AERONAUTICS AND ASTRONAUTICS UNDERGRADUATE MAJOR

COVID-19-Related Degree Requirement Changes
For information on how Aeronautics and Astronautics degree requirements have been affected by the pandemic, see the 'COVID-19 Policies tab (http://exploredegrees.stanford.edu/schoolofengineering/aeronauticsandastronautics/#covid19policytext)' in the 'Aeronautics and Astronautics' of this bulletin. For University-wide policy changes related to the pandemic, see the 'COVID-19 and Academic Continuity (http://exploredegrees.stanford.edu/covid-19-policy-changes/)' section of this bulletin.

See the 'Department of Aeronautics and Astronautics (http://exploredegrees.stanford.edu/schoolofengineering/aeronauticsandastronautics/#)' section of this bulletin for additional information on the department, and its programs and faculty.

The department offers a B.S. as well as a minor in Aeronautics and Astronautics.

Aeronautics and Astronautics (AA)
Mission of the Undergraduate Program in Aeronautics and Astronautics
The mission of the undergraduate program in Aeronautics and Astronautics Engineering is to provide students with the fundamental principles and techniques necessary for success and leadership in the conception, design, implementation, and operation of aerospace and related engineering systems. Courses in the major include engineering fundamentals, mathematics, and the sciences, as well as in-depth courses in aeronautics and astronautics, dynamics, mechanics of materials, autonomous systems, computational engineering, embedded programming, fluids engineering, and heat transfer. The major prepares students for careers in aircraft and spacecraft engineering, autonomy, robotics, unmanned aerial vehicles, drones, space exploration, air and space-based telecommunication industries, computational engineering, teaching, research, military service, and other related technology-intensive fields.

Completion of the undergraduate program in Aeronautics and Astronautics leads to the conferral of the Bachelor of Science in Aeronautics and Astronautics.

Requirements

<table>
<thead>
<tr>
<th>Mathematics</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>24 units minimum</td>
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</tr>
<tr>
<td>MATH 19 Calculus (required)</td>
<td>3</td>
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<tr>
<td>MATH 20 Calculus (required)</td>
<td>3</td>
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<tr>
<td>MATH 21 Calculus (required)</td>
<td>4</td>
</tr>
<tr>
<td>CME 100/ENGR 154 Vector Calculus for Engineers (required)</td>
<td>5</td>
</tr>
<tr>
<td>or MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications</td>
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<tr>
<td>CME 102/ENGR 155A Ordinary Differential Equations for Engineers (required)</td>
<td>5</td>
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</tbody>
</table>

Aero/Astro Focus Electives
12 units minimum

or MATH 53 Ordinary Differential Equations with Linear Algebra 4-5
or STAT 110 Statistical Methods in Engineering and the Physical Sciences 4-5
or STAT 116 Theory of Probability 3-5
or CS 109 Introduction to Probability for Computer Scientists 3-5
CME 104 Linear Algebra and Partial Differential Equations for Engineers (recommended) 2 5
or MATH 52 Integral Calculus of Several Variables 3
CME 108 Introduction to Scientific Computing (recommended ) 3

Science
20 units minimum
PHYSICS 41 Mechanics (required) 3 4
or PHYSICS 41E Mechanics, Concepts, Calculations, and Context 4
PHYSICS 43 Electricity and Magnetism (required) 3 4
PHYSICS 45 Light and Heat (required) 4
CHEM 31M Chemical Principles: From Molecules to Solids (or CHEM 31A and CHEM 31B, or AP Chemistry) (required) 5
ENGR 80 Introduction to Bioengineering (Engineering Living Matter) (recommended) 4

School of Engineering approved Science Electives: See Undergraduate Handbook, Figure 4-2 3-5

Technology in Society (one course required)
School of Engineering approved Technology in Society courses: See Undergraduate Handbook, Figure 4-3. The course must be on the School of Engineering approved list the year you take it. 3-5
AA 252 Techniques of Failure Analysis (recommended) 3

Engineering Fundamentals (three courses required)
11 units minimum
ENGR 21 Engineering of Systems (required) 3
CS 106A Programming Methodology 3-5
ENGR 10 Introduction to Engineering Analysis (recommended ) 4
ENGR 40M An Intro to Making: What is EE (recommended ) 3-5

Fundamentals Elective; see list of Approved Courses in Undergraduate Engineering Handbook website at ughb.stanford.edu, Figure 4-4 3-5

Aero/Astro Depth Requirements
35 units minimum
ENGR 14 Intro to Solid Mechanics (required) 3
ENGR 15 Dynamics (required) 3
ENGR 105 Feedback Control Design (required) 3
ME 30 Engineering Thermodynamics (required) 3
ME 70 Introductory Fluids Engineering (required) 3
AA 100 Introduction to Aeronautics and Astronautics (required) 3
AA 131 Space Flight (required) 3
AA 141 Atmospheric Flight (required) 3
AA 151 Lightweight Structures (required) 3
AA 174A Principles of Robot Autonomy (required) 5
AA 190 Directed Research and Writing in Aero/Astro (required) satisfies the Writing in the Major requirement, (WIM) 3-5
The Department of Aeronautics and Astronautics honors program has been designed to allow undergraduates with strong records and enthusiasm for independent research to engage in a significant project leading to a degree with departmental honors.

Students who meet the eligibility criteria and wish to be considered for the honors program should apply to the program by the end of the junior year. All applications are subject to the review and final approval by the Aero/Astro Undergraduate Curriculum Committee.

Application Requirements:
- One-page written statement describing the research topic and signed adviser form
- GPA of 3.5 or higher in the major
- Unofficial Stanford transcript (from Axess)
- Signature of thesis adviser

Honors criteria:
- Maintain the 3.5 GPA required for admissions to the honors program.
- Arrangement with an Aero/Astro faculty member who agrees to serve as the thesis adviser. The adviser must be a member of the Academic Council.
- Under the direction of the thesis adviser, complete at least two quarters of research with a minimum of 9 units of independent research; 3 of these units may be used towards a student’s Aero/Astro Focus Elective requirement.
- Submit an honors thesis (20-30 pages). Thesis is due by April 30th of senior year in order to be eligible for University prizes.
- Attend Research Experience for Undergraduates Poster Session or present in another suitable forum approved by the faculty adviser.

Aeronautics and Astronautics (AA) Minor

The Aero/Astro minor introduces undergraduates to the key elements of modern aerospace systems. Within the minor, students may focus on aircraft, spacecraft, or disciplines relevant to both. The course requirements for the minor are described in detail below. If any core classes (aside from ENGR 21; see footnote) are part of student’s major or other degree program, the Aero/Astro adviser can help select substitute courses to fulfill the Aero/Astro minor requirements; no double counting allowed. All courses taken for the minor must be taken for a letter grade if that option is offered by the instructor. Minimum GPA for all minor courses combined is 2.0.

The following core courses fulfill the minor requirements:

**AA Core**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>ENGR 21</td>
<td>Engineering of Systems 1</td>
<td>3</td>
</tr>
<tr>
<td>AA 100</td>
<td>Introduction to Aeronautics and Astronautics</td>
<td>3</td>
</tr>
<tr>
<td>AA 131</td>
<td>Space Flight</td>
<td>3</td>
</tr>
<tr>
<td>AA 141</td>
<td>Atmospheric Flight</td>
<td>3</td>
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</tbody>
</table>

**AA Electives**

Choose 4 courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 105</td>
<td>Feedback Control Design</td>
<td>3</td>
</tr>
<tr>
<td>ME 70</td>
<td>Introductory Fluids Engineering</td>
<td>3</td>
</tr>
<tr>
<td>AA 102</td>
<td>Introduction to Applied Aerodynamics</td>
<td>3</td>
</tr>
<tr>
<td>AA 103</td>
<td>Air and Space Propulsion</td>
<td>3</td>
</tr>
<tr>
<td>AA 113</td>
<td>Aerospace Computational Science</td>
<td>3</td>
</tr>
<tr>
<td>AA 135</td>
<td>Introduction to Space Policy</td>
<td>3</td>
</tr>
<tr>
<td>AA 151</td>
<td>Lightweight Structures</td>
<td>3</td>
</tr>
<tr>
<td>AA 156</td>
<td>Mechanics of Composite Materials</td>
<td>3</td>
</tr>
<tr>
<td>AA 173</td>
<td>Flight Mechanics &amp; Controls</td>
<td>3</td>
</tr>
<tr>
<td>AA 174A</td>
<td>Principles of Robot Autonomy I</td>
<td>5</td>
</tr>
<tr>
<td>AA 261</td>
<td>Building an Aerospace Startup from the Ground Up</td>
<td>3</td>
</tr>
<tr>
<td>AA 272</td>
<td>Global Positioning Systems</td>
<td>3</td>
</tr>
<tr>
<td>AA 279A</td>
<td>Space Mechanics</td>
<td>3</td>
</tr>
</tbody>
</table>

For additional information and sample programs see the Handbook for Undergraduate Engineering (http://ughb.stanford.edu) and the Aeronautics and Astronautics Undergraduate Program Sheet (https://ughb.stanford.edu/program-sheets/).

All courses taken for the major must be taken for a letter grade if that option is offered by the instructor.

Minimum Combined GPA for all courses in Engineering Topics (Engineering Fundamentals and Depth courses) is 2.0.

Transfer and AP credits in Math, Science, Fundamentals, and the Technology in Society course must be approved by the School of Engineering Dean’s office.

1 A score of 4 on the Calculus BC test or 5 on the AB test only gives students 8 units, not 10 units, so is equal to MATH 19 + MATH 20, but not MATH 21. The Math Placement Exam determines what math course the student starts with.

2 It is recommended that the CME series (100, 102, 104) be taken rather than the MATH series (51, 52, 53). It is recommended that students taking the MATH series also take CME 192 Introduction to MATLAB.

3 A score of 5 on the AP Physics C Mechanics test places the student out of PHYSICS 41. Similarly, a score of 5 on the AP Physics Electricity and Magnetism test places the student out of PHYSICS 43.

Honors Program

The Department of Aeronautics and Astronautics honors program has been designed to allow undergraduates with strong records and enthusiasm for independent research to engage in a significant project leading to a degree with departmental honors.

Students who meet the eligibility criteria and wish to be considered for the honors program should apply to the program by the end of the junior year. All applications are subject to the review and final approval by the Aero/Astro Undergraduate Curriculum Committee.
ENGR 21 is waived as minor requirement if already taken as part of the major program.