DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

Undergraduate Study

Undergraduate study in the department leads to the Bachelor of Science in Aerospace Engineering (Course 16), or the Bachelor of Science in Engineering (Course 16-ENG) at the end of four years.

Bachelor of Science in Aerospace Engineering (Course 16)
This program is designed to prepare the graduate for an entry-level position in aerospace and related fields and for further education at the master's level; it is accredited by the Engineering Accreditation Commission of ABET (*http://www.abet.org*). The program includes an opportunity for a year's study abroad.

The formal learning in the program builds a conceptual understanding in the foundational engineering sciences and professional subjects that span the topics critical to aerospace. This learning takes place within the engineering context of conceiving-designing-implementing-operating (CDIO) aerospace and related complex high-performance systems and products. The skills and attributes emphasized go beyond the formal classroom curriculum and include modeling, design, the ability for self-education, computer literacy, communication and teamwork skills, ethics, and—underlying all of these—appreciation for and understanding of interfaces and connectivity between various disciplines. Opportunities for formal and practical (hands-on) learning in these areas are integrated into the departmental subjects through examples set by the faculty, subject content, and the ability for substantive engagement in the CDIO process in the department's Learning Laboratory for Complex Systems.

The curriculum (*https://catalog.mit.edu/degree-charts/aerospace-engineering-course-16*) includes the General Institute Requirements (GIRs) (*https://catalog.mit.edu/mit/undergraduate-education/general-institute-requirements*) and the departmental program, which covers a fall-spring-fall sequence of subjects called Unified Engineering, subjects in dynamics and principles of automatic control, a statistics and probability subject, a subject in computers and programming, professional area subjects, an experimental project laboratory, and a capstone design subject. The program also includes subject 18.03 Differential Equations.

Unified Engineering is offered in sets of two 12-unit subjects in two successive terms. These subjects are taught cooperatively by several faculty members. Their purpose is to introduce new students to the disciplines and methodologies of aerospace engineering at a basic level, with a balanced exposure to analysis, empirical methods, and design. The areas covered include statics, materials, and structures; thermodynamics and propulsion; fluid mechanics; and signals and systems. Several laboratory experiments are performed and a number of systems problems tying the disciplines together and exemplifying the CDIO process are included.

Unified Engineering is usually taken in the sophomore year, 16.09 Statistics and Probability in the spring of the sophomore year, and the subjects 16.07 Dynamics and 16.06 Principles of Automatic Control respectively in the first and second term of the junior year. Subjects 6.100A Introduction to Computer Science Programming in Python and 6.100B Introduction to Computational Thinking and Data Science can be taken at any time, starting in the first year of undergraduate study, but the fall term of the sophomore year is recommended.

The professional area subjects offer a more complete and in-depth treatment of the materials introduced in the core courses. Students must take four subjects (48 units) from among the professional area subjects, with subjects in at least three areas. Students may choose to complete an option in Aerospace Information Technology by taking at least 36 of the 48 required units from a designated group of subjects specified in the degree chart (*https://catalog.mit.edu/degree-charts/aerospace-engineering-course-16*).

Professional area subjects in the four areas of Fluid Mechanics, Materials and Structures, Propulsion, and Computational Tools represent the advanced aerospace disciplines encompassing the design and construction of airframes and engines. Topics within these disciplines include fluid mechanics, aerodynamics, heat and mass transfer, computational mechanics, flight vehicle aerodynamics, solid mechanics, structural design and analysis, the study of engineering materials, structural dynamics, and propulsion and energy conversion from both fluid/thermal (gas turbines and rockets) and electrical devices.

Professional area subjects in the four areas of Estimation and Control, Computer Systems, Communications Systems, and Humans and Automation are in the broad disciplinary area of information, which plays a dominant role in modern aerospace systems. Topics within these disciplines include feedback, control, estimation, control of flight vehicles, software engineering, human systems engineering, aerospace communications and digital systems, fundamentals of robotics, the way in which humans interact with the vehicle through manual control and supervisory control of telerobotic processes (e.g., modern cockpit systems and human-centered automation), and how planning and real-time decisions are made by machines.

The capstone subjects serve to integrate the various disciplines and emphasize the CDIO context of the AeroAstro curriculum. They also satisfy the Communication Requirement (*https://catalog.mit.edu/mit/undergraduate-education/general-institute-requirements/#communicationrequirementtext*) as Communication-Intensive in the Major (CI-M) subjects. The vehicle and system design subjects require student teams to apply their undergraduate knowledge to the design of an aircraft or spacecraft system. One of these two subjects is required and is typically taken in the second term of the junior year

or in the senior year. (The completion of at least two professional area or concentration subjects is the prerequisite for capstone subjects 16.82 and 16.83[J].) The rest of the capstone requirement is satisfied by one of four 12–18 unit subjects or subject sequences, as outlined in the Course 16 degree chart; these sequences satisfy the Institute Laboratory Requirement. In 16.821 and 16.831[J] students build and operate the vehicles or systems developed in 16.82 and 16.83[J]. In 16.405[J], students specify and design a small-scale yet complex robot capable of real-time interaction with the natural world.

To take full advantage of the General Institute Requirements (*https://catalog.mit.edu/mit/undergraduate-education/general-institute-requirements*) and required electives, the department recommends the following: 3.091 Introduction to Solid-State Chemistry for the chemistry requirement; the ecology option of the biology requirement; a subject in economics (e.g., 14.01 Principles of Microeconomics) as part of the HASS Requirement; and elective subjects such as 16.00 Introduction to Aerospace and Design, a mathematics subject (e.g., 18.06 Linear Algebra, 18.075 Methods for Scientists and Engineers, or 18.085 Computational Science and Engineering I), and additional professional area subjects in the departmental program. Please consult the department's Academic Programs Office (Room 33-202) for other elective options.

Bachelor of Science in Engineering (Course 16-ENG)

Course 16-ENG is an engineering degree program designed to offer flexibility within the context of aerospace engineering and is a complement to our Course 16 aerospace engineering degree program. The program leads to the Bachelor of Science in Engineering (*https://catalog.mit.edu/degree-charts/engineering-aeronautics-astronautics-course-16-eng*). The 16-ENG degree is accredited by the Engineering Accreditation Commission of ABET (*http://www.abet.org*). Depending on their interests, Course 16-ENG students can develop a deeper level of understanding and skill in a field of engineering that is relevant to multiple disciplinary areas (e.g., robotics and control, computational engineering, mechanics, or engineering management), or a greater understanding and skill in an interdisciplinary area (e.g., energy, environment and sustainability, or transportation). This is accomplished first through a rigorous foundation within core aerospace engineering disciplines, followed by a six-subject concentration tailored to the student's interests, and completed with hands-on aerospace engineering lab and capstone design subjects.

The core of the 16-ENG degree is very similar to the core of the 16 degree. A significant part of the 16-ENG curriculum consists of electives (72 units) chosen by the student to provide in-depth study of a field of the student's choosing. A wide variety of concentrations are possible in which well-selected academic subjects complement a foundation in aerospace engineering and General Institute Requirements. Potential concentrations include aerospace software engineering, autonomous systems, communications, computation and sustainability, computational engineering, embedded systems and networks, energy, engineering management, environment, space exploration, and transportation. AeroAstro faculty have developed specific recommendations in these areas; details are available from the AeroAstro Academic Programs Office (Room 33-202) and on the departmental website. However, concentrations are not limited to those listed above. Students can design and propose technically oriented concentrations that reflect their own needs and those of society.

The student's overall program must contain a total of at least one and one-half years of engineering content (144 units) appropriate to his or her field of study. The required core, lab, and capstone subjects include 102 units of engineering topics. Thus, concentrations must include at least 42 more units of engineering topics. In addition, each concentration must include 12 units of mathematics or science.

The culmination of the 16-ENG degree program is our aerospace laboratory and capstone subject sequences. The capstone subjects serve to integrate the various disciplines and emphasize the CDIO context of our engineering curriculum. They also satisfy the Communication Requirement as CI-M subjects. The laboratory and capstone options in the 16-ENG degree are identical to those in the Course 16 degree program (see the description of this program for additional details on the laboratory and capstone sequences).

Double Major

Students may pursue two majors under the Double Major Program (*https://catalog.mit.edu/mit/undergraduate-education/academic-programs/majors*). In particular, some students may wish to combine a professional education in aeronautics and astronautics with a liberal education that links the development and practice of science and engineering to their social, economic, historical, and cultural contexts. For them, the Department of Aeronautics and Astronautics and the Program in Science, Technology, and Society offer a double major program (*https://catalog.mit.edu/schools/humanities-arts-social-sciences/science-technology-society*) that combines majors in both fields.

Other Undergraduate Opportunities

Undergraduate Research Opportunities Program

To take full advantage of the unique research environment of MIT, undergraduates, including first-year students, are encouraged to become involved in the research activities of the department through the Undergraduate Research Opportunities Program (UROP) (*https://catalog.mit.edu/mit/undergraduate-education/academic-research-options/undergraduate-research-opportunities-program*). Many of the faculty actively seek undergraduates to become a part of their research teams. Visit research centers' websites to learn more about available research opportunities. For more information, contact Marie Stuppard (*mas@mit.edu*) in the AeroAstro Academic Programs Office, Room 33-202, 617-253-2279.

Advanced Undergraduate Research Opportunities Program
Juniors and seniors in Course 16 may participate in an advanced undergraduate research program, SuperUROP (*https://superurop.mit.edu*), which was launched as a collaborative effort between the Department of Electrical Engineering and Computer Science (EECS) and the Undergraduate Research Opportunities Program (UROP) (*https://catalog.mit.edu/mit/undergraduate-education/academic-research-options/undergraduate-research-opportunities-program*). For more information, contact Joyce Light (*jlight@mit.edu*), AeroAstro Headquarters, (617) 253-8408, or visit the website.

Undergraduate Practice Opportunities Program
The Undergraduate Practice Opportunities Program (UPOP) (*http://upop.mit.edu*) is a program sponsored by the School of Engineering and administered through the Office of the Dean of Engineering. Open to all School of Engineering sophomores, this program provides students an opportunity to develop engineering and business skills while working in industry, nonprofit organizations, or government agencies. UPOP consists of three parts: an intensive one-week engineering practice workshop offered during IAP, 10–12 weeks of summer employment, and a written report and oral presentation in the fall. Students are paid during their periods of residence at the participating companies and also receive academic credit in the program. There are no obligations on either side regarding further employment.

Summer Internship Program
The Summer Internship Program provides undergraduates in the department the opportunity to apply the skills they are learning in the classroom in paid professional positions with employers throughout the United States. During recruitment periods, representatives from firms in the aerospace industry will visit the department and offer information sessions and technical talks specifically geared to Course 16 students. Often, student résumés are collected and interviews conducted for summer internships as well as long-term employment. Employers wishing to offer an information session or seeking candidates for openings in their company may contact Marie Stuppard (*mas@mit.edu*), 617-253-2279.

Students are also encouraged to take advantage of other career resources available through the MIT Career Advising and Professional Development Office (CAPD) or through the MIT International Science and Technology Initiatives (MISTI). AeroAstro students can also apply through MISTI to participate in the Imperial College London-MIT Summer Research Exchange Program. CAPD coordinates several annual career fairs and offers a number of workshops, including workshops on how to navigate a career fair as well as critique on résumé writing and cover letters.

Year Abroad Program
Through the MIT International Science and Technology Initiatives (MISTI) students can apply to study abroad in the junior year. In particular, the department participates in an academic exchange with the University of Pretoria, South Africa, and with Imperial College, United Kingdom. In any year-abroad experience, students enroll in the academic cycle of the host institution and take courses in the local language. They plan their course of study in advance; this includes securing credit commitments in exchange for satisfactory performance abroad. A grade average of B or better is normally required of participating AeroAstro students.

For more information, contact Marie Stuppard (*mas@mit.edu*). Also refer to Undergraduate Education (*https://catalog.mit.edu/mit/undergraduate-education/academic-research-options/other-universities/#studyabroadtext*) for more details on the exchange programs.

Massachusetts Space Grant Consortium
MIT leads the NASA-supported Massachusetts Space Grant Consortium (MASGC) in partnership with Boston University, Bridgewater State University, Harvard University, Framingham State University, Northeastern University, Mount Holyoke College, Olin College of Engineering, Tufts University, University of Massachusetts (Amherst, Dartmouth, and Lowell), Wellesley College, Williams College, Worcester State University, Worcester Polytechnic Institute, Boston Museum of Science, the Christa McAuliffe Center, the Maria Mitchell Observatory, and the Five College Astronomy Department. The program has the principal objective of stimulating and supporting student interest, especially that of women and underrepresented minorities, in space engineering and science at all educational levels, primary through graduate. The program offers a number of activities to this end, including support of undergraduate and graduate students to carry out research projects at their home institutions, support for student travel to present conference papers, and summer workshops for pre-college teachers. The program coordinates and supports the placement of students in summer positions at NASA centers for summer academies and research opportunities. MASGC also participates in a number of public outreach and education policy initiatives in Massachusetts to increase public awareness and inform legislators about the importance of science, technology, engineering, and math education in the state.

For more information, contact Helen Halaris, Massachusetts Space Grant Consortium program coordinator, 617-258-5546.

Inquiries
For additional information concerning academic and undergraduate research programs in the department, suggested four-year undergraduate programs, and interdisciplinary programs, contact Marie Stuppard (*mas@mit.edu*), 617-253-2279.