Course Description

In this capstone course, students will work in teams to develop an original solution to a valid open-ended technical problem by applying the engineering design process. They will research, validate, and justify a technical problem. Each team will design, build, and test their solution. While progressing through the engineering design process, students will work closely with experts and will continually hone their organizational, communication and interpersonal skills, their creative and problem solving abilities, and their understanding of the design process. Finally, student teams will present and defend their original solution to an outside panel.

<table>
<thead>
<tr>
<th>Core Code</th>
<th>38.01.00.00.390</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concurrent Enrollment Core Code</td>
<td>None</td>
</tr>
<tr>
<td>Units of Credit</td>
<td>1.0</td>
</tr>
<tr>
<td>Intended Grade Level</td>
<td>12</td>
</tr>
<tr>
<td>Prerequisite</td>
<td>PLTW IDE, PLTW PoE</td>
</tr>
<tr>
<td>Skill Certification Test Number</td>
<td>9680 (Rubric-based)</td>
</tr>
<tr>
<td>Test Weight</td>
<td>1.0</td>
</tr>
<tr>
<td>License Type</td>
<td>Secondary Education 6-12</td>
</tr>
<tr>
<td>Required Endorsement(s)</td>
<td>Technology &amp; Engineering, or</td>
</tr>
<tr>
<td></td>
<td>Limited Engineering, or</td>
</tr>
<tr>
<td></td>
<td>Engineering</td>
</tr>
</tbody>
</table>
STRAND 1
Students will research a problem.

Standard 1
Become an expert on the identified problem.
• Distinguish between credible and non-credible sources and use APA citation style while conducting research.

Standard 2
Develop a clear, complete, and concise problem statement.
• Document research that validates and justifies problem academically, ethically, or through market research.
• Employ a Gantt chart for project planning purposes.
• Evaluate the market to determine whether solving the problem is compelling to other entities.
• 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.
• Disclose and appraise all current and past solution attempts available as commercial products or patents.
• Document and summarize a patent search.
• Communicate professionally with experts and mentors on a specific topic.
• Record and organize correspondence with experts and mentors.

Standard 3
Create a Project Proposal document and/or presentation to summarize important research in order to justify moving forward with a chosen problem.

STRAND 2
Functioning as part of a team, students will design a solution to an engineering problem.

Standard 1
Write a clear, complete, and concise design specification.
• Identify and describe specific criteria for and constraints to the design of a product.
• Generate and document multiple potential solutions to a problem.
• Develop a decision matrix to compare and rank potential solutions.
• Distinguish between practical and potentially successful design solutions and solutions that are not practical or potentially successful.

Standard 2
Combine, refine, and optimize conceptual ideas to effectively solve a problem.
• Sketch and annotate ideas and details while designing a prototype.
• Describe a Product Lifecycle Assessment and how it impacts design.
• Identify math and science concepts that will be or could be utilized in the process of solving an identified problem.

**Standard 3**
Assess the product design based on a variety of design factors and implement design changes to improve the product.
• Use scientific, mathematical, and engineering concepts to design a prototype.
• Communicate design concepts using visual and written documentation.
• Evaluate other teams’ conceptual solutions and make recommendations.
• Evaluate feedback from reviewers and modify design concepts as appropriate.
• Collaborate with teammates to select a solution path to pursue.
• Identify subsystems of a prototype design.
• Create virtual designs of a prototype.
• Create a set of working drawings to document their proposed product design.
• Perform a peer design review to evaluate their product design in an effort to identify and correct potential mistakes and flaws in their design.
• Perform a cost estimate to build a prototype of their proposed product.
• Compare the positive and negative consequences of their product design to determine the ethical implications of product development.
• Evaluate choices of materials and fastening procedures for a prototype design.
• Determine and document resource needs, including a bill of materials, tools, equipment, and knowledge required to build a prototype.

**Standard 4**
Create a document to present their proposed design and provide justification for further development of a product.
• Communicate professionally with experts and mentors to obtain feedback on the technical feasibility of their product design, document the interactions, and implement recommended changes to their product design.

**STRAND 3**
Students will create a prototype and a testing plan.

**Standard 1**
Construct a testable prototype.
• Document project progress in an engineering notebook.
• Create a step-by-step plan for building a prototype.
• Devise a list of testing criteria that will be used to evaluate the prototype and determine the success or failure of the design solution.
• Prepare a description of the testing method that will be used to validate and verify the design solution.
• Select and describe a valid testing method that will be used to accurately evaluate the effectiveness of their design solution in solving the problem.
• Create a valid justification for the selected testing method.

**Standard 2**
Conduct testing of the prototype.
• Design and implement a prototype testing procedure and data collection plan.
• Identify opportunities to incrementally test a prototype.
• Identify, define, and implement necessary modifications to testing methods based on expert feedback and ongoing research.
• Design and participate in a critical design review to evaluate the prototype and determine how the project will proceed.
• Identify, define, and implement necessary modifications to their design based upon the test results.

**STRAND 4**
Students will evaluate and reflect on their design process.

**Standard 1**
Interpret test results
• Contact stakeholders and experts directly related to this project and problem. Share the testing results and conclusions about the effectiveness of this solution and testing plan?
• Gather feedback from stakeholders and experts related to the conclusion and testing analysis.
• Provide designer feedback on next steps or if starting over from a different point in the design process.

**STRAND 5**
Students will develop a marketing plan.

**Standard 1**
Define, explain, and demonstrate an understanding of common vocabulary words used in association with product cost analysis.

**Standard 2**
Formulate a product cost analysis for a given product.

**Standard 3**
Demonstrate an understanding of packaging design requirements and design a package for a given product.

**STRAND 6**
Students will develop a production plan.
Standard 1
Recognize the need to involve all of the manufacturing team members in the decision making process of designing a product.

Standard 2
Categorize manufacturing specifications and constraints needed to produce a product.
- Evaluate material characteristics for manufacturing a specific product and identify the correct manufacturing process needed to produce that product.
- Evaluate and apply the correct machine process.
- Recognize the need to limit the number of processes used to manufacture a product.
- Develop an understanding of process routing.
- Distinguish the differences between CNC, FMS, and CIM.

Standard 3
Explain the need for a company to minimize material handling by procurement of materials in a timely fashion. Students should explain the JIT process.

Standard 4
Identify the need to perform a cost analysis of a product.
- Interpret data, which has been statically analyzed, to ensure product quality.
- Identify the need to evaluate the areas of manpower and facility requirements.

Standard 5
Recognize the need to protect a product for shipping. (Packaging)
- Analyze aesthetic requirements to enhance packaging for the consumer.

STRAND 7
Students will report on each step of their design process.

Standard 1
Gather data and information compiled throughout the project and create a project portfolio and presentation of their design solution.

Standard 2
Orally present an effective technical presentation on the chosen design solution.
- Identify appropriate techniques for delivering formal presentations.