

Course Title:	Principles of Engineering (POE) - Project Lead the Way (PLTW)
Department:	Engineering
Course #:	2446
Grade Level/s:	10 – 12
Length of Course:	Year
Prerequisite/s:	Introduction to Design - Engineering (PLTW)
UC/CSU (A-G) Req:	G (Pending)
Brief Course Description:	Principles of Engineering (POE) is the second course in the Project Lead the Way (PLTW) Engineering pathway. This course exposes students to major concepts they will encounter in a postsecondary engineering course of study. Students will explore a broad range of engineering topics to include: mechanisms, strength of materials and structures, automation, and kinematics. POE applies and further develops knowledge and skills in mathematics, science and technology. Students have the opportunity to develop skills and understanding of course concepts through activity, project and problem-based (APB) learning. By solving rigorous and relevant design problems, students will continually hone their interpersonal, creative and problem solving skills. Through hands-on projects, students will apply engineering standards while documenting their work and designs in an engineer's notebook. Students will design solutions to solve proposed problems and communicate solutions to peers and members of the professional community. Students will develop strategies to enable and direct their own learning, which is the ultimate goal of education.

I. GOALS

The students will:

- A. Understand mechanisms through the application of theory-based calculations accompanied by lab experimentation
- B. Investigate thermal energy and alternative energy applications
- C. Explore solar hydrogen systems and thermal energy transfer through materials
- D. Solve a design problem/s related to energy and power.

Course Title: Principles of Engineering (POE) - Project Lead the Way (PLTW)

- E. Understand materials properties and statics through beam deflection and forces on truss structures
- F. Select proper materials for creating new products to meet a given need or want
- G. Reuse/recycle materials for continued and unique uses
- H. Perform destructive and non-destructive material testing to identify properties of materials
- I. Perform tensile testing and other material processes.
- J. Solve a materials design problem/s
- K. Control mechanical systems by recognizing computer outputs and writing codes
- L. Use various input devices and computer codes to control outputs
- M. Connect applications using pneumatic and hydraulic power
- N. Manipulate mechanisms using work and power
- O. Solve design problems utilizing knowledge, skills and understandings of simple machines, material properties and control systems
- P. Solve problems involving input devices, coding and various output devices
- Q. Evaluate experiment/s
- R. Understand and apply dynamics specifically kinematics and freefall motion
- S. Use theoretical and experimental data in statistical analysis
- T. Design a self-propelled vehicle
- U. Design a machine to launch objects within given specifications

CTE Model Standards:

The student will:

1. Communicate and interpret information clearly in industry-standard visual and written formats.
2. Demonstrate sketching process used in concept development.
3. Identify the fundamentals of the theory, measurement, control, and applications of electrical energy, including alternating and direct currents.
4. Understand the concepts of physics that are fundamental to engineering technology.
5. Understand how the principles of force, work, rate, power, energy, and resistance relate to mechanical, electrical, fluid, and thermal engineering systems.
6. Employ the design process to solve analysis and design problems.

Course Title: Principles of Engineering (POE) - Project Lead the Way (PLTW)

7. Understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance.
8. Understand fundamental control system design and develop systems that complete preprogrammed tasks.
9. Understand the fundamentals of systems and market influences on products as they are developed and released to production.
10. Design and construct a culminating project effectively using engineering technology.
11. Understand the methods of creating both written and digital portfolios.

II. OUTLINE OF CONTENT FOR MAJOR AREAS OF STUDY

Semester 1

A. Unit 1: Energy and Power

1. Lesson 1.1 Mechanisms
2. Lesson 1.2 Energy Sources
3. Lesson 1.3 Energy Applications
4. Lesson 1.4 Design Problem – Energy and Power

B. Unit 2: Materials and Structures

1. Lesson 2.1 Statics
2. Lesson 2.2 Material Properties
3. Lesson 2.3 Material Testing
4. Lesson 2.4 Design Problem – Materials and Structures

Semester 2

A. Unit 3: Control Systems

1. Lesson 3.1 Machine Control
2. Lesson 3.2 Fluid Power
3. Lesson 3.3 Design Problem – Control Systems

B. Unit 4: Statistics and Kinematics

1. Lesson 4.1 Statistics
2. Lesson 4.2 Kinematics

III. ACCOUNTABILITY DETERMINANTS

A. Key Assignments

1. Unit 1: Energy and Power.

The goal of Unit 1 is to introduce students to mechanisms, energy sources, and alternative energy applications. Students will gain an understanding of mechanisms through the application of theory-based calculations accompanied by lab experimentation. They will learn as energy and power are transferred and transformed, losses to friction in the system will occur. Students will understand such losses affect the overall efficiency of the system. They will have an opportunity to investigate thermal energy and alternative energy applications. Students will explore and gain experiences relating to solar hydrogen systems and thermal energy transfer through materials. The unit concludes with students working in teams to solve a design problem focused on energy and power.

Course Title: Principles of Engineering (POE) - Project Lead the Way (PLTW)

- a. Lesson 1.1 Mechanisms
In this lesson, students will gain an understanding of mechanisms through the application of theory based calculations accompanied by lab experimentation.
 - b. Lesson 1.2: Energy Sources
In this lesson, students will learn that technological systems would not be possible without energy, work, and power. Students will investigate ways to generate energy and make systems more efficient.
 - c. Lesson 1.3: Energy Applications
This lesson is designed to provide students with an opportunity to investigate thermal energy and alternative energy applications. Students will explore and gain experiences relating to energy transformations in solar hydrogen systems and thermal energy transfer through materials.
 - d. Lesson 1.4 Design Problem – Energy and Power
In this lesson, students will work in teams to solve a design problem on energy and power.
2. Unit 2: Materials and Structures
- The goal of Unit 2 is for students to have a more concrete understanding of engineering through materials properties and statics. Students will learning about beam deflection and forces on truss structures. They learn to calculate internal and external forces acting on those structures.
- The students will learn material properties, which contributes to proper selection of material for a given task. Students will investigate the creation of new products to meet a given need or want. Reuse and recycled materials for continued and unique uses is examined.
- In this unit, students will learn destructive and non-destructive material testing. Tensile testing is the major destructive test. Students will learn how machines perform these tests. This unit concludes with students, working in teams to follow the design process to solve the problem.
- a. Lesson 2.1: Statics
In this lesson, students will learn how to identify and calculate forces acting on a body when it is in static equilibrium. Students will calculate internal and external forces of a truss. They will use this knowledge to design, build, and test their own truss designs.
 - b. Lesson 2.2: Material Properties
This lesson is designed to provide students with an opportunity to investigate the basic categories and properties of materials. Students will discover how products are made and how they are recycled once they are no longer useful.
 - c. Lesson 2.3: Material Testing
Material Testing is a critical process that determines whether a product is reliable, safe, and predictable in function. In this lesson, students will experiment with destructive testing and nondestructive testing.

Course Title: Principles of Engineering (POE) - Project Lead the Way (PLTW)

- d. Lesson 2.4: Design Problem – Materials and Structures
In this lesson, students work in teams to solve a materials design problem. They will use the knowledge and understandings developed throughout the unit to solve the problem.
3. Unit 3: Control Systems
The goal of Unit 3 is for students to recognize the abundance and variety of computer use. Students learn to control mechanical systems by writing code to control computer outputs. Furthermore, students gain an understanding of fluid power, hydraulic and pneumatic. The unit concludes with students working in teams to solve a design problem using control systems. They will integrate their prior knowledge, skills, and understandings from Unit 1: Simple Machines, Unit 2: Material Properties, and this unit. Students will decide what input devices to use, how to code their use, and the various output devices necessary to create a solution to the problem.
 - a. Lesson 3.1: Machine Control
In this lesson, students will learn how to control mechanical processes using computer software and hardware. The software communicates through a hardware interface with different inputs and outputs.
 - b. Lesson 3.2: Fluid Power
In this lesson, students will be introduced to both pneumatic and hydraulic power. They will learn the basic components of each system and how they are designed to manipulate components through work and power.
 - c. Lesson 3.3: Design Problem – Control Systems
In this lesson, students will work in teams to solve a design problem related to the control systems using the design process. They will use the knowledge and understanding gained throughout the course to create a solution to the problem.
 4. Unit 4: Statistics and Kinematics
In Unit 4, students are learning to use statistics to evaluate an experiment. Students learn statistical analysis through use theoretical and experimental data. By collecting, organizing, and interpreting the data, students build the skills needed to understand data results. Students will study dynamics, specifically kinematics, and apply statistical skills to study freefall motion. Students will use these skills and knowledge to design a self-propelled vehicle. Later, students will address the problem of designing a machine to launch an object within given specifications including projectile motion.
 - a. Lesson 4.1: Statistics
In this lesson, students will learn the processes of gathering, organizing, interpreting and formulating an understanding of data through probability and statistics.
 - b. Lesson 4.2: Kinematics
In this lesson, students will create a vehicle to learn important aspects of motion and freefall. Students will design a launching machine to help them understand and apply kinematics concepts.

Course Title: Principles of Engineering (POE) - Project Lead the Way (PLTW)

- B. Assessment Methods
 - 1. Skill mastery and quality of work
 - 2. Engineers notebook / portfolio
 - 3. Tests and quizzes
 - 4. Individual projects/group projects/final projects
 - 5. Classwork/homework
 - 6. Performance tasks
 - 7. In-class lecture notes
 - 8. End of unit exams
 - 9. Semester final exam/s

IV. INSTRUCTIONAL MATERIALS AND METHODOLOGIES

- A. Required Textbook(s)
 - 1. PLTW's Learning Management System

- B. Supplementary Materials
 - 1. Robotics hardware
 - 2. Classroom supplemental materials
 - 3. VEX Robotics Equipment
 - 4. CAD/Inventor Autodesk Software

- C. Instructional Methodologies
 - 1. Guided Inquiry
 - 2. Direct Instruction
 - 3. Cooperative Learning
 - 4. Discourse
 - 5. Problem-based Learning
 - 6. Visual Representations and Concrete Models