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.

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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. |