Fairfax Collegiate

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Space Engineering 3-4 Syllabus

Course Goals

1 Discover the history of space exploration
Students discover how humanity has been exploring space for thousands of years, from observing the constellations to building telescopes to launching space missions. They learn about the history of discovery, early space pioneers, and the space race.

2 Understand space science technology
Students learn about the operating principles and use of the tools scientists use to explore space, from telescopes and star maps to rockets and rovers. They discover principles of aeronautics, astronautics, and space mission design through a variety of hands-on activities.

3 Discover space environments
Students use computer simulations and hands-on activities to explore the diverse conditions that exist in various space environments. They learn about the other planets in our solar system, the comets and asteroids, the stars and the galaxy. They discover the challenges posed by extremes of temperature, distance, pressure, and radiation, and the ways space explorers overcome these challenges.

Course Topics

1 The History of Exploration
Students learn about the history of human exploration and about historical explorers, with a focus on space-related discoveries.

2 Heat in Space
Students learn about radiation and absorption of heat, and why this is so important for astronauts.

3 Telescopes
Students learn about the functionality and importance of telescopes, and they build their own refracting telescope.

4 Our Solar System and the Planets
Students learn about our sun, our planetary neighbors, moons and comets, and orbital motion.

5 Our Moon
Students learn about the history, origins, composition, and characteristics of our moon, and about its phases and influence on Earth.

6 Rovers and Unmanned Systems
Students learn about how and why scientists use robotic rovers and other unmanned systems to explore alien environments.

7 Launch Systems and the Space Shuttle
Students learn about the challenges of surface-to-orbit launch, and how the space shuttle and other rocket launch systems achieve this task.

8 Aeronautics
Students learn about the forces of flight and how they act on aircraft and spacecraft inside and outside of Earth's atmosphere.

9 Space Mission Design

Students learn about the process and challenges of planning space missions, and they work in teams to design their own lunar sample retrieval mission.

10 Rocketry and Propulsion
Students learn how rocket motors work and understand the principles they rely on. They build and launch their own pressurized water rocket.

Course Schedule

Day 1

Icebreaker and Course Introduction
Students get to know each other and their instructor, and they briefly review classroom rules.

Investigating Explorers
Students review the history of human exploration, discuss the contributions of great explorers, and share their views on what it means to be an explorer. They think about how the nature of exploration has changed over time, and why.

Investigation - Why Are Space Suits White?
Students learn the basic science of thermal absorption and the role color plays in this. They learn why spacesuits and other space equipment are often colored white or coated in reflective materials, and they gain an understanding of the importance of heat management in spaceflight.

Timeline project
Students trace the history of spaceflight, space discoveries, and important space pioneers. They assemble a timeline and fill it with milestone moments and important events in the history of spaceflight.

Day 2

Our Solar System and the Planets
Students learn about our solar system and Earth's planetary neighbors. They discover the harsh environmental extremes that exist on various other planets, the reasons that different planets have years and days of differing lengths, and the variations in planetary features like moon systems and rings.

Scale Model of the Solar System
Students work as a team to assemble a scale model of the solar system in which relative interplanetary distances are accurately reflected. They gain an understanding of the vast distances involved in spaceflight, especially in the outer solar system, and of the physical structure of our solar system.

Creating planetary models
Students work in teams to construct and paint models of our solar system. They gain an understanding of the physical appearance of the planets and the reasons for that appearance, as well as the different sizes of our planetary neighbors.

Facts About the Planets
Students build on previous activities to gain additional understanding of the environments and physical characteristics of other planets in our solar system. They also learn about the origins of planets' names and the history of their discovery.

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Day 3

Moon Phases
Students learn why the moon has phases, and they understand the relationship between moon phases and the moon's position relative to the Earth and the sun. They learn the different phases of the lunar month and their names.

Moon Phase Flipbook
Students create a flipbook that presents a visual demonstration of the moon's phases throughout the lunar month.

Introduction to Stellarium
Students familiarize themselves with the Stellarium virtual sky software and use it to locate and identify constellations and planets.

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Day 4

Constellation Creation
Students learn about the history and meaning of constellations, and they work with a partner to design their own constellation on a star map showing a part of the night sky.

Stellarium Constellation Search
Students use Stellarium to locate and identify constellations that they want to find in the real night sky using the telescope they will build in the next activity.

Sky Maps
Students make printed sky maps that they can use as references when using their telescopes to locate constellations they identified in Stellarium during the previous activity.

Refractor Telescopes
Students learn about different types of telescopes, with a focus on the refracting design. They construct their own refractor telescopes, which they will take home and use to observe the moon, stars, and night sky, including the constellations they identified in the previous Stellarium activity.

Day 5

Telecope Share and Tell
Students share with the class what they observed the previous night using their refractor telescopes.

The Hubble Telescope
Students learn about the limits of ground-based telescopes and the advantages of space-based telescopes. They learn about the Hubble space telescope and its history, design, function, and discoveries. They also explore the imagery that Hubble has captured of distant galaxies, stars, and nebulae.

Exploring Strange Environments (Rovers)
Students learn about the limitations of even space-based telescopes, and about why we send rovers and other robotic explorers into various space environments. They will focus on the Mars rovers which NASA has deployed, and will learn about the design, mission, and functionality of these rovers.

Investigating Rovers
Students use online resources and simulation software to learn more about Mars rover design and functionality and to explore virtual Martian environments with a rover they control.

Rover Races

Students play a team-based classroom game to understand the challenges and difficulties of remotely operating rovers in distant locations. Students take turns trying to navigate difficult terrain using only pre-written instructions from their mission team.

Day 6

What is the Space Shuttle?
Students learn about the design and capabilities of the Space Shuttle launch system. Although the shuttle was recently retired and will be replaced by the new SLS rocket, it remains a unique technological achievement and a milestone in spaceflight history. Its design features reflect the many challenges of space launch operations, and students understand these challenges by learning how the shuttle system overcame them.

Forces of Flight
Students use interactive simulations to learn about the various forces at work on a flying aircraft or spacecraft. They modify and experiment with a virtual aircraft design to achieve higher flight speeds and see the effects of aerodynamic forces in action. They learn which forces do and do not affect spacecraft beyond Earth's atmosphere.

Spacecraft and Rover Design
Students work in teams to design a complex space mission. Teams work through all the stages of mission design and modelling, and they present their finished mission plan to the class. They gain an understanding of the challenges of complex multi-stage space missions, and of the processes that real engineers and scientists use to develop them.

Day 7

Spacecraft and Rover Design
Students work in teams to design a complex space mission. Teams work through all the stages of mission design and modelling, and they present their finished mission plan to the class. They gain an understanding of the challenges of complex multi-stage space missions, and of the processes that real engineers and scientists use to develop them.

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Day 8

Investigating Space Missions Over the Years
Students use online resources to explore the history of the Space Shuttle program and the International Space Station. Students work in pairs to conduct in-depth research on a particular shuttle mission, and they present their findings to the class.

Space Mission Simulation
Students use interactive software tools to carry out simulated space missions in a virtual environments. Students gain an understanding of space operations such as launch, orbital insertion, orbital maneuvering, and atmospheric entry.

Day 9

Solar Array Packaging
Students design and build model solar sail arrays to be folded into compact forms for packaging in a launch vehicle's payload bay. They gain a hands-on understanding of the challenging design constraints imposed on space mission payloads by issues such as deployment from limited payload volumes.

Investigation - Astronaut Pencils
Students use a hands-on investigation to learn how even simple tasks can become complicated for astronauts in space suits. They experience the challenges of basic tool use under spacewalk conditions, then they work in teams to devise creating engineering solutions to these challenges.

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Day 10

Pressurized Water Rockets
Students work in teams to design and build pressurized water rockets from common materials. They learn the principle of Newton's second law of motion, upon which all reaction engines depend. Students launch their rockets with teacher supervision.

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