

# **ENGINEERING DESIGN COSC/ECE 401 & 402**

## **Capstone Research Design Project Guidance**

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This engineering design guidance document is patterned after the U.S. Naval Academy's Capstone Research Design Project Guidance, Spring Academic Year 2015, last retrieved Nov. 3, 2019.  
<https://www.usna.edu/EngineeringandWeapons/ResearchAndCapstone/Capstone%20Courses/index.php>

# **Engineering Design COSC/ECE 401-402 Capstone Research Design Project Guidance**

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## **The Capstone Research Design Project**

This document describes the requirements for capstone design as they apply to research students, students in the COSC\_ECE 401/402 Senior Design program. The specific deliverables for the first and second semesters are summarized and guidance about the form and content of these deliverables is provided.<sup>1</sup>

### **I. Overview**

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<https://www.usna.edu/EngineeringandWeapons/ResearchAndCapstone/Capstone%20Courses/index.php>

## Engineering Design COSC/ECE 401-402 Capstone Research Design Project Guidance

### Participation

All Engineering students must participate in a capstone design project as part of the engineering curriculum. The capstone design project is an opportunity for you to solve a practical engineering design problem using the engineering skills and knowledge that you have developed over the past three years. You will be challenged to define a problem, explore different ways of solving it, apply technical reasoning to select the best solution path, and to carry out your proposed solution – demonstrating that the design objectives have been achieved.

You will document the design process in a report that you'll revise and add to throughout the academic year. You'll also present your work regularly to a panel of outside customers, faculty and staff members, and your peers in order to check your progress and offer additional guidance along the way. The due dates for these reports and presentations are detailed in the syllabus.

### Course Administration

You are scheduled for three class periods per week. Each lecture will start with a review of the reading guide that covers the assigned reading. The reading guides are linked from the syllabus, which is available on the Canvas course website. For one of the remaining class periods each week you'll have a group meeting with your team and project mentor. The mentor will be the instructor for your follow-on research courses where you will complete the design sequence. The instructor will consult with your mentor in assigning the grades for the first course.

## II. Course Shared Drive

For the “traditional” design track, there usually is a course shared drive which contains a number of resources that you may wish to access. You can access this folder from anywhere by mapping the drive to the computer you wish to use, or create your own folder.

In your academic year there is a folder called *zzDesign Team Folder*. Make a duplicate of this folder or create it and name it *Research Design <LastName> Folder*. This will be the folder where you will archive your project. Inside your team shared folder you will find the following sub-folders (or create them):

**1 Reports and Presentations.** In this folder, keep the final version of all reports and presentations. A word of advice with regard to version control: so often we've seen student reports titled something like, “Project Proposal FINAL FINAL DO NOT DELETE” followed by “Project Proposal FINAL FINAL FINAL DO NOT DELETE – SERIOUSLY.” Might we suggest using a simple convention: v1, v2, etc. where the largest number is the latest version.

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**2 Purchase Orders and Budget.** In this folder, keep all purchase order paperwork with files named so as to be able to discern their contents without having to open them. Also, save an up-to-date copy of your team's budget.

**3 Work Orders.** In this folder, keep any work orders including the associated part files, assembly files, and drawing files. You'll also keep a copy of your shop hour tracker, which will be covered in a later section.

**4 Progress Reports.** Your mentor may wish you to make a weekly record of your progress. Such reports should be stored in this folder. Please name the file or files something logical so they are easy to find, *2020-09-20 progress report* for example.

**5 Communications and Correspondence.** Following each conversation with customers, technical advisors, etc., either in-person or over the telephone, type a brief summary of the communication and save it in this folder for future reference. Be sure to include who was involved in the discussion. Please use the same file naming convention suggested for meeting minutes. You should also save copies of important e-mails in this folder.

**6 Images and Video.** A picture is worth 1,000 words as the old saying goes. Today it is easier than ever to capture the design process with images and video, both of which will add to the effectiveness of your reports and presentations.

**7 Code.** If your project involves programming, you should save your programs in this folder. You should also use a logical file naming convention for code in order to preserve version control.

**8 Background Literature.** Here you should store the .pdf files of literature that is relevant to your project. Establish a file naming convention for your background literature to help you keep the articles straight.

### **III. Design Communication: Formatting, Conduct, Submission, and Archiving**

In Senior Design COSC/ECE 401 you'll give three presentations to the faculty review board. These presentations are your Project Proposal, Preliminary Design, and Detail Design Presentations. There are three additional presentations in Senior Design COSC\_ECE 402. Those presentations are the Prototype Demonstration, Progress Update, and the Final Presentation, which is given on Capstone Day. Participation in Capstone Day is required for Senior Design COSC/ECE 402. A corresponding report for each presentation is due a week or two after each of these presentations. See the syllabus for specific dates.

Unless otherwise specified, all formal written communications will be submitted according to the ***Design Report Template*** available in the course shared folder and on the

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course webpage. The goal of all design communication is that it should be professional in appearance and make it easy for the reader to access the content.

A computer with PowerPoint, access to the Internet, and a projection system will be available in the presentation room. Students are advised to load their presentation ahead of time – before presentations begin for the day - to preclude the delay of downloading and opening the presentation in front of the audience. Also, occasionally the e-mail server or the shared drive is unavailable. Students should have a back-up plan in the event of a technical malfunction.

### IV. Purchase Orders

Your project may require making purchases. ***Under no circumstances should you buy an item with your own money, expecting to be reimbursed.*** The following is a guideline for how to handle purchases:

1. Go online and find what you need. Use screen capture to save .pdf files that describe each part—as you will need these for the ordering process. If possible, try not to order one part at a time. The credit card purchase process is time consuming and it's preferable to keep the total number of orders to a minimum. Order multiple items in a single transaction whenever possible.
2. Once you've found what you need, call the vendor on the phone and get a quote. This is very easy. All you have to say is, "Hello, I'd like a quote." Most vendors are well acquainted with the ordering process, even if you aren't. This saves a lot of time in ordering because all the purchase card holder has to do is give the vendor the quote number instead of reading off the parts list. This way you're more likely to get the parts you ordered too! Be sure to request an estimated shipping charge to zip code 37996. **DO NOT commit to purchase when requesting quotes.**
3. If you can't get a quote, save a screen capture of the "shopping basket" to make things easier on the purchase card holder.
4. Fill in the purchase order form (.pdf file, located in the course shared folder) and ensure information is accurate. Save the purchase card order form and all other required items in your teams *2\_Purchase Orders and Budget* folder.
5. Notify your instructor and mentor that you have a purchase order ready to go. Check with your mentor to see whether they prefer to use the share drive, or would rather you e-mail them the files.
6. Your instructor will submit the purchase order packet to the course to the EECS Parts Store. Your mentors should carbon-copy you so that you have visibility as to who is making the purchase for them.

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7. Ideally, once the order is received by the EECS Parts Store, the cardholder will notify the team purchaser that their items are ready for pick-up. However, it is your responsibility to follow up on purchase orders. Our purchase card holders process many, many orders. You have a vested interest in tracking the purchase.

### **V. Design Communication Guidance and Rubrics**

Guidance for each report, presentation, and deliverable is provided in the following pages. To make this easier, the labels for each section and specific format can vary as needed. However, all of the content described here should be included.

These sections meet specific learning objectives for the design courses and need to be included if your project is to count towards your design requirement. Since they are not part of the other applications, however, you can put them at the back of the proposal as an appendix instead of in the main body of the document.

The presentation corresponding to each report is scheduled at least a week prior to the date the written report is due in order to give you the opportunity to revise the material in your report prior to submitting it formally. The content guidance provided below is written from the context of the written report. It is up to you to decide how best to use the time you are allotted to communicate your progress during your presentation. Be sure to use the presentation and report rubrics as guides in addition to consultation with your project mentor(s).

### **VI. COSC/ECE 401 – Preparation of the Project Proposal Description**

#### ***Purpose***

The Project Proposal is the initial design communication. The purpose of the Project Proposal is to define as specifically as possible the problem and what will be undertaken over the course of the project to solve it. It should communicate to the reader that a specific need exists, provide background and context on the problem, present the problem statement, outline specific design requirements, and convince him or her that a solution can be achieved in a timely and cost-effective manner.

#### ***Content***

##### **Title Page**

The title page shall include the student's name, project short and long title, the name of report (in this case the Project Proposal), the name of the course (Engineering Design 401 or 402), the date submitted, and the names of the team mentors.

##### **Executive Summary**

The executive summary is a brief summary of the contents of the report. At its longest, when submitted affixed to your final report in April, it will be no longer than a page. It is

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used to help the reader decide if the report as a whole contains information that is of interest. The executive summary for the Project Proposal should contain a statement of the problem and a summary of the five most important customer requirements.

The executive summary should be on its own page and precede the table of contents as shown in the template.

### **Table of Contents/List of Figures/List of Tables**

It is recommended that your report include a Table of Contents followed by a List of Figures and a List of Tables. These come after the executive summary and are not generally paginated except with lower-case Roman numerals.

### **Problem Definition & Background**

Page numbering should start with this section. This section should begin with the problem statement – the one you were provided at the start of the project. It then should provide the background and context for the project. Here are the sorts of questions that this section should answer:

1. What is the problem? Why is the current situation unsatisfactory?
2. Who is having this problem? Who are the would-be customers for a solution?
3. What basic functions must the design perform?
4. How will the design be used by the customer(s)? Under what circumstances and in what environment? Don't limit your considerations only to those of the end user!
5. What is the underlying theory or background that needs to be understood in order to address this problem?
6. What prior work has been done on this problem?
7. What products, currently available, were not designed or intended for this particular application but could be used to perform a similar function?

Provide ample evidence that you have used all sources of information that are applicable to your project, including technical papers, product literature, and patent literature.

There may be some engineering modeling/calculation required to answer some of these questions, even at this early stage. For example, if one of the project requirements is to design a power system for a forward operating base, you should estimate what the energy needs are likely to be for that base. This sort of information is *solution-neutral* which is to say it doesn't matter what your final design looks like, this is information that must be known in order to provide a solution – any solution.

Also, regardless of the design, there are most likely associated codes and standards that may place particular constraints on the design. Please ensure these are referenced and the pertinent portions included in the discussion.

### **The Requirement Specification**

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In this section you will define the goals toward which the entire rest of your project will be focused.

First, include a list of your project objectives (aka “customer requirements”), listed in order from most important to least important. Be sure to explain any customer requirements that require it. Accompany the table with a brief summary – how you developed them, with whom you spoke to confirm them, and which are most important. Please include images wherever useful in communicating the necessary details.

Next, include a table of your engineering requirements, or “Engineering Characteristics (ECs)” - listed from most to least important - including units, target values, and direction of improvement, as appropriate. Specify which of these design parameters are design variables (a parameter over which the team has a choice) and which are design constraints (a parameter whose value has been fixed). In the accompanying text, describe how these requirements relate to the customer needs and how you arrived at your target values.

### **Deliverables**

Together with your mentor develop a list of what you will provide at the conclusion of the project. Think of it in terms of answering the question, “What are we going to give the customer in exchange for their patronage” be it their time, material support, or financial support.

### **Project Management**

Understanding many of the specifics will not have been determined yet, this section should contain a proposed timeline for your project. Following a brief introduction, include a table of project-specific milestones (in addition to those listed on the syllabus). These dates may seem very vague at this stage, but it is useful to think through your project schedule even in the initial stages. You will refine the schedule later.

### **Budget**

Likewise, it may seem a bit premature to propose a budget for a project for which the details have yet to be determined. However, projects are almost never proposed without preliminary budget estimates. In fact, the proposed budget is likely to be a deciding factor in determining which firm the client will select.

This section should include an accounting of the anticipated expenditures for the project, provided in table format. Be sure to include travel if you anticipate attending a conference. (Include the conference information as a footnote).

### **References**

Technical documentation should always be written such that without direct contact with any of the group members someone could follow the design process and continue or revise the design without reconstructing the project themselves. Thus, documenting references is crucial. In this course the *IEEE style* format is recommended for the List of References. You may use endnotes, so long as they appear prior to the appendices as



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described in the Design Report Template.

Appendices should be lettered A – Z and appear in the order they are referenced in the text. Appendices are composed of any information that does not complement the narrative flow of the in-text discussion but must be included for the sake of completeness.

**Appendix – Project Quad Chart / Business Matrix Canvas.**

This is a single PowerPoint slide that describes your project. It will be discussed in lecture and there is also an example posted on the syllabus. You will update this slide throughout the year as your project evolves. It will become part of the project portfolio which the capstone coordinator uses to solicit support for the capstone program.

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**A. COSC/ECE 401 – Project Proposal Rubric**

Student: \_\_\_\_\_ Reviewer: \_\_\_\_\_

<b>Grading Criteria or Requirement</b>	<b>Comments</b>	<b>Target Word Count</b>	<b>Points</b>
<b>Front Matter</b> Title Page – student name, project title, course and number, name of report, date submitted, and student signature. Executive Summary – problem statement and description of top five ECs Concise and on its own page; ahead of ToC/LoF/LoT, no page #s Table of Contents, List of Figures, and List of Tables		<b>100</b>	<b>/5</b>
<b>Problem Definition &amp; Background</b> Needs identified and explained. Sufficient background provided to understand project context. All relevant sources consulted. Estimations and preliminary calculations included as needed.		<b>500</b>	<b>/25</b>
<b>Requirements Specification</b> Table of customer requirements or objectives included, prioritized, and explained. Table of ECs including units and direction of improvement; identification of which are variables, and which are constraints, target values and discussion of how targets were defined.		<b>500</b>	<b>/25</b>
<b>Deliverables</b> What you plan to have upon completion		<b>500</b>	<b>/5</b>
<b>Project Management</b> Table of project-specific milestones in addition to those included in the syllabus.		<b>500</b>	<b>/5</b>
<b>Budget</b> Table of planned expenditures Discussion of anticipated costs (well-researched versus estimated)		<b>500</b>	<b>/5</b>
<b>References</b> Complete listing Proper format		<b>150</b>	<b>/5</b>
<b>Appendices – Project Quad Chart / Business Matrix Canvas (if required)</b>		<b>250</b>	<b>/5</b>
<b>Formatting</b> Figure/table formatting (centered, numbered, captioned, referenced) Justification and pagination Clean and professional appearance			<b>/10</b>
<b>Style</b> Strong, logical narrative / Correct voice (third person) Appropriate tense – consistent with narrative for each section Grammar and spelling; evidence of proofreading			<b>/10</b>
<b>Overall</b>		<b>3000</b>	<b>/100</b>

## Engineering Design I/II - Capstone Design Project Guidance

### B. COSC/ECE 401 – Project Proposal Presentation Rubric

Student: \_\_\_\_\_

Reviewer: \_\_\_\_\_

Topic	Not Meets Expectations	Meets Expectations	Exceeds Expectations	Possible	Awarded
Problem Definition	Not included or significantly incomplete	Problem statement contains errors, biases, or implied solutions	Describes who and what; refined to succinctly describe design intent	10	
Background	Not included or significantly incomplete	Prior work and context described but only using one or two sources. Elements of background left out.	Thoughtful and complete discussion of prior work and context for project. Multiple sources consulted.	10	
Requirements Specification	Not included or significantly incomplete	ECs incl., but incomplete; not well correlated to needs	Complete, abstract, verifiable, unambiguous and traceable to the project needs.	10	
Design Estimation and Target Determination	Not included or significantly incomplete	Incl. but limited; targets vague or unrealistic	Good estimation of problem parameters and target values.	10	
Deliverables	Not included or significantly incomplete	Incl., but missing key items; includes items that are not deliverable; did not discuss with mentor	All deliverables clearly identified and included, based on agreement with mentor	10	
Project Management	Not included or significantly incomplete	Milestones only or primarily from syllabus, few project-specific tasks	Considered project management plan with all major milestones and tasks identified	5	
Budget	Not included or significantly incomplete	Too vague to be useful; too detailed to be correct; missing items; limited discussion of researched vs. est. costs	Major expenses identified and researched; sufficient discussion of researched versus estimated costs	5	
Project Quad Chart / Business Matrix Canvas	Not included or significantly incomplete	Requires some revision before it is ready to be seen by a sponsor.	Describes project well. Ready to be seen by a sponsor.	5	
Slide Quality	Unorganized. Impossible to follow.	Slides wordy or hard to follow.	Slides visually stimulating. One idea per slide. Good use of images.	10	
Delivery	Talking to the screen.	Low energy but at least facing audience.	Dynamic and engaging.	10	
Professionalism	Wrong business attire. Late. Egregious typos in slides	Correct business attire. Some typos in slides that indicate last-minute scrambling.	Correct business attire. Slides loaded and ready to go at start.	5	
Response to Questions	Unresponsive or defensive	Answered questions but with some rambling.	Answered questions concisely and correctly	5	
Timeliness	10 min > time > 18 min	10 min < time < 13 min or 15 min < time < 18 min	13 min < time < 15 min	5	

Comments:

Total Score (out of 100) \_\_\_\_\_

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## **VII. COSC/ECE 401 – Preparation of the Preliminary Design Report Description**

### ***Purpose***

The purpose of the Preliminary Design Report (PDR) is to document the process of design evaluation and selection for the first semester of COSC\_ECE 401. In it, multiple design concepts are presented and evaluated. In order to select a single design from these alternatives they must be compared on an impartial basis, based on each concept's predicted performance with regards to the engineering characteristics developed in the Project Proposal.

### ***Content***

#### **The Preliminary Design Report**

This report (and subsequent reports) builds upon work previously submitted. Begin by revising your Project Proposal, as marked up by and discussed with your project mentor. Be sure also to continually revise the content of previously written sections to reflect new information gained since the last time it was submitted. As a matter of course, the report should also contain the most up-to-date table of contents, list of figures, list of tables, project management information, budget, and references. In addition to those sections included in the Project Proposal, the PDR shall include sections describing the Design Concepts and Concept Evaluation and Selection.

#### **Executive Summary**

In addition to what was included in the Project Proposal, include a brief summary of the design concepts proposed. State which of the concepts was ultimately selected for detail design and why.

#### **Restatement of Problem Definition, Background and Requirements**

These sections should be the same as your project proposal, updated to reflect your better understanding of the project, and revised as suggested by your mentors. If you do not agree with a suggested revision you should discuss it with your mentor.

#### **Technical Approach**

You should begin this section with an overview of your project space. Even though it is likely that your project is already somewhat defined, you should aim to keep your design space as open as possible without being artificial. For example, if you plan to focus on the development of an optical communications link it would be artificial to feign to consider alternative communication strategies such as smoke signals, but it would be reasonable to not yet specify a particular light wavelength, receiver type or communication protocol.

Next, you should describe the functional decomposition of your system. This involves breaking down the overall performance of the system into individual functional units. You might find a block diagram or flow chart useful for illustrating the functional decomposition.

Finally, you should identify the major design decisions within your project. If your project

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contains no design decisions, then it cannot be used to fulfill the capstone design requirement and you will need to complete a separate capstone project! Fortunately, most engineering projects involve design decisions. If you are struggling with identifying meaningful design decisions within your project, please discuss this with your mentor and/or the capstone coordinator for the department. As you identify these design choices, you should also identify the engineering characteristics that will be affected by each choice. You will use those engineering characteristics to choose between different alternative concepts for each design decision.

### **Design Concepts, Evaluation & Selection**

In this section, you will apply the formalized design techniques taught in this course to the major design decisions in your project. For each major design decision:

- **Develop at least two complete concepts for the design.** The concept should be developed to the extent that you can reasonably estimate the engineering characteristics that would result from that choice. You should also include all design concepts that your “customer” might reasonably expect to be considered. For example, if the design choice you are considering is what you should use for a portable power source, you would be expected to at least consider batteries and solar arrays as possible options.
- **Predict how each of the design concepts would affect your engineering characteristics.** Be as quantitative as possible. If there are modeling tools available that are applicable to your problem, then you should make use of them. For example, if you are considering different material choices for a transmission line, you should model the structure in Sonnet, making reasonable approximations for material parameters, in order to calculate how your material choices would affect engineering characteristics such as insertion loss.
- **Select the best design concept for the design decision using your predictions for the engineering characteristics.** Use a weighted decision matrix for design decisions that affect more than one engineering characteristic. Discuss the results of the weighted decision matrix. If your gut and the decision matrix outcome don’t agree, find the source of the discrepancy— you may have an error in your estimation of performance, or a hidden requirement which should in fact be stated and included in the analysis. Often students will make a design choice based on the availability of a part. Rather than saying “All my analysis leads me to want to choose X, but instead I’m choosing Y” it is better to include project development time and cost as engineering characteristics to be considered along with performance characteristics. This will allow you to examine the trade-off between development time and performance in your selection.

### **Restatement of Deliverables, Project Management, Budget, References and Appendices:**

These sections should be the same as your project proposal, updated to reflect your better understanding of the project, and revised as suggested by your mentors. If you do not agree with a suggested revision you should discuss it with your mentor. A note on the presentation: you’ll notice that for this and each subsequent presentation, including the final presentation, you are still limited to 15 minutes even though you have more to talk about each time.

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**A. COSC/ECE 401 – Preliminary Design Report Rubric**

Student: \_\_\_\_\_ Reviewer: \_\_\_\_\_

Customer: \_\_\_\_\_

Criteria or Requirement	Comments	Suggested Word Count	Points
<b>Front Matter</b> Title Page – student name, project title, course and number, name of report, date submitted, and student signature. Executive Summary – problem statement and description of top five ECs Concise and on its own page; ahead of ToC/LoF/LoT, no page #s Table of Contents, List of Figures, and List of Tables		500	/3
<b>Problem Definition &amp; Background</b> Section revised and updated		500	/5
<b>Requirements Specification</b> Section revised and updated		500	/5
<b>Technical Approach</b> Clear and concise overview of solution approach System decomposed as appropriate Major design decisions identified, with relevant ECs		500	/10
<b>Design Concepts, Evaluation &amp; Selection</b> For each major design decision: <ul style="list-style-type: none"> <li>- Description of at least two alternative concepts</li> <li>- Relevant figures included</li> <li>- Performance prediction for relevant ECs given each concept</li> <li>- Weighted decision matrix and discussion</li> <li>- Statement of concept selected with explanation</li> </ul> Concluding paragraph (with figure if relevant) summarizing the overall concept for the solution including the different design decisions discussed		1000	/50
<b>Project Deliverables</b> Section revised and updated		500	/3
<b>Project Management</b> Section revised and updated		500	/3
<b>Budget</b> Section revised and updated		500	/2
<b>References</b> Section revised and updated		200	/2
<b>Appendices (Quad Chart / Business Matrix Canvas)</b> Revised and updated		300	/2
<b>Formatting</b> Figure/table formatting (centered, numbered, captioned, referenced) Justification and pagination Clean and professional appearance			/5
<b>Style</b> Strong, logical narrative / Correct voice (third person) Appropriate tense – consistent with narrative for each section Grammar and spelling; evidence of proofreading			/10
<b>Overall</b>		5000	/100

## COSC/ECE 401 Engineering Design - Capstone Design Project Guidance

### **B. COSC/ECE 401 – Preliminary Design Presentation Rubric**

Student: \_\_\_\_\_

Reviewer: \_\_\_\_\_

Topic	Not Meets Expectations	Meets Expectations	Exceeds Expectations	Possible	Awarded
Problem Definition & Background	Not included or revisions ignored	Further revision or update necessary	Appropriately revised and updated	5	
Requirements Specification	Not included or revisions ignored	Further revision or update necessary	Appropriately revised and updated	5	
Technical Approach	Not included	Incl. but project overview and decomposition are insufficient	Good birds-eye view of approach and sufficient decomposition	5	
Design Decision Identification	Not included	Major design decisions left unaddressed; or things falsely identified as design decisions	All major design decisions identified	5	
Design Concepts	Alternate concepts not developed	At least two concepts considered but concepts not fully developed or obvious alternatives were neglected.	Multiple concepts considered. Concepts fully developed. All obvious concepts considered.	20	
Concept Evaluation	Concepts left unevaluated	Concepts evaluated but only qualitatively.	Concepts evaluated using sound technical reasoning, including calculations were appropriate	20	
Concept Selection	Not included	Concepts selected but insufficiently justified	Sound selection decisions utilizing concept selection methodology taught in class	10	
Deliverables, Project Management & Budget	Not included or revisions ignored	Further revision or update necessary	Appropriately revised and updated	5	
Slide Quality	Unorganized. Impossible to follow.	Slides wordy or hard to follow.	Slides visually stimulating. One idea per slide. Good use of images.	5	
Delivery	Talking to the screen.	Low energy but at least facing audience.	Dynamic and engaging.	5	
Professionalism	Wrong business attire. Late. Egregious typos in slides	Correct business attire. Some typos in slides that indicate last-minute scrambling.	Correct business attire. Slides proofread, loaded and ready to go at start.	5	
Response to Questions	Unresponsive or defensive	Answered questions but with some rambling.	Answered questions concisely and correctly	5	
Timeliness	10 min > time > 18 min	10 min < time < 13 min or 15 min < time < 18 min	13 min < time < 15 min	5	

Comments:

Total Score (out of 100) \_\_\_\_

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## **VIII. COSC/ECE 402 – Preparation of the Detailed Design Report Description**

### ***Purpose***

Design is a process which involves making decisions at successively finer levels of detail; from enumerating functions, to identifying systems and subsystems to carry out those functions, to designing and selecting specific components, to manufacturing and assembling those components. The purpose of the **Detail Design Report (DDR)** is to lay out the project in a sufficient level of detail such that you and your evaluators know exactly how you will accomplish your project goal. This is during the second semester for COSC\_ECE 402.

### ***Content***

As with each previous report, the DDR should build upon the previous iteration.

#### **Restatement of Problem Definition, Background, Requirements, Technical Approach, and Design Concepts Sections**

These sections should be the same as your project proposal, updated to reflect your better understanding of the project, and revised as suggested by your mentors. If you do not agree with a suggested revision you should discuss it with your mentor.

#### **Embodiment Design**

Begin by presenting your product architecture, specifying the modules of your system, their inputs and outputs, and how the modules interact. Use graphics as appropriate to explain your project. This might include block diagrams or flow charts as is appropriate to your project.

Then, discuss configuration design. This section should get into the weeds of every module of your system, describing and justifying things such as component selection and the choice of operating system or programming language. Also, be sure to discuss how engineering best practices were incorporated into your design (for example, considering a safety margin for the maximum amperage when selecting a wire gauge).

For any parts that will need to be made, this section should reference detailed engineering drawings, contained in an appendix. You may also wish to include product data sheets for key components that you will purchase as another appendix.

Use calculation, modeling, and sound technical estimation to justify your decisions. At this stage, you are *encouraged* to make lots of models and/or mockups and try them out! The idea is to ensure you've considered the elements of embodiment design and that you've made your design choices based on objective engineering. Also, nothing says these reports have to be dry and boring (they must, however, remain professional). Please feel free to write in a narrative (still third person!) style including all attempts and failures, and plenty of photos!



## **COSC/ECE 402 - Engineering Design Capstone Design Project Guidance**

### **Prototype Test Plan**

Ultimately, you will need to demonstrate how your project has met your original design objectives, which should be fully captured by your engineering characteristics. This section of the DDR describes how you are going to make your case that your design objectives have been met. To do this, you should design a set of experiments that address the five most important engineering characteristics for your project. In the main body of your DDR you should describe these experiments in conversational terms—describing what you plan to do in each test, what variables you will fix and what variables you will alter, and the result you would expect. In this section you should also make reference to the Appendix where you will include test matrices which lay out every detail for those experiments (see the text for examples of test matrices).

### **Restatement of Deliverables, Project Management, Budget, and References**

These sections should be updated to reflect your better understanding of the project and revised as suggested by your mentors. If you do not agree with a suggested revision you should discuss it with your mentor. The Project Management and Budget sections in particular should be revised reflect the level of detail of the DDR. You should also now include a Gantt chart with detailed tasking and milestones as an appendix and the Gantt chart should match your discussion of project management in the text.

### **Appendices**

In addition to the quad chart and house of quality (if required) that you had in your earlier reports, you should also now include appendices for your test plan matrices and your project Gantt chart. There may be other materials, such as engineering drawings and component data sheets, that should also be included depending on the project.

# COSC/ECE 402 - Engineering Design Capstone Design Project Guidance

## A. COSC/ECE 402 – Detailed Design Report Rubric

Team: \_\_\_\_\_ Reviewer: \_\_\_\_\_

Customer: \_\_\_\_\_

Criteria or Requirement	Comments	Target Word Count	Points
<b>Front Matter</b> Title Page – student name, project title, course and number, name of report, date submitted, and student signature. Executive Summary – problem statement and description of top five ECs Concise and on its own page; ahead of ToC/LoF/LoT, no page #s Table of Contents, List of Figures, and List of Tables		250	/2
<b>Problem Definition &amp; Background</b> Section revised and updated		250	/1
<b>Requirements Specification</b> Section revised and updated		250	/1
<b>Technical Approach</b> Section revised and updated		500	/5
<b>Design Concepts, Evaluation &amp; Selection</b> Section revised and updated		500	/5
<b>Embodiment Design</b> Includes product architecture: -Spatial layout including visual aids -Discussion of interaction between modules -Inputs, outputs for each module Includes configuration design: -Component selection—specifying part numbers and justification for selection -Drawings, material and process selection and justification manufactured parts -Detailed process flow for algorithms, including specification of data format & processing environment. -Best practices considered		1000	/25
<b>Test Plan</b> Description of how you plan to evaluate performance for each EC (Test plan matrices should be included in Appendices)		500	/18
<b>Project Deliverables</b> Section revised and updated		500	/1
<b>Project Management</b> Section revised and updated, (Gantt chart included as an appendix)		500	/5
<b>Budget</b> Section revised and updated		500	/1
<b>References</b> Section revised and updated		250	/1
<b>Appendices</b> Quad Chart, Business Matrix Canvas, revised and updated Engineering Drawings for parts to be Manufactured (if relevant) Test Plan Matrices—required for all projects, Draft Patent Application Gantt Chart—required for all projects		1000	/10
<b>Formatting</b> Figure/table formatting (centered, numbered, captioned, referenced) Justification and pagination Clean and professional appearance			/5
<b>Style</b> Strong, logical narrative / Correct voice (third person) Appropriate tense – consistent with narrative for each section Grammar and spelling; evidence of proofreading			/10
<b>Overall</b>		<b>6000</b>	<b>/100</b>

**COSC/ECE 402 - Engineering Design  
Capstone Design Project Guidance**

**COSC/ECE 402 - Capstone Design Project Guidance**

***B. COSC/ECE 402 – Detailed Design Presentation Rubric***

Student:

Reviewer:

<b>Topic</b>	<b>Not Meets Expectations</b>	<b>Meets Expectations</b>	<b>Exceeds Expectations</b>	<b>Possible</b>	<b>Awarded</b>
Problem Definition & Background	Not included or revisions ignored	Further revision or update necessary	Appropriately revised and updated	<b>5</b>	
Requirements Specification	Not included or revisions ignored	Further revision or update necessary	Appropriately revised and updated	<b>5</b>	
Technical Approach	Not included	Incl. but project overview and decomposition are insufficient	Good birds-eye view of approach and sufficient decomposition	<b>5</b>	
Design Decision Overview	Not included	Incl. but too much time spent rehashing the last presentation	Concise reminder of the design decisions made and why	<b>5</b>	
Product Architecture	Not included	Unclear	Clearly and concisely explained; inputs, outputs and module interactions detailed	<b>10</b>	
Configuration Design	Not included or significantly incomplete	Components/ functions listed, but specifics undetermined or unclear	All components and details specified; consideration of best practices	<b>20</b>	
Analysis and Calcs to Support Design/Selection	Not included or significantly incomplete	Analysis incomplete or not well correlated to design choices	Clear justification for design choices and sound supporting analysis	<b>10</b>	
Prototype Test Plan	Not included or significantly incomplete	All or most necessary info. presented but unprepared to test immediately	Detailed testing plan; prepared to begin prototype evaluation immediately	<b>10</b>	
Plans for Completion Project Management	Missing milestones or unrealistic expectations	Optimistic expectations; likely will require significant extra time	Key milestones clearly identified; timely completion expected	<b>5</b>	
Budget	Missing or incomplete	Insufficient revision/level of detail for conclusive projection	Detailed and complete with revised cost estimates	<b>5</b>	
Communication clarity and visual presentation	Unpracticed, unorganized, and unengaging; not focused on audience	Evidence of preparation but some rambling or tangents; slides adequate	Obvious preparation; professional speech; slides visually stimulating	<b>10</b>	
Complete within time allotted	10 min > time > 18 min	10 min < time < 13 min or 15 min < time < 18 min	13 min < time < 15 min	<b>10</b>	

**COSC/ECE 402 - Engineering Design  
Capstone Design Project Guidance**

**Comments:**

**Total Score (out of 100)** \_\_\_\_\_

## COSC/ECE 402 - Engineering Design Capstone Design Project Guidance

### IX. COSC/ECE 402 – Preparation of the Draft Patent Application

#### *Purpose*

Novel designs should be reviewed by your team, sponsor, and university to determine if sufficient **Intellectual Property (IP)** should be protected. Guidance for students, faculty, and staff as cited below by UT's Office of Research & Engagement, can be found on website <https://research.utk.edu/ip/student-ip/>

Some IP can be protected by patent applications and should be considered in every Capstone Design Project. The purpose of the draft **Patent Application** is to lay out the project in a sufficient level of detail that the IP of your team's invention can be protected. This is during the second semester for COSC/ECE 402.

#### *Intellectual Property Guidance for UT Students*

UT students often ask, "Why should I protect my intellectual property?" UT's policy states the protecting your intellectual property excludes others from it. No one can take your idea and profit from it. If you want to make money or start your own business, you need to protect your intellectual property.

With the exception of capstone design projects funded by an outside organization or agency, if you are employed by the university, the intellectual property belongs to UT. The is UT owns the intellectual property of all its employees who use UT facilities and resources. (If you receive a W-2 from UT at the end of the year, even as an undergraduate, you're considered an employee.) You should submit an invention disclosure to the University of Tennessee Research Foundation (UTRF) via [idea.tennessee.edu/](http://idea.tennessee.edu/) if you fit this criteria.

If you work outside UT but are still getting paid by UT or have funding through UT, the intellectual property belongs to UT. If funding comes from the facility, you are subject to their regulations. For example, if you're being paid by Oak Ridge National Laboratory (ORNL) or other facility as an employee, then the intellectual property belongs to ORNL. If you are being paid by ORNL or other facility through a stipend, then you have options you'll want to discuss with the UT Research Foundation if you think you have something worth patenting and want to know your options.

Finally, guidelines are if you are not employed by UT and not working at an outside facility, you own your intellectual property.

#### *Campus Resources*

**Anderson Center for Entrepreneurship & Innovation (ACEI)** – Located in the Haslam College of Business, the ACEI is open and available to any UT student – both undergraduate and graduate student. The Anderson Center offers coaching and mentoring to

## **COSC/ECE 402 - Engineering Design Capstone Design Project Guidance**

students with ideas. Vol Court, a pitch competition, is a great way to get started. Or just schedule an appointment for a consultation.

**UT Research Foundation (UTRF)** – As a non-profit 501(c)3 organization, the UTRF promotes commercialization of UT intellectual property and is available to work with both the campus and the community in exploring their idea and help move ideas to the marketplace. They are available to help you navigate the patent process whether you invent something in class, in your garage, or while on an internship. They can even work with you once you are an alumni of UT! The bottom line is, the idea stays yours, they help you take it to market. It's good to have someone on your side.

**Business Law and Trademark Clinic** – Located in the College of Law, the Business Law Clinic is open and available to both the campus and the community. The Clinic provides a wide range of services including IP counseling and trademark and copyright registration.

**UT Policy on Patents, Copyrights, and Other Intellectual Property** – The general campus policy on Intellectual Property is available as a reference, but the resources above will provide greater insight. Refer to website for further information.

### ***Content***

In the Capstone Design Project, each team is expected to draft a patent application that would protect the IP of the invention. As with each the Detailed Design Report, the draft patent application should build upon the guidelines:

- Title
- Abstract
- Drawings
- Background of the Invention
- Summary of the Disclosure
- Brief Description of the Drawings
- Detailed Description of the Invention
- Claims

Detailed instruction on drafting and examples of successful patent applications will be reviewed during the lectures and discussion sessions.

**COSC/ECE 402 - Engineering Design  
Capstone Design Project Guidance**

**A. COSC/ECE 402 – Draft Patent Application**

Team: \_\_\_\_\_ Reviewer: \_\_\_\_\_

Customer: \_\_\_\_\_

Criteria or Requirement	Comments	Target Word Count	Points
Title			/50
Abstract		100	/50
Drawings		50	/200
Background of the Invention		100	/100
Summary of the Disclosure		200	/100
Brief Description of the Drawings		50	/100
Detailed Description of the Invention		400	/200
Claims		100	/100
Style Strong, logical narrative / Correct voice (third person) Appropriate tense – consistent with narrative for each section Grammar and spelling; evidence of proofreading			/100
Overall		1000	/100

## COSC/ECE 402 - Capstone Design Project Guidance

### ***B. COSC/ECE 402 – Draft Patent Application Presentation Rubric***

Student: \_\_\_\_\_

Reviewer: \_\_\_\_\_

<b>Topic</b>	<b>Not Meets Expectations</b>	<b>Meets Expectations</b>	<b>Exceeds Expectations</b>	<b>Possible</b>	<b>Awarded</b>
Title	Not included or revisions ignored	Further revision or update necessary	Appropriately revised and updated	<b>10</b>	
Abstract	Not included or revisions ignored	Further revision or update necessary	Appropriately revised and updated	<b>10</b>	
Drawings	Not included	Included but project overview and decomposition are insufficient	Good birds-eye view of approach and sufficient decomposition	<b>10</b>	
Background of the Invention	Not included	Included but too much time spent rehashing the last presentation	Concise reminder of the design decisions made and why	<b>10</b>	
Summary of the Disclosure	Not included	Unclear	Clearly and concisely explained; inputs, outputs and module interactions detailed	<b>10</b>	
Brief Description of the Drawings	Not included or significantly incomplete	Components/functions listed, but specifics undetermined or unclear	All components and details specified; consideration of best practices	<b>10</b>	
Detailed Description of the Invention	Not included or significantly incomplete	Analysis incomplete or not well correlated to design choices	Clear justification for design choices and sound supporting analysis	<b>10</b>	
Claims	Not included or significantly incomplete	All or most necessary info. presented but unprepared to test immediately	Detailed testing plan; prepared to begin prototype evaluation immediately	<b>10</b>	
Communication clarity and visual presentation	Unpracticed, unorganized, and unengaging; not focused on audience	Evidence of preparation but some rambling or tangents; slides adequate	Obvious preparation; professional speech; slides visually stimulating	<b>10</b>	
Complete within time allotted	10 min > time > 18 min	10 min < time < 13 min or 15 min < time < 18 min	13 min < time < 15 min	<b>10</b>	

**Comments:**

**Total Score (out of 100)** \_\_\_\_\_



## **X. End of Term Status Memorandum Guidance**

### ***Purpose***

Your project may be fresh on your mind now, but for most of you at least break will pass before you return to this project. The purpose of this memorandum is to ensure that you leave your project in a state where it can be easily resumed when you return.

### ***Procedure***

You should complete this memo in consultation with your project mentor. It should be addressed to the department capstone director and should be initialed by your project mentor.

### ***Content***

Your memo must contain the following:

- A summary of overall project progress at the conclusion of the semester
- How project documentation (reports, images, code, etc.) is organized and where it is archived. This is easy if you make proper use of the project share drive, however it is recommended that you back up those files before leaving for the semester. You should also make sure that your project mentor has access to all of those files in your absence.
- The procurement status for anything that should be purchased for your project during your absence. Ideally all purchases should be submitted before the end of the semester. If money is not yet available, then you should at least provide the purchasing paperwork so that the items can be quickly purchased as soon as funds are available.
- Your plan for follow on coursework. Here you should explain what future courses you are planning to take that relate to this project and when.
- The plan for where your equipment and materials will be stored in your absence. The location should be secure, and your mentor should have access to it.
- The plan for where you will work when you return to your project. This is to help the capstone coordinator in preserving space for your project when spaces are assigned for your classmates in the Fall. If you have been assigned a particular work bench in the design space, please include that information in addition to the room number.
- Your contact information. Please provide a cell phone number or non-UT e-mail address where your mentor can reach you while you are away from UT in case the need arises.

# COSC/ECE 402 - Engineering Design Capstone Design Project Guidance

## A. End of Term Status Rubric

Team: \_\_\_\_\_

Reviewer: \_\_\_\_\_

Customer: \_\_\_\_\_

Topic	Not Meets Expectations	Meets Expectations	Exceeds Expectations	Points Possible	Awarded
Overall Progress	No progress	Behind schedule but moving forward	On track for completion	50	
Documentation Archive	Not addressed	Included but insufficiently organized or detailed	Archived in an organized fashion that is available to both mentor and student	20	
Procurement Status	Not included	Not all purchases identified or paperwork complete	Purchases identified and paperwork complete for anything to be bought during the break	10	
Follow-on Course Plan for Follow-up Teams	Not provided	Minimal provided	Provided	5	
Equipment and Materials Storage	Not addressed	Addressed but not sufficiently organized or secure	Appropriate location for materiel identified and utilized	5	
Workspace	Not addressed	Given as not yet determined	Workspace has been set aside which will be available when the student returns	5	
Contact Information	Not included	Only UT e-mail address and/or phone number given	Students have provided external contact information (email addresses) that will work for after course completion. <u>Suggestion:</u> Use IEEE, ACM, or Gmail	5	

Comments (Use back if necessary):

Total Score (out of 100) \_\_\_\_\_