AERONAUTICS AND ASTRONAUTICS
Course 16

Department Contact
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Description
The vision of AeroAstro is to have an aerospace field that is a diverse and inclusive community, leading through excellence in research and education, and pushing the boundaries of the possible to ensure lasting positive impact on our society, economy, and environment.

The AeroAstro core curriculum introduces students to the fundamental disciplines of aerospace engineering, providing a basic understanding of materials and structures, fluids and aerodynamics, thermodynamics, physics and dynamics, electronic signals, systems, circuits, propulsion, control systems, computer programming, probability and statistics (for the Course 16 degree only). Much of the core curriculum is covered in Unified Engineering, which is offered in sets of two 12-unit subjects in the fall and spring semesters. The Unified experience includes a flight competition at the end of the spring semester. AeroAstro students take Unified together, building friendships and connections. The remainder of the curriculum includes dynamics and principles of automatic control (only one is required for the 16-ENG degree), differential equations, professional area subjects (for the Course 16 degree) or concentration subjects (for the 16-ENG degree). Culminating the 16 and 16-ENG programs are the aerospace laboratories and capstone subject sequences. These include the flight engineering and development subjects, the systems engineering and development subjects, and the robotics science and systems subject.

Inside Course 16
16	Aeronautics and Astronautics	Undergraduates: 121
16-ENG	S.B. in Engineering as recommended by the Department of Aeronautics and Astronautics	Undergraduates: 29

Introductory Classes

16.001 **Unified Engineering: Materials and Structures**
Presents fundamental principles and methods of materials and structures for aerospace engineering, and engineering analysis and design concepts applied to aerospace systems. Topics include statics; analysis of trusses; analysis of statically determinate and indeterminate systems; stress-strain behavior of materials; analysis of beam bending, buckling, and torsion; material and structural failure, including plasticity, fracture, fatigue, and their physical causes. Experiential lab and aerospace system projects provide additional aerospace context.

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16.002 **Unified Engineering: Signals and Systems**
Presents fundamental principles and methods of signals and systems for aerospace engineering, and engineering analysis and design concepts applied to aerospace systems. Topics include linear and time invariant systems; convolution; Fourier and Laplace transform analysis in continuous and discrete time; modulation, filtering, and sampling; and an introduction to feedback control. Experiential lab and system projects provide additional aerospace context. Labs, projects, and assignments involve the use of software such as MATLAB and/or Python.

16.003 **Unified Engineering: Fluid Dynamics**
Presents fundamental principles and methods of fluid dynamics for aerospace engineering, and engineering analysis and design concepts applied to aerospace systems. Topics include aircraft and aerodynamic performance, conservation laws for fluid flows, quasi-one-dimensional compressible flows, shock and expansion waves, streamline curvature, potential flow modeling, an introduction to three-dimensional wings and induced drag. Experiential lab and aerospace system projects provide additional aerospace context.

16.004 **Unified Engineering: Thermodynamics and Propulsion**
Presents fundamental principles and methods of thermodynamics for aerospace engineering, and engineering analysis and design concepts applied to aerospace systems. Topics include thermodynamic state of a system, forms of energy, work, heat, the first law of thermodynamics, heat engines, reversible and irreversible processes, entropy and the second law of thermodynamics, ideal and non-ideal cycle analysis, two-phase systems, and introductions to thermochemistry and heat transfer. Experiential lab and aerospace system projects provide additional aerospace context.

18.03 **Differential Equations**
Study of differential equations, including modeling physical systems. Solution of first-order ODEs by analytical, graphical, and numerical methods. Linear ODEs with constant coefficients. Complex numbers and exponentials. Inhomogeneous equations: polynomial, sinusoidal, and exponential inputs. Oscillations, damping, resonance. Fourier series. Matrices, eigenvalues, eigenvectors, diagonalization. First order linear systems: normal modes, matrix exponentials, variation of parameters. Heat equation, wave equation. Nonlinear autonomous systems: critical point analysis, phase plane diagrams.

16.C20[J] **Introduction to Computational Science and Engineering**
Provides an introduction to computational algorithms used throughout engineering and science (natural and social) to simulate time-dependent phenomena; optimize and control systems; and quantify uncertainty in problems involving randomness, including an introduction to probability and statistics. Combination of 6.100A and

16.C20[J] counts as REST subject.

Course 16-Friendly UROP Areas

- Aerospace Controls Lab
- Aerospace Plasma Group
- Astrodynamics, Space Robotics, & Controls Lab
- CSAIL (Computer Sci & AI Lab)
- Engineering Systems Lab
- Gas Turbine Lab
- Human Systems Lab
- Hypersonics Research Lab
- Institute for Soldier Nanotech (ISN)
- Interactive Robotics
- Lab for Aviation & the Environment
- LIDS (Lab for Info & Decision Sys)
- Space Propulsion Lab
- SPARK Lab (Sensing, Perception, Autonomy, & Robot Kinetics)
- STAR Lab (Space Telecom, Astronomy & Radiation)

** See full lab listings & descriptions at https://aeroastro.mit.edu/research/.

Get Involved with Course 16

- American Institute of Aeronautics and Astronautics (AIAA)
- Design-Build-Fly
- Rocket Team

Skills

- Problem-solving and analytical abilities
- Generating or adapting equipment and technology
- Interpreting and writing technical documentation
- Time and project management

Possible Future Jobs

- **Payload specialist:** Accompany equipment onboard spacecrafts to ensure proper installation and functionality.

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- **Systems engineer:** Analyze mission and design requirements and coordinate high level stages of a project. Systems engineers are responsible for integrating different subsystems into the overall system.
- **Design engineer:** Takes the concept or working model of a product to create a design that meets the customer's requirements, industry standards, and can be manufactured economically.

Career Industry Examples

Aerospace and defense	Computer hardware and software	Electrical engineering
Chemicals and materials	Consulting	Military

Sample Employers

Accion	Airbus	Amazon
Aerospace Corporation	Aurora Flight Services	Avidyne
BCG	Blue Origin	Draper Laboratory
General Electric	General Motors	Google
Jet Propulsion Laboratory	Lincoln Laboratory	Lockheed Martin
McKinsey & Company	NASA	Northrop Grumman
Pratt & Whitney	Raytheon	Sikorski Aircraft
Skydio	Space X	United Technologies
U.S. Air Force		