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 the 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.

Admission to engineering via a Change of College application for current UC Berkeley students is very competitive, as there are 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.

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 overall grade point average (GPA) of 3.0 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 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

General Guidelines
1. All technical courses taken in satisfaction of major requirements 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 further information regarding a Change of College to Engineering, please see the College of Engineering’s website.

Lower Division Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
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<tbody>
<tr>
<td>MATH 1A</td>
<td>Calculus</td>
<td>4</td>
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<tr>
<td>MATH 1B</td>
<td>Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 53</td>
<td>Multivariable Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 54</td>
<td>Linear Algebra and Differential Equations</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 7A</td>
<td>Physics for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 7B</td>
<td>Physics for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 1A</td>
<td>General Chemistry</td>
<td>4</td>
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<tr>
<td>CHEM 1AL</td>
<td>General Chemistry Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 4A</td>
<td>General Chemistry and Quantitative Analysis</td>
<td>4</td>
</tr>
<tr>
<td>ENGIN 7</td>
<td>Introduction to Computer Programming for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>COMPSCI 6</td>
<td>The Structure and Interpretation of Computer Programs</td>
<td>4</td>
</tr>
<tr>
<td>ENGIN 93</td>
<td>Energy Engineering Seminar</td>
<td>1</td>
</tr>
<tr>
<td>MEC ENG 40</td>
<td>Thermodynamics</td>
<td>3-4</td>
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<tr>
<td>or ENGIN 40</td>
<td>Engineering Thermodynamics</td>
<td>3-4</td>
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<td>Select two Engineering Prep courses:</td>
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<tr>
<td>CHEM 1B</td>
<td>General Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 3A</td>
<td>Chemical Structure and Reactivity</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 11</td>
<td>Engineered Systems and Sustainability</td>
<td>3-4</td>
</tr>
</tbody>
</table>
**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
- **or** **EL ENG 113** Power Electronics
- **ENE,RES C100** Energy and Society 4
- **ENGIN 194** Undergraduate Research 3
- **MEC ENG 109** Heat Transfer 3

**Sustainability Course, select one course from the following:** 3
- **CIV ENG 110** Water Systems of the Future [3]
- **CIV ENG 111** Environmental Engineering [3]
- **CIV ENG 113** Ecological Engineering for Water Quality Improvement [3]
- **CIV ENG 115** Water Chemistry [3]
- **CY PLAN 119** Planning for Sustainability [3] 3
- **ENE,RES 101** Ecology and Society [3]

**Economics Course: Choose one from the following:** 3-4
- **CIV ENG 156** Infrastructure Planning and Management [3]
- **ENE,RES 180** Ecological Economics in Historical Context [3]
- **ENGIN 120** Principles of Engineering Economics [3]
- **ENCECON 147** Regulation of Energy and the Environment [4]
- **ENCECON 153** Economic Development [4]
- **ENCECON 154** Population, Environment, and Development [3]
- **ENCECON 154** Economics of Poverty and Technology [3]
- **ESPM 102D** Climate and Energy Policy [4]
- **POLECON 101** Contemporary Theories of Political Economy [4]

or an economics course chosen in consultation with faculty adviser.

**Math/Statistics/Analysis Course: Choose from list below or choose 3-4**
- **CIV ENG 191** or **EECS 127**
- **CIV ENG 93** Engineering Data Analysis [3]
- **ENCECON 70** Discrete Mathematics and Probability Theory [4]
- **ENGIN 117** Methods of Engineering Analysis [3]
- **IND ENG 172** Probability and Risk Analysis for Engineers [4]
- **MATH 55** Discrete Mathematics [4]

**Engineering Electives 6** 12

1. **ENE,RES C100** satisfies both a major requirement and one of the upper division humanities/social sciences requirements. It must be taken for a letter grade.
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. It must be taken for a letter grade.
4. This course satisfies both the economics requirement and one of the upper division humanities/social sciences requirements. It must be taken for a letter grade.
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 include upper division courses in any engineering department and must be chosen in consultation with a faculty adviser. The only course not offered by an engineering department that can count toward this requirement is ENE,RES 190C. Engineering electives cannot include any courses taken on a P/NP basis; **BIOENG 100**, **CHMENG 185**, **COMPSCI 195**, **H195**, **DESINV** courses (except **DES INV 190E**); **ENGIN 125**, **157AC**, **180**, **185**, **187**; **INDENG 172**, **185**, **186**, **190** series, **191**, **192**, **195**; **MECENG 190K**, **191AC**, **191K**. 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 courses)
   - **Distribution**: **COMPSCI 61B** (exception approved for this lower division course), **EL ENG 105**, **EL ENG 113**, **EL ENG 117**, **EL ENG 120**, **EL ENG 128**/**MATH 134**, **MATH 135**
   - **Generation**: **BIO ENG 181**, **MEC ENG 130**, **MEC ENG 140**, **MEC ENG 146**, **NUC ENG 161**
   - **Materials**: **MATH 103**, **MATH 111**, **MATH 113**, **MATH 125**, **MATH 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 minors must be declared no later than one semester before a student’s Expected Graduation Term (EGT). If the semester before EGT is fall or spring, the deadline is the last day of RRR week. If the semester before EGT is summer, the deadline is the final Friday of Summer Sessions. To declare a minor, contact the department advisor for information on requirements, and the declaration process.

2. All courses taken to fulfill the minor requirements must be taken for graded credit.

3. 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.

4. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.

5. No more than one upper division course may be used to simultaneously fulfill requirements for a student’s major and minor programs.

6. 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 General Chemistry 4
& 1AL and General Chemistry Laboratory
CHEM 4A General Chemistry and Quantitative Analysis 4

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 Course Not Available
EL ENG 137A Introduction to Electric Power Systems 4

Select one of the following: 4

ENE,RES C10 Energy and Society [4]
CIV ENG 111 Environmental Engineering [3]

CIV ENG C106 Air Pollution 3

Select two of the following: 8

ARCH 140 Energy and Environment [4]
CY PLAN 119 Planning for Sustainability [3]

CIV ENG 107 Climate Change Mitigation [3]
CIV ENG 111 Environmental Engineering [3]

CIV ENG 113N Course Not Available [3]
CIV ENG 115 Water Chemistry [3]
CIV ENG 156 Infrastructure Planning and Management [3]
EL ENG 134 Fundamentals of Photovoltaic Devices [4]

EL ENG 137B Introduction to Electric Power Systems [4]
ENE,RES C10 Energy and Society [4]
ENE,RES 101 Ecology and Society [3]
ENE,RES C180 Course Not Available [3]
ENGIN 120 Principles of Engineering Economics [3]
ENGIN 194 Undergraduate Research [3]
ENVECON 147 Regulation of Energy and the Environment [4]
ENVECON C158 Economic Development [4]
ENVECON 153 Population, Environment, and Development [3]
ENVECON 154 Economics of Poverty and Technology [3]
ESPM 102D Climate and Energy Policy [4]
GEOG 142 Climate Dynamics [4]
IND ENG 172 Probability and Risk Analysis for Engineers [3]
or STAT 134 Concepts of Probability
MAT SCI 136 Materials in Energy Technologies [4]
MEC ENG 106 Fluid Mechanics [3]
MEC ENG 109 Heat Transfer [3]
NUC ENG 161 Nuclear Power Engineering [4]
POLECON 101 Contemporary Theories of Political Economy [4]

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://engineering.berkeley.edu/academics/undergraduate-programs) 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) that can fulfill requirements for the student’s major 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 Sciences (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://engineering.berkeley.edu/hsreq).
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). The first half (R&C Part A) must be completed by the end of the freshman year; the second half (R&C Part B) must be completed by no later than the end of the sophomore year. Please see the Reading and Composition Requirement (http://guide.berkeley.edu/undergraduate/colleges-schools/engineering/reading-composition-requirement) page for a complete list of R&Cs available and a list of exams that can be applied toward the R&C Part A requirement. Students can also use the Class Schedule (https://classes.berkeley.edu) to view R&C courses offered in a given semester. Note: Only R&C Part A can be fulfilled with an AP, IB, or A-Level exam score. Test scores do not fulfill R&C Part B for College of Engineering students.
4. Four additional courses must be chosen from the five areas listed in #13 below. These four courses may be taken on a pass/no pass basis.
5. Special topics courses of 3 semester units or more will be reviewed on a case-by-case basis.
6. Two of the six courses must be upper division (courses numbered 100-196).
7. One of the six courses must satisfy the campus American Cultures (http://guide.berkeley.edu/undergraduate/colleges-schools/engineering/american-cultures-requirement) (AC) requirement. Note that any American Cultures course of 3 units or more may be used to meet H/SS.
8. 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) that can be applied toward H/SS requirements.
9. No courses offered by any engineering department other than BIO ENG 100, COMPSCI C79, ENGIN 125, ENGIN 157AC, ENGIN 185, and MEC ENG 191K may be used to complete H/SS requirements.
10. Language courses may be used to complete H/SS requirements. View the list of language options (http://guide.berkeley.edu/undergraduate/colleges-schools/engineering/approved-foreign-language-courses).
11. Courses may fulfill multiple categories. For example, CY PLAN 118AC satisfies both the American Cultures requirement and one upper division H/SS requirement.
12. Courses numbered 97, 98, 99, or above 196 may not be used to complete any H/SS requirement.
13. 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. The five areas are:
   - Arts and Literature
   - Historical Studies
   - International Studies
   - Philosophy and Values
   - Social and Behavioral Sciences

Within the guidelines above, choose courses from any of the Breadth areas listed above. (Please note that you cannot use courses on the Biological Science or Physical Science Breadth list to complete the H/SS requirement.) To find course options, go to the Class Schedule (http://classes.berkeley.edu), (http://classes.berkeley.edu/search/class) select the term of interest, and use the Breadth Requirements (https://ls.berkeley.edu/sites/default/files/breadth_search_annotation_in_guide.png) filter.

**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, with the exception of Engineering 25, 26 and 27) required of the major program of study in which the student is officially declared. (Note: For most majors, normal progress (https://engineering.berkeley.edu/academics/undergraduate-guide/policies-procedures/scholarship-progress/#ac12282) will require enrolling in 3-4 technical courses each semester). Students who are not in compliance with this policy by the end of the fifth week of the semester are subject to a registration block that will delay enrollment for the following semester.
- All technical courses (math, science, engineering) that satisfy requirements for the major must be taken on a letter-graded basis (unless only offered as P/NP).

**Minimum Academic (Grade) Requirements**
- A minimum overall and semester grade point average of 2.00 (C average) is required of engineering undergraduates. Students 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 for the major curriculum each semester.
- A minimum overall grade point average of 2.00, and a minimum 2.00 grade point average in upper division technical course work required for 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 (https://engineering.berkeley.edu/academics/undergraduate-guide/degree-requirements/major-programs) of study.
- A maximum of 16 units of special studies coursework (courses numbered 97, 98, 99, 197, 198, or 199) is allowed towards B.S. degree, and no more than 4 units in any single term can be counted.
- A maximum of 4 units of physical education from any school attended will count towards the 120 units.
- Passed (P) grades may account for no more than one third of the total units completed at UC Berkeley, Fall Program for Freshmen (FFP), UC Education Abroad Program (UCEAP), or UC Berkeley Washington Program (UCDC) toward the 120 overall minimum unit requirement. Transfer credit is not factored into the limit.
The American Cultures requirement and courses constitute an approach that responds directly to the problem encountered in numerous disciplines of how better to present the diversity of American experience. This is not an ethnic studies requirement, nor a Third World cultures requirement, nor an adjusted Western civilization requirement. These courses focus upon how the diversity of America’s constituent cultural traditions have shaped and continue to shape American identity and experience.

Visit the Class Schedule (http://classes.berkeley.edu) or the American Cultures website (http://americancultures.berkeley.edu) for the specific American Cultures courses offered each semester. For a complete list of approved American Cultures courses at UC Berkeley and California Community Colleges, please see the American Cultures Subcommittee’s website (https://academic-senate.berkeley.edu/committees/amcult). See your academic adviser if you have questions about your responsibility to satisfy the American Cultures breadth requirement.

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.

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Fall Units</th>
<th>Spring Units</th>
<th>Freshman Units</th>
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<tr>
<td>CHEM 4A or 1A and 1AL&lt;sup&gt;1&lt;/sup&gt;</td>
<td>4</td>
<td>4</td>
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<tr>
<td>MATH 1A</td>
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<tr>
<td>ENGIN 93</td>
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<tr>
<td>Reading &amp; Composition Part A Course&lt;sup&gt;4&lt;/sup&gt;</td>
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<td>4</td>
</tr>
<tr>
<td>Humanities/Social Sciences course&lt;sup&gt;4&lt;/sup&gt;</td>
<td>3-4</td>
<td></td>
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</tbody>
</table>

American Cultures courses focus upon how the diversity of America’s constituent cultural traditions have shaped and continue to shape American identity and experience.

This includes transfer units from outside of the UC system, other UC campuses, credit-bearing exams, as well as UC Berkeley Extension XB units.

**Normal Progress**

Students in the College of Engineering must enroll in a full-time program and make normal progress (https://engineering.berkeley.edu/academics/undergraduate-guide/policies-procedures/scholarship-progress/#ac12283) 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.)

**University of California Requirements**

**Entry Level Writing** (https://www.ucop.edu/elwr)

All students who will enter the University of California as freshmen must demonstrate their command of the English language by fulfilling the Entry Level Writing Requirement. Satisfaction of this requirement is also a prerequisite to enrollment in all Reading and Composition courses at UC Berkeley.

**American History and American Institutions** (http://guide.berkeley.edu/undergraduate/education/#universityrequirementstext)

The American History and Institutions requirements are based on the principle that a U.S. resident graduated from an American university should have an understanding of the history and governmental institutions of the United States.

**Campus Requirement**

**American Cultures** (http://guide.berkeley.edu/undergraduate/education/#campusrequirementstext)

The American Cultures requirement is a Berkeley campus requirement, one that all undergraduate students at Berkeley need to pass in order to graduate. You satisfy the requirement by passing, with a grade not lower than C- or P, an American Cultures course. You may take an American Cultures course any time during your undergraduate career at Berkeley.

The requirement was instituted in 1991 to introduce students to the diverse cultures of the United States through a comparative framework. Courses are offered in more than fifty departments in many different disciplines at both the lower and upper division level.

The American Cultures requirement and courses constitute an approach that responds directly to the problem encountered in numerous disciplines of how better to present the diversity of American experience to the diversity of American students whom we now educate.

Faculty members from many departments teach American Cultures courses, but all courses have a common framework. The courses focus on themes or issues in United States history, society, or culture; address theoretical or analytical issues relevant to understanding race, culture, and ethnicity in American society; take substantial account of groups drawn from at least three of the following: African Americans, indigenous peoples of the United States, Asian Americans, Chicano/Latino Americans, and European Americans; and are integrative and comparative in that students study each group in the larger context of American society, history, or culture.
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. It must be taken for a letter grade.
4. The Humanities/Social Sciences (H/SS) requirement includes two approved Reading & Composition (R&C) courses and four additional approved courses, with which a number of specific conditions must be satisfied. R&C courses must be taken for a letter grade (C- or better required). The first half (R&C Part A) must be completed by the end of the freshman year; the second half (R&C Part B) must be completed by no later than the end of the sophomore year. The remaining courses may be taken at any time during the program. See engineering.berkeley.edu/hss for complete details and a list of approved courses.