Introduction to Engineering Design

9-12th Grade: Glenwood Community High School

Course Purpose: **Introduction to Engineering Design (IED) is a high school level foundation course in the PLTW Engineering Program. In IED students are introduced to the engineering profession and a common approach to the solution of engineering problems, an engineering design process. Utilizing the activity-project-problem-based (APB) teaching and learning pedagogy, students will progress from completing structured activities to solving open-ended projects and problems that require them to develop planning, documentation, communication, and other professional skills.**

Course Outcome	Outcome Component	Description
IED.1		**The Design Process: Students will develop solutions to multiple problems by applying PLTW's Design Process.**
	IED.1.1	Identify and describe the steps in an engineering design process.
	IED.1.2	Identify and describe multiple brainstorming techniques.
	IED.1.3	Create sketches or diagrams of different objects.
	IED.1.4	Generate and document multiple ideas or solution paths to a problem through brainstorming.
	IED.1.5	Describe the design process used in the solution of a particular problem and reflect on all steps in the process.
	IED.1.6	Create a deliverable explaining the contributions of an engineer or technician in the mathematical/science field.
IED.2		**Technical Sketching and Drawing: Students will create various technical representations used throughout the design process.**
	IED.2.1	Identify line types used in a technical drawing and explain the purpose of each line.
	IED.2.2	Identify and define technical drawing representations including isometric, orthographic projection, oblique, and perspective.
	IED.2.3	Hand sketch isometric, 1-pt perspective, orthographic projection, and oblique view of a simple object or part of a more difficult object when the scale is given.
	IED.2.4	Sketch a pictorial and give a detailed verbal/written description.
	IED.2.5	Apply tonal shading to enhance the appearance of a pictorial sketch to create a more realistic appearance of a sketched object.
	IED.2.6	Choose and justify the choice for the front view in an orthographic projection.

IED.3		**Measurement and Statistics: Students will learn and apply appropriate methods of making and recording measurements, describe the difference between precision and accuracy, and use descriptive and inferential statistics to make informed decisions.**
	IED.3.1	Measure linear distances with accuracy using a ruler and dial caliper.
	IED.3.2	Convert measurements within and between the metric and US customary systems.
	IED.3.3	Identify and use general rules for dimensioning on technical drawings used in standard engineering practice.
	IED.3.4	Identify and correct errors and omissions in the dimensions applied in a technical drawing.
	IED.3.5	Calculate measure of central tendency. (Mean, median, mode, range, sample standard deviation)
	IED.3.6	Use statistics to quantify information, support design decision, and justify problem solutions.
	IED.3.7	Store, manipulate, and display data using a spreadsheet program.
	IED.3.8	Evaluate and compare the accuracy and precision of different measuring devices.
IED.4		**Modeling Skills: Students will create graphical 3D computer models of design ideas using sketches and engineering drawings and use mathematical functions to explain relationships between two quantities.**
	IED.4.1	Develop and/or use graphical, computer, physical and mathematical models as appropriate to represent or solve problems.
	IED.4.2	Create three-dimensional solid models of parts within CAD from sketches or dimensioned drawings using appropriate geometric and dimensional constraints.
	IED.4.3	Construct a testable prototype of a problem solution.
	IED.4.4	Create a set of working drawings to detail a design project.
	IED.4.5	Evaluate a function for inputs in its domain and interpret statements that use function notation in terms of a context.
	IED.4.6	Compare the efficiency of the modeling method of an object using different combinations of additive and subtractive methods of creating three-dimensional models.

IED.5		**Geometry of Design: Students will calculate the area of two-dimensional shapes, the surface area, volume, and weight of three-dimensional solids and the interaction of volume and weight to determine material density. Students will also use CAD modeling software to enhance their understanding of plane and solid geometry.**
	IED.5.1	Identify types of polygons and other common shapes and be able to match with the correct formula to find its area.
	IED.5.2	Solve real world and mathematical problems involving area, surface area, and volume of two- and three-dimensional objects.
	IED.5.3	Create three-dimensional solid models of parts within CAD from sketches or dimensioned drawings using appropriate geometric and dimensional constraints and model features.
	IED.5.4	Measure mass and volume with accuracy and report the measurement with an appropriate level of precision.
	IED.5.5	Calculate a physical property using available data or perform appropriate measurements to gather the necessary data (e.g., determine area or volume using linear measurements or determine density using mass and volume measurements).
	IED.5.6	Use the capabilities of the CAD software to determine the mass, volume, surface area, and density of an object for which a 3D solid model has been created.
IED.6		**Reverse Engineering: Students will perform a functional analysis through non-destructive methods of observation and generate hypotheses of the sequential operations of their products, and identify the inputs and outputs that are indicative of those systems. Students will also physically disassemble a product and document the constituent parts, their properties, and their operation with the intent of providing students with a better understanding of the product's strengths, weaknesses and the manufacturing processes used in manufacturing.**
	IED.6.1	Identify and describe the visual elements, principles, and elements of design apparent in a natural or man-made object.
	IED.6.2	Explain the various reasons to perform reverse engineering including discovery, documentation, investigation, and product improvement.
	IED.6.3	Perform a functional analysis of a product in order to determine the purpose, inputs and outputs, and the operation of a product or system.
	IED.6.4	Perform a structural analysis of a product in order to determine the materials used, the form of component parts, and the configuration and interaction of component parts when assembled.
	IED.6.5	Document and present findings that resulted by going through the reverse engineering process on a product.

IED.7		**Documentation: Students will use drafting, dimensioning, and tolerancing standards to communicate designs and models to others.**
	IED.7.1	Identify and correctly apply size, location, chain, and datum dimensions.
	IED.7.2	Identify the shapes of two-dimensional cross sections of three-dimensional objects.
	IED.7.3	Read and interpret a hole note to identify the size and type of hole including through, clearance, blind, counterbore, and countersink holes.
	IED.7.4	Identify and differentiate among limit dimensions, a unilateral tolerance, a bilateral tolerance, clearance fit, and interference fit.
	IED.7.5	Explain each assembly constraint (including mate, flush, insert, and tangent), its role in an assembly model, and the degrees of freedom that it removes from the movement between parts.
	IED.7.6	Hand sketch a scaled full or half section view in the correct orientation to fully detail an object or part when given the actual object, a detailed verbal description of the object, a pictorial view of the object, or a set of orthographic projections.
	IED.7.7	Generate and dimension a section view using CAD according to standard engineering practice.
	IED.7.8	Create specific notes on a technical drawing to convey important information about a specific feature of a detailed object, and create general notes to convey details that pertain to information presented on the entire drawing (such as units, scale, patent details, etc.).
	IED.7.9	Determine the specified dimension, tolerance, upper limit, and lower limit for any given dimension and related tolerance (or any distance that is dependent on given dimensions) shown on a technical drawing.
	IED.7.10	Define and justify a design problem. Express the concerns, needs, and desires of the primary stakeholders. Jointly develop a decision matrix based on accepted outcome criteria and constraints.
IED.8		**Advanced Computer Modeling: Students will use advanced modeling skills to develop design solutions to various projects and problems.**
	IED.8.1	Identify, define, and explain the proper use of an auxiliary view in technical drawing.
	IED.8.2	Use advanced modeling features to create three-dimensional solid models of complex parts and assemblies within CAD.
	IED.8.3	Create an exploded assembly view of a multi-part product. Identify each component of the assembly with identification numbers and create a parts list to detail each component using CAD.
	IED.8.4	Perform a peer review of technical drawings and offer constructive feedback based on standard engineering practices.

IED.9		**Design Team: Students will experience shared decision-making as they investigate different materials, manufacturing processes, and the short and long term impacts that their decision-making may have on society or potentially on the world.**
	IED.9.1	Identify and describe the steps of a typical product lifecycle (including raw material extraction, processing, manufacture, use and maintenance, and disposal).
	IED.9.2	Identify and explain how the basic theories of ethics relate to engineering.
	IED.9.3	Assess the development of an engineered product and the impact of the product on society and the environment.
	IED.9.4	Identify appropriate technology to support remote collaboration among virtual design team members.
	IED.9.5	Document correspondence and conversations in an accurate and organized manner.
	IED.9.6	Create and utilize a Gantt chart to plan, monitor, and control task completion during a design project.
IED.10		**Design Challenge: Students will work in pairs to apply the design process to create a solution to a chosen problem.**
	IED.10.1	Identify, define, and explain the proper use of an auxiliary view in technical drawing.
	IED.10.2	Develop and document an effective solution to a problem that meets specific design requirements.
	IED.10.3	Document and describe the design process used in the solution of a problem and reflect on all steps of the design process.