Aerospace Engineering

Leonardo da Vinci wrote, “Once you have tasted flight, you will forever walk the earth with your eyes turned skyward. For there you have been, and there you will always long to return.” Perhaps, like da Vinci, you’ve always been obsessed with airborne machines: Gliders and lighter-than-air craft. Fixed-wing airplanes and jets. Autogyros and helicopters. Or even rockets, satellites, and spacecraft. Aeronautical engineers generally design aircraft to fly within the Earth’s atmosphere, while astronautical engineers design the technology for spacecraft to fly beyond the atmosphere. Either way, the sky’s the limit.

Major Program
At Berkeley Engineering, we offer a modern aerospace engineering major that combines comprehensive topical coverage, technical rigor and practical relevance. This major has been designed from the ground up for students who aspire to become leaders in an emerging era of aerospace technologies, including sustainable aviation, autonomous flight and space exploration. With a UC Berkeley aerospace engineering degree, you can find employment in industry — such as multinational corporations that design and manufacture aerospace systems at scale, or mid-size and small private companies that develop targeted technologies — or in federal government agencies such as NASA, the FAA or federal defense organizations.

The aerospace engineering degree program began instruction with an inaugural freshman class in Fall 2022.

Minor Program
To declare your intention to pursue the Aerospace Minor, please use your Berkeley email address/calnet ID and fill out the following application to declare (https://docs.google.com/forms/d/e/1FAIpQLSc5GQhRPAm58pS5YOyJydfjQvbhQjKL4nt9Q5HSrk8V7w/viewform?usp=sf_link) form.

Non-Mechanical Engineering major students can declare their intention to complete the minor after completing prerequisite courses MEC ENG 85 Introduction to Solid Mechanics, MEC ENG 106 Fluid Mechanics, and MEC ENG 132 Dynamic Systems and Feedback. Mechanical Engineering majors are allowed to overlap prerequisite courses. Students must have a minimum overall grade-point average of 3.0, as well as a minimum grade-point average of 3.0 in the prerequisite courses, in order to be admitted to the minor program.

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.

General Guidelines
1. All technical courses taken in satisfaction of major requirements must be taken for a letter grade.
2. A minimum overall grade point average (GPA) of 2.0 is required for all work undertaken at UC Berkeley.
3. A minimum GPA of 2.0 is required for all upper division 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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERO ENG 1</td>
<td>Aerospace Engineering 1 Seminar</td>
<td>1</td>
</tr>
<tr>
<td>AERO ENG 2</td>
<td>Aerospace Engineering 2 Seminar</td>
<td>1</td>
</tr>
<tr>
<td>AERO ENG 10</td>
<td>Introduction to Aerospace Engineering Design</td>
<td>4</td>
</tr>
<tr>
<td>CIV ENG C30</td>
<td>Introduction to Solid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>MEC ENG C1</td>
<td>Introduction to Solid Mechanics</td>
<td></td>
</tr>
<tr>
<td>COMPSCI 61A</td>
<td>The Structure and Interpretation of Computer Programs</td>
<td>4</td>
</tr>
<tr>
<td>ENGIN 7</td>
<td>Introduction to Computer Programming for Scientists and Engineers</td>
<td></td>
</tr>
<tr>
<td>ENGIN 40</td>
<td>Engineering Thermodynamics</td>
<td>3-4</td>
</tr>
<tr>
<td>MAT SCI 45</td>
<td>Properties of Materials</td>
<td>3</td>
</tr>
<tr>
<td>MAT SCI 45L</td>
<td>Properties of Materials Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>MATH 1A</td>
<td>Calculus</td>
<td>4</td>
</tr>
<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 86</td>
<td>Introduction to Mathematical Physics</td>
<td></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>Science Elective</td>
<td></td>
<td>4-5</td>
</tr>
</tbody>
</table>

1 Choose one of the following: ASTRON 7A, ASTRON 10; BIOLOGY 1A + BIOLOGY 1AL, BIOLOGY 1B; CHEM 1A + CHEM 1AL, CHEM 1B, CHEM 3A + CHEM 3AL, CHEM 3B + CHEM 3BL, CHEM 4A, CHEM 4B; MCELLBI 32; PHYSICS 7C. Some of these courses require prerequisites and would therefore be more appropriately taken in a later semester.

Upper Division Requirements

Students must complete the Upper Division Core Requirements and four Technical Electives.

Upper Division Core Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV ENG 93</td>
<td>Engineering Data Analysis</td>
<td>3-4</td>
</tr>
<tr>
<td>DATA C100</td>
<td>Principles &amp; Techniques of Data Science</td>
<td></td>
</tr>
<tr>
<td>ENGIN 178</td>
<td>Statistics and Data Science for Engineers</td>
<td></td>
</tr>
<tr>
<td>CIV ENG 126</td>
<td>Engineering Dynamics and Vibrations</td>
<td>3</td>
</tr>
<tr>
<td>MEC ENG 10</td>
<td>Engineering Mechanics II</td>
<td></td>
</tr>
<tr>
<td>MEC ENG 100</td>
<td>Electronics for the Internet of Things</td>
<td>4</td>
</tr>
<tr>
<td>EL ENG 120</td>
<td>Signals and Systems</td>
<td></td>
</tr>
<tr>
<td>EECS 149</td>
<td>Introduction to Embedded and Cyber Physical Systems</td>
<td></td>
</tr>
<tr>
<td>MEC ENG 103</td>
<td>Experimentation and Measurements</td>
<td>4</td>
</tr>
<tr>
<td>MEC ENG 106</td>
<td>Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>MEC ENG 132</td>
<td>Dynamic Systems and Feedback</td>
<td>3</td>
</tr>
<tr>
<td>EL ENG 12</td>
<td>Feedback Control Systems</td>
<td></td>
</tr>
</tbody>
</table>

Aerospace Engineering 1
Technical Electives
Students must take four elective courses total from the areas listed below, two from one area and an additional two from another.

Communications Systems
- COMPSCI 168 Introduction to the Internet: Architecture and Protocols 4
- EL ENG 117 Electromagnetic Fields and Waves 4
- EL ENG 121 Introduction to Digital Communication Systems 4
- EL ENG 122 Introduction to Communication Networks 4
- EL ENG 142 Integrated Circuits for Communications 4

Computational Tools
- CIV ENG C133 Engineering Analysis Using the Finite Element Method 3
- ENGIN 150 Basic Modeling and Simulation Tools for Industrial Research Applications 4
- IND ENG 174 Simulation for Enterprise-Scale Systems 3
- NUC ENG 155 Introduction to Numerical Simulations in Radiation Transport 3

Control, Autonomy, & Artificial Intelligence
- COMPSCI 188 Introduction to Artificial Intelligence 4
- COMPSCI 189 Introduction to Machine Learning 4
- EL ENG/BIO Introduction to Robotics 4
- ENG/MEC ENG C106A Robotic Manipulation and Interaction 4
- EL ENG/BIO ENG/MEC ENG C106B Introduction to Machine Learning and Data Analytics 4
- MEC ENG 136 Introduction to Control of Unmanned Aerial Vehicles 3

Design
- EL ENG 192 Mechatronic Design Laboratory 4
- MEC ENG 135 Design of Microprocessor-Based Mechanical Systems 4

Dynamical Systems
- MEC ENG 170 Engineering Mechanics III 3
- MEC ENG/AERO Introduction to Flight Mechanics ENG C162 3
- MEC ENG 175 Intermediate Dynamics 3

Humans and Automation
- CIV ENG 190 Special Topics in Civil and Environmental Engineering (Aviation control topics) 1-4
- COG SCI 131 Computational Models of Cognition 4
- COMPSCI 160 User Interface Design and Development 4
- IND ENG 170 Industrial Design and Human Factors 3

Manufacturing
- IND ENG 130 Methods of Manufacturing Improvement 3
- MEC ENG 163 Engineering Aerodynamics 3
- MEC ENG 132 is only offered during fall semesters.

Materials
- MAT SCI 102 Bonding, Crystallography, and Crystal Defects 3
- MAT SCI 104 Materials Characterization 4
- MAT SCI 104 & 104L Materials Characterization Laboratory 3
- MAT SCI 112 Corrosion (Chemical Properties) 3
- MAT SCI 113 Mechanical Behavior of Engineering Materials 3
- MAT SCI 136 Materials in Energy Technologies 4
- MEC ENG 108 Mechanical Behavior of Engineering Materials 4
- MEC ENG 127 Introduction to Composite Materials 3
- NUC ENG 120 Nuclear Materials 4

Mechanics
- CIV ENG 132 Applied Structural Mechanics 3
- MEC ENG/AERO Flight Vehicle Structures and Aeroelasticity ENG C184/ CIV ENG C138 3
- MEC ENG 185 Introduction to Continuum Mechanics 3

Operations and Project Management
- CIV ENG 167 Engineering Project Management 3
- IND ENG 120 Principles of Engineering Economics 3
- IND ENG 130 Methods of Manufacturing Improvement 3
- IND ENG 150 Production Systems Analysis 3
- IND ENG 153 Logistics Network Design and Supply Chain Management 3

Optimization
- EECS 127 Optimization Models in Engineering 4
- IND ENG 160 Nonlinear and Discrete Optimization 3
- IND ENG 162 Linear Programming and Network Flows 3
- IND ENG 164 Introduction to Optimization Modeling 3

Power
- CIV ENG 190 Special Topics in Civil and Environmental Engineering ((Power topics)) 1-4
- MEC ENG 140 Combustion Processes 3
- MEC ENG 146 Energy Conversion Principles 3
- MEC ENG 154 Thermophysics for Applications 3
- NUC ENG 150 Introduction to Nuclear Reactor Theory 4
- NUC ENG 161 Nuclear Power Engineering 4

Propulsion
- AERO ENG 143 Course Not Available
- MEC ENG 109 Heat Transfer 3
- MEC ENG 140 Combustion Processes 3
- MEC ENG 151A Conductive and Radiative Transport 3
- MEC ENG 151B Convective Transport and Computational Methods 3
- MEC ENG 154 Thermophysics for Applications 3

Risk Management
- CIV ENG 193 Engineering Risk Analysis 3
- IND ENG 165 Engineering Statistics, Quality Control, and Forecasting 4
- IND ENG 166 Decision Analytics 3
- IND ENG 172 Probability and Risk Analysis for Engineers 4
With the following provisions:

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 (https://engineering.berkeley.edu/students/undergraduate-guide/degree-requirements/major-programs/) 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) 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 five semesters to complete their degree requirements. Summer terms are optional and do not count toward the maximum. Students are responsible for planning and satisfyingly completing all graduation requirements within the maximum allowable semesters.
6. Adhere to all college policies and procedures (https://engineering.berkeley.edu/students/undergraduate-guide/policies-procedures/) as they complete degree requirements.
7. Complete lower division technical courses before enrolling in upper division technical 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. See the humanities and social sciences (https://engineering.berkeley.edu/students/undergraduate-guide/degree-requirements/humanities-and-social-sciences/) section of our website for details.

### Class Schedule Requirements

- Minimum units per semester: 12.0
- Minimum units per semester: 20.5
- Minimum technical courses: College of Engineering undergraduates must include at least two letter graded technical courses (of at least 3 units each) in their semester program. Every semester students are expected to make satisfactory progress in their declared major. Satisfactory progress is determined by the student’s Engineering Student Services Advisor. (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 required of your current major 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 Requirements

- Students must have a minimum overall and semester grade point average of 2.00 (C average). 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 are required to earn a Bachelor of Science in the College of Engineering.
- Students must make normal degree progress toward the Bachelor of Science degree and their officially declared major.

### 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/students/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 to count towards...
the 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 (FPF), 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. 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/students/undergraduate-guide/policies-procedures/scholarship-progress/#ac12282) each semester toward their declared major. Students who fail to achieve normal academic progress shall be subject to dismissal. (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 (http://guide.berkeley.edu/undergraduate/education/#earningyourdegreetext)

All students who will enter the University of California as freshmen must demonstrate their command of the English language by satisfying the Entry Level Writing Requirement (ELWR). The UC Entry Level Writing Requirement website (https://admission.universityofcalifornia.edu/elwr/) provides information on how to satisfy the requirement.

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

The American History and Institutions (AH&I) requirements are based on the principle that a US 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/#earningyourdegreetext)

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.

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.
Humanities/Social Sciences Course 2 3-4

Total Units: 12-14

Spring Units

Junior

CIV ENG 93, DATA C100, or ENGIN 178 3-4
MEC ENG 100, EL ENG 120, or EECS 149 4
MEC ENG 163 3
Humanities/Social Sciences Course 2 3-4

Total Units: 13-15

Fall Units

Senior

MEC ENG 103 4
Technical Elective 1 3-4
Technical Elective 2 3-4
Free Elective 2-4

Total Units: 12-16

Spring Units

Senior

AERO ENG 100 4
Technical Elective 3 3-4
Technical Elective 4 3-4
Free Elective 2-4

Total Units: 12-16

Total Units: 120 (minimum)

Choose one of the following: ASTRON 7A, ASTRON 10; BIOLOGY 1A + BIOLOGY 1AL, BIOLOGY 1B; CHEM 1A + CHEM 1AL, CHEM 1B, CHEM 3A + CHEM 3AL, CHEM 3B + CHEM 3BL, CHEM 4A, CHEM 4B; MCELLBI 32; PHYSICS 7C. Some of these courses require prerequisites and would therefore be more appropriately taken in a later semester.

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.

Students must take four technical elective courses total: two from one of the areas listed on the Major Requirements page and two from another.