



PLTW Engineering

Aerospace Engineering | Course Outline

Aerospace engineering transforms the dream of flight into vehicles that ignite our imagination.

Students explore fundamentals of flight in air and space through software simulations and hands-on experiences. Students learn how these concepts apply to a career in aerospace engineering and to other engineering fields.

Where can aerospace engineering take us next?

Aerospace Engineering ignites students' learning in the fundamentals of atmospheric and space flight. Aerospace Engineering is one of the specialization courses in the PLTW Engineering program. The course deepens the skills and knowledge of an engineering student within the context of atmospheric and space flight. Students explore the fundamentals of flight in air and space as they bring the concepts to life by designing and testing components related to flight such as an airfoil, propulsion system, and a rocket. They learn orbital mechanics concepts and apply these by creating models using industry-standard software. They also apply aerospace concepts to alternative applications such as a wind turbine and parachute. Students simulate a progression of operations to explore a planet, including creating a map of the terrain with a model satellite and using the map to execute a mission using an autonomous robot.

The following is a summary of the units of study that are included in the course. The course is aligned with Next Generation Science Standards; Common Core State Standards for Mathematical Practice (HS); Common Core State Standards for English Language Arts; and Standards for Technological Literacy.

The course is planned for a rigorous pace, and it is likely to contain more material than a skilled teacher new to the course will be able to complete in the first iteration. Building enthusiasm while learning real world skills related to the Aerospace industry is a primary goal of the course. Teachers are encouraged to emphasize content that will be fresh and exciting to students, and the course is structured to facilitate local adaptation to a particular group of students' prior knowledge and experience.

AE Unit Summary

Unit 1 Introduction to Aerospace (28%)

Unit 2 Aerospace Design (29%)

Unit 3 Propulsion (18%)

Unit 4 Alternative Applications (25%)



Unit 1: Introduction to Aerospace

The goal of this unit is to excite students about aerospace engineering while providing a foundation of knowledge related to flight. In this unit students explore the rich history of aerospace achievement that advanced the industry. Students are introduced to the physics that allow flight within the atmosphere and the systems which provide safe coordination for aircraft.

Introduction to Aerospace Lesson Summary

- Lesson 1.1 Evolution of Flight
- Lesson 1.2 Physics of Flight
- Lesson 1.3 Flight Planning and Navigation

Lesson 1.1 Evolution of Flight

The goal of this lesson is for students to develop a foundational understanding of aerospace accomplishments. Achievements in aerospace engineering are set within the context of applying science, technology, math, and engineering to solve problems. Students develop their skills of working with a team and then within a larger group of the entire class while researching and discussing achievements in aerospace.

Lesson 1.2 Physics of Flight

The goal of this lesson is for students to build a foundational understanding of how flight within the Earth's atmosphere is possible. Students learn about the parts of an aircraft, how aircraft are controlled, and how the four forces of flight interrelate. Each of the forces of flight is explored individually to emphasize their impact. Students use a simulator to design an airfoil and analyze performance under changing conditions. An option is included for students to design, build, and test an airfoil in a wind tunnel if available. Students apply their knowledge and skills through a series of activities and projects to design, optimize, build, and test a competitive glider.

Lesson 1.3 Flight Planning and Navigation

The goal of this lesson is for students to fly an aircraft using simulation software and learn how aircraft are safely coordinated. In this lesson students use a flight simulator to experience how aircraft respond to control systems. Students are introduced to navigation systems such as the Global Positioning System (GPS). Students apply their knowledge of GPS to plan a route and exchange this plan with another group to evaluate the plan's accuracy. Students learn how aircraft are safely coordinated through Air Traffic Control (ATC). Students apply this knowledge to scenarios where students make decisions in a simulated environment.

Unit 2: Aerospace Design

The goal of this unit is for students to learn about factors which affect aircraft design. Students develop knowledge and skills in this unit through the use of software design, simulation tools, and hands-on construction of composites.



Aerospace Design Lesson Summary

- Lesson 2.1 Materials and Structures
- Lesson 2.2 Propulsion
- Lesson 2.3 Flight Physiology

Lesson 2.1 Materials and Structures

The goal of this lesson is for students to learn about aerospace materials and their application. In this lesson students will explore properties of some aerospace materials. Students will design an aircraft structural component in computer aided design (CAD) simulation software. Students will create and test composite samples which represent structural components used in aircraft construction.

Lesson 2.2 Propulsion

The goal for this lesson is for students to develop a deeper understanding of one of the four forces of atmospheric flight – thrust – while understanding the foundation of spacecraft propulsion. In this lesson students will learn about ways thrust is produced for aircraft and spacecraft. Students learn how aircraft propulsion system parameters interrelate using simulation software. Students design, build, and test their own model rockets.

Lesson 2.3 Flight Physiology

The goal of this lesson is for students to learn how the human body is affected by flight conditions and its impact on aircraft design. Students will measure various parameters of their vision, reaction time, and communication effectiveness. Students research and present aircraft accident investigation resources.

Unit 3: Space

The goal of this unit is for students to focus on space related-concepts defined in aerospace engineering. Students will learn about the governance of space and the impact of exploration of space. Students learn orbital mechanics and apply these concepts to modeling orbiting systems with software used by aerospace engineers.

Space Lesson Summary

- Lesson 3.1 Space Travel
- Lesson 3.2 Orbital Mechanics

Lesson 3.1 Space Travel

The goal of this lesson is for students to gain a perspective of the immense scale of the universe and our exploration of space. In this lesson students are oriented to the dimensions of space by relating it to distances which they can see in the world close to them. Students learn about the accomplishments in space exploration and the legal system which governs these activities. Students explore the growing space debris problem and design and mock up a space junk mitigation system.



Lesson 3.2 Orbital Mechanics

The goal of this lesson is for students to understand the need for various types of satellite orbits and how different orbits are well-suited for different satellite missions. This lesson will provide students with an introduction to and basic understanding of laws governing and describing satellite orbits. Students will learn about the Keplerian Element Set and Kepler's Laws of Motion. Students apply what they learned by creating a model of the International Space Station orbit using Systems Tool Kit (STK). STK is a powerful software package used by aerospace engineers.

Unit 4: Alternative Applications

The goal of this unit is for students to consider applications of aerospace concepts beyond the design of aircraft and spacecraft and to explore career opportunities in the field of aerospace engineering. Students simulate a progression of operations to explore a planet. Students build and operate a remote sensing model to measure a physical terrain similar to the satellite overflight of an unexplored planet. Students transform the data into a topographical map that students will use to plan an autonomous planetary rover mission.

Alternative Applications Lesson Summary

Lesson 4.1 Alternative Applications

Lesson 4.2 Remote Systems

Lesson 4.3 Aerospace Careers

Lesson 4.1 Alternative Applications

The goal of this lesson is for students to learn how aerospace engineering concepts can be applied beyond the design of aircraft and spacecraft. Students apply concepts related to airfoils and wind turbines to determine efficiency. Students apply the airfoil drag equation to design a parachute which they build and test.

Lesson 4.2 Remote Systems

The goal of this lesson is for students to learn to integrate mechanical, electrical, and software systems in the context of accomplishing a sequence of objectives to explore a new planet. In this lesson students learn to design, create, and test using a robot modeling system which includes input sensors and output devices. This system provides students a platform to model systems such as a robot and satellite. Students use the robot system to create a satellite model to gather elevation data of a terrain. This data is processed to generate a topographical map that they use as an input to planning a rover mission to that terrain. Students use the modeling system to design, build, program, and test an autonomous vehicle which simulate a rover sent to explore a remote location such as a planet or moon. An optional project is available for differentiated instruction in a classroom with a diverse level of student knowledge and skill. Students use the modeling system to create a physical simulation of an autopilot system. Students create a program to use an accelerometer input to control the output of an aircraft control surface.

Lesson 4.3 Aerospace Careers

The goal of this lesson is for students to consider a career in aerospace engineering. In this lesson students envision themselves as future aerospace professionals and propose the major steps to achieve that vision.