

Principles of Engineering

Principles of Engineering explores a broad range of engineering and technology topics with their relationship to science and mathematics by solving real world problems. This hands-on course is designed to provide students interested in engineering and technology career opportunities to explore applications related to specialized fields such as civil, mechanical, and materials engineering, among others. Students will engage in research, development, planning, design, production, and project management. Classroom activities are organized to allow students to work in teams and use modern technological processes, software, and production systems to develop and present solutions to engineering problems.

- PLTW DOE Codes: 4814
- Non-PLTW DOE Code: 5644
- Recommended Grade Level: 10-11
- Recommended Prerequisites: Introduction to Engineering Design
- Credits: 2 semester course, 2 semesters required, 1 credit per semester, maximum of 2 credits
- Fulfills a Directed Elective or Elective requirement for all diploma types
- Qualifies as a quantitative reasoning course

Dual Credit

This course provides the opportunity for dual credit for students who meet postsecondary requirements for earning dual credit and successfully complete the dual credit requirements of this course. The Dual Credit crosswalk can be accessed [here](#).

Application of Content and Multiple Hour Offerings

Intensive laboratory applications are a component of this course and may be either school based or work based or a combination of the two. Work-based learning experiences should be in a closely related industry setting. Instructors shall have a standards-based training plan for students participating in work-based learning experiences.

Implementation Guidance

Domain Zero (0) was created much like a process standard to be implemented throughout the length of the course. These standards should be taught in conjunction with Content Area Standards throughout all domains.

Career and Technical Student Organizations (CTSOs)

Career and Technical Student Organizations are considered a powerful instructional tool when integrated into Career and Technical Education programs. They enhance the knowledge and skills students learn in a course by allowing a student to participate in a unique program of career and leadership development. Students should be encouraged to participate in a Career and Technical Student Organization, such as the Technology Student Association (TSA)

Domain 0 – Project Management

Core Standard 1 Students will exhibit appropriate safety practices while working with tools and equipment.

- POE– 0.1.1 Demonstrate relevant safety practices when using tools and equipment as determined by task, materials, environment, and protective attire.
- POE – 0.1.2 Apply corrective action(s) to eliminate hazards.
Understand the format and content of industry based Material Safety Data Sheets (MSDS).

Core Standard 2 Students will investigate various careers within the fields of engineering and technology.

- POE – 0.2.1 Identify engineering and technology occupations and the roles and responsibilities of each.
- POE – 0.2.2 Report job outlook, demand, and projected wages for engineering and technology careers.
- POE – 0.2.3 Explore job opportunities that are available in engineering and technology.
- POE – 0.2.4 Investigate post-secondary training opportunities and industry certifications that are available.
- POE – 0.2.5 Explore professional organizations related to engineering and technology.

Core Standard 3 Students will communicate the design process.

- POE - 0.3.1 Explain the importance of documentation.
- POE - 0.3.2 Apply sketching and annotation skills to document work.
- POE - 0.3.3 Produce working drawings using appropriate drawing styles and techniques.
- POE - 0.3.4 Construct design models or finish models to display concepts of design or theory investigated.
- POE - 0.3.5 Document project components into an engineering notebook (digital or paper).
- POE - 0.3.6 Communicate technical knowledge in a variety of formats.
- POE - 0.3.7 Utilize presentation software to create a presentation that outlines team or individual priorities for design and share with peers.
- POE - 0.3.8 Document best work in a portfolio (digital or paper).

Core Standard 4 Students will apply appropriate research techniques.

- POE - 0.4.1 Formulate unbiased research questions to collect information/data.
- POE - 0.4.2 Apply appropriate investigative strategies.
- POE - 0.4.3 Evaluate sources appropriate for academic research.
- POE - 0.4.4 Select resources relevant to the identified problem.
- POE - 0.4.5 Synthesize information collected during the research process.
- POE - 0.4.6 Generate a list of sources used to gather information using APA or MLA format.

Content Standards

Domain – Design and Documentation

Core Standard 1 **Students will create solutions utilizing the design process.**

- POE – 1.1 Describe the steps in the design process.
- POE – 1.2 Create a decision making matrix for design problems.
- POE – 1.3 Select an approach that meets or satisfies the constraints provided in a design brief.
- POE – 1.4 Assess and refine original design solutions based upon reflection, critique, practice, and research.
- POE – 1.5 Collaborate with team members to develop a design solution.

Domain – Energy and Power

Core Standard 2 **Students adapt and apply energy and power concepts to develop an efficient system.**

- POE – 2.1 Categorize energy sources.
- POE – 2.2 Analyze energy source processes.
- POE – 2.3 Determine systems efficiency and energy use.
- POE – 2.4 Identify and describe the possible types of power conversion.
- POE – 2.5 Assess energy sources that can be combined to convert energy to useful forms.
- POE – 2.6 Calculate circuit resistance, current, and voltage using Ohm's law.
- POE – 2.7 Compare the advantages and disadvantages of parallel and series circuit design.
- POE – 2.8 Analyze the relationships between voltage, current, and resistance.
- POE – 2.9 Explore ways to produce mechanical power using alternative energy.

Domain – Statics

Core Standard 3 **Students interpret science and math concepts to determine the effect of stresses placed on a structure and its components.**

- POE – 3.1 Classify different structural elements of a system.
- POE – 3.2 Analyze forces acting upon an object in a given situation.
- POE – 3.3 Calculate the centroid location of simple and complex shapes.
- POE – 3.4 Illustrate the moment of inertia of structural members.
- POE – 3.5 Differentiate between scalar and vector.
- POE – 3.6 Demonstrate appropriate scalar and vector calculations.
- POE – 3.7 Calculate unknown forces using equations of equilibrium.
- POE – 3.8 Determine forces acting on an object using the method of joints strategy.

Domain – Material Properties, Testing, and Structural Analysis

Core Standard 4 Students synthesize results of tested materials and structures to determine fitness of use.

- POE – 4.1 Verify non-destructive/destructive material property tests on selected common products using measuring instruments, investigation methods of discovery, and assembly/disassembly of material components.
- POE – 4.2 Analyze material properties used to create products.
- POE – 4.3 Execute testing procedures to justify calculations of product mass properties in relation to various material properties.
- POE – 4.4 Identify and describe the manufacturing processes used to create common products.
- POE – 4.5 Describe the lifecycle of materials.
- POE – 4.6 Identify common recycling symbols of materials and codes that regulate recycling.

Domain – Kinematics

Core Standard 5 Students apply the laws of motion as they apply to principles of engineering.

- POE – 5.1 Demonstrate the calculation of projectile motion given parameters.
- POE – 5.2 Examine the propulsion of an object.
- POE – 5.3 Explain how gravity impacts motion.
- POE – 5.4 Apply the laws of motion to solutions.
- POE – 5.5 Analyze the forces acting on an object while in motion.
- POE – 5.6 Describe the relationships among force, mass, and direction.

Domain – Simple Machines

Core Standard 6 Students evaluate simple machines for the purpose of solving a wide range of design and application problems.

- POE – 6.1 Apply the six simple machines (lever, wheel and axle, pulley, inclined plane, wedge and screw), their attributes, and components.
- POE – 6.2 Calculate mechanical advantage of different mechanisms.
- POE – 6.3 Design, create, and test gear, pulley, and sprocket systems.
- POE – 6.4 Calculate work and power in mechanical systems.
- POE – 6.5 Determine efficiency in a mechanical system.
- POE – 6.6 Measure forces and distances related to mechanisms.

Domain – Statistics

Core Standard 7 Students apply basic statistics principles as it applies to project solutions.

- POE – 7.1 Compare theoretical and experimental data
- POE – 7.2 Use statistics to determine theoretical outcomes.
- POE – 7.3 Illustrate the use of statistics in the engineering design process.
- POE – 7.4 Determine probability and graph data and outcomes using software.

Domain – Hydraulics and Pneumatics

Core Standard 8 Students assess hydraulic and pneumatic systems for the purpose of use as a control system component.

- POE – 8.1 Distinguish between hydrodynamic and hydrostatic systems.
- POE – 8.2 Calculate values in a fluid power system (pneumatic and hydraulic).
- POE – 8.3 Distinguish between the laws of fluid power to calculate pressure, temperature, and volume.
- POE – 8.4 Differentiate between the characteristics of pneumatic and hydraulic systems.
- POE – 8.5 Identify and explain basic components and functions of fluid power devices.

Domain – Control Systems

Core Standard 9 Students apply concepts of computer programming, logic, and fluid power to establish an automated control system.

- POE – 9.1 Create control systems using computer software that optimizes hardware functionality.
- POE – 9.2 Choose appropriate input and output devices based on the need of a technological system.
- POE – 9.3 Differentiate between the characteristics of digital and analog devices.
- POE – 9.4 Determine the most appropriate open and closed loop systems in order to solve a given technological problem.
- POE – 9.5 Describe applications of process control and automation systems.
- POE – 9.6 Apply design concepts to problems in process control and automations systems.