedia Writing
Writing 105PD Writing and Public Discourse
Writing 105PS Writing for Public Speaking
Writing 105S Writing about Sustainability
Writing 105SW Science Writing for the Public
Writing 107B Business and Administrative Writing
Writing 107EP Writing for Environmental Professions
Writing 107G Professional Writing for Global Careers
Writing 107J Journalism and News Writing
Writing 107L Legal Writing
Writing 107M Magazine Writing for Publication
Writing 107T Technical Writing
Writing 107WC Writing for Web Content
Writing 109ED Writing for the Teaching Professions
Writing 109ES Writing for Environmental Studies
Writing 109HP Writing for Health Professions
Writing 109ST Writing for Science and Technology

Area D: Social Sciences (2 courses minimum)

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

+	Anthropology 2	Introductory Cultural Anthropology
+	Anthropology 3	Introductory Archaeology
+	Anthropology 3SS	Introduction to Archaeology
	Anthropology 7	Introduction to Biosocial Anthropology
*+	Anthropology 25	Violence and the Japanese State
+	Anthropology 103A	Anthropology of China
+	Anthropology 103B	Anthropology of Japan
+	Anthropology 103C	Anthropology of Korea
	Anthropology 109	Human Universals
+	Anthropology 110	Technology and Culture
*+	Anthropology 122	Anthropology of World Systems
+	Anthropology 130A	Coupled Human and Natural Systems: Risks, Vulnerability, Resilience, and Disasters
+	Anthropology 130B	Global Tourism and Environmental Conservation
@ +	Anthropology 131	North American Indians
+	Anthropology 134	Modern Cultures of Latin America
*+	Anthropology 135	Modern Mexican Culture
+	Anthropology 136	Peoples and Cultures of the Pacific
+	Anthropology 137	The Ancient Maya
*+	Anthropology 141	Agriculture and Society in Mexico: Past and Present
+	Anthropology 142	Peoples and Cultures of India
+	Anthropology 156	Understanding Africa
*+	Anthropology 176	Representations of Sexuality in Modern Japan (Same as HIST 188S and JAPAN 162)
&	Anthropology 191	Indigenous Movements in Asia
@&	Asian American Studies 1	Introduction to Asian American History, 1850-Present
@&	Asian American Studies 2	American Migration since 1965
&	Asian American Studies 7	Asian American Globalization
&	Asian American Studies 8	Introduction to Asian American Gender and Sexuality
&	Asian American Studies 9	Asian American Freedom Struggles and Third World Resistance
&	Asian American Studies 100AA	Chinese Americans
&*	Asian American Studies 100BB	Japanese Americans
&*	Asian American Studies 100FF	South Asian Americans
&	Asian American Studies 107	Third World Social Movements
&*	Asian American Studies 111	Asian American Communities and Contemporary Issues
&	Asian American Studies 119	Asian Americans and Race Relations
&	Asian American Studies 130	Colonialism and Migration in the Passage to America
&*	Asian American Studies 131	Asian American Women's History
&*	Asian American Studies 136	Asian American Families
&*	Asian American Studies 137	Multiethnic Asian Americans
&	Asian American Studies 154	Race and Law in Early American History
&	Asian American Studies 155	Racial Segregation from the Civil War to the Civil Rights Movement
&	Asian American Studies 156	Race and Law in Modern America
&	Asian American Studies 157	Asian Americans and Education
&	Asian American Studies 165	Ethnographies of Asian Americans
@&*	Black Studies 1, 1H	Introduction to Afro-American Studies
&	Black Studies 4	Critical Introduction to Race and Racism
@&*	Black Studies 6, 6H	The Civil Rights Movement
	Black Studies 100	Africa and United States Policy
&*	Black Studies 102	Black Radicals and the Radical Tradition
@&*	Black Studies 103	The Politics of Black Liberation-The Sixties
&	Black Studies 122	The Education of Black Children
*	Black Studies 124	Housing, Inheritance and Race
*	Black Studies 125	Queer Black Studies
&*	Black Studies 129	The Urban Dilemma
&*	Black Studies 131	Race and Public Policy
&*	Black Studies 160	Analyses of Racism and Social Policy in the U.S.
@ &*	Black Studies 169AR-BR-CR	Afro-American History (Same as HIST 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 124G	The Virgin of Guadalupe: From Tilma to Tattoo (Same as RG ST 124G)
&	Chicano Studies 137	Chicana/o Oral Traditions
&	Chicano Studies 140	The Mexican Cultural Heritage of the Chicano
@&*	Chicano Studies 144	The Chicano Community
&	Chicano Studies 151	De-Colonizing Feminism
@&	Chicano Studies 168A-B	History of the Chicano (Same as HIST 168A-B)
&*	Chicano Studies 172	Law and Civil Rights
&	Chicano Studies 173	Immigrant Labor Organizing
@&	Chicano Studies 174	Chicano/a Politics (Same as POL S 174)
&*	Chicano Studies 175	Comparative Social Movements
	Chicano Studies 176	Theories of Social Change and Chicano Political Life
&	Chicano Studies 178A	Global Migration, Transnationalism in Chicano/a Contexts
*	Chicano Studies 179	Democracy and Diversity
&*	Chicano Studies 187	Language, Power, and Learning
*	Communication 1	Introduction to Communication
*	Comparative Literature 119	Psychoanalytic Theory
* ^	Comparitive Literature 186FL	Vegetarianism: Food, Literature, Philosophy
+	East Asian Cultural Studies 40	Gender and Sexuality in Modern Asia

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

+	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
	Economics 1	Principles of Economics - Micro
	Economics 2	Principles of Economics - Macro
	Economics 9	Introduction to Economics
*	Environmental Studies 1	Introduction to Environmental Studies
+	Environmental Studies 130A	Coupled Human and Natural Systems: Risk, Vulnerability, Resilience, and Disasters
+	Environmental Studies 130B	Global Tourism and Environmental Conservation
	Environmental Studies 132	Human Behavior and Global Environment
*	Feminist Studies 20 or 20H	Women, Society and Culture
*	Feminist Studies W20	Women, Society and Culture (Online course)
*+	Feminist Studies 30 or 30H	Women, Development, and Globalization
*	Feminist Studies 50 or 50H	Global Feminisms and Social Justice
&*	Feminist Studies 60 or 60H	Women of Color: Race, Class and Ethnicity
@*	Feminist Studies 159B	Women in American History (Same as HIST 159B)
@*	Feminist Studies 159C	Women in Twentieth-Century American History (Same as HIST 159C)
	French 111	Greatest French Speeches
+	French 151G	Globalization and Development in the Francosphere
+	French 154L	Globalization and Development in the Francosphere
+	Geography 2	World Regions
	Geography 5	People, Place and Environment
	Geography 20	Geography of Surfing
	Geography 108	Urban Geography
*	Geography 108E	Urban Geography
	Geography 150	Geography of the United States
	Global Studies 2	Global Socioeconomic and Political Processes
	Global Studies 11	Introduction to Law and Society
	History 5	The History of the Present
*	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 25	Violence and the Japanese State
*	History 74	Poverty, Inequality and Social Justice in Historical and Global Context
@	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 144J	Race and Juvenile Justice in U.S. History
&*	History 144C	Chicanas and Latinas in U.S. History
@*	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 Chicano (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
	Interdisciplinary 133c	Cognitive social science of nonordinary experiences
*	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
	Linguistics 20	Language and Linguistics
&	Linguistics 36	African-American English
*	Linguistics 70	Language in Society
	Linguistics 130	Language as Culture
*	Linguistics 132	Language, Gender, and Sexuality
&*	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
@*	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 12	American Government and Politics
@*	Political Science 115	Courts, Judges and Politics
*	Political Science 121	International Politics
*	Political Science 145	The European Union
	Political Science 150A	Politics of the Middle East
@	Political Science 151	Voting and Elections
@*	Political Science 155	Congress
	Psychology 1	Introduction to Psychology
	Psychology 101	Health Psychology
	Psychology 102	Introduction to Social Psychology
	Psychology 103	Introduction to Psychopathology
	Psychology 105	Developmental 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 115A	Literature and Religion of the Hebrew Bible Old Testament
&	Religious Studies 124G	The Virgin of Guadalupe: From Tilma to Tattoo (Same as CH ST 124G)
+	Religious Studies 131H	Politics and Religion in the City: Jerusalem
*	Religious Studies 141A	Sociology of Religion: The Classical Statements
*	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 156A	Anthropology of Religion
&*	Religious Studies 162F	South Asians in the U.S.
*	Slavic 152A	Slavic and East European Folklore
*	Slavic 152B	Language and Cultural Identity
*	Slavic 152C	Ideology and Representation
	Sociology 1	Introduction to Sociology
	Sociology 131	Political Sociology
*	Sociology 134	Social Movements
@&*	Sociology 144	The Chicano Community (Same as CH ST 144)
	Sociology 152A	Sociology of Human Sexuality
&*	Sociology 153	Women and Work (Same as FEMST 153)
	Spanish 124	Psycholinguistics
*+	Spanish 178	Mexican Culture

Area E: Culture and Thought (2 courses minimum)

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

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

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

	Course	Title
	Art History 148B	Global Art After 1980
&	Asian American Studies 71	Introduction to Asian American Religions
&	Asian American Studies 138	Asian American Sexualities
& *	Asian American Studies 161	Asian American Religions (Same as RG ST 123)
+	Black Studies 3	Introduction to African Studies
*+	Black Studies 5	Blacks and Western Civilization
*+	Black Studies 7	Introduction to Caribbean Studies
*+	Black Studies 49A-B	Survey of African History
&*	Black Studies 50	Blacks in the Media
*+	Black Studies 104	Black Marxism
*+	Black Studies 130A	Negritude and African Literature
+	Black Studies 130B	The Black Francophone Novel
+	Chicano Studies 113	Critical Introduction to Ancient Mesoamerica
+	Chinese 26	New Phenomena in 21st Century Chinese
+	Chinese 32	Contemporary Chinese Religions
+	Chinese 148	Historic Lives
+	Chinese 183B	Religious Practice and the State in China
*+	Chinese 185A	Qing Empire
*+	Chinese 185B	Modern China (since 1911)
^	Classics 20B	The Romans
^	Classics 50	Introduction to Classical Archaeology
^	Classics 101	The Greek Intellectual Experience: From Poetry to Philosophy
* ^	Classics 106	Magic and Medicine in Ancient Greece
^	Classics 140	Slavery and Freedom in the Ancient World
^	Classics 150	The Fall of the Ancient Republic: Cicero, Caesar, and Rome
	Classics 151	Emporers and Gladiators: History of the Roman Empire to 180CE
^	Classics 152	Citizenship: Ancient Origins and Modern Practices
* ^	Classics 171	Artifact and Text: The Archaeology and Literature of Early Greece
	Comparative Literature 27	Memory: Bridging the Humanities and Neurosciences (Same as FR 40X & MCDB27)
* ^	Comparative Literature 30A-B-C	Major Works of European Literature
*	Comparative Literature 35	The Making of the Modern World
*	Comparative Literature 113	Trauma, Memory, Historiography
*	Comparative Literature 119	Psychoanalytic Theory
*	Comparative Literature 122A	Representations of the Holocaust (Same as GER 116A)
+	Comparative Literature 171	Post Colonial Cultures (Same as FR 154G)
*	Comparative Literature 179A	Revolutions: Marx, Nietzsche, Freud (Same as GER 179A)
*	Comparative Literature 186RR	Romantic Revolutions: Philosophy, History, and the Arts in Europe
*+	East Asian Cultural Studies 3	Introduction to Asian Religious Traditions (Same as RG ST 3)
*+	East Asian Cultural Studies 4A	East Asian Traditions: Pre-Modern
*+	East Asian Cultural Studies 4B	East Asian Traditions: Modern
*+	East Asian Cultural Studies 5	Introduction to Buddhism
+	East Asian Cultural Studies 7	Asian Values
*+	East Asian Cultural Studies 21	Zen
*+	East Asian Cultural Studies 80	East Asian Civilization (Same as HIST 80)
+	East Asian Cultural Studies 164B	Buddhist Traditions in East Asia
	English 23	The Climate Crisis: What it is and what each of us can do about it
^	English 22	Introduction to Literature and the Environment
	English 24 I	Introduction to Literature and the Environment, Part 2, World Perspectives
&	English 34	Pan-Latinx Literatures
	English 34NA	Animacy and the Speaking Earth: The Power of Native Story
*	English 171	Literature and the Human Mind
*	Environmental Studies 3	Introduction to the Social and Cultural Environment
*	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 149C	Reading Paris (1830-1890)
*	French 154F	Time Off in Paris

	Course	Title
*+	French 154G	Post-Colonial Cultures (Same as C LIT 171)
	French 154I	Economic Fictions: Literature and Theory in Modern France (1802-2018)
*	French 155D	Citoyennes! Women and Politics in Modern France (Same as FEMST 171CN)
*	German 35	The Making of the Modern World
*	German 43A	Dreaming Revolutions: Introduction to Marx, Nietzsche and Freud
*	German 43C	Germany Today
^	German 109	Current Trends in German Culture and Literature
* ^	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 177A	Law, Rights, and Justice
*	German 179A	Revolutions: Marx, Nietzsche, Freud
+	Global Studies 1	Global History, Culture, and Ideology
*^	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 20	Science, Technology, and Medicine in Modern Society
*+	History 46A	The Middle East from Muhammad to the Nineteenth Century
*+	History 46B	The Middle East: From the Ninetheenth Century to the Present
*+	History 49A-B-C	Survey of African History
*	History 74	Poverty, Inequality and Social Justice in Historical and Global Context
*+	History 80	East Asian Civilization (Same as EACS 80)
*+	History 87	Japanese History through Art and Literature
*+	History 88	Survey of South Asian History
*	History 104G	The Trial of Galileo
*	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 107C	The Darwinian Revolution and Modern Biology (Same as ENV S 107C)
*	History 114B-C-D	History of Christianity
	History 133B-C	Twentieth Century Germany
^	History 133D	The Holocaust in German History
*^	History 140A-B	Early Modern Britain
&*	History 144J	Race and Juvenile Justice in U.S. History
@*	History 164C	Civil War and Reconstruction
*	History 171C	The United States of the World, 1898-1945
*	History 171D	The United States and the World since 1945
*+	History 182A-B	Korean History and Civilization (Same as KOR 182A-B)
*+	History 184A	History of China (to 589 CE)
*	History 184B	History of China
*+	History 185A	Qing Empire
*+	History 186B	Modern China (Since 1911)
*+	History 187A	Japan Under the Tokugawa Shoguns
*+	History 187B	Modern Japan
*+	History 187C	Recent Japan
*+	History 188S	Representations of Sexuality in Modern Japan (Same as ANTH 176 and JAPAN 162)
*+	History 189E	History of the Pacific
*	Interdisciplinary 35HD	History of Disease and Epimimiology
	Interdisciplinary 133C	Cognitive Social Science of Nonordinary Experiences
	Italian 20X	Introduction to Italian Culture
	Italian 138AA, CX, D, DX, EX, FF, FX, N, RX, X, XX	Cultural Representations in Italy
*	Italian 138AX	Cultural Representations in Italy
*	Italian 144AX	Gender and Sexuality in Italian Culture
^	Italian 189A	Italy Mediterranean
^	Italian 189X	Italy in the Mediterranean: History, Arts, and Culture
*+	Japanese 162	Representations of Sexuality in Modern Japan

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

+	Japanese 164	Modernity and the Masses of Taisho Japan (Same as HIST 188T)
*+	Japanese 165	Popular Culture in Japan
&*+	Japanese 166	The Modern Girl Around the World
*	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 15	Language in LIFE
* ^	Linguistics 30	The Story of English
&	Linguistics 36	African-American English
	Linguistics 50	Language and Power
+	Linguistics 80	Endangered Languages
+	Middle East Studies 45	Introduction to Islamic & Near East Studies
	MCDB 27	Memory: Bridging the Humanities and Neuroscience (Same as C LIT 27 & FR 40X)
*	MCDB 28	Human Genetics and Society
*	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)
*	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 18	Comparing Religions
*+	Religious Studies 19	The Gods and Goddesses of India
+	Religious Studies 20	Indic Civilization
*+	Religious Studies 21	Zen
^	Religious Studies 25	Global Catholicism Today
	Religious Studies 28	Gandhi: Nonviolence, Resistance, Truth
+	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 61	African Regions of the Americas
&	Religious Studies 62	Dark Goddesses and Black Madonnas
&	Religious Studies 71	Introduction to Asian American Religions
* ^	Religious Studies 80A-B-C	Religion and Western Civilization
*+	Religious Studies 82	Modern Arab Culture
+	Religious Studies 115G	The Dead Sea Scrolls and Their Community
*	Religious Studies 116A	The New Testament and Early Christianity
	Religious Studies 119F	History of Islamic Theology
&*	Religious Studies 123	Asian American Religions (Same as AS AM 161)
*	Religious Studies 126	Roman Catholicism Today
*	Religious Studies 130	Judaism
*+	Religious Studies 133C	Studies in Jewish Law
	Religious Studies 136	Creation Myths
*+	Religious Studies 138B	Catholic Practices & Global Cultures
*	Religious Studies 141	Religious Diversity in Theory and Practice
	Religious Studies 149H	Islamic Humanism
+	Religious Studies 157I	Persian Media and Translation
+	Religious Studies 162C	Sikhism
*	Religious Studies 162E	Indian Civilization
+	Religious Studies 164B	Buddhist Traditions in East Asia
+	Religious Studies 183B	Religious Practice and the State in China
	Slavic 33	Russian Culture
	Slavic 130D	Russian Art
	Spanish 153	Basque Studies
+	Spanish 177	Spanish-American Thought

AREA F: ARTS (1 course minimum)

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

*	Art 1A	Visual Literacy
	Art 7A	The Intersections of Art and Life
	Art 106W	Introduction to 2D/3D Visualizations in Architecture
	Art 125	Art Since 1950
	Art History 1	Introduction to Art
*	Art History 5A	Introduction to Architecture and the Environment
	Art History 5B	Introduction to Museum Studies
* ^	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 6J	Survey: Contemporary Architecture
*+	Art History 6K	Islamic Art and Architecture
*	Art History 6L	History of Games
* ^	Art History 6R	Rome: The Game
	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 111B	Dutch Art in the Age of Rembrandt
	Art History 111C	Dutch Art in the Age of Vermeer
	Art History 111F	Rethinking Rembrandt
	Art History 113A	Seventeenth-Century Art in Southern Europe
	Art History 113B	Seventeenth-Century Art in 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 117B	Nineteenth-Century Art 1848-1900
	Art History 117C	Nineteenth-Century British Art and Culture
	Art History 117F	Impressionism and Post-Impressionism
	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

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@	Art History 121C	Twentieth-Century American Art: Modernism and Pluralism 1900-Present
&	Art History 121D	African-American Art and the African Legacy
	Art History 121E	Three Dimensional Arts of the United States
+	Art History 127A	African Art I
+	Art History 127B	African Art II
+	Art History 130A	Pre-Columbian Art of Mexico
+	Art History 130B	Pre-Columbian Art of the Maya
	Art History 130C	The Arts of Spain and New Spain
+	Art History 130D	Pre-Columbian Art of South America
+	Art History 132A	Mediterranean Cities
	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 136C	Architecture of the United States
	Art History 136D	Design & the American Architect
@	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 136R	Architecture of the Americas
+	Art History 136V	Modern Indian Visual Culture
	Art History 136W	Introduction to 2D/3D Visualizations in Architecture
	Art History 136Y	Modern Architecture in Souther California
	Art History 141D	Birth of the Modern Museum
^	Art History 141G	The Architecture of Museums and Galleries from c. 1800 to the Present
	Art History 144A	The Avant-Garde in Russia
	Art History 144C	Contemporary Art in Russia and Eastern Europe (Same as SLAV 130C)
	Art History 144D	Russian Artx
	Art History 148A	Contemporary Art History: 1960-2000
	Art History 148B	Global Art After 1980
&*	Asian American Studies 4	Introduction to Asian American Popular Culture
*	Asian American Studies 79	Introduction to Playwriting
&	Asian American Studies 118	Asian Americans in Popular Culture
&	Asian American Studies 120	Asian American Documentary
&	Asian American Studies 127	Asian American Film, Television, and Digital Media
&	Asian American Studies 140	Theory & Production of Social Experience
&	Asian American Studies 146	Racialized Sexuality on Screen and Scene
&	Asian American Studies 170KK	Special Topics in Asian American Studies
&*	Black Studies 14	History of Jazz
*	Black Studies 45	Black Arts Expressions
&	Black Studies 142	Music in Afro-American Culture: U.S.A.
*	Black Studies 153	Black Popular Music in America
+	Black Studies 161	Third-World Cinema
*+	Black Studies 162	African Cinema
&*	Black Studies 170	Afro-Americans in the American Cinema
*+	Black Studies 171	Africa in Film
&*	Black Studies 172	Contemporary Black Cinema
+	Black Studies 175	Black Diaspora Cinema
&	Chicano Studies 125B	Contemporary Chicano and Chicana Art
&	Chicano Studies 138	Barrio Popular Culture
&	Chicano Studies 148	Chicana Art and Feminism
@&	Chicano Studies 188C	Chicano Theater Workshop
*+	Chinese 40	Popular Culture in Modern Chinese Societies
*+	Chinese 170	New Taiwan Cinema
+	Chinese 176	Chinese Cinema: Nationalism and Globalism
* ^	Classics 102	Greek Tragedy in Translation
^	Classics 165	Greek Painting
^	Classics 170	Pompeii
	Comparative Literature 186FF	NOIR: 1940's Film and Fiction
+	Dance 35	History and Appreciation of World Dance
*	Dance 36	History of Modern Dance
*	Dance W36	History of Modern Dance (online course)
	Dance 45	History and Appreciation of Dance
*	Dance 145A-B	Studies in Dance History
+	East Asian Cultural Studies 134A	Buddhist Art
	Environmental Studies 136O	Sustainable Architecture: History and Aesthetics
*	Film & Media Studies 46	Introduction to Cinema
*	Film & Media Studies 55AA-ZZ	Media Arts: The High and the Low
*	Film & Media Studies 56AA-ZZ	Media Cultures and Thought
*+	Film & Media Studies 120	Japanese Cinema (Same as JAPAN 159)
+	Film & Media Studies 121	Chinese Cinema
*	Film & Media Studies 122AA-ZZ	Topics in National Cinema
*	Film & Media Studies 124	Indian Cinema
+	Film & Media Studies 124V	Modern Indian Visual Culture
*	Film & Media Studies 125A-B	Documentary Film
*	Film & Media Studies 126	Cuban Cinema
&*	Film & Media Studies 127	Latin American Cinema
*	Film & Media Studies 127M	Mexican Film and Cinema
*	Film & Media Studies 134	French and Francophone Cinema
*	Film & Media Studies 136	British Cinema
*	Film & Media Studies 144	The Horror Film (Same as GER 183)
*	Film & Media Studies 163	Women and Film: Feminist Perspectives
	Film & Media Studies 169	Film Noir
	Film & Media Studies 175	Experimental Film
*	Film & Media Studies 178Z	Technology and Cinema (Same as FR 156D)
*	French 156A	French Cinema: History and Theory
*	French 156B	French and Francophone Cinema
*	French 156C	Modern Images of the Middle Ages: The Intersection of Text, History, and Film
*	French 156D	Technology and Cinema (Same as FLMST 178Z)
*	German 55A	Contemporary German Pop Culture
	Italian 124X	Italian Theatre
	Italian 178B	Italian Cinema
	Italian 179X	Fiction and Film in Italy
	Italian 180Z	Italian Cinema
+	Japanese 134F	Arts of Japan (Same as ARTHI 134F)
+	Japanese 134G	Japanese Painting (Same as ARTHI 134G)
+	Japanese 134H	Ukiyo-e: Pictures of the Floating World (Same as ARTHI 134H)
+	Japanese 149	Traditional Japanese Drama
*+	Japanese 159	Japanese Cinema (Same as FLMST 120)
	Japanese 159A	Postwar Japanese Cinema (1945-1985)
+	Korean 75	Introduction to Popular Culture in Korean Film
*	Music 3B	Writing about Music
	Music 11	Fundamentals of Music
*	Music 15	Music Appreciation
*	Music 16	Listening to Jazz: Demystifying America's Musical Art Form
	Music 17	World Music
*	Music 113A	The Histoy of Opera: 1600-1800
*	Music 114	Music and Popular Culture in America
*	Music 115	Symphonic Music
*	Music 116	American Music History: Colonial to Present
*	Music 118A	History and Literature of Great Composers in Western Music
*	Music 119A	Music and Politics
	Music 119B	Music in Political Films
	Religious Studies 13	Religion and Popular Culture
&	Religious Studies 133B	From Superman to Speigelman: The Jewish Graphic Novel
+	Religious Studies 157G	Persian Cinema
	Slavic 130A	The Avantgarde in Russia
	Slavic 130B	Russian Cinema
	Slavic 130C	Contemporary Art in Russia and Eastern Europe (Same as ARTHI 144C)
	Slavic 130D	Russian Art
	Slavic 130E	Masters of Soviet Cinema

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	Spanish 126	Spanish Cinema
+	Theater 2A	Performance in Global Contexts: Africa and the Caribbean
*+	Theater 2B	Performance in Global Contexts: Asia
* ^	Theater 2C	Performance in Global Contexts: Europe
*	Theater 3	Life of the Theater
	Theater 5	Introduction to Acting
*	Theater 7	Performance of the Human Body
*	Theater 9	Introduction to Playwriting
	Theatre 143	The People's Voice
@*	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 182A	Ancient Theater and Drama
*	Theater 182M	Modern Theater and Drama
*	Theater 182MC	Modern Contemporary
*	Theater 182N	Neoclassical 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 (1 course minimum)

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

&	Asian American Studies 5	Introduction to Asian American Literature
*	Asian American Studies 122	Asian American Fiction
*	Asian American Studies 128	Writings by Asian American Women
*+	Black Studies 33	Major Works of African Literatures (Same as C LIT 33)
&*	Black Studies 38A-B	Introduction to Afro-American Literature
*+	Black Studies 126	Comparative Black Literatures
&*	Black Studies 127	Black Women Writers
*+	Black Studies 130A	Negritude and African Literature
+	Black Studies 130B	The Black Francophone Novel
&*	Chicano Studies 152	Postcolonialism
&*	Chicano Studies 180	Survey of Chicano Literature
&*	Chicano Studies 181	The Chicano Novel
&*	Chicano Studies 184A	Chicana Writers
+	Chinese 35	Introduction to Taiwan Literature
	Chinese 80	Masterpieces of Chinese Literature
+	Chinese 115A	Imagism, Haiku, and Chinese Poetry
*+	Chinese 124A-B	Readings in Modern Chinese Literature
*+	Chinese 132A	Classical Chinese Poetry
+	Chinese 148	Historic Lives
^	Classics 20A	The Ancient Greeks
^	Classics 36	Ancient Epic
* ^	Classics 39	Women in Classical Literature
^	Classics 40	Greek Mythology
* ^	Classics 55	Troy
* ^	Classics 102	Greek Tragedy in Translation
* ^	Classics 109	Viewing the Barbarian: Representations of Foreign Peoples in Greek Literature
* ^	Classics 110	From Homer to Harlequin: Masculine, Feminine, and the Romance
^	Classics 130	Comedy and Satire in Translation
* ^	Classics 175	Ancient Theories of Literature
* ^	Comparative Literature 30A-B-C	Major Works of European Literature
*+	Comparative Literature 31	Major Works of Asian Literatures
*+	Comparative Literature 32	Major Works of Middle Eastern Literatures
*+	Comparative Literature 33	Major Works of African Literatures (Same as BL ST 33)
*	Comparative Literature 34	Literature of the Americas
*	Comparative Literature 100	Introduction to Comparative Literatures
*	Comparative Literature 103	Going Postal: Epistolary Narratives (Same as ENGL 128EN)
*	Comparative Literature 107	Voyages to the Unknown
*	Comparative Literature 113	Trauma, Memory, Historiography
*	Comparative Literature 122A	Representations of the Holocaust (Same as GER 116A)
*	Comparative Literature 122B	Holocaust in France (Same as FR 154E)
*+	Comparative Literature 126	Comparative Black Literatures
*	Comparative Literature 128A	Children's Literature
@*	Comparative Literature 133	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 170	Literary Translation: Theory and Practice
+	Comparative Literature 171	Post-Colonial Cultures (Same as FR 154G)
*	Comparative Literature 179A	Revolutions: Marx, Nietzsche, Freud (Same as GER 179A)
*	Comparative Literature 179B	Mysticism
*	Comparative Literature 179C	Mediatechnology (Same as GER 179C)
	Comparative Literature 186AD	Adultery in the Novel
	Comparative Literature 186EE	Interdisciplinary Comparative Literature
	Comparative Literature 188	Narrative Studies
*	Comparative Literature 189	Narrative in the First Person
	Comparative Literature 191	Fantasy and the Fantastic (Same as FR 153D)
*	English 15	Introduction to Shakespeare
	English 23	The Climate Crisis: What it is and what each of us can do about it
^	English 22	Introduction to Literature and the Environment
	English 24	Introduction to Literature and the Environment, Part 2, World Perspectives
*	English 25	Introduction to Literature and the Culture of
&	English 34	Pan-Latinx Literatures Information
	English 34NA	Animacy and the Speakng Earth: The Power of Native Story
&*	English 38A-B	Introduction to African American Literature
&*	English 50	Introduction to U.S. Minority Literature
*	English 65AA-ZZ	Topics in Literature
*	English 101	English Literature from the Medieval Period to 1650
*	English 102	English and American Literature from 1650 to 1789
*	English 103A	American Literature from 1789 to 1900
*	English 103B	British Literature from 1789 to 1900
*	English 104A	American Literature from 1900 to Present
*	English 104B	British Literature from 1900 to Present
*	English 105A	Shakespeare: Poems and Earlier Plays
*	English 105B	Shakespeare: Later Plays
*	English 113AA-ZZ	Literary Theory and Criticism
*	English 114AA-ZZ	Women and Literature
&*	English 114BW	Black Women Authors
*	English 115	Medieval Literature
*	English 116A	Biblical Literature: The Old Testament
*	English 116B	Biblical Literature: The New Testament
*	English 119X	Medieval Literature in Translation
*	English 120	Modern Drama
*	English 121	The Art of Narrative
*	English 122AA-ZZ	Cultural Representations
*	English 122NE	Cultural Representations of Nature and the Environment (Same as ENV S 122NE)
*	English 124	Readings in the Modern Short Story
*	English 126B	Survey of British Fiction
*	English 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 136	Seventeenth and Eighteenth Century American Literature
@*	English 137A-B	Poetry in America
*	English 140	Contemporary American Literature
*	English 150	Anglo-Irish Literature
*	English 152A	Chaucer: Canterbury Tales
*	English 156	Literature of Chivalry
*	English 157	English Renaissance Drama
*	English 162	Milton
*	English 165AA-ZZ	Topics in Literature
*	English 170AA-ZZ	Studies in Literature and the Mind
*	English 172	Studies in the Enlightenment
*	English 179	British Romantic Writers
*	English 180	The Victorian Era
*	English 181AL,MT	Studies in the Nineteenth Century
*	English 184	Modern European Literature

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*	English 185	Modernism in English
&*	English 187AA	Studies in Modern Literature
*	English 187BB-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 122CC	Cultural Representations: The Rhetoric of Climate Change
*	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 154I	Economic Fictions: Literature and Theory in Modern France (1802-2018)
	French 154J	Medicine and Comedy
*	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 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 177A	Law, Rights, and Justice
*	German 179A	Revolutions: Marx, Nietzsche, Freud
*	German 179B	Mysticism
*	German 179C	Mediatechnology (Same as C LIT 179C)
*	German 182	Vampirism in German Literature and Beyond
^	Greek 100	Introduction To Greek Prose
^	Greek 101	Introduction To Greek Poetry
*	Hebrew 114A-B-C	Readings in Modern Hebrew Prose and Poetry
^	INT 35LT	Experiencing Shakespeare
	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 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
*	Music 187	Strauss and Hofmannsthal
	Portuguese 31	Literatures of the Portuguese Speaking World
	Portuguese 105A-B-C	Survey of Portuguese Literature
	Portuguese 106A-B-C	Survey of Brazilian Literature
	Portuguese 115 A-AA-BB-ED EE-EO	Brazilian Literature in English Translation
	Portuguese 116	Portugese Literature in Translation
	Religious Studies 22	Introduction to Literature and the Environment
*	Religious Studies 114X	Dante's "Divine Comedy"
+	Religious Studies 115G	The Dead Sea Scrolls and Their Community
	Religious Studies 129	Religions of the Ancient Near East
&*	Religious Studies 133D	Gender in Jewish Culture
+	Religious Studies 133E	Introduction to Modern Hebrew Literature
+	Religious Studies 157PP	Classic Persian Literature
* ^	Slavic 35	Short Fiction by Major Russian Writers
	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 164B	Science Fiction in Eastern Europe
*	Slavic 164C	Women in Russian Literature
	Spanish 31	Literatures of the Spanish Speaking World
	Spanish 102L	Introduction to Hispanic Literary Studies
*	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 139	U.S. Latino Literature
	Spanish 140A-B	Cervantes: Don Quijote
	Spanish 174	The Hispanic Novel and Cinema
&*	Spanish 179	Chicano Novel
*+	Spanish 181	Hispanic Poetry: 1900-1945

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 105	Survey of Portuguese Literature from the Middle Ages to the Present
	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

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

*	^Slavic 35	Short Fiction by Major Russian Writers
	Spanish 30	Introduction to Hispanic Literature
	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 139	U.S. Latino Literature
	Spanish 140A-B	Cervantes: Don Quijote
	Spanish 174	Hispanic Novel and Cinema

Special Subject Area Supplementary List of Courses

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

*	Anthropology 102A	Introduction to Women, Culture, and Development (Same as GLOBL 180A and SOC 156A)
*	Anthropology 116A	Myth, Ritual, and Symbol
*	Anthropology 116B	Anthropological Approaches to Religion
*	Anthropology 143	Introduction to Contemporary Social Theory
&	Anthropology 148A	Comparative Ethnicity
*	Anthropology 169	The Evolution of Cooperation
*	Anthropology 172	Colonialism and Culture
@	Anthropology 176B	The American West
*	Art History 186AA-ZZ	Seminar in Advanced Studies in Art History
*	Art History 187H	Museums in Transition: From the Early Modern to the Modern Period
*	Art History 187Z	Museum Studies Seminar
&	Asian American Studies 100CC	Filipino Americans
&	Asian American Studies 100DD	Korean Americans
&	Asian American Studies 109	Asian American Women and Work
&	Asian American Studies 113	The Asian American Movement
&*	Asian American Studies 121	Asian American Autobiographies and Biographies
&	Asian American Studies 124	Asian American Literature in Comparative Frameworks
*	Asian American Studies 134	Asian American Men and Contemporary Men's Issues
&	Asian American Studies 138	Asian American Sexualities
&	Asian American Studies 148	Introduction to Video Production
&	Asian American Studies 149	Screenwriting
&	Asian American Studies 160	Asian American Politics
&	Asian American Studies 162	Asian American Mental Health
&	Black Studies 108	Obama as a Political and Cultural Phenomenon
@&*	Black Studies 137E	Sociology of the Black Experience
&	Chicano Studies 168E	History of the Chicano Movement
&	Chicano Studies 168F	Racism in American History
&	Chicano Studies 171	The Brown/Black Metropolis: Race, Class, & Resistance in the City
&	Chicano Studies 189	Immigration and the US Border
*+	Chinese 132B	Special Topics in Modern Chinese Poetry
*	Chinese 150	The Language of Vernacular Chinese Literature
*+	Chinese 166B	Taoist Traditions in China
*+	Chinese 166C	Confucian Tradition: The Classical Period
+	Chinese 184B	History of China
	^Classics 60	Science and Medicine in Ancient Greece
*	Communication 130	Political Communication
*	Communication 137	Global Communication, International Relations and the Media
*	Communication 153	Communication and Global Advocacy
*	Comparative Literature 28	Storytelling in the Anthropocene
& *	Comparative Literature 29	Media, Literature and Black Lives
*+	Comparative Literature 36	Global Humanities: The Politics and Poetics of Witnessing
*	Counseling, Clinical & School Psychology 101	Introduction to Applied Psychology
*	Earth Science 6	Mountains, Boots and Backpacks: Field Study of the High Sierra
*	Earth Science 104A	Field Studies in Geological Methods
*	Earth Science 104B	Field Methods
*	Earth Science 117	Earth Surface Processes and Landforms
*	Earth Science 123	The Solar System
*	Earth Science 130	Global Warming - Science and Society
*	Economics 107A	History of Economics
*	Economics 117A	Law and Economics
*	Education 20	Introduction to the University Experience
*	EEMB 124	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 149	Mariculture for the Twenty-first Century
*	EEMB 179	Modeling Environmental and Ecological Change
*	English 18	Public Speaking
*+	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 106	Critical Thinking About Human-Environment Problems and Solutions
*	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 & Media Studies 101A-B-C	History of Cinema
*	Film & Media Studies 191	Film Criticism
*	Film & Media Studies 193	Film Narrative
*	Geography 8	Living with Global Warming
*	Geography W8	Living with Global Warming (online course)
*	Geography 140	Environmental Impacts in Human History
*	Geography 148	California
*	Global Sudies 180A	Introduction to Women, Culture, and Development (Same as ANTH 102A & SOC 156A)
*+	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 144B	Social and Cultural History of the US - Mexico Border
&*	History 144W	Women of Color and Social Movements in the United States
+	History 146	History of the Modern Middle East
+	History 146T	History of Israel/Palestine
+	History 146W	Women and Gender in the Middle Eastern History
*	History 155A-B	History of Portugal
*+	History 156A	History of Mexico: Pre-Hispanic and Colonial Periods
+	Hisotry 156B	History of Mexico
*	History 156I	Indians of Mexico
*	History 157A-B	History of Brazil
@&	History 160A-B	The American South
@&*	History 164IA-IB	American Immigration
@	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 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

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

@&*	History 179A	Native American History to 1838
@&	History 179B	Native American History, 1838 to Present
+	History 184B	History of China
*	INT 36 SAA-ZZ	Enganing Humanities Learning Community
*	INT137AA-ZZ	Engaging Humanities Discovery Course
+	Japanese 17	Imagining the Samurai
*	Japanese 167A	Religion in Japanese Culture
*	Japanese 186RW	Seminar in Japanese Art
*+	Latin American & Iberian Studies 10	Introduction to the Latin American and Iberian
*+	Latin American & Iberian Studies 100	Introduction to 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 149	Mariculture for the 21st Century
*	Music 3A	Introduction to Music Studies
*	^Music 10A-B-C	History of Music from Early Modern Culture through Modernism
*	Philosophy 7	Biomedical Ethics
*	Physics 13AH	Honors Experimental Physics
*	Physics 128AL-BL	Advanced Experimental Physics
*	Political Science 1	Introduction to Political Philosophy
*	Political Science 7	Introduction to International Relations
*	Political Science 114	Democracy and Diversity
@*	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 160	Asian American Politics
&	Political Science 161	U.S. Minority Politics
@	Political Science 162	Urban Government and Politics
@	Political Science 165	Criminal Justice
@	Political Science 180	Bureaucracy and Public Policy
@	Political Science 185	Government and the Economy
*	Psychology 10A	Research Methods
*	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 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 153L	Laboratory in Developmental and Evolutionary Psychology
*+	Religious Studies 84	Introduction to Islamic Civilization
*	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 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 140D	Islam in South Asia
&	Religious Studies 140E	Islam in America
+	Religious Studies 140F	Modern Islamic Movements
*	Religious Studies 145	Patterns in Comparative Religion
+	Religious Studies 149R	Islamic Philosophy and Theology
+	Religious Studies 160A	Religious Traditions of India
+	Religious Studies 162A	Indian Philosophy
*+	Religious Studies 166C	Confucian Traditions: The Classical Period
*	Religious Studies 167A	Religion in Japanese Culture
+	Religious Studies 169	Hindu Devotional Traditions
&*	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 16A	Spanish for Heritage Speakers
&*	Spanish 16B	Spanish for Heritage Speakers
*	Spanish 25	Advanced Grammar and Composition
&	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 18	Public Speaking
*	Writing 24	Journalism Today
*	Writing 110L	Advanced Legal Writing
*	Writing 110MK	Professional Communications in Marketing and Public Relations
*	Writing 126	Journalism for the Web and Social Media
*	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 World Cultures requirement.
@ This course applies toward the American History & Institutions requirement.
^ This course applies toward the European Traditions requirement.

CHECKLIST OF GENERAL UNIVERSITY AND GENERAL EDUCATION REQUIREMENTS

GENERAL UNIVERSITY REQUIREMENTS

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

Passed Exam __________ or Writing 1, 1E or Ling 12 ____________ or transferred appropriate course _____________

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

One course ___________ or Advanced Placement ______________ or International waiver ________________

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

GENERAL EDUCATION REQUIREMENTS

A course listed in more than one General Subject Area can be applied to only **one area.** Course total in Areas D, E, F, and G must be **at least 6.**

General Subject Areas

1. ***Area A: English Reading and Composition***

   Writing 2 or 2E and Writing 50, 50E, 105CD, 105CW, 105M, 105PD, 105PS, 105S, 105SW, 107B, 107EP, 107G, 107J, 107L, 107M, 107T, 107WC, 109ED, 109ES, 109HP, or 109ST

   __________________________ __________________________

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

   __________________________ __________________________

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

   __________________________ __________________________

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

   ____

5. ***Area G: Literature*** (1 course minimum)

   ____

Special Subject Areas

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

a. ***Writing Requirement – (4 courses)***

   ___________________ ___________________ ___________________ ___________________

b. ***Ethnicity Requirement – (1 course)*** _________________________

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

Chemical Engineering

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

Chair: Rachel A. Segalman
Vice-Chairs: Michael J. Gordon
M. Scott Shell

Faculty

Joseph Chada, Ph.D., University of Wisconsin, Lecturer with Potential Security of Employment

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

Phillip N. Christopher, Ph.D., University of Michigan, Associate Professor (catalysis, photocatalysis, plasmonics, nanomaterials synthesis, in-situ characterization)

Siddharth S. Dey, Ph.D., UC Berkeley, Assistant Professor (systems biology, single-cell genomics, epigenetics, stem cell biology)

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

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

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

Song-I Han, Ph.D., Aachen University of Technology, Professor (magnetic resonance methods and applications, protein biophysics, spectroscopy)

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

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

Arnab Mukherjee, Ph.D., University of Illinois at Urbana-Champaign, Assistant Professor (protein and cell engineering, genetic tools for molecular imaging, fluorescence imaging, magnetic resonance imaging, anaerobic biosystems, synthetic biology)

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

James B. Rawlings, Ph.D., University of Wisconsin, Distinguished Professor (chemical process monitoring and control, reaction engineering, computational modeling)

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

Rachel A. Segalman, Ph.D., UC Santa Barbara, Professor (polymer design, self-assembly, and properties) *1

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

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

Sho Takatori, Ph.D., California Institute of Technology, Assistant Professor (statistical mechanics and fluid dynamics of biological systems, microbial and cellular communities)

Emeriti Faculty

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

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

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

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

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

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

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

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

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

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

Affiliated Faculty

Christopher Bates, Ph.D. (Materials)

David Gay, Ph.D. (ICB)

Mahdi Abu Omar, Ph.D. (Chemistry)

Philip Alan Pincus, Ph.D. (Materials)

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

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

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

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

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

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

Mission Statement

The program in Chemical Engineering has a dual mission:

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

Objectives for the Undergraduate Program

Educational Objectives

- Our graduates will be innovative, competent, contributing chemical engineers.
- Our graduates will demonstrate their flexibility and adaptability in the workplace, so that they remain effective engineers, take on new responsibilities, and assume leadership roles.
- Our graduates will continually develop new skills and knowledge through formal and informal mechanisms.

Student Outcomes

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

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

Undergraduate Program

Bachelor of Science—Chemical Engineering

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

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

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

Chemical Engineering Courses

LOWER DIVISION

5. Introduction to Chemical Engineering Design
(3) DOHERTY, SHELL, CHADA

Introduction to the design and analysis of processes involving chemical change in the context of chemical and biomolecular engineering. Students learn mathematical, empirical, and conceptual strategies to analyze.

10. Material & Energy Balances
(3) GORDON, CHADA

Prerequisites: Chemical Engineering 5 (May be taken concurrently); Chemistry 1A-B-C or 2A-B-C; Mathematics 2A or 3A, Mathematics 2B or 3B, and Mathematics 4A or 4AI; Space may be limited and registration prority will be given to Chemical engineering and CoE majors.

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

99. Introduction to Research
(1-3) STAFF

Prerequisites: consent of instructor and undergraduate advisor.

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

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

UPPER DIVISION

102. Biomaterials and Biosurfaces
(3) STAFF

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

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

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

107. Introduction to Biological Processing
(3) O'MALLEY, DEY

Prerequisites: Chemical Engineering 10

Familiarizes engineering students with biological processing and production at multiple scales. Chemical engineering principles will be infused with key biological concepts, including an introduction to biochemistry, cell biology, and molecular biology.

110A. Chemical Engineering Thermodynamics
(3) SHELL

Prerequisite: Chemical Engineering 5, Chemical Engineering 10; Mathematics 4B or 4BI; Space may be limited and registration priority will be given to Chemical engineering and CoE majors.

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

110B. Chemical Engineering Thermodynamics
(3) HAN, SCOTT

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

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

118. Technical Communication of Chemical Engineering
(1) STAFF

Prerequisites: Chemical Engineering 110A.

Provides an introduction to technical communication in the form of writing reports and oral presentations. Emphasis placed on how to analyze and present data; critical thinking; organization, logic and constructing a technical narrative; literature searching and citations for written reports; and how to give oral presentations. Includes various lectures on technical communication, individual and group assignments, and peer-review exercises.

120A. Transport Processes
(4) SQUIRES, DEY

Prerequisites: Chemical Engineering 10 with a minimum grade of C- (may be taken concurrently); Mathematics 4B or 4BI; Mathematics 6A or 6AI-6B.

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

120B. Transport Processes
(3) HELGESON, CHMELKA

Prerequisite: Chemical Engineering 10 with minimum grade of C-; Chemical Engineering 110A with minimum grade of C- (may be taken concurrently); Chemical Engineering 120A.

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

120C. Transport Processes
(3) DEY, SQUIRES

Prerequisite: Chemical Engineering 10 with a minimum grade of C-; Chemical Engineering 110A with minimum grade of C-; Chemical Engineering 110B (may be taken concurrently) and Chemical Engineering 120B.

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

121. Colloids and Biosurfaces
(3) STAFF

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

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

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

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

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

Same course as ME 124.

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

125. Principles of Bioengineering
(3) STAFF

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

126. Non-Newtonian Fluids, Soft Materials and Chemical Products
(3) SQUIRES, HELGESON

Prerequisite: Chemical Engineering 120C

Overview of soft materials (suspensions, gels, polymers, surfactants, emulsions, powders and granules) that arise in diverse industries, including consumer products, foods, advanced materials, biotechnology, and mineral and energy production. Influence of non-Newtonian rheology (shear- thickening and thinning, viscoelasticity, extension- thickening, yield stresses, normal stress differences, and metastability) upon handling, processing, production, and performance of chemical products. Strategies to design chemical products that meet performance targets, and to scale-up production. Real-world case studies and classroom demonstrations.

128. Separation Processes
(3) SCOTT, CHMELKA

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

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

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

Prerequisites: Engineering 3, Mathematics 4B or 4BI; Mathematics 6A or 6AI.

Develop analytical tools to solve elementary partial differential equations and boundary value problems. Separation of variables, Laplace transforms, Sturm- Liouville theory, generalized Fourier analysis, and computer math tools.

132B. Computational Methods in Chemical Engineering
(3) CHADA, FREDRICKSON, GORDON

Prerequisite: Mathematics 4B or 4BI; Mathematics 6A or 6AI-6B, Engineering 3.

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) MUKHERJEE

Prerequisites: Mathematics 4B or 4BI; Mathematics 6A or 6AI-6B.

Probability concepts and distributions, random variables, error analysis, point estimation and confidence intervals, hypothesis testing, development of empirical chemical engineering models using regression techniques, design of experiments, process monitoring based on statistical quality control techniques.

140A. Chemical Reaction Engineering
(3) MCFARLAND, SCOTT, CHRISTOPHER

Prerequisites: Chemical Engineering 10 with minimum grade of C-; Chemical Engineering 110A with a minimum grade of C-; Chemical Engineering 110B (may be taken concurrently). Chemical Engineering 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, RAWLINGS**

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

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

141. The Science and Engineering of Energy Conversion
(3) MCFARLAND

Prerequisite: Chemical Engineering 110A and 140A.

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

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

146. Heterogenous Catalysis
(3) STAFF

Prerequisite: Chemical Engineering 140A-B or consent of instructor.

Concepts and definitions. Physical and chemical methods of catalyst characterization. Adsorption, desorption, and surface reaction on well-defined surfaces. Thermodynamic and kinetic treatments of overall reactions on uniform and nonuniform surfaces. Correlations and theoretical approaches in chemical engineering catalysis.

152A. Process Dynamics and Control
(4) CHMELKA, CHRISTOPHER

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

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

152B. Advanced Process Control
(3) RAWLINGS

Prerequisite: Chemical Engineering 152A.

The theory, design, and experimental application of advanced process control strategies including feedforward control, cascade control, enhanced single- loop strategies, and model predictive control. Analysis of multi-loop control systems. Introduction to on-line optimization.

154. Engineering Approaches to Systems Biology
(3) STAFF

Prerequisite: Chemical Engineering 107; Mathematics 4B or 4BI; Mathematics 6A or 6AI and Mathematics 6B

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

160. Introduction to Polymer Science
(3) SEGALMAN

Prerequisite: Chemical Engineering 110A or Chemistry 113A or equivalent.

Same course as 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.

166. Mechatronics and Instrumentation for Chemical Engineers
(3) GORDON

Prerequisite: Engineering 3 and Chemical Engineering 110A and B, or consent of instructor

Recommended Preparation: Chemical Engineering 120A and B and Chemical Engineering 132A and B.

Enrollment Comments: Concurrently offered with Chemical Engineering 266.

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

171. Introduction to Biochemical Engineering
(3) DEY, O'MALLEY

Prerequisite: Chemical Engineering 107 or MCDB 1A.

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

173. Omnics-Enabled Biotechnology
(3) O'MALLEY

Prerequisite: Chemical Engineering 107 or MCDB 1A

This course will integrate genomic, transcriptomic, metabolmoic, and proteomic approaches to quantify and understand intricate biological stystems.

174. Model-Guided Engineering of Biological Systems
(3) MUKHERJEE

Prerequisites: Chemical Engineering 10; Chemical Engineering 107 or equivalent, or consent of instructor.

Introduces students to fundamental principles underlying synthetic biology with an emphasis on mathematical modeling of gene regulation using differential equations and mass action kinetics. Students will also learn to design and predict the functional outcomes of synthetic gene circuits and review primary literature in the field.

180A Chemical Engineering Laboratory
(3) STAFF

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

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

180B Chemical Engineering Laboratory
(3) STAFF

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

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

184A. Design of Chemical Processes
(3) DOHERTY, MCFARLAND, CHADA

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

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, MCFARLAND, CHADA

Prerequisites: Chemical Engineering 184A.

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

193. Internship in Industry
(1-4) STAFF

Prerequisite: Consent of Department.

Enrollment Comments: Student must have a minimum 3.0 GPA. May not be used as departmental elective. May be repeated to a maximum of 12 units.

Special projects for selected students. Offered in conjunction with engineering practice in selected industrial and research firms, under direct faculty supervision. A 2-4 page paper and an evaluation from the supervisor will be required for credit.

196.Undergraduate Research
(2-4) STAFF

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

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

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

198. Independent Studies in Chemical Engineering
(1-5) STAFF

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

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

Directed individual studies.

GRADUATE COURSES

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

Computer Engineering

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

Faculty

Jonathan Balkind, Ph.D., Princeton University, Assistant Professor (Computer Architecture, Programming Languages, and Operating Systems)
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)

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

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

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

Bongjin Kim, Ph.D., University of Minnesota (Integrated Circuits and Systems, Memory-Centric Computing, Analog Mixed-Signal & Digital VLSI, Hardware Accelerator, Alternative Computing, Brain-Inspired & Neuromorphic computing, Machine Learning Hardware, Design Automation)

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)

Peng Li, Ph.D., Carnegie Mellon University, Professor (Integrated circuits and systems, learning algorithms and circuits for brain-inspired computing, electronic design automation, computational brain modeling, hardware machine learning systems)

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

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

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

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

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

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

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

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.

Student Outcomes

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

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

Undergraduate Program

Bachelor of Science—Computer Engineering

A minimum of 191 units is required for graduation. A complete list of requirements for the major can be found on page 48.

Schedules should be planned to meet both General Education and major requirements.

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

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

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

The upper-division requirements consist of a set of required courses and a minimum of 48 units (12 classes) of additional departmental elective courses comprised of at least two sequences chosen from a set of eight specialty sequences. Each sequence must consist of two or more courses taken from the same course/sequence group. The department electives must also include a capstone design project (CMPSC 189A-B/ECE 189A-B-C). Upper-division courses required for the major are: Computer Science 130A; ECE 152A,154A; either ECE 139 or PSTAT 120A; Engineering 101.

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

Satisfactory Progress & Prerequisites

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

Computer Engineering Courses

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

Computer Science

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

Faculty

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

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

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

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

Michael Beyeler, Ph.D, University of Califorina, Irvine, Assistant Professor (human centered and social computing; visual computing and interaction)*6

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Yekaterina Kharitonova, PhD., University of Arizona, AssistantAssistantTeaching Professor

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

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

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

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

Diba Mirza, PhD., University of California, San Diego, AssociateAssociateTeaching Professor

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

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

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

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

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

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

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

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

Richert K. Wang, Ph.D.,

University of California, Irvine, AssistantAssistantTeaching Professor*1

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

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

William Wang, Ph.D., Carnegie Mellon University, Assistant Professor (natural language processing, machine learning, deep learning, artificial intelligence, knowledge representation and reasoning, information extraction, computational social science, multimodality, language and vision)

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

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

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

Xifeng Yan, Ph.D., University of Illinois at Urbana Champaign,

Venkatesh Narayanamurti, Venkatesh Narayanamurti ChairChair Professor (Data Mining/Databases, Natural Language Processing/Machine Learning/AI)

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

Emeriti Faculty

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

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

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

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

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

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

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

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

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

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

Affiliated Faculty

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

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

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

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

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

Kyle Mahowald, Ph.D. (Linguistics)

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

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

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

Sharon Tettegah, Ph.D. (Black Studies

Simon Todd, Ph.D. (Linguistics)

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

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

Mission Statement

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

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

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

Department of Computer Science.

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

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

Program Goals for Undergraduate Programs

The goal of the computer science undergraduate program is to prepare future generations of computer professionals for long-term careers in research, technical development, and applications. Graduates of the B.S. program 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 tradeoffs involved in design choices.
11. An ability to apply design and development principles in the construction of software systems of varying complexity.

Undergraduate Program

Bachelor of Science—Computer Science

A minimum of 184 units is required for graduation. A complete list of requirements for the major can be found on page 50. Schedules should be planned to meet both General Education and major requirements.

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

Bachelor of Science—Computer Engineering

This major is offered jointly by the Department of Computer Science and the Department of Electrical and Computer Engineering. For information about this major, see page 25.

Computer Science Courses

LOWER DIVISION

8. Introduction to Computer Science
(4) KHARITONOVA, MIRZA, MATNI
Not open for credit to students who have completed Computer Science 16 or Engineering 3.

Legal repeat for CMPSC 5AA-ZZ.

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

16. Problem Solving with Computers
(4) KHARITONOVA, MIRZA
Prerequisite: Math 3A with a grade of C or better (may be taken concurrently), Computer Science 8 or Engineering 3 or Electrical and Computer Engineering 3 with a grade of C or better, another university-level intro to programming course, or significant prior programming experience.

Legal repeat of CMPSC 10.

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

24. Problem Solving with Computers II
(4) AGRAWAL, MIRZA
Prerequisite: Computer Science 16 with a grade of C or better; and Math 3B with a grade of C or better (may be taken concurrently).

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

Legal repeat of Computer Science 24A.

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

32. Object Oriented Design and Implementation
(4) WANG, R.
Prerequisite: Computer Science 24 with a grade of C or better.

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

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

40. Foundations of Computer Science
(5) VAN DAM, SU
Prerequisites: Computer Science 16 with a grade of C or better; and Mathematics 4A with a grade of C or better.

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

64. Computer Organization and Logic Design
(4) MATNI
Prerequisite: Computer Science 16 with a grade of C or better; and Mathematics 3C or 4A with a grade of C or better.

Not open for credit to students who have completed ECE 15B

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

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

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

Independent studies in computer science for advanced students.

UPPER DIVISION

100. Introduction to Teaching Methods in Computer Science
(4) MIRZA
Prerequisite: consent of instructor.

May be repeated to a maximum of 12 units.

Designed to train outstanding undergraduates for learning assistant positions in CS courses. Lecture/discussion surveys current research and best practices in CS pedagogy including student development theories, different pedagogical techniques, and methods for assessing learning. Students gain experience working one-on-one with students, fostering positive learning environments, and providing feedback on student work. Students who successfully complete this course will earn units by serving as an apprentice undergraduate learning assistant.

110. Introduction to Research in Computer Science
(4) MIRZA

Prerequisite: Computer Science 40 and Computer Science 32; consent of instructor.

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

111. Introduction to Computational Science
(4) GILBERT, MATNI

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

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

Introduction to the numerical algorithms that form the foundations of data science, machine learning, and computational science and engineering. Matrix computation, linear equation systems, eigenvalue and singular value decompositions, numerical optimization. The informed use of mathematical software environments and libraries, such as python/numpy/scipy.

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

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

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

130B. Data Structures and Algorithms II
(4) LOKSHTANOV, SINGH, SURI

Prerequisite: Computer Science 130A.

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

138. Automata and Formal Languages
(4) EGECIOGLU

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

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

140. Parallel Scientific Computing
(4) YANG, T., GILBERT

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

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

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

148. Computer Science Project
(4) CONRAD

Prerequisite: Computer Science 32 with a grade of C or better; open to Computer Science majors only.

Not open for credit to students who have completed Computer Science 48 with a grade of C or better.

CMPSC 148 is a legal repeat of CMPSC 48.

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

153A. Hardware/Software Interface
(4) KRINTZ

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

Same course as ECE 153A.

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

154. Computer Architecture
(4) MATNI

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

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

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

156. Advanced Applications Programming
(4) CONRAD

Prerequisite: Computer Science 24 and 32 with a grade of C or better; open to computer science and computer engineering majors only.

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

CMPSC 156 is a legal repeat of CMPSC 56.

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

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

160. Translation of Programming Languages
(4) DING, HARDEKOPF

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

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

162. Programming Languages
(4) HARDEKOPF, FENG

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

Concepts of programming languages: scopes, parameter passing, storage management; control flow, exception handling; encapsulation and modularization 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) WANG, YX., YAN

Prerequisite: Computer Science 130A

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

165B. Machine Learning
(4) WANG, W., DING

Prerequisite: Computer Science 130A[the 'recommended preparation' should be on the next line and not italicized]

Recommended preparation: Computer Science 111.

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

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

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

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

171. Distributed Systems
(4) EL ABBADI

Prerequisite: Computer Science 130A.

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

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

172. Software Engineering
(4) BULTAN

Prerequisite: Computer Science 130A; computer science or computer engineering majors only, or by consent of department.

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

174A. Fundamentals of Database Systems
(4) SU

Prerequisite: Computer Science 130A

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

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

174B. Design and Implementation Techniques of Database Systems
(4) SU, YAN

Prerequisite: Computer Science 130B.

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

Q[insert the next line here to separate the course description from the 'recommended preparation']ueries 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) BELDING

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

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

Recommended preparation: PSTAT 120B.

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

176B. Network Computing
(4) GUPTA, A.

PREREQUISITE: COMPUTER SCIENCE 176A.

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

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

176C. Advanced Topics in Internet Computing
(4) GUPTA, A.

Prerequisite: Computer Science 176A

[the 'recommended preparation' should not be italicized]Recommended preparation: PSTAT 120B.

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) KRUEGEL, VIGNA

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

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

178. Introduction to Cryptography
(4) ANANTH

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) YAN, L.

Prerequisite: Computer Science 130A or consent of instructor.

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

181. Introduction to Computer Vision
(4) WANG Y-F.,

Prerequisite: Upper-division standing.

Same course as ECE 181.

Not open for credit to students who have completed ECE/CMPSC 181B with a grade of C or better. ECE/CMPSC 181 is a legal repeat of ECE/CMPSC 181B.

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

184. Mobile Application Development
(4) HOLLERER

Prerequisite: Computer Science 56 or Computer Science 156; and Computer Science 130A.

An introduction to programming mobile computing devices. Students will learn about and study the shift in software development from desktop to mobile device applications. Topics will include software engineering and design practices, advances in programming practice, and support tools for mobile application development and testing. Students will develop and deploy mobile applications as part of their course work.

185. Human-Computer Interaction
(4) HOLLERER

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

Recommended preparation: Students are strongly encouraged to complete Computer Science 56 or Computer Science 156 prior to enrolling in Computer Science 185. Proficiency in the Java/C++ programming language, some experience with user interface programming.

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

189A. Senior Computer Systems Project
(4) BULTAN, KRINTZ

Prerequisite: Computer Science 48 or 56 or 148 or 156 or 172; Senior standing in computer science or computer engineering.

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

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

189B. Senior Computer Systems Project
(4) BULTAN, KRINTZ

Prerequisite: CMPSC 189A; Senior standing in computer science or computer engineering.

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

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

190AA-ZZ. Special Topics in Computer Science
(4) STAFF

Prerequisite: consent of instructor.

May be repeated with consent of the department chair.

Courses provide for the study of topics of current interest in computer science: A. Foundations; B. Software Systems; C. Programming languages and software engineering; D. Information management; E. Architecture; F. Networking; G. Security; H. Scientific computing; I. Intelligent and interactive systems; N. General

192. Projects in Computer Science
(1-5) STAFF

Prerequisite: consent of instructor.

Students must have a minimum 3.0 GPA.

May be repeated to a maximum of 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

Prerequisite: Students must: (1) have attained upper-division standing (2) have a minimum 3.0 grade-point average for preceding three quarters, (3) have consent of instructor.

May be repeated for up to 12 units. No more than 4 units may be applied to departmental electives.

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

196B. Undergraduate Research
(2-4) STAFF

Prerequisite: Students must (1) have taken 4 letter-graded units of CMPSC 196, (2) have consent of instructor.

Designed for majors. May be repeated for up to 12 units. No more than 4 units may be applied to departmental electives.

Advanced research for undergraduate students, by petition after completing a minimum of 4 units of CMPSC 196 for a letter grade. The student will propose a specific research project and make a public presentation of final results. Evaluation and grade will be based on feedback from the research faculty advisor and one other faculty member.

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

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

Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated with consent of chair. Students are limited to 5 units per quarter and 30 units total in all 198/199 courses combined. May not be used for credit towards the major.

Independent study in computer science for advanced students.

GRADUATE COURSES

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

Electrical & Computer Engineering

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

Faculty

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

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

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

Ilan Ben-Yaacov, Ph.D., UC Santa Barbara, Lecturer SOE (semiconductor device physics and electronic devices, power electronics, engineering education)

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

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

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

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

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

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

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

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

Steven P. DenBaars, Ph.D., University of Southern California, Distinguished Professor (metalorganic vapor phase epitaxy, optoelectronic materials, compound semiconductors, indium phosphide and gallium nitride, photonic devices) *1

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

Joao Hespanha, Ph.D., Yale University, Professor (hybrid and switched systems, multi-agent control systems, game theory, optimization, distributed control over communication networks also known as networked control systems, coordination and control of groups of unmanned air vehicles, the use of vision in feedback control, network security)

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

Bongjin Kim, Ph.D., University of Minnesota (Integrated Circuits and Systems, Memory-Centric Computing, Analog Mixed-Signal & Digital VLSI, Hardware Accelerator, Alternative Computing, Brain-Inspired & Neuromorphic computing, Machine Learning Hardware, Design Automation)

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

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

Peng Li, Ph.D., Carnegie Mellon University, Professor (Integrated circuits and systems, learning algorithms and circuits for braininspired computing, electronic design automation, computational brain modeling, hardware machine learning systems)

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

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

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

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

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

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

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

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

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

Mark J.W. Rodwell, Ph.D., Stanford University, Distinguished Professor (nm and THz electronics: THz Transistors, nm VLSI Transistors VLSI, 100-1000GHz RF/Wireless ICs, beyond-5G-wireless, ICs for fast Optical Fiber Communication)

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

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

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

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

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

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

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

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

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

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

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

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

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

Emeriti Faculty

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

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

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

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

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

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

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

Ronald 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)

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

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

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

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

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

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

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

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

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

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

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

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

*1 Joint appointment with Materials

*2 Joint appointment with Computer Science

Affiliated Faculty

Bassam Bamieh, Ph.D. (Mechanical Engineering)

Elizabeth Belding, Ph.D. (Computer Science)

Francesco Bullo, Ph.D. (Mechanical Engineering)

Ranjit Deshmukh, Ph.D. (Environmental Studies)

Yufei Ding, Ph.D. (Computer Science)

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

Chandra Krintz, Ph.D. (Computer Science)

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

Kunal Mukherjee, Ph.D. (Materials)

Shuji Nakamura, Ph.D. (Materials)

Tim Sherwood, Ph.D. (Computer Science)

William Wang, Ph.D. (Computer Science)

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.

Student Outcomes

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

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

Undergraduate Program

Bachelor of Science—Electrical Engineering

A minimum of 189 units is required for graduation. A complete list of requirements for the major can be found on page 52.

Schedules should be planned to meet both General Education and major requirements.

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

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

Three matters should be noted: (1) students who fail to attain a grade-point average of at least 2.0 in the major may be denied the privilege of continuing in the major, (2) a large majority of electrical and computer engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite courses means receiving a grade of C- or better in prerequisite courses except for Mathematics 3A-B, Mathematics 4A-B and Mathematics 6A and 6B which require a grade of C or better to apply these courses as prerequisites, (3) courses required for the pre-major or major, inside or outside of the Department of Electrical Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.

Bachelor of Science—Computer Engineering

This major is offered jointly by the Department of Computer Science and the Department of Electrical and Computer Engineering. For information about this major, see page 25.

Electrical & Computer Engineering Courses

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

LOWER DIVISION

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

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

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

5. Introduction to Electrical & Computer Engineering
(4) STAFF
Prerequisite: Open only to Electrical Engineering and Computer Engineering majors. Lecture: 2 hours; Laboratory: 3 hours
Aims at exposing freshmen students to the different sub-fields within Electric and Computer Engineering. Composed of lectures by different faculty members and a weekly laboratory based on projects that are executed using the Arduino environment.

10A. Foundations of Analog and Digital Circuits & Systems
(3) STAFF
Prerequisite: Mathematics 2A-B or 3A-B or Mathematics 3AH-3BH, and Mathematics 3C or 4A or 4AI with a minimum grade of C; and, Math 4B or 4BI or 5A with a minimum grade of C (may be taken concurrently); Physics 3 or 23 (may be taken concurrently); open only to electrical engineering and computer engineering majors. Lecture: 3 hours
Not open for credit for those who have received a C- or higher in ECE 2A.
The objective of the course is to establish the foundations of analog and digital circuits. The course will introduce the student to the power of abstraction, resistive networks, network analysis, nonlinear analysis and the digital abstraction. (F)

10AL. Foundations of Analog and Digital Circuits and Systems Lab
(2) STAFF
Prerequisite: ECE 10A (may be taken concurrently) with a C- or better grade. Laboratory: 4 hours
Not open for credit for those who have received a C- or higher in ECE 2A.
The goal of 10AL is to provide the student with a hands-on application of the concepts discussed in ECE 10A. The lab will introduce the use of microcontrollers as a data acquisition system, network analysis, resistors, nonlinear analysis and digital abstraction.

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

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

amplifier design and basic instrumentation.

10C. Foundations of Analog and Digital Circuits and Systems
(3) STAFF
Prerequisite: ECE 10B with a C- or better grade. Lecture: 3 hours

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

The objective of the course is to introduce the student to the basics of transient analysis. The course will energy and power dissipation in digital circuits, first-order and second-order linear time invariant circuits, sinusoidal steady state, impedance representation, feedback and resonance. (S)

10CL. Foundations of Analog and Digital Circuits and Systems Lab
(2) STAFF
Prerequisite: ECE 10C (may be taken concurrently) with a C- grade or better. Laboratory: 4 hours

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

The goal of 10CL is to provide the student with a hands- on application of the concepts discussed in ECE 10C. The lab will utilize the microcontroller to introduce students to the understanding of propagation delay in digital circuits and the resulting power dissipation, first order linear networks, second order linear networks, sinusoidal steady-state, impedance analysis and op-amp circuits.

15A. Fundamentals of Logic Design
(4) ZHANG
Prerequisites: Open to electrical engineering, computer engineering, and pre-computer engineering majors only.

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

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

92. Projects in Electrical and Computer Engineering
(4) STAFF
Prerequisite: Consent of instructor; for Electrical Engineering and Computer Engineering majors only

Projects in electrical and computer engineering for advanced undergraduate students.

94AA-ZZ. Group Studies in Electrical and Computer Engineering
(1-4) STAFF
Prerequisite: consent of instructor.

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

96. Undergraduate Research
(2-4) STAFF
Prerequisite: Consent of instructor. Must have a 3.00 GPA. May be repeated for up to 12 units.

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

UPPER DIVISION

120A. Integrated Circuit Design and Fabrication
(4) BEN-YAACOV
Prerequisite: ECE 132 with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hours

Not open for credit for those who have taken ECE 124B.

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

120B. Integrated Circuit Design and Fabrication
(4) BEN-YAACOV
Prerequisite: Either ECE 120A or ECE 124B with a minimum grade of C- or better in each of the courses. Lecture: 3 hours; Laboratory: 3 hours

Not open for credit to those who have taken ECE 124C.

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

122A. VLSI Principles
(4) BANERJEE
Prerequisite: ECE 152A with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hours

Not open for credit for those who have taken ECE 124A or ECE 123.

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

122B. VLSI Architecture and Design
(4) BREWER
Prerequisite: ECE 124A or ECE 123 or ECE 122A with a minimum grade of C-. Lecture: 3 hours; Laboratory: 2 hours

Not open for credit for those who have taken ECE 124D.

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

123. High-Performance Digital Circuit Design
(4) THEOGARAJAN
Prerequisite: ECE 10A-B-C and ECE 10AL-BL-CL or ECE 2A-B-C with a minimum grade of C- in each of those courses; open to both electrical engineering and computer engineering majors only.

Not open for credit for those who have taken ECE 124A or ECE 122A.

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

125. High Speed Digital Integrated Circuit Design
(4) BANERJEE
Prerequisite: ECE 124A or 137A with a minimum grade of C- in either. Lecture, 4 hours.

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

130A. Signal Analysis and Processing
(4) STAFF
Prerequisite: Mathematics 4B or 5A with a minimum of grade of C; 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) STAFF
Prerequisite: Physics 4 or 24 with a minimum grade of C-; Mathematics 4B or 5A with a minimum grade of C; and, ECE 10A-B and ECE 10AL-BL or ECE 2A-B (may be taken concurrently) with a minimum grade of C- in each; open to EE and computer engineering majors only. 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
Prerequisite: Physics 3 or 23 with a minimum grade of C-; Mathematics 4B or 4BI or 5A and Mathematics 5B or 6A or 6AI with a minimum grade of C in each; and Mathematics 5C or 6B with a minimum grade of C-; open to EE and computer engineering majors only Lecture: 3 hours; Discussion: 2 hours.

Introduction to applied electromagnetics and wave phenomena in high frequency electron circuits and systems. Waveson 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 10A-B-C and ECE 10AL-BL-CL or ECE 2A-B-C, 130A, and 132 all with a minimum grade of C- in all; open to EE majors only. Lecture, 3 hours; laboratory, 3 hours.

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

137B. Circuits and Electronics II
(4) RODWELL
Prerequisites: ECE 10C and 10CL or ECE 2C and 137A with a minimum grade of C- in both; open to EE majors only. Lecture, 3 hours; laboratory, 3 hours.

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

139. Probability and Statistics
(4) STAFF
Prerequisite: Open to Electrical Engineering, Computer Engineering and pre-Computer Engineering majors only. Lecture, 3 hours; discussion, 2 hours.

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

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

MEMS)
(3) PENNATUR

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

Introduction to nano- and microtechnology. Scaling laws and nanoscale physics are stressed. Individual subjects at the nanoscale including materials, mechanics, photonics, electronics, and 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

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

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

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

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

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

142. Introduction to Power Electronics
(4) MISHRA

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) KLAMKIN

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

Waves on transmission lines, Maxwell's equations, skin effect, propagation and reflection of electromagnetic waves, microwave integrated circuit principles, 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) BUCKWALTER

Prerequisite: ECE 145A with a minimum grade of C-; EE majors only. Lecture, 3 hours; laboratory, 6 hours.

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

145C. Communication Electronics III
(5) BUCKWALTER

Prerequisites: ECE 145B 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. Digital Communication Fundamentals
(5) MADHOW

Prerequisite: ECE 130A-B with a minimum grade of C-; open to EE majors only. Lecture: 3 hours; Laboratory: 6 hours

Signal and channel models, with emphasis on wireless systems; digital modulation; demodulation basics; statistical modeling of noise, including review of probability theory and random variables.

146B. Communication Systems Design
(5) MADHOW

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

Optimal demodulation, including signal space geometry; communication performance characterization; advanced wireless communication techniques, including multi-antenna and multicarrier systems; other emerging frontiers in communications.

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

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

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

147B. Digital Control Systems - Theory and Design
(5) BYL

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

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

147C. Control System Design Project
(5) HESPANHA

Prerequisite: ECE 147A or ME 155B or ME 173 with a minimum grade of C-. Lecture, 3 hours; laboratory, 6 hours.

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

148. Applications of Signal Analysis and Processing
(4) LEE

Prerequisite: ECE 130A and 130B with a minimum grade of C- in both. Lecture: 3 hours; Discussion: 2 hours

Recommended Preparation: concurrent enrollment in ECE 130C.

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

149. Game Theory for Networked Systems
(4) MARDEN

Prerequisite: upper division standing or consent of instructor.

An overview of game theory with an emphasis on application to multiagent systems. Game theory focuses on the study of systems that are comprised of interacting and possibly competing decision-making entities. Examples drawn from engineered, economics, and social systems.

150. Mobile Embedded Systems
(4) STAFF

Prerequisite: Proficiency in JAVA programming, and a C- in ECE 152A.

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

152A. Digital Design Principles
(5) STAFF

Prerequisite: ECE 15A and 2A or ECE 10A & ECE 10AL with a minimum grade of C- in each course; or Computer Science 30 or 64 with a minimum grade of C- in each course; open to electrical engineering, computer engineering, and computer science majors only. Lecture: 3 hours; Laboratory: 6 hours

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

153A. Hardware/Software Interface
(4) 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) STAFF

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

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

154A. Introduction to Computer Architecture
(4) PARHAMI

Prerequisite: ECE 152A with a minimum grade of C-; open to EE and CMPEN majors only. Lecture: 3 hours; Discussion: 1 hour

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

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

154B. Advanced Computer Architecture
(4) STRUKOV

Prerequisite: ECE 154A with a C- grade or better. Open to EE and CMPEN majors only. Lecture: 3 hours; Laboratory: 4 hours

Not open for credit to those who have taken Computer Science 154.

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

157A. Machine Learning in Design and Test Automation
(4) LI C. WANG

Prerequisite: ECE 152A with a minimum grade of C-.

Introduces the various machine learning techniques and how they are utilized to improve hardware design and test automation
processes. The potential benefits and theoretical barriers for implementing a machine learning solution in practice are explained.

157B. Artificial Intelligence in Design and Test Automation
(4) LI C. WANG

Prerequisite: ECE 157A with a minimum grade of C-.

Introduces an artificial intelligence system view to apply machine learning in design and test automation processes. The various
components for building an Intelligent Engineering Assistant (IEA) to perform an engineering task in an industrial setting are explained.

158. Digital Signal Processing
(4) GIBSON

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

Lecture, 3 hours; laboratory, 3 hours.

Recommended Preparation: Mathematics 124A. Mathematics 124A is recommended but not required

Digital Signal Processing, with Applications: The Fast Fourier transform, discrete cosine transform, and multirate digital signal processing techniques, with applications to digital cellular communications and wireless access points, and audio, voice, still image, video, and biological signal analysis, recognition and compression.

160. Multimedia Systems
(4) MANJUNATH

Prerequisite: Upper-division standing; open to electrical engineering, computer engineering, computer science, and creative studies majors only. Lecture: 3 hours; Laboratory: 3 hours

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

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

162A. The Quantum Description of Electronic Materials
(4) STAFF

Prerequisites: ECE 130A-B and 134 with a minimum grade of C- in all; open to EE, seniors in the BS/MS program and Materials graduate students only.

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

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

162B. Fundamentals of the Solid State
(4) STAFF

Prerequisite: ECE 162A with a minimum grade of C-; open to EE, senior students in the BS/MS programs and Materials graduate students only.

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

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) STAFF

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

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) STAFF

Prerequisites: open to EE, computer engineering, and computer science majors with upper-division standing. Lecture, 3 hours; discussion, 1 hour.

Basic concepts in image and video processing. Topics include image formation and sampling, image transforms, image enhancement, 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 181.

Same course as ME 179P.

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

180. Introduction to Deep Learning
(4) MANJUNATH

Prerequisite: Open to EE, Computer Engineering and Computer Science with upper-division standing.

Introduction to multilayered neural networks, early models of perceptrons and associative memory; back-propagation learning; convolutional neural networks; recurrent neural networks; attention models; applications to natural language processing and computer vision.

181. Introduction to Computer Vision
(4) MANJUNATH

Prerequisite: Upper-division standing in Electrical Engineering, Computer Engineering, Computer Science, Chemical Engineering or Mechanical Engineering. Lecture: 3 hours; Discussion: 1 hour

Same course as Computer Science 181B.

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

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

183. Nonlinear Phenomena
(4) STAFF

Prerequisites: Physics 105A or Physics 103; or ME 163 or upper-division standing in ECE.

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

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

188A. Senior Electrical Engineering Project
(3) BEN YAACOV

Prerequisite: ECE 130A and ECE 130B with a C- grade or better in both; or ECE 137A and ECE 137B with a C- or better in both.

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

188B. Senior Electrical Engineering Project
(3) BEN YAACOV

Prerequisite: ECE 188A with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hours

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

188C. Senior Electrical Engineering Project
(3) BEN YAACOV

Prerequisite: ECE 188B with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hour

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

189A. Senior Computer Systems Project
(4) ISUKAPALLI

Prerequisite: ECE 153B; senior standing in Computer Engineering, Computer Science or EE. Lecture: 3 hours; Laboratory: 3 hours

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

Student groups design a significant computer-based project. The focus will be on designing a significant project based on the knowledge and skills acquired in earlier coursework. Groups work independently with interaction among groups via interface specifications and informal meetings. The project is evaluated through successful completion of milestones and individual/group project reports and presentations.

189B. Senior Computer Systems Project
(4) ISUKAPALLI

Prerequisite: ECE 189A; senior standing in Computer Engineering, Computer Science or EE. Lecture: 3 hours; Laboratory: 3 hours

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

Student groups design a significant computer-based project. Focus will be on building and implementing an embedded hardware system. Each group works independently. The project is evaluated through project reports, achieving milestones and through successful demonstration of hardware functionality.

189C. Senior Computer Systems Project
(4) ISUKAPALLI

Prerequisite: ECE 189B; senior standing in Computer Engineering, Computer Science or EE. Lecture: 3 hours; Laboratory: 3 hours

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

Student groups design a significant computer-based project. The focus in this course will be on the integration of both hardware and software components. Students continue to work in groups. Apart from project reports and presentations, the evaluation will be based on successful demonstration of both hardware and software aspects of the project.

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;
(805) 893-2809
www.engineering.ucsb.edu/undergraduate/majors-programs/engineering-sciences
Chair & Associate Dean: Glenn E. Beltz

Faculty

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

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

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

Tyler G. Susko, Lecturer Potential SOE

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

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

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

Engineering Sciences Courses

LOWER DIVISION

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

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

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

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

UPPER DIVISION

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

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

ENGR 120A. Molecular Bioengineering
(4) STAFF
Prerequisite: Chemistry 1B, Chemistry 1BL, Mathematics 6B, and Physics 3

Recommended Preparation: One or more undergraduate courses in biochemistry or cell biology similar to MCDB 108ABC or Chem 142ABC or MCDB 103, or consent of instructor.

Enrollment Comments: Quarters usually offered: Winter, Fall.

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

ENGR 120B. Cellular Bioengineering
(4) STAFF
Prerequisite: Engr 120A or consent of Instructor

Enrollment Comments: Quarters usually offered: Winter.

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

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

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

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

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

Provides experience in communicating science and technology to 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.

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

This course allows the coordination of senior students in multiple departments while they undertake a multi-departmental capstone design project. Participating students are required to concurrently enroll in their respective departmental capstone/senior design project courses (ECE 189AB, CMPSC 189AB, ECE 188AB, ME 189ABC), and will additionally enroll in 1 unit of this course for the Fall, Winter and Spring quarters. By taking this course, students will understand practical engineering approaches to collaborate on complex multidisciplinary engineering systems.

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

This course allows the coordination of senior students in multiple departments while they undertake a multi-departmental capstone design project. Participating students are required to concurrently enroll in their respective departmental capstone/senior design project courses (ECE 189AB, CMPSC 189AB, ECE 188AB, ME 189ABC), and will additionally enroll in 1 unit of this course for the Fall, Winter and Spring quarters. By taking this course, students will understand practical engineering approaches to collaborate on complex multidisciplinary engineering systems.

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

This course allows the coordination of senior students in multiple departments while they undertake a multi-departmental capstone design project. Participating students are required to concurrently enroll in their respective departmental capstone/senior design project courses (ECE 189AB, CMPSC 189AB, ECE 188AB, ME 189ABC), and will additionally enroll in 1 unit of this course for the Fall, Winter and Spring quarters. By taking this course, students will understand practical engineering approaches to collaborate on complex multidisciplinary engineering systems.

199. Independent Studies in Engineering
(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;
(805) 893-4601
www.materials.ucsb.edu
Chair: Michael L. Chabinyc
Vice Chair: Stephen Wilson

Faculty

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

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

Irene J. Beyerlein, Ph.D., Cornell University, Professor (computational materials science, microstructure-property relationships, deformation mechanisms, composites)

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

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

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

Xi Dai, PhD, Chinese Academy of Sciences, Professor (electronic structure of correlated materials, topological materials, quantum materials, density functional theory)

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

Daniel S. Gianola, Ph.D., Johns Hopkins University, Associate Professor (nanomechanical behavior of materials, tunable energy conversion, micro- and nanoelectronics, thermal management, and waste heat collection)

John W. Harter, PhD, Cornell University, Assistant Professor (quantum materials, unconventional superconductors, strongly-correlated electrons, nonlinear optical spectroscopy, angle-resolved photoemission spectroscopy)

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

Sriram Krishnamoorthy, PhD, The Ohio State University, Assistant Professor (ultra-wide band gap semiconductors, epitaxial materials and electronic/photonic devices, metalorganic vapor phase epitaxy, Gallium Oxide)

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

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

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

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

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

Angela A. Pitenis, Ph.D., University of Florida (interfacial engineering, soft materials, surface physics, biotribology, contact mechanics, adhesion, in situ techniques, imaging)

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

Cyrus R. Safinya, Ph.D., Massachusetts Institute of Technology, Distinguished Professor (biophysics, supramolecular assemblies of biological molecules, non-viral gene delivery systems)

Omar A. Saleh, Ph.D., Princeton University, Assistant Professor (single-molecule biophysics, motor proteins, DNA-protein interactions)

Rachel A. Segalman, Ph.D., University of California, Santa Barbara, Professor (synthesis of macromolecules, self-assembly, electronic properties of molecular and macromolecular materials, transport processes in polymers)

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

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

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

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

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

Anton Van der Ven, Ph.D., Massachusetts Institute of Technology, Associate Professor (First principles prediction of thermodynamic, kinetic and and mechanical properties of alloys, ceramics and compound semiconductors, statistical mechanical methods development,electrochemcial energy storage materials, high temperature structural materials corrosion)

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

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

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

Emeriti Faculty

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Affiliated Faculty

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

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

Mahn Won Kim, Ph.D. (Physics)

Gary Leal, Ph.D. (Chemical Engineering)

Gene Lucas, Ph.D. (Chemical Engineering)

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

The department has major research groups working on a wide range of advanced inorganic and organic materials, including advanced structural alloys, ceramics and polymers; high performance composites; thermal barrier coatings and engineered surfaces; organic, inorganic and hybrid semiconductor and photonic material systems; catalysts and porous materials, magnetic, ferroelectric and multiferroic materials; biomaterials and biosurfaces, including biomedically relevant systems; colloids, gels and other complex fluids; lasers, LEDs and optoelectronic devices; packaging systems; microscale engineered systems, including MEMS. The groups are typically multidisciplinary involving faculty, postdoctoral researchers and graduate students working on the synthesis and processing, structural characterization, property evaluation, microstructure-property relationships and mathematical models relating micromechanisms to macroscopic behavior.

Materials Courses

LOWER DIVISION

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

UPPER DIVISION

100A. Structure and Properties I
(3) STAFF
Prerequisites: Chemistry 1A-B; Physics 4; and, Mathematics 4B, 6A-B. Lecture, 3 hours.
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) STAFF
Prerequisite: Materials 100A.
Students who take Matrl 101 & 100B will only receive major credit for one of these courses. 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) STAFF
Prerequisite: Materials 100A and Materials 100B.
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.
Students who take MATRL 101 & 100B will only receive major credit for one of these courses. Students interested in following the BS Engineering/MS Materials program should not take this course.
Introduction to the structure of engineering materials and its relationship with their mechanical properties. Structure of solids and defects. Concepts of microstructure and origins. Elastic, plastic flow and fracture properties. Mechanisms of deformation and failure. Stiffening, strengthening, and toughening mechanisms.

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

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

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

162B. Fundamentals of the Solid State
(4) **STAFF**
Prerequisites: ECE 162A with a minimum grade of C-; open to EE and materials majors only.
Same course as ECE 162B.
Crystal lattices and the structure of solids, with emphasis on semiconductors. Lattice vibrations, electronic states and energy bands. Electrical and thermal conduction. Dielectric and optical properties. Semiconductor devices: Diffusion, P-N junctions and diode behavior.

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

186A. Manufacturing and Materials
(3) LEVI
Prerequisites: ME 15 and 151C; and, Materials 100B or 101.
Same course as ME 186. Lecture, 3 hours.
Introduction to the fundamentals of common manufacturing processes and their interplay with the structure and properties of materials as they are transformed into products. Emphasis on process understanding and the key physical concepts and basic mathematical relationships involved in each of the processes discussed.

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

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

GRADUATE COURSES

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

Mechanical Engineering

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

Faculty

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

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

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

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

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

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

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

Samantha H. Daly, PhD, California Institute of Technology, Associate Professor (mechanics of materials, development of small-scale experimental methods, effects of microstructure on the meso and macroscopic properties of materials, active materials, composites, fatigue, plasticity, fracture)

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

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

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

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

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

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

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

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

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

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

Carl D. Meinhart, Ph.D., University of Illinois at Urbana-Champaign, Professor (wall turbulence, microfluidics, flows in complex geometries)

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

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

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

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

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

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

Tyler G. Susko, phD, Massachusetts Institute of Technology, Assistant Teaching Professor (mechanical and product design, engineering education, rehavilitation robotics, human-machine interaction)

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

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

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

Emeriti Faculty

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Affiliated Faculty

Paul J. Atzberger (Mathematics)

Katie A. Byl (Electrical and Computer Engineering)

Hector D. Ceniceros, PhD (Mathematics)

Tommy D. Dickey, PhD (Geography)

Kimberly L. Foster, PhD (Mechanical Engineering)

Joao P. Hespanha, PhD (Electrical and Computer Engineering)

Patricia Holden (Bren School of Environmental Science and Management)

Arturo Keller (Bren School of Environmental Science and Management)

L. Gary Leal (Chemical Engineering)

Kevin W. Plaxco, PhD (Chemistry and Biochemistry, Biomolecular Science and Engineering Program)

Yon Visell, PhD (Electrical and Computer Engineering and Materials)

Libe Washburn, PhD (Geography)

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

Mission Statement

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

Educational Objectives for the Undergraduate Program

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

1. Successfully practice in either the traditional or the emerging technologies comprising mechanical engineering;
2. Are successful in a range of engineering graduate programs;
3. Have a solid background in the fundamentals of engineering allowing them to pass the Fundamentals of Engineering examination;
4. Engage in life-long learning opportunities such as professional workshops and activity in professional societies.

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

Student Outcomes

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

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

new knowledge as needed, using appropriate learning strategies.

Undergraduate Program

Bachelor of Science—Mechanical Engineering

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

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

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

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

Research Opportunities

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

Mechanical Engineering Courses

LOWER DIVISION

6. Basic Electrical and Electronic Circuits
(4) MARKS
Prerequisites: Physics 3-3L; Mathematics 4A; open to ME majors only.

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

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

10. Engineering Graphics: Sketching, CAD, and Conceptual Design
(4) SUSKO
Prerequisite: ME majors only.
Course materials fee required.

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

11. Introductory Concepts in Mechanical Engineering
(1) FIELDS
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) FIELDS
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) LINLEY
Prerequisite: ME majors only.

Course materials fee required.

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

14. Statics
(4) DALY, BEGLEY, MCMEEKING
Prerequisite: Math 3B, or AP Calculus AB with a score of 5, or AP Calculus BC with a score of 3 or better; and Physics 1

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

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

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

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

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) GIBOU
Prerequisite: Engineering 3; Mathematics 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, Students are limited to 5 units per quarter and 30 units total in all 98/99/198/199/199AA-ZZ courses combined.

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

UPPER DIVISION

100. Professional Seminar
(1) STAFF
Prerequisite: undergraduate standing.

May be repeated for up to 3 units. May not be used as a departmental elective.

A series of weekly lectures given by university staff and outside experts in all fields of mechanical and environmental engineering.

102. Finite Elements Analysis of Heat Transfer and Fluid Flow with COMSOL
(3) MATTHYS
Prerequisite: ME 151C and ME 152B; or consent by instructor

Study of modeling and analysis of Heat Transfer and Fluid Flow problems using Finite Elements numerical techniques. Students learn to develop sound numerical models of engineering devises using COMSOL Multiphysics Finite Elements software. Addresses geometry construction, model development, meshing, results generation, and physical analysis.

104. Mechatronics
(4) STAFF
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) VALENTINE, BENNETT
Prerequisite: ME 151B, 152B, 163; and, Materials 101 or 100B.

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

110. Aerodynamics and Aeronautical Engineering
(3) BELTZ, MEINHART
Prerequisites: ME 14 and 152A.

Concepts from aerodynamics, including lift and drag analysis for airfoils as well as aircraft sizing/scaling issues. Structural mechanics concepts are applied to practical aircraft design. Intended for students considering a career in aeronautical engineering.

112. Energy
(3) MATTHYS

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

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

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

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

Same course as Chemical Engineering 124.

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.

Course materials fee may be required.

Introductory course addresses the challenges of biomedical device design, prototyping and testing, material considerations, regulatory requirements, design control, human factors and ethics.

134. Advanced Thermal Science
(3) MATTHYS

Prerequisite: ME 151C.

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

140A. Numerical Analysis in Engineering
(3) MEIBURG

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

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

140B. Theoretical Analysis in Mechanical Engineering
(3) MOEHLIS, GIBOU, MEIBURG

Prerequisites: ME 140A

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

141A. Introduction to Nanoelectromechanical and Microelectromechanical systems (NEMS/ MEMS)
(3) PENNATHUR

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

Introduction to nano- and microtechnology. Scaling 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

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

Same course as ECE 141B.

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

146. Molecular and Cellular Biomechanics
(3) VALENTINE

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

147. Mechatronics Using Labview
(3) HARE

Prerequisite: Engineering 3; and ME 6

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

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

151A. Thermosciences 1
(4) BENNETT, MEINHART

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

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

151B. Thermosciences 2
(4) BENNETT, LIAO

Prerequisite: ME 151A and 152A.

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

151C. Thermosciences 3
(3) BENNETT, SAURET

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

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

152A. Fluid Mechanics
(4) CAMPAS, MEINHART

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

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

152B. Fluid Mechanics
(3) LUZZATTO

Prerequisite: ME 152A; open to ME majors only.

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

153. Introduction to Mechanical Engineering Design
(3) HAWKES

Prerequisites: ME 10 and 16; open to ME majors only.

Course materials fee required.

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

154. Design and Analysis of Structures
(3) MCMEEKING, BEGLEY, BEYERLEIN

Prerequisites: ME 15 and 16 with minimum grades of C-; open to ME majors only.

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

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

Prerequisite: ME 17 with a minimum grade of C-; and ME 163.

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

155B. Control System Design
(3) BAMIEH

Prerequisite: ME 155A.

Dynamic system modeling using state-space methods, controllability and observability, state-space methods for control design including pole placement, and linear quadratic regulator methods. Observers and observer-based feedback controllers. Sampled-data and digital control. Laboratory exercises using MATLAB for simulation and control design.

155C.Control System Design
(3) BAMIEH

Prerequisite: ME 155A. Not open for additional credit to students who have completed ME 106A.

An advanced lab course with experiments in dynamical systems and feedback control design. Students design, troubleshoot, and perform detailed, multi-session experiments.

156A. Mechanical Engineering Design - I
(3) SUSKO

Prerequisite: ME 14, with a minimum grade of C-; and ME 15, with a minimum grade of C-; and MATRL 101 (or MATRL 100B); or consent of instructor. Open to ME majors only

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

156B. Mechanical Engineering Design II
(3) SUSKO

Prerequisites: ME 156A; open to ME majors only.

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.

157. Introduction to Multiphysics Simulation
(3) MEINHART

Prerequisite: Mechanical Engineering 151A-B; and Mechanical Engineering 152A-B; and Mechanical Engineering 140A

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

Introduces students to the concepts of multiphysics simulation. Students are introduced to PDE's, associated analytical solutions, and the finite elements method. Multiphysics problems are solved in multiple domains, and with fluid/structure interactions. Each student conducts a project where multiphysics tools are used to explore details of multiphysical processes.

158. Computer Aided Design and Manufacturing
(3) STAFF

Prerequisites: ME 10 and 156A; open to ME majors only.
Course materials fee required.

Emphasis on programming, operation and design of automated manufacturing tools. Students learn to program CNC tools to make parts with G&M Code and Mastercam CAM software. Students make parts in hands-on labs using CNC tools, 3D printers and laser cutters. Select topics in automated tool design and construction.

162. Introduction to Elasticity
(3) 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

Prerequisites: ME 16 with a minimum grade of C-; open to ME majors only.

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

166. Advanced Strength of Materials
(3) DALY

Prerequisite: ME 15.

Analysis of statically determinate and indeterminate systems using integration, area moment, and energy methods. Beams on elastic foundations, curved beams, stress concentrations, fatigue, and theories of failure for ductile and brittle materials. Photoelasticity and other experimental techniques are covered, as well as methods of interpreting in-service failures.

167. Structural Analysis
(3) YANG

Prerequisites: ME 15. May not be taken for additional credit by studetns who have completed ME W 167.

Presents introductory matrix methods for analysis of structures. Topics include review of matrix algebra and linear equations, basic structural theorems including the principle of superposition and energy theorems, truss bar, beam and plane frame elements, and programming techniques to realize these concepts.

169. Nonlinear Phenomena
(4) MOEHLIS

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

Same course as ECE 183 and Physics 106.

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

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

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

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

179L. Introduction to Robotics: Design Laboratory
(4) STAFF

Prerequisites: ENGR 3; and ME 6 or ECE 2A. Not open for credit to student who have completed Mechanical Engineering 170C or ECE 181C.

Course materials fee required.

Design, programming, and testing of mobile robots. Design problems re formulated in terms of robot performance. Students solve electromechanical problems, developing skills in brainstorming, concept selection, spatial reasoning, teamwork and communication. Robots are controlled with microcontrollers 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.

Same course as ECE 179P

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

185. Materials in Engineering
(3) LEVI

Prerequisite: Materials 100B or 101.

Same course as Materials 185.

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

186A. Manufacturing and Materials
(3) LEVI

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

Same course as Materials 186A.

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

186B. Introduction to Additive Manufactoring
(3) BEGLEY

Same course as Materials 186B.
Introduction to additive manufacturing processes: review of manufacturing methods and process selection consideration, economies of production, common additive manufacturing strategies, and brief description of the physics of photopolymerization, extrusion, selective laser melting and e-beam melting fabrication.

189A. Capstone Mechanical Engineering Design Project
(3) SUSKO

Prerequisite: ME 105, ME 151C, ME 152B, ME 153, and ME 163; or consent of instructor. Open to ME majors only.

Course materials fee required.

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

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

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

189B. Capstone Mechanical Engineering Design Project
(3) SUSKO

Prerequisite: ME 189A

Course materials fee required.

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. (W)

189C. Capstone Mechanical Engineering Design Project
(3) SUSKO

Prerequisite: ME 189A,B

Course materials fee required.

Designed for majors. Quarters usually offered: Spring. A 3-quarter sequence with grades issued for each quarter. Students may not concurrently enroll in ME 197 and ME 189A-B-C with the same design project. Course can only be repeated as a full sequence (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 2219
(805) 893-2729
www.tmp.ucsb.edu
Chair: Kyle Lewis

Faculty

Matthew Beane, Ph.D., Massachusetts Institute of Technology, Assistant Professor

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

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

Paul Leonardi, Ph.D., Stanford University, Professor

Kyle Lewis, Ph.D., University of Maryland, Professor

Nelson Phillips, Ph.D., University of Alberta,

Professor

Renee Rottner, Ph.D., UC Irvine, Assistant Professor

Jessica Santana, Ph.D., Stanford University, Assistant Professor

Mary Tripsas, Ph.D., Massachusetts Institute

of Technology, Professor

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

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, build sound business models that account for the competitive environment, lead and manage other and diverse groups and apply basic marketing principals.

The Technology Management Program (TMP) provides a solid foundation in these areas to help cultivate managerial and entrepreneurial leadership for technology businesses.

Mission Statement

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

The Technology Management Certificate

The Technology Management Certificate program provides students a solid foundation in business fundamentals and entrepreneurship as it applies to new technologies and technology-oriented companies. This certificate serves as an official recognition that the student has a solid grounding in fundamental business strate- gies and models, opportunity recognition and new-venture creation and marketing.

The program also provides access to many professionals familiar with the demands of starting new businesses as well as running existing companies through its extra-curricular offerings.

Technology Management Program Courses

21. Past, Present and Future of Entrepreneurship
(3) GREATHOUSE
Quarters usually offered: Spring.
The historical and present state of entrepreneurship will be explored, along with the potential future direction of startups. Students will be encouraged to start small ventures as a means of determining their proclivity for an entrepreneurial lifestyle.

34. Selling High Tech Products
(4) STAFF
Prerequisite: upper division standing.
Learn the art of persuasion and selling. Theory and applications of the basic tenets of persuasion and how such scientifically supported techniques can be deployed to positively impact the sales process.

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

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

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

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

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

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

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

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

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

GRADUATE COURSES

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

CHEMICAL ENGINEERING 2021-22

	Units
PREPARATION FOR THE MAJOR	**74**
CH E 5	3
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 or AH, 109B or BH	8
ENGR 3	3
MATH 3A-B, 4A or 4AI, 4B or 4BI, 6A or 6AI, 6B	24
PHYS 1, 2, 3, 3L	12

UPPER DIVISION MAJOR	**81**
CH E 107	3
CH E 110A-B	6
CH E 118	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 180A-B	6
CH E 184A-B	6
CHEM 113B-C	8
MATRL 101 or MATRL 100C *^	3

*^ see note on next page

Technical Elective requirement. 15

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

At least 9 of the 15 units must be in the following departments in the College of Engineering: CH E, ECE, MATRL, ME

Approved Technical Elective Requirement classes:

CH E 102	CHEM 109C	MATRL 160
CH E 121	CHEM 115A,B,C	MATRL 185
CH E 124	CHEM 123	MCDB 101A,B
CH E 125	CHEM 126	MCDB 111
CH E 126	CHEM 142A,B,C	MCDB 126A,B,C
CH E 141	CHEM 145	MCDB 133
CH E 146	CHEM 147	MCDB 138
CH E 152B	CHEM 150	ME 110
CH E 154	ECE 130A,B,C	ME 112
CH E 160	ECE 183	ME 128
CH E 166	ENGR 101	ME 134
CH E 171	ENGR 103	ME 169
CH E 173	ENV S 105	ME 185
CH E 174	MATH 122A,B	PHYS 123A,B
CH E 196[1]	MATRL 100A,B	PHYS 127AL
CH E 198[1]	MATRL 135	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:

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

UNIVERSITY REQUIREMENTS

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

____

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

____

GENERAL EDUCATION

General Subject Areas

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

A-1: ______________ **A-2**: ______________

Area D: Social Science
(2 courses minimum)

______________ ______________

Area E: Culture and Thought
(2 courses minimum)

______________ ______________

Area F: The Arts
(1 course minimum)

____

Area G: Literature
(1 course minimum)

____

Special Subject Areas

Ethnicity (1 course):______________

European Traditions
or World Cultures (1 course):______________

Writing (4 courses required):

______________ ______________

______________ ______________

NON-MAJOR ELECTIVES

Free Electives taken:

____

____

____

____

____

TOTAL UNITS REQUIRED FOR GRADUATION......187

CHEMICAL ENGINEERING 2021-22

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

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
CH E 5	3	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	ENGR 3	3
MATH 3A	4	PHYS 1	4	MATH 4A or 4AI	4
WRIT 1E or 2E	4	WRIT 2E or 50E	4	PHYS 2	4
TOTAL	**16**		**17**		**16**

SOPHOMORE YEAR

FALL	units	WINTER	units	SPRING	units
CH E 10	3	CH E 107	3	CH E 110B	3
CHEM 109A or 109AH	4	CH E 110A	3	CH E 132A	4
MATH 4B or 4BI	4	CHEM 6AL	3	CHEM 6BL	3
PHYS 3	3	CHEM 109B or 109BH	4	MATH 6B	4
PHYS 3L	1	MATH 6A or 6AI	4	G.E.	4
TOTAL	**15**		**17**		**18**

JUNIOR YEAR

FALL	units	WINTER	units	SPRING	units
CH E 120A	4	CH E 120B	3	CH E 118	1
CH E 128	3	CH E 132C	3	CH E 120C	3
CH E 132B	3	CHEM 113B	4	CH E 140A	3
G.E.	4	MATRL 101 or MATRL 100C*^	3	CH E 180A	3
		Technical Elective	3	CHEM 113C	4
				Technical Elective	3
TOTAL	**14**		**16**		**17**

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
CH E 140B	3	CH E 180B	3	CH E 184B	3
CH E 152A	4	CH E 184A	3	G.E.	8
G.E.	4	G.E.	4	Technical Elective	3
Technical Elective	3	Technical Elective	3		
TOTAL	**14**		**13**		**14**

* If applying to the BS/MS Materials program, student must take:
Sophmore year- Phys 4 in Winter or Spring
Junior year- MATRL 100A in Fall, MATRL 100B in winter, MATRL 100C in Spring
^Students may only count one course toward the major. (MATRL 101 OR MATRL 100C)

COMPUTER ENGINEERING 2021-22

	Units
PREPARATION FOR THE MAJOR	**75**
CHEM 1A, 1AL or 2A, 2AC	5
CMPSC 16	4
CMPSC 24	4
CMPSC 32	4
CMPSC 40	5
ECE 1A- 1B	2
ECE 10A, 10AL, 10B, 10BL, 10C, 10CL	15
ECE 15A	4
MATH 3A-B, 4A-B	16
PHYS 1, 2, 3, 3L, 4, 4L	16
UPPER DIVISION MAJOR	**68**
CMPSC 130A	4
ECE 139 or PSTAT 120A	4
ECE 152A	5
ECE 154A	4
ENGR 101	3
CMPSC 189 A-B* / ECE 189+ A-B-C	8-12

* Prerequisite to CMPSC 189A is CMPSC 156
+ Prerequisite to ECE 189A is ECE 153B

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

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

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

CMPSC 130B	CMPSC 181/ ECE 181	ECE 194AA-194ZZ (except 194R)
CMPSC138	ECE 122A-B	
CMPSC 153A/ ECE153A	ECE 123	
CMPSC 156	ECE130A-B-C	
CMPSC 160	ECE 147A-B	
CMPSC 162	ECE 149	
CMPSC 165A-B	ECE 150	
CMPSC 170	ECE 153B	
CMPSC 171	ECE 154B	
CMPSC 174A	ECE 157A-B	
CMPSC 176A-B	ECE 160	
CMPSC 176C	ECE 178	
CMPSC 177	ECE 179D, 179P	
CMPSC 178	ECE 180	

Computer Engineering electives taken:_______________

____

____

____

MATH, SCIENCE, ENGR. ELECTIVE — 4

(See ECE Dept. student office for the approved list)
Elective taken: _______________________

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

UNIVERSITY REQUIREMENTS

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

____

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

____

GENERAL EDUCATION

General Subject Areas

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

A-1: ________________________ **A-2**: ________________

Area D: Social Science
(2 courses minimum)

______________________ ______________________

Area E: Culture and Thought
(2 courses minimum)

______________________ ______________________

Area F: The Arts
(1 course minimum)

____

Area G: Literature
(1 course minimum)

____

Special Subject Areas

Ethnicity (1 course):______________________________

European Traditions
or World Cultures (1 course):______________________

Writing (4 courses required):

______________________ ______________________

______________________ ______________________

NON-MAJOR ELECTIVES

Free Electives taken:

____

____

____

____

____

____

TOTAL UNITS REQUIRED FOR GRADUATION......191

COMPUTER ENGINEERING 2021-22

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

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
CHEM 1A or 2A	3	ECE 1A	1	ECE 1B	1
CHEM 1AL or 2AC	2	CMPSC 16	4	MATH 4A	4
MATH 3A	4	MATH 3B	4	PHYS 2	4
G.E. Elective or CMPSC 8[1]	4	PHYS 1	4	WRIT 50E or G.E. Elective	4
WRIT 1E or 2E	4	WRIT 2E or 50E	4	MATH, SCIENCE, ENGR. ELECTIVE	4
TOTAL	**17**		**17**		**17**

SOPHOMORE YEAR

FALL	units	WINTER	units	SPRING	units
CMPSC 24	4	CMPSC 40	5	CMPSC 32	4
ECE 10A	3	ECE 10B	3	ECE 10C	3
ECE 10AL	2	ECE10BL	2	ECE 10CL	2
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**		**18**		**18**

JUNIOR YEAR

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

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
ECE 189A*/ CMPSC+ 189A	4	ECE 189B/ CMPSC 189B	4	ECE 189C or CMPEN Elect.	4
CMPEN Electives	8	ENGR 101[3]	3	CMPEN Elective	4
G.E.	4	G.E.	4	G.E.	4
		CMPEN Elective	4		
TOTAL	**16**		**15**		**12**

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

COMPUTER SCIENCE 2021-22

PREPARATION FOR THE MAJOR	Units 57
CMPSC 16	4
CMPSC 24	4
CMPSC 32	4
CMPSC 40	5
CMPSC 64	4
MATH 3A-B, 4A-B, 6A	20
PSTAT 120A	4
PHYS 1, 2, 3, 3L	12

UPPER DIVISION MAJOR	71
CMPSC 111 or 140	4
CMPSC 130A-B	8
CMPSC 138	4
CMPSC 148 or 156 or 172	4
CMPSC 154	4
CMPSC 160 or 162	4
CMPSC 170	4
ENGR 101	3
PSTAT 120B	4
Major Field Electives	32

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

CMPSC 111[1]	CMPSC 177	ECE 152A
CMPSC 140[1]	CMPSC 178	ECE 153B
CMPSC 148[2]	CMPSC 180	ECE160
CMPSC/ECE 153A	CMPSC/ECE 181	ECE 178
CMPSC 156[2]	CMPSC 184	MATH 108A-B
CMPSC 160[3]	CMPSC 185	MATH 119A-B
CMPSC 162[3]	CMPSC 189 A-B	MATH 124A-B
CMPSC 165A-B	CMPSC 190 AA-ZZ	PSTAT 122
CMPSC 171/ECE 151	CMPSC 192[4]	PSTAT 130
CMPSC 172[2]	CMPSC 196[4]	PSTAT 160A-B
CMPSC 174A-B	CMPSC 196B[5]	
CMPSC 176A-B-C	ECE 130A-B-C	

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

Major Field Electives taken:

____

SCIENCE COURSES

Science Electives (see Dept. for list) 8

Science Electives taken:

____

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

UNIVERSITY REQUIREMENTS

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

____

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

____

GENERAL EDUCATION

General Subject Areas

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

A-1: _______________ **A-2**: _______________

Area D: Social Science
(2 courses minimum)

_______________ _______________

Area E: Culture and Thought
(2 courses minimum)

_______________ _______________

Area F: The Arts
(1 course minimum)

____

Area G: Literature
(1 course minimum)

____

Special Subject Areas

Ethnicity (1 course):_______________

European Traditions
or World Cultures (1 course):_______________

Writing (4 courses required):

_______________ _______________

_______________ _______________

NON-MAJOR ELECTIVES

Free Electives taken:

____

____

____

____

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TOTAL UNITS REQUIRED FOR GRADUATION......184

COMPUTER SCIENCE 2021-22

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

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
G.E. Elective or CMPSC 8[1]	4	CMPSC 16[1]	4	CMPSC 24	4
MATH 3A	4	MATH 3B	4	MATH 4A	4
WRIT 1, 2, or G.E. Elective	4/5	PHYS 1	4	PHYS 2	4
G.E. Elective	4	WRIT 1, 2, or G.E. Elective	4/5	Science or Free Elective	4
TOTAL	**16/17**		**16/17**		**16**

SOPHOMORE YEAR

FALL	units	WINTER	units	SPRING	units
CMPSC 32	4	CMPSC 64	4	CMPSC 138	4
CMPSC 40	5	MATH 4B	4	MATH 6A	4
PSTAT 120A	4	WRIT 50	4	G.E.	4
PHYS 3	3	CMPSC 130A	4	Science or Free Elective	4
PHYS 3L	1				
TOTAL	**17**		**16**		**16**

JUNIOR YEAR

FALL	units	WINTER	units	SPRING	units
CMPSC 148 or 156 or 172	4	G.E.	4	CMPSC 154	4
CMPSC 130B	4	Field Elective	4	PSTAT 120B	4
CMPSC 111[3]	4	Free Elective	4	Field or Free Elective	4
Science or Free Elective	4	G.E.	4	G.E.	4
TOTAL	**16**		**16**		**16**

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
Field or Free Elective	4	CMPSC 170	4	Field or Free Elective	4
CMPSC 160[2]	4	Field Elective	4	Field or Free Elective	4
Field or Free Elective	4	ENGR 101[4]	3	G.E. or Free Elective	4
		Field or Free Elective	4		
TOTAL	**12**		**15**		**12**

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

ELECTRICAL ENGINEERING 2021-22

	Units
PREPARATION FOR THE MAJOR	**80**
CHEM 1A, 1AL or 2A, 2AC	5
CMPSC 16	4
ECE 5	4
ECE 10A, 10AL, 10B, 10BL, 10C, 10CL	15
ECE 15A	4
ECE 3	4
MATH 2A-B or 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
ECE 188 A-B-C	9
Departmental electives selected from the following list:	23

Approval of the student's departmental electives must be obtained from the student's faculty adviser.
Must include at least 1 sequence, see ECE Department student office for list of approved sequences. Minimum six courses.

Approved Departmental Electives:

ECE 120A-B	ECE 148	ECE 181
ECE 122A-B	ECE 149	ECE 183
ECE 123	ECE 150	ECE 192 or 196 (4 units combined max)
ECE 125	ECE 153A-B	ECE 194 AA-ZZ (excluding ECE 194R)
ECE 130C	ECE 154A-B	MATRL 100A, C
ECE 135	ECE 157A-B	MATRL 100B or MATRL 101
ECE 141A-B	ECE 158	MATRL 162A-B
ECE 142	ECE 160	TMP 120, 122 (1 course max)
ECE 144	ECE 162A-B-C	
ECE 145A-B-C	ECE 178	
ECE 146A-B	ECE 179D, P	
ECE 147A-B-C	ECE 180	

Departmental Electives taken:

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

UNIVERSITY REQUIREMENTS

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

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

GENERAL EDUCATION

General Subject Areas

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

A-1: ____ **A-2**: ____

Area D: Social Science
(2 courses minimum)

Area E: Culture and Thought
(2 courses minimum)

Area F: The Arts
(1 course minimum)

Area G: Literature
(1 course minimum)

Special Subject Areas

Ethnicity (1 course): ____

European Traditions
or World Cultures (1 course): ____

Writing (4 courses required):

NON-MAJOR ELECTIVES

Free Electives taken:

TOTAL UNITS REQUIRED FOR GRADUATION......189

ELECTRICAL ENGINEERING 2021-22

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

FRESHMAN YEAR

FALL	units	WINTER	units	SPRING	units
CHEM 1A or 2A	3	MATH 3B	4	MATH 4A	4
CHEM 1AL or 2AC	2	PHYS 1	4	PHYS 2	4
ECE 3	4	ECE 5	4	WRIT 50E or G.E.	4
MATH 3A	4	WRIT 2E or 50E	4		
WRIT 1E or 2E	4				
TOTAL	**17**		**16**		**12**

SOPHOMORE YEAR

FALL	units	WINTER	units	SPRING	units
ECE 10A	3	ECE 10B	3	ECE 10C	3
ECE 10AL	2	ECE 10BL	2	ECE 10CL	2
MATH 4B	4	ECE 15A	4	MATH 6B	4
PHYS 3	3	MATH 6A	4	PHYS 5	3
PHYS 3L	1	PHYS 4	3	PHYS 5L	1
CMPSC 16	4	PHYS 4L	1		
TOTAL	**17**		**17**		**13**

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.	4	G.E.	4	G.E.	4
TOTAL	**16**		**16**		**17**

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
ECE 188A	3	ECE 188B	3	ECE 188C	3
ECE Electives	8	ECE Electives	8	ECE Electives	8
G.E.	4	G.E.	4	Free Elective[4]	4
		ENGR 101[3]	3		
TOTAL	**15**		**18**		**15**

[1] ECE 139 may also be taken in the spring quarter of the sophomore year.
[2] ECE 152A may also be taken in the spring quarter of the sophomore year.
[3] ENGR 101 may be taken any quarter of senior year.
[4] This course may not be required. Students must complete at least 189 units to graduate.

MECHANICAL ENGINEERING 2021-22

PREPARATION FOR THE MAJOR — Units 77

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 12S 1
ME 14 4
ME 15 4
ME 16 4
ME 17 3
PHYS 1, 2, 3, 3L, 4, 4L 16

UPPER DIVISION MAJOR — 69

Third Year

MATRL 101 or MATRL 100C 3
ME 103 4
ME 104 4
ME 107 3
ME 108 3
ME 151A-B 8
ME 152A 4
ME 153 3
1 Specialization Group* 6

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
L1	ENGR 120A	ME 163	ME 127	ME 141A	ME 166	ME 152B
L2	ENGR 120B	ME 155A	ME 129	ME 141B	ME 154	ME 151C

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

Fourth Year

ME 154 or 157 or 167 3
ME 105 4
ME 156A-B 6
ME 189A-B-C 9
Engineering Electives 9

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 158
CHEM 123	ME 112	ME 162
ECE 147A,C	ME 124	ME 166
CMPSC/ECE 181B	ME 125 AA-ZZ	ME 167
ENGR 101	ME 128	ME W167[1]
ENGR 120 A-B	ME 134	ME 169
ENGR 195A-B-C	ME140A-B	ME 179D-L-P
ENV S 105	ME141A-B	ME 185
MATRL 100A	ME 146	ME 186A-B
MATRL 100B	ME 147	ME 197[2]
MATRL 186A-B	ME 154	ME 199[2]
MATRL 188	ME 155B-C	TMP 120, 122
ME 102	ME 157	(max 1 course)

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

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

UNIVERSITY REQUIREMENTS

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

Satisfied by: ______________________

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

____

GENERAL EDUCATION

General Subject Areas

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

A-1: ______________ **A-2**: ______________

Area D: Social Science
(2 courses minimum)

______________ ______________

Area E: Culture and Thought
(2 courses minimum)

______________ ______________

Area F: The Arts
(1 course minimum)

____

Area G: Literature
(1 course minimum)

____

Special Subject Areas

Ethnicity (1 course): ______________

European Traditions
or World Cultures (1 course): ______________

Writing (4 courses required):

______________ ______________

______________ ______________

NON-MAJOR ELECTIVES

Free Electives taken:

____
____
____
____
____

TOTAL UNITS REQUIRED FOR GRADUATION.....180

MECHANICAL ENGINEERING 2021-22

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

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
MATH 3A	4	MATH 3B	4	ENGR 3	3
ME 12S[1]	1	PHYS 1	4	PHYS 2	4
WRIT 1E or 2E	4	WRIT 2E or 50E	4	WRIT 50E or G.E.	4
TOTAL	**14**		**17**		**19**

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
ME 17	3	ME 15	4	G.E.	8
PHYS 3	3	PHYS 4	3		
PHYS 3L	1	PHYS 4L	1		
TOTAL	**15**		**16**		**16**

JUNIOR YEAR

FALL	units	WINTER	units	SPRING	units
ME 103	4	MATRL 101^ or	3	ME 104	4
ME 107	3	MATRL 100B[2]		ME 153	3
ME 151A	4	ME 108	3	Specialization Course	3
ME 152A	4	ME 151B	4	G.E.	4
MATRL 100A[2]	3	Specialization Course	3	MATRL 100C^[2]	3
TOTAL	**15/18**		**13**		**14/17**

SENIOR YEAR

FALL	units	WINTER	units	SPRING	units
ME 154, ME 157, or ME 167[3]	3	ME 156B	3	ME 189C	3
ME 105	4	ME 189B	3	Departmental Elective	3
ME 156A	3	Departmental Elective	3	G.E. or Free Electives	8
ME 189A	3	G.E. or Free Electives	4		
Departmental Elective	3				
TOTAL	**16**		**13**		**14**

1 ME 12S is offered every Fall, Winter, and Spring quarter. The ME 12S requirement must be finished before the start of the third year.

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

3 Course availability may vary. If using ME 154, ME 157, or ME 167 to satisfy requirement, students may not count the course as an Engineering Elective. If either of the other courses are also taken, those additional courses will count as an engineering elective.

^ Students may only count one course toward the major. (MATRL 101 or MATRL 100C)

Additional Resources and Information

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

Advising Staff

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

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

	Phone	**Email**	**Location**
College Advising staff	(805) 893-2809	coe-info@engr.ucsb.edu	Harold Frank Hall, Rm. 1006
Departmental Advisors:			
Chemical Engineering	893-8671	cheugrads@engr.ucsb.edu	Engr.II, Rm. 3357
Computer Engineering	893-8292	ugrad-advisor@ece.ucsb.edu	Trailer 380, Rm. 101
Computer Science	893-4321	ugradhelp@cs.ucsb.edu	Harold Frank Hall, Rm. 2104
Electrical Engineering	893-8292	ugrad-advisor@ece.ucsb.edu	Trailer 380, Rm. 101
Mechanical Engineering	893-8198	meugrad@engr.ucsb.edu	Engr.II, Rm. 2355
Technology Management	893-2729	advising@tmp.ucsb.edu	Phelps 2219

Academic Integrity

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

Student Conduct Code and Student Due Process: http://www.sa.ucsb.edu/regulations/student-conduct-code/student-conduct-code (B. Student Rights: Procedural Due Process).

Instructor Responsibilities and Procedures: https://senate.ucsb.edu/bylaws-and-regulations/ (Section 10, Reg. 90)

Academic dishonesty includes cheating, plagiarism, unauthorized collaboration, furnishing false information, and misuse of course materials. Definitions and misconduct are posted at http://studentconduct.sa.ucsb.edu/academic-integrity.

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

Notes

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