Spokane Public Schools
PLTW Aerospace Engineering

Course: Aerospace Engineering			**Total Framework Hours up to: 180**
CIP Code:	**149998**	☒**Exploratory** ☐**Preparatory**	**Date Last Modified:11/16/15**
Career Cluster:	**STEM**		**Cluster Pathway: Science & Math**

COMPONENTS AND ASSESSMENTS

Performance Assessments:

It is expected that students will:

- Create a historical perspective on Aerospace industry and Aerospace technology to provide context for subsequent curriculum lessons.
- Summarize historical precedence in problem solving.
- Explain cause and effect relationships in design.
- Explain that aerospace terminology and expanded history are integral parts of design.
- Determine the center of gravity location of an aircraft.
- Explain how aircraft are designed for stability and control.
- Design and analyze an airfoil considering lift and drag.
- Use the lift and draft equations to calculate associated forces and conditions.
- Describe the requirements for a glider to remain stable in flight.
- Design and construct a glider that meets the design requirements provided by the instructor.
- Summarize test data to evaluate glider performance against design criteria.
- Explain the progression of navigation technology and its influence on navigation.
- Demonstrate aircraft control through the use of a flight simulator.
- Plan a flight and accurately navigate this plan using a flight simulator.
- Explain why simulators are valuable tools for preparing pilots to fly aircraft.
- Use the Global Positioning System, GPS, unit to navigate.

Leadership Alignment:

- **Collaborate with Others**: In the Airfoil experiment students will be working together to establish different types of airfoils to test.
- **Solve Problems:** During the center of gravity section students use a mathematical formula to calculate the center of gravity of different objects.
- **Produce Results:** Within this unit students will build and test their gliders. The performance of the glider affects their grade. So students

will need to produce results.

- **Access and Evaluate Information:** In the GPS section as well as the Air traffic control section, students will access information online for current data and then complete a project in each section where they showcase and utilize the information they obtained.
- **Adapt to Change:** During the flight simulation section students will undergo real-time flight data that constantly changes. They will have to adapt and overcome the challenges that arise.

Standards and Competencies

Standard/Unit: Introduction To Aerospace

- **Lesson 1.1: Evolution of Flight**
- **Lesson 1.2: Physics of Flight**
- **Lesson 1.3: Flight Planning & Navigation**

Competencies	**Total Learning Hours for Unit: 50**

- Understanding the evolution of flight instills an appreciation of past engineering accomplishments.
- Knowledge of aerospace history provides insight to future challenges involving travel through the atmosphere and space.
- Aerospace engineers typically work in teams to design smaller components of a larger system. The success of the entire system relies on each component to function correctly and to interact correctly with each other.
- Success often comes from learning from failures which is demonstrated throughout the history of aerospace development.
- Aircraft have fixed and moveable surfaces to control forces and change flight direction.
- The center of gravity of an object is where its weight is concentrated.
- Four major forces act on an aircraft flying in the Earth's atmosphere.
- Atmospheric conditions impact aircraft performance.
- Lift and drag are generated by fluid flow around an airfoil.
- Aircraft performance can be simulated in a safe and cost effective environment.
- Wind tunnels allow the performance of shapes to be tested in real fluid flow.
- Gliders are designed to fly long distances without a system to produce thrust.
- Simulations are widely used in the aerospace industry to develop skills which can be effectively applied to the actual device.
- Each flight should be planned in advance of the actual flight.
- Pilots then apply the principles of navigation to safely travel to their destinations.
- The Global Positioning System, GPS, is a complex system designed to provide accurate location information to many users.
- The history of navigation is intertwined with technology development.
- Air traffic is coordinated within a complex system to improve safety and efficiency.

Aligned Washington State Standards

Arts	
Educational Technology	
Health and Fitness	
Language	

Math	**Number and Quantity** Quantities -Reason Quantitatively And Use Units To Solve Problems. 1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (N.Q .1) 3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (N.Q .3) Vector And Matrix Quantities -Represent And Model With Vector Quantities. 1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). (N.VM.1) 3. (+) Solve problems involving velocity and other quantities that can be represented by vectors. (N.VM.3) **Algebra** Creating Equations -Create Equations That Describe Numbers Or Relationships 1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* (A.CED.1) 4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.* (A.CED.4) Reasoning With Equations And Inequalities -Solve Equations And Inequalities In One Variable 3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. (A.REI.3) -Represent And Solve Equations And Inequalities Graphically 10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). (A.REI.10) **Functions** Interpreting Functions -Understand The Concept Of A Function And Use Function Notation 2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. (F.IF.2) Building Functions -Build A Function That Models A Relationship Between Two Quantities 1. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. (F.BF.1.a) Linear, Quadratic, And Exponential Models -Interpret Expressions For Functions In Terms Of The Situation They Model 5. Interpret the parameters in a linear or exponential function in terms of a context. (F.LE.5) **Geometry** Geometric Measurement And Dimension -Visualize Relationships Between Two-Dimensional And Three- Dimensional Objects 4. Identify the shapes of two-dimensional cross-sections of three- dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. (G.GMD.4) Modeling With Geometry -Apply Geometric Concepts In Modeling Situations 3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).* (G.MG.3)

Reading	Comprehension and Collaboration 1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. (AS.SL.1) 2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. (AS.SL.2) 4. Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. (AS.SL.4) 5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. (AS.SL.5) 6. Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate. (AS.SL.6) Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. (AS.R.1) 2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. (AS.R.2) 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone. (AS.R.4) 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. (AS.R.7) 9. Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. (AS.R.9) 10. Read and comprehend complex literary and informational texts independently and proficiently. (AS.R.10)
Science	Engineering Design HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. (HS.ETS1.1) HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (HS.ETS1.3) HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (HS.ETS1.4) Motion and Stability: Forces and Interactions HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (HS.PS2.1) Energy HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* (HS.PS3.3)

	Earth's Systems HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. (HS.ESS2.4) Waves and their Applications in Technologies for Information Transfer HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information. (HS.PS4.2)
Social Studies	
Speaking and Listening	
Writing	Text Types and Purposes 2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. (AS.W.2) 3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. (AS.W.3) 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4) 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. (AS.W.7) 8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. (AS.W.8) 9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (AS.W.9) Conventions of Standard English 1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1) 2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. (AS.L.2) 3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening. (AS.L.3) 4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate. (AS.L.4) 6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. (AS.L.6)

21st Century Skills

Check those that students will demonstrate in this course:

LEARNING & INNOVATION

Creativity and Innovation
- ☐ Think Creatively
- ☐ Work Creatively with Others
- ☐ Implement Innovations

Critical Thinking and Problem Solving
- ☐ Reason Effectively
- ☐ **U**se Systems Thinking
- ☐ Make Judgments and Decisions
- ☒ Solve Problems

Communication and Collaboration
- ☐ Communicate Clearly
- ☒ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS

Information Literacy
- ☒ Access and /evaluate Information
- ☐ Use and Manage Information

Media Literacy
- ☐ Analyze Media
- ☐ Create Media Products

Information, Communications and Technology (ICT Literacy)
- ☐ Apply Technology Effectively

LIFE & CAREER SKILLS

Flexibility and Adaptability
- ☒ Adapt to Change
- ☐ Be Flexible

Initiative and Self-Direction
- ☐ Manage Goals and Time
- ☐ Work Independently
- ☐ Be Self-Directed Learners

Social and Cross-Cultural
- ☐ Interact Effectively with Others
- ☐ Work Effectively in Diverse Teams

Productivity and Accountability
- ☐ Manage Projects
- ☒ Produce Results

Leadership and Responsibility
- ☐ Guide and Lead Others
- ☐ Be Responsible to Others

COMPONENTS AND ASSESSMENTS

Performance Assessments:

It is expected that students will:

- Research the properties of materials used in the aerospace industry.
- Calculate and use properties of material.
- Design and analyze a frame system 3D modeling software.
- Create composite material.
- Determine material properties through testing.
- Design an engine for an aircraft.
- Determine the thrust of an engine.
- Design an effective model rocket.
- Research and investigate rocket engines for use in a rocket.
- Test a model rocket to perform as predicted.
- Identify the main propulsion systems and the parts of a rocket engine.
- Compare the advantages and disadvantages of various rocket systems.
- Explain the rocket types used by various spacecraft.
- Explain how Newton's three laws of motion relate to rocket propulsion.
- Determine individual human factors.
- Identify applications of human factors in aerospace engineering.
- Apply human factors in an aerospace engineering design.

- Explore an aviation accident and report on its causes.

Leadership Alignment:

- **Work Creatively with Others:** In the section of rocketry there are a handful of instances where students will be working creatively. Both in the designing and launching of the rockets.
- **Reason Effectively:** Apply reason to the analysis of different composites that could potentially make up a wing of a plane. Both unilateral and bilateral layering of mesh.
- **Use and Manage Information:** Use the test results from the rocket engine test in their decision for the launch as well as the analysis within the software.
- **Apply Technology Effectively:** Students will be using a variety of software to design and analyze the structural integrity of a frame that makes up a planes body.
- **Manage Goals and Time:** The launch date is very specific so students must manage their time effectively so that they complete their rocket prior to the launch date.

Standards and Competencies

Standard/Unit: Aerospace Design

- **Lesson 2.1: Materials & Structures**
- **Lesson 2.2: Propulsion**
- **Lesson 2.3: Flight Physiology**

Competencies	**Total Learning Hours for Unit: 45**

- Aerospace material selection is based upon many factors including mechanical, thermal, electromagnetic, and chemical properties.
- Structural design, including centroid location, moment of inertia, and a material's modulus of elasticity, are important considerations for an aircraft.
- Static equilibrium occurs when the sum of all forces acting on a body is equal to zero.
- Composites combine different materials to create a material with properties superior to that of the individual materials.
- Material testing provides a reproducible evaluation of material properties.
- Energy transformed between forms of energy produces propulsion.
- Newton's Three Laws of Motion are central to the idea of propulsion.
- Engines vary in terms of efficiency, speed, and altitude.
- Air and fuel are used for combustion.
- Engine configuration impacts flight performance.
- Rocket engines produce thrust through rapid expansion of gases.
- The capabilities and limitations of the human body need to be understood by pilots, crews, and aerospace engineers.
- An aerospace engineer considers the human interaction with the machine for more effective designs.
- The human body consists of systems that work together to ensure functionality and life.
- Extreme environments and forces can harm or kill a human.
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Aligned Washington State Standards

Arts	
Educational Technology	
Health and Fitness	

Language	
Math	**Number and Quantity** Quantities -Reason Quantitatively And Use Units To Solve Problems. 1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (N.Q .1) 2. Define appropriate quantities for the purpose of descriptive modeling. (N.Q .2) 3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (N.Q .3) **Algebra** Creating Equations -Create Equations That Describe Numbers Or Relationships 1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* (A.CED.1) 4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.* (A.CED.4) Reasoning With Equations And Inequalities -Understand Solving Equations As A Process Of Reasoning And Explain The Reasoning 1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. (A.REI.1) -Solve Equations And Inequalities In One Variable 3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. (A.REI.3) -Represent And Solve Equations And Inequalities Graphically 10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). (A.REI.10) **Functions** Interpreting Functions -Understand The Concept Of A Function And Use Function Notation 2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. (F.IF.2) -Interpret Functions That Arise In Applications In Terms Of The Context 6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.* (F.IF.6) [OPTIONAL] Building Functions -Build A Function That Models A Relationship Between Two Quantities 1. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. (F.BF.1.a) Linear, Quadratic, And Exponential Models -Interpret Expressions For Functions In Terms Of The Situation They Model 5. Interpret the parameters in a linear or exponential function in terms of a context. (F.LE.5) **Geometry** Similarity, Right Triangles, And Trigonometry -Define Trigonometric Ratios And Solve Problems Involving Right Triangles 8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.* (G.SRT.8) Geometric Measurement And Dimension -Visualize Relationships Between Two-Dimensional And Three- Dimensional Objects 4. Identify the shapes of two-dimensional cross-sections of three- dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. (G.GMD.4)

	Modeling With Geometry -Apply Geometric Concepts In Modeling Situations 3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).* (G.MG.3)
Reading	Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. (AS.R.1) 2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. (AS.R.2) 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone. (AS.R.4) 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. (AS.R.7) 9. Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. (AS.R.9) 10. Read and comprehend complex literary and informational texts independently and proficiently. (AS.R.10)
Science	Matter and Its Interactions HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. (HS.PS1.3) Motion and Stability: Forces and Interactions HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (HS.PS2.1) Energy HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. (HS.PS3.1) HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* Engineering Design HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS.ETS1.2) HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (HS.ETS1.3) HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (HS.ETS1.4)
Social Studies	
Speaking and Listening	Comprehension and Collaboration 4. Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. (AS.SL.4) 5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. (AS.SL.5) 6. Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or

	appropriate. (AS.SL.6)
Writing	Conventions of Standard English 1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1) 2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. (AS.L.2) 4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate. (AS.L.4) 6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. (AS.L.6) Text Types and Purposes 2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. (AS.W.2) 3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. (AS.W.3) 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4) 8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. (AS.W.8) 9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (AS.W.9)

21st Century Skills		
Check those that students will demonstrate in this course:		
LEARNING & INNOVATION **Creativity and Innovation** ☐Think Creatively ☒Work Creatively with Others ☐Implement Innovations **Critical Thinking and Problem Solving** ☒Reason Effectively ☐**U**se Systems Thinking ☐Make Judgments and Decisions ☐Solve Problems **Communication and Collaboration** ☐Communicate Clearly ☐Collaborate with Others	**INFORMATION, MEDIA & TECHNOLOGY SKILLS** **Information Literacy** ☐Access and /evaluate Information ☒Use and Manage Information **Media Literacy** ☐Analyze Media ☐Create Media Products **Information, Communications and Technology (ICT Literacy)** ☒Apply Technology Effectively	**LIFE & CAREER SKILLS** **Flexibility and Adaptability** ☐Adapt to Change ☐Be Flexible **Initiative and Self-Direction** ☒Manage Goals and Time ☐Work Independently ☐Be Self-Directed Learners **Social and Cross-Cultural** ☐Interact Effectively with Others ☐Work Effectively in Diverse Teams **Productivity and Accountability** ☐Manage Projects ☐Produce Results **Leadership and Responsibility** ☐Guide and Lead Others ☐Be Responsible to Others

COMPONENTS AND ASSESSMENTS

Performance Assessments:

It is expected that students will:

- Describe the relative sizes of celestial bodies.
- Apply space law to an accident involving space hardware.
- Explain how technology development is intertwined into the culture of a nation.
- Design a space junk mitigation system.
- Describe the contributions to orbital theory of the discipline's historical figures.
- Define the six orbital parameters that describe an orbit.
- Design and simulate the path of an orbiting body.
- Calculate the energy of an orbiting body.

Leadership Alignment:

- **Think Creatively**: Students will be conducting a hypothetical mission to Mars and will need t to think out of the box to generate the needs and demands of a mission.
- **Make Judgments and Decisions**: Decisions will have to be made during the process of designing the mission to mars. (i.e. what materials do they need/ not need)
- **Apply technology effectively**: Students will use the appropriate software to track and predict the flight path of several different satellites.
- **Be Self-Directed Learners**: Students will need to investigate on their own how to track and predict the location of the international space station.
- **Manage Projects**: In the mission to mars assignments students will have different roles to fill within their mission, one in particular will be project manager.

Standards and Competencies	
Standard/Unit: Space • **Lesson 3.1: Space Travel** • **Lesson 3.2: Orbital Mechanics**	
Competencies	**Total Learning Hours for Unit: 45**
• The universe exists in a scale that is difficult to conceptualize. • Space law is a system based on international agreements designed to promote the use of space for the good of all humankind. • The exploration of space is successful through learning from previous missions and the development of technology and systems. • Orbital mechanics provides a means for describing orbital behavior of bodies. • The same laws that govern satellite orbits also govern celestial body (e.g. comets, planets and moons) orbits. • All objects exert an attraction force to each other. • Objects orbit other objects in a pattern governed by forces exerted on each other. • Objects in orbit are continuously falling toward the body about around which they orbit. • Orbital elements can be used to fully define a satellite's orbit, allowing the accurate prediction of the precise location of the satellite at a given time. • A satellite's mission is a major factor when designing its orbit.	
Aligned Washington State Standards	
Arts	
Educational Technology	
Health and Fitness	
Language	
Math	**Number and Quantity** Quantities -Reason Quantitatively And Use Units To Solve Problems. 1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (N.Q .1) 3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (N.Q .3) **Algebra** Creating Equations -Create Equations That Describe Numbers Or Relationships 1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* (A.CED.1) 4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.* (A.CED.4) Reasoning With Equations And Inequalities -Understand Solving Equations As A Process Of Reasoning And Explain The Reasoning 1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. (A.REI.1) -Solve Equations And Inequalities In One Variable

	3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. (A.REI.3) -Represent And Solve Equations And Inequalities Graphically 10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). (A.REI.10) **Functions** Interpreting Functions -Understand The Concept Of A Function And Use Function Notation 2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. (F.IF.2) Building Functions -Build A Function That Models A Relationship Between Two Quantities 1. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. (F.BF.1.a) Linear, Quadratic, And Exponential Models -Interpret Expressions For Functions In Terms Of The Situation They Model 5. Interpret the parameters in a linear or exponential function in terms of a context. (F.LE.5) **Geometry** Circles -Understand And Apply Theorems About Circles 2. Identify and describe relationships among inscribed angles, radii, and chords. *Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.* (G.C.2) Geometric Measurement And Dimension -Visualize Relationships Between Two-Dimensional And Three- Dimensional Objects 4. Identify the shapes of two-dimensional cross-sections of three- dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. (G.GMD.4) Modeling With Geometry -Apply Geometric Concepts In Modeling Situations 1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).* (G.MG.1) 3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).* (G.MG.3)
Reading	Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. (AS.R.1) 2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas. (AS.R.2) 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone. (AS.R.4) 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. (AS.R.7) 9. Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take. (AS.R.9) 10. Read and comprehend complex literary and informational texts independently and proficiently. (AS.R.10)

Science	Earth and Human Activity HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* (HS.ESS3.4) Motion and Stability: Forces and Interactions HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (HS.PS2.1) HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. (HS.PS2.4) Energy HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields. (HS.PS3.2) HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. (HS.PS3.5) Earth's Place in the Universe HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. (HS.ESS1.4) Engineering Design HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. (HS.ETS1.1) HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS.ETS1.2) HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (HS.ETS1.3)
Social Studies	
Speaking and Listening	Comprehension and Collaboration 2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. (AS.SL.2) 4. Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. (AS.SL.4) 5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. (AS.SL.5) 6. Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate. (AS.SL.6)
Writing	Text Types and Purposes 2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. (AS.W.2) 3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. (AS.W.3) 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4) 9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (AS.W.9) Conventions of Standard English

	1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1) 2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. (AS.L.2) 4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate. (AS.L.4) 6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. (AS.L.6)

21st Century Skills

Check those that students will demonstrate in this course:

LEARNING & INNOVATION

Creativity and Innovation
- ☒ Think Creatively
- ☐ Work Creatively with Others
- ☐ Implement Innovations

Critical Thinking and Problem Solving
- ☐ Reason Effectively
- ☐ **U**se Systems Thinking
- ☒ Make Judgments and Decisions
- ☐ Solve Problems

Communication and Collaboration
- ☐ Communicate Clearly
- ☐ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS

Information Literacy
- ☐ Access and /evaluate Information
- ☐ Use and Manage Information

Media Literacy
- ☐ Analyze Media
- ☐ Create Media Products

Information, Communications and Technology (ICT Literacy)
- ☒ Apply Technology Effectively

LIFE & CAREER SKILLS

Flexibility and Adaptability
- ☐ Adapt to Change
- ☐ Be Flexible

Initiative and Self-Direction
- ☐ Manage Goals and Time
- ☐ Work Independently
- ☒ Be Self-Directed Learners

Social and Cross-Cultural
- ☐ Interact Effectively with Others
- ☐ Work Effectively in Diverse Teams

Productivity and Accountability
- ☒ Manage Projects
- ☐ Produce Results

Leadership and Responsibility
- ☐ Guide and Lead Others
- ☐ Be Responsible to Others

COMPONENTS AND ASSESSMENTS

Performance Assessments:

It is expected that students will:

- Apply aerospace engineering concepts into design or industries not intended for flight.
- Describe the impact of air travel on society and the environment.
- Apply concepts of the product life cycle to the aerospace industry.
- Identify alternative methods of sustainability for flight in the future.
- Justify the need for efficiency in design relating to cost and economic impact.
- Describe the impact of a communication delay on the success of a mission.
- Design and create a functional remote system, including integration of structural, mechanical, electrical, and software systems.
- Demonstrate proper setup and operation of remote system sensor inputs.
- Interpret remote system data and create a visual data representation.

- Operate a remote system through a series of performance tasks including autonomous navigation.
- Develop a career plan to achieve their vision as a future professional.
- Conduct an interview with a professional.
- Prepare a presentation for peer review.

Leadership Alignment:

- **Think Creatively:** Students will design and test several different designs for both the parachute and wind turbine to analyze efficiency. Generate a list of potential future careers that do not exist.
- **Communicate Clearly:** Students will communicate their results from both the wind turbine and parachute test with their peers so that they may make a comprehensive decision.
- **Apply Technology Effectively:** Students will design and test a robot that uses a type of sonar to map a surface. This surface once analyzed will house their robots.
- **Be Flexible:** Students will realize that not everything is going to work as planned and that failure in a test does not mean failure in the assignment only that they must readdress the situation.
- **Produce Results:** Students will be measured on the results they produce, both in the parachute and wind turbine assignment.

Standards and Competencies

Standard/Unit: Alternative Applications

- **Lesson 4.1: Alternative Applications**
- **Lesson 4.2: Remote Systems**
- **Lesson 4.3: Aerospace Careers**

Competencies	**Total Learning Hours for Unit: 40**

- Aerospace concepts traditionally considered applicable to flight can be used in a variety of applications and industries.
- Fluid movement is an important consideration in the design of many products.
- Air travel impacts society and the environment in many ways.
- Efficiency is major criteria for aircraft design.
- Remote system designs are used in air, ground, maritime, and space environments.
- Remote system design is based upon the integrated system design of mechanical, electrical, and software systems.
- Remote systems use sensor feedback to modify behavior.
- Operator input is established through the use of an operator interface and a means to communicate with the remote system.
- Remote systems can be designed to perform an extended operation with little human input or impact.

- Career planning should consider many factors.
- Career planning should begin by exploring one's own interests and understanding possible options.
- The wide variety of career paths available to students requires careful consideration for future professional success.

Aligned Washington State Standards

Arts	
Educational Technology	
Health and Fitness	
Language	
Math	**Number and Quantity**

	Quantities -Reason Quantitatively And Use Units To Solve Problems. 1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (N.Q .1) 3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (N.Q .3) **Algebra** Creating Equations -Create Equations That Describe Numbers Or Relationships 1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* (A.CED.1) 4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.* (A.CED.4) Reasoning With Equations And Inequalities -Solve Equations And Inequalities In One Variable 3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. (A.REI.3) -Represent And Solve Equations And Inequalities Graphically 10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). (A.REI.10) **Functions** Interpreting Functions -Understand The Concept Of A Function And Use Function Notation 2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. (F.IF.2) Linear, Quadratic, And Exponential Models -Interpret Expressions For Functions In Terms Of The Situation They Model 5. Interpret the parameters in a linear or exponential function in terms of a context. (F.LE.5) **Geometry** Geometric Measurement And Dimension -Visualize Relationships Between Two-Dimensional And Three- Dimensional Objects 4. Identify the shapes of two-dimensional cross-sections of three- dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. (G.GMD.4) Modeling With Geometry -Apply Geometric Concepts In Modeling Situations 1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).* (G.MG.1) 3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).* (G.MG.3)
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	the net force on a macroscopic object, its mass, and its acceleration. (HS.PS2.1) Energy HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. (HS.PS3.1) HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* (HS.PS3.3) Earth and Human Activity HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* (HS.ESS3.4) Engineering Design HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. (HS.ETS1.1) HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS.ETS1.2) HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (HS.ETS1.3) HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (HS.ETS1.4)
Social Studies	
Speaking and Listening	Comprehension and Collaboration 1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. (AS.SL.1) 2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. (AS.SL.2)
Writing	Text Types and Purposes 2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. (AS.W.2) 3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. (AS.W.3) 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4) Conventions of Standard English 1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1) 2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. (AS.L.2) 4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate. (AS.L.4) 6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. (AS.L.6)

21st Century Skills		
Check those that students will demonstrate in this course:		
LEARNING & INNOVATION **Creativity and Innovation** ☒Think Creatively ☐Work Creatively with Others ☐Implement Innovations **Critical Thinking and Problem Solving** ☐Reason Effectively ☐**U**se Systems Thinking ☐Make Judgments and Decisions ☐Solve Problems **Communication and Collaboration** ☒Communicate Clearly ☐Collaborate with Others	**INFORMATION, MEDIA & TECHNOLOGY SKILLS** **Information Literacy** ☐Access and /evaluate Information ☐Use and Manage Information **Media Literacy** ☐Analyze Media ☐Create Media Products **Information, Communications and Technology (ICT Literacy)** ☒Apply Technology Effectively	**LIFE & CAREER SKILLS** **Flexibility and Adaptability** ☐Adapt to Change ☒Be Flexible **Initiative and Self-Direction** ☐Manage Goals and Time ☐Work Independently ☐Be Self-Directed Learners **Social and Cross-Cultural** ☐Interact Effectively with Others ☐Work Effectively in Diverse Teams **Productivity and Accountability** ☐Manage Projects ☒Produce Results **Leadership and Responsibility** ☐Guide and Lead Others ☐Be Responsible to Others