Unit 4 Modeling Skills

Unit 4 – Concepts & Objectives

Concepts	Objectives
An engineering design process involves a characteristic set of practices and steps.	• Identify and define the terminology used in engineering design and development. • Identify the steps in an engineering design process and summarize the activities involved in each step of the process. • Complete a design project utilizing all steps of a design process, and find a solution that meets specific design requirements.
Brainstorming may take many forms and is used to generate a large number of innovative, creative ideas in a short time.	• Describe a variety of brainstorming techniques and rules for brainstorming. • Generate and document multiple ideas or solution paths to a problem through brainstorming.
A solution path is selected and justified by evaluating and comparing competing design solutions based on jointly developed and agreed-upon design criteria and constraints.	• Clearly justify and validate a selected solution path.
Physical models are created to represent and evaluate possible solutions using prototyping technique(s) chosen based on the presentation and/or testing requirements of a potential solution.	• Construct a testable prototype of a problem solution.
Problem solutions are optimized through evaluation and reflection and should be clearly communicated.	• Describe the design process used in the solution of a particular problem and reflect on all steps of the design process. • Justify and validate a problem solution. • Identify limitations in the design process and the problem solution and recommend possible improvements or caveats.
The scientific method guides the testing and evaluation of prototypes of a problem solution.	• Analyze the performance of a design during testing and judge the solution as viable or non-viable with respect to meeting the design requirements.
Statistical analysis of uni-variate data facilitates understanding and interpretation of numerical data and can be used to inform, justify, and validate a design or process.	• Calculate statistics related to central tendency including mean, median, and mode. • Use statistics to quantify information, support design decisions, and justify problem solutions. • Calculate statistics related to variation of data including standard deviation, interquartile range, and range.
Spreadsheet programs can be used to store, manipulate, represent, and analyze data.	• Use a spreadsheet program to store and manipulate raw data. • Use a spreadsheet program to graph bi-variate data and determine an appropriate mathematical model using regression analysis. • Use function tools within a spreadsheet program to calculate

	statistics for a set of data including mean, median, mode, quartiles, range, **interquatile range,** and standard deviation. **Note: Interquatile range is included for continuous improvement beyond 2012-2013.**
An equation is a statement of equality between two quantities that can be use to describe real phenomenon and solve problems.	• Represent constraints with equations or inequalities. • Formulate equations and inequalities to represent linear**, quadratic, simple rational, and exponential** relationships between quantities. **Note: Quadratic, simple rational, and exponential are included for continuous improvement beyond 2012-2013.** • Compute (using technology) and interpret the correlation coefficient of a linear fit. **Note: This aligns with the 2012-2013 PREVIEW curriculum.** • Construct a scatter plot to display bi-variate data, investigate patterns of association, and represent the association with a mathematical model (linear equation) when appropriate. **Note: This aligns with the 2012-2013 PREVIEW curriculum.**
Solving mathematical equations and inequalities involves a logical process of reasoning and can be accomplished using a variety of strategies and technological tools.	• Solve equations for unknown quantities by determining appropriate substitutions for variables and manipulating the equations.
Functions describe a special relationship between two sets of data and can be used to represent real world relationships and to solve problems. **Note: This aligns with the 2012-2013 PREVIEW curriculum.**	• Explain the term “function” and identify the set of inputs for the function as the domain and the set of outputs from the function as the range. **Note: This aligns with the 2012-2013 PREVIEW curriculum.** • Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. **Note: This aligns with the 2012-2013 PREVIEW curriculum.** • Build a function that describes a relationship between two quantities given a graph, a description of a relationship, or two input-output pairs. **Note: This aligns with the 2012-2013 PREVIEW curriculum.** • Interpret a function to solve problems in the context of the data. **Note: This aligns with the 2012-2013 PREVIEW curriculum.** • Interpret the slope (rate of change) and the intercept (constant term) of a linear function in the context of data. **Note: This aligns with the 2012-2013 PREVIEW curriculum.**
Technical drawings convey information according to an established set of drawing practices which allow for detailed and universal interpretation of the drawing.	• Identify line types (including construction lines, object lines, hidden lines, cutting plane lines, section lines, and center lines) used on a technical drawing per ANSI Line Conventions and Lettering Y14.2M-2008 and explain the purpose of each line. • Determine the minimum number and types of views necessary to fully detail a part. • Choose and justify the choice for the best orthographic projection of an object to use as a front view on technical drawings. • Identify and correct errors and omissions in technical drawings including the line work, view selection, view orientation, appropriate scale, and annotations. • Create a set of working drawings to detail a design project. • Fabricate a simple object from technical drawings that may include

	an isometric view, orthographic projections, and a section view.
Dimensions, specific notes (such as hole and thread notes), and general notes (such as general tolerances) are included on technical drawings according to accepted practice and an established set of standards so as to convey size and location information about detailed parts, their features, and their configuration in assemblies.	• Dimension orthographic projections and section views of simple objects or parts according to a set of dimensioning standards and accepted practices. • Identify and correct errors and omissions in the dimensions applied in a technical drawing based on accepted practice and a set of dimensioning rules.
Hand sketching of multiple representations to fully and accurately detail simple objects or parts of objects is a technique used to convey visual and technical information about an object.	• Hand sketch isometric views of a simple object or part at a given scale using the actual object, a detailed verbal description of the object, a pictorial view of the object, or a set of orthographic projections. • Hand sketch orthographic projections at a given scale and in the correct orientation to fully detail an object or part using the actual object, a detailed verbal description of the object, or a pictorial an isometric view of the object.
Computer aided drafting and design (CAD) software packages facilitate virtual modeling of parts and assemblies and the creation of technical drawings. They are used to efficiently and accurately detail parts and assemblies according to standard engineering practice.	• Create three-dimensional solid models of parts within CAD from sketches or dimensioned drawings using appropriate geometric and dimensional constraints. • Generate CAD multi-view technical drawings, including orthographic projections, sections view(s), detail view(s), auxiliary view(s) and pictorial views, as necessary, showing appropriate scale, appropriate view selection, and correct view orientation to fully describe a part according to standard engineering practice. • Dimension and annotate (including specific and general notes) working drawings according to accepted engineering practice. Include dimensioning according to a set of dimensioning rules, proper hole and thread notes, proper tolerance annotation, and the inclusion of other notes necessary to fully describe a part according to standard engineering practice. • 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. • Create assemblies of parts in CAD and use appropriate assembly constraints to create an assembly that allows correct realistic movement among parts. Manipulate the assembly model to demonstrate the movement.
Technical professionals clearly and accurately document and report their work using technical writing practice in multiple forms.	• Organize and express thoughts and information in a clear and concise manner. • Adjust voice and writing style to align with audience and purpose. • Support design ideas using a variety of convincing evidence. • Utilize project portfolios to present and justify design projects.
Sketches, drawings, and images are used to record and convey specific types of information depending upon the audience and the purpose of the	• Create drawings or diagrams as representations of objects, ideas, events, or systems.

communication.	

Essential Questions (Unit-Specific)

1. What is the role of models in the design process?
2. How can we use technology to make the design and manufacture of a product more efficient and less prone to error?
3. What is the purpose of a portfolio? How do you decide what information to include in a portfolio?

Essential Questions (Course-Wide)

1. How does the design process promote the development of good solutions to technical problems?
2. How can an engineer or technical professional effectively communicate ideas and solutions in a global community?
3. How do inventors and innovators impact and shape society?