

Introduction to Engineering Design

Introduction to Engineering Design is a fundamental pre-engineering course where students become familiar with the engineering design process. Students work both individually and in teams to design solutions to a variety of problems using industry standard sketches and current 3D design and modeling software to represent and communicate solutions. Students apply their knowledge through hands-on projects and document their work with the use of an engineering notebook. Students progress from completing structured activities to solving open-ended projects and problems that require them to develop planning, documentation, communication, and other professional skills. Ethical issues related to professional practice and product development are also presented.

NOTE: If PLTW curriculum is used, PLTW training is required of the teacher.

- DOE Code: 4802
- Recommended Grade Level: 9
- Recommended Prerequisites: None
- 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

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 Domains 1-7.

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.*

- IED – 0.1.1 Demonstrate relevant safety practices when using tools and equipment as determined by task, materials, environment, and protective attire.
- IED – 0.1.2 Apply corrective action(s) to eliminate hazards.

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

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

Core Standard 3 *Students will communicate the design process.*

- IED - 0.3.1 Explain the importance of documentation.
- IED - 0.3.2 Apply sketching and annotation skills to document work.
- IED - 0.3.3 Produce working drawings using appropriate drawing styles and techniques.
- IED - 0.3.4 Document project components into an engineering notebook (digital or paper).
- IED - 0.3.5 Communicate technical knowledge in a variety of formats.
- IED - 0.3.6 Create a presentation that outlines team or individual priorities for design and share with peers.

Core Standard 4 *Students will apply appropriate research techniques.*

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

Domain 1 – Design Process

Core Standard 5 *Students perform the steps of the design process to develop and analyze products and systems.*

- IED – 1.5.1 Describe the steps in the design process.
- IED – 1.5.2 Generate a valid and justifiable problem.
- IED – 1.5.3 Create a design brief by constructing a problem and design statement and identifying problem constraints.
- IED – 1.5.4 Apply the steps of the design process as they are used to solve the problem.
- IED – 1.5.5 Describe the iterative nature of the design loop.
- IED – 1.5.6 Discuss how the design process impacts the outcome when designing solutions to problems.
- IED – 1.5.7 Assess and refine original design solutions based upon reflection, critique, practice, and research.

Domain 2 – Technical Drawing Standards

Core Standard 6 *Students will produce industry standard sketches and drawings to allow for universal communication.*

- IED – 2.6.1 Distinguish between line types utilized on a technical drawing per industry standard (ANSI Line Conventions and Lettering Y14.2M-2008).
- IED – 2.6.2 Interpret and develop appropriate annotations for technical drawings.
- IED – 2.6.3 Differentiate between the various types of tolerances.
- IED – 2.6.4 Analyze types of fits in relation to mating parts.
- IED – 2.6.5 Collect and display data related to the sizes and shapes of objects utilizing various measuring tools.
- IED – 2.6.6 Determine the appropriate number of views, including alternate views (auxiliary, section, detail), to fully document the details of a design.
- IED – 2.6.7 Identify and produce various pictorial drawings including isometric, oblique, and perspective drawings for technical drawing representations.
- IED – 2.6.8 Differentiate when the physical properties of geometric shapes can be utilized in order to optimize design solutions.
- IED – 2.6.9 Apply industry accepted dimensioning practices to technical drawings in order to annotate design features.
- IED – 2.6.10 Identify and produce multiview drawings in proper orientation, scale, and proportion through methods of orthographic projection.
- IED – 2.6.11 Illustrate and calculate mathematical problems related to real world situations involving characteristics of geometric shapes and solids.

Domain 3 – Reverse Engineering

Core Standard 7 *Students will perform various analyses of systems or products with the purpose of developing appropriate improvements.*

- IED – 3.7.1 Identify visual, functional and structural properties of a product.
- IED – 3.7.2 Differentiate between invention and innovation.
- IED – 3.7.3 Describe the relationship between reverse engineering and product/system improvement.
- IED – 3.7.4 Create an innovation to a system or product using information obtained from a product analysis.
- IED – 3.7.5 Evaluate the effectiveness of elements and principles in other design solutions and use analysis to revise original design.
- IED – 3.7.6 Perform mathematical calculations to identify structural properties of a product.

Domain 4 – Project Documentation

Core Standard 8 *Explain the role of intellectual property in design and the necessity of producing and keeping an engineering notebook.*

- IED – 4.8.1 Maintain a working engineering notebook for the duration of the course.
- IED – 4.8.2 Implement design briefs in the problem solving process.
- IED – 4.8.3 Collaborate on engineering projects by working in design teams to solve valid problems.
- IED – 4.8.4 Manage time and the progress of a project through effective use of a Gantt chart.

Domain 5 – Engineering Design

Core Standard 9 *Students assess the components and ethics of engineering design to understand their role in the design process.*

- IED – 5.9.1 Discuss historical and current events related to engineering and technology and analyze the impact on society.
- IED – 5.9.2 Discuss the importance of ethics in engineering design.
- IED – 5.9.3 Apply the design principles and elements.
- IED – 5.9.4 Use engineering design equipment (3D modeling software, 3D printer, etc.) to create 3D and 2D models to document engineering design.
- IED – 5.9.5 Identify the qualities of engineering design and their relationship to a design matrix.
- IED – 5.9.6 Examine a design (product) with respect to its quality and usability.
- IED – 5.9.7 Use the design principles and elements to meet the design criteria and constraints to solve a valid problem.

Domain 6 - Modeling

Core Standard 10 *Students create designs using a variety of modeling techniques to communicate information.*

- IED – 6.10.1 Formulate methods of communicating designs using various forms of modeling such as conceptual, graphical, mathematical, physical or computer modeling.
- IED – 6.10.2 Utilize appropriate modeling materials to construct a physical model such as a prototype or mock-up.
- IED – 6.10.3 Interpret the details of a sketch and generate physical or computer models using appropriate modeling materials and techniques.
- IED – 6.10.4 Recognize and utilize constraints such as dimensional, geometric, assembly and parametric constraints in regard to modeling.
- IED – 6.10.5 Identify the six degrees of freedom of a component floating in space in the context of an assembly.
- IED – 6.10.6 Differentiate between assemblies and subassemblies and their appropriate use.
- IED – 6.10.7 Analyze the remaining degrees of freedom of mating components after systematically applying assembly constraints until only desired components are allowed to move.

Domain 7 - Aesthetics

Core Standard 11 *Students demonstrate artistic fundamentals which are utilized throughout the engineering design process to solve visual problems and communicate ideas for a product or system.*

- IED – 7.11.1 Apply visual design principles to enhance the aesthetic appeal of a design solution.
- IED – 7.11.2 Analyze products or systems by identifying problematic features to generate potential solution(s).
- IED – 7.11.3 Choose appropriate symbols and metaphors from art and design and describe their origin, function, and value in the solutions.
- IED – 7.11.4 Create multiple solutions that demonstrate and distinguish mastery in producing effective relationships between elements, media, and function.
- IED – 7.11.5 Create design solutions that use specific elements, principles, and functions that demonstrate skill and understanding of different communication processes to solve problems.