Chino Valley Unified School District
High School Course Description

CONTACTS	
1. School/District Information:	**School/District:** Chino Valley Unified School District **Street Address:** 5130 Riverside Dr., Chino, CA 91710 **Phone:** (909) 628-1201 **Web Site:** chino.k12.ca.us
2. Course Contact:	**Teacher Contact:** Office of Secondary Curriculum **Position/Title:** Director of Secondary Curriculum **Site:** District Office **Phone:** (909) 628-1201 X1630
A. COVER PAGE - COURSE ID	
1. Course Title:	Aerospace Engineering
2. Transcript Title/Abbreviation:	Aero Eng
3. Transcript Course Code/Number:	5P05, C5P05
4. Seeking Honors Distinction:	No
5. Subject Area/Category:	Meets the UC/CSU “g” General Elective requirement
6. Grade level(s):	10-12
7. Unit Value:	5 credits per semester/10 credits total
8. Course Previously Approved by UC:	No
9. Classified as a Career Technical Education Course:	Yes
10. Modeled after an UC-approved course:	Yes
11. Repeatable for Credit:	No
12. Date of Board Approval:	May 17, 2018

13. Brief Course Description:

Aerospace Engineering (AE) is the study of the engineering discipline which develops new technologies for use in aviation, defense systems, and space exploration. The course explores the evolution of flight, flight fundamentals, navigation and control, aerospace materials, propulsion, space travel, orbital mechanics, ergonomics, remotely operated systems and related careers. In addition, the course presents alternative applications for aerospace engineering concepts. Students will analyze, design, and build aerospace systems. While implementing these designs, students will continually hone their interpersonal skills, creativity, and application of the design process. Students apply knowledge gained throughout the course in a final multi-media project to envision their future professional accomplishments. The course applies and concurrently develops secondary-level knowledge and skills in mathematics, science, and technology.

14. Prerequisites:	Principles of Engineering (POE) Integrated Math 1 or higher (Recommended) Biology and the Living Earth or higher (Recommended)

15. Context for Course:

This course is part of the Project Lead the Way (PLTW) CTE engineering sequence. The course is considered a CTE Specialization course and follows the introductory Principles of Engineering course.

15. History of Course Development:

This course was designed to provide students with skills and knowledge in a Career Technical Education (CTE) pathway. Coursework is meant to prepare students for professional life as indicated by the College and Careers Readiness Standards. The course has been updated to reflect the changes in CTE standards.

16. Textbooks:	None
16. Supplemental Instructional Materials:	Access to computers with appropriate software and engineering lab with appropriate tools.

B. COURSE CONTENT

1. Course Purpose:

Through both individual and collaborative team activities, projects, and problems, students will problem solve as they practice common engineering design and development protocols such as project management and peer review. Students will develop skill in technical representation and documentation of design solutions according to accepted technical standards, and they will use current 3d design and modeling software to represent and communicate solutions. In addition, the development of computational methods that are commonly used in engineering problem solving, including statistical analysis and mathematical modeling, are emphasized. Ethical issues related to professional practice and product development are also presented.

This course is designed for the California Career and Technical Education **Engineering and Architecture (EA) sector**. This course is aligned to the California Career and Technical Education Standards: **Engineering and Design Pathway** and is designed to be a **capstone level course**.

2. Course Outline:

Unit 1: Overview of Aerospace Engineering

Tech Lit: 1.9-12.J, 1.9-12.K, 1.9-12.L, 2.9-12.W, 2.9-12.X, 2.9-12.Y, 2.9-12.Z 2.9-12.AA, 2.9-12.BB, 2.9-12.CC, 3.9-12.G, 3.9-12.H, 3.9-12.J, 4.9-12.H, 4.9-12.I, 4.9-12.J, 6.9-12.H, 6.9-12.I, 7.9-12.G, 7.9-12.H, 7.9-12.I, 7.9-12.J, 7.9-12.M, 7.9-12.N, 9.9-12.J, 9.9-12.L, 10.9-12.I, 10.9-12.J, 10.9-12.L, 13.9-12.K, 13.9-12.L, 17.9-12.P, 18-9-12.J

CTE Anchor Standards: 1.0, 3.0, 3.1

EA: B5.0, B5.1, B5.2, B5.3, B5.4, B5.5

- History of Flight:
  - Knowledge of the history of flight enables an appreciation and understanding of past engineering accomplishments to be recognized.
  - Knowledge of aerospace history provides insight to future challenges involving travel through the atmosphere and space.
  - Many types of vehicles have been designed to fly.
  - Airplanes consist of several major components each of which has a specific function in the design and operation of the airplane.
  - The forces acting on an aircraft enable it to fly.

Unit 2: Aerodynamics and Aerodynamics Testing

NGSS: HS.PS2.1, HS.PS3.1, HS.PS3.3, HS.ETS1.2, HS.ETS1.3, HS.ETS1.4, DCI - PS2.A, DCI - PS3.A, DCI - PS3.B, DCI - PS3.B, DCI - PS3.B, DCI - PS3.B, DCI - PS3.B, DCI - PS3.D, DCI - ETS1.B, DCI - ETS1.C

Tech Lit: 2.9-12.W, 2.9-12.Z, 2.9-12.AA, 2.9-12.BB, 4.9-12.I, 8.9-12.H, 8.9-12.J, 9.9-12.L, 11.9-12.N, 11.9-12.O, 11.9-12.P, 11.9-12.Q, 11.9-12.R, 12.9-12.L, 12.9-12.M, 12.9-12.N, 12.9-12.O, 12.9-12.P, 13.9-12.J, 17.9-12.N, 17.9-12.P, 17.9-12.Q

CTE Anchor Standards: 1.0, 2.5, 4.0, 4.1, 4.3, 4.5, 5.0, 5.1, 5.2, 5.3, 5.4, 6.0, 6.1, 6.3, 6.4, 6.6, 7.0, 7.2, 7.3, 7.4, 7.5, 7.7, 7.8, 8.0, 8.1, 8.2, 8.7, 9.0, 9.1, 9.2, 9.5, 9.7, 10.0, 10.1, 10.2, 10.3, 11.0, 11.1, 11.2, 11.5

EA: B4.0, B4.1, B4.2, B6.0, B6.1, B6.2, B6.3, B6.4, B6.5, B6.6, B6.7, B7.0, B7.1, B7.2, B7.3, B7.4, B7.5, B7.6

- Aerodynamics:
  - The forces applied to an airplane in flight are lift, weight, drag, and thrust.
  - Wings provide the lifting forces needed to overcome the weight of an airplane.
  - Engines provide the thrust force needed to overcome the aerodynamic drag from the body of an airplane.
  - The design of an aircraft wing requires knowledge of aerodynamics and physics.
  - The design process involves the use of computer simulation tools to predict the performance of a design prior to the building of a physical model.

    - The design process involves creating multiple solutions to a problem and then evaluating and ranking the solutions in order select the best solution.
- Airfoil Construction:
    - Design ideas are verified by the construction and testing of prototypes and models.
    - Sub-scale models are used to represent a full-size system.
    - Coordinate geometry is used to create varied shapes, such as airfoils.
    - Basic hand tools and equipment can be used to create accurate scale models.
- Wind Tunnel Testing:
    - Testing prototypes is an important part of the design process.
    - Engineers use scaled models to evaluate, to test, and to determine the performance of their designs.
    - Test results are best analyzed through the use of graphs and other methods to depict the data collected during testing.
- Introduction to Propulsion:
    - Newton's Three Laws of Motion are central to the idea of propulsion.
    - An external force is required to change the state of an object from rest to motion and from motion to rest.
    - The direction of acceleration is the same as the direction of the external force.
    - Newton's Third Law of Motion can be used to explain the production of thrust by a propulsion system.
    - The three principal propulsion systems are the propeller, the jet engine, and the rocket engine.

Unit 3: Flight Systems

NGSS: HS.ETS1.2, HS.ETS1.3, HS.ETS1.4, DCI - ETS1.B, DCI - ETS1.C

Tech Lit: 1.9-12.K, 2.9-12.W, 2.9-12.X, 2.9-12.Y, 2.9-12.Z, 2.9-12.AA, 2.9-12.BB, 3.9-12.J, 4.9-12.I, 7.9-12.G, 8.9-12.H, 8.9-12.J, 9.9-12.J, 9.9-12.L, 12.9-12.P, 17.9-12.M, 17.9-12.P, 17.9-12.Q

CTE Anchor Standards: 2.5, 5.0, 5.1, 5.2, 5.3, 5.4, 6.0, 6.1, 6.3, 6.4, 6.6, 7.0, 7.2, 7.3, 7.4, 7.5, 7.7, 7.8, 10.0, 10.1, 10.2, 10.3

EA: B4.0, B4.3, B4.4, B4.5, B6.0, B6.1, B6.2, B6.3, B6.4, B6.5, B6.6, B6.7, B7.0, B7.1, B7.2, B7.3, B7.4, B7.5, B7.6

- Glider Design, Construction, and Test:
    - Aircraft designs are the result of the best available theories, knowledge, and skills available to the designer at the time of their creation.
    - Software utilizing the mathematics of flight theory can be used to predict the flight performance of an aircraft prior to its construction.
    - Construction of a multi-component device is aided by the use of assembly and alignment jigs.
    - Flight testing data is essential for evaluating an aircraft design.
    - Radically different designs can achieve similar results.
- GPS and Spatial Awareness:
    - Pilots need to know where they are and how to proceed to the next waypoint in their flight plan.
    - Flight safety requires spatial awareness.
    - Numerous methods have been used to communicate positional information to pilots using old, current, and cutting-edge technology to improve flight safety through redundancy.
    - Global Positioning Systems use information provided by a constellation of satellites to calculate a position and motion in all three axes and through time.
    - Location and motion information is tremendously enhanced when it is correlated to 2D and 3D representations of the world around a pilot.

Unit 4: Astronautics

NGSS: HS.ESS1.4, HS.ESS3.4, HS.ETS1.1, HS.ETS1.2, HS.ETS1.3, HS.ETS1.4, HS.PS2.1, HS.PS2.3, HS.PS2.4, HS.PS3.1, HS.PS3.2, DCI - ETS1.A, DCI - ESS1.B, DCI - ESS3.C, DCI - ETS1.B, DCI - ETS1.C, DCI - PS2.A, DCI - PS2.B, DCI - PS3.A, DCI - PS3.B, DCI - PS3.C

Tech Lit: 1.9-12.J, 10.9-12.K, 11.9-12.N, 11.9-12.O, 11.9-12.P, 11.9-12.Q, 11.9-12.R, 12.9-12.L, 12.9-12.P, 13.9-12.K, 16.9-12.J, 17.9-12.N, 17.9-12.P, 17.9-12.Q, 2.9-12.AA, 2.9-12.BB, 2.9-12.W, 2.9-12.X, 2.9-12.Z, 3.9-12.J, 4.9-12.I, 4.9-12.J, 6.9-12.I, 7.9-12.G, 7.9-12.I, 7.9-12.L, 7.9-12.M, 8.9-12.H, 8.9-12.I, 8.9-12.J, 8.9-12.K, 9.9-12.I, 9.9-12.J, 9.9-12.K, 9.9-12.L

CTE Anchor Standards: 1.0, 5.0, 5.1, 5.2, 5.3, 5.4, 6.0, 6.1, 6.3, 6.4, 6.6, 7.0, 7.2, 7.3, 7.4, 7.5, 7.7, 7.8, 8.0, 8.1, 8.2, 8.7, 9.0, 9.1, 9.2, 9.5, 9.7, 10.0, 10.1, 10.2, 10.3, 11.0, 11.1, 11.2, 11.5

EA: B4.0, B4.1, B4.2, B4.3, B4.4, B5.0, B5.1, B5.2, B5.4, B5.5, B6.0, B6.1, B6.2, B6.3, B6.4, B6.5, B6.6, B6.7, B7.0, B7.1, B7.2, B7.3, B7.4, B7.5, B7.6

- Measuring Rocket Engine Thrust:
  - Rocket thrust can be measured using a simple device.
  - Calibration of a thrust measurement device can provide accurate data.
  - Thrust vs. time data can be acquired using a strip chart recorder.
  - Rocket thrust must be controlled to reduce the damaging effects of traveling through dense atmosphere.
- Model Rocket Trajectory:
  - Parts of a model rocket and parts of a model rocket engine have specific function(s) during a rocket’s flight.
  - The forces of weight, thrust, drag, and lift interact differently on a rocket in flight than on an aircraft in flight.
  - Newton’s three laws of motion (inertia, F = ma, and action-reaction) can be used to describe and predict events during each phase of a rocket launch.
  - Rocket design features are interrelated and determine how well a rocket will perform during powered flight.
  - The maximum velocity and maximum acceleration of a rocket during flight can be calculated mathematically given model rocket and engine performance data.
  - A rocket’s maximum altitude can be calculated by using indirect measurement.
- Rocket Camera:
  - The Internet and the library are useful tools for conducting research.
  - Aerial photography has many applications.
  - Using the scientific method to design a project to answer a research question is an important skill to conducting a scientific/engineering investigation.
  - Formulating a research question based on research, gathering data, analyzing data, and making judgments about experimental data are vital processes for conducting a research project/an investigation.
  - The scale factor of aerial photographs can be used to determine a rocket’s altitude, number, and kind of objects in the photograph, and the dimension of objects in the photographs.
  - Aerial photographs can be used to identify, classify, and enumerate objects in the photograph.
  - A rocket’s launch angle affects the forces of lift, thrust, weight, and drag.
- Orbital Mechanics:
  - Ellipses are conic sections, and circles are special cases of ellipses.
  - Orbits involve the steady procession of a small mass object around a large mass object. This includes planets processing around the sun, as well as satellites processing around a planet.
  - 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.
  - Orbital mechanics provides a means for describing orbital behavior of bodies.

Unit 5: Space Life Sciences

NGSS: HS.ETS1.3, DCI - ETS1.B, DCI - ETS1.C

Tech Lit: 2.9-12.W, 2.9-12.Z, 4.9-12.I, 8.9-12.H, 8.9-12.J, 9.9-12, 17.9-12.M, 17.9-12.P, 17.9-12.Q

CTE Anchor Standards: 1.0, 2.0, 2.5, 3.0, 3.1, 5.0, 5.1, 5.2, 5.3, 5.4, 6.0, 6.1, 6.3, 6.4, 6.6, 7.0, 7.2, 7.3, 7.4, 7.5, 7.7, 7.8, 8.0, 8.1, 8.2, 8.7, 9.0, 9.1, 9.2, 9.5, 9.7, 10.0, 10.1, 10.2, 10.3, 11.0, 11.1, 11.2, 11.5

EA: B4.0, B4.1, B4.2, B4.3, B4.4, B4.5, B6.0, B6.1, B6.2, B6.3, B6.4, B6.5, B6.6, B6.7, B7.0, B7.1, B7.2, B7.3, B7.4, B7.5, B7.6, B9.0, B9.1, B9.2

- Life Support and Environmental Systems
  - Basic physiological needs of the human body when living safely within and outside of Earth's atmosphere are oxygen, pressure, food and water, sleep, gravity, temperature, protective clothing, voiding by bladder and bowel.
  - The environment on earth and in space must be considered when designing solutions to problems in aerospace engineering.
  - Engineers have solved many technological challenges faced when designing solutions for living higher atmospheres and space.
  - The force, mass, and acceleration phenomena or G-forces that astronauts, fighter pilots, and Formula One drivers might experience is because of the rocket, jet, or internal combustion engine that provides the force needed to accelerate them, not gravity.
- Effect of Gravity on the Human Body:
  - Reduced gravity environments can be simulated in a 1-g, Earth-normal, environment.
  - The action of spinning can fool the senses and stimulate the vestibular system in the inner ear.
  - An increase stress-filled environment is physically unique and can affect the ability to perform mental functions.
  - Cooperative and supportive team behaviors result in increased safety and higher quality data.
- Microgravity Drop Tower:
  - Gravity is the weakest force known in nature, yet it holds galaxies and the solar system together.
  - Any object in freefall experiences microgravity conditions, which occur when the object falls toward the Earth with an acceleration equal to that due to gravity alone (approximately 9.8 meters per second squared [m/s2], or 1 g at Earth's surface).
  - Brief periods of microgravity can be achieved on Earth by dropping objects from tall structures.
  - The microgravity environment associated with the space shuttle is a result of the spacecraft being in orbit, which is a state of continuous freefall around the Earth.
  - A microgravity environment gives researchers a unique opportunity to isolate and study the influence of gravity on physical processes, as well as phenomena that are normally masked by gravity and thus difficult, if not impossible, to study on Earth.

Unit 6: Aerospace Materials

NGSS: HS.PS1.3, HS.ETS1.2, HS.ETS1.3, HS.ETS1.4, DCI - ETS1.B, DCI - ETS1.C

Tech Lit: 2.9-12.W, 2.9-12.Z, 2.9-12.AA, 2.9-12.BB, 4.9-12.I, 8.9-12.H, 8.9-12.J, 9.9-12.L, 11.9-12.N, 11.9-12.O, 11.9-12.P, 11.9-12.Q, 11.9-12.R, 12.9-12.L, 12.9-12.P, 13.9-12.J, 17.9-12.N, 17.9-12.P, 17.9-12.Q 19.9-12.M, 19.9-12.Q

CTE Anchor Standards: 1.0, 2.0, 2.5, 3.0, 3.1, 5.0, 5.1, 5.2, 5.3, 5.4, 6.0, 6.1, 6.3, 6.4, 6.6, 7.0, 7.2, 7.3, 7.4, 7.5, 7.7, 7.8, 8.0, 8.1, 8.2, 8.7, 9.0, 9.1, 9.2, 9.5, 9.7, 10.0, 10.1, 10.2, 10.3, 11.0, 11.1, 11.2, 11.5

EA: B4.0, B4.1, B4.2, B4.3, B4.4, B4.5, B5.0, B5.1, B5.2, B5.3, B5.4, B5.5, B6.0, B6.1, B6.2, B6.3, B6.4, B6.5, B6.6, B6.7, B7.0, B7.1, B7.2, B7.3, B7.4, B7.5, B7.6, B8.0, B8.1, B8.2, B8.3, B8.4, B8.5, B8.6, B9.0, B9.1, B9.2

- Composites Fabrication and Testing:
  - Multiple layers of any material are stronger than a single layer of that material.
  - Composite materials are fabricated by molding together layers of reinforced fabric, such as often glass or carbon fiber with a plastic matrix, such as epoxy.

  - Composite materials are used in the aerospace industry because they have excellent strength to weight ratios, which means they are able to carry large loads with a lighter structure.
  - The strength and stiffness of composite materials can be significantly increased by altering the distance

between adjacent sheets using a core material to create a sandwich construction.
  - Material performance is sometimes assessed by comparing strength to weight ratios.
  - A deflection test can be used to accurately determine the modulus of elasticity of a composite plastic sample.
  - A deflection test can be used to indicate the stiffness of various composite plastic samples.
- Thermal Protection Systems for Space Vehicles:
  - An understanding of the physics of space vehicle re-entry into the atmosphere is important for designing thermal protection systems.
  - Knowledge of material properties and testing is essential when trying to protect a space vehicle.
  - Heat transfer is a process that creates high temperatures in a space vehicle.
  - Energy is dissipated and converted into heat during a space vehicle re-entry.
  - Thermal Protection Systems (TPS) consist of various materials and coatings that are designed to protect a space vehicle.

Unit 7: Systems Engineering

NGSS: HS.PS2.1, HS.PS2.3, HS.PS3.1, HS.PS3.3, HS.PS4.2, HS.ESS3.4, HS.ETS1.2, HS.ETS1.3, HS.ETS1.4, DCI - PS2.A, DCI - PS3.A, DCI - PS3.B, DCI - PS3.D, DCI - ETS1.A, DCI - ETS1.B, DCI - ETS1.C, DCI - ESS2.D, DCI - ESS3.C

Tech Lit: 2.9-12.AA, 2.9-12.BB, 2.9-12.FF, 2.9-12.W, 2.9-12.X, 2.9-12.Y,2.9-12.Z, 4.9-12.I, 8.9-12.H, 8.9-12.I, 8.9-12.J, 8.9-12.K, 9.9-12.I, 9.9-12.J, 9.9-12.K, 9.9-12.L, 11.9-12.N, 11.9-12.O, 11.9-12.P, 11.9-12.Q, 11.9-12.R, 12.9-12.L, 12.9-12.M, 12.9-12.N, 12.9-12.O, 12.9-12.P, 13.9-12.J, 13.9-12.K, 17.9-12.L, 17.9-12.M, 17.9-12.N, 17.9-12.P, 17.9-12.Q, 18-9-12.M

CTE Anchor Standards: 1.0, 2.0, 2.5, 3.0, 3.1, 5.0, 5.1, 5.2, 5.3, 5.4, 6.0, 6.1, 6.3, 6.4, 6.6, 7.0, 7.2, 7.3, 7.4, 7.5, 7.7, 7.8, 8.0, 8.1, 8.2, 8.7, 9.0, 9.1, 9.2, 9.5, 9.7, 10.0, 10.1, 10.2, 10.3, 11.0, 11.1, 11.2, 11.5

EA: B4.0, B4.1, B4.2, B4.3, B4.4, B4.5, B5.0, B5.1, B5.2, B5.3, B5.4, B5.5, B6.0, B6.1, B6.2, B6.3, B6.4, B6.5, B6.6, B6.7, B7.0, B7.1, B7.2, B7.3, B7.4, B7.5, B7.6, B8.0, B8.1, B8.2, B8.3, B8.4, B8.5, B8.6, B9.0, B9.1, B9.2, B10.0, B10.1, B10.2, B10.3

- Intelligent Vehicles:
  - The two incentives for building robots are social, replacing humans in undesirable or dangerous jobs, and economic, reducing the cost of manufacturing while improving its quality.
  - Interactive systems are used in complicated arenas, such as science exploration.
  - Electronic data communication allows information to be transferred from human to human, human to machine, machine to human, and machine-to-machine.
  - The determination of the pH (potential of Hydrogen) of an unknown substance or substances aids in identifying the substance.
  - Robotic devices must be designed to perform effectively in the environment in which they will be used.
  - Robotic devices are composed of mechanical, electrical, and computer based systems that can be programmed to make decisions and control actions based upon sensor readings.
  - The fundamental challenge when working in robotics is deciding what motions the robot should perform in order to achieve a goal.

<u>Next Generation Science Standards</u>

HS-ESS3-4 Earth and Human Activity**:** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ETS1-1 Engineering Design: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2 Engineering Design: 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-ETS1-3 Engineering Design: 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-PS1-3 Matter and its Interactions: 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-PS2-3 Motion and Stability: Forces and Interactions: Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
DCI-ETS1.A: Defining and Delimiting an Engineering Problem
DCI-ETS1.B: Developing Possible Solutions
DCI-ETS1.C: Optimizing the Design Solution
DCI-ESS1.B: Earth and the Solar System
DCI-ESS1.C: The History of Planet Earth

Standards for Technological Literacy

2.9-12: Students will develop an understanding of the core concepts of technology.
- 2.9-12 W: Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems.
- 2.9-12 X: Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems for example, a food processor is a system made up of components and subsystems.
- 2.9-12 Z: selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste.
- 2.9-12 AA: requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.
- 2.9-12 BB: optimization is an ongoing process or methodology of redesigning or making a product and is dependent on criteria and constraints.

3.9-19: Students will develop an understanding of relationships among technologies and the connections between technology and other fields of study.
- 3.9-12 J: technological process promotes the advancement of science and mathematics.

4.9-12: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- 4.9-12 I: making decisions about the use of technology evolves win the trade-offs between the positive and negative effects.
- 4.9-12 J: ethical considerations are important in the development, selection, and use of technologies.

6.9-12: Students will develop an understanding of the role of society in the development and use of technology.
- 6.9-12.I: The decision whether to develop the technology is influenced by societal opinions and downs, in addition to corporate cultures.

7.9-12: Students will develop an understanding of the influence of technology on history.

- 7.9-12 G: most technological development has been evolutionary, the result of a series of refinements to a basic invention.
- 7.9-12 I: throughout history, technology has been a powerful force in reshaping the social, cultural, political, and

economic landscape.

8.9-12: Students will develop an understanding of the attributes of design.

8.9-12 H: The design process includes defining a problem, brainstorming, research and generating ideas, identifying criteria and specify constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refine the design, creating or making it, and communicating processes and results.

8.9-12 I: Design problems are seldom presented in a clearly defined form.

8.9-12 J: The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.

8.9-12 K: Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.

9.9-12: Students will develop an understanding of engineering design.

9.9-12 I: Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.

9.9-12 J: Engineering design is influenced by personal characteristics, and the ability to visualize and think abstractly.

9.9-12 K: A prototype is a working model used to text a design concept by making actual observations and necessary adjustments.

9.9-12 L: The process of engineering design takes into account a number of factors.

10.9-12: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

10.9-12.K: Not all problems are technological, and not every problem can be solved using technology.

11.9-12: Students will develop abilities to apply the design process.

11.9-12 N: Identify criteria and constraints and determine how these will affect the design process.

11.9-12 O: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.

11.9-12 P: Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.

11.9-12 Q: Develop and produce a product or system using a design process.

11.9-12 R: Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal. Graphic, quantitative, virtual, and written means, in addition to three-dimensional models.

12.9-12: Students will develop the abilities to use and maintain technological products and systems.

12.9-12.L: Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.

13.9-12: Students will develop the abilities to assess the impact of products and systems.

13.9-12.K; Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and the environment.

17.9-12: Students will develop an understanding of and be able to select and use information and communication technologies.

17.9-12 N: Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.

17.9-12 P: There are many ways to communicate information, such as graphic and electronic means.

17.9-12 Q: Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic imaged, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

19.9-12: Students will develop an understanding of and be able to select and use manufacturing technologies.

CTE Anchor Standards

1.0 Academics: Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the Engineering and Architecture academic alignment matrix for identification of standards.

2.0 Communications: Acquire and accurately use Engineering and Architecture sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats.

2.4 Demonstrate elements of written and electronic communication, such as accurate spelling, grammar, and format.

2.5 Communicate information and ideas effectively to multiple audiences using a variety of media and formats.

2.6 Advocate and practice safe, legal, and responsible use of digital media information and communications technologies.

3.0 Career Planning and Management: Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans. (Direct alignment with SLS 11-12.2)

3.1 Identify personal interests, aptitudes, information, and skills necessary for informed career decision making.

3.3 Explore how information and communication technologies are used in career planning and decision making.

3.6 Recognize the role and function of professional organizations, industry associations, and organized labor in a productive society.

4.0 Technology: Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Engineering and Architecture sector workplace environment.

4.1 Use electronic reference materials to gather information and produce products and services.

4.3 Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources.

4.5 Research past, present, and projected technological advances as they impact a particular Pathway.

5.0 Problem Solving and Critical Thinking: Conduct short, as well as more sustained, research projects to create alternative solutions to answer a question or solve a problem unique to the Engineering and Architecture sector using critical and creative thinking; logical reasoning, analysis, inquiry, and problem-solving techniques.

5.1 Identify and ask significant questions that clarify various points of view to solve problems.

5.2 Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate.

5.3 Use systems thinking to analyze how various components interact with each other to produce outcomes in a complex work environment.

5.4 Interpret information and draw conclusions, based on the best analysis, to make informed decisions.

6.0 Health and Safety: Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Engineering and Architecture sector workplace environment.

6.1 Locate, and adhere to, Material Safety Data Sheet (MSDS) instructions.
6.3 Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies.
6.4 Practice personal safety when lifting, bending, or moving equipment and supplies.
6.6 Maintain a safe and healthful working environment.

7.0 Responsibility and Flexibility: Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Engineering and Architecture sector workplace environment and community settings. (Direct alignment with SLS 9-10, 11-12.1)

7.2 Explain the importance of accountability and responsibility in fulfilling personal, community, and workplace roles.
7.3 Understand the need to adapt to changing and varied roles and responsibilities.
7.4 Practice time management and efficiency to fulfill responsibilities.
7.5 Apply high-quality techniques to product or presentation design and development.
7.7 Demonstrate the qualities and behaviors that constitute a positive and professional work demeanor, including appropriate attire for the profession.
7.8 Explore issues of global significance and document the impact on the Engineering and Architecture sector.

8.0 Ethics and Legal Responsibilities: Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms.

8.1 Access, analyze, and implement quality assurance standards of practice.
8.2 Identify local, district, state, and federal regulatory agencies, entities, laws, and regulations related to the Engineering and Architecture industry sector.
8.7 Conform to rules and regulations regarding sharing of confidential information, as determined by Engineering and Architecture sector laws and practices.

9.0 Leadership and Teamwork: Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution as practiced in the SkillsUSA career technical student organization.

9.1 Define leadership and identify the responsibilities, competencies, and behaviors of successful leaders.
9.2 Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decision-making skills, as applied in groups, teams, and career technical student organization activities.
9.5 Understand that the modern world is an international community and requires an expanded global view.
9.7 Participate in interactive teamwork to solve real Engineering and Architecture sector issues and problems.

10.0 Technical Knowledge and Skills: Apply essential technical knowledge and skills common to all pathways in the Engineering and Architecture sector, following procedures when carrying out experiments or performing technical tasks.

10.1 Interpret and explain terminology and practices specific to the Engineering and Architecture sector.
10.2 Comply with the rules, regulations, and expectations of all aspects of the Engineering and Architecture sector.
10.3 Construct projects and products specific to the Engineering and Architecture sector requirements and expectations.
10.4 Collaborate with industry experts for specific technical knowledge and skills.

11.0 Demonstration and Application: Demonstrate and apply the knowledge and skills contained in the Engineering and Architecture anchor standards, pathway standards, and performance indicators in classroom, laboratory and workplace settings, and through the SkillsUSA career technical student organization.

11.1 Utilize work-based/workplace learning experiences to demonstrate and expand upon knowledge and skills gained during classroom instruction and laboratory practices specific to the Engineering and Architecture sector program of study.

11.2 Demonstrate proficiency in a career technical pathway that leads to certification, licensure, and/or continued learning at the postsecondary level.

11.5 Create a portfolio, or similar collection of work, that offers evidence through assessment and evaluation of skills and knowledge competency as contained in the anchor standards, pathway standards, and performance indicators.

Engineering and Architecture Pathway Standards

Engineering Technology Pathway

B4.0 Understand the concepts of physics that are fundamental to engineering technology.

- B4.1 Describe newton's laws and how they affect and define the movement of objects.
- B4.2 Explain how the laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.
- B4.3 Compare the effects and applications of heat transfer and thermal dynamic processes.
- B4.4 Explore the fundamentals and properties of waveforms and how waveforms may be used to carry energy.
- B4.5 Analyze how electric and magnetic phenomena are related and know common practical applications.

B5.0 Understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems.

- B5.1 Differentiate between scalars and vectors.
- B5.2 Solve problems by using the concept of vectoring to predict resultants.
- B5.3 Compare and explore the six simple machines and their applications.
- B5.4 Evaluate how energy is transferred and predict the effects of resistance in mechanical, electrical, fluid, and thermal systems.
- B5.5 Formulate and solve problems by using the appropriate units applied in mechanical, electrical, fluid, and thermal engineering systems.

B6.0 Employ the design process to solve analysis and design problems.

- B6.1 Understand the steps in the design process.
- B6.2 Determine what information and principles are relevant to a problem and its analysis.
- B6.3 Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution.
- B6.4 Translate word problems into mathematical statements when appropriate.
- B6.5 Demonstrate the process of developing multiple details, within design constraints, into a single solution.
- B6.6 Construct a prototype from plans and test it.
- B6.7 Evaluate and redesign a prototype on the basis of collected test data.

B7.0 Understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance.

- B7.1 Know the structure and processes of a quality assurance cycle.
- B7.2 Describe the major manufacturing processes.
- B7.3 Use tools, fasteners, and joining systems employed in selected engineering processes.
- B7.4 Estimate and measure the size of objects in both Standard International and United States units.

B7.5 Apply appropriate geometric dimensioning and tolerancing (GD&T) practices.
B7.6 Calibrate precision measurement tools and instruments to measure objects.

B8.0 Understand fundamental control system design and develop systems that complete preprogrammed tasks.
B8.1 Identify the elements and processes necessary to develop a controlled system that performs a task.
B8.2 Demonstrate the use of sensors for data collection and process correction in controlled systems.
B8.3 Perform tests, collect data, analyze relationships, and display data in a simulated or modeled system using appropriate tools and technology.
B8.4 Program a computing device to control systems or process.
B8.5 Use motors, solenoids, and similar devices as output mechanisms in controlled systems.
B8.6 Assemble input, processing, and output devices to create controlled systems capable of accurately completing a preprogrammed task.

B9.0 Understand the fundamentals of systems and market influences on products as they are developed and released to production.
B9.1 Understand the process of product development.
B9.2 Understand decision matrices and the use of graphic tools in illustrating the development of a product and the processes involved.

B10.0 Design and construct a culminating project effectively using engineering technology.
B10.1 Use methods and techniques for employing all engineering technology equipment appropriately.
B10.2 Apply conventional engineering technology processes and procedures accurately, appropriately, and safely.
B10.3 Apply the concepts of engineering technology to the tools, equipment, projects, and procedures of the engineering technology pathway.

3. Key Assignments:

Lesson 1.1

It is expected that students will:

- Identify the various vehicles used for human flight.
- Identify and explain the function of the main components of an airplane.
- Identify and explain the forces acting on an airplane.
- Evaluate and compare the effects of design changes on the performance of an airplane.
- Experience the flight characteristics of an airplane through the use of a flight simulator.

Lesson 2.1

It is expected that students will:

- Identify the various forces acting on an airplane in flight.
- Identify the various factors that affect the lift and drag forces generated by an airfoil.
- Define the technical terms used to describe the geometry and performance of an airfoil.
- Analyze using a computer simulation tool the performance of an airfoil design.
- Evaluate and compare using a computer simulation several airfoil designs.
- Apply their knowledge of aerodynamics to design an airfoil that meets specifications.

Lesson 2.2

It is expected that students will:

- Extract geometric data from the FoilSim applet.
- Use a spreadsheet application to scale the geometric data points extracted from FoilSim to define an airfoil with a given chord length.
- Use modeling software to design templates to be used for accurately cutting airfoil shapes from a foam core.
- Use appropriate tools and machines to safely and accurately construct an airfoil to be tested in a wind tunnel.

- Evaluate different types of readily available foam products to determine the advantages and disadvantages of each in the construction of airfoil shapes.

Lesson 2.3

It is expected that students will:

- Identify the various components of a wind tunnel.
- Identify the various instruments used to measure the lift and drag forces generated by an airfoil.
- Synthesize a test plan to measure the performance of an airfoil.
- Measure the performance of an airfoil using lab equipment.
- Analyze the performance data gathered during testing.
- Evaluate and compare several performance characteristics of the airfoil.
- Communicate their test results through a technical report and a presentation to the class.

Lesson 2.4

It is expected that students will:

- Learn about Newton's Three Laws of Motion and how they relate to propulsion.
- Research and investigate propulsion and propulsion systems.
- Identify the four main propulsion systems and the parts of an engine.
- Conduct a propulsion systems analysis with calculations and graphs of data of various types of airplanes and propulsion systems.
- Design an engine and test the design using Engine Simulation software.
- Optional: Design, construct, and launch a water bottle rocket and make predictions of the rocket's altitude.
- Calculate the average altitude and relate Newton's Three Laws of Motion to the height the rocket achieved.

Lesson 3.1

It is expected that students will:

- Describe the requirements for a glider to remain stable in flight.
- Utilize software to layout a glider that complies with characteristics provided by the instructor.
- Design a glider for maximum flight distance.
- Construct a glider that accurately represents their design.
- Summarize test data to identify the best glider design.
- Write a proposal for "phase two" funding for a revised glider design.

Lesson 3.2

It is expected that students will:

- Gain a familiarity with the evolving technology of aerial navigation.
- Use a GPS unit to measure the location of objects.
- Summarize GPS data and create a navigational chart.
- Plan a multi-segment flight through a simulated airspace.
- Compare the ease of maintaining situational awareness using textual versus visual information when completing a "flight" through a simulated airspace.
- Explore the enhancements of the Wide Area Augmentation System (WAAS), Local Area Augmentation Systems (L.A.A.S.), and Synthetic Vision systems to the Global Positioning System.

Lesson 4.1

It is expected that students will:

- Design and build a rocket engine thrust testing device.
- Test the thrust of a model rocket engine.

- Modify the test to provide thrust vs. time data.

Lesson 4.2

It is expected that students will:

- Define the terms and concepts of the design, flight, and forces on a model rocket and be able to explain how they interaction.
- Investigate how changes in various design characteristics of a model rocket will affect the model rocket's flight performance.
- Work as an engineering team to construct a model rocket from a kit, fly it safely, and make predications, observations, and comparisons of flight data.
- Use trigonometry to calculate an estimate for the maximum altitude a model rocket obtains during a launch.
- Calculate a rocket's maximum velocity and maximum acceleration given rocket data and rocket engine performance specifications.

Lesson 4.3

It is expected that students will:

- Use the Internet and the library to conduct research on the importance of aerial photography.
- Demonstrate an understanding of the scientific method by formulating a testable research question, and designing and conducting an aerial photography project/experiment.
- Calculate the scale factor of aerial photographs, and use the scale factor to determine the rocket's altitude when the photography was taken, and determine the length of objects in the photographs using the photograph's scale factor.
- Describe how the launch angle relates to or affects the forces of lift, thrust, weight, and drag.

Lesson 4.4

It is expected that students will:

- Be able to define conic sections.
- Learn about historical figures in orbit theory.
- Observe basic orbit theory through a laboratory exercise.
- Learn about satellite motion and the application of orbit parameters by observing actual earth satellite motion.

Lesson 5.1

It is expected that students will:

- Work cooperatively in a team to design and conduct experiments related to positive g-force.
- Safely conduct experiments and collect data.
- Analyze the results of experiments through careful observation of experiment videotape.
- Synthesize the data and apply experimental conclusions to real-world situations.

Lesson 5.2

It is expected that students will:

- Experience the feeling of vestibular stimulation.
- Acquire data such as pulse rate and response time during stress tests performed in a reduced gravity environment.
- Analyze data and draw conclusions regarding the effects of reduced gravity and vestibular stimulation on the human body.
- Research the effects gravity has on the body both in space and on earth.

Lesson 5.3

It is expected that students will:

- Show and describe the videotape of drop experiment.
- Evaluate the results of the drop experiment with regard to anticipated outcomes.
- Describe recommendations for modifying the experiment.
- Keep a journal, including a daily entry that explains what was done, what needs to be done and their results.

Lesson 6.1

It is expected that students will:

- Mold various composite materials into the standard size 1" x 12" test sample.
- Build a test jig to test each composite sample for deflection.
- Conduct experiments and record data on the deflection of various composite samples using a micrometer and a dial indicator.
- Analyze and graph the results of the deflection experiments.

Lesson 6.2

It is expected that students will:

- Identify the material properties that are necessary for an effective Thermal Protection Systems (TPS).
- Describe the process of a space vehicle re-entry and the temperature extremes that a space vehicle may be subjected to.
- Determine the thermal protection capability of several materials through tests of materials and related research.
- Evaluate and compare the thermal test results of several materials.
- Apply their knowledge of material properties to select the best candidate materials for use in a thermal protection system.

Lesson 7.1

It is expected that students will:

- Design a computer driven system for a robot to perform a series of predetermined functions without having anything impede its progress while successfully delivering a payload to a predetermined location.
- Develop a rubric that will be used to assess the design-build-operate criteria of the robot.
- Design, build, and test an intelligent vehicle that will meet criteria determined by the goals established by the students.

4. Instructional Methods and/or Strategies:

Project Lead the Way APB (Activity, Project, and Problem-based) Instructional Design providing students with unique opportunities to work collaboratively, identify problems, apply what they know, persevere through challenges, find unique solutions, and lead their own learning. Students will be engaged in a variety of activities that balance direct instruction with project work. Students will be expected to apply the concepts and processes learned during direct instruction to their projects. Students will attend lectures, complete labs, become involved with professional mentors, complete real-world projects, and make presentations that demonstrate understanding of design/fabrication concepts and the research process.

Methods of instruction will include:

- Direct instruction (lectures, discussions, readings, and lab activities specific for mastery of content);
- Use of activity, problem, project-based learning with support from professional mentors;
- Development of language arts skills while students complete reports, journals, analyses, and essays;

- Use of educational courseware, interfaced probe ware, scientific instrumentation, and professional software;
- Use of a variety of instructional materials and resources including electronic media, handbooks, professional journals, reference materials, and textbooks;
- Self-directed, cooperative, and collaborative learning opportunities to increase responsibility of students for their own learning;
- Use of student presentations, exhibits, and competitions;
- Embedded assessments as a learning tool;
- Differentiated instruction for exceptional students; and
- Activities which promote scientific knowledge and adaptation of technology

5. Assessment Including Methods and/or Tools:

- Project-based assessments using PLTW APB rubrics
- A computer-based End of Course (EOC) exam delivered online
- PLTW LMS system supports delivery of curriculum and assessments

The evaluation of student progress and evaluation will be based on the following criteria outlined in Board Policy:

- Assessments: 60-75% of the final grade
- Assignments and class discussions: 25-40% of the final grade