Unit 3 Measurement and Statistics

Unit 3 – 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.	• Generate and document multiple ideas or solution paths to a problem through brainstorming.
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. • 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. • Represent data with plots on the real number line (e.g., dot plots, histograms, and box plots). • 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 perform calculations using formulas. • Use a spreadsheet program to create and display a histogram to represent a set of data. • 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.**

Units and quantitative reasoning can guide mathematical manipulation and the solution of problems involving quantities.	• Use units to guide the solution to multi-step problems through dimensional analysis and choose and interpret units consistently in formulas. • Choose a level of precision and accuracy appropriate to limitations on measurement when reporting quantities. • Convert quantities between units in the SI and the US Customary measurement systems. • Convert between different units within the same measurement system including the SI and US Customary measurement systems.
Error is unavoidable when measuring a physical property, and a measurement is characterized by the precision and accuracy of the measurement.	• Define accuracy and precision in measurement. • Evaluate and compare the accuracy and precision of different measuring devices. • Measure linear distances (including length, inside diameter, and hole depth) with accuracy using a scale, ruler, or dial caliper and report the measurement using an appropriate level of precision.
The style of the engineering graphics and the type of drawing views used to detail an object vary depending upon the intended use of the graphic.	• Identify and define technical drawing representations including isometric, orthographic projection, oblique, perspective, auxiliary, and section views.
Technical drawings convey information according to an established set of drawing practices which allow for detailed and universal interpretation of the drawing.	• Determine the minimum number and types of views necessary to fully detail a part. • Identify and correct errors and omissions in technical drawings including the line work, view selection, view orientation, appropriate scale, and annotations.
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 correctly apply chain dimensioning or datum dimensioning methods to a technical drawing. • 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. • Generate non-technical concept sketches to represent objects or convey design ideas.
Technical professionals	• Organize and express thoughts and information in a clear and

clearly and accurately document and report their work using technical writing practice in multiple forms.	concise manner. • Adjust voice and writing style to align with audience and purpose. • Support design ideas using a variety of convincing evidence. • Utilize an engineering notebook to clearly and accurately document the design process according to accepted standards and protocols to prove the origin and chronology of a design.
Sketches, drawings, and images are used to record and convey specific types of information depending upon the audience and the purpose of the communication.	• Create drawings or diagrams as representations of objects, ideas, events, or systems.
In order to be an effective team member, one must demonstrate positive team behaviors and act according to accepted norms, contribute to group goals according to assigned roles, and use appropriate conflict resolution strategies.	• Demonstrate positive team behaviors and contribute to a positive team dynamic.

Essential Questions (Unit-Specific)

1. How can statistical data and analysis be used to inform, justify, and validate a design or process?
2. If error is unavoidable in measurement, how can we indicate our confidence in the precision of a measurement we make?
3. What is dimensional analysis and how can it help solve problems involving quantities?
4. Why do engineers generally adhere to a set of dimensioning standards and guidelines?

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?