



UNIVERSITY OF SOUTH FLORIDA COLLEGE OF ENGINEERING

EGN3000L: FOUNDATIONS OF ENGINEERING LAB

**SYLLABUS**  
3 Credits

Creative Thinking (CT) Student Learning Outcomes (SLO) and associated activities are highlighted in green (CT SLO #2) and blue (CT SLO #5). The CT assignments are also highlighted using these colors with required written communication assignments, objectives, and outcomes highlighted in grey. Assignments "#GEA1 Breaking Down Complex Problems" and "#GEA2 Creating Unique Solutions" are used to assess CT SLO #5 and CT SLO #2.

**INSTRUCTOR:**  
**PHONE:**  
**OFFICE HOURS:**  
**CLASS HOURS:**

**OFFICE LOCATION:**  
**EMAIL:**  
**CLASSROOM:**

*This course is part of the University of South Florida's General Education Curriculum. It is certified for Creative Thinking . Students enrolled in this course will be asked to participate in the USF General Education assessment effort. This will involve submitting copies of writing assignments for review via Canvas*

Course Catalog Description: Introduction to the profession of engineering. Exposure to the different disciplines of engineering incorporate examples of tools and techniques used in design and presentation. Laboratory exercises will include computer tools, engineering design, and presentation skills.

**COURSE OBJECTIVES:**

This course will provide students in the College of Engineering with a service learning based engineering design experience as a member of an interdisciplinary team. Students will design and manufacture a product that is relevant to a community partner and, while doing so, learn and practice essential skills useful in the engineering profession. Through this course students will: (1) learn strategies for maximizing performance in engineering courses; (2) learn procedures for effective problem solving; (3) gain experience in working as part of an engineering team; (4) be introduced to the engineering design experience; (5) get practice in written and oral communication. Further, student will: (6) create and manufacture a product in a collaborative environment that considers the needs of a real community partner; (7) synthesize essential parts of engineering solutions to complex problems through use of the engineering design process and application of engineering technology; (8) analyze complex problems to propose, support, and apply engineering solutions through the engineering design process. (9) apply engineering problem solving considering the roles reciprocity, teamwork, and reflection play in understanding the needs of a collaborator and/or fellow design team members through service learning.

## LEARNING OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Create an original contribution within a specific discipline.
2. Synthesize disparate or conflicting thoughts when evaluating questions or problems to form cohesive and collaborative solutions.
3. Break Down complex problems to examine, propose, and support potential solutions, even if those solutions deviate from acceptable, mainstream solutions.
4. Analyze the opportunities or limitations of the manufacturing process when converting a design to a tangible and functional product that meets customer needs.
5. Use software or hardware based technologies as engineering tools to (1) design a prototype, (2) fabricate the design, (3) test the design, and/or (4) improve the design
6. Apply written and oral communication tools to articulate the effects the design process on a final design including input from shareholders and the individual steps of product design and development.
7. Demonstrate professional development, knowledge, and interpersonal skills useful for getting a job in an engineering or engineering-related field.
8. Explore engineering problem solving considering the role reciprocity plays in understand both the transformational change of the community and their own personal edification

## METHODS OF INSTRUCTION

**Service Learning:** This course teaches engineering skills through problem based learning and a service learning approach. Service learning is defined as a teaching method that combines classroom instruction with valuable community interactions to provide for the mutual benefit of all. At its core, this involves reflection on how the experience might improve critical thinking skills, increase student civic engagement, help to achieve learning objectives, impact the community or community partner, and/or provide for reciprocity between student and the community. In addition, engineering is defined in this class as “the art of problem solving towards solutions that benefit society”. This course intends to add to the relevance of course activities by exposing students to project experiences reflective of the engineering profession. Service learning achieves this considering 1. the role engineers play in helping and improving the lives of others, 2. the characteristics of the engineering design process as being iterative and based in critical thinking, and 3. the value of engineering tools, teamwork, creativity, and communication. At the conclusion of this course, students will have developed a solution to a real world problem and manufactured/tested their solution. They will reflect on their experiences and build the relationships necessary for their own interpersonal and intrapersonal growth.

**Format:** Students will design, manufacture, fabricate, and test a functional project deliverable in collaboration with a USF community member. All activities of the course are structured around this foundation including those for personal and professional development. This ensures that students complete projects with educational significance, real-world value, and practical constraints while also requiring soft skills such as professionalism, ethics, interpersonal skills, and mastery of engineering communication. Generally, the course will follow a structure that starts heavy classroom instruction and transitions to more student centered activities. The class mirrors a seven step design process which has them produce deliverables for (1) customer needs, (2) engineering specifications, (3) internal/external search, (4) concept generation, (5) concept selection, (6) evaluation and testing, (7) final specifications. Steps (1)-(3) of this

process will require a format heavy on in classroom lecture and individual performance as students learn about their project choices, select a project, learn computer based engineering tools to better express their ideas, and present/defend their ideas to others. Steps (4)-(5) require out of classroom learning as students are first assigned to their semester design teams, adopt a role on their teams, and develop an understanding of their engineering technology. Lecture will be used to provide students with skills for successful completion of their product and solidification of plans for project completion. Step (1)-(5) are completed approximately halfway through the semester. After a plan is developed and their design's characteristics are decided upon, students will fabricate and test a prototype the latter half of the semester that will allow them as a team to complete step (6)-(7). Experiential learning is emphasized for the final two steps of their design process, requiring student centered classroom interactions.

**RECOMMENDED TEXTBOOK**

Thinking Like an Engineer: An Active Learning Approach, USF Edition (STEPHAN, BOWMAN, PARK, SILL AND OHLAND)

**COURSE REQUIREMENTS:**

**Assignment Submission:** Two types of assignments are to be submitted: core assignments and attendance assignments. Individual submission is required for all assignments including those that are completed as a group and consist of content generated in a collaborative environment. This policy ensures individual participation and contribution. If a core assignment does not have content uploaded to CANVAS, the individual will not receive credit. Assignments that are submitted late will also receive a grade of zero. There will be no late submission.

Students are expected to complete attendance assignments before coming to class. Incomplete assignments will earn a grade of zero. Late attendance is grounds for dismissal from class and an absence for the day's assignments. Lack of participation or respect for classmates is also grounds for dismissal from class for the day and an absence for the day's assignments. Multiple offenses are grounds for acceleration of consequences.

**Attendance Policy:** Attendance is required and mandatory. Class time will oftentimes be used to complete our aid in the completion of project work. Failure to attend 2 or more classes may result in an incomplete for the semester unless special permission is granted by the instructor. Failure to attend class will result in a grade of zero for all submitted assignments for the week.

**GRADING SCALE**

A+	97-100	B+	87-90	C+	77-80	D+	67-70
A	93-97	B	83-87	C	73-77	D	63-67
A-	90-93	B-	80-83	C-	70-73	D-	60-63
						F	60 or below

**ASSESSMENT SUMMARY**

#GEA1 Breaking Down a Complex Problem.....	20%
#GEA2 Creating an Original Contribution.....	20%
Synthesizing for Cohesive/Collaborative Solutions..	20%
Classwork and Tutorials.....	20%
Reflection and Professional Development.....	20%

Each graded submission is worth 4 points or 4% of the final grade.  
 Assessment Summary and page 4 group each per assessment area.  
 Page 5 groups each by activity type.

**Assessment:**

For a full description of the #GEA1 and #GEA2 assignments go to the Appendix. To break down a complex problem (course outcome 1) in order to create an original contribution to the discipline (course outcome 3), multiple activities are needed over time to effectively implement the design process. Therefore, each assignment is five submissions. Creative Thinking courses should also include a substantial writing component. Approximate minimum word counts per submission are highlighted in grey with Written Comm. 2 an implementation of process writing.

**#GEA1 Breaking Down a Complex Problem.....20%**

- CAD2: Cosmetic Design (Assignment 1A worth 4%)
- CAD3: Functional Design (Assignment 1B worth 4%)
- Design Review 1: Step 1-4 (Assignment 1C worth 4%). 250 words of writing
- Design Review 2: Presentation (Assignment 1D worth 4%)
- CAD4: First Group Design (Assignment 1E worth 4%)

**#GEA2 Creating an Original Contribution.....20%**

- Written Comm. 1: Memo Part 1 (Assignment 2A worth 4%) 300 words of writing
- Written Comm. 2: Memo Part 2 (Assignment 2B worth 4%) 200 words of writing
- Showcase: Final Product Presentation (Assignment 2C worth 4%)
- Written Comm 3: Final Report Part 1 (Assignment 2D worth 4%) 750 words of writing
- Written Comm 4: Final Report Part 2 (Assignment 2E worth 4%) 500 words of writing

**Synthesizing for Cohesive/Collaborative Solutions.....20%**

- Design Review 3: Manufacture (Assignment 3A worth 4%) 250 words of writing
- Teamwork 1: CATME Team Review (Assignment 3B worth 4%)
- Teamwork 2: Fabrication Part 1 (Assignment 3C worth 4%)
- Teamwork 4: Fabrication Part 2 (Assignment 3D worth 4%)
- Design Review 4: Presentation (Assignment 3E worth 4%)

**Classwork and Tutorials: .....20%**

- Classwork 1: Design Process (Assignment 4A worth 4%)
- Classwork 2: Engineering Disciplines (Assignment 4B worth 4%)
- CAD1: TinkerCAD Tutorial (Assignment 4C worth 4%)
- Classwork 3: Ethics and Intellectual Property (Assignment 4D worth 4%)
- Classwork 4: Iteration and Improving Designs (Assignment 4E worth 4%)

**Reflection and Professional Development: .....20%**

- Professional Development 1: Student Reflection (Assignment 5A worth 4%) 250 words of writing
- Professional Development 2: Engineering Society Meeting (Assignment 5B worth 4%)
- Professional Development 3: Student Reflection (Assignment 5C worth 4%) 250 words of writing
- Teamwork 3: Parent/Partner Reflection (Assignment 5D worth 4%) 250 words of writing
- Professional Development 4: (Assignment 5E worth 4%)

Assignment	Assessment Strategies	Pts
In-class activities (Classwork 1-4)  Outcomes: 5, 7	Students will complete four in-class activities worth 4 points each. <b>Classwork 1-4</b> are intended to be both interactive and informative. These activities are intended to introduce engineering design, discuss its interdisciplinary nature, explore the types of interdisciplinary problems being solved, and introduce methods to iterate on solutions in a collaborative way.	16
Computer Aided Drafting (CAD 1-4)  Outcomes: 2, 3, 4, 5	Students will complete four Computer Aided Drafting assignments with 4 points each. <b>CAD 1</b> and <b>CAD 2</b> introduce students to CAD, teach basic CAD skills, and apply these skills to help individual students brainstorm project solutions. <b>CAD 3</b> and <b>CAD 4</b> are completed as group assignments as ideas become solidified, students look to synthesize ideas, and fabricate prototypes.	16
Reviews and Presentations (Design Review 1-4)  Outcomes: 2, 3, 4, 6, 7  500 total words written	Students will complete two design reviews worth 4 points each and two group presentations worth 4 points each. <b>Design Review 2</b> and <b>Design Review 4</b> are group presentations on design and manufacture, respectively. <b>Design Review 1</b> presents individual and group analysis to understand the problem and process for solving it. <b>Design Review 3</b> focuses on individual and group synthesis including a plan for individual contributions towards project completion and results from collaboration.	16
Written Communication (Written Comm. 1-4)  Outcomes: 1, 6, 8  1750 total words written	Students will complete one memo worth 8 points and one final paper worth 8 points. <b>Written Comm. 1</b> focuses on writing a first draft of the memo. <b>Written Comm. 2</b> focuses on the revision of the initial memo using process writing. <b>Written Comm. 3</b> teaches students how to write a technical report and provides discipline appropriate guidelines for more technical aspects. <b>Written Comm. 4</b> is a revision of the technical report using process writing.	16
Interpersonal skills activities (Professional Development 1-4)  Outcomes: 7, 8  500 total words written	Students will complete four reflection worth 4 points each. <b>Professional Development 1</b> and <b>Professional Development 3</b> are student reflections on the project experience including a reflection on service learning. <b>Professional Development 2</b> and <b>Professional Development 4</b> are reflections from attendance at two engineering society meetings intended to increase awareness about student opportunities on campus.	16
Testing, Fabrication, Feedback (Teamwork 1-4)  Outcomes: 2, 4, 5  250 total words written	Students will complete individual and group deliverables on project progress. <b>Teamwork 1</b> is a peer review on personal team contribution and that of teammates using the NSF CATME tool. <b>Teamwork 2</b> and <b>Teamwork 4</b> are deliverables that document each team member's fulfillment of their design roles towards completion of the project. <b>Teamwork 3</b> is community partner feedback.	16
Final Product Showcase (Showcase)  Outcomes: 1, 6, 8	The project showcase is worth 4 points. The <b>Showcase</b> will require groups to bring in functioning project deliverables which will be judged in a gallery style by a panel of judges. Peers will help select project awards.	4
*Research based assessment (*not graded)  Outcomes: 7, 8	Students will complete two surveys provided by the Office of Community Engagement and Partnerships used to assess the effectiveness of service learning. One will be given the first day and one will be given the last day.	—
<b>TOTAL POINTS</b>		<b>100</b>

	Tue	Thr	Activities and guiding questions	Deliverable #1	Deliverable #2
1	Aug 21	Aug 23	<b>Introduction/Overview: Jigsaw 1, design, discussion, CAD</b> What is the structure of the course? What is the design process? What is service learning? What is CAD and how is it used and accessed?	<b>Classwork 1:</b> Design Process	<b>*Service-learning Assessment</b> Pre-test (*not graded)
2	Aug 28	Aug 30	<b>Engineering Disciplines/Tools: Jigsaw 2, discussion, CAD</b> What are the characteristics of engineering disciplines? What opportunities exist for engineering students? What are customer needs and engineering specifications? What is a cosmetic design and why is it important?	<b>Classwork 2:</b> Engineering Disciplines	<b>CAD 1:</b> Tutorial
4	Sep 11	Sep 13	<b>Ethics/intellectual property: Jigsaw 3, IP, ethics, prototyping</b> What are intellectual property rules and ethics considerations? What is a functional design in CAD? What strategies have been learned to help in CAD? What is rapid prototyping?	<b>Classwork 3:</b> Ethics and intellectual property	<b>CAD 2:</b> Cosmetic design.
5	Sep 18	Sep 20	<b>Reflection: Design specifics, engineering skills and strategies</b> What are our customer needs and engineering specifications? Why is reflection important? What has been learned about the engineering technology? What is a weighted benefit analysis?	<b>*Project team finalization</b> (*not graded)	<b>CAD 3:</b> Functional design
6	Sep 25	Sep 27	<b>Design Review: Assign design teams, complete design reviews</b> Why is teamwork important? What is the group, instructor, and community partner feedback? What are the group values and the group mission statement? What is a memo and why are memos useful?	<b>Professional Development 1:</b> Student Reflection 1	<b>Design Review 1:</b> Step 1-4
7	Oct 2	Oct 4	<b>Engineering Communication: Memo writing, oral communication</b> What is engineering written communication? How do you write a memo? What is engineering oral communication? What slides should be prepared for presentations and what format?	<b>Classwork 4:</b> Iterating and Improving	<b>Professional Development 2:</b> Engineering Society Meeting
8	Oct 9	Oct 11	<b>Project 1 Presentations: Project presentations from all groups</b> What were the competing ideas? What is the result of the weighted benefit analysis? How did the group incorporate input from the community partner? What challenges has the group encountered?	<b>Written Comm. 1:</b> Memo part 1	<b>Design Review 2:</b> Presentation
9	Oct 16	Oct 18	<b>Technical skills and manufacture: 3D printing, technical skills</b> What technical skills are being learned? What new considerations arise when considering manufacture? What is the 3D printing plan? What competing ideas are present in the first group design?	<b>Written Comm. 2:</b> Memo part 2	<b>CAD 4:</b> First group design
10	Oct 23	Oct 25	<b>Design Review: Progress and roles, complete design review</b> What is the role of each individual team member? What is the group, instructor, and community partner feedback? How has the team functioned and what are the challenges? What aspects of the project inspire the community partner?	<b>Professional Development 3:</b> Student Reflection 2	<b>Design Review 3:</b> Manufacture
11	Oct 30	Nov 1	<b>Function and reflection: Fabrication, sharing of reflection</b> What did the community partner share with design teams? What challenges were present in the manufacturing process? What opportunities are there for redesign? How do you present qualitative and quantitative results?	<b>Teamwork 1:</b> Team Review	<b>Teamwork 2:</b> Fabrication 1
12	Nov 6	Nov 8	<b>Finalizing specifications: Re-design, sharing of reflection</b> What was the result of the redesign? What challenges persist for future work after the redesign? What are technical reports and how are they written? What aspects of the product can be tweaked before the showcase?	<b>Teamwork 3:</b> Partner/Parent Reflection	<b>Teamwork 4:</b> Fabrication 2
13		Nov 15	<b>Project showcase and reflection: Discuss and present projects</b> What are the strengths and weaknesses of the final product? Does the product address the customer needs? What are the strengths and weaknesses of service learning? What useful skills were gained?	<b>Showcase:</b> Final Product Presentation	<b>Professional Development 4</b>
15	Nov 27		<b>Engineering communication: Report writing and communication</b> What was learned about engineering communication? What is important to retain about memo writing? What slides should be prepared for the presentation and what format? What about professionalism was gained from society meetings?	<b>Written Comm 3:</b> Final Report part 1	<b>*Service-learning Assessment:</b> Post-test (*not graded)
Final Exam			<b>Project Presentations</b> Completed during the final exam period	<b>Written Comm. 4:</b> Final Report part 2	<b>Design Review 4:</b> Presentation

**Required CRITICAL AND ANALYTICAL THINKING:** Aspects of this course require critical and analytical thinking since students design a product, represent the design's characteristics using computer tools, fabricate/test a final product, and iterate/improve the design through working with a real community partner.

**Required PROBLEM SOLVING:** Students will work as part of a design team and therefore will have technical problems to solve as well as interpersonal problem solving related to teamwork and collaboration. Because the design project is open ended, teams are expected to apply the design process to

**Required WRITTEN COMMUNICATION:** This course teaches students how to write discipline specific written deliverables. Students will write a professional memo and a formal report, providing them with examples of two of the most common means of communication in the field of engineering. Students will also write reflections throughout the semester.

**Required PROCESS WRITING:** The memo assignment is dedicated to process writing. Students will plan the writing of their memo in class and receive feedback on a first draft. They will then develop a plan for their revisions and execute that plan to revise their memo the following week.

**Required FOR STUDENTS:** Each section will be limited to 45 students/grader and students will be encouraged to rent the course textbook for less than \$100 which is less than \$40/credit hour.

## Appendix A: Assessment of CT SLO #5/Course Outcome 3

### #GEA1 Breaking Down a Complex Problem (20% of grade)

**Overview:** #GEA1 Breaking Down a Complex Problem” is worth 20% of the final grade and assesses CT SLO #5 (course learning outcome 3) which is “Upon successful completion of this course, students will be able to Break Down complex problems to examine, propose, and support potential solutions, even if those solutions deviate from acceptable, mainstream solutions.” For this assignment, the project groups complete five submissions: Three CAD assignments designed to have students examine and propose solutions, a group presentation for students to propose and support solutions in front of their peers, and a design review for students to propose and support solutions in front of a community partner and instructor. Table gives a summary of the #GEA1 assignment showing that the assignment is worth 20% of the grade and each individual submission is worth 4% of the grade.

Table A1: Summary of #GEA1 Assignment with each submission listed as a sub-assignment

#GEA1 Breaking Down Complex Problems  			
Criteria	Ratings		Pts
CAD2: Cosmetic Design (Sub-assignment 1A)	4 to >0 pts Grade	0 pts Incomplete	4 pts
CAD3: Functional Design (Sub-assignment 1B)	4 to >0 pts Grade	0 pts Incomplete	4 pts
CAD4: Group Design (Sub-assignment 1C)	4 to >0 pts Grade	0 pts Incomplete	4 pts
Design Review 1: Step 1-4 (Sub-assignment 1D)	4 to >0 pts Grade	0 pts Incomplete	4 pts
Design Review 2: Presentation (Sub-assignment 1E)	4 to >0 pts Grade	0 pts Incomplete	4 pts
			Total Points: 20

Each of the sub-assignment submissions is provided in this appendix with a description and respective grading rubric. The necessity for multiple submissions to encapsulate the creative thinking learning outcome is a necessity because it reflects a sustained effort to break down complex problems towards the creation of an original contribution to the discipline. Activities that correspond to #GEA1 are multifaceted and therefore require a varied assessment.

**Sub-assignment 1A—CAD2: Cosmetic Design (4% of grade)**

To complete CAD2: Cosmetic Design, students will use Computer Aided Drafting skills to mock up their ideas in a way that can be communicated to others. Assessment will be based on effort examining potential solutions and proposing potential solutions. To assess the examination of potential solutions, students will submit a paragraph describing how their ideas address the project customer needs. To assess the proposal of potential solutions, students will submit CAD drawings that capture their general ideas with enough detail to describe defining characteristics

Table A2: Assessment rubric for CAD2: Cosmetic Design

Criteria	Ratings					Pts
Examination of Potential Solution <i>Paragraph description demonstrates a thoughtful examination of a potential solution that considers customer needs</i>	2 pts Full credit	1.5 pts Mostly completed description or limited consideration of customer needs	1 pts Partially completed description or done without considering customer needs	0.5 pts Description completed with major deficiencies	0 pts Incomplete	2 pts
Proposal of Potential Solution <i>CAD model that captures the general idea in enough detail so the major characteristics can be shared</i>	2 pts Full credit	1.5 pts Mostly completed CAD with full effort	1 pts Partially completed CAD with limited effort	0.5 pts Incomplete CAD with limited effort	0 pts Poor effort	2 pts
Total Points: 4						

**Sub-assignment 1B—Functional Design (4% of grade)**

To complete CAD3: Functional Design, students will mock up their ideas for the project in a way that captures engineering specifications. Assessment will be based on effort examining potential solutions and proposing potential solutions. To assess the examination of potential solutions, students will submit a paragraph describing how their ideas address the project engineering specifications. To assess the proposal of potential solutions, students will submit CAD drawings that capture the general function of their design.

Table A3: Assessment rubric for CAD3: Functional Design

Criteria	Ratings					Pts
Proposal of Potential Solution <i>Paragraph description demonstrates a thoughtful support of a potential solution that considers engineering specifications</i>	2.0 pts Full credit	1.5 pts Mostly completed description or limited consideration of engineering specifications	1.0 pts Partially completed description or done without considering engineering specifications	0.5 pts Description completed with major deficiencies	0.0 pts Incomplete	2.0 pts
Examination of Potential Solution <i>CAD model that captures the general function in enough detail so the major functionality is reflected and can be shared</i>	2.0 pts Full credit	1.5 pts Mostly completed CAD with full effort	1.0 pts Partially completed CAD with limited effort	0.5 pts Incomplete CAD with limited effort	0.0 pts Poor effort	2.0 pts
Total Points: 4.0						

**Sub-assignment 1C—Group Design (4% of grade)**

To complete CAD4: Group Design, students will mock up their group’s ideas for the project in a way that captures general functionality. Assessment will be based on effort examining potential solutions and proposing potential solutions. To assess the examination of potential solutions,

students will submit a paragraph describing how their ideas address the project engineering specifications. To assess the proposal of potential solutions, students will submit CAD drawings that capture the general function of their design.

Table A4: Assessment rubric for CAD4: Group Design

Group Design							
Criteria	Ratings					Pts	
Proposal of Potential Solution <i>Paragraph description demonstrates a thoughtful support of a potential solution that considers group customer needs and engineering specifications</i>	2 pts Full credit	1.5 pts Mostly completed description or limited consideration of engineering specifications	1 pts Partially completed description or done without considering engineering specifications	0.5 pts Description completed with major deficiencies	0 pts Incomplete	2 pts	
Examination of Potential Solution <i>CAD model that captures the general function in enough detail so the group's ideas are reflected and can be shared</i>	2 pts Full credit	1.5 pts Mostly completed CAD with full effort	1 pts Partially completed CAD with limited effort	0.5 pts Incomplete CAD with limited effort	0 pts Poor effort	2 pts	
Total Points: 4							

### **Sub-assignment 1D—Design Review 1: Step 1-4 (4% of grade)**

Design Review 1: Step 1-4 captures the breaking down of a complex problem towards supporting potential solutions to a community partner and class instructor. The document is used in a design review involving the instructor and/or community partner and is prepared to reflect the whole solution to this point in the design process. To complete Design Review 1: Step 1-4, groups will prepare a design review document which consists of 1. individually drafted customer needs from week 2 of class for all group members, 2. individually drafted isometric and orthographic depiction from TinkerCAD of cosmetic designs used to communicate ideas to the group from all group members, 3. collaboratively drafted group customer needs which should break down the complex problem to examine potential solutions, and 4. Collaboratively drafted group candidate designs that clearly propose and support realistic and differentiable solutions. The collaboratively drafted group customer needs, engineering specifications, and candidate designs should be derivatives of the individually drafted deliverables. The group will submit all of the requested content as “Design Review 1: Step 1-4” and bring four hard copies of the document to class in order to participate in the in-class design review. The design review will be an opportunity to get feedback on the group’s design process from stakeholders as a precursor to the selection of a final design for fabrication.

**Instructions:** The design review document you submit should have the following content:

1. Each individual group member’s list of customer needs and engineering specifications. All customer needs should have a weighting and all engineering specifications should have a target value. It is best to generate each using the provided Microsoft Excel template.
2. Image captures of an isometric view and orthographic view from TinkerCAD of each group member’s individual cosmetic design. The images that capture individual cosmetic designs should clearly illustrate characteristics well enough to propose and discuss the design as a potential solution. A paragraph should accompany each individual cosmetic design written by the creator that explains its characteristics. The creator’s name should be in the figure captions.

3. Each group's list of customer needs and engineering specifications. The group's customer needs and engineering specifications should be derived from the individual lists. All customer needs should have a weighting and all engineering specifications should have a target value.

4. Image captures of isometric views and orthographic views from TinkerCAD of at least two collaboratively derived group candidate designs. The images that capture group candidate designs should clearly illustrate characteristics well enough to clearly propose and support realistic and differentiable solutions. A collaboratively written paragraph should accompany the group's candidate designs that clearly outlines the next steps for the group and the defining characteristics of each candidate design. The group candidate designs can be similar to the individual candidate designs, have a combination of characteristics from multiple individual candidate designs, or be completely different from the individual candidate designs. The paragraph should just generally capture the group's current ideas. If the group candidate designs are a major departure from all of the individual cosmetic designs the group must add a sentence or two explaining this departure.

Completion of (1)-(4) is worth 1 point each. Each individual will be assessed based on the content he or she provides. For example, Item (1) listed above requires each group member to provide individual customer needs. The point will be awarded for this item based on the individual's list. Therefore, each individual's list should have his or her name as part of the table's label. The same logic applies to individual TinkerCAD cosmetic design images which should also have the individual group member's name as part of the figure label.

**Assessment:** The following rubric will be used to assess CT SLO #5 based on the contents of this assignment. The quality of customer needs and engineering specifications is assessed to determine how effectively a complex problem can be broken down to help examine a potential solution both as an individual and as a member of a team. The quality of cosmetic designs and candidate designs is assessed to determine how effectively a complex problem can be broken down towards proposing and supporting potential solutions both as an individual and as a member of a team.

Table A4: Assessment Rubric for Design Review: Step 1-4

Criteria	Ratings						Pts
Individual Customer Needs and Engineering Specifications	1.0 pts Customer needs are clear and complete with weightings. Engineering specifications are clear and complete with target values	0.8 pts Customer needs are clear and complete with weightings. Engineering specifications have minor errors but complete with target values.	0.6 pts Customer needs have minor errors but complete with weightings. Engineering specifications are clear and complete with target values.	0.4 pts Customer needs have minor errors but complete with weightings. Engineering specifications have minor errors but complete with target values.	0.2 pts Either customer needs or engineering specifications have major errors including but not limited to a list being insufficient or missing weightings or target values.	0.0 pts Both customer needs and engineering specifications have major errors with both being insufficient or missing weightings and target values.	1.0 pts

(Continued on next page)

Group Customer Needs and Engineering Specifications	1.0 pts Customer needs are clear and complete with weightings. Engineering specifications are clear and complete with target values.	0.8 pts Customer needs are clear and complete with weightings. Engineering specifications have minor errors but complete with target values.	0.6 pts Customer needs have minor errors but complete with weightings. Engineering specifications are clear and complete with target values.	0.4 pts Customer needs have minor errors but complete with weightings. Engineering specifications have minor errors but complete with target values.	0.2 pts Either customer needs or engineering specifications have major errors including but not limited to a list being insufficient or missing weightings or target values.	0.0 pts Both customer needs and engineering specifications have major errors including but not limited to both lists being insufficient or missing weightings and target values.	1.0 pts
Individual TinkerCAD and Explanation	1.0 pts CAD model clearly reflects quality analysis of the problem and explanation clearly used to support CAD model as a potential solution.	0.8 pts CAD model clearly reflects quality analysis of the problem but explanation has minor difficulties supporting design as a potential solution.	0.6 pts CAD model has minor difficulties reflecting analysis of the problem but explanation clearly used to support CAD model as a potential solution.	0.4 pts CAD model has minor difficulties reflecting analysis of the problem and the explanation has minor difficulties supporting design as a potential solution.	0.2 pts CAD model has major difficulties reflecting analysis of the problem or explanation has major flaws supporting CAD model as a potential solution	0.0 pts CAD model has major difficulties reflecting analysis of the problem and explanation has major flaws supporting CAD model as a potential solution.	1.0 pts
Group Candidate Designs and Explanation	1.0 pts Candidate designs clearly propose and support realistic and differentiable solutions and explanation clearly outlines next steps for the group.	0.8 pts Candidate designs clearly propose and support realistic and differentiable solutions but explanation has minor flaws outlining next steps for the group.	0.6 pts Candidate designs do not clearly propose and support at least two competing ideas but explanation clearly outlines next steps for the group.	0.4 pts Candidate designs do not clearly propose and support at least two competing ideas and explanation fails to clearly outline next steps for the group.	0.2 pts Either poor effort with candidate designs not proposing or supporting realistic solutions or poor effort on explanation outlining next steps for the group.	0.0 pts Both poor effort on candidate designs proposing or supporting realistic solutions and poor effort on explanation outlining next steps for the group.	1.0 pts
Total Points: 4.0							

**Sub-assignment 1E—Design Review 2: Presentation (4% of grade)**

Design Review 2: Presentation captures the breaking down of a complex problem towards supporting potential solutions to peers. The document is used in an in class presentation with PowerPoint presentation prepared to reflect the solution to this point in the design process. The rubric reflects the proper way to propose a solution using an engineering presentation with content that also is used to demonstrate the group’s process towards breaking down the problem.

**Table A5: Assessment rubric for Design Review 2: Presentation**

Criteria	Ratings					Pts	
Is the presentation 6 minutes or less?	1.0 pts Yes	0.4 pts 7 minutes or less			0.0 pts No	1.0 pts	
Does the presentation include a cover slide, overview slide, and motivation slide? The motivation answers the key question of why the project is being done. It should have a heading "Motivation".	1.0 pts Yes	0.8 pts Mostly complete	0.5 pts Partially complete	0.2 pts Incomplete or poorly executed	0.0 pts No	1.0 pts	
Slide for weighted benefit analysis. This result should be shown along with a given explanation as to the role of the weighted benefit analysis on the selection of the final design.	1.0 pts Yes	0.7 pts Partially complete	0.4 pts Incomplete or poorly executed		0.0 pts No	1.0 pts	
Figures and Formatting. Deductions range based on severity up to a deduction of -1	0.0 pts All figures and tables formatted properly in the presentation and the presentation formatting makes the ppt appear professional and useful.		0.0 pts Figures are poorly formatting and take away from the presentation	0.0 pts Incomplete or poorly executed	0.0 pts Mostly complete	0.0 pts Partially complete	0.0 pts
Does the presentation include a conclusion slide? Does the group outline next steps for the project? Does every person in the group participate? Deductions range in severity up to a deduction of -1	0.0 pts Incomplete or poorly executed		0.0 pts Mostly complete	0.0 pts No	0.0 pts Partially complete	0.0 pts Yes	0.0 pts
Slide for candidate designs. Images for both candidate designs should be given. Each should be discussed in the presentation.	1.0 pts Yes	0.7 pts Partially complete	0.4 pts Incomplete or poorly executed		0.0 pts No	1.0 pts	
<b>Total Points: 4.0</b>							

## Appendix B: Assessment of CT SLO #2/Course Outcome 1

### #GEA2 Creating an Original Contribution (20% of grade)

**Overview:** “#GEA2 Creating an Original Contribution” is worth 20% of the overall grade and assesses CT SLO #2 (course learning outcome 1) which is “Upon successful completion of this course, students will be able to **Create an original contribution within a specific discipline.**” For this assignment, the project groups complete five submissions: Two written communication submissions drafting a memo, two written communication submissions drafting a final report, and a product showcase. The memo documents the design process and also is drafted using process writing, the final report documents the fabrication process for the final deliverable and provides a foundation from the literature for the creation of an original contribution, and the showcase documents functionality. Table B1 gives a summary of the #GEA1 assignment showing that it is worth 20% of the grade and each submission is worth 4% of the grade.

Table B1: Summary of #GEA2 Assignment with each submission listed as a sub-assignment

#GEA2 Creating an Original Contribution  			
Criteria	Ratings		Pts
Written Comm. 1: Memo <i>Sub-assignment 2A</i>	4 to >0 pts Full Marks	0 pts Incomplete	4 pts
Written Comm. 2: Memo Process Writing <i>Sub-assignment 2B</i>	4 to >0 pts Full Marks	0 pts Incomplete	4 pts
Showcase <i>Sub-assignment 2C</i>	4 to >0 pts Full Marks	0 pts Incomplete	4 pts
Written Comm. 3: Final Report Introduction and Results/Discussion <i>Sub-assignment 2D</i>	4 to >0 pts Full Marks	0 pts Incomplete	4 pts
Written Comm. 4: Final Report Appendix and Formatting/Section Content <i>Sub-assignment 2E</i>	4 to >0 pts Full Marks	0 pts Incomplete	4 pts
			Total Points: 20

Each of the sub-assignment submissions is provided in this appendix with a description and respective grading rubric. The necessity for multiple submissions to encapsulate the creative thinking learning outcome is a necessity because it reflects a sustained effort to break down complex problems towards the creation of an original contribution to the discipline. Activities that correspond to #GEA1 are multifaceted and therefore require a varied assessment.

## **Sub-assignment 2A & 2B: Written Comm. 1 & 2: Memo with Process Writing (8% of grade)**

Table B2: Assessment rubric for both Written Comm. 1 and 2 memo writing assignment

Criteria	Ratings							Pts
Criteria 1C: Heading and Formatting	0.5 pts Correct	0.4 pts Formatting with minor errors. Heading correct	0.3 pts Heading incorrect. Formatting correct otherwise	0.2 pts Formatting with major errors. Heading correct.	0.1 pts Formatting with minor errors. Heading incorrect	0.0 pts Incorrect		0.5 pts
Criteria 2C: Opening	0.5 pts Correct	0.4 pts Main ideas with minor errors. Opening concise.	0.3 pts Opening not concise (reads like a description of what was done as opposed to a summary of main ideas and deliverables). Main ideas given with numerical deliverables (if necessary)	0.2 pts Main ideas with major errors. Opening concise.	0.1 pts Main ideas with minor errors. Opening not concise (reads like a description of what was done as opposed to a summary of main ideas and deliverables).	0.0 pts Incorrect		0.5 pts
Criteria 3C: Middle	0.5 pts Supporting details provided, complete, and enumerated.	0.4 pts Supporting details provided with minor errors and enumerated correctly.	0.3 pts Detail enumeration exists but enumeration does not separate independent details provided and complete.	0.2 pts Supporting details provided with major errors and enumerated correctly.	0.1 pts Supporting details provided with minor errors. Detail enumeration exists but enumeration does not separate independent points.	0.0 pts Incorrect (points may be correct but if no enumeration is present this will be an automatic 0)		0.5 pts
Criteria 4C: Closing	0.5 pts Closing clearly explains the action required from the information given and is concise.	0.4 pts Closing explains action with minor errors and is concise.	0.3 pts Closing not concise (provides information that should be located in the opening or middle) but clearly explains the action required from the information given.	0.2 pts Closing present but does not indicate actions required. Closing is concise and seems to be well thought out.	0.1 pts Closing present but does not indicate actions required. Closing not concise (provides information that should be located in the opening or middle)	0.0 pts Poorly executed		0.5 pts
Tables and Figures	0.5 pts Figures and tables formatted correctly with a descriptive label below for a figure or above for a table.	0.4 pts Figures and tables have minor formatting errors with a descriptive label below for a figure and above for a table.	0.3 pts The location of figure or table labels is not followed for all figures but the label is present and descriptive. Figures are otherwise formatted correctly.	0.25 pts Figures and tables have minor formatting errors. Label is not descriptive but located properly	0.2 pts Figures and tables formatted correctly with no descriptive label	0.1 pts Figures and tables have major formatting issues but a descriptive label exists below for a figure and above for a table	0.0 pts Figures and tables missing or the majority of figures and tables are improperly labeled and formatted	0.5 pts
Memo length	0.5 pts Major error with acceptable content on the first page of the Memo. Memo length is correct.	0.4 pts Memo exceeds 1 page by a sentence or two. All figures, tables, and equations not included in this first page of content.	0.3 pts Memo exceeds 1 page by a sentence or two. Minor error with figure or equation placement on the first page of the Memo.	0.2 pts Memo heading, opening, middle, and closing less than 1 page and all figures, tables, and equations not included in this first page of content	0.1 pts Minor error with acceptable content on the first page of the memo. Memo length is correct.	0.0 pts Poorly Executed		0.5 pts
Content of Appendix	1.0 pts Appendix is completed correctly and professionally with required content	0.8 pts Minor errors with content in the Appendix. Appendix is completed professionally.	0.7 pts Minor errors with Appendix content and formatting. Appendix completed professionally.	0.6 pts Appendix is completed but there are some minor errors with its content and/or Figures/Tables have a minor issue with clarity or professionalism	0.5 pts Appendix is completed professionally and with good effort but there is a conceptual misunderstanding that leads to major errors in its contents	0.3 pts Appendix has minor omissions. There is a a conceptual misunderstanding that leads to major errors in its contents	0.0 pts Poorly executed	1.0 pts
Process Writing - Prewrite	1.0 pts Student completes pre-writing assignment in class		0.5 pts Student partially completes pre-writing assignment in class		0.0 pts Student has poor effort on pre-writing activity in class			1.0 pts

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Process Writing - Expansion of ideas to adequately outline original contribution	1.0 pts Student outlines quality revisions based on feedback from instructor	0.7 pts Student partially outlines revisions based on feedback from the instructor but with good effort	0.4 pts Student partially outlines revisions based on feedback from the instructor with limited effort	0.0 pts Student has poor effort on expansion of ideas to incorporate instructor feedback	1.0 pts
Process Writing - Rewriting quality to capture proper formatting	1.0 pts Student rewrites memo to address all formatting issues	0.7 pts Student rewrites memo to address most formatting issues	0.4 pts Student rewrites memo to partially address formatting issues but with good effort	0.0 pts Student has poor effort revising memo to incorporate feedback	1.0 pts
Process Writing - Rewriting quality to capture proper content	1.0 pts Student rewrites memo to address all content issues	0.7 pts Student rewrites memo to address most content issues	0.4 pts Student rewrites memo to partially address content issues but with good effort	0.0 pts Student has poor effort revising memo to incorporate feedback	1.0 pts
Total Points: 8.0					

Table B2 provides the assessment rubric for both Written Comm. 1: Memo which is Sub-assignment 2A and Written Comm. 2: Memo Process Writing which is Sub-assignment 2B. Students will plan, write and revise their memo with feedback being given in class. The rubric reflects the memo's base content which should be considered the first four points as defined. This is Written Comm. 1: Memo. The rubric also reflects the bulk of the process writing in the latter four points as allocated on the rubric. As part of their process writing, students will develop a plan for correcting their memo, expand the content of their original memo to adequately outline their potential for an original contribution, and rewrite their memo considering content and formatting.

**Sub-assignment 2C—Project Showcase (4% of grade):**

The project showcase assesses the functionality of the original contribution. The final product must be fully functional and the educational materials must be complete to receive credit. The project team should also have a video of their project working which they should also display alongside the physical prototype. The project showcase will be a gallery style presentation of each group's fully functional hardware and educational materials. Groups will have time to present their project to judges and peers who will judge submissions based on four criteria. These criteria are as follows: 1. Original contribution to engineering education, 2. Clarity of purpose and quality presentation, 3. Integration and understanding of engineering technology, and 4. Quality and collaborative development of educational materials. The first two criteria are important because the final product should be an original contribution developed with clear understanding and ability to articulate its purpose as it relates to service learning. The third criteria are important because the final product should be an original design around an

engineering technology the contributes a new and useful educational approach to the engineering discipline. The fourth criteria is important because the original contribution must be developed as a service-learning project through collaboration with a community partner so the final product solves a real problem in a way that affectively addresses a community need.

**Submission:** Every group should bring one hard copy of its educational materials and a means to display the group’s final video of their project working. In addition, the final project hardware should also be functional and on display. Each individual group member should upload an electronic copy of the educational materials to Canvas in order to receive credit.

**Instructions:** The project showcase will begin at the beginning of class. Each project group must have at least one group member by their project at all times in order to discuss its characteristics. The showcase is gallery style, meaning all students not manning the table for their respective projects will roam and view the projects of other teams. Judges also will circulate the room during this time. Each judge will have approximately 10 minutes to assess criteria (1)-(4) using an assessment rubric. Each criteria on the rubric is worth 1 point with the average score from each of the judges becoming the group’s final project showcase grade.

**Assessment:** The following rubric is used to assess the Project Showcase. The ability to create an original contribution for the engineering discipline is determined considering how original and educational the final project is, how their novel ideas are tied to the original motivation, and the degree to which complex technology is used and explained in a new way so the final project is relatable to the community partner.

Table B3: Assessment rubric for Project Showcase

Criteria	Ratings						Pts
Original contribution to engineering education	1 pts Product is very original and clearly educational	0.8 pts Product is very original with minor educational flaws	0.6 pts Product is somewhat original and clearly educational	0.4 pts Product is somewhat original with minor educational flaws	0.2 pts Product has major flaws in either its originality or educational characteristics	0 pts Product has major flaws in both its originality and its educational characteristics	1 pts
Clarity of Purpose and Quality of Presentation	1 pts Product has high clarity of purpose and content is presented in an effective manner	0.8 pts Product has high clarity of purpose with minor inconsistencies in the quality of presentation	0.6 pts Product has a mildly inconsistent clarity of purpose and but content is otherwise presented in an effective manner	0.4 pts Product has a mildly inconsistent clarity of purpose and content is presented with a minor lack of clarity	0.2 pts Product has major flaws in clarity of purpose or major flaws in the quality of presentation	0 pts Product has major flaws in clarity of purpose and major flaws in the quality of presentation	1 pts

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Integration and Understanding of Engineering Technology	1 pts Product demonstrates proficiency with the engineering technology used and the engineering technology is well integrated within the final product	0.8 pts Product reflects minor deficiencies in the understanding of the engineering technology but the engineering technology is otherwise well integrated within the final product	0.6 pts Product demonstrates proficiency with the engineering technology but the integration of the engineering technology in the final product is somewhat limited	0.4 pts Product reflects minor deficiencies in the understanding of the engineering technology and the integration of the engineering technology in the final product is somewhat limited	0.2 pts Product reflects major deficiencies in either the understanding of the engineering technology or the integration of the engineering technology has major limitations	0 pts Product reflects major deficiencies in both the understanding of the engineering technology and the integration of the engineering technology has major limitations	1 pts
Quality and Collaborative Development of Educational Materials	1.0 pts Product presents high quality educational materials that are clearly developed in collaboration with the community partner	0.8 pts Product presents educational materials that are mildly limited but clearly developed in collaboration with the community partner	0.6 pts Product presents high quality educational materials but are slightly limited in their collaborative development with the community partner	0.4 pts Product presents educational materials that are mildly limited and are slightly limited in their collaborative development with the community partner	0.2 pts Product has educational materials that are majorly flawed in either the quality of materials or their collaborative development	0.0 pts Product has educational materials that are majorly flawed in both the quality of materials or their collaborative development	1.0 pts
Total Points: 4.0							

Project functionality the day of the showcase is a precondition for assessment. Students are responsible for making sure their project is fully functional. Those that have a video of their project working and their educational materials may be permitted to present their working hardware to the instructor at a later date for partial credit.

**Sub-assignment 2D & 2E: Written Comm. 3 & 4: Final Report (8% of grade)**

Sub-assignments 2D and 2E document the final specifications of the design that led the group to creating an original contribution to the discipline. This original contribution is framed against the engineering education literature. The final report is written in two parts. The first submission is Written Comm. 3: Final Report Introduction and Results and Discussion which provides the basis for the project and documents the project characteristics with discussion. The second submission is Written Comm. 4: Appendix and Formatting/Section Content which provides all materials to replicate the project in the format of a discipline relevant technical report.

Table B4: Assessment Rubric for Written Comm. 3 and 4 for writing of the final report

Final Report									
Criteria	Ratings								Pts
Introduction that provides the basis for the creation of a contribution to the discipline	2.0 pts Literature review complete and technical information provided for project understanding	1.8 pts Technical information with minor errors but literature review complete	1.6 pts Literature review with minor errors but technical information complete	1.3 pts Literature review and technical information with minor errors	1.0 pts Technical information with major errors but literature review complete	0.8 pts Literature review with major errors but technical information complete	0.5 pts Major and minor errors with both technical information and literature review but completed with decent effort	0.0 pts Incomplete or done with poor effort	2.0 pts
Results and Discussion towards the creation of an original contribution to the discipline	2.0 pts Results complete and thoughtful discussion provided for project understanding/future work	1.8 pts Discussion with minor errors but results complete	1.6 pts Results with minor errors but discussion complete	1.3 pts Results and discussion with minor errors	1.0 pts Discussion with major errors but results complete	0.8 pts Results with major errors but discussion complete	0.5 pts Major and minor errors with both results and discussion but completed with decent effort	0.0 pts Incomplete or done with poor effort	2.0 pts
Role specific materials and appendix	2.0 pts Role specific materials complete and other aspects of the appendix provided for project implementation	1.8 pts Appendix with minor errors but role specific deliverables complete	1.6 pts Role specific deliverables with minor errors but appendix otherwise complete	1.3 pts Role specific deliverables and rest of the appendix with minor errors	1.0 pts Appendix with major errors but role specific contribution complete	0.8 pts Role specific deliverables with major errors but rest of the appendix otherwise complete	0.5 pts Major and minor errors with both role specific deliverables and the rest of the appendix but completed with decent effort	0.0 pts Incomplete or done with poor effort	2.0 pts
Discipline specific formatting and professionalism	2.0 pts Formatting follows discipline specific guidelines and section content completed with professionalism	1.8 pts Formatting with minor errors but section content complete and professional	1.6 pts Section content with minor errors but formatting done professionally	1.3 pts Formatting and section content with minor errors	1.0 pts Formatting with major errors but section content complete	0.8 pts Section content with major errors but formatting done professionally	0.5 pts Major and minor errors with both formatting and section content but completed with decent effort	0.0 pts Incomplete or done with poor effort	2.0 pts
Total Points: 8.0									

**NOTE: Overall assessment of #GEA1 and #GEA2 (40% of final grade)**

Canvas will calculate “#GEA1 Breaking Down a Complex Problem” and “#GEA2 Creating an Original Contribution” by summing up the results from their respective sub-assignments. Each is 20% of the final grade. When taken together, they are 40% which is a significant portion of the final grade. Each individual assignment addresses an aspect of the course project that is essential for creating a product that successfully breaks down a complex problem towards the creation of an original contribution to the engineering discipline. #GEA1 includes CAD work that allows for the breaking down of complex problems through examining and proposing potential solutions and design reviews for supporting potential solutions. #GEA2 includes written communication for documenting the creation of an original contribution and a project showcase to document the functionality of the original contribution. The memo documents the design process and the final report documents the fabrication process along with giving context from the literature.