

# STRANDS AND STANDARDS

## ENGINEERING CAPSTONE



### Course Description

As members of an engineering team, students apply science, technology, and mathematical concepts and skills to solve engineering design problems or to significantly innovate existing products. Students research, develop, test, and analyze designs using criteria such as cost, effectiveness, safety, human factors, and ethics. Long term project development by student teams and regular interaction with and presentations to members of industry are essential components to the success of this course.

<b>Core Code</b>	38.01.00.00.990
Concurrent Enrollment Core Code	None
Units of Credit	1.0
Intended Grade Level	12
Prerequisite	CAD Mechanical Design 2, and Engineering Principles 2
Skill Certification Test Number	USB E Project Rubric
Test Weight	1.0
<b>License Type</b>	Secondary Education 6-12
<b>Required Endorsement(s)</b>	Technology & Engineering, or Engineering

## STRAND 1

**Students will follow safety practices.**

### Standard 1

Identify potential safety hazards and follow general laboratory safety practices.

- Assess workplace conditions regarding safety and health.
- Identify potential safety issues and align with relevant safety standards to ensure a safe workplace/jobsite.
- Locate and understand the use of shop safety equipment.
- Select appropriate personal protective equipment.

### Standard 2

Use safe work practices.

- Use personal protective equipment according to manufacturer rules and regulations.
- Follow correct procedures when using any hand or power tools.
- Ref: <https://schools.utah.gov/cte/engineering/resources> under the Safety Program and Management section.

### Standard 3

Complete a basic safety test without errors (100%) before using any tools or shop equipment.

## STRAND 2

**Students will describe a formal engineering design process to address a specific design problem.**

### Standard 1

Develop a clear, complete, and concise problem statement.

- Identify & define the design problem.
- List requirements.
- Identify constraints.
- Conduct research to identify similar efforts and become an expert on the topic.

### Standard 2

Write a clear, complete, and concise design specification.

- Brainstorm solutions.
- Develop a decision matrix to compare and rank potential solutions.
- Synthesize the results and select the best solution.
- Sketch and annotate ideas and details while designing a prototype.

### Standard 3

Create models & build a prototype.

- Mathematical models
- 3D solid models
- Scale models

## Standard 4

Test the prototype.

- Record test results data.
- Evaluate the test results against the requirements.
- Identify weaknesses.

## Standard 5

Redesign and optimize.

- Record findings.
- Improve on the initial design.
- Consider discarded ideas.

## STRAND 3

**Functioning as part of a team, students will design a solution to an engineering problem.**

### Standard 1

Employ a formal engineering design process to create a solution to an existing problem.

- Identify specific principles of design used in engineering and use them appropriately and effectively.
- Demonstrate creativity, resourcefulness, and the ability to think abstractly while applying a formal design process in the solution of an authentic engineering problem.
- Employ fundamental design principles within the context of a sequential and iterative design process while identifying, locating, and using mathematical, scientific, and technology-based resources to solve an engineering problem.
- Effectively apply a “systems thinking” approach in the solution of a specific and authentic engineering design challenge reflective of current industry practices.
- Create a Project Proposal document and/or presentation that justifies moving forward with a chosen problem.
- Perform a peer design review to evaluate the design in an effort to identify and correct potential mistakes and design flaws.
- Collaborate with and seek input from industry experts and mentors throughout the design process.

### Standard 2

Develop and test a prototype.

- Design and implement a prototype testing procedure and data collection plan.
- Create a set of working drawings to document their proposed product design.
- Determine and document resource needs, including a bill of materials, tools, equipment, and knowledge required to build a prototype.
- Perform a cost estimate to build a prototype of the proposed product.

- Communicate professionally with experts and mentors to obtain feedback on the technical feasibility of the design, document the interactions, and implement recommended changes.

### STRAND 4

**Students will develop a marketing plan.**

#### Standard 1

Evaluate the market to determine whether solving the problem is compelling to other entities.

#### Standard 2

Identify the target market for a potential solution to an identified problem. If so, create, execute, and evaluate a market research plan to gather data related to an identified problem.

#### Standard 3

Define, explain, and demonstrate an understanding of common vocabulary words used in association with product cost analysis.

#### Standard 4

Formulate a product cost analysis for a given product.

#### Standard 5

Demonstrate an understanding of packaging design requirements and will design a package for the product.

#### Standard 6

Document and summarize a patent search; disclose and appraise all current and past solution attempts available as commercial products or patents.

### STRAND 5

**Students will develop a production plan.**

#### Standard 1

Identify, describe, and use research-based contemporary management processes in the design and development of specific engineering problems.

#### Standard 2

Design and implement a current industry standard system for quality control as part of an engineering design enterprise.

### STRAND 6

**Students will evaluate and reflect on their design process and will report on each step of their design process.**

## Standard 1

Utilize an engineering notebook per established conventions throughout the entire project.

## Standard 2

Contact stakeholders and experts directly related to this project and problem and share the results of the testing results and effectiveness of the design solution.

## Standard 3

Complete a comprehensive, multimedia presentation and portfolio that provides an overview of each step of the design experience using a variety of media.

## Standard 4

Present a comprehensive report of the design to a panel of industry experts for their evaluation by the approved rubric.

## Skill Certificate Test Project Rubric

See project rubric, <https://schools.utah.gov/file/24af062e-9951-4379-b789-97a76bca1702>.

## Performance Skills

1. Create and utilize an engineering notebook per established conventions.  
<https://schools.utah.gov/cte/engineering/resources>
2. Demonstrate practice of the *Technology & Engineering Professional Workplace Skills*.  
<https://schools.utah.gov/cte/engineering/resources>
3. Participate in a significant activity that provides each student with an opportunity to render service to others, employ leadership skills, or demonstrate skills they have learned through this course, preferably through participation in a Career & Technical Student Organization (CTSO) such as the Technology Student Association (TSA).