CS 25-339: Publicly Detectable Watermarking for Large Language Models

Project Proposal

Prepared for

VCU College of Engineering

By

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Executive Summary

Over the past few years, the use of artificial intelligence has been growing at an extremely high rate. Many people use it in their daily lives to help them with basic tasks such as creating a shopping list or even help in technological ways such as creating a new web application. However, with all the good that artificial intelligence does for us, there are also some downsides that come along with it. There are two main downsides that come with using artificial intelligence: cheating and refeeding the same data back into the AI model. The main purpose why we are working on this project is to minimize these harms as much as we can. Failure to do so can result in cheating in assignments or giving back false data/responses.

So how are we going to achieve our primary objectives? We are going to use “Watermarking” which is the process of embedding unique and easy to find signals/tokens into the output of a large language model. Specific scanning algorithms are used to scan for these specific outputs to detect whether the text/image contains the watermark. There have been many watermarking techniques which have been used to safeguard AI-generated content. Our primary objective is to allow platforms and social media access to the watermarking detection algorithm so that they can detect machine-generated text. We can also keep it private and run with an API for privacy reasons.

There are multiple design requirements which we would like to fulfill. Our main two requirements are security and robustness. We can achieve these by first making the watermarking process only detectable with the algorithm. We want to make sure that no one can detect the watermark without prior knowledge and keep access limited to authorized users. Next, the watermarked text can only be generated using a standard language model without having to retrain it. We also want to make sure that even if someone only has a chunk of the generated text, they can still detect the watermark. We do not want the generated tokens to be removed from the watermarked text. Finally, we want a high mathematical and theoretical confidence that the generated text is watermarked or not.

Artificial Intelligence is going to continue to improve in the future. We want to see these improvements but want to keep the integrity of data. The main reasons why we want integrity is to reduce cheating and re-using training data. Creating a watermark that can be algorithmically detected will allow us to have a high confidence of saying if some generated text/image has been modified or not.

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Section A. Problem Statement

The rapid growth of artificial intelligence has transformed many industries since it can be used for increasing productivity, streamlining processes, and allowing different types of innovation. AI has become a critical tool which can be used for many different things such as developing web applications or coming up with solutions to complex programming tasks. However, it also comes with many drawbacks such as ethical uses and data integrity. This can directly impact software development or even education.

The first primary challenge that we face when using artificial intelligence is the growing concern over academic dishonesty. Nowadays, people can ask AI to program an assignment which causes them to not learn anything. This challenges the integrity and ethics which those people agree to when attending those classes.

Another major problem that artificial intelligence faces is data recycling. This causes major issues as it can lead to degrading models and can lead to higher inaccuracies in the AI's responses. This will make the models less reliable and slow down technological advancements.

Scope of the Problem: The problem is most seen in academic and professional settings where artificial intelligence tools are being used increasingly. Academic settings are facing rising cases of AI-assisted plagiarism which goes against the credibility and integrity of assignments. In professional environments, recycling of data threatens accuracy and efficiency of the AI models that are being used every day. The stakeholders that need to be addressed in this project are AI developers, educational facilities, and end-users. All of them are directly impacted by the quality of AI outputs.

Historical Perspective: Artificial intelligence assisted cheating has been around since the 2010s, with tools like essay generators and code helpers becoming available. There were early efforts that were created to attempt to stop plagiarism using checkers, but AI advanced too quickly with models like ChatGPT. Over time, AI models would recycle data which would affect the accuracy of the data in areas where real-time data is needed.

Relevant Research and Prior Solutions: There have been multiple solutions developed to try and combat AI-assisted cheating with examples such as detecting specific writing patterns or cross-checking content with known AI-generated outputs. However, these types of methods only focus on text. Our project aims to improve previous approaches by utilizing more advanced detection tools which contain preventive measures which should help with ethics and integrity.

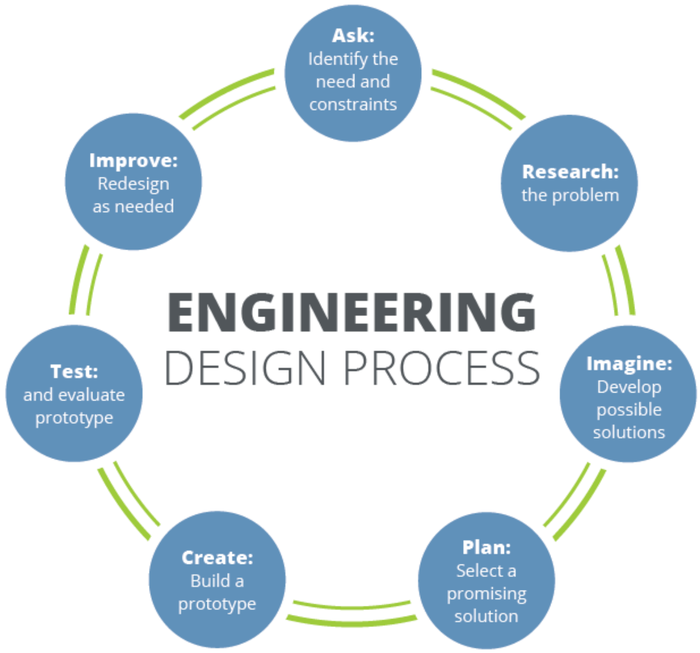


Figure 1. The iterative nature of the engineering design process [2].

Section B. Engineering Design Requirements

B.1 Project Goals (i.e. Client Needs)

The primary goal of this project is to develop a secure and robust watermarking system that embeds unique, detectable signals in AI-generated content (text or images) to minimize harms such as cheating and refeeding data back into AI models. This project aims to allow platforms and social media to detect machine-generated content, ensuring the integrity and authenticity of data while reducing misuse of AI technologies.

B.2 Design Objectives

Security: Ensure that the watermark is only detectable with a proprietary algorithm, limiting access to authorized users. Robustness: Guarantee that the watermark remains detectable even if the watermarked content is only partially available. Non-intrusiveness: The watermark should be embedded without altering the normal output of the language model, so it doesn't require retraining the model. Privacy Options: Provide the flexibility for watermark detection to be run either publicly for platforms or privately through an API to protect data privacy.

B.3 Design Specifications and Constraints

- The watermark should be undetectable without the scanning algorithm.

- Watermarked content should retain the watermark even when sections are removed or altered.

- The system must integrate seamlessly with standard language models, without the need for retraining.

- Detection algorithms must maintain high mathematical and theoretical confidence in determining whether content is watermarked or not.

- The system must be scalable and capable of handling large amounts of generated content in real-time.

B.4 Codes and Standards

The watermarking system will adhere to relevant privacy and data protection laws such as GDPR (General Data Protection Regulation) and CCPA (California Consumer Privacy Act), ensuring that user data is handled securely and responsibly.

Security best practices in software engineering and cryptography will be followed, particularly around access control, encryption, and detection methods.

Standards for ethical AI use will guide the design, ensuring that the system supports transparency, integrity, and trustworthiness in AI-generated content detection.

Section C. Scope of Work

C.1 Deliverables

The deliverables for this project will include a secure watermarking algorithm designed to embed detectable signals into AI-generated text without needing to retrain the model. We will develop a publicly accessible API for watermark detection, which can be used either publicly by platforms or privately for sensitive applications. Along with the working system, we'll deliver comprehensive documentation covering both technical aspects for developers and user instructions. We'll also demonstrate the effectiveness of the watermarking, showing how it remains detectable even if the text is modified or partially removed.

C.2 Milestones

Weeks 1-2: Research and Planning: Start by reviewing existing watermarking techniques to find areas we can improve. We'll also map out our project plan and goals to keep everything on track.

Weeks 3-4: Developing the Watermarking Algorithm: Build the watermarking system using rejection sampling to embed signals in the text. The goal is to do this without changing the model's output quality or needing to retrain it.

Weeks 5-6: API Development and Testing: Develop both public and private APIs for watermark detection. Test them to ensure they run smoothly and securely, meeting all performance requirements.

Week 7: Prototype Demonstration: Present a working prototype of the system and demonstrate how the watermark remains detectable, even if parts of the text are altered or removed.

Week 8: Documentation and Final Review: Finish up by creating detailed documentation for developers and end-users. Review everything to ensure it meets the project's goals and is ready for deployment.

C.3 Resources

To complete the project, we'll need access to pre-trained large language models like ChatGPT to test and embed the watermarks properly. We'll use Python or Java as our main programming language along with tools available on GitHub for building and testing the watermarking algorithms. Cloud-based infrastructure will help us with scalability testing to ensure the system works smoothly in real-time. Our team will work together under the supervision of Professor Hong-Sheng Zhou, and we'll rely on their guidance throughout the project. The GitHub repository for this project will also serve as a key resource for code management and collaboration.

Section D. Concept Generation

A number of methods can be used to help generate design concepts from simple reflection and brainstorming, to working the problem backwards, using reverse thinking techniques, and looking to nature for inspiration (i.e. biomimicry). Existing solutions, or components of existing solutions, can be substituted, combined, adapted, modified, put to other uses, eliminated, or rearranged to meet new design objectives and specifications. A minimum of 3 overall design concepts is required for this section although more are welcome. Provide a brief description of how each design concept addresses the design problem. Discuss the potential pros and cons, including and potential risks of failure, of each of these concepts.

It is likely that each design concept may consist of several components. In this case, one or more of these components may offer a sub-problem that can be further explored, modified, or otherwise improved upon. These sub-problems may lead to the addition of several additional design concepts and may require the inclusion of a design concept chart or matrix to organize all ideas and potential solutions.

Provide any initial design sketches, drawings, 3D renderings, or conceptual models such as dataflow diagrams, process flows, etc. developed during the concept ideation phase. All hand drawings should be drawn to scale using basic engineering drafting tools (i.e. ruler, protractor, and compass). Geometric stencils can also be used to help produce quality hand drawings. Drawings should be presented in a profession manner, preferably done on engineering graph paper and using a high-quality scan. All sketches should be labeled to identify major components and different drawing views or projections if applicable. Basic dimensions should be provided to give a general sense of scale. Label each sketch or drawing with the name of the team member responsible for the sketch, the date it was drawn, and the drawing scale.

Section E. Concept Evaluation and Selection

Using a systematic decision-making process, evaluate each of the design concepts and choose the one that is most likely to succeed in meeting the design objectives and constraints. A Decision Matrix, or Pugh Matrix, helps to analyze alternatives, eliminate biases, and make rational decisions through thought and structure. First, work to develop a set of selection criteria for which to evaluate the previously generated design concepts. Selection criteria often include concepts of performance, cost, safety, reliability, risk, etc. Note that the selection criteria developed here will likely be more general than the project design objectives. As with the design objectives, conversations with the client help define appropriate selection criteria.

In many cases, the client may value the selection criteria differently, preferring that more emphasis be placed on some than others. In this case, weighting factors may be used to place more or less importance on the various criteria in the decision making process. Again, conversations with the client can be used to define criteria weighting factors. Often times, these conversations must be analyzed and interpreted by the team to determine which criteria are more important to the client and by how much. Feel free to discuss the assigned weighting factors with the client to see if they seem accurate.

Next, define an associated metric to represent each criteria. Metrics should be specific and quantifiable, providing numerical values that quantify the often vague concepts of the selection criteria. Metrics can be obtained, generated, or estimated through a number of methods including simple background research, preliminary design calculations, or basic analyses. Note that these metrics do not need to specifically align with the design specifications although there may be some commonality between the two. Provide a brief discussion of the rationale for selecting each of the assigned metrics.

Using the defined metrics, evaluated each design concept against all selection criteria by filling out a Decision Matrix. Design concepts can be compared by using simple rank scoring, raw scoring, or weighted scoring techniques and design concept with which to move forward can be selected. This type of process provides a meaningful, unbiased means for choosing a preliminary design concept prior to moving forward with more comprehensive, detailed analyses as provided in the design methodology section below. The results of this process should be discussed with the project client prior to moving forward with the selected design. Table 1 provides an example of a simple decision matrix.

Table 1. Example of a Decision Matrix.

	Design Concept A	Design Concept B	Design Concept C	Design Concept D
Criteria 1				
Criteria 2				
Criteria 3				
Criteria 4				
Criteria 5				
Total Score				

Note: Weights can be assigned to each criterion if desired.

Section F. Design Methodology

Provide a detailed explanation of the methods that will be used to help evaluate, improve, and evolve the design through the iterative engineering design process. Consider that ultimately, the final design must be verified and validated to ensure that it meets all of the previously developed and listed design objectives and specifications. Verification ensures that the design meets all specification, while validation confirms that the design functions as intended such to meet the client's needs. While it is common for initial design concepts to first be evaluated using simplified design criteria and metrics, the chosen design should be advanced, and later verified, using engineering calculations, computational models, experimental data, and/or testing procedures.

Use this section to describe any underlying physical principles and mathematical equations that govern the design. Provide details of any computer-aided modeling techniques used to evaluate the design including the software used, prescribed boundary conditions, and assumptions. Include a detailed description of any experimental testing methods including required testing equipment, test set-up layout, data acquisition and instrumentation, and testing procedures. If one or more prototypes is to be produced and tested, provide a detailed description of how each will be evaluated.

Note: The contents of this section are expected to vary from project to project. Subsections may be appropriate for providing details of analytical, computational, experimental, and/or testing methods. Some potential subsections that may be included in this section are provided. While critical design equations may be provided here, lengthy mathematical derivations may be included in an appendix. Validation procedures are critical and all projects should address such topic.

F.1 Computational Methods (e.g. FEA or CFD Modeling, example sub-section)

F.2 Experimental Methods (example subsection)

F.3 Architecture/High-level Design (example subsection)

F.5 Validation Procedure

Describe how the design team will validate that the final design meets the client's needs. This section should include a plan to meet with the client towards the end of the project to discuss final design details and demonstrate a prototype, experimental test, and/or simulation results. Provide a relative time frame for this validation to occur (e.g. "mid-March" or "early-April"). Include a brief discussion on how client feedback will be captured, such as a formal survey, interview, or observation notes of the client using the prototype. It may also include plans to solicit feedback from other stakeholders and/or potential users.

Section G. Results and Design Details

Use this section to highlight the major results of the design methodology described above including important analytical, computational, experimental, modeling, assembly, and testing results. This section should be one of the most substantial sections of the report showcasing all of the hard work and effort that went into the completion of the final design and delivery of the project deliverables. Show how the identified problem was solved.

Highlight the prominent features of the final design through analysis results, modeling, drawings, renderings, circuit schematics, instrumentation diagrams, flow and piping diagrams, etc. to show that the design functions as intended and meets all design objectives and constraints. Overview designs such as dataflow diagrams, process flow, swim lane diagrams, as well as presentation-layer designs (e.g. storyboards for front-ends) should be included here. Detailed designs such as database designs, software designs, procedure flowcharts, or pseudocode should be included here. Support computational and experimental results with key plots and figures. All supporting figures should be clearly labeled and annotated to highlight the most important points of the figure (i.e. explicitly point out what the reader should focus on or understand about the image).

Note that while all results should be used to help inform design decisions, not all results may be necessary to include in the main body of the report. Extraneous supporting results (e.g. graphs, data, design renderings, drawings, etc.) that are not necessary for presenting the fundamental findings can be placed in one or more appendices. Detailed documentation of each program module can be provided as appendix.

G.1 Modeling Results (example subsection)

G.2 Experimental Results (example subsection)

G.3 Prototyping and Testing Results (example subsection)

G.4. Final Design Details/Specifications (example subsection)

Note that while the design constraints and specifications may have provided minimum or maximum values, or ranges or values, that the design needed to meet, the final design specifications should be listed here showing that the required design values were met. A list of final design details can also be included demonstrate fulfillment of the design objectives.

Note: Preliminary results should be included in the Preliminary Design Report to show the progress made of the selected design concept to-date. This section should be updated for the

Final Design Report to include documentation of all of the work that was completed on the project throughout the entirety of the academic year.

Section H. Societal Impacts of Design

In addition to technical design considerations, contemporary engineers must consider the broader impacts that their design choices have on the world around them. These impacts include the consideration of public health, safety, and welfare as well as the potential societal, political/regulatory, economic, environmental, global, and ethical impacts of the design. As appropriate for the project design, discuss how each of these considerations influenced design choices in separate subsections. How will the design change the way people interact with each other? What are the political implications of the design? Does the technology have the potential to impact or shift markets? Does the design have any positive or negative effects on the environment? Don't forget to consider unintended consequences such as process or manufacturing byproducts. What impacts might the design have on global markets and trade? Are there any ethical questions related to the design?

While it is hard to forecast the various impacts of a technology, it is important to consider these potential impacts throughout the engineering design process. When considered during the early stages of the design phase, consideration of these impacts can help determine design objectives, constraints, and specifications and help drive design choices that may mitigate any potential negative impacts or unintended consequences.

Note: A minimum of 4 of these design considerations, including the consideration of public health, safety, and welfare, are required for the Preliminary Design Report while a section for all considerations must be included in the final design report.

H.1 Public Health, Safety, and Welfare

Provide a list of all design safety features and provide a brief description of each. Discuss the potential effects the design may have on public health, safety, and welfare. References to the codes and standards previous provided and the organizations that produced them may be summarized or referenced here.

H.2 Societal Impacts

H.3 Political/Regulatory Impacts

H.4. Economic Impacts

H.5 Environmental Impacts

H.6 Global Impacts

H.7. Ethical Considerations

Section I. Cost Analysis

Provide a simple cost analysis of the project that includes a list of all expenditures related to the project. If an experimental test set-up or prototype was developed, provide a Bill of Materials that includes part numbers, vendor names, unit costs, quantity, total costs, delivery times, dates received, etc. Do not forget to include all manufacturing costs incurred throughout the completion of the project. If the design is expected to become a commercial product, provide a production cost estimate including fixed capital, raw materials, manufacturing (including tooling and/or casting), and labor costs to produce and package the device. Note that this type of detailed cost analysis may be listed as a project deliverable.

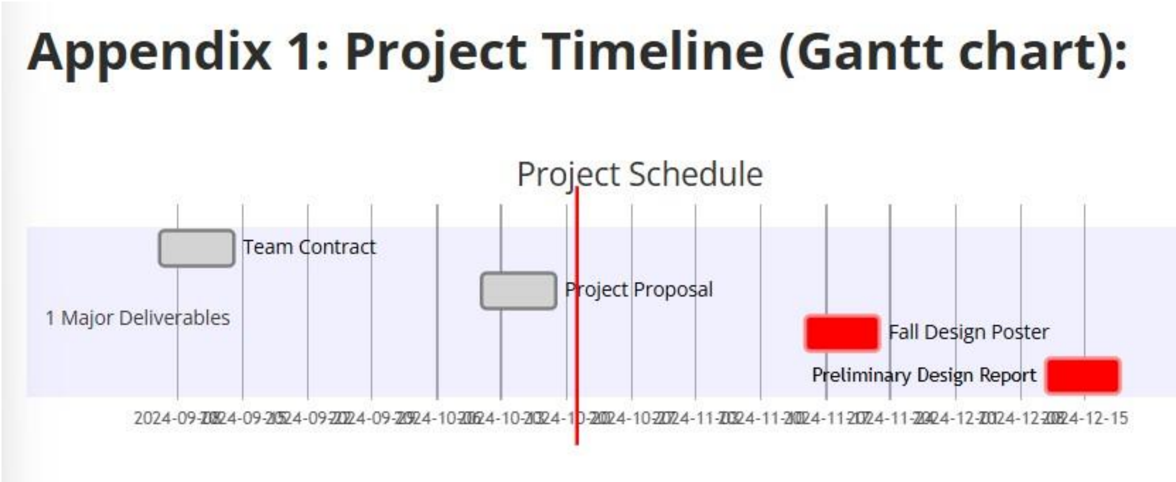
Note: The Preliminary Design Report should include all costs incurred to date. It is expected that this section will be expanded and updated between the preliminary and final design reports.

Section J. Conclusions and Recommendations

Use this section to summarize the story of how the design team arrived at the final design. Focus on the evolution of the design through the use of the engineering design process including lessons learned, obstacles overcome, and triumphs of the final design. Revisit the primary project goals and objectives. Provide a brief summary of the final design details and features paramount to the function of the design in meeting these goals and objectives.

A discussion may be included to discuss how the design could be further advanced or improved in the future. If applicable, summarize any questions or curiosities that the final results/design of this effort bring to mind or leave unanswered. If this project might continue on as a future (continuation) senior design project, detail the major milestones that have been completed to date and include any suggested testing plans, relevant machine drawings, electrical schematics, developed computer code, etc. All relevant information should be included in this section such that future researchers could pick up the project and advance the work in as seamless a manner as possible. Documents such as drawings, schematics, and codes could be referenced here and included in one or more appendix. If digital files are critical for future work, they should be saved on a thumb drive, external hard drive, cloud, etc. and left in the hands of the project advisor and/or client.

Appendix 1: Project Timeline



Appendix 2: Team Contract (i.e. Team Organization)

Step 1: Get to Know One Another. Gather Basic Information.

Task: This initial time together is important to form a strong team dynamic and get to know each other more as people outside of class time. Consider ways to develop positive working relationships with others, while remaining open and personal. Learn each other's strengths and discuss good/bad team experiences. This is also a good opportunity to start to better understand each other's communication and working styles.

Team Member Name	***Strengths each member bring to the group***	***Other Info***	***Contact Info***
Neil Inge	*Computer Science Skills and strong understanding of data structures, algorithms, and solving complex problems.*	These strengths allow me to solve difficult problems in a timely and efficient manner. I have some experience coding in Python and Java.	ingen@vcu.edu 804-687-6257
Joe Hughes	*Communication, leadership, collaboration, hard-working*	*I enjoy being a part of a team and meeting new people. I also like doing a lot of research into a topic before we start to*	hughesj5@vcu.edu 804-833-0329

		help us in the beginning.	
Ronit Sharma	Communication, industry experience, collaborative spirit	I love being a part of a collaborative effort, and as a part of a team I try and prioritize multiple perspectives and approaches to the work at hand.	sharmarp@vcu.edu 571-345-6694
Waleed Elbanna	Communication, effective research, and problem-solving	I enjoy working on projects and always try to learn and improve my skills if an issue arises.	elbannawa@vcu.edu +1 (804) 502-1328

Other Stakeholders	***Notes***	***Contact Info***
Faculty Advisor and Sponsor *Hongsheng Zhou*		*hszhou@vcu.edu*

Step 2: Team Culture. Clarify the Group's Purpose and Culture Goals.

Task: Discuss how each team member wants to be treated to encourage them to make valuable contributions to the group and how each team member would like to feel recognized for their efforts. Discuss how the team will foster an environment where each team member feels they are accountable for their actions and the way they contribute to the project. These are your Culture Goals (left column). How do the students demonstrate these culture goals? These are your Actions (middle column). Finally, how do students deviate from the team's culture goals? What are ways that other team members can notice when that culture goal is no longer being honored in team dynamics? These are your Warning Signs (right column).

Resources: More information and an example Team Culture can be found in the Biodesign Student Guide "Intentional Teamwork" page (webpage | PDF)

Culture Goals	***Actions***	***Warning Signs***
Being on time to every meeting	- Set up meetings in shared calendar - Send reminder e-mail in day before meeting	- Student misses first meeting, warning is granted - Student misses meetings afterwards – issue is brought up with faculty advisor

Informing the group of any delays in completing assignments	- Stay up to date with each other's project responsibilities - Set reasonable deadlines and note when an extension is needed	- Student shows up for weekly meeting with no considerable work done

Helping Each Other When Needed	-If a partner is struggling and falling behind in their part of the project, we need to help each other so the whole project doesn't fall behind.	• Student falls behind and no one helps to fix it, resulting in the project coming to a halt.

Step 3: Time Commitments, Meeting Structure, and Communication

Task: Discuss the anticipated time commitments for the group project. Consider the following questions (don't answer these questions in the box below):

- What are reasonable time commitments for everyone to invest in this project?
- What other activities and commitments do group members have in their lives?
- How will we communicate with each other?
- When will we meet as a team? Where will we meet? How Often?
- Who will run the meetings? Will there be an assigned team leader or scribe? Does that position rotate or will same person take on that role for the duration of the project?

Required: How often you will meet with your faculty advisor advisor, where you will meet, and how the meetings will be conducted. Who arranges these meetings?

See examples below.

Meeting Participants	*Frequency* *Dates and Times / Locations*	*Meeting Goals* *Responsible Party*
Students Only	As Needed, On Discord Voice Channel This will be on Thursdays at around 2pm. Joe will be arranging the meetings.	Update group on day-to-day challenges and accomplishments (Avery will record these for the weekly progress reports and meetings with advisor)
Students + Faculty advisor/Sponsor	Our faculty advisor and sponsor are the same person. We have already sent an email where he will be joining us every week on Thursdays as well. He is also available Monday and Wednesday mornings.	Update faculty advisor and get answers to our questions The faculty advisor will also help us if we are struggling with a specific topic such as cryptography.

Step 4: Determine Individual Roles and Responsibilities

Task: As part of the Capstone Team experience, each member will take on a leadership role, ***in addition to*** contributing to the overall weekly action items for the project. Some common leadership roles for Capstone projects are listed below. Other roles may be assigned with approval of your faculty advisor as deemed fit for the project. For the entirety of the project, you should communicate progress to your advisor specifically with regard to your role.

- **Before meeting with your team**, take some time to ask yourself: what is my "natural" role in this group (strengths)? How can I use this experience to help me grow and develop more?

● **As a group,** discuss the various tasks needed for the project and role preferences. Then assign roles in the table on the next page. Try to create a team dynamic that is fair and equitable, while promoting the strengths of each member.

Communication Leaders

Suggested: Assign a team member to be the primary contact for the client/sponsor. This person will schedule meetings, send updates, and ensure deliverables are met.

Suggested: Assign a team member to be the primary contact for faculty advisor. This person will schedule meetings, send updates, and ensure deliverables are met.

Common Leadership Roles for Capstone

1. **Project Manager:** Manages all tasks; develops overall schedule for project; writes agendas and runs meetings; reviews and monitors individual action items; creates an environment where team members are respected, take risks and feel safe expressing their ideas.

Required: On Edusourced, under the Team tab, make sure that this student is assigned the Project Manager role. This is required so that Capstone program staff can easily identify a single contact person, especially for items like Purchasing and Receiving project supplies.

2. **Logistics Manager:** coordinates all internal and external interactions; lead in establishing contact within and outside of organization, following up on communication of commitments, obtaining information for the team; documents meeting minutes; manages facility and resource usage.

2. **Financial Manager:** researches/benchmarks technical purchases and acquisitions; conducts pricing analysis and budget justifications on proposed purchases; carries out team purchase requests; monitors team budget.

2. **Systems Engineer:** analyzes Client initial design specification and leads establishment of product specifications; monitors, coordinates and manages

integration of sub-systems in the prototype; develops and recommends system architecture and manages product interfaces.

2. **Test Engineer:** oversees experimental design, test plan, procedures and data analysis; acquires data acquisition equipment and any necessary software; establishes test protocols and schedules; oversees statistical analysis of results; leads presentation of experimental finding and resulting recommendations.

2. **Manufacturing Engineer:** coordinates all fabrication required to meet final prototype requirements; oversees that all engineering drawings meet the requirements of machine shop or vendor; reviews designs to ensure design for manufacturing; determines realistic timing for fabrication and quality; develops schedule for all manufacturing.

Team Member	***Role(s)***	***Responsibilities***
Joe Hughes	Project Manager/Financial Manager	• Keep a detailed record of meeting notes and share with group • Send out weekly emails and other correspondence • Make sure everyone understands what is going on and keeps them on the same page • Reminders on assignments/important due dates • Research and figure out how much our budget will be for resources and then allocate the time to purchase needs.

Waleed Elbanna	Systems Engineer	Analyzes Client initial design specification and leads establishment of product specifications; monitors, coordinates and manages integration of sub-systems in the prototype; develops and recommends system architecture and manages product interfaces.
Neil Inge	Logistics Manager	coordinates all internal and external interactions; lead in establishing contact within and outside of organization, following up on communication of commitments, obtaining information for the team; documents meeting minutes; manages facility and resource usage.
Ronit Sharma	Test Engineer	oversees experimental design, test plan, procedures and data analysis; acquires data acquisition equipment and any necessary software; establishes test protocols and schedules; oversees statistical analysis of results; leads presentation of experimental finding and resulting recommendations.

Step 5: Agree to the above team contract

Team Member: Joe Hughes	*Signature: Joe Hughes*
Team Member: Waleed Elbanna	*Signature: Waleed Elbanna*
Team Member: Neil Inge	*Signature: Neil Inge*
Team Member: Ronit Sharma	*Signature: Ronit Sharma*

Appendix 3: [Insert Appendix Title]

Note that additional appendices may be added as needed. Appendices are used for supplementary material considered or used in the design process but not necessary for understanding the fundamental design or results. Lengthy mathematical derivations, ancillary results (e.g. data sets, plots), and detailed mechanical drawings are examples of items that might be placed in an appendix. Multiple appendices may be used to delineate topics and can be labeled using letters or numbers. Each appendix should start on a new page. Reference each appendix and the information it contains in the main text of the report where appropriate.

Note: Delete this page if no additional appendices are included.

References

Provide a numbered list of all references in order of appearance using APA citation format. The reference page should begin on a new page as shown here.

[1] Kirchenbauer, J., Geiping, J., Wen, Y., Katz, J., Miers, I., & Goldstein, T. (2023, June 6). A Watermark for Large Language Models. ArXiv.org. https://doi.org/10.48550/arXiv.2301.10226