Unit 7 Documentation

Unit 7 – Concepts & Objectives

Concepts	Objectives
An engineering design process involves a characteristic set of practices and steps.	• 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.
Research derived from a variety of sources (including subject matter experts) is used to facilitate effective development and evaluation of a design problem and a successful solution to the problem.	• Utilize research tools and resources (such as the Internet; media centers; market research; professional journals; printed, electronic, and multimedia resources; etc.) to gather and interpret information to develop an effective design brief. • Utilize research tools and resources (such as the Internet; media centers; market research; professional journals; printed, electronic, and multimedia resources; etc.) to validate design decisions and justify a problem solution.
A problem and the requirements for a successful solution to the problem should be clearly communicated and justified.	• Define and justify a design problem, and express the concerns, needs, and desires of the primary stakeholders. • Present and justify design specifications, and clearly explain the criteria and constraints associated with a successful design solution. • Write a design brief to communicate the problem, problem constraints, and solution criteria.
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.
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.	• Jointly develop a decision matrix based on accepted outcome 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	• Describe the design process used in the solution of a particular

optimized through evaluation and reflection and should be clearly communicated.	problem and reflect on all steps of the design process. • Justify and validate a problem solution.
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.
An equation is a statement of equality between two quantities that can be used to describe real phenomenon and solve problems.	• Represent constraints with equations or inequalities.
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. • Choose and justify the choice for the best orthographic projection of an object to use as a front view on technical drawings. • Create a set of working drawings to detail a design project. • 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 pertains to information presented on the entire drawing (such as units, scale, patent details, etc.
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 differentiate between size dimensions and location dimensions. • Identify and correct errors and omissions in the dimensions applied in a technical drawing based on accepted practice and a set of dimensioning rules. • Read and interpret a hole note to identify the size and type of hole including through, clearance, blind, counter bore, and countersink holes. • Model and annotate (with a hole note) through, clearance, blind, counter bore, and countersink holes.
A degree of variation always exists between specified dimensions and the measurement of a manufactured object which is controlled by the use of tolerances on technical drawings.	• Identify and differentiate among limit dimensions, a unilateral tolerance, and a bilateral tolerance. • Define and 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. • Determine the allowance between two mating parts of an assembly based on dimensions given on a technical drawing.

	• Differentiate between clearance and interference fit and identify the type of fit given a drawing, a description, or a physical example of two mating parts. • Compare the effect of chain dimensioning and datum dimensioning on the tolerance of a particular specified dimension.
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 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. • Hand sketch a scaled full or half section view in the correct orientation to fully detail an object or part given the actual object, a detailed verbal description of the object, a pictorial view of the object or a set of orthographic projections.
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. • Create a CAD assembly drawing. Identify each component of the assembly with identification numbers and create a parts list to detail each component using CAD.
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 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. • Create a technical report according to the American National Standards Institute (ANSI) technical report layout and format specifics.

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.
Reverse engineering involves disassembling and analyzing a product or system in order to understand and document the visual, functional, and/or structural aspects of its design.	• Analyze information gathered during reverse engineering to identify shortcoming of the design and/or opportunities for improvement or innovation.
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 do you define a problem so that it can be effectively communicated and yield the best possible solution?
2. How does one know that a given design solution is the best possible solution?
3. How might a given solution be more or less acceptable to various types of stakeholders?
4. How do you select the best possible solution from multiple alternatives?
5. How do engineers communicate an object’s dimensional information including the margin of acceptable error?

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?