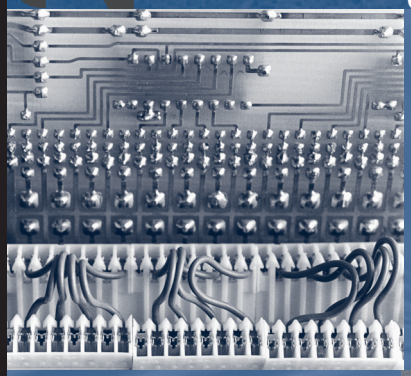
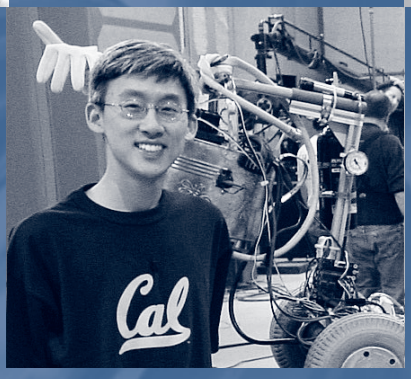
2008-2009 announcement

College of Engineering

A Guide to Undergraduate and Graduate Study

University of California, Berkeley





Fall Semester 2008

Tele-BEARS Begins	April 14	Monday
Fee Payment Due	August 15	Friday
Welcome Week	August 25-26	Monday-Friday
Fall Semester Begins	August 21	Thursday
Instruction Begins	August 27	Wednesday
Labor Day Holiday	September 1	Monday
Veterans Day Holiday	November 11	Tuesday
Thanksgiving Holiday	November 27-28	Thursday-Friday
Instruction Ends	December 10	Wednesday
Final Examinations	December 13-20	Saturday-Saturday
Fall Semester Ends	December 20	Saturday
Winter Holiday	December 25-26	Thursday-Friday
New Year's Holiday	December 31-January 1, 2009	Wednesday-Thursday

Spring Semester 2009

Tele-BEARS Begins	October 20, 2008	Monday
Spring Semester Begins	January 13	Tuesday
Fee Payment Due	January 15	Thursday
Martin Luther King Jr. Holiday	January 19	Monday
Instruction Begins	January 20	Tuesday
Presidents' Day Holiday	February 16	Monday
Spring Recess	March 23-27	Monday-Friday
César Chávez Holiday	March 27	Friday
Cal Day	April 18	Saturday
Instruction Ends	May 11	Monday
Final Examinations	May 14-21	Thursday-Thursday
Spring Semester Ends	May 21	Thursday

Summer Sessions 2009

Memorial Day Holiday	May 25	Monday
First Six-Week Session	May 26-July 2	Tuesday-Thursday
Ten-Week Session	June 8-August 14	Monday-Friday
Eight-Week Session	June 22-August 14	Monday-Friday
Independence Day Holiday	July 3	Friday
Second Six-Week Session	July 6-August 14	Monday-Friday
Three-Week Session	July 27-August 14	Monday-Friday

Contents

Announcement of the College of Engineering, University of California, Berkeley, 2008-09.
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ENGINEERING

From the Dean

This is truly an amazing time to be an engineer. Science and technology have an impact on nearly every facet of our daily lives — how we communicate, travel, obtain information, protect and preserve our environment, improve our health, build and protect our cities, and solve many of today's most pressing problems. UC Berkeley's College of Engineering prepares students to meet these challenges as leaders, with creativity and innovation.

The engineering programs described within these pages offer a solid foundation in mathematics and science to prepare students for specialization in one of our engineering departments or interdisciplinary programs. In addition, the engineering curricula call for study in the humanities and social sciences, to give students the well-rounded background needed to contribute to our increasingly complex and multifaceted society.

Our engineering student organizations, a vital part of the College, also offer many opportunities to develop the communication and leadership skills that are essential in all aspects of a well-rounded professional career.

This announcement — read in conjunction with the *General Catalog* and the College of Engineering web site — explains procedures and outlines courses of study in the College. I urge you to seek out all that the College and University have to offer — courses, special seminars and lectures, alumni events, and the breadth of cultural activities hosted by the Berkeley campus. This will enrich your years at Berkeley and your preparation for a rewarding career in engineering.

S. Shankar Sastry
Dean, College of Engineering

◀ ***McLaughlin Hall, the main administration building for the College of Engineering***

About the College of Engineering

UC Berkeley Engineering is a community that is dedicated to creating tomorrow's leaders and supporting today's pioneers. Students and researchers from around the world are drawn to Berkeley by its outstanding reputation, its internationally recognized faculty, and its strong tradition of impact in research and teaching.

Earlier Berkeley engineers brought water to California's great agricultural lands, pioneered the microelectronics that seeded Silicon Valley, and helped build the unbuildable in structures like Hoover Dam and the Golden Gate Bridge. Today, Berkeley engineers in every field remain at the center of technological innovation worldwide.

Choosing Engineering

Engineers are problem solvers. Drawing on a solid foundation in math and the sciences, engineers develop efficient ways to improve our quality of life. And when technological progress creates adverse side effects, engineers work to remedy them.

Is Engineering for You?
If you see yourself as a designer or builder — whether of structures, machines, electrical circuits, or systems of operation — then engineering may be right for you.

If you would like to work as a manager or administrator of a technical enterprise, an engineering degree could be the best background to meet your goals.

If you imagine yourself as a researcher in a technical field, then an education in engineering or one of the physical sciences may be your right choice. Most engineering research is directed toward a specific objective, applying science to meet a human need. It is most often a team effort, involving people with engineering, science, business, and other backgrounds.

An Engineering Education. As rapidly as technology evolves, engineering evolves a step ahead, incorporating new knowledge and emerging technologies. Engineering today is broadly interdisciplinary; solving today's challenges requires engineers from many disciplines working together with experts in such fields as business, biology, medicine, public policy, and economics.

◀ ***Historic Hearst Memorial Mining Building, ornamented with suspended foam balls installed by artist J. Ignacio Díaz de Rábago and a team of interdisciplinary Berkeley students.***

Engineering: The Berkeley Equation

UC Berkeley engineering students are not only taught by leading engineers, they benefit from top faculty in every field and the resources of one of the world's great intellectual centers. In the latest survey by the National Research Council, 35 of 36 programs at Berkeley ranked in the top 10, more than any other university, public or private.

Berkeley is not your typical place, and there are no typical Berkeley students. They are musicians, politicians, athletes, scientists, writers — bound together simply by their passion for learning. Students hail from every region in California, each state in the union and over 100 countries, and represent all backgrounds.

On any given day at Berkeley, one could find themselves in a classroom being taught by a Nobel Laureate, at a free concert by a local independent rock band, an information session for the Concrete Canoe Team, a football game with over 75,000 California Golden Bears (Cal) fans, or shopping on world famous Telegraph Avenue.

When in Berkeley...

Sheltered by rolling hills and the San Francisco Bay, Berkeley is a vibrant and spirited city of surpassing richness. The University, the City of Berkeley, and the San Francisco Bay Area combine to form an extraordinary environment for all types of educational, artistic, and recreational pursuits.

Coffeehouses, bookstores, and vendors line the streets near campus, and lecturers, artists and performers from around the world make sure to visit UC Berkeley.

If you want to head into San Francisco, a city full of cultural and recreational opportunities, Bay Area Rapid Transit (BART) is just a few blocks away in downtown Berkeley. Scenic Napa Valley, just one hour's drive north of Berkeley, produces some of the best wines in the country. Regardless of what you choose to do, you won't find a more temperate climate or a more beautiful setting.

Student Information

College of Engineering Student Information Online Resources

For more information on programs and resources narrated in this section, please see the following web sites:

Academic Advising and Support Undergraduate Student Affairs Office:
www.coe.berkeley.edu/advising

Student Involvement:
www.coe.berkeley.edu/student-involvement

Kresge Engineering Library:
www.lib.berkeley.edu/ENGI

Undergraduate Research Opportunities Program (URO):
www.coe.berkeley.edu/uro

Freshman and Sophomore Seminars:
fss.berkeley.edu

Continuing Education:
www.unex.berkeley.edu

Center for Underrepresented Engineering Students (MEP, GrAD, JMEP, PEP, SUPERB,):
www.coe.berkeley.edu/cues

Alumni Relations:
www.coe.berkeley.edu/alumni

Supporting the College:
www.coe.berkeley.edu/support-the-college

Other Student Information Web Sites

Campus Life and Leadership:
cll.berkeley.edu

Career Center:
career.berkeley.edu

Financial Aid:
financialaid.berkeley.edu

Housing and Dining Services:
housing.berkeley.edu

University Health Services:
uhs.berkeley.edu

Student Activities and Services

Engineering Undergraduate Student Affairs Office

The Undergraduate Student Affairs Office provides advising and administrative services in all matters pertaining to undergraduate engineering students. The staff is available to assist students, faculty, and the public with information on university, college, and departmental rules and regulations, degree requirements, transfer admission requirements and other student matters.

Advising and Academic Support

Each undergraduate within in the College of Engineering is assigned both a student affairs and faculty adviser at the time of admission. Insofar as possible, students will continue with these advisers throughout their undergraduate careers. Student affairs advisers guide students in regards to academic requirements and assist with academic questions or concerns. Faculty advisers serve as academic and professional mentors and aid in long term course planning, locating research opportunities and information regarding their respective fields.

Academic departments also have advisers to help students learn more about the programs, facilities and research, as well as to point students toward appropriate faculty contacts.

A wide selection of tutoring and additional support services are available at the university, college and departmental levels, including alumni mentorships, peer advising and a buddy program that pairs a new student with a current undergraduate.

Graduate students should consult their department for information on support and advising services.

Student Involvement

An engineering education at Berkeley does not begin and end in the classroom. Active participation in student organizations enhances and broadens a student's experience and provides the unique opportunity to integrate material learned in the classroom with a chance to develop character and leadership skills. Through professional societies, campus groups, award-winning competitive engineering teams and publications, students are encouraged to explore engineering and its implication with their peers, faculty and practicing engineers.

Engineering Libraries

The 22,000 square-foot Kresge Engineering Library provides 250 stations for reading or studying, access to the campus wireless network, and an array of electronic information resources. The library's collection includes approximately 250,750 volumes, over 2,400 engineering journals in electronic and/or print format, over 2,100 electronic books in engineering, and over 730,000 technical reports.

In addition to the Kresge Engineering Library, the College is served by three specialized libraries: the Water Resources Center Archives, Earthquake Engineering Research Center Library, and Harmer E. Davis Transportation Library.

Student Center

The Stephen D. Bechtel Engineering Center is the intellectual and social hub of the College. The center houses the Kresge Engineering Library and the Meakin Interdisciplinary Studies Center. The Sibley Auditorium of the Bechtel Center accommodates large audiences to hear visiting speakers, and conference rooms provide a place where students can meet with professional engineers and alumni. In addition, the center houses the offices of student organizations and adjoining lounges for informal student activities.

Academic Enrichment Opportunities

Undergraduate Research Opportunities (URO) Program

The College of Engineering's Undergraduate Research Opportunities (URO) program provides an occasion for undergraduate students in the College of Engineering, or any Berkeley student taking appreciable course work, to participate in research with engineering faculty members. The program is intended to enhance the undergraduate experience and provide practical training for future employment and educational opportunities.

Freshman and Sophomore Seminars

The College of Engineering provides a number of introductory courses of interest to freshmen and sophomores. These courses are generally not in the required programs but are for enrichment, orientation to the College and major, and guidance in the profession. They provide an unparalleled opportunity for faculty members and small groups of lower division students to explore a scholarly topic of mutual interest together.

Continuing Education

The Continuing Education in Business and Technology Department of University Extension provides a broad range of technical courses for engineers, engineering managers, environmental management personnel, and engineering-oriented personnel in related fields who are interested in updating their knowledge in their own field or in exploring other areas of engineering. The most recent advances and newest technologies are covered in intensive short courses, evening classes, online courses, lecture series, and an annual Summer Engineering Institute offered in cooperation with the College of Engineering.

Center for Underrepresented Engineering Students

Charles Tunstall Multicultural Engineering Program (MEP)

The objective of the Charles Tunstall Multicultural Engineering Program is to increase the number of underrepresented students who enroll and graduate with bachelor's degrees in engineering from Berkeley. To achieve this objective, the program provides outreach and recruitment activities; an academic enrichment summer program; counseling and advising; academic support (i.e., workshops, individual and group tutoring); and information on financial assistance, research opportunities, and graduate school.

Graduate Academic Diversity (GrAD) Program

The Graduate Academic Diversity Program (GrAD) provides support services for prospective and current students in the College of Engineering. It advises applicants on opportunities in the College, the graduate admissions process, financial aid, and academic support services of the College and the Berkeley campus, and it provides a forum for ideas and programs designed to enhance the educational experience of underrepresented engineering students.

Julia Morgan Engineering Program (JMEP)

The mission of the Julia Morgan Engineering Program is to stimulate female students to achieve their full potential in careers as engineers and leaders. JMEP provides educational materials and academic support, such as preadmissions advising, tutoring, graduate school advising, and financial aid resources. The program also provides seminars on reducing test anxiety and applying to graduate school.

Pre-Engineering Partnerships (PEP)

The mission of Pre-Engineering Partnerships (PEP) is to remove the barriers that prevent diverse students from enrolling and succeeding in engineering at Berkeley. PEP emphasizes participation by students who are underrepresented in engineering, particularly those with educational or economic limitations or whose parents have not completed a baccalaureate degree. All PEP resources are focused on informing middle- and high-school students about engineering careers and supporting the academic performance of PEP students in math and science to qualify for enrollment in engineering majors.

Summer Undergraduate Program in Engineering Research at Berkeley (SUPERB)

The objective of SUPERB is to offer outstanding underrepresented students and students who have been educationally or economically disadvantaged the opportunity to gain research experience by participating in eight-week summer research projects with engineering faculty and graduate students.

Alumni and Support for the College of Engineering

Berkeley Engineering Alumni Relations

Every student graduating from the College of Engineering or in chemical engineering belongs to the Berkeley Engineering Alumni Relations, or BEAR, family. The College's alumni relations department hosts a number of social and professional development events for students throughout the year to help them connect with each other, meet alumni and prepare for their careers. Events include:

- Real World Engineering, a student career conference showcasing alumni speakers offering career advice
- Success Seminars, on subjects like resume critiquing and preparing for job interviews
- Speed career networking with alumni
- New student orientation
- New graduate student beer and pizza parties
- Graduate student champagne receptions
- Online career fairs

Support for the College

Through gifts to the Berkeley Engineering Annual Fund, alumni, parents, friends, faculty, and students help ensure the College's continued excellence as one of the premier engineering educational and research institutions in the world. The Annual Fund supports a number of initiatives intended to enhance a student's experience while at Berkeley Engineering, such as:

- Undergraduate research opportunities
- Competitive start-up packages to attract talented new professors
- Expansion of the College's Kresge Engineering Library collection
- Innovative student-run projects like the human-powered vehicle
- BEAR social and professional development events
- Student and alumni publications like *Engineering News* and *Forefront* magazine

Admission and Degree Requirements

Undergraduate Admission and Degree Requirements Online Resources:

For more information on the topics in this section, please see the following web sites:

UC Berkeley General Catalog:
catalog.berkeley.edu

Office of Undergraduate Admissions:
admissions.berkeley.edu

College of Engineering Prospective Students:
www.coe.berkeley.edu/prospective-students

Transfer Admission Program Requirements/Course Articulation:
www.assist.org

Undergraduate Student Affairs Office:
www.coe.berkeley.edu/advising

Undergraduate Programs

Students in the College of Engineering at Berkeley may elect one of the curricula listed below. Each is four years in length and leads to the Bachelor of Science degree.*

Bioengineering[3]
Civil Engineering[1]
Electrical Engineering and Computer Sciences
Electrical and Computer Engineering[1]
Computer Science and Engineering[2]
Engineering Science[3]
Computational Engineering Science
Engineering Mathematics and Statistics
Engineering Physics
Environmental Engineering Science

*In addition to the majors listed, freshman applicants may apply to the Engineering — Undeclared admission option. This option is designed for students with a strong background and interest in mathematics and physics who have not yet identified a specialization within engineering. After completing the Engineering — Undeclared curriculum, the student must transfer into a degree program for the final two years. For more information, see the Engineering — Undeclared section of this announcement.

[1]These B.S. programs are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

[2]This B.S. program is accredited by the Computing Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

[3]These programs are not accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

Industrial Engineering and Operations Research[1]
Manufacturing Engineering[3]
Materials Science and Engineering[3]
Mechanical Engineering[1]
Nuclear Engineering[1]

Joint Majors[3]
Bioengineering/Materials Science and Engineering
Electrical Engineering and Computer Sciences/Materials Science and Engineering
Electrical Engineering and Computer Sciences/Nuclear Engineering
Materials Science and Engineering/Mechanical Engineering
Materials Science and Engineering/Nuclear Engineering
Mechanical Engineering/Nuclear Engineering

—

Chemical Engineering/Materials Science and Engineering
Chemical Engineering/Nuclear Engineering

(Chemical Engineering and the Chemical Engineering joint major programs are offered through the College of Chemistry and are described in detail in the *Announcement of the College of Chemistry.*)

Undergraduate Minors

Bioengineering
Computer Science
Electrical Engineering and Computer Science
Environmental Engineering (Civil and Environmental Engineering)
Industrial Engineering and Operations Research
Materials Science and Engineering
Mechanical Engineering
Nuclear Engineering
Structural Engineering (Civil and Environmental Engineering)

Admission

Admission to Undergraduate Programs

The College of Engineering admits students at the freshman and junior-transfer levels.

All applications are administered by the University's Office of Undergraduate Admission. See the *General Catalog* or visit the admissions office web site for details on requirements and the application process.

Additional information for prospective College of Engineering applicants may be found on the College's Prospective Students web page.

Junior-transfer applicants from a California community college should also consult assist.org for information on which courses can be used to satisfy requirements for the College of Engineering.

Admission to Joint Major Programs

Admission to an engineering joint major is open to transfer applicants only. Students who enter as freshmen may petition for change to a joint major in the final semester of their sophomore year. Transfer applicants interested in the joint majors with chemical engineering must apply to the College of Chemistry.

Admission to Minor Programs

Admission to minors programs are administered by the respective department. See the Academic Departments and Programs section of this announcement or the department web site for more information.

Admission from another college at UC Berkeley

Students who have completed at least one semester and are in progress to complete a second semester may petition to transfer to the College of Engineering from another college on campus. Admission is competitive and petitions are reviewed only once each academic year at the beginning of the spring term. All interested students are encouraged to attend change of college workshops during the fall semester before they apply. See the College's Prospective Students web page for more information.

Admission as a Second Bachelor's Degree candidate

Although this is ordinarily discouraged, some applicants who already hold a bachelor's degree in a nontechnical or non-engineering field may be considered for admission. Applicants interested in a second degree should contact the Undergraduate Student Affairs Office for further information.

Readmission

Students who withdrew after the first eight weeks of classes and before the end of the semester are not eligible for readmission until one year from the beginning of the semester in which the withdrawal was granted.

Continuing students who complete a semester of study and are eligible to attend the following semester but fail to do so and remain out of school are required to apply for readmission to the University for any future semester that they wish to attend. Students who are granted withdrawal are also required to apply for readmission in order to resume study in a future semester.

Readmission is not guaranteed and is based upon the students' academic record at the time of withdrawal and upon any course work taken during their absence from UC Berkeley. Students whose records are not satisfactory should not expect to be readmitted. Courses taken for the purpose of readmission must be approved by the associate dean before the student takes the course. An academic plan indicating courses expected to be taken and places of attendance must be submitted to the associate dean.

Students returning to the University after an absence *must meet the requirements of their degree program in effect at the time they are readmitted.* If students have attended other institutions during their absence from the University, they must present an official transcript of record from each college before readmission will be considered.

Students who are applying for readmission after dismissal should discuss readmission with their student affairs adviser at the time of their dismissal.

General Degree Requirements

Engineering students must fulfill University of California, Berkeley campus and the College of Engineering requirements to graduate.

University Requirements

Students must complete the general University requirements of Entry-Level Writing (formerly Subject A) and American History and Institutions discussed in the *General Catalog.*

Berkeley Campus Requirements

The Berkeley campus American Cultures Breadth requirement is satisfied by passing an approved course that is integrative and comparative and addresses theoretical and analytical issues relevant to understanding race, culture and ethnicity in American history and society. See the *General Catalog* for more information.

College of Engineering Requirements

Students in the College of Engineering must complete 120 semester units with the following provisions:

1. Completion of the requirements of one program of study

2. A minimum overall grade point average of 2.000 (C average) and a minimum of 2.000 grade point average in upper division technical course work.

3. The final 30 units are completed in residence in the College of Engineering on the Berkeley campus in two consecutive semesters.

Humanities and Social Studies. To promote a well-rounded education with foundations in the liberal arts, the College has established a humanities and social studies requirement. The skills learned in the humanities and social studies supply students with additional tools to help them succeed in their intended engineering fields.

Students are expected to complete six approved courses in the humanities or social studies, two of which must be courses in *reading and composition.* Please visit coe.berkeley.edu/hssreq.pdf for more information on the requirement and a list of approved courses.

Academic Rules and Regulations

Absence from the University. Students returning after an absence from the University must meet the current curriculum requirements at the time of readmission. See the Admission section for more information.

Scholarship Requirements. 1. Students are subject to dismissal if they (a) do not have a minimum C average for all work undertaken at the University; (b) do not obtain a minimum C average in each semester.

2. Students must have a minimum C average in all upper division technical courses required and elected in the curriculum in order to obtain the bachelor's degree.

Passed/Not Passed Grades. Students in good standing may undertake certain elective courses on a *passed/not passed* basis. These courses are not included in determining grade point average. No more than 40 units and no technical courses (mathematics, science, or engineering) nor courses required for the major program may be taken on a passed/not passed basis.

Upper Division. Students are expected to complete the lower division program before enrolling in upper division engineering courses. Exceptions may be made if the lower division deficiency is not a prerequisite to the intended upper division course and if the lower division program is being completed expeditiously.

Normal Progress. Students in the College of Engineering must — except for reasons of health or outside employment — enroll in a full-time program and make normal progress toward the bachelor's degree. Normal progress requires 30 units of completed course work each year. The continued enrollment of students who fail to achieve minimum academic progress shall be subject to the approval of the dean. To achieve minimum academic progress, two criteria must be met:

1. Students must have successfully completed a number of units no fewer than 15 times the number of semesters less one, in which they have been enrolled on the Berkeley campus. Summer Sessions will not be counted as a semester.

2. Students' study lists must contain at least 12 units of credit in any term. Students' programs must receive the approval of the faculty adviser and must include at least two technical courses related to the chosen curriculum. *Students are responsible for planning and satisfactorily completing graduation requirements* and should follow, as closely as possible, the curricular recommendations given on the succeeding pages. Program deviations should be discussed with the faculty adviser.

In all cases, students desiring to take more than 20.5 units or fewer than 12 units per semester must have prior approval of the dean.

The minimum unit requirement for the bachelor's degree is 120 semester units, within which the student is expected to satisfy graduation requirements. For valid reasons, this minimum may be exceeded by 10 units. The associate dean's approval is required for students who, having entered as freshmen, have accrued more than 125 units and have been in attendance for four or more years and still have not satisfied graduation requirements. Junior transfers who have accrued more than 125 units and have been in attendance for two or more years without satisfying degree requirements also require the associate dean's approval to continue.*

Entering freshmen are normally allowed eight semesters to graduate, and entering junior transfers are normally allowed four semesters to graduate. Students who need an extra semester to graduate must petition to do so. Two extra semesters are almost never approved. If the associate dean grants an extra semester, the student will be required to enroll in at least 12 units *and two technical courses* in that extra semester.

Honors. 1. *Honors to Date.* Students must have completed a minimum of 12 units undertaken for letter grades on the Berkeley campus to be considered for the award of semester honors. To qualify for this award, students must achieve a grade point average equal to or greater than the grade point average as determined for the College by the method outlined below. The actual date on which honors are awarded shall be entered on the student's transcript.

2. *Honors in General Scholarship at Graduation.* To be eligible for honors in general scholarship at graduation, students must have: (a) completed at the University of California a minimum of 50 semester units, of which at least 43 units must be undertaken for a letter grade; for those students who complete more than 50 units at the University of California, the limit of passed/not passed units is one-third of the total units undertaken and passed on the Berkeley campus at the time the degree is awarded; units completed in an Education Abroad Program, or on another University of California campus by an undergraduate in an Intercampus Visitor Program, are considered Berkeley work for the purpose of this regulation (204-A); (b) completed a minimum of 30 units on the Berkeley campus; and (c) achieved a grade point average ranking in the College as follows:

- Top 3 percent, highest honors
- Next 7 percent, high honors
- Next 10 percent, honors

At the end of each academic year, the Office of the Registrar determines for the College the minimum grade point averages of the top three percent, the next seven percent, and the next 10 percent of the students graduating in that year. These grade point averages serve the College as minimal criteria for honors during the next academic year. Students should consult the Undergraduate Student Affairs Office to learn the minimum grade point averages in effect for the current academic year.

*At present, the 125-unit maximum does not apply to students in the Chemical Engineering/Materials Science and Engineering or Chemical Engineering/Nuclear Engineering joint major programs.

Graduate Admission and Degree Requirements Online Resources

For more information on the topics in this section, please see the following web sites:

UC Berkeley General Catalog:
catalog.berkeley.edu

Graduate Division (Admission, Financial Aid, Academic Policies):
www.grad.berkeley.edu

Graduate Programs

The principal objectives of graduate study in engineering are:

1. To provide students with the scientific and professional knowledge necessary for their fields of interest.

2. To develop students' abilities to formulate solutions to new and complex problems in their fields in the context of current economic, sociological, and environmental considerations.

These objectives are accomplished by providing flexible programs of study designed to meet individual student needs.

Programs

The College offers programs of study in seven departments:

- Bioengineering
- Civil and Environmental Engineering
- Electrical Engineering and Computer Sciences
- Industrial Engineering and Operations Research
- Materials Science and Engineering
- Mechanical Engineering
- Nuclear Engineering

In addition to the departmental majors, the College offers two interdisciplinary programs leading to the following degrees:

- Ph.D. degree in applied science and technology.

- Ph.D. degree in bioengineering, a joint degree program with the University of California, San Francisco.

Concurrent degree programs that provide a broad integrated curriculum between two disciplines are:

- Architecture, M.Arch. — Civil and Environmental Engineering (Structural), M.S.

- City and Regional Planning, M.C.P. — Civil and Environmental Engineering (Transportation), M.S.

- Public Policy, M.P.P. — various Engineering, M.S.

Interdisciplinary Programs

The College also offers a number of interdisciplinary programs in which graduate study is related to the work of faculty in more than one engineering department and may include faculty and students from other areas of the University. These programs relate the application of technical, social, and economic knowledge to the analysis and solution of engineering problems. The following graduate interdisciplinary programs are available. Interested applicants should contact the department/unit indicated with the program: applied science and technology (Engineering Interdisciplinary Studies); environmental (Civil and Environmental Engineering); engineering and business administration (Mechanical Engineering or Business Administration); nanoscale science and engineering (Nanoscale Science and Engineering Graduate Group, Applied Science and Technology, Materials Science and Engineering, et al.); plasmas (Electrical Engineering and Computer Sciences); robotics and manufacturing (Electrical Engineering and Computer Sciences or Mechanical Engineering); rock mechanics (Civil and Environmental Engineering or Mechanical Engineering); surface and subsurface hydrology (Civil and Environmental Engineering, Materials Science and Engineering, or Mechanical Engineering).

College Certificate Programs

- **Intelligent Transportation Systems** — being established jointly by the Departments of Civil and Environmental Engineering, Mechanical Engineering, and Electrical Engineering and Computer Sciences. This certificate is not issued by the University of California, Berkeley.

- **Logistics** — offered jointly by the Departments of Industrial Engineering and Operations Research and Civil and Environmental Engineering (see pages 25 and 36). This certificate is not issued by the University of California, Berkeley.

- **Energy and Business for Sustainability** — offered in conjunction with the Haas School of Business, Energy and Resources Group, Goldman School of Public Policy, College of Natural Resources, and School of Public Health. It is the first certificate program approved at the highest campus level.

- **Management of Technology (MOT)** — jointly sponsored by the College, the Haas School of Business, and the School of Information. This certificate is not issued by the University of California, Berkeley.

The Management of Technology (MOT) Certificate Program was established in 1987 as a research and teaching program that seeks to bring together faculty and students to address critical technology management issues. The certificate program is open to all graduate students enrolled in the Haas School of Business, College of Engineering, or other departments, and it allows students to specialize in the management of technology as they obtain their degrees. There is no separate admissions process for the MOT program. Once enrolled, students are eligible to take courses leading to a Certificate in Management of Technology. For information, contact the Management of Technology Certificate Program; 230 Bechtel Engineering Center; University of California, Berkeley; Berkeley CA 94720-1708; telephone: (510) 642-8790; email: motadmin@haas.berkeley.edu; web site: mot.berkeley.edu.

Admission

Students admitted by the Graduate Division of the University to graduate study in engineering, including those interested in multidisciplinary programs, must be accepted by one of the engineering departments. Students must state on the admission application the department and the program of study they desire.

Application for Admission. All necessary applications and information on graduate programs and department application deadlines are available at the department of interest. Prospective graduate students wishing to participate in an interdisciplinary program should apply for admission to one of the departments of the College or to the Graduate Group in Applied Science and Technology or the Joint UCSF/UCB Graduate Group in Bioengineering. Students with an interest in Management and Technology may apply to Business Administration. See the *General Catalog,* the Graduate Division and your department of interest for details on admission requirements, deadlines, and financial support.

Graduate Student Instructorships and Graduate Student Researchships. Graduate student instructorships (GSIs) and graduate student researchships (GSRs) are available to qualified graduate students. Graduate student instructors and researchers must carry a study program of at least 12 units. Students interested in these positions should indicate this in the department admission application.

Requirements for Higher Degrees

Graduate study in engineering can be carried out in one of four general areas:

1. Master of Science and Doctor of Philosophy in Engineering. Degrees are granted after completion of programs of study that emphasize the application of the natural sciences to the analysis and solution of engineering problems. Advanced courses in mathematics, chemistry, physics, and the life sciences are normally included in a program that incorporates the engineering systems approach for analysis of problems.

Students must have a B.S. degree in one of the accredited engineering curricula or satisfy the equivalent of a B.S. degree in engineering as determined by the department concerned.

2. Master of Science and Doctor of Philosophy in Engineering Science. Degrees are granted after completion of programs of study emphasizing the fundamental principles on which engineering is founded. Advanced courses in mathematics, chemistry, physics, and the life sciences are normally included in such programs. Graduates in chemistry, physics, mathematics, geology, life sciences, social sciences, and other nonengineering fields who are interested in basic research in a field of engineering or engineering science are eligible and are invited to participate in these programs. These programs are also open to students with a B.S. degree in one of the accredited engineering curricula.

3. Master of Science and Doctor of Philosophy in Computer Science. Degrees are granted after completion of programs of study emphasizing computer science.

4. Master of Engineering and Doctor of Engineering. Degrees are granted after completion of programs of study in professional engineering emphasizing technical, sociological, environmental, and economic problems involved in the design, construction, and operation of engineering structures, processes, and equipment. Studies include courses in the engineering sciences necessary to the engineering interpretation of the latest scientific developments, as well as courses in design, operation, humanities, and economics to provide bases for the analysis and solution of problems in professional engineering. Students must have a B.S. degree in one of the accredited engineering curricula or satisfy the equivalent of a B.S. degree in engineering as determined by the department concerned.

Master of Science

Amount and Distribution of Work. The Master of Science degree is awarded for studies carried out under one of two plans, both of which normally take one year of full-time work to complete. Departments may have additional requirements.

Plan I carries a minimum requirement of 20 units plus a thesis. Of these 20 units, eight must be strictly graduate work in the major subject, and of these eight units, no more than two units of credit shall be given for individual study and research courses. The remaining 12 units may be composed of graduate or advanced undergraduate courses organized to a logical program of study. Some departments may have different requirements, e.g., in the Department of Materials Science and Engineering, only two upper division undergraduate courses may be included in the graduate program.

Plan II carries a minimum requirement of 24 units and a comprehensive final examination. Of the 24 units at least 12 must be in strictly graduate courses in the major subject with no more than two units of credit for individual study and research courses. The balance may be in approved graduate or advanced undergraduate courses.

Standard of Scholarship. Only courses in which the student is assigned grades A, B, C, or S may be counted in satisfaction of the unit requirements for the master's degree. However, lower grades are included in the overall grade point average. The student must maintain an average of at least 3.000 out of a possible 4.000 in all upper division and graduate courses taken in residence at the University of California as a graduate student. The units for courses in which the grade of S is assigned are not included in the overall grade point average. Students may repeat only those courses in which they received a grade of D+, D, D-, F, or U. If they have received a grade of D+, D, D-, or F, students may not repeat the course on a satisfactory/unsatisfactory basis. In computing the grade point averages of students who repeat courses in which they received a D+, D, D-, or F, the units are counted only once and only the most recently earned grades and grade points are used for the first 12 units repeated. For graduate students, "I" grades must be replaced by a letter grade (including S/U, etc.) before application for advancement to candidacy for any graduate degree unless the departmental major-field adviser specifies in writing for each such "I" grade that the work undertaken in that course is neither necessary nor closely related to the degree and that removal of the "I" grade would only impede progress toward the degree.

Four points per unit are assigned to grade A; 3.7 points to grade A-; 3.3 points to grade B+; 3 points to grade B; 2.7 points to grade B-; 2.3 points to grade C+; 2 points to grade C; 1.7 points to grade C-; 1.3 points to grade D+; 1 point to grade D; 0.7 points to grade D-; none to grades I and F. (The scholarship standard and the system of computation apply to both plans.)

Residence (Attendance) Required. The student is normally in residence at least two semesters. It is not always possible, however, to complete subject requirements within the minimum period of residence. Students are not regarded as students in residence unless they are actually attending regularly authorized University courses amounting to at least 4 units of work at the upper division or graduate level. While all of the work for the master's degree is expected to be done in residence, candidates may complete a part of their work elsewhere, subject to the approval of the dean of the Graduate Division.

Acceptance of Work Completed in Graduate Status Elsewhere. In exceptional cases, where the entire record of the student indicates superior scholarship, a limited amount of credit obtained at institutions with high standards may be accepted toward fulfilling the minimum unit requirement for the master's degree. Up to 4 semester units or 6 quarter units may be allowed. Where such allowance is made, the units accepted may not be used to reduce the minimum residence requirement or the minimum requirement in strictly graduate (200) courses. In some cases, credit for graduate work completed on other campuses of the University may be granted in excess of 6 quarter or 4 semester units to a maximum of 15 semester units. University Extension concurrent courses may be accepted toward the unit requirements for higher degrees. Petitions are handled on an individual basis. See your department for more information.

Advancement to Candidacy. Application for admission to candidacy for a master's degree must be made no later than the end of the third week of instruction of the semester in which the degree is to be awarded.

Master of Engineering

Amount and Distribution of Work. The Master of Engineering degree is awarded for a program of study containing a minimum of 40 units. It consists of approved upper division, graduate, and professional courses, of which a minimum of 20 units must be in graduate courses. This program shall include 16-20 units of courses oriented toward design and analysis, of which 12 units must be strictly graduate courses in the major subject; 8 units of graduate or advanced undergraduate courses must be in technical fields unrelated to the major subject to provide technical breadth; 8 units of graduate or advanced undergraduate courses must be in social sciences and humanities, or from certain special schools, such as Law, Public Health, Social Welfare, Business, or the College of Environmental Design to provide nonengineering breadth; and 4-8 units at the graduate level must be professionally-oriented individual study or research culminating in a report to be written under the supervision of a faculty member. Individual departments may increase the number of units required in each of these course groupings, except for individual study; however, the total number of units must not exceed 48. This is normally a two-year program.

Standard of Scholarship. The scholarship standard and the system of computation described under requirements for the Master of Science degree also apply for the Master of Engineering degree.

Residence (Attendance) Required. The student shall have completed at least three semesters of graduate study in residence. Details are the same as those listed under requirements for the Master of Science degree.

Acceptance of Work Completed in Graduate Status Elsewhere. The same regulations as those listed under requirements for the Master of Science degree apply to the transfer of credit obtained at another institution. A maximum of 16 units already credited toward the previous award of a Master of Science degree at the University of California may be credited toward the Master of Engineering degree with an appropriate decrease in residence requirements, provided they meet the definition of one of the categories of courses listed for the degree.

Advancement to Candidacy. The same regulations as those listed under requirements for the Master of Science degree apply.

Doctoral Degrees

Amount and Distribution of Work. Whether students should proceed to the doctoral degree is a matter both they and their department must decide on the basis of graduate work already completed. Normally, advancement to doctoral studies status is determined after completion of requirements for a master's degree. A minimum of four semesters of residence is required to attain the doctoral degree.

The program of study for doctoral candidates consists of a major field, two minor fields, and a dissertation. The doctoral candidate must also pass a qualifying examination. The major is usually devoted to one field of study within a single department and should include the dissertation research. In cases of multidisciplinary programs, courses from several departments may constitute a major; such programs are subject to approval by the chair of graduate advisers and the Graduate Division on the recommendation of the major field adviser. The minor fields should broaden the base of the studies and lend support to the major field. One minor program should consist of courses outside of the department of the major. A recommended minimum program of 33 units of formal courses as developed in consultation with the major field adviser is necessary to fulfill the major and minor requirements.

The dissertation gives evidence that the candidate has made creative and imaginative contributions to the knowledge of the chosen field of study or to the solution of an engineering problem. Thus, the course program and the dissertation should reflect the philosophy of the objectives of the doctoral degree pursued by the candidate.

Standard of Scholarship. The method of scholarship computation described under requirements for the Master of Science degree applies for the doctoral degrees. The scholarship standard, however, is an average of at least 3.500 grade points per unit in the major field formal courses and an average of at least 3.000 grade points per unit in the minor field courses.

Foreign Language Requirement. For the degree of Doctor of Philosophy, students must satisfy a language option as determined by their department and approved by the Graduate Council. Details should be checked with the departmental major field adviser.

For the degree of Doctor of Engineering, the requirement of a foreign language depends on the character of the studies.

If a foreign language is not required, the time that would have been devoted to fulfilling a language requirement is normally used to establish a sociological or ecological background or a knowledge of computer language.

Examinations. Most of the engineering departments hold supplementary or preliminary examinations at the beginning of the Ph.D. program of study. After completing all courses and language requirements, the student must also pass an oral qualifying examination in the presence of an appointed four- or five-member faculty committee approved by the dean of the Graduate Division. This committee is appointed by the Graduate Council upon receipt of the recommendation of the department, through the major field adviser and the chair of the graduate advisers.

Residence Requirement. By regulation of the Academic Senate, the minimum residence requirement for the Ph.D. degree or the D.Eng. degree is four semesters. The College of Engineering requires at least two of these semesters to be completed in continuous residence at the University, after students have passed the qualifying examinations and while they are working on their dissertations. The semester during which students are advanced to candidacy can be counted as one of these two semesters.

Advancement to Candidacy. When all of the requirements for the doctoral degree have been fulfilled except the dissertation, candidates must file their application for advancement to candidacy, properly approved by their departmental major field adviser, the chair of graduate advisers, and the instructor in charge of the dissertation. When the dean of the Graduate Division approves, students are advanced to candidacy.

Dissertation. A dissertation on a subject chosen by the candidate, bearing on the principal subject of the student's major study and demonstrating the candidate's ability to carry out independent investigation, must be completed and receive the approval of the dissertation committee and the dean of the Graduate Division. The committee, appointed by the dean of the Graduate Division, consists of three members, including the instructor in charge of the dissertation and one member outside the department of the candidate, preferably outside the College of Engineering. This committee shall guide the candidate's research and shall arrange for such conferences as may be necessary for the complete elucidation of the subject treated in the dissertation. After presentation of the dissertation, but before final action has been taken upon it, the candidate may, at the discretion of the committee, be required to defend it in a formal oral examination.

General Requirements for Higher Degrees

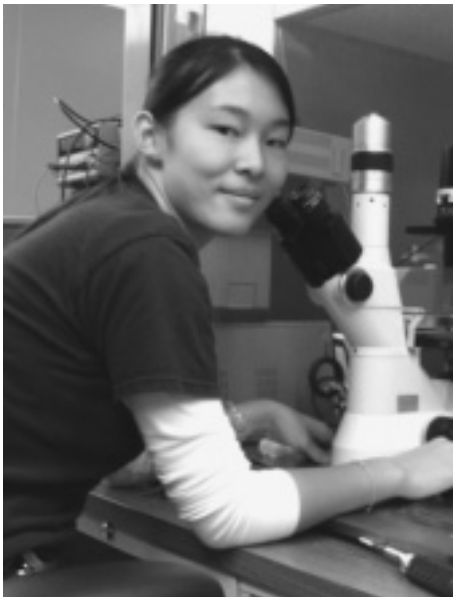
Amount and Distribution of Work. A normal program of study for a full-time graduate student is 16 upper division or 12 graduate units. A program containing both upper division and graduate courses should be made up in the proper proportion of 16 to 12, e.g., 8 upper division and 6 graduate units. Fellowship recipients take at least 12 units. Some departments may have different requirements, e.g., in the Department of Materials Science and Engineering, only two upper division undergraduate courses may be included in the graduate program for full credit. Graduate student researchers and graduate student instructors must take at least 12 units of upper division graduate level courses. Recipients of financial assistance administered by the Office of Financial Aid must take at least 8 units of upper division or graduate level courses. Departments may set additional requirements for amount and distribution of work.

Satisfactory/Unsatisfactory. The following rules will apply to satisfactory/unsatisfactory grades for graduate students in the College of Engineering:

• **Master's Degrees.** All courses taken in the major must be letter-graded except individual or group study courses such as 298, 299, or 601. Other upper division or graduate courses taken to satisfy unit requirements may be taken on a satisfactory/unsatisfactory basis, subject to the regulations established by the various departments. Credit for courses graded "satisfactory" may be assigned for no more than one-third of the total units undertaken and passed on the Berkeley campus at the time the degree is awarded. (Students intending to go on for a doctoral degree should be careful to fulfill the grading requirements for that degree.)

• **Thesis.** The required form of the thesis and the procedures related to thesis approval may be obtained from the Graduate Division.

• **Doctoral Degrees.** Courses taken in the major and minor fields to meet the minimum requirements must be taken on a letter-graded basis except individual or group study courses such as 298, 299, or 602. Additional courses may be taken on a satisfactory/unsatisfactory basis subject to the regulations established by the various departments.



Academic Departments and Programs

Bioengineering

306 Stanley Hall #1762
(510) 642-5833
bioeng.berkeley.edu
Chair: Dorian Liepmann, Ph.D.

Department Overview

Established in 1998, the Department of Bioengineering at UC Berkeley applies engineering principles and practices to living things, integrating biological and medical sciences with advanced technology to help people live longer and healthier lives.

No other field fulfills the potential for interdisciplinary research and education more than bioengineering. Our work is concentrated on high-impact applications in molecular and cellular engineering that will bring about major advances in medicine and the life sciences. We anticipate future breakthroughs ranging from the design of drugs customized to an individual's genome to tiny implantable drug delivery devices, to software and components that allow researchers to design bacteria like electronic circuits.

Research efforts in the Department of Bioengineering are organized around five focus areas: Cell and Tissue Engineering, Biomaterials and Nanotechnology, Bioinstrumentation, Computational Biology, and Systems and Synthetic Biology. The department offers students the opportunity to work with outstanding faculty in these areas, plus the freedom to pursue studies with world-class faculty in related areas of interest. This unique environment for learning and research in a rapidly growing discipline provides dedicated students with the foundation required to become leaders in the field of bioengineering.

The Department of Bioengineering at UC Berkeley is supported by exceptional faculty, strong ties to other departments on campus, and close collaborations with other institutions like UC San Francisco and Lawrence Berkeley National Laboratory. We continue to expand our department with new faculty, staff, facilities, and research programs, and we are coordinating a broad range of bioengineering-related activities currently underway on campus.

Undergraduate Program

The multidisciplinary undergraduate major in bioengineering is intended for academically strong students who excel in the physical sciences, mathematics, and biology. It offers students an opportunity to learn how to apply the physical sciences and mathematics in an engineering approach to biological systems. The undergraduate curriculum is designed to ensure that students will be well grounded in the fundamental principles and methods of engineering, as well as in integrative and molecular biology. There are further opportunities for specialization in advanced areas of both engineering and biology, including laboratory and clinical components. Bioengineering graduates may enter industry, go on to medical school, and/or pursue graduate studies in bioengineering and related disciplines.

See undergraduate sample curricula on page 14 for more information on the undergraduate program requirements and concentrations.

Bioengineering Minor

The department offers a minor in bioengineering that is open to all students not majoring in bioengineering who have completed the necessary prerequisites for the minor requirements. Information is available in the Student Services Office, 306 Stanley Hall.

Joint Major in Bioengineering/ Materials Science and Engineering

The Department of Bioengineering offers a joint major with Materials Science and Engineering (MSE) for students who have an interest in the field of biomaterials. The broad-based curriculum includes exposure to fundamental courses in engineering and life sciences and will allow students to understand the interface between the two major fields. Students who graduate with this joint major will successfully compete for jobs in the field of biomaterials in academia, industry, and government.

Berkeley Summer Bioengineering Research Program

Established in 2000, the Berkeley Summer Bioengineering Research Program provides intensive laboratory research experience to promising undergraduates. After a competitive application process, selected students are supported by a stipend while performing full-time research in faculty laboratories for 10 weeks during the summer. The intensive experience allows students to devote themselves to the project and learn a lot in a short time. Many continue to do research with their faculty mentors into the fall. More information is available at bioeng.berkeley.edu/bsbrp.

Graduate Study

A list of Graduate Group faculty can be found at bioegrad.berkeley.edu.

The graduate degree (Ph.D.) in bioengineering is jointly offered by UC Berkeley and UC San Francisco (UCSF). The Joint Graduate Group in Bioengineering is an interdisciplinary program that combines the resources in biomedical sciences at UCSF with the excellence in engineering, physical, and life sciences at UC Berkeley. With over 140 faculty members from 35 departments on the two campuses, our program offers unmatched graduate training opportunities in bioengineering.

All students in the program are simultaneously enrolled at both the Berkeley and San Francisco campuses and may take courses and perform research on either or both campuses. The program awards the Doctor of Philosophy in Bioengineering degree from UC Berkeley and UCSF.

Students with a B.A. or B.S. degree in engineering, biology, or other related fields are eligible for admission. Students can obtain additional information and application materials by contacting the Bioengineering Graduate Program, Department of Bioengineering, 306 Stanley Hall, University of California, Berkeley; Berkeley, CA, 94720-1762; (510) 642-9931; bioegrad.berkeley.edu.

Facilities

Laboratory research is an important component of the bioengineering educational program. Numerous undergraduate and graduate research opportunities are made possible in laboratory facilities located at the Berkeley campus, the UCSF campus, and Lawrence Berkeley National Laboratory (LBNL).

Most core bioengineering faculty have laboratories in Stanley Hall, a new interdisciplinary science and engineering building recently completed at Berkeley. Housing research groups from the Departments of Bioengineering, Chemistry, Molecular and Cell Biology, and Physics, the new Stanley Hall was designed to foster collaboration among faculty and students who do research at the intersection of the biological and physical sciences and engineering. The eight-floor, 285,000-square-foot building is also home to the Department of Bioengineering offices, teaching labs, the Biomolecular Nanotechnology Center, and other multi-user facilities. Bioengineering students have access to a number of specialized laboratories that reflect the breadth of research activities in the department, either in Stanley Hall or other buildings in close proximity on the Berkeley campus. More information about labs and facilities can be found on the Department of Bioengineering web site.

Undergraduate Program in Bioengineering		**120 Units[1]**
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Chemistry 3A and 3AL, or Chemistry 112A, Organic Chemistry[2]	-	5
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis or BioE 10, Introduction to Biomedicine for Engineers	3	-
E 7, Introduction to Applied Computing or CS 61A, Structure and Interpretation of Computer Programs	-	4
Reading and Composition[3]	4	-
Freshman Seminar: BioE 24 and/or BioE 25[4]	1	1
Total	**16**	**18**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
Biology 1A and 1AL, General Biology	-	5
Chemistry 3B or 112B, Organic Chemistry[5]	3	-
Engineering/Biology Preparation[6]	3	3
Electives: Humanities/Social Studies[3,4]	-	3
Total	**14**	**15**
Junior Year		
Bioengineering Fundamentals (see concentrations for recommendations)[7]	4	4
Engineering Topic (see concentrations for recommendations)[8]	3	-
Technical Electives (see concentrations for recommendations)[9]	4	3
Upper division biology elective (see concentrations for recommendations)[10]	-	3
BioE 100 or Humanities/Social Studies course with ethics content[3,4]	-	3
Electives: Humanities/Social Studies[3]	4	-
Total	**15**	**13**
Senior Year		
Bioengineering Lab Course	4	-
Bioengineering Topics (see concentrations for recommendations)	4	4
Engineering Topic (see concentrations for recommendations)[8]	-	4
Technical Elective (see concentrations for recommendations)[9]	3	-
Senior Engineering Design Project or Bioengineering Research[4]	-	4
Electives: Humanities/Social Studies[3]	3	3
Total	**14**	**15**

[1]Students must complete 42 units of upper-division course work in technical subjects, such as engineering, chemistry, physics, integrative biology, molecular and cell biology, mathematics, or statistics. Of these 42 units, at least 22 must be in bioengineering. Students are advised to consult the approved concentrations, to identify an appropriate course sequence for bioengineering specialty areas. Students may also design their own program that meets with above requirements with permission from their faculty adviser. Regular consultation with an adviser is strongly recommended. Courses must be selected so that engineering subjects (including bioengineering) comprise at least 45 units of the complete program of study.

[2]Chemistry 112A/B is intended for students majoring in chemistry or a closely related field and is more intensive than Chemistry 3A/3B. **Note:** Prerequisites to Chemistry 112A/B include Chemistry 1A and Chemistry 1B (or Chemistry 4A and Chemistry 4B).

[3]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses. Consult the Ethics List for courses with ethics content.

[4]This requirement may be completed at any time in the program.

[5]Pre-Med students should take Chemistry 3B and 3BL or Chemistry 112B and Biology 1B.

[6]Select two from the Engineering/Biology Preparation list.

[7]Choose courses from the approved Bioengineering Fundamentals list.

[8]Choose courses from the approved Engineering Topics list.

[9]Choose courses from the approved Technical Elective list. Cannot include BioE 100, E 124, or E 195.

[10]Choose courses from the approved Upper Division Biology list.

Approved Courses

Approved Course Lists:

Bioengineering Fundamentals:
BioE 101, 102, 104, 115, 131

Bioengineering Topics:
BioE 10, 22 and 22L, 24, 25, 101, 102, 104, C105B, 110, 112, 115, 116, C117, C118, C119, 121, 121L, C125, 131, C141, 142, 143, 144, C145L, C145M, C146, 164, C165, 168L, 190.

Engineering Topics:
Chem E 140, 141, 150A, 150B, 170, 171, C178; CE 130; CS 61A, 61B or 61BL, 70, 170, 186, C191; E 45, 115, 170; EE 20N, 40, 100, 105, 117, 120, 126, 129, 142, 143, 192; IEOR 162; ME 102, 104, 105, 106, 109, 118, 119, 128, 133, 167, 185; MSE 102, 104, 111, C113, 151; NE 101, 107, 170B. Also includes any course from the BioE Topics list.

Technical Electives:
Biology 1B; Chemistry 120A, 120B, C130/MCB C100A, 130B; CS 61B or 61BL; E 45, 190; Math 55, 110, 118, 127, 128A, 170; MCB C100A; Physics 7C, 110A, 112, 137A, 177, C191; Public Health 143; Statistics 101, 133, 134, 135, 150. Also includes any course from the Bioengineering Fundamentals, Engineering Topics, Upper Division Biology, or BioE Topics lists.

Upper Division Biology:
IB 115, 127 and 127L, 131, 132, 134, 135, 148, C163/MCB C142; Chemistry 135; MCB C100A, 100B, 102, 110, 111, 130, 130L, 133, 135G, 135K, 136, 140, 140L, C142, C145, C148, 150, 160, 160L, 166.

Bioengineering Lab Courses:
BioE 22 and 22L, 115, 121L, 145L, 145M, 168L

Engineering / Biology Preparation:
BioE C105B; E 45; EE 20N, 40 or 100; CS 61B or 61BL; Chemistry 120B, C130/MCB C100A.

Engineering Design Project and Research:
BioE 121, 168L, H194, 196

Ethics List:
Fulfills Humanities/Social Students and Ethics Content: Anthropology 156B; Environmental Science, Policy, and Management 161, 162; Letters and Science 124; Legal Studies 100A; Philosphy 2, 104, 105, 107; Political Science 108A, 124C; Public Policy 170; E 195; BioE 100; Public Health 115. Fulfills Ethics Content only: E 191, Public Health 116

Bioengineering Concentrations

Recommended Courses:

See bioeng.berkeley.edu/curriculum for curriculum diagrams for each concentration.

I. Biomaterials

Engineering/Biology Preparation: E 45 and BioE C105; Chemistry 120B or C130/MCB 100A

Bioengineering Fundamentals: BioE 102, 104

Engineering Topics: MSE 102 (Junior), MSE 104 or Chem E 178 (Senior)

Bioengineering Topics: BioE C118 and BioE 116 or 117

Technical Electives: Chemistry 135 or MCB 110; Statistics 134 or EE 126 (Junior); Physics 7C or BioE course (Senior)

Upper Division Biology: MCB 130 or 150

Bioengineering Lab Course: BioE 115

II. Biomechanics

Engineering/Biology Preparation: E 45 and BioE C105; Chemistry 120B or C130/MCB 100A

Bioengineering Fundamentals: BioE 102, 104

Engineering Topics: ME 106 or BioE 101 (Junior); BioE C118 or 164 (Senior)

Bioengineering Topics: BioE 112 and C117 or C119

Technical Electives: Chemistry 135 or MCB 110 and Statistics 134 or EE 126 (Junior); IB 131, 132, and/or 135 (Senior)

Upper Division Biology: MCB 130 or 150

Bioengineering Lab Course: BioE 115 or 168L

III. Biomedical Devices

Engineering/Biology Preparation: E 45 and EE 40 or 100

Bioengineering Fundamentals: BioE 102, 104

Engineering Topics: EE 143 or ME 119 (Junior), BioE 112 or C118 (Senior)

Bioengineering Topics: BioE 121 and 164

Technical Electives: Chemistry 120B or Chemistry C130/MCB 100A and BioE 22 and 22L (Junior), any from approved list (Senior)

Upper Division Biology Elective: Chemistry 135; MCB 110, 150, or 166

Bioengineering Lab Course: BioE 115

IV. Cell and Tissue Engineering

Engineering/Biology Preparation: E 45 and BioE C105, Chemistry 120B or C130/MCB C100A

Bioengineering Fundamentals: BioE 102, 104

Engineering Topics: ME 104 (Junior), 106 (Senior)

Bioengineering Topics: BioE 116 and 112, C118 or C218

Technical Electives: Chemistry 135 or MCB 110 and Statistics 134 or EE 126 (Junior); IB 131, 132, 135, MCB 150 and/or 160 (Senior)

Upper Division Biology: MCB 130 or 150

Bioengineering Lab Course: BioE 115

V. Computational Bioengineering

Engineering/Biology Preparation: CS 61B (Sophomore); BioE C105, Chemistry 120B or C130/MCB C100A (Junior)

Bioengineering Fundamentals: BioE 131 (Sophomore), 102 or 110 (Senior)

Engineering Topics: BioE 112 (Junior); BioE 102, 104, C118, 164; CS 70, 170, 186 (Senior)

Bioengineering Topics: BioE 143, 144

Technical Electives: MCB 110, C145 and IB 115, MCB 111, 130, 148, 150; Math 55, 128A, 170, Physics 177, or Statistics 150

Upper Division Biology Elective: MCB 100B

Bioengineering Lab Course: BioE 22 and 22L

VI. Imaging

Engineering/Biology Preparation: EE 20N, 40 or 100

Bioengineering Fundamentals: BioE 102, 104

Engineering Topics: BioE 145L (Junior), any from approved list (Senior)

Bioengineering Topics: BioE 164 and C165

Technical Electives: EE 117 or 120 and Statistics 134 or EE 126 (Junior), any from approved list (Senior)

Upper Division Biology Elective: Chemistry 135, MCB 102, 130, or IB 131

Bioengineering Lab Course: BioE 145M or 168L

VII. Pre-Med

Engineering/Biology Preparation: Chemistry C130/MCB C100A (Sophomore); E 45 or EE 100 (Junior)

Bioengineering Fundamentals: BioE 102, 110

Engineering Topics: BioE 104 (Junior), any from approved list (Senior)

Bioengineering Topics: BioE 116, C118, 121, 164 and/or C165

Technical Electives: Biology 1B (Sophomore); Statistics 134 or EE 126 (Junior), any from approved list (Senior)
Upper Division Biology Elective: MCB 150

Bioengineering Lab Course: any from approved list

Civil and Environmental Engineering

760 Davis Hall #1710
(510) 642-3261
www.ce.berkeley.edu
Chair: Lisa Alvarez-Cohen, Ph.D.

Department Overview

Civil and environmental engineers design, construct, and maintain the built environment in which we live and work. Projects range from the tallest skyscrapers and soaring bridge spans to tunnels and underground structures. Our graduates work to ensure efficient transportation of people and goods on the highway system, by rail, by ship, and by air. We manage scarce water and groundwater resources, and we design and operate systems to protect public health, water quality, and the environment. We use modern materials and system analysis methods to manage and renew the civil infrastructure. Computing and information technology tools make it possible to sense the condition of the infrastructure, and then to communicate and rapidly respond to disruptions in normal operations. High-performance computing is used to simulate the behavior of complex civil systems, visualize the results, and optimize management strategies.

Demands for improvements to civil infrastructure are ever-present, because of population growth and deterioration of existing systems over time. Infrastructure must be designed and managed to minimize impacts on the environment. Our infrastructure also must be protected against natural and man-made hazards such as earthquakes, landslides, floods, fires, and explosions.

The program in civil engineering at UC Berkeley, which is top-ranked nationally, combines fundamental science with modern engineering to address societal needs.

Undergraduate Program

The mission of the Civil Engineering B.S. degree program is to educate engineering leaders who will contribute to solving societal problems by improving the civil infrastructure, resource protection, natural hazard mitigation, and the efficient and sustainable functioning of engineered and natural systems in California, the United States, and worldwide.

To achieve the missions of the College of Engineering and the Department of Civil and Environmental Engineering, the CEE faculty have established the following Program Educational Objectives for the B.S. degree:

1. To prepare graduates to pursue post-graduate education in engineering or other professional fields.

2. To prepare graduates to become licensed professional engineers.

3. To prepare graduates to become leaders in the civil and environmental engineering profession.

Undergraduates at Berkeley have opportunities for professional interactions and community service. CEE has active student chapters of the American Society of Civil Engineers and the national honor society of Chi Epsilon. Additional student societies and clubs are available on campus for students to develop leadership skills and engage in professional and social interactions.

The undergraduate program is accredited by Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: (410) 347-7700.

Civil Engineering Areas of Emphasis

Students with a specific interest within civil engineering may choose to emphasize one of the areas listed on page 18. For each area of emphasis, suggestions are listed for elective courses and the capstone design project.

Non-technical electives may fulfill the degree's humanities requirement. (Please refer to the handout at www.coe.berkeley.edu/hssreq.pdf or in 308 McLaughlin Hall.) Students may also take the 8 units of credit required to earn a Certificate in Management of Engineering and Innovation offered through the College of Engineering's Center for Entrepreneurship and Technology.

Civil and Environmental Engineering Minors

The department offers two minors, one in Structural Engineering and the other in Environmental Engineering. These minors are open to all students who are not majoring in Civil and Environmental Engineering and who have completed the necessary prerequisites. Information is available in the Student Affairs Office, 750 Davis Hall, and on the department web site.

Graduate Study

The Civil and Environmental Engineering Department administers graduate programs that lead to both academic (Master of Science and Doctor of Philosophy) and professional (Master of Engineering) degrees in the major areas of professional specialization.

Engineering and Project Management

The objective of the engineering and project management program is to educate professionals for leadership in corporate and project management, research, and teaching associated with the lifecycle of civil engineered systems. Teaching and research are

organized around seven areas of emphasis: business management and leadership; human and organizational considerations; quality and reliability assessments; lifecycle engineering and management processes; production and construction engineering; engineering and the environment; and implementation processes and strategies.

Because of the broad and interdisciplinary nature of this area of study, students are encouraged to pursue advanced and relevant course work in all of the department's and college's programs, and other campus programs, such as architecture, business, public policy, management of technology, and logistics.

Environmental Engineering

Environmental engineers apply science and technology to manage our water and air resources and to control contaminants that threaten environmental quality. This program recognizes that engineering solutions to the challenges of human health and ecosystem protection require a broad-based approach to teaching and research. Because of the complex nature of these issues, education in preparation for professional practice is accomplished primarily at the graduate level. Students should have a solid undergraduate foundation in the engineering sciences.

Areas of emphasis include the improvement of indoor and atmospheric air quality; conventional and natural processes for treatment processes of drinking water, wastewater, and hazardous wastes; quantification of contaminant transport processes in multimedia environments; soil chemistry, photochemical transformations, subsurface thermal and biological remediation technologies; identification and restoration of degraded ecosystems; surface and groundwater hydrology; hydrologic mixing processes; climate variability and change; water resources management; environmental fluid mechanics; and coastal zone processes in estuaries and shorelines.

Geoengineering

The graduate program in geoengineering offers a full complement of education and research opportunities in the traditional geotechnical areas of soil mechanics, foundation engineering, earthquake engineering, geological engineering, underground construction, and rock mechanics, as well as in the emerging areas of environmental geotechnology, including groundwater hydrology, contaminant transport, and geotechnical aspects of waste disposal, clean up, and containment. In addition, this program also offers both educational and research opportunities in the areas of geophysics and petroleum engineering. Opportunities for interdisciplinary studies are provided through close interaction in teaching and research with other areas of engineering, geology (and geophysics), seismology, and soil science.

Structural Engineering, Mechanics, and Materials (SEMM)

SEMM at Berkeley has programs in the fields of structural engineering, structural mechanics, and civil engineering materials. The programs are founded on rigorous principles and methods with application to engineering challenges in today's world. The master's degrees (M.Eng. and M.S.) provide an advanced education for a life-long career in professional practice or preparation for doctoral studies. The doctoral degree provides opportunities for careers in academic research and teaching, applied research, or advanced professional practice. Broad areas of graduate study within SEMM include earthquake engineering, including modern performance-based approaches; structural design, materials, and construction; hybrid experimental simulation of structures; computational structural analysis and dynamics; structural and geotechnical engineering; theoretical, structural, and computational mechanics; high-performance structural materials; information technologies in structural and civil engineering; reliability and risk engineering; and civil systems engineering.

Transportation Engineering

The graduate program in transportation engineering offers courses in analysis techniques, planning methods, systems operations, design, systems engineering, management, economics, administration, and policy. Students have the opportunity to study in one of the world's leading centers for transportation research, education, and scholarship. Research areas include transportation, including aviation and airport design and operation, intelligent transportation, transit, traffic safety, transportation finance, transportation economics, infrastructure design and maintenance, traffic theory, public policy, logistics, systems analysis, and environmental policy.

The Institute of Transportation Studies (ITS) on the Berkeley campus provides students with a stimulating research environment and one of the world's leading transportation libraries. ITS's research program presents many opportunities for qualified students to obtain part-time employment.

Civil Systems

Many civil and environmental engineering problems involve large systems, such as transportation systems, environment systems, and metropolitan or national infrastructures, that operate as a network of complex and interrelated components. Innovative solutions often require a combination of domain knowledge, systems analysis, new technologies, economics, and management science that is rarely found in traditional disciplines alone.

The purpose of the Civil Systems program is to prepare students who can address the broad challenges of the future with relevant knowledge and skills. Civil Systems is a multidisciplinary program made up of students with degrees in a wide range of engineering and science disciplines, including civil and environmental engineering. The guidelines for the Ph.D. course work and research are flexible while maintaining intellectual rigor. The program provides the opportunity for in-depth knowledge in one or more specialties important for understanding civil and environmental systems. Students may enter the systems program with a Bachelor of Science or a Master of Science degree.

Concurrent Degrees and Certificate Programs

The Department of Civil and Environmental Engineering offers three concurrent degree programs: Structural Engineering and Architecture (M.Arch/M.S.), Transportation Engineering and City and Regional Planning (M.C.P./M.S.), and any civil engineering program and Public Policy (M.P.P./M.S.).

CEE offers three certificate programs: the Certificate in Management of Technology Program (MOT) that is offered in conjunction with the Haas School of Business and the School of Information; the Certificate in Logistics that is offered in conjunction with the Department of Industrial Engineering and Operations Research; and the Certificate in Engineering and Business for Sustainability that is offered in conjunction with the College of Engineering, the Haas School of Business, the College of Natural Resources, and the Schools of Public Health and Public Policy.

Facilities

Facilities for advanced study and research are located on the Berkeley campus, at Lawrence Berkeley National Laboratory and the Richmond Field Station.

Students and faculty in the department are supported by a range of outstanding research facilities, including laboratories in structures and materials, environmental water resources, environmental quality, transportation engineering, geoengineering, and earthquake engineering.

Departmental computing facilities include multiple instructional computing labs featuring high performance networked Windows workstations running advanced engineering applications, servers for centralized file storage and backup, and high-speed wired and wireless networks for data sharing. Additional computing resources are made available by research groups.

See the department web site for more information on our research and facilities.

Undergraduate Program in Civil Engineering		121-124 units
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis	3	-
E 7, Introduction to Applied Computing	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3
Freshman Seminar or E 92 (Survey Course)	<1>[2]	<1>[2]
Total	**15-16**	**15-16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
Basic Science Elective (one of the following): Chemistry 1B, General Chemistry, or Physics 7C, Physics for Scientists and Engineers	-	4
CE 60, Structure and Properties of Civil Engineering Materials	-	3
CE 93, Engineering Data Analysis	-	3
CE C30, Introduction to Solid Mechanics	3	-
Engineering Science and Sustainability Option (one of the following): CE 11, Engineered Systems and Sustainability, or CE 70, Engineering Geology	-	3
Electives: Humanities/Social Studies[2]	4	-
Total	**15**	**17**
Junior Year		
CE 100, Elementary Fluid Mechanics	4	-
CE 130, Mechanics of Materials I	3	-
Engineering Science Elective (one of the following): E 115, Thermodynamics; ME 104, Engineering Mechanics; ME 105, Thermodynamics, or ME C105B, Thermodynamics and Biothermodynamics		3-4
Elective Core (four of the following seven) CE 103, Hydrology; CE 111, Structural Engineering; CE 155, Transportation Systems Engineering; CE 167, Engineering Project Management; CE 175, Geotechnical and Geoenvironmental Engineering; CE 191, Civil and Environmental Systems Analysis	3	9
Electives: Humanities/Social Studies[1]	4	4
Total	**14**	**16-17**
Senior Year		
CE 192, The Art and Science of Civil and Environmental Engineering Practice	-	1
Design Elective (one of the following): CE 103, Hydrology; CE 112, Environmental Engineering Design; CE 122, Design of Steel Structures; CE 123, Design of Reinforced Concrete Structures; CE 153, Design of Transportation Facilities; CE 177, Foundation of Engineering Design; or CE 180, Design, Construction, and Maintenance of Civil and Environmental Systems	-	3-4
Engineering Electives[3]	15	-
Electives	-	6
Electives: Humanities/Social Studies[1]	-	4
Total	**15**	**14-15**

Civil Engineering Areas of Emphasis

Note: Selection of an area of emphasis is optional. A bachelor of science in engineering is awarded whether or not a student follows the broad and general program or chooses an area of emphasis.

Engineering and Project Management:
Elective Core: CE 120 and 167
Design Elective: CE 180
Engineering Electives: CE 165, 166, 171, 173, 176, 191, 193; E 190
Suggested non-technical electives: Business Administration 124, 125, 150, 154, 155.

Environmental Engineering:
Elective Core: CE 103 and 111
Design Electives: CE 104N and 112
Engineering Electives: CE 101, 107, 108, 109, 113N, 114, 115, C116, 173, 176, C178; E 117, 118, 190; MSE 112, 161; NE 124
Suggested non-technical electives: Biology 1B; Energy and Resources 100; Integrative Biology 153

Geoengineering:
Elective Core: CE 111, 120 and 175
Design Elective: CE 177
Engineering Electives: CE 171, 172, 173, 176, C178, 103, 115, 121, 122, 123, 124, 167, 184; E 190

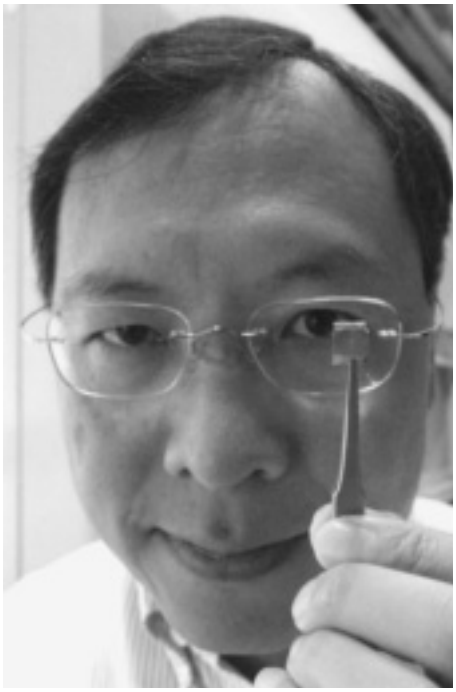
Structural Engineering:
Elective Core: CE 120, 167 and 175
Design Elective: CE 122 and 123
Engineering Electives: CE 121, 124, 131, C133, 140, 165, 177, 193; E 190

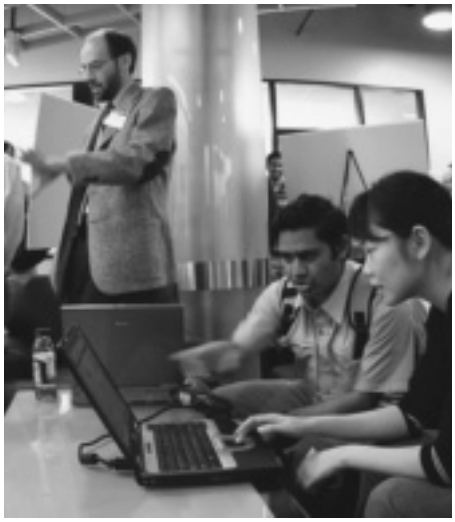
Note: CE 121 is required for admission for graduate study in Structural Engineering, Mechanics and Materials.

Transportation:
Elective Core: CE 155 and 191
Design Elective: CE 153
Engineering Electives: CE 108, C154, 167, 177, 250, 251, 259 and 260; E 102, 117, and 190; IEOR 153
Suggested non-technical electives: City and Regional Planning 110; Economics 101A, 125; Energy and Resources 100; Geography C188, Public Policy 101

Note: Undergraduates wishing to enroll in graduate courses must have at least a 3.0 grade point average and the consent of the instructor.

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses. Consult the Ethics List for courses with ethics content.
[2]Can be taken either fall or spring. Civil and Environmental Engineering students are encouraged to take CE 92.
[3]Engineering electives must include at least 15 units of upper division course work offered in the College of Engineering or in Chemical Engineering; 12 of these units must be upper division CE courses not used for other program requirements. Courses numbered 197-199, BioE 100; E 100, 124, 140, 193, and 195 are not accepted. Students taking E 115 can count 1 unit toward the 15 units. E 190 can be taken as an approved engineering elective.





Electrical Engineering and Computer Sciences

Center for Student Affairs
205 Cory Hall #1770
(510) 642-3068
www.eecs.berkeley.edu
Chair: Edward Lee, Ph.D.

Department Overview

UC Berkeley's Department of Electrical Engineering and Computer Sciences (EECS) offers one of the strongest research and instructional programs in this field anywhere in the world. Our key strength is in our cross-disciplinary team-driven projects. The integration of electrical engineering (EE)[1] and computer science (CS)[2] forms the core, with strong interactions that extend into biological sciences, mechanical and civil engineering, physical sciences, chemistry, mathematics, and operations research. Our programs have been consistently ranked in the top three nationwide and worldwide by various organizations that rank academic programs.

The mission of the EECS department has three parts: (1) educating future leaders in academia, government, industry, and entrepreneurial pursuit, through a rigorous curriculum of theory and application that develops the ability to solve problems, individually and in teams; (2) creating knowledge of fundamental principles and innovative technologies, through research within the core areas of EECS and in collaboration with other disciplines, that is distinguished by its impact on academia, industry and society; and (3) serving the communities to which we belong, at local, national, and international levels, with a deep awareness of our ethical responsibilities to our profession and to society.

Our strategy to accomplish this mission is simple: recruit and retain the very best faculty, students, and staff, and then empower them to direct and drive the creation and dissemination of knowledge. We know that we have succeeded in this mission when our students succeed, becoming leaders and serving society.

Organizationally, the EECS department smoothly integrates its world class faculty with dedicated staff and extremely active and involved student groups.

[1]Accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: (410) 347-7700.

[2]Accredited by the Computing Accreditation Commission of the Accreditation Board for Engineering and Technology, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: (410) 347-7700.

Undergraduate Programs

Under the auspices of the College of Engineering, EECS offers two undergraduate programs: Electrical and Computer Engineering (ECE) and Computer Science and Engineering (CSE). The CSE program puts a greater emphasis on computer science, whereas the ECE program puts a greater emphasis on electrical engineering. Both programs require the same set of five lower-division core courses in EECS (EE 20N, 40; CS 61A, 61B, and 61C) and nearly the same math and science courses. After satisfying program requirements at the lower-division level, students are free to choose from a variety of elective upper-division courses. To guide students into a coherent choice of courses, we ask students to choose from one of five "options." The choice of option affects the faculty advisor assignment, and the options provide sample programs that suggest reasonable tracks. See the sample programs for more information on the EECS options.

Additional details about the curriculum, requirements, and sample programs that satisfy the requirements can be found in *Undergraduate Notes,* prepared by the Student Affairs Office of the EECS department at www.eecs.berkeley.edu/Programs/Notes/index.shtml.

Our undergraduate programs recognize the daunting intellectual breadth of the field by offering a great deal of flexibility. These programs are accredited by the Accreditation Board for Engineering and Technology and by the Computing Accreditation Commission (CAC) of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: 410-347-7700.

EECS Options

• **Physical Electronics** (Option I)

This option is for students interested in integrated circuits, electronic devices, nanotechnology, electromagnetics, micro and nano fabrication, photonics and optoelectronics, microelectromechanical systems (MEMS), electronic design automation (EDA), high power circuits, and applications to biomedicine, micro-robotics, sensors, actuators, energy production, storage, and conservation, and silicon structures.

• **Communication, Networks, and Systems** (Option II)

This option is for students interested in networks, control systems, digital and analog communications, information theory, signal processing, and systems modeling, design, verification, and optimization, together with applications to robotics, biomedicine, wireless communications systems, multimedia systems, multi-sensor fusion, and machine intelligence.

• **Computer Systems** (Option III)

This option is for students interested in machine architecture and logic design, communication networks, computer security, operating systems, database systems, programming systems and languages, embedded software, and/or digital devices and circuits, together with applications for networked computing, embedded systems, computer games, and information systems.

• **Computer Science** (Option IV)

This option is for students interested in the foundations of computing, which includes the theory of computation, the design and analysis of algorithms, complexity theory, the architecture and logic design of computers, programming languages, compilers, operating systems, scientific computation, computer graphics, database systems, artificial intelligence and natural language processing, and cryptography and computer security.

• **General Course of Study** (Option V)

This flexible program enables students whose interests are broad or who have yet to focus on a specific field to explore several topics in the areas mentioned above.

EECS Honors Degree Program

The Honors Degree Program is designed to provide very talented undergraduate students with more flexibility at the undergraduate level. Honors students select an academic concentration outside of EECS. In addition, students receive a special faculty advisor, engage in research, receive official notation of the honors degree on their Berkeley transcript, and are invited to special events with faculty and EECS honors alumni. Applications to the Honors Degree Program are accepted at the end of the fall and spring semesters. Typically students apply during their junior year. Visit the EECS Student Affairs Office or www.eecs.berkeley.edu/Programs/honors.html for more information about the program.

EECS Minor

The EECS minor, offered through the College of Engineering, is open to any undergraduate who has declared a major on the Berkeley campus, with the exception of EECS majors. It is intended for students who have an interest in electrical engineering and computer science. Students interested only in computer science courses should consider the computer science minor. Applications are accepted throughout the year and are available from the Center for Student Affairs, 205 Cory Hall.

Joint Major Programs

The department offers two joint majors with the Department of Materials Science and Engineering and Nuclear Engineering. See the Joint Majors section for more information and details on the curricula.

Computer Science Leading to the Bachelor of Arts Degree

In addition to a CS major through the College of Engineering, which confers the B.S. degree, the Computer Science Division also offers the major through the College of Letters and Science (L&S), which confers the B.A. degree. An essential difference between the two majors is that the EECS program requires a greater number of math and science courses than the CS program, which requires a greater number of non-technical, or breadth, courses. The computer science major under L&S auspices is not accredited by the Computing Accreditation Commission of the Accreditation Board for Engineering and Technology.

For further information about L&S computer science programs and requirements, see the booklet, *The CS Major and Minor,* which is available from the Computer Science Advising Office in 377 Soda Hall. Useful information can also be found at www.eecs.berkeley.edu/Peer/resources/cshandbook.html.

Details about the computer science major offered through the College of Letters and Science also may be found under the course listings for computer science in the *General Catalog.*

Computer Science Minor

A minor in computer science is available to all undergraduate students at Berkeley with a declared major, except Computer Science and EECS majors, through the College of Engineering. Applications and more information on the Computer Science minor are available at the Computer Science Advising Office, 377 Soda Hall.

Advanced Degree Programs

The Five-Year Bachelor's/Master's Program in EECS (B.A./M.S. or B.S./M.S.)

The combined Bachelor's/Master's program is designed to take outstanding EECS and CS (L&S) undergraduates immediately into an intensive two-semester program conferring the Master of Science degree. This combined program promotes interdisciplinary focus and is best suited to those who are more "professionally oriented" as opposed to those wishing to pursue a more traditional research-based and discipline-specialized advanced course of study. As such, a distinguishing feature of this five-year program is its emphasis upon extended study in interdisciplinary, though allied, technical fields such as physics, biology, and statistics, or in professional disciplines such as business, law, or public policy. The program is aptly entitled, "Educating Leaders for the Emerging Global Economy," and reflects a growing need for those who are technically skilled and who also possess an understanding

of the business, legal, and social context of technology development and use.

Conferral of the degree requires either writing a thesis (Plan I) or reporting on a project (Plan II), as is required of our other Master's students.

The EECS Graduate Program

The EECS Graduate Program offers a comprehensive program geared toward research and teaching (Master of Science and Doctor of Philosophy), and for careers in design, development, and management (Master of Engineering and Doctor of Engineering). The Master of Science program requires three to four semesters of study, while the Doctor of Philosophy program is normally completed in five to six years. The Master of Engineering program requires four semesters of study and includes a minor in a technical subject outside the major and a second minor in a nontechnical subject such as law, business administration, or the like. The Doctor of Engineering program, of about two years duration, builds on the course work for the Master of Engineering degree and requires a one-year internship in a design and development organization. Students with either a B.S. or an M.S. who intend to study for the D.Eng. should apply first for the M.Eng. program.

Admission into the graduate program is extremely competitive, but, once admitted, students have a wide variety of cluster areas from which to choose an affiliation, and a large number of courses and seminars taught by leaders in their fields from which to design their study programs. Students apply to either the Electrical Engineering Division or to the Computer Science Division, although once they have been admitted to the department, the boundaries between the divisions are fluid. The principal area of interest of the student should determine which division to apply to. Students whose principal interests are in the following areas should apply to Electrical Engineering:

- **Communications and Networking**
- **Control and Robotics**
- **Design of Electronic Systems**
- **Energy**
- **Integrated Circuits**
- **Physical Electronics**
- **Signal Processing**
- **Security**

Students whose principal interests are in the following areas should apply to Computer Science:

- **Artificial Intelligence**
- **Computer Architecture and Engineering**
- **Database Management Systems**
- **Graphics and Human-Computer Interaction**
- **Operating Systems and Networking**
- **Programming Systems**
- **Scientific Computing**
- **Theory of computation**

Students with an interest in **Biosystems** can apply to either division.

See the department web site for more information on graduate study and specializations.

With the exception of those in the Five-Year Bachelor's/Master's Program, most who enter the graduate program do so with the expectation of pursuing their doctorates. The department does, however, accept "M.S. only" students and offers three types of degrees, discussed below.

Master of Science (M.S.)

The Department awards three types of Master of Science degrees:

• *Engineering — EECS:* For EE students with a B.S. degree from an accredited engineering program, or for those who have the equivalent of a B.S. degree as determined by the department.

• *Engineering Science:* For EE students with a Bachelor's degree in a non-engineering field (i.e., chemistry, physics, math, geology, or the life sciences).

• *Computer Science:* For CS students with a B.S. in computer science, or an equivalent as determined by the department.

Students may choose to pursue Plan I, which requires writing a thesis, or they may pursue Plan II, which requires a report on a project.

Doctor of Philosophy (Ph.D.)

The department offers three types of Ph.D. degrees, awarded to students under the same conditions as the corresponding M.S. degrees, above:

• *Engineering — EECS*

• *Engineering Science*

• *Computer Science*

The principal requirements for the Ph.D. are: (1) course work from a major subject area and two minor subject areas; (2) the departmental preliminary requirement, consisting of an oral exam and breadth courses, which differ for EE and CS; (3) the qualifying exam; and (4) the dissertation. There is no foreign language requirement. For further information on establishing major and minor subject areas, division-specific requirements for prelims and breadth requirements, qualifying exam, and the dissertation, please refer to the Graduate Handbook prepared by the Graduate Admissions Office at www.eecs.berkeley.edu/Gradnotes.

Designated Emphasis (DE): In keeping with the departmental priority given to cross-disciplinary applications of engineering and computer science, graduates may also choose to add a designated emphasis to their program. A designated emphasis is a specialization offered by existing Ph.D. programs that provides multi-disciplinary training and research opportunities outside of EECS proper, but in areas that share overlapping interests and goals. At present, three such designated emphases are available to our doctoral students:

- **Communication, Computation and Statistics**
- **Computational and Genomic Biology**
- **Nanoscale Science and Engineering**

Students who pursue a DE receive recognition of their specialization on their transcripts and are well positioned to compete for preferred jobs in academia and industry.

The Management of Technology (MOT) Certificate Program: This program is a joint effort between the College of Engineering, Haas School of Business, and the School of Information (SI) at Berkeley. See the Management of Technology section for more information.

Facilities

The department is supported by state of the art laboratory facilities for computing, robotics, embedded systems, microfabrication, electronic devices, signal processing, networking, communications systems, and nanotechnology. Most of the advanced research is carried out in Cory and Soda Halls, but some advanced study and research are performed in the Space Sciences Laboratory, Radio Astronomy Laboratory, Lawrence National Laboratories (Berkeley and Livermore), and the Center for Pure and Applied Mathematics. More information on facilities can be found by exploring the Centers and Labs section of the department web site.

Undergraduate Program in Electrical Engineering and Computer Sciences — 120 units

For detailed curriculum in each Electrical Engineering and Computer Sciences Option, refer to the *EECS Undergraduate Notes* book available at www.eecs.berkeley.edu/Programs/Notes or in 205 Cory Hall**.**

Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Physics 7A-7B, Physics for Scientists and Engineers	4	4
CS 61A, Structures and Interpretation of Computer Programs	4	-
CS 61B, Data Structures	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3
Total	**16**	**15**
Sophomore Year		
Math 53, Multivariable Calculus	4	-
Math 54 Linear Algebra, Differential Equations	-	4
Science Elective (see approved list in EECS Undergraduate Notes)	4	-
EE 20N, Structure and Interpretation of Systems Signals	4	-
EE 40, Introduction to Microelectronic Circuits	-	4
CS 61C, Machine Structures	-	4
Electives: Humanities/Social Studies[1]	4	4
Total	**16**	**16**
Junior Year		
Statistics Course (Math 55, CS 70, Statistics 134, EE 126)	4	-
Electives (EECS upper division)	8	12
E 190, Technical Communication	3	3
Electives: Humanities/Social Studies[1]	-	3
Total	**15**	**15**
Senior Year		
Technical Electives[2]	9	14
Electives: Humanities/Social Studies[1]	4	-
Total	**13**	**14**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.

[2]Students must take a total of 45 units of engineering courses, including at least 20 units of upper-division EECS courses.

Engineering Science

230 Bechtel Engineering Center #1708
(510) 642-8790
www.coe.berkeley.edu/engsci

Chair: David Dornfeld (Associate Dean, Interdisciplinary Studies), Ph.D.

Department Overview

The Engineering Science Program is administered by the Engineering Science Committee. Faculty associated with the major are listed at www.coe.berkeley.edu/engsci/faculty.html.

The Engineering Science Program is multidepartmental and interdisciplinary. This undergraduate program encompasses a variety of closely-related areas of the physical and biological sciences, mathematics, and engineering. It is intended to provide a means whereby students, while acquiring knowledge of engineering methods, can pursue their interests in areas of natural science. The options offered within the curriculum prepare students for advanced study in engineering, science, bioengineering, or mathematics.

There are four fully structured majors in the curriculum: Computational Engineering Science, Engineering Mathematics and Statistics, Environmental Engineering Science, and Engineering Physics.

Computational Engineering Science. This interdisciplinary program recognizes the growing importance of computation as a methodology for attacking complex scientific and engineering problems. Combined with mathematical modeling and experimental observations, scientific computation enables engineers and scientists to solve problems that are otherwise intractable. The computational engineering science program provides a solid foundation in mathematics, the sciences, and engineering and fosters skills required for modeling, simulating, and solving complex problems. The emphasis is on the computation of science rather than the science of computation (i.e., CES is *not* computer science). Students have the opportunity to select courses from a wide variety of disciplines. The program provides a sound basis for graduate studies in engineering and the applied sciences. Additionally, it nurtures skills that are needed in large-scale technological modeling and simulations relevant to research in industry and national laboratories.

Engineering Mathematics and Statistics. This interdisciplinary program offers students an opportunity to study pure and applied mathematics as essential components of modern engineering. By combining courses from pure mathematics, applied mathematics, statistics, the physical sciences, and engineering, a student may individualize a program of study in theory or applications, or both. The program provides a broad foundation for graduate studies in theoretical branches of engineering, as well as in mathematics. Alternatively, an appropriate choice of courses can prepare students for a career in specific sectors of industry or business. Also, students may choose to minor in a branch of engineering.

Engineering Physics. This program interweaves classical and modern physics, chemistry, and mathematics with their engineering applications. A great strength of the program is its flexibility. The firm base in physics and mathematics is augmented with a selection of engineering course options that prepare the student to tackle the complex problems faced by society. Because the program emphasizes science and mathematics, students are well-prepared to pursue graduate studies in physics or engineering.

Environmental Engineering Science. This is a multidisciplinary field requiring an integration of physical, chemical, and biological principles with engineering analysis for environmental protection and restoration. The program incorporates courses from many departments on campus to create a discipline that is rigorously based in science and engineering, while addressing a wide variety of environmental issues. Although an environmental engineering option exists within the civil engineering major, the engineering science curriculum provides a more broadly-based foundation in the sciences than is possible in civil engineering. This major prepares the student for a career or graduate study in many environmental areas.

Undergraduate Programs in Engineering Science

The programs in Engineering Science are all interdisciplinary. Students are encouraged to plan their individual programs in consultation with their faculty advisers. Students will be advanced to the upper division in Engineering Science upon satisfactory completion of the lower division requirements.

Computational Engineering Science	123.5-126.5 Units	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10 Engineering Design and Analysis	3	-
E 7 Introduction to Applied Computing	-	4
Science Electives[1]	-	4
E 39B, Introduction to Computational Engineering Science (Freshman Seminar)	1.5	-
Reading and Composition[2]	4	-
Total	**16.5**	**16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
Science Electives[1]	4-5	4-5
Math 55, Discrete Mathematics, Statistics 134, Concepts of Probability, Math 110, Linear Algebra, or CS 70, Discrete Mathematics and Probability Theory	3-4	-
Electives: Humanities/Social Studies[2]	-	6
Total	**15-17**	**14-15**
Junior Year		
Math 128A-128B, Numerical Analysis[3]	4	4
Core Course 1[4]	4	-
Core Course 2[4]	-	3
CES Cluster Course 1[5]	4	-
CES Cluster Course 2[5]	-	3
E 177, Advanced Programming with MATLAB	-	3
E 170, Introduction to Modeling and Simulation	4	-
Electives: Humanities/Social Studies[2]	-	3
Total	**16**	**16**
Senior Year		
E 180A, Computational Engineering Science Modeling and Simulation	-	4
Computational Project Course[6]	4	-
Core Course 3[4]	4	-
CES Cluster Course 3[5]	3	-
CES Cluster Course 4[5]	-	4
E 190, Technical Communication	-	3
Electives: Humanities/Social Studies[2]	4	4
Total	**15**	**15**

[1]Three courses from the following list of approved science electives:
Physics 7C, Physics for Scientists and Engineers
Chemistry 1B, General Chemistry
Chemistry 3A and 3AL, Chemical Structure and Reactivity with Lab (cannot receive credit for Chemistry 3A after taking Chemistry 1B)
Chemistry 3B and 3BL, Chemical Structure and Reactivity with Lab
Biology 1A and 1AL, General Biology with Lab
Biology 1B, General Biology
Engineering 45, Properties of Materials

[2]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.

[3]A course involving partial differential equations is recommended prior to Math 128B (e.g., Core Course 1). In selecting courses from these groups, students should plan ahead carefully to be sure that prerequisites are met for courses to be taken subsequently (i.e., from the core groups and from the clusters, see footnotes 4 and 5 below). Courses marked with an (*) are acceptable for the partial differential equations recommendation for Math 128B.

[4]A total of three courses from the following fifteen groups. Only one course per group is allowed.
Applied Math: E 117
Bioengineering: BioE 121, 131, 143
Electrical Engineering: EE 40, 100
*Electromagnetics: EE 117A, Physics 110A
Engineering Economics: E 120
Engineering Ethics: E 191, NE 175
*Fluid Mechanics: ME 106, Chem E 150A, CE 100
Operations Research: E 102; IEOR 160, 165
Properties of Materials: E 45; MSE 102, 111
Nuclear Engineering: NE 101
*Quantum Mechanics: Physics 137A
Solid State Electronics: EE 130, Physics 141A
Statics/Dynamics: ME 104, CE 130, Physics 105
Systems, Feedback and Control: EE 120, ME 132
Thermodynamics: ME 105, E 115, Chem E 141

[5]See the list clusters for this major. In collaboration with their advisers, students may choose 4 courses that form a coherent focus for their studies. At least 3 courses must be upper division.

[6]One course from the approved list of computational project courses:
E 180B, Computational Engineering Science: Modeling and Simulation II
BioE 143, Computational Methods in Biology
IEOR 131, Discrete Event Simulation
IEOR 162, Linear Programming
ME 135, Design of Microprocessor-Based Mechanical Systems
ME 145, Computer-Aided Thermal Design
ME 180, Engineering Analysis Using the Finite Element Method
NE 155, Introduction to Numerical Simulations in Radiation Transport
MSE 215, Computational Materials Science

Note: Technical courses must be preapproved for cluster and core requirements by the faculty adviser. BioE 100; E 110, C111, 124, 140, 193, and 195, cannot satisfy technical requirements.

Computational Engineering Science Clusters

Computational Engineering Science (CES) clusters are intended to provide depth in a cohesive multidisciplinary area. In the junior/senior year, students first select an approved CES cluster from the list below or petition to construct a new CES cluster. Then they choose four courses from the selected CES cluster. Where a core course overlaps with a CES cluster course, students may apply the course to either — but not both — areas.

The following list of clusters is intended to be a representative, evolving set, with additions and modifications resulting from both student petitions and new courses. Please consult the *General Catalog* for prerequisites.

Optoelectronics, Electromagnetics, and Plasmas. This cluster offers a specialization in the macroscopic physics of fields and charged particles. The area covers optics, electromagnetics, and plasmas and the engineering of devices based on these phenomena. Applications include optical and microwave communications devices, switches, interconnects, antennas, waveguides, electron and ion beams, plasma sources and lighting, plasma processing, fusion, printing and video displays, as well as fundamental processes such as wave propagation and charged particle dynamics. EE 117, 118, 119, 120, 121, 136, 145A; MSE 111; NE 180; Physics 142; Statistics 134.

Bionuclear Engineering. EE C145B; NE 101, 107, 162, 167.

Radiation Transport. NE 101, 124, 150, 155, 162, 180.

Thermodynamics and Combustion. Chem E 141; E 115; ME 105, 109, 140, 145, 151, 142; MSE 115; Physics 112.

Mass and Energy Transport. Chem E 150A, 150B, 152, 157, 171; ME 106, 107A, 107B, 162, 165, 185; MSE 149, 176.

Optimization. CS 170, 172, 174, 188; IEOR 131, 160, 161, 162, 166.

Computational Materials Science. Computational Materials Science provides the solid foundation in materials science that is required for advanced computational studies of materials properties. The student will be introduced to atomic scale properties that influence the macroscopic properties of materials, as well as the techniques commonly applied in computational materials science; e.g., atomic scale simulation using Monte Carlo and molecular dynamics techniques and numerical methods for solving the diffusion equation: E 45; MSE 102, 103; EE 131 or MSE 111 or Physics 141A; MSE 112, 113, 116, 117 (or Physics 141B), 118, 120, 121, 122, 123, 124, 125. In addition, it is recommended (but not required) that students select these core courses from those listed among the required core courses: CE 130 (mechanics/ dynamics), E 115 or Chem E 141 (thermodynamics), Physics 137A (quantum mechanics).

Environmental Transport. CE 108, 116, 173; Chem E 171; MSE 149, 176.

Mechanics. CE 130, 131; E 36, C164, Integrative Biology 135; ME 104, 106, 132, 133, 134, 165, 170, 175, 176, 185; Physics 105.

Other Potential Clusters. Additional clusters must be preapproved by the faculty adviser and department by petition.

Engineering Mathematics and Statistics	119-122 Units*	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A, General Chemistry	4	-
1st Computer Science course[1]	-	3-4
Physics 7A, Physics for Scientists and Engineers	-	4
Lower Division Technical Electives[2d] (1 course)	-	4
Reading and Composition[2c]	4	-
Electives: Humanities/Social Studies[2c]	3	-
<Optional> Freshman Seminar or E 92 (Survey Course)	<1>	-
Total	**15-16**	**15-16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
2nd Computer Science course[1]	3-4	-
Electives: Humanities/Social Studies[2c]	4	3
Lower Division Technical Electives[2d] (1 course)	-	3
Total	**15-16**	**14**
Junior Year		
Math 110, Linear Algebra	3	-
Math 128A, Numerical Analysis	-	4
Math 104, Introductory and Intermediate Analysis, and one of Math 105, Integration, or Math 185, Introduction to the Theory of Functions of a Complex Variable	4	4
Statistics 101, Introduction to the Theory of Probability, or Statistics 134, Concepts of Probability	3-4	-
Electives: Humanities/Social Studies[2c]	-	3
Upper Division Technical Electives[2a,b,3]	5	4
Total	**15-16**	**15**
Senior Year		
Electives: Humanities/Social Studies[2c]	-	3
Upper Division Technical Electives[2a,b,3]	15	12
Total	**15**	**15**

[1]Two CS courses are required and should be selected with the help of an adviser. E 7, 177; CS 61A and 61B are admissible choices.
[2]Electives must include: (a) 16 units of upper division courses in engineering; (b) Three additional upper division courses in mathematics or statistics from among: Math 105, 113, 118, 119, 123, 125A-125B, 126, 128B, 130, 135, 140, 142, 170, 185, 187, and 189; Statistics 102, 135, 141, 150, 151A-151B, 152, and 157; (c) Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall; (d) Six units of lower division technical electives (transfer students may substitute upper division courses with approval of adviser). Examples include E 10, 28, 36, 45; Math 55; CS 61C; (e) At least 40 units of approved upper division technical subjects (mathematics, statistics, science, and engineering).
[3]Student should select a coherent series of electives in consultation with their adviser so as to provide depth in an area of engineering with high mathematical content. Examples include: (a) Computer Science/Computation (e.g., CS 61A-61B-61C; Math 55, 113, 115, 128B; IEOR 131, 162; CS 164, 170, 172, and 174); (b) Dynamics, Differential Equations, and Physics (e.g., ME 104 or Physics 105; ME 105 or E115 or Chem E 141; Math 123, 126, 128B; Physics 110A-110B, 112, 137A-137B, 138, 142; ME 106, 165, 170, 175, and 185); (c)Communications and Control Systems (e.g., EE 40, 104, 120; CS 61A-61B-61C; ME 134, 135); (d) Operations Research (e.g., E 7; Math C103/Economics C103; Math 55, 113; Statistics 134, 135, 150; E 120; IEOR 131, 160, 161, 162).
Note: Lower division courses will not count toward the 40 upper division unit total. BioE 100; E 110, C111, 124, 140, 193, and 195 cannot satisfy technical requirements.
*__A minimum of 120 units is required for graduation.__

Engineering Physics	117-126 Units*	
Freshman Year	*Fall*	*Spring*
Mathematics 1A-1B, Calculus	4	4
Chemistry 1A-1B, General Chemistry	4	4
E 7, Introduction to Applied Computing, CS 61A, Structure and Interpretation of Computer Programs, or CS 61B, Data Structures	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3
<Optional> Freshman Seminar or E 92 (Survey Course)	<1>	-
Total	**16-17**	**15**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
Technical Electives[2]	4	4
Electives: Humanities/Social Studies[1]	3	3
Total	**15**	**15**
Junior Year		
Math 104, Introduction to Analysis, and Math 185, Introduction to Complex Analysis, or Math 121A-121B, Mathematical Tools for the Physical Sciences	4	4
ME 104, Engineering Mechanics, or Physics 105, Analytic Mechanics	3-4	-
Physics 112, Introduction to Statistical and Thermal Physics, or E 115, Engineering Thermodynamics	-	3-4
Physics 137A-137B, Quantum Mechanics[1]	4	4
Electives: Humanities/Social Studies[1]	3	-
Technical Electives[2]		3-4
Total	**14-15**	**14-16**
Senior Year		
NE 104A, Nuclear Instrumentation Lab, Physics 111A, Modern Physics and Advanced Electrical Lab[3], or EE 143, Microfabrication Technology	3-4	-
Physics 141A, Solid State Physics, or MSE 111, Electric and Magnetic Properties of Materials	3-4	-
ME 185, Introduction to Continuum Mechanics, or ME 106, Fluid Mechanics	-	3
Physics 110A-110B, Electromagnetism, or EE 117, Electromagnetic Fields and Waves, and either EE 119, Introduction to Optical Engineering, or BioE 164, Optics and Microscopy[4]	4	3-4
Electives: Humanities/Social Studies[1]	-	3
Technical Electives[2]	4-5	5-6
Total	**14-17**	**14-16**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall.
[2]Technical electives must include: (a) Two courses from the following lower division technical electives: E 10, 36, 45; EE 40; Chemistry 3A; Biology 1A, 1B; Astronomy 7; (b) 16 units in upper division courses in engineering; (c) A minimum of 14 units in upper division in physics; (d) At least 40 units of approved upper division technical subjects: mathematics, statistics, science, and engineering.
[3]If chosen, Physics 111 must be taken for at least 3 units.
[4]BioE 164 can be used to replace EE 119 only. Students opting to take the physics E & M series must take both Physics 110A and 110B.
*__A minimum of 120 units is required for graduation.__

Environmental Engineering Science	117-125 Units*	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis, or Biology 1A and AL, Chemistry 1B or 4B, Chemistry 3A and 3AL, Chemistry 5, EPS 50	-	3-5
E 7, Introduction to Applied Computing	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	3	-
<Optional> Freshman Seminar or E 92 (Survey Course)	<1>	-
Total	**15-16**	**15-17**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
Biology 1B, General Biology (Ecology)	4	-
Physics 7C, Biology 1A and AL, Chemistry 3A and 3AL, Chemistry 3B and 3BL, Chemistry 5, EPS 50	4-5	4-5
E 177, Advanced Programming with MATLAB	-	3
Electives: Humanities/Social Studies[1]	-	3
Total	**16-17**	**14-15**
Junior Year		
Fluid Mechanics: CE 100 or ME 106 or Chem E 150A	3	-
Mechanics: CE 130 or ME 104	3	-
Thermodynamics: Chem E 141 or ME 105 or 105B or E 115	3	-
CE 111, Environmental Engineering	-	3
Environmental Fluid Mechanics: CE 101 or 103 or 173; or ME 162 or EPS 105 or ESPM/EPS 129 or EPS 181	-	3
Cluster course[2]	-	3
Advanced Mathematics: Math 121A-121B; or Math 110 and 128A; or Statistics 101 and 102; or Statistics 134 and 135; or E 117 and 170	3-4	3-5
Electives: Humanities/Social Studies[1]	3	3
Total	**15-16**	**15-17**
Senior Year		
Advanced Science Sequence[3]	4	4
Cluster Courses[2]	6	3
Free Electives	3	4
Electives: Humanities/Social Studies[1]	-	3
Total	**13**	**14**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.
[2]See cluster courses.
[3]See Advanced Science Course Sequence.
Note: BioE 100; E 110, C111, 124, 140, 193, and 195, cannot satisfy technical requirements.
*__A minimum of 120 units is required for graduation.__

Advanced Science Course Sequence for Environmental Engineering Science	
One of the following sequences of 8-10 units:	
MCB 102, Survey of the Principles of Biochemistry and Molecular Biology, and MCB 112/112L, General Microbiology	
Chemistry 112A, 112B, Organic Chemistry (for students who did not take Chemistry 3A, 3B)	
Chemistry 120A, 120B, Physical Chemistry, and Chemistry 125, Physical Chemistry Laboratory	
Nine units from: EPS 101, Field Geology and Digital Mapping; EPS 105, Hydrogeology; EPS 124, Isotope geochemistry; EPS 108, Geodynamics; EPS 116, Structural Geology and Tectonics; EPS 117, Geomorphology	
EPS 180, Air Pollution; EPS 181, Atmospheric Physics and Dynamics; EPS 182, Atmospheric Chemistry and Physics Laboratory	
Nine units from ESPM 102A, Terrestrial Resource Ecology; ESPM 111, Ecosystem Ecology; ESPM 112, Microbial Ecology; ESPM 126, Environmental Soil Chemistry; ESPM 103, Principles of Conservation Biology; ESPM 120, Soil Characteristics; ESPM 128, Environmental Aqueous Geochemistry; ESPM 131 Soil Microbial Ecology	
Approved Cluster Courses in Environmental Engineering Science[1]	**12 units**
Process Engineering:	
Chem E 140, Introduction to Chemical Process Analysis	
Chem E 142, Chemical Kinetics and Reaction Engineering	
Chem E 150B, Transport and Separation Processes	
Chem E 154, Chemical Engineering Laboratory	
Chem E 170, Biochemical Engineering	
Chem E 170L, Biochemical Engineering Laboratory	
Chem E 171, Transport Phenomena	
Resources Engineering:	
CE 103, Hydrology	
CE 107, Climate Control Mitigation	
CE 113, Ecological Engineering for Water Quality Improvement	
CE 114, Environmental Microbiology	
CE 115, Water Chemistry	
EPS 180 Air Pollution	
ESPM 128, Environmental Aqueous Geochemistry	
ME 140, Combustion Processes	
NE 124, Radioactive Waste Management	

[1]The 12 units of cluster courses are in addition to engineering and science courses used to fulfill other requirements of the program.

Ecology:
ESPM 103, Principles of Conservation Biology
ESPM 104, Modeling and Management of Biological Resources
IB 149, Molecular Ecology
IB 149L, Molecular Ecology Laboratory
IB 151, Plant Physiological Ecology
IB 151L, Plant Physiological Ecology Laboratory
IB 152, Environmental Toxicology
IB 153, Population and Community Ecology
IB 153L, Laboratory in Population and Community Ecology
IB 154, Plant Population and Community Ecology
IB 154L, Laboratory in Plant Population and Community Ecology
IB 162, Evolutionary Biogeography
IB 166, Ecological Genetics
Policy Tools: [1]
Economics C103, Introduction to Mathematical Economics
Economics 104, Advanced Microeconomic Theory
Economics 118, Introductory Applied Econometrics
Economics 126, Industrial Organization: Theory and Evidence
Economics 141, Econometric Analysis
Economics C142, Applied Econometrics and Public Policy
Political Science 131A, Applied Economics and Public Policy
Sociology 105, Introduction to Sociological Methods
Sociology 106, Intermediate Sociological Methods

[1]The following policy courses are recommended for fulfilling the HSS requirements: ARE 161, Advanced Topics in Environmental and Resources Economics; ARE 162, Economics of Water Resources; Econ 125, Economics of the Environment; ERG 100, Energy and Society; ERG 151, Politics of Energy and Environmental Policy; Pub Pol 101, Introduction to Public Policy Analysis; Pub Pol 158, Risk and Uncertainty in Public Policy; Pub Pol 175, Science and Technology Policy.

Geoengineering:
CE 171, Introduction to Geological Engineering
CE 173, Groundwater and Seepage
CE 175, Geotechnical and Geoenvironmental Engineering
CE 176, Waste Containment Systems
CE C178, Applied Geophysics
CE 281, Engineering Geology
CE C172, Introduction to Rock Mechanics
Biology:
MCB 112 and 112L, General Microbiology and Laboratory
MCB 113, Applied Microbiology and Biochemistry
MCB 114, Introduction to Comparative Virology
MCB 116, Microbial Diversity
MCB 130, Cell Biology
MCB 130L, Cell and Developmental Biology Laboratory
MCB 148, Microbial Genomics and Genetics
PMB 120, Biology of Algae
PMB 120L, Laboratory for Biology of Algae
PMB 150, Plant Cell Biology
PMB 150L, Laboratory for Plant Cell Biology
PMB 180, Environmental Plant Biology
Energy:
Architecture 140, Introduction to Energy and Environmental Management
CE 170, Energy, Ecosystems, and Humans
Energy Resources Group 280, Energy Economics
ME 109, Heat Transfer
ME 146, Energy Conservation Principles

Engineering — Undeclared

230 Bechtel Engineering Center #1708
(510) 642-8790
www.coe.berkeley.edu/engsci

Department Overview

The Engineering — Undeclared program is intended for lower division students who are interested in pursuing an engineering education, but who are not yet ready to choose a specialization within engineering. The undeclared option supplements the freshman-sophomore curriculum with seminars and other courses that introduce the student to various engineering fields. After completing this curriculum, the student must transfer into a degree program for the final two years.

The freshman curriculum will provide the maximum flexibility for specializing in all non-Electrical Engineering and Computer Science (EECS) majors. During the freshman year, Undeclared students should meet frequently with their advisor in 308 McLaughlin Hall and with a faculty adviser in order to narrow down their interests before selecting sophomore year courses. Students who are interested in majoring in EECS are advised to follow the EECS curriculum in this announcement. All other students will follow the Undeclared freshman year common curriculum and the requirements for their intended major.

Students in good standing will transfer into their new degree program before the end of sophomore year by submitting a Change of Major Petition to their adviser in 308 McLaughlin Hall or 420 Latimer Hall for Chemical Engineering.

The Undeclared option is administered by the Engineering Science Committee.

Sample Program for Engineering — Undeclared

This program covers those portions of the engineering curriculum that are common to all branches of engineering in the freshman and sophomore years and also identifies appropriate tracks into the various majors. Students in good standing will transfer into their new degree program before the end of sophomore year by submitting a Change of Major petition to their adviser in 308 McLaughlin Hall or 420 Latimer Hall for Chemical Engineering.

Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or Chemistry 4A	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis	3	-
E 7, Introduction to Applied Computing	-	4
Reading and Composition[2]	4	-
Electives: Humanities/Social Studies[2]	-	3
E 92 (Freshman Seminar)	1	-
Total	**16**	**15**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
Electives: Humanities/Social Studies[2]	4	-
Electives (Fall)	1-5	
Attractor Course (e.g., ME 92, CE 92, BioE 24, BioE 25)[3]		
2nd Computer Science Course[8]		
Biology 1B, General Biology[5,6,9]		
E 36, Engineering Mechanics[9,10,11,12,15]		
CE C30, Introduction to Solid Mechanics[10]		
CE 11, Principles of Environmental Engineering and Science[9,10]		
CE 70, Engineering Geology[10]		
Statistics 134, Probability[13]		
Chemistry 112A, Organic Chemistry[14]		
Chem E 140, Introduction to Chemical Process Analysis[14]		
Electives (Spring)		11
Physics 7C, Physics for Scientists and Engineers[5,7,14,15,16]		
E 28, Basic Engineering Design Graphics[10,11,12]		
E 45, Properties of Materials[5,11,12,13,14,15,17]		
CE 60, Structure and Properties of Civil Engineering Materials[10]		
EE 40, Introduction to Electrical Engineering[8]		
EE 100, Electronic Techniques for Engineering[12,13,14,18]		
EPS 50, Introduction to Geology		
Chem E 150A, Transport Processes[14]		
ME C 85, Introduction to Solid Mechanics[11,15]		
ME 40, Thermodynamics[11]		
Total	**13-17**	**15**

[1]Students should discuss this requirement with their faculty advisers: E 7 is the normal choice, but students who feel strongly that they would like to transfer eventually to Electrical Engineering and Computer Sciences may wish to take CS 61A.
[2]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.
[3]The intent of this requirement is to guide students to an eventual choice of a major. Examples of such courses are NE 39, IEOR 39, CE 92, ME 92, MSE 24, EPS 3, or a seminar in mathematics, physics, or chemical engineering. When taken for a grade, some of these satisfy a technical requirement in certain programs in the College. Students should consult their advisers and review their intended department's section of this announcement regarding this point.
[4]Required for transfer to Engineering Physics, Nuclear Engineering; Chemistry 1B or Physics 7C is required for transfer to Civil and Environmental Engineering; Chemistry 1B or Physics 7C or Biology 1A is required for transfer to Mechanical Engineering.
[5]Required for transfer to Bioengineering.
[6]Required for transfer to Option II in Electrical Engineering and Computer Sciences.
[7]Alternative requirement for Mechanical Engineering (see footnote 4).
[8]CS 61A-61B-61C are required by Electrical Engineering and Computer Sciences.
[9]Required for transfer to Environmental Engineering Science.
[10]Required for transfer to Civil and Environmental Engineering.
[11]Required for transfer to Mechanical Engineering.
[12]Required for transfer to Manufacturing Engineering.
[13]Required for transfer to Industrial Engineering and Operations Research.
[14]Required for transfer to Chemical Engineering.
[15]Required for transfer to Materials Science and Engineering.
[16]Required for transfer to Engineering Physics, Nuclear Engineering, Engineering Mathematics and Statistics; alternative requirements for Civil and Environmental Engineering (see footnote 4).
[17]Required for transfer to Nuclear Engineering. Students who have taken E 45 can transfer to Civil and Environmental Engineering; see your faculty adviser for more information.
[18]Nuclear Engineering requires EE 40 or 100.
[19]Required for transfer to Electrical Engineering and Computer Sciences.
Note: Actual courses taken may vary from this suggested curriculum. Total units per semester should be 16.

Industrial Engineering and Operations Research

4141 Etcheverry Hall #1777
(510) 642-5484
www.ieor.berkeley.edu
Chair: Ilan Adler, Ph.D.

Department Overview

The Department of Industrial Engineering and Operations Research combines two closely-related professions concerned with the efficient operation of complex systems. The industrial engineering profession involves the design, organization, implementation, and economic operation of integrated production and service systems using people, materials, and equipment. Areas of application include not only the basic manufacturing and high technology production processes essential to our economy but also service organizations such as banks, health care facilities, libraries, and government agencies. Operations research emphasizes the basic understanding of the functioning of complex systems of technology and management through the development and analysis of mathematical models for the purpose of predicting system behavior and/or optimizing system performance, under economic and technological constraints. In addition to production and service systems described above, application areas include engineering systems such as transportation, energy production and delivery, construction management, and resource extraction; socio-technological problems such as urban services, environmental planning, waste management, and law enforcement systems; and management areas such as financial and investment analysis, resource allocation, risk analysis, and manpower planning. Both professions require a sound preparation in the mathematical sciences such as probability, statistics, and optimization theory, as well as training in economic principles, human performance and organization, and the use of computers to analyze and/or simulate systems. Elective studies can emphasize a particular area of technology or can be broadly based in either management systems or decision methodology.

Undergraduate Program

The undergraduate program in the Department of Industrial Engineering and Operations Research is designed to prepare students for technical careers in production or service industries; alternatively, it provides a strong foundation for those headed for engineering management positions, as well as those intending to go on to specialized graduate study in operations research, industrial engineering, or business administration. The core of the program includes basic science, mathematics, including probability and statistics, and engineering, followed by courses in optimization and stochastic models. These courses form the methodological foundation for upper division IEOR electives involving the analysis and design of production and service systems, information systems, and human work systems and organization, among others. The senior project enables the student to integrate knowledge acquired in other courses and apply it to the solution of actual problems from local industrial firms and government agencies.

The mission of the Department of Industrial Engineering and Operations Research is to educate students to become highly proficient in:

• the quantitative modeling and analysis of a broad array of systems-level decision problems concerned with economic efficiency, productivity, and quality;

• the development and creative use of analytical and computational methods for solving these problems;

• the collection and analysis of data, and the use of database and decision-support tools;

• the comprehension of modeling and uncertainty; and

• to obtain the broader skills, background, and knowledge necessary to be an effective professional in a rapidly changing global economy.

The undergraduate program is accredited under the guidelines for industrial engineering programs by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: (410) 347-7700.

Another program, which combines some of the requirements of the departmental major with those of other majors, deals with manufacturing engineering, a joint offering with the Department of Mechanical Engineering. This program is more tightly structured and offers fewer electives than the major. On the other hand, those students who have particular interests in manufacturing can broaden career opportunities with little or no loss of time.

Industrial Engineering and Operations Research Minor

The department offers a minor in industrial engineering and operations research that is open to all students not majoring in IEOR who have completed the necessary prerequisites for the minor requirements. Information is available at the department office.

Graduate Study

Applicants to the graduate programs in Industrial Engineering and Operations Research should have a bachelor's degree in engineering, physical science, mathematics, or other fields that provide sufficient mathematical preparation.

At the master's level, students may emphasize applied courses, preparing them for professional practice or may follow a more theoretical program intended for those who will pursue doctoral studies. In doctoral programs, students investigate additional major topics in-depth, as well as study two minor fields. A minor may augment the major in several ways, such as to provide a deeper understanding of the theory underlying portions of the major field, or to introduce an area of potential applications.

The paramount requirement of a doctoral degree is the successful completion of a thesis on a subject within the major field. Research areas may include the investigation of the mathematical foundations of, and computational methods for, optimization or stochastic models, including risk analysis. Research also may be undertaken to develop methodologies for the design, planning, and/or control of systems in a variety of application domains, including manufacturing, distribution, material handling, transportation, power generation, health care, financial services, information services, and governmental services.

Graduate students are expected to become proficient in the use of computers. Students should be able to quickly construct simple computer programs and to use software libraries and applications for such tasks as data analysis, optimization, and large scale system simulation.

The department offers a certificate program in logistics, which is cosponsored by the Department of Civil and Environmental Engineering. The department also participates in the management of the technology certificate program, which is jointly sponsored by the College of Engineering and Haas School of Business. The certificate programs are designed to provide focus on courses and campus activities related to logistics and the management of technology, respectively. Students enrolled in an M.S. or an M.Eng. program in either department can meet the certificate requirements by a judicious choice of electives without increasing the total number of credit hours toward their master's degree. Students enrolled in other departments are welcome to participate in the programs.

You may obtain further information about graduate programs in this department by exploring our web site or contacting the department office.

Facilities

The Department of Industrial Engineering and Operations Research has several computing facilities and laboratories: three instructional microcomputer laboratories equipped with a network of Pentium-based personal computers and an advanced computer-applications laboratory equipped with industry-standard software applications. The department also shares several computing facilities that are equipped with microcomputers and workstations. All the workstations are linked on a network connected to the central campus computers. IEOR students also have access to the VLSI microfabrication facility for research in computer-integrated manufacturing systems.

Program in Industrial Engineering and Operations Research		118-126 Units*
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis	3	-
E 7, Introduction to Applied Computing	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3-4
<Optional> Freshman Seminar or E 92 (Survey Course)	<1>	-
Total	**15-16**	**15-16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
Engineering Breadth[2]	4	4
E 120, Engineering Economics	-	3
Self Pace Programming Course (see note #1)	-	1
Electives: Humanities/Social Studies[1]	3-4	3-4
Total	**15-16**	**15-16**
Junior Year		
IEOR 131, Computer Simulation of Industrial Engineering Systems	-	3
IEOR 160, Operations Research I	3	-
IEOR 161, Operations Research II	-	3
IEOR 162, Linear Programming	3	-
IEOR 165, Engineering Statistics, Quality Control and Forecasting	-	3
IEOR 172, Probability and Risk Analysis for Engineering, or Statistics 134, Concepts of Probability	3	-
IEOR Electives[3]	3	3
Electives: Humanities/Social Studies[1]	3-4	3-4
Total	**15-16**	**15-16**
Senior Year		
E 190, Technical Communication	3	-
IEOR 180, Senior Project	-	4
IEOR Electives[3]	6	6
Unrestricted Electives (9 units minimum)	6	3-5
Total	**15**	**13-15**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.

[2]Engineering Breadth: 8 units of Engineering Breadth must be completed; 6 of which must be from the approved list below. (Cannot include BioE 100; E 110, C111, 140, 124 or 195. IEOR courses are permitted.)

CE 70, Engineering Geology
CE 155, Transportation Systems Engineering
EE 40 or 42, Introduction to Microelectronic Circuits or Digital Electronics
CE 11, Engineered Systems and Sustainability
E 28, Basic Engineering Design Graphics
E 36, Engineering Mechanics
E 45, Properties of Materials
ME 105 Thermodynamics
ME 132, Dynamic Systems and Feedback

The other units may consist of any courses in the College of Engineering taken for a grade, except 1-unit courses, 1-unit seminars, or CS 3.

[3]Students must take a minimum of six courses chosen from the categories listed below, including a minimum of three courses from Category A and a minimum of one course from Category B:

Category A
IEOR 130, Methods of Manufacturing Improvement
IEOR 166, Decision Analysis
IEOR 150, Production Systems Analysis
IEOR 151, Service Operations Design and Analysis
IEOR 153, Facilities Planning and Design

Category B
IEOR 115, Industrial and Commercial Data Systems
IEOR 140, Industrial Production and Design (**Note:** The prerequisite is a course in Java programming.)
IEOR 170, Human Factors for Engineering Design
IEOR 171, Introduction to Design of Human Work Systems and Organization

Additional requirements/Notes:
1. A course in Computer Programming must be completed by the end of your sophomore year: CS 9C, 9F, 9G, or any equivalent course work (with evaluation and approved petition) is acceptable.
2. No course can be used to satisfy simultaneously two requirements.

***A minimum of 120 units is required for graduation.**

Manufacturing Engineering

4141 Etcheverry Hall (Industrial Engineering and Operations Research) or 6189 Etcheverry Hall (Mechanical Engineering)

Department Overview

Manufacturing Engineering is an interdisciplinary undergraduate program offered jointly by the Departments of Industrial Engineering and Operations Research and Mechanical Engineering. The emphasis of the program is on how to manufacture products of high quality, including machinery design, plant layout, employee supervision, and economic analysis. The program demands creativity and the ability to solve problems and communicate effectively.

Course topics include computer-aided manufacturing, robotics and automated machining, production systems analysis, properties of materials, systems design and synthesis, reliability, optimization, quality management, and manufacturing processes. These fundamentals are applied to a variety of manufacturing industries, including integrated circuit, automobile, steel, and electronics.

Undergraduate Program in Manufacturing Engineering	120-129 Units	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 28, Graphic Communication in Engineering	3	-
Electives[1]	4	7
Total	**15**	**15**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
E 36, Engineering Mechanics I (Statics)	-	2
E 45, Properties of Materials	3	-
E 7, Introduction to Computer Programming for Scientists and Engineers	-	4
EE 100, Electronic Techniques for Engineering	-	4
Electives[1]	4	2
Total	**15**	**16**
Junior Year		
ME 104, Engineering Mechanics II (Dynamics)	-	3
E 120, Principles of Engineering Economy	3	-
Statistics 134, Concepts of Probability	3	-
CE 130, Mechanics of Materials	3	-
ME C124, Mechanical Behavior of Engineering Materials	-	3
ME 105, Thermodynamics	-	4
IEOR 130, Modeling and Simulation of Dynamic Systems, or IEOR 131, Computer Simulations of Industrial Systems	-	3
E 102, Introduction to Operations Research	3	-
IEOR 140, Introduction to Industrial Production Methods	-	3
Electives[1]	2	-
Total	**14**	**16**
Senior Year		
IEOR 165, Forecasting, Quality Control, and Quality Assurance	3	-
IEOR 150, Production Systems Analysis	3	-
IEOR 153, Facilities Planning and Design	3	-
ME 101, Introduction to Manufacturing Systems	3	-
ME 102B, Mechanical Engineering Design, or IEOR 180, Senior Project	3-4	4
Electives[1]	0-3	10-15
Total	**15-19**	**14-19**

[1]Electives must include the following: (1) Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year. The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses; (2) Four units of lower division engineering, mathematics, statistics, or physical science courses approved by the adviser; and (3) two courses from each of the following two groups:

Group 1:

ME 110, Project Engineering	3 units
ME 122, Processing of Materials in Manufacturing	3 units
ME 128, Computer-Aided Mechanical Design	3 units
ME 130, Mechanism and Dynamics of Machinery	3 units
ME 133, Mechnical Vibrations	3 units
ME 134, Automatic Control Systems	4 units
ME 135, Design of Microprocessor-Based Mechanical Systems	4 units
ME 136, Mechatronics and Robotics Design	4 units

Group II:

IEOR 115, Industrial and Commercial Data Systems	3 units
IEOR 131 Computer Simulation of Industrial Engineering Systems	3 units
IEOR 161, Operations Research	3 units
IEOR 162, Linear Programming	3 units
IEOR 166, Decision Analysis	3 units
IEOR 170, Human Factors for Engineering	3 units

Materials Science and Engineering

210 Hearst Memorial Mining Building #1760
(510) 642-3801
www.mse.berkeley.edu
Chair: Robert O. Ritchie, Sc.D.

Department Overview

The Department of Materials Science and Engineering administers undergraduate and graduate programs in materials science and engineering. In addition, undergraduate students may be admitted to one of several joint major programs.

Materials science and engineering encompasses all natural and man-made materials — their extraction, synthesis, processing, properties, characterization, and development for technological uses. Advanced engineering activities that depend upon optimized materials include the medical device and healthcare industries, electronics and photonics, transportation, advanced batteries and fuel cells, and the emerging field of nanotechnology.

Students in materials science and engineering apply a basic foundation of mathematics, chemistry, physics, and engineering to fields of specialization that include: biomaterials; chemical and electrochemical materials science and engineering; computational materials science and engineering; electronic, magnetic and optical materials; and structural materials. Nanoscale science and engineering play an important role in all of these specializations.

Biomaterials

Traditionally, biomaterials encompass synthetic alternatives to the native materials found in the human body. A central limitation in the performance of traditional materials used in the medical device, biotechnological, and pharmaceutical industries is that they lack the ability to integrate with biological systems through either a molecular or cellular pathway, which has relegated biomaterials to a passive role dictated by the constituents of a particular environment, leading to unfavorable outcomes and device failure. The design and synthesis of materials that circumvent their passive behavior in complex mammalian cells is the focus of the work conducted within the MSE department at UC Berkeley.

Chemical and Electrochemical Materials Science and Engineering

This area comprises both the chemical and electrochemical processing of materials and the chemical and electrochemical behavior of materials. The former includes the scientific and engineering principles utilized in mineral processing, smelting, leaching and refining materials, along with numerous etching and deposition techniques. The latter includes the environmental degradation of materials, the compatibility of materials with specific environments, and the fundamental science and engineering development of materials used in advanced energy storage devices.

Computational Materials Science and Engineering

Computational methods are becoming increasingly useful in all facets of materials science and engineering. Such methods range from the theoretical prediction of the electronic and structural properties of materials to modeling fluid flow in advanced batteries or the chemical kinetics and equilibria in a materials-processing operation.

Electronic, Magnetic and Optical Materials

This group of materials is defined by its functionality. Semiconductors, metals, and ceramics are used today to form highly complex systems, such as integrated electronic circuits, optoelectronic devices, and magnetic and optical mass storage media. In intimate contact, these various materials, with precisely controlled properties, perform numerous functions, including the acquisition, processing, transmission, storage, and display of information. Materials research in this area combines the fundamental principles of solid state physics and chemistry with electrical engineering, chemical engineering, and materials science and engineering.

Materials for Energy Technologies

Materials play a crucial enabling role in the energy technologies. All facets of energy harvesting, conversion, storage, delivery, and conservation are included in this topic. Specific examples include photovoltaics, nuclear materials, thermoelectrics, fuel cells, mechanical transducers, batteries, low-loss conductors, low-density structural materials for weight savings, and integrated materials systems for automated control of energy utilization. Technical courses relevant to this field of study are selected from undergraduate offerings in Materials Science and Engineering, Chemical Engineering, Nuclear Engineering, and Mechanical Engineering, and one course on energy policy may also be included.

Nanomaterials

The science of materials at the nanoscale provides a rich scholarly focus at the confluence of basic science (physics, chemistry, biology, and mathematics) and the engineering disciplines. This interdisciplinary focus will provide undergraduates with a comprehensive view of the key materials science issues in nanoscience and nanotechnology. Several courses on nanoscale processing, characterization, and computational approaches to understand nanomaterials are being offered under this concentration.

Structural Materials

This area focuses on the relationships between the chemical and physical structure of materials and their properties and performance. Regardless of the material class — metallic, ceramic, polymeric, or composite — an understanding of structure-property relationships provides a scientific basis for developing engineering materials for advanced applications. Fundamental and applied research in this field respond to an ever-increasing demand for improved or better-characterized materials.

Undergraduate Program

Undergraduate students in the MSE curriculum pursue a program that applies the principles of mathematics, physics, chemistry, and engineering to materials systems. The program emphasizes the relationships among these underlying principles and the structure, properties, processing, and performance of materials. Students learn to apply and integrate their understanding of materials structure, properties, processing, and performance to materials selection and design problems. The program introduces relevant experimental and computational methods and includes technical electives. Courses selected to satisfy these requirement are chosen to emphasize biomaterials, electronic materials, materials physic and chemistry, structural materials, or follow a general emphasis.

Joint Majors

Students in Materials Science and Engineering may combine their course work with a program of study in Electrical Engineering and Computer Sciences, Mechanical Engineering, Nuclear Engineering, or Chemical Engineering. Joint major programs are designed to provide foundations in two major fields of engineering.

See the Joint Majors section of this announcement for detailed curricula.

Materials Science and Engineering Minor

The department offers a minor in materials science and engineering that is open to all students not majoring in MSE who have completed the necessary prerequisites for the minor requirements. Information is available at the department office.

Graduate Study

Qualified holders of the bachelor's degree in fields such as materials science and engineering, ceramic engineering, metallurgy, physics, chemistry, and various fields of engineering can all successfully undertake graduate study in materials science. A combination of course work and research normally leads to the M.S., M.Eng., and Ph.D. degrees, qualifying the graduate for a wide range of positions in industry, governmental organizations, or universities that entail research or engineering in the production, development, and use of materials. The course work includes a core program in materials science and engineering, along with additional courses that provide breadth. Topics for graduate research include: biomaterials; chemical and electrochemical materials science and engineering; computational materials science and engineering; electronic, magnetic, and optical materials; materials for energy technologies; nanomaterials; and structural materials. There is also a designated emphasis in nanoscale science and engineering (see the NSE section of this announcement).

Facilities

Instruction and research in the Department of Materials Science and Engineering are supported by excellent and extensive facilities located on the Berkeley campus and within the Lawrence Berkeley National Laboratory (LBNL). Campus facilities for materials synthesis and characterization are found in Hearst Memorial Mining Building, Berkeley's Microfabrication Laboratory, and the Integrated Materials Laboratory. At Lawrence Berkeley National Laboratory, several unique facilities used by materials scientists and engineers are found in the Materials Sciences Division (MSD), at the National Center for Electron Microscopy (NCEM), the Advanced Light Source (ALS), and the National Energy Research Scientific Computing Center (NERSC). Further details on these and other facilities for teaching and research can be found by visiting the department's web site.

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.

[2]Technical electives must include at least twenty-one (21) units of upper division courses and may be chosen from a single area of technical emphasis: Biomaterials, Electronic Materials; Materials Physics and Chemistry; Nanomaterials; Structural Materials; or a general emphasis that includes an integrated course sequence in another engineering field, physics, chemistry, or mathematics. Technical electives cannot include E 124, 195; or BioE 100.

Undergraduate Program in Materials Science and Engineering — 122-123 Units

The program in Materials Science and Engineering consists of the core program shown below plus 21 upper division technical units in one of the five options listed below:

- Biomaterials
- Electronic Materials
- Materials Physics and Chemistry
- Structural Materials
- General

Core Program

Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis	3	-
E 7, Introduction to Applied Computing	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3
<Optional> Freshman Seminar or E 92 (Survey Course)	<1>	<1>
Total	**15-16**	**15-16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
ME C85, Introduction to Solid Mechanics	3	-
E 45, Properties of Materials	-	3
Chemistry 1B or 4B, General Chemistry	-	4
Electives: Humanities/Social Studies[1]	6	-
Total	**17**	**15**
Junior Year		
E 115, Engineering Thermodynamics	4	-
E 117, Methods of Engineering Analysis	3	-
MSE 102, Bonding, Crystallography and Crystal Defects	3	-
MSE 103, Phase Transformations and Kinetics	-	3
MSE 104, Characterization of Materials	-	4
MSE 111, Properties of Electronic Materials -	-	4
Electives: Humanities/Social Studies[1]	3	3
Technical Electives[2]	3	3
Total	**16**	**17**
Senior Year		
MSE 112, Corrosion	-	3
MSE C113, Mechanical Behavior of Materials	3	-
MSE 130, Experimental Materials Science	3	-
Chem E C178, Polymer Science and Technology	3	-
Technical Electives[2]	6	9
Total	**15**	**12**

Biomaterials Emphasis
Core Program plus the following:

Junior Year	*Fall*	*Spring*
Technical electives approved for emphasis in Biomaterials[1]	3	-
MSE C118, Biological Performance of Materials	-	3
Total	**3**	**3**
Senior Year		
Courses approved for emphasis in Biomaterials[1]	6	9
Total	**6**	**9**

Electronic Materials Emphasis
Core Program plus the following:

Junior Year	*Fall*	*Spring*
MSE 117[2], Properties of Dielectric and Magnetic Materials	3	-
Courses approved for emphasis in Electronic Materials[2,3]	-	3
Total	**3**	**3**
Senior Year		
MSE 123, Semiconductor Processing	3	-
MSE 125, Thin-Film Materials Science	-	3
Courses approved for emphasis in Electronic Materials[2,3]	3	6
Total	**6**	**9**

Materials Physics and Chemistry Emphasis
Core Program plus the following:

Junior Year	*Fall*	*Spring*
Courses approved for emphasis in Materials Physics and Chemistry[4]	3	3
Total	**3**	**3**
Senior Year		
Courses approved for emphasis in Materials Physics and Chemistry[4]	6	9
Total	**6**	**9**

Structural Materials Emphasis
Core Program plus the following:

Junior Year		
MSE 122, Ceramic Processing	3	-
Courses approved for emphasis in Structural Materials[5]	-	3
Total	**3**	**3**
Senior Year		
ME 127, Composite Materials: Analysis, Design, Manufacture	3	-
CE 131, Advanced Mechanics of Materials	3	-
Courses approved for emphasis in Structural Materials[5]	-	9
Total	**6**	**9**

[1]Technical electives in the Biomaterials emphasis must include one (1) MSE 120 series course and the remaining courses from the following approved list. (Consult the *General Catalog* for prerequisites.) Substitution of courses not on this list requires adviser approval.

- Chem E 170, Biochemical Engineering (3)
- Chemistry 112A-112B, Organic Chemistry (5),(5)
- Chemistry 112BX, Organic Chemistry: Lecture Only (3)
- Chemistry 130A-130B, Biophysical Chemistry (3),(3)
- ME C176, Orthopaedic Biomechanics (3)
- Molecular and Cell Biology 100, General Biochemistry (4)
- Molecular and Cell Biology 102, Survey of the Principles of Biochemistry and Molecular Biology (4)
- Molecular and Cell Biology 110, General Biochemistry and Molecular Biology (4)

[2]MSE 117 is offered in the spring of odd-numbered years. Students take this course during their junior or senior year, depending upon when MSE 117 is available.

[3]Technical electives in the Electronic Materials emphasis must be taken from the following approved list. (Consult the *General Catalog* for prerequisites.) Substitution of courses not listed below requires adviser approval.

- CE 179, Process Technology of Solid State Materials Devices (3)
- EE 100, Electronic Techniques for Engineering (4), (or EE 40, Introduction to Microelectronic Circuits if taken as a sophomore) (4)
- EE 130, Integrated-Circuit Devices (4)
- MSE 120 series course (other than 123 and 125)
- Physics 137A-137B, Quantum Mechanics (4),(4)
- Physics 141A-141B, Solid-State Physics (4),(3)

[4]Elective in the Materials Physics and Chemistry Emphasis must include one (1) MSE 120 series course and the remaining units from the following approved list. (Consult *General Catalog* for prerequisites.) Substitution of courses not listed below requires adviser approval.

- Chemistry 104A and/or 104B, Advanced Inorganic Chemistry (3),(3)
- Chemistry 105, Advanced Quantitative Analysis (4)
- Chemistry 120A and/or 120B, Physical Chemistry (3),(3)
- Chemistry 125, Physical Chemistry Laboratory (3)
- Chemistry 112A and/or 112B and/or 112H, Organic Chemistry (5),(5)
- MSE 117, Dielectric, Magnetic and Optical Properties of Materials (3)
- Physics 110A and/or 110B, Electromagnetism and Optics (4),(4)
- Physics 112, Introduction to Statistical and Thermal Physics (4)
- Physics 137A-137B, Quantum Mechanics (4),(4)
- Physics 141A-141B, Solid-State Physics (4),(3)
- Physics 180, Physics of Energy Conversion and Use (3)

[5]Electives in the Structural Materials emphasis must include one (1) MSE 120 series course and the remaining units from the following approved list. (Consult *General Catalog* for prerequisites.) Substitution of courses not on this list requires advisor approval.

- CE 120, Structural Engineering (3)
- CE 122, Design of Steel Structures (3)
- CE 140, Failure Mechanisms in Civil Engineering Materials (3)
- ME C117, Structural Aspects of Biomaterials (3)
- ME C223, Polymer Engineering (3)
- MSE C214, Micromechanics (3)

Energy Technology Emphasis
Core Program plus the following:

Junior Year	*Fall*	*Spring*
MSE 119, Materials in Energy Systems[1]	3	-
Courses approved for emphasis in Energy Technology[2]	-	3
Total	**3**	**3**
Senior Year		
Courses approved for emphasis in Energy Technology[2]	6	9
Total	**6**	**9**

[1]New course, submitted for approval during fall of 2006
[2]Electives in the Energy Technology Emphasis must include one (1) MSE 120 series course; at least six (6) units in the topic of "energy and society," taken from the following approved list. (Consult the *General Catalog* for prerequisites.)

CE 107, Climate Change Mitigation (3)
Earth and Planetary Science 170AC, Crossroads of Earth Resources and Society (4)
Earth and Planetary Science C180, Air Pollution (3);
Energy Resources Group 100, Energy and Society (4)
Energy Resources Group 151, Politics of Energy and Environmental Policy (4)

and at least six (6) units in "energy generation and conversion," taken from the following approved list. (Consult the *General Catalog* for prerequisites.)

Chem E 176, Principles of Electrochemical Processes (3)
Energy Resources Group 120, Renewable Resources for Electric Generation (3)
NE 161, Nuclear Power Engineering (3)
NE 180, Introduction to Controlled Fusion (3).

The remaining three (3) units may be taken from either topical area. Substitution of courses not on this list requires adviser approval.

Nanomaterials Emphasis
Core Program plus the following:

Junior Year	*Fall*	*Spring*
MSE 110, Introduction to Nanomaterials[1]	3	-
EE 143, Microfabrication Technology	-	4
Total	**3**	**4**
Senior Year		
MSE 125, Thin-Film Materials Science	-	3
Courses approved for emphasis in Nanomaterials[2]	6	6
Total	**6**	**9**

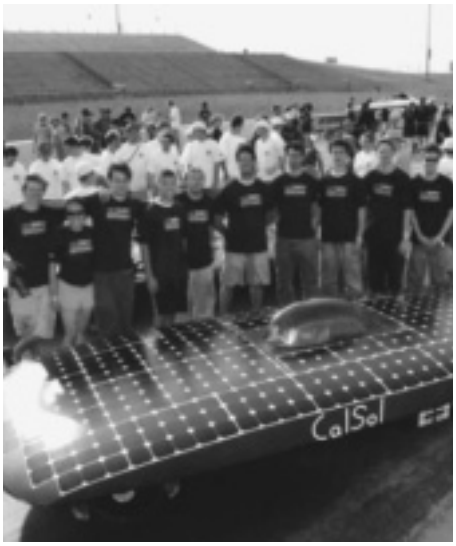
[1]New courses, submitted for approval during fall of 2006
[2]Electives in the Nanomaterials emphasis must be taken from the following approved list. (Consult the *General Catalog* for prerequisites.) Substitution of courses not on this list requires adviser approval.

Chem E 179, Process Technology of Solid State Materials Devices (3)
ME 118, Introduction to Nanotechnology and Nanoscience (3)
ME 199, Introduction to Microelectromechanical Systems (3)
MSE 114[1], Nanocharacterization (3)
MSE 115[1], Computational Materials Science (3)

General Emphasis
Core Program plus the following:

Junior Year	*Fall*	*Spring*
Technical Electives[1]	3	3
Total	**3**	**3**
Senior Year		
Technical Electives[1]	6	9
Total	**6**	**9**

[1]Technical electives in the General Emphasis must include one (1) MSE 120 series course and eighteen (18) additional units of upper division technical electives, chosen to meet individual educational objectives. A minimum of three (3) courses, selected in agreement with the faculty adviser, should constitute an integrated program in another engineering field, physics, chemistry, or mathematics. Technical electives cannot include E 124 or 195.



Mechanical Engineering

6141 Etcheverry Hall, #1760
(510) 642-1338
www.me.berkeley.edu
Chair: Albert P. Pisano, Ph.D.

Department Overview

Mechanical engineers serve society by solving problems in transportation, energy, the environment, and human health. The activity of mechanical engineers extends from investigation of physical phenomena governing the behavior of our surroundings to the manufacture and evaluation of products. The technical domain of the mechanical engineering profession encompasses topic areas, including acoustics, automatic control, bioengineering, combustion, cryogenics, design, dynamics, energy conversion, engines, environment, heat transfer, lubrication, mass transfer, manufacturing, materials processing, mechanics of solids and fluids, mechanisms, petroleum, plasma dynamics, propulsion, thermodynamics, vibration, and wave propagation.

Undergraduate Program

The undergraduate program in mechanical engineering seeks to provide students with a broad education emphasizing an excellent foundation in scientific and engineering fundamentals. Students are supplied with the tools to synthesize their engineering knowledge and apply it to the analysis of performance and design. The capstone of the program is the senior design experience, which assists in developing a deep understanding of the process.

To meet the needs of its two primary constituencies — industry and mechanical engineering graduate programs — the objectives of the undergraduate program are to produce graduates who:

• Vigorously engage in post-baccalaureate endeavors, whether in engineering graduate study, engineering practice, or the pursuit of other fields, such as science, law, medicine, business, or public policy

• Apply their mechanical engineering education to address the full range of technical and societal problems with creativity, imagination, confidence, and responsibility.

• Actively seek out positions of leadership within their profession and their community.

• Serve as ambassadors for engineering by exhibiting the highest ethical and professional standards and communicating the importance and excitement of this dynamic field.

This program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD21202-4012; telephone: (410) 347-7700.

Joint Majors

Joint major programs are available with either the Department of Nuclear Engineering or the Department of Materials Science and Engineering. See the Joint Majors section of this announcement for detailed programs.

Mechanical Engineering Minor

The department offers a minor in mechanical engineering that is open to all students not majoring in ME who have completed the necessary prerequisites for the minor requirements. Information is available on the student information section of the mechanical engineering web site or at the department office.

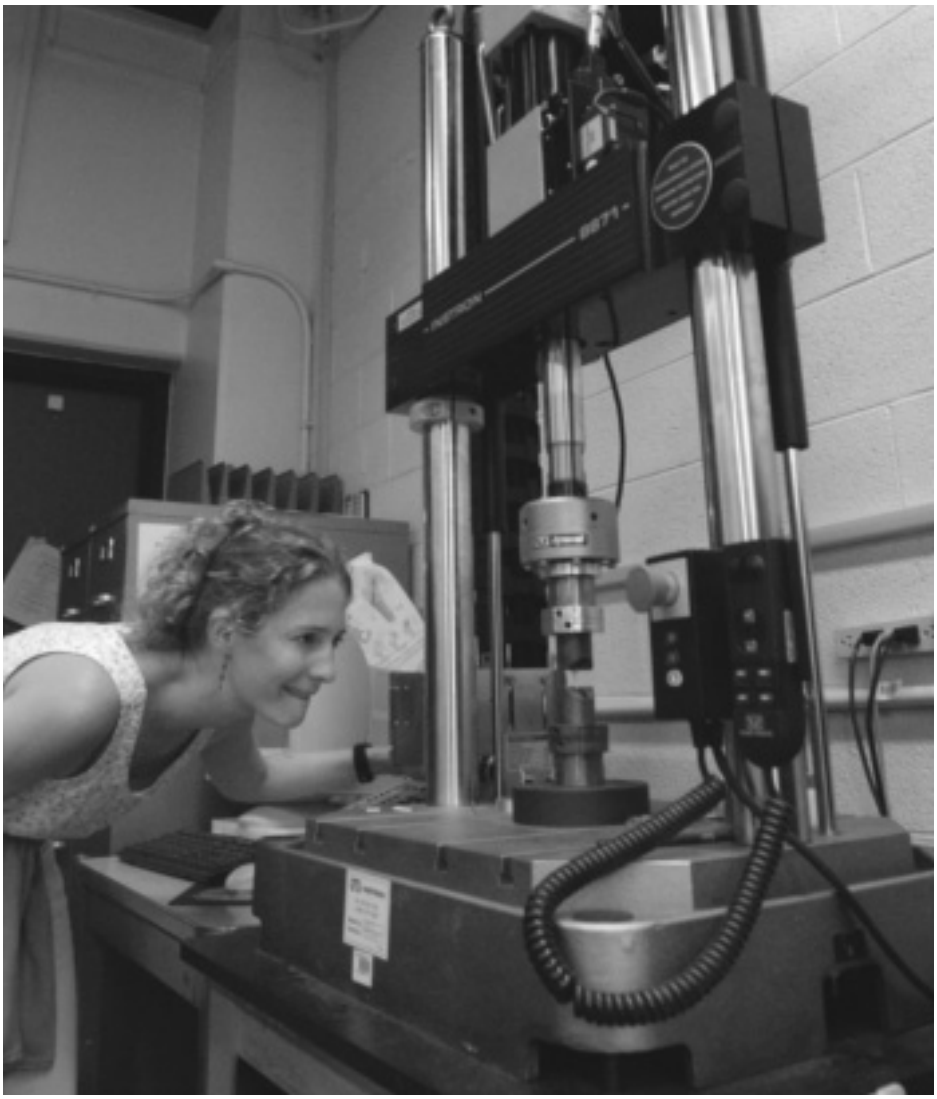
Graduate Study

Increasing demands for technical competence in engineering make it advisable for many students of suitable scholarship to continue their studies for an advanced degree. The department offers a complete program of graduate study and research in both traditional and innovative areas within mechanical engineering. It also participates in several interdisciplinary programs.

See the department web site for more information on graduate study.

The major areas of study are bioengineering, computer mechanics, controls and dynamics, energy and the environment, fluid and solid mechanics, manufacturing process, materials and design, microelectromechanical systems (MEMS), nanosystems, ocean engineering, and thermodynamics. Active interdisciplinary programs include bioengineering and environmental engineering. Degrees offered are M.S., M.Eng., Ph.D., and D.Eng. A professional-type terminal M.S. degree is also offered.

For further details and specific areas of concentration, please consult the graduate admission section of the mechanical engineering web site or contact the department.



Facilities

The Department of Mechanical Engineering maintains state of the art laboratories in Etcheverry Hall and Hesse Hall on campus, as well as the Richmond Field Station.

Faculty and researchers collaborate extensively and share facilities with the Orthopaedic Surgery, Neurological Surgery, Radiology, and Medicine units at UC San Francisco; the VAMC in San Francisco; Lawrence Livermore National Laboratory; and Lawrence Berkeley National Laboratory.

The department's other state of the art facilities include:

- The Automatic Control and Instrumentation Laboratory
- The Berkeley Expert Systems Technology Laboratory
- The Berkeley Instructional Technology Studio (BITS)
- The Berkeley Manufacturing Institute. Five main laboratory areas comprise the BMI:
    1. The Design Studio
    2. The Computer-Aided Design and Manufacturing Laboratory
    3. The Rapid Prototyping Studio
    4. The Laboratory for Manufacturing and Sustainability (LMAS). The Precision Manufacturing Laboratory
    5. The Integrated Manufacturing Laboratories
- Laboratories devoted to bioengineering include:
    1. The Biofluid Mechanics Laboratory
    2. The Orthopaedic Biomechanics Laboratory
    3. The Biomaterials Testing Facility
    4. The Bio-Thermal Engineering Laboratory
- The Combustion Laboratories
- The Composite Materials Laboratory
- The Computational Fluid Dynamics Laboratory
- The Computational Marine Mechanics Laboratory (CMML)
- The Computational Solid Mechanics Laboratory (CSML)
- The Computer Mechanics Laboratory (CML)
- The UC Berkeley Electro-Mechanical Design Laboratory
- The Environmental Restoration Laboratory
- The Fluid Mechanics Laboratories
- The Heat and Mass Transfer Laboratory
- The Human Engineering and Robotics Laboratory
- The Impact and Biomechanics Laboratory
- The Impact and Wave Propagation Laboratory
- The Laser Thermal Laboratory
- The Mechanical Behavior of Materials Laboratories
- The MEMS Analysis and Design Laboratory
- The Multiphase Transport Laboratory
- The Nanobiology Laboratory
- The Nanoengineering Laboratory (NanoLab)
- The Nano/Microsystems Laboratory
- The Richmond Model-Testing Facility
- The Robotics and Motion Control Laboratory
- The research conducted at the Surface Mechanics and Tribology Laboratory (SMTL)
- The Telerobotics and Neurology Unit
- The Transport in Porous Media Laboratories
- The Vehicle Dynamics and Control Laboratory (VDL)
- The Vibration and Dynamics Laboratories

For more information on research facilities, see the laboratories section of the mechanical engineering web site.

Undergraduate Program in Mechanical Engineering		119-121 Units*
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis[1]	3	-
E 7, Introduction to Applied Computing[1]	-	4
Reading and Composition[2]	4	-
Electives: Humanities/Social Studies[2]	-	4
<Optional> Freshman Seminar or E 92 (Survey Course)	<1>	<1>
Total	**15-16**	**16-17**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
E 28, Graphic Communication in Engineering	3	-
ME C85, Introduction to Solid Mechanics	-	3
ME 40, Thermodynamics	-	3
Electives: Humanities/Social Studies[2]	3	4
Total	**14**	**14**
Junior Year		
ME 108, Mechanical Behavior of Engineering Materials	4	-
ME 104, Engineering Mechanics II (Dynamics)	3	-
ME 106, Fluid Mechanics	3	-
ME 132, Dynamic Systems and Feedback	-	3
EE 100, Electronic Techniques for Engineering	-	4
ME 109, Heat Transfer	-	3
Technical Electives[3]	3	3
Electives: Humanities/Social Studies[2]	3	3
Total	**16**	**16**
Senior Year		
ME 102A, Experimentation and Measurement	3	-
E 190M, Technical Communication for Mechanical Engineers	1	-
ME 102B, Mechanical Engineering Design	-	3
ME 107, Mechanical Engineering Laboratory	-	3
Technical Electives[3]	6	6
Upper Division Electives[4]	3-4	3
Total	**13-14**	**15**

[1]If prerequisites are met, students are encouraged to take E 7 during the fall and E 10 during the spring.

[2]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.

[3]Technical Electives: 18 units of technical electives are required, of which at least 15 must be from upper-division elective mechanical-engineering-sponsored courses. Of these 15 units, 3 units must be an elective design course selected from the following list:

- E 128, Advanced Engineering Design Graphics
- ME 101, High Mix/Low Volume Manufacturing
- ME 110, Introduction to Product Development
- ME 119, Introduction to MEMS
- ME 128, Computer-Aided Mechanical Design
- ME 130, Design of Planar Machinery
- ME 135, Design of Microprocessor-Based Mechanical Sytems
- ME 142, Heating, Air Conditioning, and Refrigeration
- ME 145, Computer-Aided Thermal Design (if used as quantitative elective, then cannot be used again as design elective)
- ME 165, Ocean-Environment Mechanics

Also, one of the technical elective courses must be taken from the quantitative science list below:

- E 117, Methods of Engineering Analysis
- E 170, Introduction to Modeling and Simulation
- E 177, Advanced Programming with MATLAB
- Math 128A, Numerical Analysis
- ME 145, Computer-Aided Thermal Design (if used as quantitative elective, then cannot be used again as design elective)
- ME C180, Engineering Analysis Using the Finite Element Method

Students can receive up to 3 units of technical elective credit for work on a research project in ME H194, Honors Undergraduate Research. Any upper division course taught by mechanical engineering faculty may be used as part of the 15 units of upper-division mechanical engineering courses. The other technical elective units can be chosen from courses in engineering, physical science, mathematics, or statistics. The engineering courses not usable for the ME technical elective units are E 24, 39, 92, 110, 111, 115, 124, 140, 193 195, and 198, and BioE 100. Physical science is defined to include physics, chemistry, biochemistry, chemical engineering, and the biological sciences.

No more than one lower division course taken from the approved list of Lower Division Technical Electives can be used to satisfy part of the technical elective requirement. This list consists of the following courses: Astronomy 7A; Biology 1A, 1B; Chemistry 1B, 5; Molecular and Cell Biology 11, 32 (32L not required); and Statistics 20, 25.

[4]Upper Division Electives: This course can be chosen at the student's discretion.

***A minimum of 120 units is required for graduation.**

Mechanical Engineering Options Electives

Upper Division Technical Electives

The following groups of electives are presented to aid undergraduates in focusing their choices on specific professional goals. Each group contains more technical elective courses than can be taken within the standard allowance (for requirements see footnotes in the Undergraduate Program). Of the 18 technical elective units required in the ME program, 15 units must be upper division ME electives. The electives selected need not be from any single group.

Biomechanical Engineering. Biology 1A; BioE C212, C213, 214, 290A; EE C145B, 145L, 145M; ME C117, 127, 133, 134, 135, 142, 166, C176; Integrative Biology 131, 132; Molecular and Cell Biology 32*, 130.

Combustion. Chem E 140, 141, 142; CE 111; E 117; ME 140, 151.

Computer-Aided Engineering. E 28, 128, 177; ME 128.

Controls. ME 132, 133, 134, 135, 175, 190L, 190Y, 146; EE 120, 128; E 119, 177

Energy. ME 140, 142, 145, 146.

Environmental Engineering. E 191; ME 110, 140, 142, 151, 165, 173; CE 104N, 111, 173, 175; NE 162; Suggested non-technical courses: Architecture 100A, 100B, 140; Geography 144.

Fluid Mechanics and Aeronautics. E 117; ME 133, 134, 151, 163, 165, 167, 173, 175, 185; CE 131.

General Mechanical Engineering. E 117, 128, 191; ME 110, 133, 134, 165, 173, 175.

Heat and Mass Transfer. Chem E 150B, 171; E 117; ME 140, 142, 151.

Materials Processing and Manufacturing Management. E 102, 120; ME 101, 110, 122, 127, 128, 133, 134, 151; IEOR 115, 140, 170, 180.

Mechanical Engineering Design. E 128; ME 110, 118, 119, 127, 128, 130, 132, 133, 134, 135, 142, 151, 165, C176.

Mechatronics. ME 101, 128, 130, 132, 133, 134, 135.

Microelectromechanical systems (MEMS). ME 118, 119.

* ME students are not required to take Molecular and Cell Biology 32L with Molecular and Cell Biology 32.

Nuclear Engineering. NE 101, 120, 150; ME 134, 151, 173; Physics 137A.

Ocean Engineering. ME 101, 127, 128, 134, 164, 165, 167; CE 120, 180.

Robotics and Automation. ME 101, 132, 134, 133, 135, 170, 175; EE C125; IEOR 140, 170.

Theoretical and Applied Mechanics. E 117; ME 127, 133, 134, 163, 165, 170, 173, 175, C180, 185; Math 104.

Lower Division Technical Electives

Only *one* course may be used from the following list to meet the 18-unit technical elective requirement, and it must be taken for a letter grade.

Astronomy 7A; Biology 1A, 1B; Chemistry 1B, 5; CE 70; Molecular and Cell Biology 11, 32*; Statistics 20, 25; or any lower division technical course required by another engineering major.

Nuclear Engineering

4153 Etcheverry Hall, #1730
(510) 642-5010
www.nuc.berkeley.edu
Chair: Jasmina L. Vujic, Ph.D.

Department Overview

Nuclear Engineering is concerned with the understanding of nuclear processes and their application in the energy, environmental, manufacturing, materials processing, and medical industries. The teaching and research programs encompass three broad areas: nuclear energy, nuclear waste and materials management, and bionuclear engineering and radiological physics. Much of the curriculum is devoted to the analysis, design, and development of fission and fusion power reactors; the nuclear fuel cycle, including radioactive waste management and disposal; and applications of nuclear science in instrumentation, radiation detection and protection, medical diagnosis and treatment, and materials behavior. Safety and environmental impacts are considered from a risk and systems viewpoint.

Undergraduate Program

The undergraduate curriculum in nuclear engineering is designed to prepare students for a career in industry, national laboratories, or state or federal agencies. The program leading to the B.S. in Nuclear Engineering emphasizes educational experience in several fields of engineering, leading to a concentration on nuclear engineering courses in the upper division. Students can choose one of two options: general nuclear engineering or bionuclear engineering.

Rather than the degree in nuclear engineering, undergraduate students may instead elect a joint major degree program, which combines Nuclear Engineering with Electrical Engineering and Computer Sciences, or with Materials Science and Engineering, or with Mechanical or Chemical Engineering. Compared with the single major program, the joint major programs are more strictly structured and offer fewer opportunities for nontechnical electives. On the other hand, they do afford ambitious students an opportunity to qualify in two fields of engineering with little or no loss in time during their undergraduate careers. Details on the joint major programs are to be found in the Joint Majors section of this announcement.

The mission of the undergraduate program in nuclear engineering is to prepare our students to begin a lifetime of technical achievement and professional leadership in academia, government, national laboratories, and industry. To achieve this mission, the NE undergraduate program is designed to produce graduates who:

• Possess solid knowledge of the fundamental mathematics and natural sciences (both physical and biological) that provide the foundation for engineering applications.

• Understand nuclear processes and the application of general natural science and engineering principles to the analysis and design of nuclear and related systems of current and/or future importance to society.

• Have strong independent learning, analytical, and problem-solving skills, with special emphasis on design, communication, and an ability to work in teams.

• Understand the broad social, ethical, safety, and environmental context within which nuclear engineering is practiced.

• Are aware of the importance of, and opportunities for, lifelong learning.

The B.S. program in nuclear engineering is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: (410) 347-7700.

Nuclear Engineering Minor

The department offers a minor in nuclear engineering that is open to all students who are not majoring in NE and who have completed the necessary prerequisites for the minor requirements. Information is available at the department office.

Graduate Study

The graduate program is divisible into 11 areas, each representing an important aspect of nuclear technology. Course work and research opportunities are available in each area.

Applied Nuclear Physics

Applied Nuclear Physics is concerned with the low-energy nuclear physics and interaction of radiation with matter important to nuclear chemistry, nuclear technology, and applications. Research programs include fundamental nuclear physics measurements for applied purposes and the development of advanced detectors and methodologies, in addition to the application of nuclear techniques in a wide range of studies.

Current emphasis is on experimental and modeling studies in support of neutrino mass measurements, the design of methodologies and systems to counter the possible transport of clandestine nuclear materials, and applications in the biomedical and radiological sciences.

Bionuclear and Radiological Physics

This program is concerned with the biological effects of radiation, dosimetry, radiation shielding, radiation protection, and the development of methods based on the application of radiation for the prevention, diagnosis, and treatment of illness and disease. Research is focused on medical imaging, boron neutron capture therapy, and radioactive tracers, computerized tomography, positron emission tomography, and magnetic resonance imaging.

Nuclear Materials and Chemistry

This area of study is devoted to understanding the many causes of materials degradation and failure in nuclear technology. Specific emphasis is on the behavior of nuclear fuels, cladding and structural materials in nuclear fission and fusion environments where radiation damage and corrosion are the overarching concerns. This research combines computational, experimental, and theoretical techniques to investigate the dynamic response of nuclear materials. The Nuclear Materials Laboratory uses thermogravimetric techniques with microbalances to investigate the hydriding and oxidation of nuclear reactor core materials and positron annihilation spectroscopy to characterize the microstructural changes in irradiated structural steels. In addition to understanding the performance of nuclear fuels and materials in current nuclear fission plants, the materials aspects of new fuel element designs and advanced nuclear fuels and structural material systems are investigated.

Energy and the Environment

This program focuses on renewable and clean energy techniques, particularly solar, wind, and biomass sources. Research and teaching activities focus on the performance, efficiency, economics, and dissemination of these energy systems. The Renewable and Appropriate Energy Laboratory (RAEL) in Etcheverry Hall supports this program area.

Fission Reactor Analysis

Graduate study encompasses the synthesis of the basic components of nuclear technology in the engineering and design of nuclear reactors. Problems of heat removal, stress analysis, reactor dynamics and control, and nuclear reactor safety are considered.

Fusion Science and Technology

This specialty deals with current approaches to the design of a fusion reactor. For both the magnetic and the inertial confinement schemes, problems of particle confinement, plasma heating, reactor materials, fusion reactor neutronics, safety, and environmental impacts are analyzed. Experimental facilities for plasma research include the Berkeley Compact Toroid Experiment (BCTX) on the campus and several large collaborative efforts at Lawrence Livermore National Laboratory and Lawrence Berkeley Laboratory. The Rotating Target Neutron Source (RTNS), an accelerator-based fusion neutron source, is also on the Berkeley campus and is used for fusion neutron studies.

Nuclear Thermal Hydraulics

This area of study is devoted to improving the current understanding of heat and mass transfer, and fluid mechanics processes that transport energy and mass in nuclear systems and govern system performance and safety. Key phenomena studied include conduction, convection, and radiation heat transfer, phase change, and single- and multi-phase flows. In addition to water used to transport heat in present-day reactors, study in this area also covers gas, molten salt, and liquid metal coolants for advanced fission and fusion systems, as well as transport and mixing processes that occur inside reactor containment structures and in environmental systems.

Laser, Particle Beam, and Plasma Technologies

This area of study includes a broad spectrum of new technologies related to charged particles and fields. The topical areas range from interaction of lasers with plasmas to charged particle beam physics, to plasma technologies such as lighting and material processing discharges. Applications range from laser-plasma interactions to discharges for lighting, material modification and microelectronic fabrication; and from microwave-beam interactions for microwave sources and plasma heating to plasma devices such as thrusters, and ion and electron beam sources.

Fuel Cycles and Radioactive Waste

This area of study is devoted to the development of methods and models (theoretical and/or experimental) for analyzing processes that handle nuclear materials from cradle to grave. The methods and models developed are used for evaluating environmental impacts, economics, and proliferation resistance of a fuel cycle, and for designing an optimized fuel-cycle system. Basic research includes the development of deterministic models and the experimental data to support them, probabilistic methods and models, and optimization methods. An initial focus is on the Advanced Fuel Cycle Initiative, which aims at improved use of repository capacity for civilian-spent nuclear fuel from the current light-water reactors, with help of systems for separation and transmutation of problematic radionuclides.

Risk, Safety, and Systems Analysis

This area of study is devoted to the development of methods and models and the acquisition of empirical data for assessing the impacts of large-scale technological systems on public health and safety, and on the environment. Basic research includes the development of deterministic models and the experimental data to support them, probabilistic methods and models, and optimization methods. An initial focus is on Generation IV nuclear energy systems, which integrate the nuclear fuel cycle in terms of high-level radioactive waste disposal, nuclear reactor safety, overall fuel cycle analysis and economics, and safeguards and security. Other complex large-scale systems considered include biological systems, ecological systems, information systems, and electric distribution systems.

Ethics and the Impact of Technology on Society

This program focuses on the emerging ethical and technical issues arising in biotechnology, nanotechnology, information technology, and nuclear technology. The program examines how philosophy, religion and art, and natural and social science can shed light on these issues, as well as how individual and societal values are affected by these technologies.

Further information may be obtained by consulting the web site or contacting the department.

Facilities

The facilities of the department include the Nuclear Waste Research Laboratory, the Renewable and Appropriate Energy Laboratory (RAEL), the Advanced Nuclear Engineering Computational Laboratory, several research and teaching laboratories, and well-equipped mechanical and electronic shops. The neutronics laboratory includes the RTNS 14 Mev neutron source, a variety of radiation-analysis instrumentation, and subcritical multiplying assemblies. The RTNS is also being used for the study of boron-neutron capture therapy. Experimental facilities for the study of thermal problems include two-phase flow and transient-boiling apparatus, and for the study of materials problems include a variety of equipment for high-temperature and high-vacuum experiments. Some nuclear engineering students participate in research at Lawrence Berkeley and Livermore National Laboratories, Los Alamos National Laboratory, and the National Renewable Energy Laboratory (NREL).

General Nuclear Engineering Program — 119-121 Units*

Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis	3	-
E 7, Introduction to Applied Computing -	-	4
<Optional> NE 39, Issues in Nuclear Engineering (recommended)	<2>	-
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3
Total	**15-17**	**15**
Sophomore Year		
Mathematics 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
EE 40, Introduction to Microelectronic Circuits or EE 100, Electronic Techniques for Engineering	-	4
E 45, Properties of Materials	3	-
Electives: Humanities/Social Studies[1]	4	3
Total	**15**	**15**
Junior Year		
E 115, Engineering Thermodynamics	4	-
E 117, Methods of Materials Analysis	3	-
NE 101, Nuclear Reactions and Radiation	4	-
NE 104, Radiation Detection Lab	-	3
NE 150, Nuclear Reactor Theory	-	3
Electives: Humanities/Social Studies[1,2]	4	-
Technical Electives[3]	-	9
Total	**15**	**15**
Senior Year		
NE 170, Nuclear Design	-	3
Electives: Humanities/Social Studies[1]	-	3
Technical Electives[3]	14	9
Total	**14**	**15**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.
[2]Students must take one course with ethics content. This may be fulfilled within the Humanities/Social Studies Electives requirement by taking one of the following courses: BioE 100; E 124 or 195; Anthropology 156B; ESPM 161, 162; Philosophy 2, 104, 107; Political Science 108A; Public Policy 170; Public Health 115; Sociology 116; Legal Studies 19AC, 100A.
[3]32 technical elective units must include at least 17 units of upper division NE courses. Remaining technical elective units must be fulfilled by taking upper division courses in engineering and science but cannot include BioE 100; E 110, 124, 140, 193, or 195.
[4]Students must consult with and obtain approval from their faculty adviser no later than the fall semester of their junior year for their choices of technical elective courses.
[*]**A minimum of 120 units is required for graduation.**

Upper Division Technical Electives

The following groups of electives should help undergraduate students focus their choices on specific professional goals. The electives selected need not be from any single group.

Fission Power Engineering. NE 120, NE 124, ME 106, ME 109 (Chem E 150A may be substituted for ME 106 and ME 109), NE 161, NE 167, NE 175

Nuclear Fuel Cycles and Waste Management. E 120, NE 120, NE 124, NE 161, NE 175, Chem E 150AB, Energy Resources Group 151, MSE 112

Materials in Nuclear Technology. NE 120, NE 124, NE 161, MSE 102, MSE 104, MSE 112, MSE 113

Risk, Safety and Systems Analysis. E 120, NE 120, NE 124, Chem E 150A, NE 161, NE 167, NE 175, CE 193, IEOR 166

Beam and Accelerator Applications. NE 155, NE 180, Physics 110A/B (or EE 117), Physics 129 A/B, Physics 139, Physics 142

Fusion Power Engineering. NE 120, NE 180, NE 155, Physics 110A-110B, Physics 142

Radiation and Health Physics. NE 120, NE 155, NE 162, NE 180

Bionuclear Engineering Program	124-129 Units	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A, General Chemistry[1]	4	-
Chemistry 3A and 3AL, Chemical Structure and Reactivity[1]	-	5
Physics 7A, Physics for Scientists and Engineers	-	4
<Optional> NE 39A, Issues in Nuclear Engineering (recommended)	<2>	-
Computational Science Course[2]	-	4
E 10, Engineering Design and Analysis	3	-
Reading and Composition[3]	4	-
Total	**15-17**	**17**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Biology 1A and 1AL, General Biology	5	-
Physics 7B-7C, Physics for Scientists and Engineers	4	4
EE 40, Introduction to Microelectronic Circuits or EE 100, Electronic Techniques for Engineering	-	4
E 45, Properties of Materials	3	-
Electives: Humanities/Social Studies[3]	-	4
Total	**16**	**16**
Junior Year		
Physics 137A, Quantum Mechanics[4]	4	-
E 117, Methods of Engineering Analysis	3	-
NE 101, Nuclear Reactions and Radiation	4	-
NE 104, Radiation Detection and Nuclear Instrumentation Laboratory	-	3
NE 162, Radiation Biophysics and Dosimetry	3	-
1st Course, Advanced Biology Core[5]	-	3-4
Electives: Humanities/Social Studies[3]	-	9
Total	**14**	**15-16**
Senior Year		
E 115, Engineering Thermodynamics, or Chem E 141, Chemical Engineering Thermodynamics	3-4	-
NE 170B, Nuclear Design	-	3
EE 145B (Bio E C165), Image Processing and Reconstruction Tomography	-	4
2nd Course, Advanced Biology Core[5]	-	3-4
Ethics Course[6]	-	3
Technical Electives[7]	12	3
Total	**15-16**	**16-17**

[1]Pre-Med students ordinarily take Chemistry 1A, 3A/3AL, and 3B/3BL. However, with prior faculty adviser approval, students may take Chemistry 1A, 1B, and 112A, or 4A, 4B, and 112A. **Note:** The alternative sequences do not cover material included in Chemistry 3B/3BL, which is a prerequisite to MCB 102.

[2]Computational course should be selected with the help of a faculty adviser. E 7 or CS 61A is recommended.

[3]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.

[4]Students intending advanced study in nuclear and atomic physics or materials should also take Physics 137B as a technical elective.

[5]Recommended sequence: MCB 102, Survey of the Principles of Biochemistry and Molecular Biology; MCB 130, Cell Biology.

[6]Students must take one course with ethics content. This may be fulfilled within the Humanities/Social Studies Elective requirement by taking one of the following courses: BioE 100; E 124 or 195; Anthro 156B; ESPM 161, 162; Philosophy 2, 104, 107; Political Science 108A; Public Policy 170; Public Health 115; Sociology 116; Legal Studies 19AC, 100A.

[7]15 units of technical electives must include at least 9 units of upper division NE courses. Remaining technical elective units must be fulfilled by taking upper division courses in engineering and science but cannot include BioE 100; E 110, 124, 140, 193 or 195.

Completed in 2007, the 285,000 square foot Stanley Hall houses the Department of Bioengineering and the California Institute for Quantitative Biosciences (QB3) and was designed to promote multidisciplinary interaction and innovation. The atrium (pictured) forms of the heart of the building. ▶

Joint Major Programs

Students may satisfy the requirements for the B.S. degree in two major fields of engineering by electing a joint major program. Both majors will be shown on the student transcript, and the programs are designed to be completed in eight semesters. Joint major students are assigned an adviser in each of their two departments or colleges.

Admission to joint major programs is closed to entering freshmen but open to transfer students. Continuing students may petition for change to joint major programs in the final semester of the sophomore year. Transfer students interested in a joint major with chemical engineering must apply to the College of Chemistry.

The joint major programs presently offered for degrees are listed below (and the detailed curricula are shown in the proceeding pages):

- Bioengineering/Materials Science and Engineering
- Electrical Engineering and Computer Sciences/ Materials Science and Engineering
- Electrical Engineering and Computer Sciences/ Nuclear Engineering
- Materials Science and Engineering/ Mechanical Engineering
- Materials Science and Engineering/ Nuclear Engineering
- Mechanical Engineering/Nuclear Engineering

- Chemical Engineering/Materials Science and Engineering
- Chemical Engineering/Nuclear Engineering

[1]Chemistry 112A/B is intended for students majoring in chemistry or a closely related field and is more intensive than Chemistry 3A/3B. **Note:** Prerequisites to Chemistry 112A/B include Chemistry 1A and 1B (or 4A and 4B). Pre-Med students should take Chemistry 3B and 3BL or 112B, and Biology 1B.

[2]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.

[3]At least one semester of BioE 24 is required. Students may also select BioE 24, 25; MSE 24; or E 92 for optional second semester.

[4]Fulfills Humanities/Social Students and Ethics Content: Anthropology 156B; Environmental Science, Policy, and Management 161, 162; Letters and Science 124; Legal Studies 100A; Philosphy 2, 104, 105, 107; Political Science 108A, 124C; Public Policy 170; E 195; BioE 100; Public Health 115. Fulfills Ethics Content only: E 191, Public Health 116

[5]Choose from the following approved list (consult the *General Catalog* for prerequisites): MSE 103, 112, 113; BioE 116, 121; H194, 290; BioE/MSE 216, C223.

Joint Major Program in Bioengineering and Materials Science and Engineering		**131-132 Units**
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Chemistry 3A and 3AL, Chemical Structure and Reactivity or Chemistry 112A, Organic Chemistry	-	5
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis, or BioE 10, Introduction to Biomedicine for Engineers	3	-
E 7, Introduction to Applied Computing, or CS 61A, Structure and Interpretation of Computer Programs	-	4
Reading and Composition[2]	4	-
<Optional> Freshman Seminar[3]	1	<1>
Total	**16**	**17-18**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
Biology 1A and 1AL, General Biology	-	5
Chemistry 3B, Chemical Structure and Reactivity, or Chemistry 112B, Organic Chemistry[1]	3	-
EE 40, Introduction to Microelectronic Circuits; EE 100, Electronic Techniques for Engineering; or BioE 101, Instrumentation in Biology and Medicine	-	4
E 45, Properties of Materials	3	-
Electives: Humanities/Social Studies[2]	-	3
Total	**14**	**16**
Junior Year		
BioE 102, Biomechanics	4	-
MSE 102, Bonding,Crystallography and Crystal Defects	3	-
BioE 104, Biological Transport Phenomena	-	4
MSE 104, Characterization of Materials	-	4
Chemistry 135, Chemical Biology; MCB 102, Survey of the Principles of Biochemistry and Molecular Biology; or MCB 110, General Biochemistry and Molecular Biology	3	-
E 115, Engineering Thermodynamics; ME 105, Thermodynamics; BioE 105B, Thermodynamics and Biothermodynamics; Chemistry 120B, Physical Chemistry; or Chemistry C130/MCB C100A, Biophysical Chemistry	3	-
Molecular and Cell Biology 130, Cell Biology	-	4
BioE 100 or Humanities/Social Studies course with ethics content[2,4]	-	3
Electives: Humanities/Social Studies[2]	3	3
Total	**16**	**18**
Senior Year		
MSE 130, Experimental Materials Science; or BioE 115, Cell Biology Laboratory for Engineers	3	-
BioE C117, Structural Aspects of Biomaterials	-	4
BioE C118, Biological Performance of Materials	4	-
MSE 112, Corrosion; MSE C113, Mechanical Behavior of Engineering Materials; and/or Bio E 121, Introduction to Micro and Nanobiotechnology: BioMEMS *(Choose 2 of 3)*	3	3
Chem E 178, Polymer Science and Technology, or MSE 151, Polymeric Materials	4	-
Engineering Design Project or Research	-	4
Electives: Humanities/Social Studies[1]	3	3
Technical Elective[4]	-	3
Total	**17**	**17**

Joint Major Program in Electrical Engineering and Computer Sciences and Materials Science and Engineering 128-129 Units

This joint major offers a foundation in materials studies combined with courses emphasizing devices and circuits in EECS. It is especially appropriate as preparation for work on material and technology problems that affect integrated electronics. Students selecting this program have generally found employment in the semiconductor industry. In recent years, the prospect for work in this area has been good. The thrust toward the production of ultra-small structures has led to the need for a fundamental understanding of materials, technologies, and electronics.

Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
E 10, Engineering Design and Analysis	3	-
E 7, Introduction to Applied Computing	-	4
Physics 7A, Physics for Scientists and Engineers	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3
<Optional> Freshman Seminar or E 92 (Survey Course)	<1>	<1>
Total	**15-16**	**15-16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
CS 61A, Structure and Interpretation of Computer Programs	4	-
CS 61B, Data Structures	-	4
E 45, Properties of Materials	3	-
EE 40, Introduction to Microelectronic Circuits	-	4
Electives: Humanities/Social Studies[1]	3	-
Total	**18**	**16**
Junior Year		
EE 105, Microelectronic Devices and Circuits	-	4
Physics 137A, Quantum Mechanics	4	-
EE 20N, Structure and Interpretation of Systems and Signals, or CS 61C, Machine Structures	4	-
MSE 103, Phase Transformations and Kinetics	-	3
MSE 104, Characterization of Materials	-	4
E 115, Engineering Thermodynamics, or Physics 112, Statistical and Thermal Physics	4	-
MSE 102, Bonding, Crystallography, and Crystal Defects	3	-
Statistics 25, Statistics 134, or EE 126, Statistics	-	3
Electives: Humanities/Social Studies[1]	-	3
Total	**15**	**17**
Senior Year		
Physics 141A, Solid State Physics	3	-
MSE 130, Experimental Materials Science	3	-
EE 140, Linear Integrated Circuits, or EE 141, Digital Integrated Circuits	3	-
EE 117, Electromagnetic Fields and Waves	4	-
MSE 111, Properties of Electronic Materials, or EE 130, Integrated Circuit Devices	-	4
E 190, Technical Communication	-	3
Electives: Humanities/Social Studies[1]	3	3
Technical Electives[2]	-	6
Total	**16**	**16**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.

[2]You may substitute Physics 112 for E 115. For technical electives you must include at least one course from the list: EE 119, 143; and CS 150, and at least three (3) units from the MSE 120 series courses. Technical electives cannot include E 124, 195; or BioE 100.

Joint Major Program in Electrical Engineering and Computer Sciences and Nuclear Engineering	125-126 Units	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis	3	-
CS 61A, Structure and Interpretation of Computer Programs	4	-
CS 61B, Data Structures	-	4
Reading and Composition[1]	-	4
Total	**15**	**16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
EE 20N, Structure and Interpretation of Systems and Signals	4	-
EE 40, Introduction to Microelectronic Circuits	-	4
E 45, Properties of Materials	3	-
Electives: Humanities/Social Studies[1]	-	3
Total	**15**	**15**
Junior Year		
E 115, Engineering Thermodynamics	4	-
NE 101, Nuclear Reactions and Radiation	4	-
NE 104, Radiation Detection Lab	-	3
NE 150, Nuclear Reactor Theory	-	3
Statistics 25, Statistics 134, or EE 126, Statistics	-	3-4
E 190, Technical Communication	-	3
Technical Electives[2]	3	-
Electives: Humanities/Social Studies[1]	6	3
Total	**17**	**15-16**
Senior Year		
NE 170A, Nuclear Engineering Design	-	3
Technical Electives[2]	13	13
Electives: Humanities/Social Studies[1]	3	-
Total	**16**	**16**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.
Students must take one course with ethics content. This may be fulfilled within the Humanities/Social Studies Elective requirement by taking one of the following courses: BioE 100; E 124 or 195; Anthropology 156B; ESPM 161, 162; Philosophy 2, 104, 105, 107; Political Science 108A; Public Policy 170, 172; Public Health 115; Sociology 116; Legal Studies 19AC, 100A.

[2]Technical Electives include:

• At least 9 units of upper-division nuclear engineering technical courses. The following groups of electives are presented to aid undergraduate students in focusing their choices on specific professional goals. The electives selected need not be from any single group.
— Fission Power Engineering: NE 120, 124; ME 106, 109 (Chem E 150A may be substituted for ME 106 and 109); NE 161; either NE 175 or 167
— Nuclear Fuel Cycles and Waste Management: NE 120, 124, 161, 175; Chem E 150A-150B; ERG 151
— Materials in Nuclear Technology: NE 120, 124; ME 106, 109 (Chem E 150A may be substituted for ME 106 and 109); NE 161; MSE 102, 104, 113
— Risk, Safety and Systems Analysis: NE 120; ME 106, 109 (Chem E 150A may be substituted for ME 106 and 109); NE 161, 167, 175; CE 193; IEOR 166
— Beam and Accelerator Applications: NE 120, 155, 180; Physics 110A-110B (or EE 117), 129A/B, 139, 142
— Fusion Power Engineering: NE 120, 180, 155; Physics 110AB, 142
— Radiation and Health Physics: NE 120, 155, 162, 180

• At least 20 units of upper division EECS courses, including EE 120, 117, and 105. Here are some suggested electives for depth, arranged by area (at least four courses from one of the groups below):
— Electronics: EE 130, 131, 140, 141, 143; CS 150
— Power Systems and Control: EE 113, 114, 120, 128
— Electromagnetics and Plasmas: EE 118, 119, 239; Physics 137A

Joint Major Program in Materials Science and Engineering and Mechanical Engineering	123-124 Units	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis	3	-
E 7, Introduction to Applied Computing	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3
<Optional> Freshman Seminar or E 92 (Survey Course)	<1>	<1>
Total	**15-16**	**15-16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B, Physics for Scientists and Engineers	4	-
ME C85, Introduction to Solid Mechanics	-	3
ME 40, Thermodynamics	-	3
E 45, Properties of Materials	-	3
E 28, Graphics Communication in Engineering	3	-
Electives: Humanities/Social Studies[1]	3	3
Total	**14**	**16**
Junior Year		
ME 104, Engineering Mechanics II (Dynamics)	3	-
ME 106, Fluid Mechanics	3	-
ME 132, Dynamical Systems and Feedback	-	3
EE 100, Electronic Techniques for Engineering	-	4
MSE 102, Bonding, Crystallography, and Crystal Defects	3	-
MSE 103, Phase Transformation and Kinetics	-	3
ME 108, Introduction to Engineering Materials, or MSE C113, Mechanical Behavior of Engineering Materials	3	-
MSE 104, Characterization of Materials	-	4
Electives: Humanities/Social Studies[1]	3	-
Technical Electives[2]	-	3
Total	**15**	**17**
Senior Year		
ME 102A, Experimentation and Measurement	3	-
ME 102B, Mechanical Engineering Design	3	-
ME 107, Mechanical Engineering Laboratory	-	3
ME 109, Heat Transfer	3	-
MSE 130, Experimental Materials Science	3	-
MSE 112, Corrosion	-	3
E 190M, Technical Communication for Mechanical Engineers	1	-
Electives: Humanities/Social Studies[1]	-	3
Technical Electives[2]	3	6
Total	**16**	**15**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.

[2]A total of 12 upper division technical elective units are required. These must include 6 units of upper-division Mechanical Engineering courses, one of which must be from the following list: ME 101, 110, 119, 128, 130, 135, 142, 145, 161, or 165. In addition, 3 units must be from the MSE 120 series. Technical electives cannot include E 110, 124, 140, 195; or BioE 100.

Joint Major Program in Materials Science and Engineering and Nuclear Engineering	124-125 Units	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis	3	-
E 7, Introduction to Applied Computing	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3
<Optional> Freshman Seminar or E 92 (Survey Course)[2]	<1>	<1>
Total	**15-16**	**15-16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
EE 40, Introduction to Microelectronic Circuits, or EE 100, Electronic Techniques for Engineering	-	4
ME C85, Introduction to Solid Mechanics	3	-
E 45, Properties of Materials	-	3
Electives: Humanities/Social Studies[1]	6	-
Total	**17**	**15**
Junior Year		
E 115, Engineering Thermodynamics	4	-
MSE 102, Bonding Crystallography and Crystal Defects	3	-
NE 101, Nuclear Reactions and Radiation	4	-
MSE 103, Phase Transformation and Kinetics	-	3
MSE 104, Characterization of Materials	-	4
NE 104, Radiation Detection Lab	-	3
NE 150, Introduction to Nuclear Reactor Theory	-	3
Electives: Humanities/Social Studies[1]	3	3
Technical Electives[3]	3	-
Total	**17**	**16**
Senior Year		
MSE 111, Properties of Electronic Materials	-	4
MSE 112, Corrosion	-	3
MSE C113, Mechanical Behavior of Materials	-	3
MSE 130, Experimental Materials Science	3	-
NE 120, Nuclear Materials	4	-
NE 170A, Nuclear Engineering Design	-	3
Technical Electives[3]	9	-
Total	**16**	**13**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses.
Students must take one course with ethics content. This may be fulfilled within the Humanities/Social Studies Elective requirement by taking one of the following courses: BioE 100; E 124 or E 195; Anthropology 156B; ESPM 161, 162; Philosophy 2, 104, 105, 107; Political Science 108A; Public Policy 170, 172; Public Health 115; Sociology 116; Legal Studies 19AC, 100A.
[2]NE 39 also recommended.
[3]Technical electives must include at least 9 units of upper division NE courses and at least 3 units from the MSE 120 series courses. Technical electives cannot include BioE 100; E 124 or 195.

Joint Major Program in Mechanical Engineering and Nuclear Engineering	123 Units	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A or 4A, General Chemistry	4	-
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis	3	-
E 7, Introduction to Applied Computing	-	4
Reading and Composition[1]	4	-
Electives: Humanities/Social Studies[1]	-	3
Total	**15**	**15**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
E 28, Graphics Communication and Engineering	3	-
ME C85, Introduction to Solid Mechanics	-	3
ME 40, Thermodynamics	-	3
Electives: Humanities/Social Studies[1]	3	3
Total	**14**	**17**
Junior Year		
EE 40, Introduction to Microelectronic Circuits, or EE 100, Electronic Techniques for Engineering	-	4
ME 104, Engineering Mechanics II (Dynamics)	3	-
ME 106, Fluid Mechanics	-	3
ME 132, Dynamic Systems and Feedback	-	3
NE 101, Nuclear Reactions and Radiation	4	-
NE 150, Nuclear Reactor Theory	-	3
ME 108, Introduction to Bioengineering Materials	4	-
Electives: Humanities/Social Studies[1]	3	-
Technical Electives[2]	3	3
Total	**17**	**16**
Senior Year		
ME 102A, Experimentation and Measurement	3	-
E 190M, Technical Communication	1	-
ME 102B, Mechanical Engineering Design	-	3
ME 107, Mechanical Engineering Laboratory	-	3
ME 109, Heat Transfer	3	-
NE 104, Radiation Detection Lab	-	3
NE 170A, Nuclear Engineering Design	-	3
Electives: Humanities/Social Studies[1]	3	-
Technical Electives[2]	4	3
Total	**14**	**15**

[1]Humanities/Social Studies Electives include six courses of at least 3 units each in humanities and social studies selected from an approved list of courses. Two of these courses must fulfill the College of Engineering Reading and Composition requirement. **Note:** It is strongly recommended that the first half of the Reading and Composition requirement be completed within the first year (as described in the sample program). The second half must be completed before graduation. Refer to the handout at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall for details and the list of approved courses. Students must take one course with ethics content. This may be fulfilled within the Humanities/Social Studies Electives requirement by taking one of the following courses: BioE 100; E 124 or 195; Anthropology 156B; ESPM 161, 162; Philosophy 2, 104, 105, 107; Political Science 108A; Public Policy 170, 172; Public Health 115; Sociology 116; Legal Studies 19AC, 100A.
[2]Technical elective units include at least 6 units of upper-division elective Mechanical Engineering courses and 6 units of upper division Nuclear Engineering courses.

Joint Major Program in Chemical Engineering and Materials Science and Engineering	131-132 Units	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A-1B or 4A-4B, General Chemistry	4	4
Physics 7A, Physics for Scientists and Engineers	-	4
E 10, Engineering Design and Analysis[1]	3	-
Elective: Reading and Composition[2]	4	-
Elective: Humanities and Social Studies[2]	-	3
<Optional> Freshman Seminar or E 92 (Survey Course)	<1>	<1>
Total	**15-16**	**15-16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
Chemistry 112A, Organic Chemistry	5	-
Chem E 140, Introduction to Chemical Process Analysis	4	-
Chem E 141, Chemical Engineering Thermodynamics	-	3
Chem E 150A, Transport Processes	-	4
E 7, Introduction to Computer Programming for Scientists and Engineers	-	4
Total	**17**	**19**
Junior Year		
Chemistry 120A, Physical Chemistry	3	-
Chem E 142, Chemical Kinetics and Reaction Engineering	-	3
Chem E 150B, Transport and Separation Processes	4	-
Chem E 185, Technical Communication	-	3
EE 100, Electronic Techniques for Engineering	4	-
E 45, Properties of Materials	3	-
MSE 102, Bonding, Crystallography, and Crystal Defects[3]	3	-
MSE 103, Phase Transformations and Kinetics	-	3
MSE Elective[4]	-	3
Electives: Humanities and Social Studies[2]	-	6
Total	**17**	**18**
Senior Year		
Chem E 154, Chemical Engineering Laboratory	3	-
Chem E 157, Transport Processes Laboratory	-	3
Chem E 160, Chemical Process Design	-	4
Chem E 162, Dynamics and Control of Chemical Processes	-	4
MSE 120, Materials Production	3	-
MSE 130, Experimental Materials Science	3	-
MSE Elective[4]	4	-
Electives: Humanities and Social Studies[2]	3	3
Total	**16**	**14**

[1]Freshmen in the College of Engineering are required to take E 10. For other students, a humanities/social studies elective can be moved to the E 10 slot.
[2]Electives must include 19 units in the humanities and social studies which satisfy the requirements of both the College of Chemistry and the College of Engineering. For details, refer to the *Announcement of the College of Chemistry* and the College of Engineering handout. The College of Engineering handout is available at www.coe.berkeley.edu/hssreq.pdf or 308 McLaughlin Hall.
[3]Permission from the MSE 102 instructor is required to take E 45 concurrently.
[4]MSE electives must include one course from MSE 104, 111, 112, C113, 117, C118, 125; and one course from MSE 121, 122, 123, 125. The joint major program must include a minimum of 23 upper division technical units in the College of Engineering. To satisfy the 23-unit requirement, either one of the MSE electives must be four units or an additional course must be taken. Technical electives cannot include E 124, 195; or BioE 100.

Joint Major Program in Chemical Engineering and Nuclear Engineering	125-126 Units	
Freshman Year	*Fall*	*Spring*
Math 1A-1B, Calculus	4	4
Chemistry 1A-1B or 4A-4B, General Chemistry	4	4
Physics 7A, Physics for Scientists and Engineers	-	4
E 7, Introduction to Computer Programming for Scientists and Engineers	-	4
Electives[1]	7	-
Total	**15**	**16**
Sophomore Year		
Math 53-54, Multivariable Calculus, Linear Algebra and Differential Equations	4	4
Physics 7B-7C, Physics for Scientists and Engineers	4	4
Chem E 140, Introduction to Chemical Process Analysis	4	-
Chem E 141, Chemical Engineering Thermodynamics	-	3
Chem E 150A, Transport Processes	-	4
EE 100, Electronic Techniques for Engineering	4	-
Total	**16**	**15**
Junior Year		
E 45, Properties of Materials	3	-
E 117, Methods of Engineering Analysis	3	-
NE 101, Nuclear Reactions and Radiation	4	-
NE 104, Radiation Detection and Nuclear Instrumentation Lab	-	3
NE 150, Nuclear Reactor Theory	-	3
Chem E 142, Chemical Kinetics and Reaction Engineering	-	3
Chem E 150B, Transport and Separation Processes	4	-
Chem E 185, Technical Communication (may be satisfied by examination)	3	-
Electives[1]	-	6
Total	**17**	**15**
Senior Year		
Chemistry 120A, Physical Chemistry	3	-
Chem E 154, Chemical Engineering Laboratory	3	-
Chem E 157, Transport Processes Laboratory	-	3
Chem E 160, Chemical Process Design, or NE 170A, Nuclear Design	-	3-4
Chem E 162, Dynamics and Control of Chemical Processes	-	4
Nuclear Engineering Electives[1]	9	-
Electives[1]	-	6
Total	**15**	**16-17**

[1]Electives must include the following:
(a) 19 units in the humanities and social studies which satisfy the requirements of both the College of Chemistry and the College of Engineering — see adviser for College of Engineering requirements and the *Announcement of the College of Chemistry* for College of Chemistry requirements. Refer to www.coe.berkeley.edu/hssreq.pdf.
(b) Students must take one course with ethics content. This may be fulfilled within the Humanities/Social Studies Electives requirement by taking one of the following courses: BioE 100; E 124 or 195; Anthropology 156B; ESPM 161, 162; Philosophy 2, 104, 105, 107; Political Science 108A; Public Policy 170, 172; Public Health 115; Sociology 116; Legal Studies 19AC, 100A.
(c) 9 units must be upper division NE courses, including at least two courses selected from NE 120, 124, and 161. **Note:** A few of the technical electives, such as NE 161, have prerequisites which must be taken in the previous semesters.

Additional Programs and Affiliated Groups

Applied Science and Technology Graduate Program

230 Bechtel Engineering Center
www.coe.berkeley.edu/AST

This graduate group is administered by the College of Engineering's Interdisciplinary Studies Center. The program has three major areas of emphasis: applied physics, engineering science, and mathematical sciences. This program awards the Doctor of Philosophy degree. In addition, students who have been admitted to the program may also apply for the newly created Designated Emphasis in Nanoscale Science and Engineering (DE NSE), and the newly-created emphasis (DE) in Energy, Science, and Technology (DE EST). Students usually apply for the DE during their first or second year of study. For further information, see the NSE section of this announcement and the DE web site: nano.berkeley.edu/de. For information about the DE EST, see www.mse.berkeley.edu/deest.html.

Faculty associated with the program are drawn from several departments within the College of Engineering, as well as from the Departments of Physics, Chemistry, Chemical Engineering, and Mathematics. Topics of interest include the novel properties and applications of nanostructures, thin films and interface science, microelectromechanical systems (MEMS), nanoscale science and engineering, short-wavelength coherent radiation, X-ray micro-imaging for the life and physical sciences, plasma physics and plasma-assisted materials processing, laser-induced chemical processes, laser probing of complex reacting systems, ultrafast phenomena, particle accelerators, nonlinear dynamics, chaotic systems, numerical methods, and topics in computational fluid mechanics and reacting flows.

Graduate research in the AS&T Program benefits from state-of-the-art experimental facilities on the Berkeley campus and at the Lawrence Berkeley National Laboratory. Among these facilities are the National Center for Electron Microscopy, with the world's highest-resolution high-voltage microscope; a microfabrication lab for student work involving lithography, MEMS, ion implantation, and thin-film deposition; an integrated sensors laboratory; femtosecond laser laboratories; optical, electrical, and magnetic resonance spectroscopies; short wavelength laser and X-ray research laboratories; an unparalleled variety of material, chemical, and surface science analytic equipment; and a soft X-ray synchrotron dedicated to materials, chemical, and biological research based on high-brightness and partially coherent radiation. The interdisciplinary, collaborative nature of the AS&T Program provides ample opportunity to develop new research directions by making the best possible use of these facilities and the other research instrumentation available to AS&T faculty.

Students in the AS&T Program take courses drawn largely from regular departments with the concurrence of faculty advisers. In addition, faculty associated with the graduate group offer additional courses.

Admission. The complete application, including transcripts, GRE scores, TOEFL score (if previous instruction was not in English), three letters of reference, and a statement of academic and professional goals, is due the first Monday in January for the following fall semester. To obtain application information, students should contact the Applied Science and Technology Graduate Group, 230 Bechtel Engineering Center #1708, University of California, Berkeley; Berkeley, CA 94720-1708; telephone: (510) 642-8790; email: ast.program@coe.berkeley.edu; web site: www.coe.berkeley.edu/AST.

Interdisciplinary Studies

230 Bechtel Engineering Center
www.coe.berkeley.edu/ids

For an engineer to be effective in professional practice, more is required than competence in a field of engineering. Increasingly, the solution to engineering problems requires contributions from more than one field. Thus, an effective engineer must be able to interact positively with other professionals. This interaction requires good communication skills and an understanding of what other professionals provide in the solution of engineering problems.

Interdisciplinary studies that involve various branches of engineering, the natural sciences and mathematics, the biological sciences and medicine, the social sciences, and the humanities are coordinated through the Meakin Interdisciplinary Studies Center. The Meakin Center has four main goals: (1) to promote knowledge of the humanities and social sciences among students of the College of Engineering; (2) to provide students in the social sciences and humanities with a working knowledge of information technology and computing; (3) to sustain the interdisciplinary undergraduate programs in Engineering Science (i.e., Computational Engineering Science, Engineering Mathematics and Statistics, Engineering Physics, Environmental Engineering Science, and Engineering — Undeclared); (4) and to support interdisciplinary graduate programs and research.

The Meakin Interdisciplinary Studies Center assists engineers in developing skills that go beyond their preparation in a field of engineering. At the undergraduate level the center offers the interdepartmental course, Engineering 190, Technical Communication; and Engineering 140, Technical Communication for Non-Native Speakers of English. In addition, the center coordinates the course, Engineering 110, Introduction to Computers, which is offered to students outside the College.

The College of Engineering has launched the Center for Entrepreneurship and Technology (CET), a top-tier academic center designed to promote entrepreneurial education and foster new venture creation. Academic programs have initially targeted engineering undergraduate students and will subsequently become available to all members of the UC Berkeley community. CET activities include course work development, network building, student-faculty-entrepreneur mentorship, a distinguished lecture series, business plan contest preparation and competitions, and new venture creation. Academic instruction relies heavily on case-based learning and classroom discussions, and students pursue multiple projects to identify and develop commercially attractive technology-oriented ventures. CET will offer an undergraduate certificate program (pending approval), and the program is administered through the Meakin Interdisciplinary Studies Center. Details on this new program can be found at cet.berkeley.edu.

At the graduate level the Meakin Interdisciplinary Studies Center supports the activities of a number of interdepartmental committees. The graduate group in Applied Science and Technology leads to the Ph.D. degree in applied science and technology. For more information about this graduate group, see the Applied Science and Technology section of this announcement.

Current interdisciplinary committees are:

- Applied Science and Technology
- Art, Technology, and Culture
- Control, Robotics, and Manufacturing
- Engineering Science
- Entrepreneurship and Technology
- Management of Technology
- Ocean Engineering
- Technology and Sustainability

These committees provide a wide range of interdepartmental activities, including special course offerings, group studies and seminars, and public lectures and conferences presented by faculty and visitors.

Additional information about the undergraduate and graduate activities of the center may be obtained from the Meakin Interdisciplinary Studies Center, 230 Bechtel Engineering Center #1708, College of Engineering, University of California, Berkeley; Berkeley, CA 94720-1708.

Nanoscale Science and Engineering

nano.berkeley.edu

Doctoral students interested in pursuing interdisciplinary research focused on nanoscale science and engineering (NSE) may additionally join the growing Designated Emphasis (DE) in Nanoscale Science and Engineering (NSE), administered by the NSE Graduate Group. The DE, like a minor, is listed on the academic transcript (e.g., Ph.D. in Mechanical Engineering with Designated Emphasis in Nanoscale Science and Engineering). Requirements include one core course, two electives, participation in a group seminar, and a nano-related thesis. Students usually apply for the DE during their first or second year of study. For a list of participating programs, please visit nano.berkeley.edu/de/programs.html. For more information about the NSE DE, contact Prof. Eicke Weber, weber@berkeley.edu, Chair of the NSE Graduate Group, Berkeley Nanosciences and Nanoengineering Institute, 210 McLaughlin Hall #1726, University of California, Berkeley; Berkeley, CA 94720-1726; email: nanoinstitute@lists.berkeley.edu.

Chemical Engineering

cheme.berkeley.edu

Studies in Chemical Engineering are offered only by the Department of Chemical Engineering in the College of Chemistry. For information regarding the programs of study available, consult the *Announcement of the College of Chemistry*. Inquiries may be directed to the College of Chemistry Undergraduate Office (420 Latimer Hall #1460) for undergraduate students, and to the Chemical Engineering Graduate Office (201 Gilman Hall #1462) for graduate students.

Organized Research Units

There are three organized research units (ORUs) within the College: the Earthquake Engineering Research Center (EERC), the Institute for Environmental Science and Engineering (IESE), and the Institute of Transportation Studies (ITS).

The **Earthquake Engineering Research Center (EERC)** conducts research and public service programs aimed at protecting the public and its property from the destructive effects of earthquakes. Major emphasis is placed on determining the characteristics and intensities of strong ground motions; developing analytical procedures for estimating potential damage to structural, mechanical, and soil systems; improving earthquake-resistant design; developing procedures for seismic rehabilitation of existing structures; and collecting and disseminating information on earthquake engineering and allied fields.

EERC operates three main research laboratories: the *nees@berkeley* Laboratory, the micro-nees Laboratory and the EERC Shaking Table Laboratory. The *nees@berkeley* Laboratory houses the reconfigurable reaction wall, strong floor and a variety of large, high speed actuators, as well as the four million pound test machine. The micro-nees Laboratory can be independently set up to test smaller projects or provide proof of concept. The EERC Shaking Table Laboratory includes its namesake shaking table, as well as large and small damper test machines and an expansion joist test machine. EERC also houses the EERC Library, a dynamic source for electronic and paper copy volumes on earthquake engineering research.

The **Institute for Environmental Science and Engineering (IESE)**, formerly the Environmental Engineering and Health Sciences Laboratory, is an interdisciplinary organized research unit at Berkeley. IESE serves as a bridge between basic research, often associated with an academic environment, and the more applied studies necessary for sound environmental management and IESE's major objective, which is to foster cross-disciplinary research in environmental science and engineering. Through its unique position, IESE is able to focus the expertise available throughout the University of California system, including participation by faculty from the various disciplines within Engineering, Public Health, Earth and Planetary Science, Natural Resources, Integrative Biology, Biotechnology, and the University of California, San Francisco, School of Medicine.

The unit was created in 1950 in response to a state legislative mandate for research on water pollution and solid waste management. Originally, research programs were in three general areas: water and wastewater treatment, pollutant effects on lake and estuarine ecosystems, and environmental and occupational health. Research has continually expanded over the years and now includes geomorphology, chemical exposure, environmental pathogens, applied ecology, air quality, water reuse, mineral exploration, groundwater and geophysics, bioengineering, risk analysis, and nuclear waste management. There are 41 principal investigators and 67 graduate students and postgraduate researchers active in IESE.

IESE is undertaking the promotion and coordination of collaborative efforts by providing support to various campus-based centers, including the Berkeley Environmental Restoration Center, the Center for Nuclear and Toxic Waste Management, the Earth Resources Center, the Center for Risk Analysis, the Center for Infectious Disease and Epidemiology, the Center for Environmental Resource Policy, and the Center for Occupational and Environmental Health. In addition, IESE is assisting faculty in providing efficient research management services.

The **Institute of Transportation Studies (ITS)**, one of the oldest and largest transportation research institutes in the country, offers students a chance to participate in a wide range of high-level transportation research projects.

On average, its programs receive more than $25 million in research funds each year, one of the largest award totals for an organized research unit or academic department on the

Berkeley campus. Almost 100 faculty members and staff researchers, plus more than 100 graduate students, participate in ITS research, which crosses a variety of disciplines. Areas of research include aviation planning and operations, intelligent transportation systems, transit planning and operations, traffic safety, transportation economics, infrastructure design and management, traffic theory and operations, transportation policy, logistics, transportation and land use planning, and environmental assessment.

The institute currently hosts six affiliated centers that specialize in different areas of transportation research: PATH (Partners for Advanced Transit and Highways), the nation's largest program of intelligent transportation systems research that conducts research on traffic operations, transit operations, and active traffic safety; CCIT (the California Center for Innovative Transportation), which conducts "last mile" research to facilitate the deployment of new transportation technologies; NEXTOR (the National Center of Excellence for Aviation Operations Research), a Federal Aviation Administration-funded program that examines advanced air traffic management systems, security, air traffic safety, and the performance and productivity of the nation's aviation system; PRC (the Pavement Research Center), an international authority on pavement design, construction, maintenance, and rehabilitation; the UC Berkeley Center for Future Urban Transport, a Volvo Foundations Center of Excellence focused on the mutual interdependence of urban transportation policy and technology and sustainable transportation strategies for the world's cities; and TSC (the Traffic Safety Center), a joint venture of the institute and the School of Public Health that carries out traffic safety research.

In addition, ITS is home to the Harmer E. Davis Transportation Library, which is one of the world's leading transportation libraries.

ITS faculty and students regularly appear in the top ranks of the transportation engineering and planning professions. Institute graduates are leaders in the public and private sectors of transportation. A recent alumni outreach project identified more than 80 graduates who hold academic posts at universities in the U.S. and abroad.

▲ ***In Soda Hall (above), "the building is the computer," with advanced networking, wireless, and access to computer clusters for shared computing power. The building was designed to foster a team approach to computing innovation and houses classrooms and labs dedicated to computer science.***

General Information

General Administrative Officers

President of the University
Mark G. Yudof

Chancellor, Berkeley
Robert J. Birgeneau, Ph.D.

Executive Vice Chancellor and Provost
George W. Breslauer, Ph.D.

Vice Chancellor for Research
Beth Burnside, Ph.D.

College of Engineering Administrative Officers

Dean
S. Shankar Sastry, Ph.D.

Associate Deans
Fiona M. Doyle, Ph.D., Executive Associate Dean and Associate Dean, Academic Affairs
Gary Baldwin, Ph.D., Industry Relations
David A. Dornfeld, Ph.D., Interdisciplinary Studies
George C. Johnson, Ph.D., Special Programs
Thomas A. Kalil, Science and Technology
George Leitmann, Ph.D., International Relations
Vacant
Virtual Learning and Outreach Education
Carlo Séquin, Ph.D., Capital Projects
Costas Spanos, Ph.D., Research

University Professor
Richard M. Karp, Ph.D.

◀ ***The Kresge Engineering Library (left) contains nearly one million engineering print and electronic volumes, journals, and technical reports, as well as 250 stations for reading and studying.***

Contact Information

College of Engineering

www.coe.berkeley.edu

Instructional Units

Applied Science and Technology Graduate Group, Meakin Interdisciplinary Studies Center, 230 Bechtel Engineering Center #1708
www.coe.berkeley.edu/AST

Bioengineering, 306 Stanley Hall #1762
bioeng.berkeley.edu

Bioengineering Graduate Group, 306 Stanley Hall #1762
bioegrad.berkeley.edu

Civil and Environmental Engineering, 760 Davis Hall #1710 (Graduate Admissions, 750 Davis Hall #1714)
www.ce.berkeley.edu

Electrical Engineering and Computer Sciences, 205 Cory Hall #1770 (Graduate Admissions, 205 Cory Hall #1770)
www.eecs.berkeley.edu

Engineering Science, Meakin Interdisciplinary Studies Center, Interdisciplinary Studies, 230 Bechtel Engineering Center #1708
www.coe.berkeley.edu/engsci

Industrial Engineering and Operations Research, 4141 Etcheverry Hall #1777
www.ieor.berkeley.edu

Materials Science and Engineering, 210 Hearst Memorial Mining Building #1760
www.mse.berkeley.edu

Mechanical Engineering, 6189 Etcheverry Hall #1740 (Graduate Admissions, 6189 Etcheverry Hall #1740)
www.me.berkeley.edu

Nuclear Engineering, 4153 Etcheverry Hall #1730 (Graduate Admissions, 4149 Etcheverry Hall #1730)
www.nuc.berkeley.edu

Research Units

Earthquake Engineering Research Center; Professor Nicholas Sitar, Director; 451 Richmond Field Station #3580
eerc.berkeley.edu

Institute for Environmental Science and Engineering; Professor Yoram N. Rubin, Director; 412 O'Brien Hall #1766
www.iese.berkeley.edu

Institute of Transportation Studies; Professor Samer Madanat, Director; 109 McLaughlin Hall #1720
its@its.berkeley.edu
www.its.berkeley.edu

Other Offices

Admissions (graduate): Graduate Division, 309 Sproul Hall #5900
www.grad.berkeley.edu

Admissions (undergraduate): Office of Undergraduate Admissions, 110 Sproul Hall #5800
admissions.berkeley.edu

Berkeley Engineering Alumni Relations
1925 Walnut St. #1704
bears@berkeley.edu
www.coe.berkeley.edu/alumni

Berkeley Engineering Fund
208 McLaughlin Hall #1722
bef@coe.berkeley.edu
www.coe.berkeley.edu/support-the-college
(510) 642-2487

Berkeley Nanosciences and Nanoengineering Institute
210 McLaughlin Hall #1726
nano.berkeley.edu

Career Center
2111 Bancroft Way #4350
career.berkeley.edu

Center for Entrepreneurship and Technology
230 Bechtel Engineering Center #1708
cet.berkeley.edu

Charles Tunstall Multicultural Engineering Program
222 Bechtel Engineering Center
www.coe.berkeley.edu/cues/mep

Chemical Engineering, Department of
201 Gilman Hall #1462
cheme.berkeley.edu

Chemistry, College of
420 Latimer Hall #1460
chemistry.berkeley.edu

Continuing Education
University Extension
1995 University Avenue #7010
course@unex.berkeley.edu
Extension Catalog:
www.unex.berkeley.edu
Engineering Short Courses:
www.unex.berkeley.edu/engineering

Harmer E. Davis Transportation Library
412 McLaughlin Hall #1720
www.lib.berkeley.edu/ITSL

Engineers' Joint Council
220 Bechtel Engineering Center #4500
president@ejc.berkeley.edu
ejc.berkeley.edu

Financial Aid
201 Sproul Hall #1960
financialaid.berkeley.edu

Freshman and Sophomore Seminars
333 Campbell Hall #2922
fss.berkeley.edu

Graduate Academic Diversity (GrAD) Program
222 Bechtel Engineering Center
www.coe.berkeley.edu/cues/grad

Graduate Division
Third Floor, Sproul Hall #5900
www.grad.berkeley.edu

Housing and Dining Services
2610 Channing Way #2272
www.housing.berkeley.edu
Industrial Liaison Program
208 McLaughlin Hall #1722
International Student Services
International House
2299 Piedmont Avenue #2320
Julia Morgan Engineering Program
222 Bechtel Engineering Center
www.coe.berkeley.edu/cues/jmep
Kresge Engineering Library
110 Bechtel Engineering Center #1796
www.lib.berkeley.edu/ENGI
Management of Technology
Certificate Program
230 Bechtel Engineering Center #1708
mot.berkeley.edu
Marketing & Communications
312 McLaughlin Hall, #1704
www.coe.berkeley.edu
Pre-Engineering Partnerships
469 Evans #1768
www.coe.berkeley.edu/cues/pep
Student Affairs Office
308 McLaughlin Hall #1702
www.coe.berkeley.edu/advising
Summer Undergraduate Program in Engineering Research at Berkeley (SUPERB)
222 Bechtel Engineering Center
www.coe.berkeley.edu/cues/superb
Transportation Engineering, see Civil and Environmental Engineering, Institute of Transportation Studies

Other Information Sources

General Catalog, Berkeley
May be purchased from the Cal Student Store, Attn: Mail Order Department, University of California, Berkeley; Berkeley, CA 94720-4504
catalog.berkeley.edu
(510) 981-9618
Schedule of Classes
Available online only; go to schedule.berkeley.edu
EECS Undergraduate Notes
A copy may be obtained from the Center for Undergraduate Matters, 205 Cory Hall
www.eecs.berkeley.edu/Programs/Notes/newcurric-notes.html
EECS Graduate Notes
www.eecs.berkeley.edu/Gradnotes/grad.notes.html
Announcement of the College of Engineering:
www.coe.berkeley.edu/announcement
UC Berkeley home page:
www.berkeley.edu

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Access to Student Records

To implement the University Policy Governing Disclosure of Information to Students and Access to Student Records, the Engineering Student Affairs Office has established the following procedures, applicable to former students, as well as to students currently enrolled.

Public Records

Inquiries made in person or by phone will be answered only in case of clear necessity. Unless specifically requested by the student not to do so, the following information is considered public and will be provided to individuals upon written request: verification of registration; major; date of admission, attendance, graduation, or proposed date of graduation; honors and scholarships received.

Confidential Records

The following information in the student's file and maintained by the Engineering Student Affairs Office is considered confidential and will be released only pursuant to the procedures which follow:

1. Office of the Registrar's Dean's Card
2. Correspondence to, about, and from student
3. Scholarship action, recommendations, and grants-in-aid information
4. Student photograph
5. Degree check
6. Student Information Card
7. Transcripts from other schools attended, including high school
8. Copies of petitions
9. Work slips
10. Medical excuses
11. Notes of interviews with deans and curriculum advisers
12. Records of telephone calls
13. Curriculum questionnaire
14. Semester evaluations by Office of the Registrar
15. Copy of admission application and essay
16. Copy of educational test scores
17. Engineering study-list

Effective September 1974, records of engineering graduates are maintained for five years after graduation. After that date, only items 1 to 5 will be retained. Records of inactive students are maintained for five years starting from last date of enrollment. After five years, only items 1 to 12 will be retained. Semester grade reports and dean's cards from the Office of the Registrar for enrolled students are replaced when updated copies are received.

Access to Records

The following staff personnel have access to student records: staff of the Engineering Student Affairs and Dean's Offices, Engineering deans, faculty of the college, and the ombudspersons. Other campus personnel have access to records on a need-to-know basis determined by the associate dean of the Student Affairs Office.

Procedures for Access to Records

By Student. Students will be given an appointment to review their records after written request. No more than two working days will be required to provide the records for review. Letters of recommendation dated before January 1, 1975, are not subject to disclosure.

A page charge of $.25 per copy will be assessed for material duplicated from the student records. Material will be duplicated at the time of the request, if it can be done without delaying service to others. Otherwise, the students will be given a time to return for their copies, within two days from the time of the request.

By Third Party. Access to records by a third party (other than those listed under Access to Records above) is available only with the written consent of the student. Information may be released in case of emergency without the consent of the student (for example, by judicial order), to accrediting organizations, in case of health and safety emergencies, or for research purposes. For additional information about such disclosures, consult the printed directive, Policy Governing Disclosures of Information from Student Records, available upon request.

The form delegating the student's authority to release information is available at the desk of each staff member. The third party to whom information is made available must also complete a form which is available at the desk of each staff member and which requires date, reason for review of record, and signature. Furthermore, the third party must also agree that information received must not be given to another party without written consent of the student.

Challenge and Hearing. A staff member of the Student Affairs Office will explain information in a student's record upon request. If the student believes that the record is in error or misleading, an appointment will be made with the associate dean. If, after that appointment, the student is still not satisfied with the explanation, an appeal may be made to the dean of the College of Engineering. If after these appointments the matter is still not resolved, a further appeal may be made to an ombudsperson.

Challenge of grades and evaluation of student work is not within the scope of the hearing.

Nondiscrimination Statement

The University of California, in accordance with applicable Federal and State law and the University's nondiscrimination policies, does not discriminate on the basis of race, color, national origin, religion, sex (including sexual harassment), gender identity, pregnancy/childbirth and medical conditions related thereto, disability, age, medical condition (cancer-related), ancestry, marital status, citizenship, sexual orientation, or status as a Vietnam-era veteran or special disabled veteran. This nondiscrimination statement covers admission, access, and treatment in University programs and activities. It also covers faculty (Senate and non-Senate) and staff in their employment.

The Campus Climate and Compliance (CCAC) office may be contacted regarding discrimination issues. Sexual or racial harassment, hostile environment, LGBT, hate or bias issues may be directed to Nancy Chu, Director and Title IX/VI Compliance Officer, at tixco@berkeley.edu or (510) 643-7985. Disability issues may be directed to Disability Resolution Officer Derek Coates at ecs@berkeley.edu or (510) 642-2795. More information may also be found at ccac.berkeley.edu.

The Jeanne Clery Act

The University of California Police Department at Berkeley maintains an annual campus safety report in compliance with the Jeanne Clery Act. It includes the year's campus crime statistics, information about safety services, crime prevention strategies, emergency preparedness guidelines, and more. For a copy of this report, *Safety Counts,* please contact the University of California Police Department, Berkeley, by phone at (510) 642-6760 or email at police@berkeley.edu. You can also download a PDF of *Safety Counts* at police.berkeley.edu/safetycounts.

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