Energy Engineering

Bachelor of Science (BS)

The Energy Engineering major offered through the Engineering Science Program interweaves the fundamentals of classical and modern physics, chemistry, and mathematics with energy engineering applications. A great strength of the major 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 energy-related problems faced by society. Because the program emphasizes science and mathematics, students are well-prepared to pursue graduate studies in physics or engineering. Energy engineering is a multidisciplinary field requiring an integration of physical principles with engineering analysis, augmented with the realities of policy and engineering economics. The program incorporates courses from many departments on campus to create a discipline that is rigorously based in science, mathematics, and engineering, while addressing a wide variety of environmental issues.

Admission to the Major

Prospective undergraduates in the College of Engineering must apply for admission to one specific major/degree program. For further information, please see the College of Engineering's website (http://coe.berkeley.edu/students/prospective-students/admissions.html) .

Admission to engineering via a Change of College application for current UC Berkeley students is very competitive, as there few open spaces in engineering for students admitted to other colleges at UC Berkeley. For further information regarding a Change of College to Engineering, please see the college's website (http://coe.berkeley.edu/students/current-undergraduates/change-of-college) .

Minor Program

The Energy engineering minor has arisen as a natural outgrowth of the large amount of energy-related research in the College of Engineering. For a number of years, courses have been developed across the College of Engineering, and the energy engineering minor is designed to coordinate these courses for students who have an interest in systems that are associated with all aspects of energy systems, such as generation, transmission and consumption. The energy minor, offered through the College of Engineering, is an optional program that encourages coherence in the work students undertake around energy engineering.

For admission to the minor, students must have a minimum over-all grade point average (GPA) of 3.00, and have also completed all of the prerequisite courses. For information regarding the prerequisites, please see the Minor Requirements tab on this page.

After completion of the prerequisite courses, students will need to complete and submit a Petition for Admission form (http://engineeringscience.berkeley.edu/wp-content/uploads/2013/09/Energy-Minor-Application-2103-141.pdf) to the undergraduate staff adviser. Students must apply at least one semester prior to graduation (i.e., students cannot be on the official degree list at the time of application). Students will also need to submit a copy of their transcript and a course plan at the time of application.

Upon completion of the minor requirements, submit a Petition for Completion of the Undergraduate Minor (http://engineeringscience.berkeley.edu/wp-content/uploads/2013/09/energy-minor-confirm-completion-of-Minor-2013-141.pdf) to the undergraduate staff adviser. This must be completed no later than two weeks prior to the end of the semester.

Other Majors offered by the Engineering Science Program

Engineering Mathematics and Statistics (http://guide.berkeley.edu/archive/2016-17/undergraduate/degree-programs/engineering-math-statistics)
Engineering Physics (http://guide.berkeley.edu/archive/2016-17/undergraduate/degree-programs/engineering-physics)
Environmental Engineering Science (http://guide.berkeley.edu/archive/2016-17/undergraduate/degree-programs/environmental-engineering-science)

In addition to the University, campus, and college requirements, students must fulfill the below requirements specific to their major program.

General Guidelines

1. All technical courses (courses in engineering, mathematics, chemistry, physics, statistics, biological sciences, and computer science) must be taken for a letter grade.
2. No more than one upper division course may be used to simultaneously fulfill requirements for a student's major and minor programs.
3. A minimum overall grade point average (GPA) of 2.0 is required for all work undertaken at UC Berkeley.
4. A minimum GPA of 2.0 is required for all technical courses taken in satisfaction of major requirements.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

For a detailed plan of study by year and semester, please see the Plan of Study tab.

Lower Division Requirements

MATH 1A	Calculus	4
MATH 1B	Calculus	4
MATH 53	Multivariable Calculus	4
MATH 54	Linear Algebra and Differential Equations	4
PHYSICS 7A	Physics for Scientists and Engineers	4
PHYSICS 7B	Physics for Scientists and Engineers	4
Select one of the following chemistry options:		4
CHEM 1A & 1AL	General Chemistry and General Chemistry Laboratory	
CHEM 4A	General Chemistry and Quantitative Analysis [1]	
ENGIN 7	Introduction to Computer Programming for Scientists and Engineers	4
or COMPSCI 61A	The Structure and Interpretation of Computer Programs	
ENGIN 93	Energy Engineering Seminar	1
MEC ENG 40	Thermodynamics	3-4
or ENGIN 115	Engineering Thermodynamics	
Select two Engineering Prep courses: [2]		6-10
CHEM 1B	General Chemistry	

CHEM 3A	Chemical Structure and Reactivity
COMPSCI 61B	Data Structures
COMPSCI C8	Foundations of Data Science (must also take connector course: course number 88)
CIV ENG 11	Engineered Systems and Sustainability
CIV ENG 70	Engineering Geology
EL ENG 16A	Designing Information Devices and Systems I
EL ENG 16B	Designing Information Devices and Systems II
ENGIN 45 & 45L	Properties of Materials and Properties of Materials Laboratory
MEC ENG C85	Introduction to Solid Mechanics
MEC ENG 104	Engineering Mechanics II
PHYSICS 7C	Physics for Scientists and Engineers

1 CHEM 4A is intended for students majoring in chemistry or a closely-related field.

2 Students interested in the areas of data, distribution, generation or materials are advised to choose the following courses for Engineering Prep:

- Data: COMPSCI C8 + connector (course number 88) and COMPSCI 61B
- Distribution: EL ENG 16A and EL ENG 16B
- Generation: MEC ENG C85 and MEC ENG 104
- Materials: ENGIN 45 + ENGIN 45L and PHYSICS 7C

Upper Division Requirements

Due to the interdisciplinary nature of this major, electives may be approved throughout the year.

CIV ENG 100	Elementary Fluid Mechanics	3-4
or MEC ENG 106	Fluid Mechanics	
CIV ENG 186	Design of Cyber-Physical Systems	3
EL ENG 134	Fundamentals of Photovoltaic Devices	4
EL ENG 137A	Introduction to Electric Power Systems	4
EL ENG 137B	Introduction to Electric Power Systems	4
ENE,RES C100	Energy and Society [1]	4
ENGIN 194	Undergraduate Research	3
MEC ENG 109	Heat Transfer	3
Sustainability Course, select one course from the following:		3
CIV ENG 111	Environmental Engineering	
CIV ENG 113N	Course Not Available	
CIV ENG 115	Water Chemistry	
CY PLAN 119	Planning for Sustainability [3]	
ENE,RES 101	Ecology and Society	
Economics Course: Choose one from the following		3-4
CIV ENG 156	Infrastructure Planning and Management	
ENE,RES 180	Ecological Economics in Historical Context	
ENGIN 120	Principles of Engineering Economics	
ENVECON 147	Regulation of Energy and the Environment [4]	
ENVECON C15	Economic Development [4]	
ENVECON 153	Population, Environment, and Development [4]	
ENVECON 154	Economics of Poverty and Technology [4]	
ESPM 102D	Climate and Energy Policy [4]	
POLECON 101	Contemporary Theories of Political Economy [4]	
Math/Statistics/Analysis Course: Choose from list below or choose CIV ENG 191 or EL ENG 127 [5]		3-4
CIV ENG 93	Engineering Data Analysis	
COMPSCI 70	Discrete Mathematics and Probability Theory	
ENGIN 117	Methods of Engineering Analysis	
IND ENG 172	Probability and Risk Analysis for Engineers	
MATH 55	Discrete Mathematics	
STAT 134	Concepts of Probability	
Engineering Electives [6]		12

1 ENE,RES C100 satisfies both a major requirement and one of the upper division humanities/social sciences requirements.

2 CIV ENG 111 cannot be used to fulfill more than one requirement.

3 This course satisfies both the sustainability requirement and one of the upper division humanities/social sciences requirements.

4 This course satisfies both the economics requirement and one of the upper division humanities/social sciences requirements.

5 Students interested in data are advised to take CIV ENG 191, IND ENG 172 or STAT 134 for the Math/Statistics/Analysis requirement.

6 Students are required to take four Engineering Electives of at least 3 units each. Engineering Electives are upper division courses in any engineering department and must be chosen in consultation with a faculty adviser. Engineering Electives cannot include any course taken on a P/NP basis; BIO ENG 100, CHM ENG 185, COMPSCI 195, COMPSCI H195, DES INV courses (except DES INV 190E), ENGIN 125, ENGIN 157AC, IND ENG 172, IND ENG 1 IND ENG 190 series, IND ENG 191, IND ENG 192, IND ENG 195, MEC ENG 190K, MEC ENG Students interested in data, distribution, generation or materials are advised to choose from the following courses as their Engineering Electives:

- Data: COMPSCI 180 series courses, STAT 133, STAT 135 (exception approved for these two Statistics couses)
- Distribution: COMPSCI 61B (exception approved for this lower division course), EL ENG 105, EL ENG 113, EL ENG 117, EL ENG 120, EL ENG C128, MEC E
- Generation: BIO ENG C181, MEC ENG 130, MEC ENG 140, MEC ENG 146, NUC EN
- Materials: MAT SCI 103, MAT SCI 111, MAT SCI 113, MAT SCI 125, MAT SCI 136

Minor programs are areas of concentration requiring fewer courses than an undergraduate major. These programs are optional, but can provide depth and breadth to a UC Berkeley education. The College of Engineering does not offer additional time to complete a minor, but it is usually possible to finish within the allotted time with careful course planning. Students are encouraged to meet with their ESS adviser to discuss the feasibility of completing a minor program.

All the engineering departments offer minors. Students may also consider pursuing a minor in another School or College.

General Guidelines

1. All courses taken to fulfill the minor requirements must be taken for graded credit.
2. A minimum overall grade point average (GPA) of 3.0 and a minimum GPA of 3.0 in the prerequisite courses is required for acceptance into the minor program.
3. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.

4. No more than one upper division course may be used to simultaneously fulfill requirements for a student's major and minor programs.
5. Completion of the minor program cannot delay a student's graduation.

Lower Division Prerequisites

MATH 1A	Calculus	4
MATH 1B	Calculus	4
MATH 53	Multivariable Calculus	4
MATH 54	Linear Algebra and Differential Equations	4
Select one of the following:		
CHEM 1A & 1AL	General Chemistry and General Chemistry Laboratory	
CHEM 4A	General Chemistry and Quantitative Analysis	
PHYSICS 7A	Physics for Scientists and Engineers	4
PHYSICS 7B	Physics for Scientists and Engineers	4
ENGIN 7	Introduction to Computer Programming for Scientists and Engineers	4

Upper Division Minor Requirements

MEC ENG 40	Thermodynamics (or approved equivalent)	3
or ENGIN 115	Engineering Thermodynamics	
EL ENG 137A	Introduction to Electric Power Systems	4
Select one of the following:		4
ENE,RES C100	Energy and Society	
CIV ENG 111	Environmental Engineering	
CIV ENG C106	Air Pollution	3
Select two of the following:		8
ARCH 140	Energy and Environment	
CY PLAN 119	Planning for Sustainability	
CIV ENG 107	Climate Change Mitigation	
CIV ENG 111	Environmental Engineering	
CIV ENG 113N	Course Not Available	
CIV ENG 115	Water Chemistry	
CIV ENG 156	Infrastructure Planning and Management	
EL ENG 134	Fundamentals of Photovoltaic Devices	
EL ENG 137B	Introduction to Electric Power Systems	
ENE,RES C100	Energy and Society	
ENE,RES 101	Ecology and Society	
ENE,RES C180	Course Not Available	
ENGIN 120	Principles of Engineering Economics	
ENGIN 194	Undergraduate Research	
ENVECON 147	Regulation of Energy and the Environment	
ENVECON C155	Economic Development	
ENVECON 153	Population, Environment, and Development	
ENVECON 154	Economics of Poverty and Technology	
ESPM 102D	Climate and Energy Policy	
GEOG 142	Climate Dynamics	
IND ENG 172	Probability and Risk Analysis for Engineers	
or STAT 134	Concepts of Probability	
MAT SCI 136	Materials in Energy Technologies	
MEC ENG 106	Fluid Mechanics	
MEC ENG 109	Heat Transfer	
NUC ENG 161	Nuclear Power Engineering	
POLECON 101	Contemporary Theories of Political Economy	

Students in the College of Engineering must complete no fewer than 120 semester units with the following provisions:

1. Completion of the requirements of one engineering major program (http://coe.berkeley.edu/students/guide/departments) of study.
2. A minimum overall grade point average of 2.00 (C average) and a minimum 2.00 grade point average in upper division technical coursework required of the major.
3. The final 30 units and two semesters must be completed in residence in the College of Engineering on the Berkeley campus.
4. All technical courses (math, science and engineering), required of the major or not, must be taken on a letter graded basis (unless they are only offered P/NP).
5. Entering freshmen are allowed a maximum of eight semesters to complete their degree requirements. Entering junior transfers are allowed a maximum of four semesters to complete their degree requirements. (Note: junior transfers admitted missing three or more courses from the lower division curriculum are allowed five semesters.) Summer terms are optional and do not count toward the maximum. Students are responsible for planning and satisfactorily completing all graduation requirements within the maximum allowable semesters.
6. Adhere to all college policies and procedures (http://engineering.berkeley.edu/academics/undergraduate-guide) as they complete degree requirements.
7. Complete the lower division program before enrolling in upper division engineering courses.

Humanities and Social Science (H/SS) Requirement

To promote a rich and varied educational experience outside of the technical requirements for each major, the College of Engineering has a six-course Humanities and Social Sciences breadth requirement (http://engineering.berkeley.edu/student-services/degree-requirements/humanities-and-social-sciences) , which must be completed to graduate. This requirement, built into all the engineering programs of study, includes two reading and composition courses (R&C), and four additional courses within which a number of specific conditions must be satisfied. Follow these guidelines to fulfill this requirement:

1. Complete a minimum of six courses from the approved Humanities/Social Sciences (H/SS) lists (http://coe.berkeley.edu/hssreq) .
2. Courses must be a minimum of 3 semester units (or 4 quarter units).
3. Two of the six courses must fulfill the college's Reading and Composition (R&C) requirement. These courses must be taken for a letter grade (C- or better required) and must be completed by no later than the end of the sophomore year (fourth semester of enrollment). The first half of R&C, the "A" course, must be completed by the end of the freshman year; the second half of R&C, the "B" course, must be completed by no later than the end of the sophomore year. View a detailed lists of courses (http://ls-advise.berkeley.edu/requirement/rccourses.html) that fulfill Reading and Composition requirements, or use the College of Letters and Sciences search engine (http://

ls-breadth.berkeley.edu) to view R&C courses offered in a given semester.

4. The four additional courses must be chosen within College of Engineering guidelines from the H/SS lists (see below). These courses may be taken on a Pass/Not Passed basis (P/NP).
5. Two of the six courses must be upper division (courses numbered 100-196).
6. One of the six courses must satisfy the campus American Cultures requirement. For detailed lists of courses that fulfill American Cultures requirements, visit the American Cultures (http://guide.berkeley.edu/archive/2016-17/undergraduate/colleges-schools/engineering/american-cultures-requirement) site.
7. A maximum of two exams (Advanced Placement, International Baccalaureate, or A-Level) may be used toward completion of the H/SS requirement. View the list of exams (http://engineering.berkeley.edu/academics/undergraduate-guide/exams-ap-ib-level-and-transfer-credit-information) that can be applied toward H/SS requirements.
8. Courses may fulfill multiple categories. For example, if you complete CY PLAN 118AC (http://guide.berkeley.edu/search/?P=CY%20PLAN%20118AC) that would satisfy the American Cultures requirement and one upper division H/SS requirement.
9. No courses offered by any engineering department other than BIO ENG 100 (http://guide.berkeley.edu/search/?P=BIO%20ENG%20100), COMPSCI C79 (http://guide.berkeley.edu/search/?P=COMPSCI%20C79), ENGIN 125 (http://guide.berkeley.edu/search/?P=ENGIN%20125), ENGIN 157AC (http://guide.berkeley.edu/search/?P=ENGIN%20157AC), MEC ENG 191K (http://guide.berkeley.edu/search/?P=MEC%20ENG%20191K) and MEC ENG 191AC (http://guide.berkeley.edu/search/?P=MEC%20ENG%20191AC) may be used to complete H/SS requirements.
10. Foreign language courses may be used to complete H/SS requirements. View the list of language options (http://ls-advise.berkeley.edu/requirement/fl.html) .
11. Courses numbered 97, 98, 99, or above 196 may not be used to complete any H/SS requirement
12. The College of Engineering uses modified versions of five of the College of Letters and Science (L&S) breadth requirements lists to provide options to our students for completing the H/SS requirement. No courses on the L&S Biological Sciences or Physical Sciences breadth lists may be used to complete H/SS requirements. Within the guidelines above, choose courses from any of the lists below.

    - Arts and Literature (http://guide.berkeley.edu/archive/2016-17/undergraduate/colleges-schools/letters-science/breadth-requirement-arts-literature)
    - Foreign Language (http://ls-advise.berkeley.edu/requirement/fl.html)
    - Historical Studies (http://guide.berkeley.edu/archive/2016-17/undergraduate/colleges-schools/letters-science/breadth-requirement-historical-studies)
    - International Studies (http://guide.berkeley.edu/archive/2016-17/undergraduate/colleges-schools/letters-science/breadth-requirement-international-studies)
    - Philosophy and Values (http://guide.berkeley.edu/archive/2016-17/undergraduate/colleges-schools/letters-science/breadth-requirement-philosophy-values)
    - Social and Behavioral Studies (http://guide.berkeley.edu/archive/2016-17/undergraduate/colleges-schools/letters-science/breadth-requirement-social-behavioral-sciences)

Class Schedule Requirements

- Minimum units per semester: 12.0.
- Maximum units per semester: 20.5.
- Minimum technical courses: College of Engineering undergraduates must enroll each semester in no fewer than two technical courses (of a minimum of 3 units each) required of the major program of study in which the student is officially declared. (Note: for most majors, normal progress will require enrolling in 3-4 technical courses each semester).
- All technical courses (math, science, engineering), required of the major or not, must be taken on a letter graded basis (unless only offered as P/NP).
- A student's proposed schedule must be approved by a faculty adviser (or on approval from the dean or a designated staff adviser) each semester prior to enrolling in courses.

Minimum Academic (Grade) Requirements

- A minimum overall and semester grade point average of 2.00 (C average) is required of engineering undergraduates. A student will be subject to dismissal from the University if during any fall or spring semester their overall UC GPA falls below a 2.00, or their semester GPA is less than 2.00.
- Students must achieve a minimum grade point average of 2.00 (C average) in upper division technical courses required of the major curriculum each semester. A student will be subject to dismissal from the University if their upper division technical grade point average falls below 2.00.
- A minimum overall grade point average of 2.00, and a minimum 2.00 grade point average in upper division technical course work required of the major is needed to earn a Bachelor of Science in Engineering.

Unit Requirements

To earn a Bachelor of Science in Engineering, students must complete at least 120 semester units of courses subject to certain guidelines:

- Completion of the requirements of one engineering major program (http://coe.berkeley.edu/students/guide/departments) of study.
- A maximum of 16 units of special studies coursework (courses numbered 97, 98, 99, 197, 198, or 199) is allowed towards the 120 units; a maximum of four is allowed in a given semester.
- A maximum of 4 units of physical education from any school attended will count towards the 120 units.
- Students may receive unit credit for courses graded P (including P/NP units taken through EAP) up to a limit of one-third of the total units taken and passed on the Berkeley campus at the time of graduation.

Normal Progress

Students in the College of Engineering must enroll in a full-time program and make normal progress each semester toward the bachelor's degree. The continued enrollment of students who fail to achieve minimum academic progress shall be subject to the approval of the dean. (Note: students with official accommodations established by the Disabled Students' Program, with health or family issues, or with other reasons

deemed appropriate by the dean may petition for an exception to normal progress rules.)

For more detailed information regarding the courses listed below (e.g., elective information, GPA requirements, etc.), please see the College Requirements and Major Requirements tabs.

				Freshman
	Fall	**Units**	**Spring**	**Units**
CHEM 4A or 1A ***and*** 1AL[1]		4	MATH 1B	4
MATH 1A		4	PHYSICS 7A	4
ENGIN 93		1	ENGIN 7 or COMPSCI 61A	4
Reading and Composition Course from List A		4	Reading and Composition Course from List B	4
Free Elective		3		
		16		**16**
				Sophomore
	Fall	**Units**	**Spring**	**Units**
MATH 53		4	MATH 54	4
PHYSICS 7B		4	MEC ENG 40 or ENGIN 115	3-4
Engineering Prep course 1[2]		3-6	CIV ENG 100 or MEC ENG 106	3-4
ENE,RES C100[3]		4	Engineering Prep course 2[2]	3-4
			Free Elective	1
		15-18		**14-17**
				Junior
	Fall	**Units**	**Spring**	**Units**
EL ENG 137A		4	EL ENG 137B	4
MEC ENG 109		3	Engineering Electives[2]	6-8
Economics Course[2]		3-4	Humanities/ Social Sciences course	3-4
Engineering Elective[2]		3-4		
		13-15		**13-16**
				Senior
	Fall	**Units**	**Spring**	**Units**
CIV ENG 186		3	ENGIN 194	3
Math/Statistics/Analysis Course or CIV ENG 191 or EL ENG 127[2]		3-4	EL ENG 134	4
Engineering Elective[2]		3-4	Sustainability Course[2]	3
Humanities/Social Sciences course		3-4	Humanities/ Social Sciences course	3-4
Free Elective		4	Free Elective	4
		16-19		**17-18**

Total Units: 120-135

1 CHEM 4A is intended for students majoring in chemistry or a closely-related field.

2 See Major Requirements tab for approved courses.

3 ENE,RES C100 satisfies both a major requirement and one of the upper division humanities/social sciences requirements.