

Assessing the Impact of the Use of Generative AI in Developing and Using Assessment Grading Rubrics for Engineering Courses

Dr. THOMAS AMING'A OMWANDO, Simpson University

Dr. Thomas Omwando holds a PhD in Industrial Engineering from the University of Wisconsin Milwaukee. He is the Chair and Associate Professor of Engineering at Simpson University and his teaching interests are in statistical quality control, engineering/project management, engineering economy, capstone design and production and operations analysis. His research interests are in sustainable manufacturing, entrepreneurially minded learning, project based learning, and the use of generative AI in enhancing engineering education

Dr. Adel Alhalawani, Rose-Hulman Institute of Technology

Dr. Adel Alhalawani's teaching interests include engineering design, biomechanics, statics and mechanics of materials, biomaterials and design of manufacturing. His research has focused on bio-glass based adhesives for orthopedic applications and dental-based adhesives.

Dr. Ashutosh Khandha, University of Delaware

Ashutosh Khandha is an Assistant Professor in the Biomedical Engineering Department at the University of Delaware, with work experience both in Industry and Academia. His interests and expertise pertain to Engineering Education and Accreditation, Forensic Biomechanics, Medical Devices, Clinical Imaging and Bioinstrumentation.

Dr. Bhavana Kotla, The Ohio State University

Visiting Assistant Professor, Department of Engineering Education, College of Engineering, The Ohio State University

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Abstract

Engineering education is rapidly integrating generative artificial-intelligence (GenAI) tools that promise faster, more consistent assessment—yet their reliability in discipline-specific contexts remains uncertain. This mixed-methods study compared ChatGPT-4, Claude 3.5, and Perplexity AI across four undergraduate engineering assignments (two lower-level, two upper-level). Quantitative analyses—one-way ANOVA followed by Tukey’s HSD ($\alpha = .05$) contrasted AI scores with expert grades, while qualitative feedback from faculty and students captured perceptions of clarity, fairness, and workload. ChatGPT-4 mirrored expert grades on complex tasks ($|\Delta| \leq 3.5\%$), whereas Claude 3.5 and Perplexity AI under-scored upper-level work by as much as 27%. Stakeholders appreciated the rubric’s consistency and faster turnaround but criticized the models’ rigidity and opaque rationales. These findings support a hybrid approach in which AI tools provide baseline scores and instructors supply higher-order judgement. Further research should examine discipline-specific fine-tuning and the long-term impact of AI-assisted grading on student learning and educator workload.

1. Introduction

The integration of Generative Artificial Intelligence (GenAI) into education offers transformative potential, especially in crafting and applying grading rubrics for engineering courses. These courses, with their complex assessment demands, ranging from technical proficiency to creative problem-solving, stand to gain from GenAI’s scalability, consistency, and efficiency. However, this potential comes with challenges, including preserving academic integrity and aligning with sound pedagogical principles. As educators adopt GenAI, they must balance its benefits with careful attention to rubric quality and responsible implementation.

This paper examines the intersection of GenAI technologies and engineering education assessment practices. We begin by reviewing current applications of GenAI in grading and rubric development, followed by an analysis of the benefits and challenges specific to engineering education. We then present our research methodology, which utilizes a mixed-methods approach to evaluate three leading GenAI tools across four engineering assignments. The results section provides a detailed comparative analysis of these tools’ performance, followed by a discussion of implications for educational practice. We conclude with recommendations for effective integration of GenAI in engineering assessment and directions for future research.

2. Literature Review

2.1. Applications of Generative AI in Grading and Rubric Development

Generative AI (GenAI) tools have revolutionized automated grading systems by efficiently evaluating student submissions. These systems excel in tasks involving lower cognitive skills, such as recall and comprehension, but face challenges in higher-order tasks that demand critical analysis and creativity [1], [2]. By reducing grading time, automated systems allow educators to focus on more complex instructional tasks while providing consistent feedback [3], [4].

Additionally, GenAI tools, such as ChatGPT, Claude, and Perplexity, can automate the creation of detailed rubrics, ensuring consistency in grading across large student cohorts [5], [6]. These tools enable iterative refinement, incorporating specific assessment criteria like technical accuracy and innovation [7].

Effective rubric development is guided by established frameworks that ensure quality and alignment with learning objectives. The 3R Framework (Reliability, Relevance, Robustness) for instance, provides a structured approach to creating rubrics that maintain grading consistency, align with course objectives, and minimize potential biases [3]. This framework emphasizes that rubrics must be reliable enough to ensure consistent evaluation, relevant to specific learning outcomes, and robust against various biases. GenAI-developed rubrics require iterative testing to ensure their validity and adaptability across diverse assessment formats [1], [8], particularly in engineering contexts where rubrics must accurately assess technical problem-solving and real-world applications.

AI-assisted rubric development supports personalization by tailoring criteria to specific learning outcomes and individual student needs [9], [10]. For example, in engineering projects, GenAI tools can adapt rubrics to emphasize problem-solving, critical thinking, and teamwork. This adaptability ensures that grading frameworks remain relevant and impactful, even for complex, real-world tasks.

Generative AI supports the design of rubrics aligned with Bloom's Taxonomy, ensuring that assessments target a full spectrum of cognitive skills – from basic comprehension to creative synthesis [1], [7], [10], [11]. This alignment is essential for meaningful evaluation across disciplines, particularly in project-based learning. Tools like OpenAI enable educators to automate aspects of assessment while upholding academic integrity and promoting higher-order thinking. By integrating AI into rubric development, instructors can provide more comprehensive, targeted, and pedagogically sound feedback to students [12].

2.2. Benefits and Challenges of Using AI in Engineering Education

The use of Generative AI (GenAI) in engineering education offers numerous benefits. One of the most significant advantages is its ability to enhance efficiency [1], [4]. GenAI substantially reduces the grading workload for large engineering cohorts, making it particularly useful for large-scale assessments [10], [13]. Tools like GenAI also streamline the process of rubric creation and evaluation, saving educators considerable time. Automated systems further enhance the learning process by delivering timely and detailed feedback to students [6], [9]. This feedback is often real-time and personalized, supporting formative assessment and promoting student understanding [3], [14]. Moreover, GenAI tools provide structured and constructive feedback aligned with rubric criteria, fostering deeper learning and engagement [10], [13].

Consistency is another key benefit of AI-based grading tools. These systems minimize discrepancies and biases, especially in large, multi-institutional studies [15]. Additionally, the

scalability of GenAI tools addresses the challenges associated with managing assessments for large engineering courses, ensuring quality is maintained across a broad range of submissions [7], [16]. This scalability is particularly valuable in engineering education, where large cohorts can often overwhelm traditional grading processes.

However, the integration of AI in engineering education is not without its challenges. Engineering assessments frequently involve complex tasks – like multi-representational models and open-ended problems that challenge the capabilities of GenAI systems [2], [14]. While these tools excel in structured tasks, they struggle with higher-order cognitive demands, such as evaluating innovative solutions [7], [9]. This limitation highlights the challenges of relying on AI for nuanced evaluation in engineering education [10], [13].

Ethical concerns also emerge with the use of GenAI in assessments. Misuse of these tools can lead to academic dishonesty and reduce student accountability [11], [17]. Maintaining academic integrity is critical, as it ensures students engage meaningfully with assessment criteria [5], [18]. Transparency in the role of GenAI in grading processes is essential to build trust among students and educators [16].

Bias and validity present further challenges. AI tools require extensive training to avoid biases and ensure fairness across diverse student populations [1], [3]. Unfortunately, biases present in the training data of GenAI models can result in inconsistencies and fairness concerns in grading [6], [13]. Additionally, rubrics designed with AI may fail to capture subjective elements such as creativity and critical thinking, which are essential in engineering tasks [7], [12].

Despite these challenges, the benefits of using AI in engineering education highlight its potential to transform traditional grading and assessment processes. Addressing the limitations and ethical considerations will be key to realizing its full potential.

2.3. Opportunities for GenAI in Engineering Rubrics

Generative AI (GenAI) presents significant opportunities for enhancing engineering rubrics. One key area is adaptive rubric design, where GenAI can dynamically modify rubrics based on student performance and evolving curriculum goals [1], [8]. By incorporating feedback loops into the rubric development process, educators can ensure continuous improvement and alignment with desired learning outcomes.

Another opportunity lies in collaborative grading frameworks. GenAI tools can work in tandem with educators to co-create and refine grading rubrics. This approach combines the efficiency and consistency of AI with the nuanced expertise of human educators, resulting in more effective and balanced assessment tools [4], [15].

GenAI is also well-suited for real-world applications in education. These tools are particularly effective for authentic assessments, which challenge students to apply theoretical knowledge to practical problems [1], [11]. By leveraging GenAI in such contexts, educators can create

meaningful evaluation methods that mirror professional engineering scenarios and enhance student preparedness for real-world challenges.

Despite this potential, limited research exists on how GenAI can be tailored for discipline-specific assessments, particularly in fields like engineering [2], [14]. There is a pressing need to customize GenAI applications to meet the unique demands of engineering education [6], [7]. Current AI tools face challenges in effectively assessing soft skills such as teamwork and communication, which are vital components of engineering education. Research by Nikolic et al. [4], and Kadel et al. [11] underscores these limitations, pointing to the necessity for advancements in this domain. There is a notable absence of longitudinal studies that evaluate the effects of GenAI-based grading on both student learning and educator workload over extended periods [8], [15]. Furthermore, research on the long-term impact of GenAI-designed rubrics on student learning outcomes and skill development remains scarce [13], [18]. Comprehensive guidelines for the ethical use of GenAI in rubric development and assessment are still underdeveloped [6], [13]. Perkins et al. [6] and, Fuller & Christa [13] call for more robust frameworks to address ethical considerations in this evolving area. The role of educators in co-developing and validating AI-generated rubrics requires further investigation to ensure alignment with pedagogical goals. There is therefore a need for deeper exploration of how human expertise can be effectively integrated with AI capabilities [13], [16].

3. Research Methodology

3.1. Research Design

This study employed a mixed methods approach to assess the impact of generative AI in developing assessment grading rubrics for engineering courses. The methodology integrates quantitative analysis of rubric performance metrics with qualitative insights from educators and students. The study aims to evaluate the effectiveness, consistency, and practicality of generative AI-designed rubrics. The main objectives were to:

1. Evaluate the quality and consistency of grading rubrics generated by AI tools.
2. Examine the impact of AI-generated rubrics on the grading process in engineering courses, particularly in terms of efficiency and practicality.

The mixed-methods design ensured a comprehensive evaluation of both the measurable outcomes and subjective perceptions of AI-generated rubrics

3.2. Data Collection

3.2.1. Rubric Development

Three leading generative AI tools—ChatGPT, Claude, and Perplexity were employed to generate grading rubrics for four engineering course assignments. The assignments were selected from two lower-level and two upper-level courses to provide a representative sample of undergraduate engineering curricula.

Assignment 1 was an integral component of a term project in Engineering Economic Analysis course, designed to apply economic decision-making principles to real-world engineering challenges while strengthening students' communication skills in both presentation and report writing. Students voluntarily formed project teams of three each and selected a project relevant to key economic decision problems, including service improvement, equipment and process selection, equipment replacement, new product and product expansion, or cost reduction. The structured decision-making process required teams to recognize a decision problem, define objectives, collect relevant data, identify feasible alternatives, determine an appropriate decision criterion, select the best alternative, and document and present their findings. Assignment 1 specifically required students to submit a progress report detailing their term project's development. The assignment guidelines are provided in **Appendix 1A**.

Assignment 2 involved the final project report for the Principles of Engineering Design course, where students were introduced to the structured design process and required to implement it through a term project. Throughout the course, multiple assignments assessed students' progress, culminating in a comprehensive final report submission. This report served as a detailed record of their design process, showcasing how they applied engineering principles to develop and refine their project. The submission guidelines and requirements for the final report are detailed in **Appendix 2A**.

Assignment 3 was the final submission for a term project in a senior-level Quality Engineering course. Students were tasked to identify, formulate, and solve quality engineering problems. Teams, consisting of two to three students, were randomly assigned but had the flexibility to designate their leader and distribute responsibilities. Each group selected a quality improvement project within manufacturing or service sectors, following the **DMAIC (Define, Measure, Analyze, Improve, Control)** methodology. This process entailed recognizing a quality issue, defining customer-critical requirements, measuring current performance, analyzing areas for improvement, selecting the best alternative, and establishing ongoing performance control measures. The assignment submission guidelines, adapted from the term project guidelines that were given to the students, are outlined in **Appendix 3A**.

Assignment 4 constituted the final submission for the **Senior Capstone Design Project**, serving as a comprehensive documentation of the entire design process. The report was required to clearly define the project's purpose, outline customer functional requirements, and establish objectives with measurable success criteria. It provided a complete representation of the project's development, including conceptualization, design, implementation, and evaluation. The assignment guidelines and submission requirements are detailed in **Appendix 4A**.

For each assignment, instructors provided guidelines outlining key objectives and key performance metrics. A standardized prompt was used across all AI tools. A sample prompt included:

"Using the attached guidelines, create a 5-scale grading rubric for the assignment."

The AI tools generated rubrics based on these prompts, which were subsequently refined and aligned with the instructors' expectations. Each rubric incorporated comprehensive evaluation

criteria, ensuring coverage of critical components relevant to each assignment. Table 1 provides a matrix of the rubrics generated and their location in appendices 1- 4.

Table 1: Location of the Rubrics Generated by each AI tool for Each Assignment

Assignment	ChatGPT Rubric	Claude Rubric	Perplexity Rubric	Combined Refined Grading Rubric
Assignment 1	Appendix 1B	Appendix 1C	Appendix 1D	Appendix 1E
Assignment 2	Appendix 2B	Appendix 2C	Appendix 2D	Appendix 2E
Assignment 3	Appendix 3B	Appendix 3C	Appendix 3D	Appendix 3E
Assignment 4	Appendix 4B	Appendix 4C	Appendix 4D	Appendix 4E

The research compared grading rubrics generated by ChatGPT, Claude, and Perplexity across multiple assignments. These rubrics were meant to systematically evaluate various aspects of academic reports while using a consistent 5-point scoring scale. Despite the AI tools’ shared emphasis on clarity, professionalism, and comprehensive evaluation, each rubric reflects distinct approaches in structure, granularity, and scoring methodologies. Table 2 compares the rubric approaches of the three AI tools, ChatGPT, Claude, and Perplexity for each of the four assignments, highlighting their distinct evaluation priorities.

Table 2: Rubric Comparison Summary

Assignment	ChatGPT's Rubric	Claude's Rubric	Perplexity's Rubric	Key Insights
Assignment 1	Separates 'Professionalism or Formatting' as distinct; focuses on iterative feedback.	Integrates appendices, detailed scoring; summative focus.	Combines related categories for streamlined evaluation; holistic approach.	Different priorities in assessment; combining rubrics offers complementary perspectives.
Assignment 2	Assigns proportional weight to categories based on importance.	Provides granular feedback with detailed sections; precision-focused.	Simplifies evaluation with broader categories; efficiency-focused.	Claude is precise, ChatGPT is balanced, and Perplexity is efficient; blending them enhances assessment.
Assignment 3	Balances specificity with percentage-based weightings.	Offers detailed section-by-section feedback.	Consolidates criteria for simplicity.	Each rubric has unique strengths in depth, flexibility, and streamlined design.
Assignment 4	Proportional weighting aligns with section importance.	Detailed criteria and deliverable expectations cater to precision.	Holistic framework supports concise evaluation.	Rubrics are adaptable to different academic needs; combining strengths creates a robust grading system.

For Assignment 1, all rubrics aim to assess term project progress reports, focusing on elements like structure, challenges, and planning. ChatGPT’s rubric separates "Professionalism or Formatting" as a distinct category, Claude’s integrates appendices and detailed scoring systems,

and Perplexity's combines related categories for streamlined evaluation. These variations show different priorities, such as ChatGPT's iterative feedback, Claude's summative focus, and Perplexity's holistic approach. If used together, they can offer complementary perspectives for grading such assignments.

In Assignment 2, the rubrics evaluate project reports by emphasizing content structure, technical rigor, and professionalism. Claude's rubric provides granular feedback with detailed sections, ChatGPT assigns proportional weight to categories based on importance, and Perplexity simplifies evaluation with broader categories. This distinction makes Claude suitable for precision, ChatGPT for balanced weighting, and Perplexity for efficiency. A blended rubric could leverage these strengths for comprehensive assessment.

For Assignment 3, the rubrics assess final reports with criteria such as structure, data analysis, and presentation quality. While all ensure consistency and professionalism, Claude offers detailed section-by-section feedback, ChatGPT balances specificity with percentage-based weightings, and Perplexity consolidates criteria for simplicity. Claude's depth, ChatGPT's flexibility, and Perplexity's streamlined design make each uniquely valuable for different grading needs.

Assignment 4 highlights similar distinctions. The rubrics evaluate final project reports, focusing on technical and presentation quality. Claude's detailed criteria and deliverable expectations cater to precision, ChatGPT's proportional weighting aligns with section importance, and Perplexity's holistic framework supports concise evaluation. These differences emphasize the adaptability of each rubric to varying academic contexts, suggesting that combining their strengths could create a robust grading system.

While the rubrics generated by each AI tool caters to unique priorities, their combined strengths could result in a versatile and robust grading system. By integrating Claude's granular detail, ChatGPT's proportionality, and Perplexity's streamlined framework, educators could create a comprehensive tool that balances clarity, structure, and depth for diverse academic contexts.

3.2.2. Rubric Application

We used the combined and refined rubrics (Appendix 1E, 2E, 3E, 4E) to evaluate anonymized student submissions for Assignments 1 through 4, drawn from four distinct courses, two lower-level and two upper-level. Each rubric featured a five-point scale, ranging from unsatisfactory (1) to outstanding (5), with criteria specifically tailored to each assignment.

- **Rubric 1 (10 criteria):** Used for a lower-level assignment (Assignment 1) assessing an initial term project progress report. Criteria included project overview, current progress, challenges and solutions, timelines and milestones, resource status, collaboration and communication, and formatting, organization, and presentation.
- **Rubric 2 (10 criteria):** Applied to another lower-level assignment (Assignment 2). Criteria encompassed title/cover page elements, executive summary, table of contents, paragraph and sentence structure, introduction and literature review, design analysis,

product generation and analysis, design for X, conclusions and recommendations, citations, references, grammar and mechanics, appendices, and overall report quality.

- **Rubric 3 (14 criteria):** Used for an upper-level assignment (Assignment 3). Criteria included cover page format and elements, executive summary, table of contents, problem statement, quality requirements definition, project objectives, data collection (relevance and completeness), data presentation, evaluation and analysis of alternatives, decision criteria and solution selection, results analysis and discussion, conclusions and recommendations, references, documentation, and presentation.
- **Rubric 4 (11 criteria):** Employed for another upper-level assignment (Assignment 4). Criteria covered preamble elements, project purpose, objectives and functional requirements, design process and outcomes, manufacturing considerations, verification and validation, risk assessment and mitigation, project planning, lessons learned, and overall writing quality.

Each rubric was tested by inputting the assignment and corresponding rubric into each AI tool ten times. Scores and feedback generated by the AI tools were recorded and later analyzed using Minitab statistical software to ensure consistency and reliability.

3.3. Data Analysis

Rubrics were evaluated for alignment with course objectives, clarity, and specificity of assessment criteria. Quantitative measures, such as mean scores and variability, were analyzed to assess grading consistency. Additionally, statistical analyses, including paired t-tests and ANOVA, were conducted to determine whether significant differences in scoring existed between AI tools.

The results were compared against human-expert grading to evaluate alignment and reliability. This multi-faceted approach provided both descriptive insights and inferential findings on the tools' performance. The analysis was carried out under the assumption of equal variances with a significance level of $\alpha = 0.05$. The results of the analysis are presented in Table 3 and Table 4.

Table 3: ANOVA Results for the Four Assignments from Minitab

Assignment	Expert	ChatGPT-4	Claude 3.5	Perplexity AI	$F(2, 27)$	p	η^2
1 (Progress)	79	76.8	77.3	77.6	0.19	.83	.01
2 (Design)	80	80.7	61.3	66.7	112.6	<.001	.81
3 (Quality)	95.5	94.9	90.4	90.5	7.63	.002	.36
4 (Capstone)	90.5	87.0	73.2	63.8	127.2	<.001	.82

Table 4: Summary of Tukey's Post-Hoc Outputs for the Four Assignments from Minitab

Assignment	Comparison (Level A – Level B)	Diff. of Means	95 % CI	Adj. <i>p</i>	Significant (<i><.05</i>)?
1	Claude 3.5 – ChatGPT-4	+0.51	-2.72 → +3.74	0.919	No
	Perplexity – ChatGPT-4	+0.80	-2.43 → +4.03	0.814	No
	Perplexity – Claude 3.5	+0.29	-2.94 → +3.52	0.973	No
2	Claude 3.5 – ChatGPT-4	-19.40	-22.71 → -16.09	<i><.001</i>	Yes
	Perplexity – ChatGPT-4	-14.00	-17.31 → -10.69	<i><.001</i>	Yes
	Perplexity – Claude 3.5	+5.40	+2.09 → +8.71	0.001	Yes
3	Claude 3.5 – ChatGPT-4	-4.55	-7.83 → -1.27	0.005	Yes
	Perplexity – ChatGPT-4	-4.40	-7.68 → -1.12	0.007	Yes
	Perplexity – Claude 3.5	+0.15	-3.13 → +3.43	0.993	No
4	Claude 3.5 – ChatGPT-4	-13.80	-17.44 → -10.16	<i><.001</i>	Yes
	Perplexity – ChatGPT-4	-23.25	-26.89 → -19.61	<i><.001</i>	Yes
	Perplexity – Claude 3.5	-9.45	-13.09 → -5.81	<i><.001</i>	Yes

The analysis of AI tools—ChatGPT4.0, Claude3.5, and Perplexity—across four assignments aimed to evaluate their grading performance relative to a human expert. For Assignment 1, all three AI tools demonstrated scores closely aligned with the human expert score of 79, suggesting minimal variance in grading reliability. ChatGPT had a mean score of 76.8, while Claude3.5 and Perplexity achieved mean scores of 77.3 and 77.6 respectively, all slightly below the expert score. These small differences, supported by overlapping confidence intervals and non-significant ANOVA results ($P = 0.825$), highlight comparable performance across the tools in this assignment. Post-hoc Tukey comparison analysis showed that every pairwise difference lies well within its 95 % confidence interval, and the adjusted *p* values (0.814 – 0.973), reinforce the conclusion that their grading was statistically indistinguishable.

In Assignment 2, however, substantial differences emerged among the tools. ChatGPT closely matched the human expert's score of 80, with a mean score of 80.7, accompanied by minimal variability (standard deviation = 1.059). In contrast, Claude3.5 and Perplexity gave scores that were significantly different from the human expert, with mean scores of 61.3 and 66.7, respectively, and greater variability, particularly for Claude3.5. The ANOVA results ($P = 0.000$) and subsequent pairwise comparisons confirmed that ChatGPT's scores were significantly closer to the human expert's score than those of its counterparts. Tukey's post-hoc analysis confirmed that all pairwise differences between these tools are statistically significant, with particularly large gaps between ChatGPT4.0 and the other two tools (19.4 points higher than Claude3.5 and 14.0 points higher than Perplexity). These findings have important implications for users selecting AI tools for tasks similar to those evaluated in this study

Assignment 3 further underscored ChatGPT's superior performance, achieving a mean score of 94.9, closely aligned with the human expert's 95.5. The analysis revealed statistically significant differences between the tools ($P = 0.002$). Claude3.5 and Perplexity scored similarly, with means of 90.35 and 90.50, respectively, and overlapping confidence intervals. Tukey's comparisons confirmed ChatGPT's statistically significant advantage over the other two tools (*p*-values of 0.005 and 0.007 respectively). However, no significant difference was found between Claude3.5 and Perplexity (difference of only 0.15 points, $p = 0.993$), suggesting these two tools perform

similarly despite their different architectures or approaches. This pattern of consistent performance by ChatGPT, with scores very close to human expert and lower variability, was particularly evident in this assignment, positioning it as the most reliable tool among the three.

In Assignment 4, ChatGPT again demonstrated strong alignment with the human expert, achieving a mean score of 87 compared to the expert's 90.5. Claude3.5 and Perplexity trailed with mean scores of 73.2 and 63.8, respectively. The ANOVA results ($P = 0.000$) confirmed significant differences among the tools, with ChatGPT outperforming both in mean scores and consistency. Tukey's post-hoc analysis confirms that all pairwise differences between tools are highly significant (all p -values = 0.000), with the largest performance gap (23.25 points) between ChatGPT4.0 and Perplexity. These findings confirm that not only do the AI tools vary in performance, but the differences are substantial and consistent across groups. This information can guide users in selecting the most effective AI tool depending on the performance criteria relevant to their tasks..

Overall, ChatGPT displayed the highest level of alignment with human grading across all assignments, consistently achieving scores closest to the expert's benchmark and demonstrating minimal variability. In contrast, Claude3.5 and Perplexity exhibited inconsistent performance, particularly in Assignments 2 and 4, where their scores diverged significantly from both the expert and ChatGPT. These disparities underscore the varying reliability of the AI tools in academic assessments, with ChatGPT emerging as the most robust and reliable option.

Statistical analyses across all assignments supported these conclusions. ANOVA results indicated significant differences in mean scores for Assignments 2, 3, and 4, driven primarily by ChatGPT's superior performance. Tukey's pairwise comparisons consistently highlighted ChatGPT's advantage, with significant differences against Claude3.5 and Perplexity in three out of four assignments. Furthermore, descriptive statistics and confidence intervals corroborated these findings, emphasizing ChatGPT's consistency and accuracy relative to its peers.

These results underline the critical importance of selecting the appropriate AI tool for academic grading. While all tools demonstrated some level of alignment with human assessments in specific contexts, ChatGPT proved to be the most reliable and effective overall. Its consistent performance, minimal variability, and close alignment with human grading suggest that it is better suited for tasks requiring accuracy and reliability. Conversely, the variability and lower performance of Claude3.5 and Perplexity highlight their limitations and suggest that they may be less suitable for high-stakes academic evaluations.

3.4. Comparative Analysis of Feedback Across AI Tools on Assignment Reports

A comparative analysis was done on the feedback of each AI tool for each of the four assignments. Table 5 summarizes the feedback provided by the three AI tools—ChatGPT, Claude, and Perplexity—on the four assignment reports. It showcases the distinct feedback styles of each tool and highlights common strengths and weaknesses identified by the three tools across assignments. By examining these differences, the following sections provide valuable insights into how each AI tool approaches evaluation, offering a comprehensive perspective on their effectiveness in academic assessment.

Table 5: Comparative Analysis of Feedback Across AI Tools on Assignment Reports

Assignment	ChatGPT Feedback	Claude Feedback	Perplexity Feedback	Common Strengths	Common Weaknesses
Assignment 1	Balanced approach, detailed key area feedback, practical suggestions	Concise, focused on organization, formatting, professional tone	Most detailed, methodological suggestions, critical of incomplete sections	Comprehensive objectives, dual focus on environmental & financial impacts, logical timeline	Limited progress, collaboration & milestones improvement needed
Assignment 2	Balanced evaluations, actionable feedback, middle-range scores	Concise, emphasis on structural & grammatical issues, slightly lower scores	Detailed critiques, focus on technical rigor, stricter scoring	Practical & iterative design, inclusion of empirical testing, clear progress in design sections	Missing 'Table of Contents', citations, literature review, and recommendations
Assignment 3	Mix of high-level insights & practical applications	Focused on organization & formatting, slightly lower scores for documentation	Most detailed, emphasis on statistical rigor & theoretical alignment	Clarity of data visualizations, structured grading, strengths in results analysis	Insufficient depth in analyzing alternatives, incomplete decision criteria justification
Assignment 4	Balanced feedback, structural improvements, actionable recommendations	Stricter on manufacturing & project planning, emphasis on formatting	Granular technical critiques, variable scoring based on test data alignment	Clear 'Verification & Validation' sections, strong design process documentation	Lack of 'Lessons Learned', comprehensive project planning, and definition of symbols

Assignment 2

The evaluations from ChatGPT, Claude, and Perplexity shared significant similarities, particularly in their adherence to the Term Project Final Report Grading Rubric. Statistical analysis reveals meaningful differences in how each tool approached the assessment. All tools consistently identified key strengths, such as the practical and iterative approach demonstrated in the design and prototyping sections, and the inclusion of empirical evidence from testing results. High scores were often awarded to sections like "Design" and "Product Generation and Analysis," which showcased clear progress and logical development. However, all three AI tools flagged recurring weaknesses across student submissions. These included missing elements such as a "Table of Contents," "Citations," "References," and comprehensive "Recommendations." The absence of a detailed literature review and insufficient exploration of "Design for X" considerations, such as safety and sustainability, further diminished the reports' overall quality scores.

Despite these similarities in content evaluation, significant differences emerged in scoring patterns and feedback style. ChatGPT provided balanced evaluations with actionable feedback, resulting in middle-range scores that closely aligned with human expert assessment. Claude's feedback was more concise, frequently highlighting structural and grammatical issues while offering slightly lower scores for areas like organization and introductory paragraphs. Perplexity provided the most detailed critiques, often focusing on technical rigor, engineering specifications, and detailed benchmarks. This emphasis on depth led to stricter scoring, particularly for sections requiring technical clarity or academic rigor.

The varied approaches of these tools suggest different potential applications in engineering education. ChatGPT's balanced feedback is ideal for providing actionable insights, Claude's concise evaluations are well-suited for structural and organizational refinement, and Perplexity's detailed critiques benefit teams prioritizing technical depth. All tools effectively highlighted the importance of addressing missing components and enhancing recommendations to improve the academic robustness of student reports.

Assignment 3

The feedback from ChatGPT, Claudia, and Perplexity on the project reports shared significant similarities, emphasizing adherence to the provided rubric and structured grading across key sections like "Executive Summary," "Data Collection," and "Results Analysis." All tools praised the clarity of data visualizations, such as control charts and interaction plots, and offered suggestions for minor improvements in presentation and contextualization. Additionally, they identified common weaknesses, including insufficient depth in analyzing alternatives, incomplete justification of decision criteria, and minor formatting inconsistencies in sections like the "Table of Contents." Each tool provided balanced critiques, recognizing the strengths of the reports while offering constructive feedback for enhancement.

Despite these similarities, notable differences emerged in scoring tendencies and focus areas. ChatGPT provided a mix of high-level insights and actionable suggestions, emphasizing practical applications and the alignment of project objectives. Claudia, on the other hand, focused more on the organizational and formatting aspects, often assigning slightly lower scores for sections like "Documentation" and "Executive Summary" due to perceived presentation gaps. Perplexity offered the most detailed and methodical feedback, delving deeply into statistical rigor and theoretical alignment but occasionally presenting overly granular evaluations that might be less accessible to a general audience.

For this assignment, the tools demonstrated distinct strengths in their evaluations. ChatGPT balanced strategic insights with actionable critiques, making its feedback broadly applicable. Claudia excelled in identifying issues related to formatting and professional presentation, while Perplexity highlighted statistical robustness and methodological depth. The feedback from these tools provides a comprehensive analysis of the report, with varied perspectives that cater to different aspects of evaluation. Hence, opportunities exist to integrate these strengths for a more holistic and universally applicable assessment framework.

Assignment 4

The evaluations provided by ChatGPT, Claudie, and Perplexity were consistent in adhering to the Fall Final Report Guidelines and grading rubric. Each tool identified recurring strengths, such as the clarity and thoroughness of the "Verification and Validation" sections, which often included well-presented data and tables. Similarly, the "Design Process and Outcome" sections were commended for their use of decision matrices and diagrams, though all tools noted room for improvement in the depth of trade studies and alternative analyses. A common critique across the tools was the absence of key sections like "Lessons Learned," "Comprehensive Project Planning," and "Definition of Symbols/Nomenclature," which negatively impacted the overall scores.

Despite these shared observations, the tools differed in their scoring tendencies and depth of feedback. ChatGPT provided balanced feedback with scores ranging from 75% to 86%, emphasizing structural improvements and actionable recommendations for missing sections. Claudie offered slightly stricter evaluations, particularly in the areas of manufacturing and project planning, often scoring reports lower (e.g., 66% to 77%) due to insufficient documentation or formatting inconsistencies. Perplexity's feedback was the most variable, with scores ranging widely (33% to 92%) depending on the trial. It provided granular technical critiques, delving deeply into the alignment of test data with requirements and the rigor of risk assessments, though its strictness could make its feedback less accessible.

Overall, for assignment 4, the tools effectively highlighted the strengths in technical execution, particularly in design and testing, while identifying significant gaps in project documentation and planning. ChatGPT excelled at offering actionable and balanced feedback, Claudie focused on structural and organizational improvements, and Perplexity emphasized advanced technical refinements and rigorous analysis. Their feedback underscores the importance of addressing missing sections, improving documentation, and integrating detailed technical and planning components to enhance the report quality comprehensively.

4. Results and Discussion

The results of the study demonstrate that Generative AI tools such as ChatGPT, Claude, and Perplexity can play significant roles in grading and rubric development for engineering courses, but their effectiveness varies based on the complexity and specificity of the task.

4.1. Grading Performance Across Assignments

Assignment 1: All AI tools aligned closely with human grading, demonstrating reliability for straightforward, lower-level assignments. ChatGPT showed the closest alignment with human grading, but the ANOVA results indicated no significant differences among the tools, highlighting the potential for all tools to handle simpler tasks effectively [14].

Assignments 2 and 4: ChatGPT consistently outperformed its counterparts in these complex assignments, closely aligning with human grading and demonstrating minimal variability. The statistically significant differences ($P = 0.000$) in scores across tools underscore ChatGPT's ability to manage higher-order cognitive tasks. Conversely, Claude and Perplexity exhibited variability, with lower mean scores and greater inconsistencies, particularly in Assignment 4, where Perplexity's scores ranged widely [19].

Assignment 3: While all tools performed well, ChatGPT's performance again stood out with its high alignment to human grading and low variability. Claude and Perplexity scored similarly but lagged behind ChatGPT in terms of alignment and precision

4.2. Bias in AI Grading and Its Impact on Student Populations

Our statistical analysis revealed significant variations in how different AI tools evaluated the same engineering assignments, raising important considerations about potential biases in AI-assisted grading. These differences directly relate to fairness and equity in student assessment.

Bias in Grading Outcomes: The study found clear differences in the grading patterns of AI tools, with ChatGPT consistently aligning better with human expert grading while Claude and Perplexity exhibited greater inconsistencies, particularly in Assignments 2 and 4. These discrepancies suggest that AI bias may manifest in systematic over-scoring or under-scoring of specific student submissions based on training data. For example, Perplexity's significantly lower scores for Assignment 4 (mean of 63.8 compared to the human expert's 90.5) demonstrate how an AI system's internal biases could potentially disadvantage students if used without human oversight. If AI tools are not properly calibrated, certain groups of students – such as non-native English speakers or those with unconventional writing styles – may receive systematically lower scores [20].

Bias in Rubric Interpretation. Our comparative analysis of AI-generated feedback revealed that each tool interpreted rubric criteria differently. While all AI tools emphasized technical accuracy, they varied in how they weighted creativity and innovation. Since AI models are typically trained on structured responses, students who employ more creative or unconventional problem-solving approaches may be unfairly penalized, as evidenced by the varying scores for design innovation components in Assignments 2 and 4. This finding aligns with previous research indicating that engineering assignments requiring open-ended problem-solving may be graded inconsistently if AI tools fail to recognize innovative approaches outside their training parameters [21].

Impact on Student Learning and Feedback. Different AI tools provided varying levels of feedback detail. Some AI models, such as Perplexity, were overly strict in technical critiques, while others, such as Claude, focused more on organization. If AI disproportionately emphasizes structure and formatting over content quality, students may prioritize presentation over substantive learning. Conversely, a model that focuses on technical details might disadvantage students with strong conceptual understanding but weaker written communication skills [22].

Disparities in Access to AI-Optimized Learning. If AI grading systems are not transparent, students who understand how AI evaluates work may have an advantage over those who do not. Students from underprivileged backgrounds with less exposure to AI-generated feedback might be at a disadvantage compared to those who learn to "game" the AI system by structuring their responses in ways that maximize AI scores.

Ethical and Fairness Concerns. AI models trained on past grading patterns may perpetuate historical biases in education, disadvantaging students who have historically received lower scores due to systemic issues. If AI grading tools are not regularly audited for fairness, biases in AI training data can reinforce existing inequalities in educational outcomes. Additionally, transparency in AI grading is crucial for building trust among students and educators [23].

4.3. Feedback Quality

The tools varied in their feedback approaches. ChatGPT provided balanced and actionable insights, focusing on both high-level and detailed improvements. Perplexity excelled in technical depth but often presented overly granular critiques, making its feedback less accessible for some users. Claude emphasized organizational aspects, offering concise but less detailed feedback. These differences highlight the complementary strengths of the tools, suggesting that combining their capabilities could yield comprehensive feedback [19].

4.4. Faculty feedback on the use of grading rubrics

Two Engineering faculty provided feedback on the introduction of AI-generated rubrics in grading their engineering assignments through open-ended surveys. The qualitative analysis employed inductive coding and thematic analysis to derive insights into the rubric's impact, focusing on its efficiency and consistency in standardizing grading practices.

Faculty responses highlighted significant advantages, such as streamlined grading and uniform evaluation criteria, which reduced subjective biases. However, concerns were raised regarding the rigidity of the rubrics, as they sometimes failed to capture creative, non-traditional approaches. This raised questions about the AI's ability to adapt to the nuances of complex engineering assignments.

Overall, the feedback suggests that while AI-generated rubrics can enhance grading efficiency, they should be viewed as complementary to human judgment rather than a complete replacement. Recommendations include developing customizable rubric systems, enhancing the explainability of AI algorithms, and maintaining human oversight to ensure fairness and mitigate potential bias in grading.

4.5. Student Feedback

The study further analyzed student perceptions of AI-generated rubrics used for engineering assignment feedback, focusing on aspects such as clarity, fairness, and the overall impact on learning. The study gathered open-ended survey responses from a group of engineering students

from two of the courses and used thematic analysis to identify key strengths and areas for improvement.

Students noted that the AI rubric provided a clear, systematic breakdown of grading criteria. One student remarked, "The rubric clearly outlined what was expected for each section, which helped me understand where I lost points," highlighting how the structured format helped demystify complex grading processes. Another student added, "I found the feedback to be impartial – every submission was judged by the same standard," underscoring the perceived objectivity and consistency of the AI-generated feedback.

Despite these positive aspects, some students expressed concerns over the lack of personalized, nuanced feedback. As one student stated, "While the rubric was detailed, it sometimes felt too generic, missing the unique strengths of my project." This feedback indicates that while the AI system was effective in standardizing grading, it occasionally overlooked individual creativity and contextual subtleties in the work.

Based on the feedback, many students recommended adopting a hybrid approach. They suggested that combining the systematic benefits of the AI-generated rubric with personalized comments from instructors could provide a more comprehensive evaluation. One student summarized this perspective by saying, "A mix of AI rubric feedback and personalized comments from the instructor would give a more complete picture of my performance." This recommendation points toward a blended feedback model that leverages both technology and human expertise for improved learning outcomes.

4.6. Challenges and Limitations Identified

The study identified several limitations in AI tools:

- **Higher-Order Tasks:** Claude and Perplexity struggled with assignments requiring critical thinking and creativity, such as those involving innovative design and project planning.
- **Ethical Concerns:** Ensuring transparency and mitigating biases in AI-generated grading remains a challenge [20]
- **Consistency:** The variability in scores, particularly for Claude and Perplexity, indicates room for improvement in training these models for complex grading tasks [23].

4.7. Opportunities for Improvement

Integrating AI tools into grading processes offers opportunities for adaptive rubric development and collaborative frameworks. By leveraging AI capabilities and human expertise, educators can refine rubrics and grading systems to align more closely with pedagogical goals.

Addressing the limitations and ethical considerations surrounding AI grading is essential to ensure fairness, equity, and the meaningful assessment of student learning outcomes. Human oversight, regular audits, and customizable AI rubrics can help mitigate bias, ensuring a fair and robust grading system for all student populations.

5. Conclusions and Recommendations

This study demonstrates the significant potential of Generative AI tools in engineering education, particularly in grading and rubric development. Our comprehensive analysis across four diverse assignments yields several key findings that have direct implications for educational practice:

- ChatGPT consistently displayed the highest alignment with human expert grading across assignments of varying complexity, proving its reliability for academic evaluations in engineering contexts.
- While Claude and Perplexity show promise in specific applications – particularly in providing detailed technical critique and organizational feedback – their inconsistent performance limits their standalone applicability for high-stakes assessment tasks.
- GenAI tools demonstrably streamline grading processes, enhance feedback quality, and reduce educator workload, particularly for structured assignments with clearly defined evaluation criteria.

However, our research also identifies important challenges that must be addressed to maximize these tools' effectiveness. These include variability in grading consistency, particularly for complex assignments; limited ability to assess higher-order skills such as creativity and innovation; and ethical considerations regarding transparency, bias, and academic integrity.

Based on these findings, we recommend that educators prioritize ChatGPT for grading tasks requiring close alignment with human expertise, particularly for complex, upper-level assignments. Furthermore, combining AI tools with human oversight can create effective hybrid assessment models that leverage the strengths of each approach while mitigating their individual limitations. To advance this field, future research should focus on fine-tuning AI tools to better assess discipline-specific engineering skills, establishing clear ethical guidelines for AI-assisted grading, and conducting longitudinal studies to evaluate the long-term impact of AI-generated rubrics on student learning outcomes and educator workload.

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Appendices

Appendix 1A: Term Project Progress Report Guidelines

Submit a progress report on the status of your term project which should constitute the following

1. **Cover Page and Project Overview (5%)**

(a) **Cover Page/Title**

- Project Title
- Team Name or Member Names
- Course and Instructor Name
- Date of Submission

(b) **Project Overview**

- **Objective:** Briefly state the purpose and goals of the project.
- **Scope:** Define the extent/scope and expected deliverables of the project.

3. **Current Progress (20%)**

- **Tasks Completed:** Summarize milestones or tasks achieved since the project started.
 - Example: Completed research, finalized methodology, created project outline.
- **Work in Progress:** Outline what tasks are currently being worked on.
 - Example: Data collection, preliminary designs, coding, or analysis.

4. **Challenges Encountered (15%)**

- Detail any issues or obstacles faced so far.
 - Example: Resource limitations, technical difficulties, conflicting schedules.
- Explain steps taken or planned to address these challenges.

5. **Timeline and Milestones (15%)**

- **Updated Timeline:** Provide an updated schedule if necessary, comparing with the original plan.
- **Upcoming Milestones:** Highlight major tasks and deadlines for the next phase of the project.

6. **Resource Status (10%)**

- **Allocated Resources:** Mention what data has been obtained.
- **Needed Resources:** Identify additional project resources/requirements and plans to acquire them.

7. **Collaboration and Communication (10%)**

- Describe how the team is coordinating (e.g., meetings, tools used).
- Highlight contributions of each member so far.

8. **Next Steps (10%)**

- Outline immediate priorities and action items for the next reporting period.

9. **Questions/Requests for Guidance (5%)**

- Pose any questions or concerns to stakeholders or instructors that require clarification or assistance.

Appendices (5%)

- Include supplementary materials, such as diagrams, charts, or draft documents.

Overall Organization & Clarity (5%)

Appendix 1B: Term Project Progress Report Grading Rubric

ChatGPT Output

Criterion	5 - Excellent	4 - Good	3 - Average	2 - Below Average	1 - Poor
Cover Page/Title	Complete, clear, and professionally formatted.	All required details included with minor issues.	Basic details present but lacks clarity or formatting.	Some required details missing.	Missing or incomplete.
Project Overview	Objectives and scope are well-stated, concise, and comprehensive.	Objectives and scope clear, some minor improvements needed.	Objectives and scope stated but not fully clear or thorough.	Lacks sufficient details in objectives or scope.	Objectives and scope unclear or missing.
Current Progress	Comprehensive and clear account of completed and ongoing tasks.	Tasks listed and clearly described, minor gaps.	Tasks listed and described adequately, minor omissions.	Tasks listed but incomplete or poorly described.	Little to no tasks listed or unclear.
Challenges Encountered	Challenges encountered are well-explained with thoughtful solutions.	Challenges and solutions are clear, minor improvements possible.	Challenges and some solutions described but lack detail.	Challenges noted but vague or no solutions provided.	Challenges missing or no explanation of solutions.
Timeline and Milestones	Detailed and fully updated timeline, aligns perfectly with project progress.	Updated and well-aligned timeline, minor gaps in detail.	Timeline provided, aligns with progress but lacks some updates.	Basic timeline but lacks clarity or alignment with progress.	No timeline or milestones provided.
Resource Status	Resources comprehensively listed with thoughtful analysis of needs.	Comprehensive resource description, minor details missing.	Resources described adequately but some gaps.	Resources listed but incomplete or not specific.	Resource section missing or unclear.
Collaboration/Communication	Comprehensive and clear explanation of team coordination and contributions.	Collaboration well-described, minor gaps.	Basic description of team collaboration, lacks some specifics.	Coordination described minimally.	No mention of team coordination.
Next Steps	Clear and thorough next steps, demonstrating forward thinking.	Detailed next steps, well-aligned with project.	Next steps described adequately, minor gaps.	Basic next steps provided but vague.	No next steps provided or unclear.
Professionalism/Formatting	Exceptionally well-organized and professional presentation.	Well-organized, professional, minor room for improvement.	Organized, minor formatting issues.	Poorly organized, several errors.	Lacks structure or major errors.

Appendix 1C: Assignment 1 - Term Project Progress Report Grading Rubric

Claude AI Output

Evaluation Criteria	5 - Exceptional	4 - Proficient	3 - Satisfactory	2 - Developing	1 - Insufficient
Document Structure and Formatting	Perfect formatting with all required sections clearly labeled and organized; professional presentation	Well-formatted with clear sections and consistent styling	Basic formatting present but some inconsistencies in organization	Poor organization with multiple formatting issues	Missing multiple required sections or severely disorganized
Project Overview and Objectives	Exceptionally clear objectives with comprehensive scope definition and detailed deliverables	Clear objectives and well-defined scope with specific deliverables	Basic objectives stated with general scope outlined	Vague objectives or unclear scope	Missing objectives or scope definition
Progress Reporting	Comprehensive detail of completed and in-progress tasks with specific examples and metrics	Clear description of both completed and in-progress tasks with supporting details	Basic overview of tasks with limited detail	Incomplete or vague task descriptions	Missing or severely limited progress information
Challenges and Solutions	Thorough analysis of challenges with innovative solutions and contingency plans	Clear identification of challenges with specific solutions proposed	Basic challenges identified with general solutions	Challenges listed without solutions	No challenges or solutions discussed
Timeline and Resource Management	Detailed timeline with specific milestones and comprehensive resource analysis	Clear timeline with defined milestones and good resource planning	Basic timeline and resource information provided	Incomplete timeline or resource information	Missing timeline or resource information
Team Collaboration	Exceptional detail on team dynamics, communication methods, and individual contributions	Clear description of team coordination and member contributions	Basic information about team collaboration provided	Limited information about team collaboration	Missing collaboration information
Future Planning	Comprehensive next steps with detailed action items and clear priorities	Well-defined next steps and priorities	Basic next steps outlined	Vague or incomplete future plans	Missing future planning
Questions and Appendices	Thoughtful questions raised with relevant supporting materials in appendices	Clear questions with appropriate supporting materials	Basic questions or appendices included	Minimal questions or supporting materials	Missing questions and supporting materials

Appendix 1D: Assignment 1 - Term Project Progress Report Grading Rubric

Perplexity AI Output

Criteria	5 (Excellent)	4 (Very Good)	3 (Good)	2 (Fair)	1 (Poor)
Cover Page & Project Overview	Comprehensive cover page; thorough and well-defined project overview	Detailed cover page; clear project overview	Complete cover page; adequate project overview	Basic cover page; vague project overview	Missing or incomplete cover page; project overview lacks clarity
Current Progress	Comprehensive and well-organized summary of completed tasks and current work, with clear examples	Detailed description of completed tasks and ongoing work	Adequate summary of completed tasks and current work	Minimal description of completed tasks and ongoing work	No clear indication of completed tasks or work in progress
Challenges & Solutions	In-depth analysis of challenges with well-thought-out solutions and contingency plans	Detailed description of challenges with corresponding solutions	Basic description of challenges and some proposed solutions	Challenges mentioned but no solutions proposed	No challenges mentioned or addressed
Timeline & Milestones	Comprehensive timeline with well-defined milestones, including comparisons to original plan	Detailed timeline with clear milestones	Basic timeline with some milestones	Vague timeline with few milestones	No timeline or milestones provided
Resource Status	Comprehensive analysis of resource allocation and acquisition plans	Detailed description of resource status	Basic overview of allocated and needed resources	Minimal information on resources	No mention of resources
Collaboration & Communication	Comprehensive overview of team dynamics, coordination methods, and specific member contributions	Detailed account of team coordination and individual contributions	Adequate description of team coordination and member contributions	Minimal description of team coordination	No information on team coordination
Next Steps	Comprehensive, prioritized list of next steps with action items	Clear and detailed next steps	Basic outline of next steps	Vague or incomplete next steps	No clear next steps outlined
Questions/Requests for Guidance	Well-formulated, insightful questions that demonstrate critical thinking	Clear and pertinent questions or requests	Some relevant questions or requests	Vague or irrelevant questions	No questions or requests included
Overall Organization & Clarity	Exceptionally well-organized, clear, and professional presentation	Well-organized and clear	Adequately organized and mostly clear	Basic organization with some clarity issues	Poorly organized and unclear
Appendices (if applicable)	Comprehensive, high-quality supplementary materials that enhance the report	Relevant and well-presented supplementary materials	Basic supplementary materials included	Minimal or poorly presented supplementary materials	No appendices or irrelevant materials

Appendix 1E: Assignment 1 - Term Project Progress Report Grading Rubric (Used)

Criteria	Outstanding (5)	Above Average (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Cover Page & Project Overview (5%)	Comprehensive cover page; well-defined and thorough project overview with clear objectives and scope.	Detailed cover page; clear project overview.	Complete cover page; adequate project overview.	Basic cover page; vague project overview.	Missing or incomplete cover page; project overview lacks clarity.
Current Progress (20%)	Comprehensive and well-organized summary with clear examples and metrics.	Detailed description of completed tasks and ongoing work.	Adequate summary of completed tasks and current work.	Minimal description of completed tasks and ongoing work.	No clear indication of completed tasks or work in progress.
Challenges & Solutions (15%)	In-depth analysis of challenges with well-thought-out solutions and contingency plans.	Detailed description of challenges with corresponding solutions.	Basic description of challenges with some proposed solutions.	Challenges mentioned but no solutions proposed.	No challenges mentioned or addressed.
Timeline & Milestones (15%)	Comprehensive timeline with well-defined milestones, including comparisons to original plan.	Detailed timeline with clear milestones.	Basic timeline with some milestones.	Vague timeline with few milestones.	No timeline or milestones provided.
Resource Status (10%)	Comprehensive analysis of resource allocation and acquisition plans.	Detailed description of resource status.	Basic overview of allocated and needed resources.	Minimal information on resources.	No mention of resources.
Collaboration & Communication (10%)	Comprehensive overview of team dynamics, coordination methods, and specific member contributions.	Detailed account of team coordination and individual contributions.	Adequate description of team coordination and member contributions.	Minimal description of team coordination.	No information on team coordination.
Next Steps (10%)	Comprehensive, prioritized list of next steps with action items.	Clear and detailed next steps.	Basic outline of next steps.	Vague or incomplete next steps.	No clear next steps outlined.
Questions or Requests for Guidance (5%)	Well-formulated, insightful questions that demonstrate critical thinking.	Clear and pertinent questions or requests.	Some relevant questions or requests.	Vague or irrelevant questions.	No questions or requests included.
Overall Organization & Clarity (5%)	Exceptionally well-organized, clear, and professional presentation.	Well-organized and clear.	Adequately organized and mostly clear.	Basic organization with some clarity issues.	Poorly organized and unclear.
Appendices (5%)	Comprehensive, high-quality supplementary materials that enhance the report.	Relevant and well-presented supplementary materials.	Basic supplementary materials included.	Minimal or poorly presented supplementary materials.	No appendices or irrelevant materials.

Appendix 2A: Assignment 2 - Final Term Project Report Guidelines

Submit a final term project report which should constitute the following

1. **Cover Page:** Project Title, Names of Design Group, Faculty Mentor/Coordinator, Address, and Date. Signatures can be included as well.
2. **Abstract (or Summary):** Describe the goals or objectives of the design, the product developed, and its applications. Summarize the project accomplishments.
3. **Introduction:** Summarize relevant background information including the need for the project. Clarify the technical design requirements and cost benefit analyses. State the project objectives.
4. **Design:** Review the engineering specifications and targets; summarize and evaluate existing benchmarks with particular emphasis on any gaps which the project is intended to fill; discuss the concept generation and evaluation aspects of the project, followed by justification for developing the final product; provide a detailed description of the procedures used for product evaluation; and share the details of analysis, experiment, or field test results.
5. **Design for X:** Discuss how the product addresses a number of factors (X) such as cost, safety, sustainability, and impact on the environment and society.
6. **Conclusions:** Provide empirical evidence to support major project accomplishments and demonstrate that the project has satisfied critical engineering specifications.
7. **Recommendations:** Discuss any recommendations you may have for extending/improving the design in the future.
8. **References:** Use appropriate professional style and language in citing sources (internet, books, journals, etc.) used in the design project. Provide an alphabetized bibliography of references at the end of the design report.
9. **Appendices:** Attach supplementary materials such as drawings (layout drawings, detail drawings, assembly drawings), design analysis results (such as stress analysis, failure plots), product development plans, etc
10. **Overall Report Quality**

Appendix 2B: Assignment 2 -Final Term Project Report Grading Rubric

ChatGPT Output

Criteria	Score 5 - Excellent	Score 4 - Good	Score 3 - Satisfactory	Score 2 - Needs Improvement	Score 1 - Unsatisfactory
Cover Page (5%)	Includes all required elements: title, group names, mentor, address, date, and signatures (optional but present).	Includes most elements; minor details missing (e.g., signature or date).	Includes some elements but lacks key information (e.g., mentor or group names).	Minimal elements provided; not well-organized or formatted.	Missing the cover page or lacks essential information.
Abstract (10%)	Clearly summarizes objectives, product, applications, and accomplishments concisely and engagingly.	Addresses all required aspects but lacks clarity or conciseness in some areas.	Covers most elements but lacks depth or clarity in describing goals or results.	Abstract is vague and does not provide a clear project overview.	Abstract is missing or does not reflect project content.
Introduction (15%)	Comprehensive summary of background, project need, technical requirements, and objectives.	Covers most aspects but lacks depth or clarity in explaining technical requirements or cost-benefit analysis.	Summarizes background and objectives but misses key technical details or relevance.	Introduction is minimal and does not establish the project context effectively.	Missing or incomplete introduction.
Design (30%)	Thoroughly reviews specifications, benchmarks, concept generation, and procedures with clear justification and detailed analysis.	Covers most aspects with minor gaps in justification or procedure details.	Discusses design aspects but lacks depth in benchmarks, analysis, or justification.	Design discussion is minimal, missing key elements like procedures or benchmarks.	Lacks discussion or explanation of design process and results.
Design for X (10%)	Thoughtfully addresses multiple factors (e.g., cost, safety, sustainability, societal impact) with clear integration into design.	Covers most factors but lacks detailed integration or consideration of some elements.	Discusses some factors but misses key areas or does so superficially.	Minimal discussion of factors, with little relevance to the project.	No discussion of Design for X factors.
Conclusions (10%)	Provides clear, evidence-based conclusions demonstrating satisfaction of critical specifications.	Includes conclusions with some supporting evidence but lacks clarity or depth.	Provides general conclusions without strong evidence or connection to project goals.	Conclusions are minimal or do not align with the project content.	Missing or insufficient conclusions.
Recommendations (10%)	Offers insightful, practical recommendations for future improvements or extensions of the design.	Provides recommendations but lacks detailed reasoning or feasibility analysis.	Includes some recommendations but lacks clarity or practicality.	Recommendations are minimal or vague.	Missing or irrelevant recommendations.
References (5%)	Complete, alphabetized, and properly formatted bibliography with all sources cited appropriately.	Includes references but with minor formatting or citation errors.	References are present but incomplete or inconsistently formatted.	Minimal references provided, with significant errors or omissions.	References are missing or improperly cited.
Appendices (5%)	Includes relevant and comprehensive supplementary materials (e.g., drawings, analysis results) clearly linked to the main text.	Appendices are present but lack organization or completeness.	Includes some materials but misses key elements or connections to the report.	Minimal or irrelevant appendices provided.	Missing appendices.
Overall Report Quality (10%)	Professionally written, well-organized, free of errors, and visually appealing.	Well-written and organized but with minor errors or formatting inconsistencies.	Adequate quality but with notable errors, inconsistencies, or lack of polish.	Poorly written or organized, with significant errors or issues.	Unacceptable quality, difficult to read or understand.

Appendix 2C: Assignment 2 - Final Term Project Report Grading Rubric

Claude AI Output

Criteria	5 - Outstanding	4 - Above Average	3 - Satisfactory	2 - Needs Improvement	1 - Unsatisfactory
Document Format and Organization	Flawless formatting, professional presentation, perfect organization of all sections.	Well-organized with clear sections and consistent formatting.	Adequate organization with minor formatting issues.	Several formatting inconsistencies or organizational issues.	Poor organization, missing sections, or major formatting problems.
Abstract and Introduction	Exceptional clarity in objectives, comprehensive background, compelling project justification.	Clear objectives, good background information, well-justified need.	Basic objectives and background presented adequately.	Incomplete background or unclear objectives.	Missing critical information or poorly justified project need.
Design Documentation	Comprehensive design details, exceptional analysis of benchmarks, thorough evaluation procedures.	Detailed design specifications, good benchmark analysis, clear evaluation methods.	Basic design information and evaluation procedures included.	Incomplete design documentation or missing key analyses.	Insufficient design details or missing evaluation procedures.
Design for X Analysis	Outstanding analysis of multiple factors (cost, safety, sustainability, societal impact).	Thorough consideration of major design factors.	Adequate coverage of basic design factors.	Limited analysis of design factors.	Missing or inadequate factor analysis.
Results and Conclusions	Exceptional presentation of evidence, comprehensive achievement of specifications.	Strong evidence provided, clear achievement of specifications.	Basic evidence and achievement demonstration.	Limited evidence or unclear achievements.	Insufficient evidence or missing achievements.
Recommendations	Innovative, well-justified recommendations for future improvements.	Clear, practical recommendations for enhancement.	Basic recommendations provided.	Vague or limited recommendations.	Missing or irrelevant recommendations.
References and Citations	Perfect citation format, comprehensive bibliography, excellent source quality.	Proper citations, good source variety and quality.	Adequate citations and basic bibliography.	Inconsistent citations or limited sources.	Missing citations or poor source quality.
Appendices and Supporting Materials	Comprehensive, well-organized supplementary materials that enhance understanding.	Relevant, clear supporting materials included.	Basic supporting materials provided.	Limited or poorly organized materials.	Missing or irrelevant supporting materials.

Appendix 2D: Assignment 2 – Final Term Project Report Grading Rubric

Perplexity AI Output

Criteria	Score 5 - Excellent	Score 4 - Good	Score 3 - Satisfactory	Score 2 - Needs Improvement	Score 1 - Unsatisfactory
Content and Structure (0-5 points)	All required sections are present and well-developed (Cover Page, Abstract, Introduction, Design, Design for X, Conclusions, Recommendations, References, Appendices)	Most sections are present and adequately developed, with minor omissions	Key sections are present, but some are underdeveloped or missing	Several required sections are missing or poorly developed	Majority of required sections are missing or severely underdeveloped
Technical Depth and Analysis (0-5 points)	Comprehensive technical details, in-depth analysis of design specifications, benchmarks, and evaluation procedures	Solid technical content with some areas lacking depth or detail	Basic technical information provided, but lacking in-depth analysis	Limited technical details and superficial analysis	Minimal technical content and lack of meaningful analysis
Design for X Considerations (0-5 points)	Thorough discussion of multiple factors (cost, safety, sustainability, environmental and societal impact)	Discussion of most key factors with some depth	Basic coverage of some factors, but lacking comprehensive analysis	Limited consideration of Design for X factors	Minimal or no discussion of Design for X considerations
Supporting Materials and Documentation (0-5 points)	Comprehensive appendices with detailed drawings, analysis results, and development plans	Most required supporting materials included with good detail	Basic supporting materials provided, but some key elements missing	Limited supporting materials or lack of detail	Minimal or no supporting materials included
Overall Report Quality and Professionalism (0-5 points)	Professional writing style, proper citations, well-organized, and visually appealing	Generally well-written and organized with minor issues in style or formatting	Acceptable writing quality with some organizational or formatting issues	Significant issues with writing quality, organization, or formatting	Poor writing quality, disorganized, and unprofessional presentation

Appendix 2E: Assignment 2 - Final Term Project Report Grading Rubric

Criteria	Outstanding (5)	Above Average (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Document Format and Organization (5%)	Professionally formatted, well-structured, with all required sections clearly presented.	Well-organized with minor inconsistencies in formatting or structure.	Adequate organization but with some formatting issues or missing minor sections.	Poorly structured with noticeable formatting errors and missing sections.	Disorganized, difficult to follow, and missing multiple required sections.
Abstract and Introduction (10%)	Exceptionally clear objectives, comprehensive background, and compelling project justification.	Clear objectives and well-justified need, though some background details may be lacking.	Basic objectives and background provided but lacking depth.	Incomplete background or unclear project objectives.	Critical background details missing or project need not justified.
Technical Depth and Analysis (25%)	Comprehensive technical details, strong analysis of specifications, benchmarks, and evaluation procedures.	Good technical content but with minor gaps in depth or detail.	Basic technical content present but lacks thorough analysis.	Limited technical discussion with superficial analysis.	Minimal technical content with insufficient analysis.
Design for X Considerations (10%)	Thoughtful discussion of multiple factors such as cost, safety, sustainability, and societal impact.	Consideration of most key factors with adequate depth.	Basic coverage of some factors but lacking comprehensive analysis.	Limited discussion of Design for X factors.	Minimal or no discussion of Design for X considerations.
Results, Conclusions, and Recommendations (15%)	Clear evidence-based conclusions demonstrating achievement of objectives, along with insightful and practical recommendations.	Strong conclusions supported by some evidence; recommendations are clear but may lack depth.	Basic conclusions provided with general recommendations.	Weak conclusions with limited recommendations.	Conclusions missing or unsupported, and recommendations absent or irrelevant.
Supporting Materials and Documentation (10%)	Comprehensive appendices with detailed drawings, analysis results, and supporting documentation.	Most required supporting materials included with good detail.	Basic supporting materials provided, but missing some key elements.	Limited supporting materials or lack of detail.	Minimal or no supporting materials included.
References and Citations (5%)	Properly formatted citations and a complete bibliography with high-quality sources.	Proper citations with minor formatting errors or missing minor sources.	Basic citations provided but with inconsistencies or missing key references.	Inconsistent citation style, limited sources.	Missing citations or poor source quality.
Overall Report Quality and Professionalism (10%)	Exceptional clarity, professional writing style, well-organized, free of errors, visually appealing.	Well-written and organized, with minor errors in style or formatting.	Acceptable writing quality with some organizational or formatting issues.	Significant writing, organization, or formatting issues.	Poor writing quality, disorganized, and unprofessional presentation.

Appendix 3A: Assignment 3 - Final Term Project Report Guidelines

Submit a final term project report which should constitute the following:

- Cover page
- Executive Summary (100 ~ 150 words). Should constitute short and concise paragraphs capturing the following
 - Background Information
 - Objectives of the Study
 - Study/Analysis methods
 - Results
 - Discussion
 - Conclusion
- Table of Contents
- **Report body:** Should include following sections
 1. Problem statement (recognize a quality improvement problem)
 2. Project objectives (define the goals or objectives)
 3. Data and sources (describe the data used and list any outside sources)
 4. Problem analysis (collect all the relevant information, identify a set of feasible quality improvement alternatives)
 5. Evaluate and analyze alternatives (select the decision criterion to use and conduct economic analysis)
 6. Analyze and discuss your results
 7. Conclusions and recommendations (Discuss any limitations to your study and make recommendation for future action).
 8. List of References (APA style citation and referencing style required)

Grade Distribution

- Cover Page format & Elements (5 points)
- Executive Summary (10 points):
- Table of Contents (5 points)
- Problem Statement (5 points)
- Definition of Quality Requirements (10 points):
- Project Objectives (5 points)
- Data Collection, Relevance and Completeness (10 points):
- Presentation of Data (5 points)
- Evaluate and Analyze Alternatives (10 points):
- Decision Criteria and Solution Selection (5 points)
- Results Analysis and Discussion (10 points):
- Conclusions and Recommendations (10 points):
- References (5 points)
- Documentation and Presentation (5 points)

Appendix 3B: Assignment 3 - Final Term Project Report Grading Rubric

ChatGPT Output

Criteria	Score 5 - Excellent	Score 4 - Good	Score 3 - Satisfactory	Score 2 - Needs Improvement	Score 1 - Unsatisfactory
Cover Page Format & Elements (5 %)	Excellent formatting, includes all required elements (title, name, date, etc.), and is visually appealing.	Good formatting with minor errors or omissions in elements.	Adequate formatting but missing one significant element.	Poor formatting with several missing elements.	No proper cover page provided.
Executive Summary (10 %)	Comprehensive, concise, and captures all required sections (background, objectives, methods, results, discussion, conclusion) with clarity.	Addresses most sections but with minor lapses in clarity or completeness.	Includes some sections but lacks clarity or depth in analysis.	Limited in scope, missing key sections or unclear.	Very poor or incomplete summary.
Table of Contents (5 %)	Clearly organized, correctly formatted, and matches report structure.	Well-organized with minor formatting or structural errors.	Basic organization, missing minor elements.	Poorly organized or incomplete.	No table of contents.
Problem Statement (5 %)	Clearly identifies the quality improvement problem with relevant context.	Identifies the problem but lacks minor details or clarity.	Addresses the problem superficially or misses key context.	Poorly framed or unclear problem statement.	No problem statement provided.
Definition of Quality Requirements (10 %)	Fully and clearly defines quality requirements with relevant examples.	Defines most quality requirements with minor gaps.	Provides basic definitions but lacks depth or relevance.	Limited or vague definitions provided.	No clear definition of quality requirements.
Project Objectives (5 %)	Clearly defines specific, measurable, and relevant objectives.	Good objectives with minor gaps in specificity or relevance.	Objectives are basic but somewhat unclear or incomplete.	Vague or poorly defined objectives.	Objectives are missing.
Data Collection, Relevance, and Completeness (10 %)	Excellent data collection, fully relevant, and comprehensive.	Good data collection with minor omissions.	Adequate data but lacks relevance or depth.	Limited or unclear data collection.	No meaningful data collection.
Presentation of Data (5 %)	Data is well-organized, clear, and visually appealing.	Good presentation with minor lapses in clarity or organization.	Adequate presentation but lacks polish or organization.	Poorly presented or difficult to follow.	No data presentation.
Evaluate and Analyze Alternatives (10 %)	Comprehensive evaluation with well-reasoned analysis and alternatives.	Good analysis with minor gaps or omissions.	Basic analysis with limited alternatives.	Superficial or incomplete analysis.	No meaningful evaluation or analysis.
Decision Criteria and Solution Selection (5 %)	Clear, well-justified criteria with sound solution selection.	Good criteria and solution with minor gaps.	Basic criteria but limited justification.	Poor or unclear criteria.	Criteria not addressed.
Results Analysis and Discussion (10 %)	Thorough, insightful analysis with well-structured discussion.	Good analysis with minor issues in depth or organization.	Adequate analysis but lacks depth or clarity.	Limited discussion with unclear analysis.	No meaningful analysis or discussion.
Conclusions and Recommendations (10 %)	Clear, actionable recommendations with strong conclusions.	Good conclusions with minor omissions or unclear recommendations.	Basic conclusions but limited actionable recommendations.	Poorly articulated conclusions or vague recommendations.	No meaningful conclusions or recommendations.
References (5 %)	All references cited correctly in APA format.	Minor formatting errors in references.	Basic referencing with some formatting issues.	Poorly formatted or incomplete references.	No references provided.
Documentation and Presentation (5 %)	Professionally documented and visually appealing.	Well-documented with minor formatting or design issues.	Basic documentation but lacks polish.	Poor documentation or presentation.	Incomplete or unprofessional presentation.

Appendix 3C: Assignment 3 - Final Term Project Report Grading Rubric

Claude AI Output

Criteria	Score 5 - Outstanding	Score 4 - Above Average	Score 3 - Satisfactory	Score 2 - Needs Improvement	Score 1 - Unsatisfactory
Cover Page (5 %)	Professional format with all required elements perfectly presented.	Well-formatted with all elements present.	Basic format with required elements.	Missing elements or poor formatting.	Severely incomplete or unprofessional.
Table of Contents (5 %)	Perfect organization, all sections listed with correct page numbers.	Well-organized with minor formatting issues.	Complete but with some inconsistencies.	Incomplete or poorly formatted.	Missing or severely disorganized.
Documentation and Presentation (5 %)	Exceptional professional quality throughout.	Professional presentation with minor issues.	Adequate professional quality.	Inconsistent quality.	Poor overall quality.
Executive Summary (10 %)	Exceptional 100-150 word summary covering all required elements.	Well-written summary with most elements clearly presented.	Adequate summary with basic elements.	Incomplete or poorly structured summary.	Missing critical elements or exceeds word limit.
Problem Statement (5 %)	Clear, compelling problem identification and justification.	Well-defined problem with good context.	Basic problem statement provided.	Vague or poorly defined problem.	Missing or unclear problem statement.
Definition of Quality Requirements (10 %)	Comprehensive quality requirements with clear metrics.	Well-defined requirements with good detail.	Basic requirements outlined.	Incomplete or vague requirements.	Missing or inadequate requirements.
Project Objectives (5 %)	Clear, measurable objectives perfectly aligned with problem.	Well-defined objectives with good alignment.	Basic objectives stated.	Vague or poorly defined objectives.	Missing or misaligned objectives.
Data Collection, Relevance, and Completeness (10 %)	Comprehensive, relevant data with perfect documentation.	Well-documented data with good relevance.	Adequate data collection.	Incomplete or partially relevant data.	Missing or irrelevant data.
Presentation of Data (5 %)	Outstanding visual and textual presentation of data.	Clear and effective data presentation.	Basic data presentation.	Poor or confusing presentation.	Missing or inappropriate presentation.
Evaluate and Analyze Alternatives (10 %)	Exceptional analysis of all feasible alternatives.	Good analysis of multiple alternatives.	Basic alternative analysis.	Limited or superficial analysis.	Missing or inadequate analysis.
Decision Criteria and Solution Selection (5 %)	Comprehensive criteria with excellent justification.	Clear criteria with good justification.	Basic criteria presented.	Limited or unclear criteria.	Missing or unjustified criteria.
Results Analysis and Discussion (10 %)	Outstanding analysis with insightful discussion.	Thorough analysis with good discussion.	Basic analysis and discussion.	Limited or superficial analysis.	Missing or inadequate analysis.
Conclusions and Recommendations (10 %)	Exceptional conclusions with actionable recommendations.	Clear conclusions with good recommendations.	Basic conclusions provided.	Weak or unsupported conclusions.	Missing or irrelevant conclusions.
References (5 %)	Perfect APA formatting with comprehensive sources.	Good APA formatting with appropriate sources.	Basic APA formatting with adequate sources.	Inconsistent formatting or limited sources.	Missing or improper citations.

Appendix 3D: Assignment 3 - Final Term Project Report Grading Rubric

Perplexity AI Output

Criteria	5 (Excellent)	4 (Very Good)	3 (Good)	2 (Fair)	1 (Poor)
Structure and Organization	Exceptional organization; seamless flow between all sections	All sections present and well-organized; good flow between sections	All required sections present; adequate organization	Some sections missing or incomplete; organization needs improvement	Missing multiple required sections; poor organization
Executive Summary	Exemplary summary; perfectly captures project essence within word limit	Concise and comprehensive; covers all elements effectively	Includes all required elements within word limit; adequate conciseness	Covers some key elements; may exceed word limit	Incomplete or missing key elements; exceeds word limit
Problem Statement	Exceptional problem statement with clear relevance and significance	Well-defined quality improvement problem with context	Clear statement of quality improvement problem	Quality improvement problem stated but lacks clarity	Vague or irrelevant quality improvement problem
Project Objectives	Comprehensive, measurable objectives perfectly aligned with problem	Well-defined objectives aligned with problem statement	Clear and relevant objectives stated	Objectives stated but vague or misaligned	Objectives missing or irrelevant
Data and Sources	Comprehensive data description with critical evaluation of sources	Detailed description of data and sources with justification	Adequate description of data and sources used	Limited description of data and sources	Data sources not described or irrelevant
Problem Analysis	In-depth, insightful analysis with multiple perspectives	Thorough analysis with good depth	Adequate analysis of the problem	Basic analysis with limited depth	Superficial or irrelevant analysis
Alternatives Evaluation	Comprehensive set of alternatives with robust evaluation methodology	Good range of alternatives with clear evaluation criteria	Adequate alternatives and evaluation criteria	Limited alternatives or weak evaluation	No clear alternatives or evaluation criteria
Results and Discussion	Exceptional presentation of results with critical analysis and insights	Thorough results presentation with insightful discussion	Clear presentation of results with adequate discussion	Basic presentation of results with limited discussion	Results missing or irrelevant
Conclusions and Recommendations	Insightful conclusions with innovative, actionable recommendations	Well-reasoned conclusions with strong recommendations	Adequate conclusions and recommendations	Basic conclusions with weak recommendations	Missing or irrelevant
References and Citations	Extensive, relevant references perfectly cited in APA style	Good range of references, correctly cited in APA style	Adequate references with mostly correct APA style	Few references with inconsistent APA style	No references or improper citation

Appendix 3E: Assignment 3 - Final Term Project Report Grading Rubric

Combined Grading Rubric Used for Assignment 3

Criteria	Outstanding (5)	Above Average (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Structure & Organization (5 %)	Exceptionally structured; seamless flow	Well-organized with good flow	All sections present but organization could improve	Some sections missing or incomplete; poor organization	Missing multiple sections; disorganized
Cover Page (5 %)	Perfect formatting, all elements, visually appealing	Well-formatted, all elements present	Includes basic elements, minor errors	Poor formatting, missing elements	Missing or unprofessional
Table of Contents (5 %)	Perfectly structured with correct page numbers	Well-organized with minor formatting issues	Contains required elements but inconsistent	Incomplete or poorly formatted	Missing or severely disorganized
Executive Summary (10 %)	Outstanding summary, perfectly captures project	Well-structured, concise, and complete	Covers key elements within word limit	Includes some elements but lacks clarity	Missing or incomplete
Problem Statement (5 %)	Exceptional problem statement with relevance	Well-defined with proper context	Clear statement of problem	Stated but lacks clarity	Vague or unclear problem
Project Objectives (5 %)	Comprehensive, measurable, and well-aligned	Well-defined, aligned with problem	Clear and relevant objectives	Stated but vague	Objectives missing or irrelevant
Definition of Quality Requirements (10 %)	Comprehensive, clear definitions with metrics	Well-defined with good examples	Basic quality requirements outlined	Limited or unclear requirements	Missing or vague definitions
Data Collection & Sources (10 %)	Comprehensive data collection with critical evaluation	Detailed data collection, justified sources	Adequate data with basic sources	Limited data with unclear sources	No data or irrelevant sources
Presentation of Data (5 %)	Outstanding, visually appealing, well-structured data	Well-organized, clear presentation	Basic organization, minor clarity issues	Poorly structured, difficult to follow	No data presentation or disorganized
Problem Analysis (10 %)	In-depth, insightful, multiple perspectives	Thorough analysis with good depth	Adequate problem analysis	Basic analysis with limited depth	Superficial or lacks relevance
Evaluation of Alternatives (10 %)	Comprehensive, robust evaluation methodology	Good range of alternatives with clear criteria	Adequate alternatives and evaluation criteria	Weak evaluation, limited alternatives	No alternatives or evaluation criteria
Decision Criteria & Solution Selection (5 %)	Exceptional decision-making process, well-reasoned	Well-justified selection process	Basic criteria presented	Poor or unclear criteria	No criteria or justification
Results Analysis & Discussion (10 %)	Exceptional results with critical analysis	Thorough results with insightful discussion	Clear results, adequate discussion	Basic presentation, limited discussion	No results or irrelevant
Conclusions & Recommendations (10 %)	Insightful, innovative, and actionable recommendations	Well-reasoned conclusions with strong recommendations	Adequate conclusions and recommendations	Basic conclusions with weak recommendations	Missing or weak conclusions
References & Citations (5 %)	Extensive, relevant, perfectly formatted citations	Well-cited references, proper APA style	Adequate references, mostly correct formatting	Few references, inconsistent citations	No references or incorrect format
Documentation & Presentation (5 %)	Exceptionally well-documented and visually appealing	Professionally presented, minor issues	Adequate professional quality	Inconsistent quality, needs improvement	Poorly documented, unprofessional

Appendix 4A: Assignment 4 – Capstone Design Project Final Report Guidelines

1.0 Document Scope

This document specifies the required elements and deliverables for the Capstone Design Project Final Report (PFR).

2.0 Report Objective and Scope

The Project Final Report is a comprehensive documentation of the project, with an emphasis on the design practicum portion of the Capstone Design Projects course. It is a counterpart to the Fall Final Report (FFR), but has distinct objectives:

Closed Design Loop: While the FFR provided a comprehensive overview of the design at the project's midpoint, the PFR should present a complete picture of the project, encompassing manufacturing and testing. Additionally, it should clearly demonstrate how these results align with the project's original objectives and validate its functional requirements.

Documentation archive: The PFR provides a central collection of all relevant documentation in the project, to be collected and organized as if further project development were to follow.

The PFR must serve as a comprehensive, standalone description of the project, without assuming the reader has prior knowledge of the FFR. It should clearly define the project's purpose, outline the customer's functional requirements, and specify the project's objectives, including measurable success criteria.

Additionally, the PFR must present a requirements flow-down, linking functional requirements to detailed design specifications. It should describe the design solution from a high-level overview down to specific design details and key decisions, including modeling efforts, while also explaining how the system operates.

Furthermore, the report should cover essential aspects of manufacturing for mechanical, electrical, and software components. It must also detail the verification and validation strategy, present test results, and interpret these findings in relation to both design and functional requirements.

3.0 Required Structure and Authorship

All team members should make a meaningful contribution to the PFR, both in terms of content and writing. The report must follow the organizational structure outlined below, with appropriately named chapters. Within each chapter, you have the flexibility to structure the discussion in a way that best conveys the specifics of your project.

Due to the collaborative nature of many project efforts, authorship may not always be neatly divided among team members. To ensure a fair evaluation of individual contributions, the report must include a contribution summary section. This section should be organized by team member and detail their specific content contributions as well as their role in writing the PFR..

4.0 Final Report Data Package

4.1 PFR Data package Content

The Project Final Report consists of two volumes:

- 1) Written report named according to: TEAM_PFR.docx [must be a Microsoft Word document].
- 2) Electronic documentation archive, organized by project sub-systems, containing all relevant and up-to-date diagrams, drawings, schematics, source code, product spec sheets, images, videos, etc. needed to carry the project forward. Any of these items used in the written report must be inserted into the report to make it self-contained and readable, but reference to specific archive items can be made for more detail. Each archive sub-section should contain a Word file with a short summary of its contents.

4.2 Required Written Report Content

The written portion of the Project Final Report (PFR) is a comprehensive technical document that compiles all design-related work into a cohesive and readable report. It incorporates information and insights from previous documents, including the Preliminary Design Document (PDD), Critical Design Document (CDD), Preliminary Design Report (PDR), Critical Design Report (CDR), Fall Final Report (FFR), Manufacturing Status Review (MSR), Testing Readiness Report (TRR), and Spring Final Report (SFR), along with detailed testing results not included in the FFR.

Much of the content required for the PFR has already been developed in these earlier reports. However, the PFR must present a well-organized and concise description of the project, reflecting the more informed perspective gained by the end of the project. Instead of simply compiling previous work, the PFR should refine, edit, and re-evaluate earlier design materials to create a clear and coherent narrative. This approach ensures that the report enhances the reader's understanding rather than overwhelming them with unstructured information. As much prior work as possible should be reused, but only in a way that contributes to a structured and insightful final report.

Organization and Clarity

Compiling a comprehensive report that captures months of engineering work requires careful organization. A well-structured document is crucial to maintaining clarity and ensuring that the reader fully appreciates the scope and impact of the work.

- Begin each section with an overview of its content and purpose, linking it to previous and subsequent sections.
- Present context before diving into details—an overview should precede in-depth analysis.
- Use diagrams to introduce concepts visually before explaining them in text or analysis.
- Just as each slide in a presentation should convey a key point, each paragraph in the report should do the same, supported by diagrams, equations, and plots where necessary.
- Creating a detailed outline—down to the key points each paragraph should make—can help structure the report, assign sections to team members, and ensure a seamless integration of contributions.

Writing Style and Technical Precision

- Be concise and direct, using clear and simple language to express ideas effectively.
- Assign unique names to all system components for clarity and label diagrams accordingly.

- Clearly connect analytical methods to project needs, linking equations with relevant diagrams, numerical results, and explanations.
- Use unique and consistent symbols in analytical work, ensuring they match those used in related diagrams and descriptions.
- Employ technical terminology correctly and consistently.
- Avoid pronouns, as they can reduce specificity and introduce ambiguity.

Depth of Understanding

Most importantly, the PFR must clearly explain how the system works. Avoid unnecessary detail, bureaucratic filler, excessive plots, unexplained diagrams, or unlabeled images that obscure key insights. The goal is to demonstrate a deep understanding of the engineering challenges and solutions, not simply to present a large volume of material.

Each section should include conclusions that interpret results in the context of the project's needs. Rather than just describing "what" was done, explain "why" it was done. Address the report to a knowledgeable professional engineering audience but assume they are unfamiliar with the specifics of your system.

The PFR should not merely document the project—it should provide a clear, logical, and insightful explanation of the design, testing, and overall success in meeting project objectives.

The top-level organization of the written report shall have the following structure:

Preamble (5%)

- Title Page, including project title, names of all group members, customer, advisor, and date.
- Table of Contents
- List of Figures
- List of Tables
- List of Acronyms
- Definition of symbols (nomenclature)

Section 1: Project Purpose (5%)

Describe the field of application, the specific problem the project addresses, and the potential benefits of a successful outcome. Provide context by relating the problem to existing work in the field, highlighting its relevance and significance. Clearly identify what is novel about the project and how it differs from or improves upon previous approaches.

Support your discussion with references to engineering literature, reputable sources in the popular press, or relevant websites. Do not use or cite proprietary documents or personal communications that are not publicly available.

Section 2: Project Objectives and Functional Requirements (5%)

Clearly define what the project needed to accomplish to address the design problem or need, and establish what constituted "success" for the project. Use a structured approach with success levels ranging from the minimum required for the project to be considered successful (Level 1) to the highest level of achievement the project aimed for (Level 13). Illustrate how the system operates in

this application using CONOPS diagrams, and provide a detailed description of the project deliverables, to the course and to the customer.

Include a Functional Block Diagram (FBD) along with a clear explanation. The FBD should outline the major components of a functional system and illustrate their interactions in solving the problem. Clearly differentiate between elements designed by the team and those that were supplied or acquired. In many cases, a Capstone Design Project addresses only part of a larger system or problem; therefore, the FBD should distinguish the project's specific components from the broader system.

Finally, provide a numbered list of the project's functional requirements, along with explanations of their origins/source and justifications.

Section 3: Design Process and Outcome (20%)

Outline the set of conceptual design alternatives considered and the trade studies that were conducted. Discuss how the results of trade studies were evaluated, and how that led to the baseline design selection.

Describe the requirements flow-down from functional requirements to detailed design requirements. Describe the rationale for each major requirement, i.e. how it flows logically or technically from the parent requirement

Describe the resulting design, showing what the whole system looks like, its key parameters (dimensions, mass, data rates, etc.), what the major elements or subsystems are, and most importantly, how it works. Provide key engineering design details, showing drawings, schematics, layouts, flow charts, timing diagrams, etc., as needed to convey your understanding of all critical design elements and the corresponding design solutions.

Section 4: Manufacturing (20%)

Describe the scope of the manufacturing tasks in the project, including what parts were manufactured vs. purchased, what was involved in their manufacture, where and how they were manufactured. Include mechanical, electrical, and software manufacturing elements.

Describe the outcome of the manufacturing tasks, including a summary of challenges faced and how they were overcome.

Show how the components in the project were integrated into a functioning system.

Section 5: Verification and Validation (25%)

Describe how the design was verified against predictive models through characterization testing. Use diagrams to convey the test set up, the facilities and equipment needed, and how the test works. Describe the measurements made, and key measurement issues (resolution, sampling rate, etc.) Show how the selected sensors, instruments, data acquisition, test fixtures, etc., provided the required capabilities.

Describe how the design was validated against functional requirements and overall project success criteria.

Section 6: Risk Assessment and Mitigation (5%)

Discuss how risks in the project were identified, tracked, and mitigated. Describe the extent to which these risks were realized during project development, and what the impact was on the success of the project.

Section 7: Project Planning (5%)

Describe the planning that was carried out and how it was used in project development. Your discussion should include the following planning components:

- Organizational Chart (OC), showing the leadership roles of all team members.
- Work Breakdown Structure (WBS), showing all the work products for the project. Explain how the work products were determined.
- Work Plan (WP), showing the main tasks to accomplish the WBS products, along with their scheduling, in the form of a Gantt chart. Describe critical path tasks, and discuss how schedule margins were allocated.
- Cost Plan (CP), in the form of a financial budget, for all major items in the project, highlighting uncertainties and corresponding budget margins.
- Provide a Test Plan (TP) showing all major tests conducted and how they were scheduled. Note the use of specialized test equipment or facilities used, and how their use was secured.

Section 8: Lessons Learned (5%)

Identify the key lessons learned in the development of this project. This should include items that you wish you had known at the start of the project, as well as advice for new seniors to improve their experience and success in the conduct of their projects.

Section 9: Individual Report Contributions (0%)

Briefly describe the contributions of each team member to the PFR, including both design/development work (content) and the writing itself. Each team member should write this for themselves, drawing upon information already provided in the final self-evaluations.

4.3 Written Report Format

The written report shall conform to the following standard format.

4.3.1 Font

The text of your report must use 11-point Times Roman font, 1.15 line spaced. Remember: Easy reading makes grading easier! Advisors are human too.

Other fonts (Calibri or Arial) may be used for headings, figure captions, table captions, and figure labels. Figure labels should be at least 10 point font size.

4.3.2 Margins

Use 1 inch margins on all sides.

4.3.3 Figures

Figures must be included within the text, following their first reference within the text. Do not include figures that are not referenced within the text.

4.3.4 Tables

Tables must be included within the text, following their first reference within the text. Do not include tables that are not referenced within the text.

4.4 Delivery Instructions

The data package must be submitted in the Canvas Portal as a word document (doc or docx) file.

4.5 Due Date and Time

All materials must be submitted to canvas by the due date and time indicated in Canvas and the Course Syllabus.

5.0 Grading

The PFR will be evaluated by your advisor, who will recommend a group grade to the project advisory board (PAB) based on the section weightings given below. The team reports and grades will be discussed by the PAB to resolve any grading inconsistencies, and the PAB will issue a group grade for each team's PFR.

Individual grades on the PFR will be derived as differential adjustments from the group grade, based on advisor assessments of individual contributions, peer evaluations, and the stated individual contributions to the report (Section 9). Any individual adjustments will preserve the group grade as the average of the individual grades in a group.

Preamble (5%)

Section 1: Project Purpose (5%)

Section 2: Project Objectives and Functional Requirements (5%)

Section 3: Design Process and Outcome (20%)

Section 4: Manufacturing (20%)

Section 5: Verification and Validation (25%)

Section 6: Risk Assessment and Mitigation (5%)

Section 7: Project Planning (5%)

Section 8: Lessons Learned (5%)

Section 9: Individual Report Contributions (0%)

Overall writing quality (5%)

Appendix 4B: Assignment 4 - Capstone Design Project Final Report Grading Rubric

ChatGPT Output

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Preamble (5%)	Complete, clear, professional formatting and includes all required elements.	Minor omissions or formatting issues.	Includes most elements but lacks clarity or professionalism in some areas.	Significant omissions or formatting errors.	Missing key elements or lacks clarity.
Project Purpose (5%)	Clearly articulates the field, problem, and benefits with well-supported context and references.	Clearly describes purpose and benefits but with less context or weak references.	Adequately describes purpose, but lacks depth, clarity, or strong references.	Description is unclear or incomplete, with minimal context.	Missing or fails to articulate purpose, benefits, or context.
Objectives & Requirements (5%)	Objectives and functional requirements are thorough, logical, and supported by clear diagrams and rationale.	Clearly stated objectives and requirements with minor gaps in diagrams or explanation.	Meets minimum requirements but lacks depth, clarity, or supporting diagrams.	Vague or incomplete objectives and requirements with weak or missing supporting details.	Objectives and requirements are absent or irrelevant.
Design Process & Outcome (20%)	Comprehensive design alternatives, trade studies, and rationale for decisions. Explains system thoroughly with clear visuals and detailed engineering design.	Strong design discussion with minor omissions or less detailed visuals.	Adequate design process and explanation but lacks depth, clear rationale, or strong visuals.	Limited discussion of design process and outcome, with weak or missing visuals.	Fails to explain design process or outcome meaningfully.
Manufacturing (20%)	Fully explains scope, challenges, and solutions with clear integration of components into the system.	Strong explanation with minor omissions in scope or integration details.	Adequate manufacturing discussion but lacks detail or completeness.	Incomplete or unclear discussion of manufacturing tasks and challenges.	Little to no discussion of manufacturing or integration.
Verification & Validation (25%)	Thorough explanation of testing strategy, methodology, and results, clearly linking to requirements.	Well-documented testing with minor omissions or weaker links to requirements.	Adequate testing discussion, but lacks depth, clarity, or connection to requirements.	Limited testing discussion with unclear or incomplete results.	Missing or fails to explain testing or results clearly.
Risk Assessment (5%)	Comprehensive risk identification, tracking, and mitigation with detailed impact assessment.	Identifies and assesses risks with minor gaps in tracking or mitigation discussion.	Sufficient risk assessment but lacks detail or thoroughness.	Vague or incomplete discussion of risks and mitigation strategies.	Fails to identify or address risks meaningfully.
Project Planning (5%)	Detailed and clear organizational chart, WBS, Gantt chart, and budget with strong rationale for critical tasks and margins.	Good planning components with minor omissions or weaker rationale for critical tasks.	Planning elements included but lack detail, clarity, or rationale.	Minimal or unclear planning discussion with weak critical path analysis or budgeting.	Fails to include or explain planning components adequately.
Lessons Learned (5%)	Insightful lessons with actionable advice for future projects, clearly connected to the project experience.	Thoughtful lessons with minor gaps in clarity or actionable advice.	Sufficient discussion of lessons learned, but lacks depth or clear advice.	Limited or vague discussion of lessons learned with little connection to project experience.	Fails to provide meaningful lessons or advice.
Overall Writing Quality (5%)	Writing is professional, clear, concise, and well-organized, with effective use of visuals and technical terminology.	Generally clear and professional writing with minor errors or less effective use of visuals.	Writing is satisfactory but lacks organization, clarity, or professionalism in places.	Writing is unclear or unprofessional, with significant errors or poorly integrated visuals.	Writing quality is poor, unprofessional, or disorganized, with little attention to clarity or technical accuracy.

Appendix 4C: Assignment 4 - Capstone Design Project Report Grading Rubric

Claude AI Output

Criteria	5 - Outstanding	4 - Proficient	3 - Satisfactory	2 - Developing	1 - Insufficient
Preamble (5%)	Perfect formatting of all required elements (title page, TOC, lists, acronyms, symbols).	Well-organized with minor formatting issues.	All elements present but some formatting inconsistencies.	Missing elements or significant formatting issues.	Severely incomplete or improper formatting.
Project Purpose (5%)	Outstanding context, novel aspects clearly identified, excellent references.	Clear problem description with good context and references.	Basic purpose and context provided.	Unclear purpose or missing context.	Purpose poorly defined or missing key elements.
Objectives & Functional Requirements (5%)	Comprehensive success levels, excellent CONOPS diagrams, clear FBD.	Well-defined objectives with good supporting diagrams.	Basic objectives and requirements stated.	Incomplete objectives or unclear requirements.	Missing critical objectives or requirements.
Design Process & Outcome (20%)	Exceptional design analysis, trade studies, and requirements flow-down.	Strong design process with good documentation.	Basic design process described.	Incomplete process or missing key decisions.	Poor design documentation or missing critical elements.
Manufacturing (20%)	Comprehensive manufacturing documentation, excellent integration details.	Clear manufacturing process with good challenges/solutions.	Basic manufacturing information provided.	Limited manufacturing details or missing elements.	Poor manufacturing documentation.
Verification & Validation (25%)	Outstanding test documentation, excellent analysis of results.	Clear test procedures with good results analysis.	Basic testing information provided.	Incomplete testing or poor analysis.	Missing critical test data or analysis.
Risk Assessment & Mitigation (5%)	Comprehensive risk analysis with excellent mitigation strategies.	Good risk assessment and mitigation plans.	Basic risk analysis provided.	Limited risk assessment or missing mitigation.	Poor risk documentation.
Project Planning (5%)	Outstanding OC, WBS, WP, CP, and TP documentation.	Well-documented planning elements.	Basic planning documentation provided.	Missing planning elements or poor documentation.	Inadequate planning documentation.
Lessons Learned (5%)	Exceptional insights with valuable recommendations.	Clear lessons with good recommendations.	Basic lessons provided.	Limited or superficial lessons.	Missing or irrelevant lessons.
Overall Writing Quality (5%)	Exceptional clarity, professional style throughout.	Clear writing with minor style issues.	Adequate professional writing.	Multiple writing or style issues.	Poor writing quality.

Appendix 4D: Assignment 4 - Capstone Design Project Report Grading Rubric

Perplexity AI Output

Criteria	5 - Exceptional	4 - Very Good	3 - Satisfactory	2 - Needs Improvement	1 - Unsatisfactory
Preamble & Project Purpose (10%)	All required elements present, clear title page, comprehensive TOC, lists, and definitions. Project purpose excellently contextualized with relevant citations.	Most elements present and well-organized. Project purpose well-explained with some context.	Basic elements present. Project purpose adequately described.	Some elements missing or poorly organized. Project purpose lacks clarity or context.	Major elements missing. Project purpose unclear or absent.
Objectives & Functional Requirements (5%)	Clear, specific objectives with well-defined success levels. Comprehensive CONOPS diagrams and FBD. Detailed, numbered functional requirements with rationale.	Well-defined objectives and success levels. Good CONOPS and FBD. Numbered functional requirements present.	Basic objectives and functional requirements stated. CONOPS and FBD included.	Vague objectives or incomplete functional requirements. CONOPS or FBD missing or unclear.	Objectives and functional requirements poorly defined or absent.
Design Process & Outcome (20%)	Comprehensive description of design alternatives, trade studies, and selection process. Excellent requirements flow-down. Detailed design description with clear explanations and visuals.	Good description of design process and outcome. Clear requirements flow-down. Design well-explained with appropriate visuals.	Adequate description of design process and outcome. Basic requirements flow-down. Design explained with some visuals.	Limited description of design process. Unclear requirements flow-down. Design explanation lacks detail or clarity.	Insufficient description of design process and outcome. Missing or inadequate requirements flow-down and design explanation.
Manufacturing (20%)	Comprehensive description of manufacturing scope, challenges, and solutions. Clear explanation of integration process. Excellent detail on mechanical, electrical, and software elements.	Good description of manufacturing process and integration. Challenges and solutions well-addressed.	Adequate description of manufacturing and integration. Basic coverage of challenges and solutions.	Limited description of manufacturing process. Unclear integration explanation. Challenges poorly addressed.	Insufficient coverage of manufacturing and integration processes.
Verification & Validation (25%)	Comprehensive description of verification and validation processes. Excellent test setup diagrams and explanations. Clear connection to functional requirements and success criteria.	Good description of verification and validation. Clear test setups and explanations. Well-linked to requirements and criteria.	Adequate description of verification and validation. Basic test setups explained. Some links to requirements and criteria.	Limited description of verification and validation. Unclear test setups or weak links to requirements.	Insufficient coverage of verification and validation processes.
Risk Assessment, Project Planning & Lessons Learned (15%)	Comprehensive risk assessment and mitigation strategies. Detailed project planning. Insightful lessons learned.	Good risk assessment and project planning. Clear lessons learned section.	Adequate risk assessment and basic project planning. Some lessons learned provided.	Limited risk assessment or project planning. Vague or few lessons learned.	Insufficient coverage of risks, project planning, or lessons learned.
Overall Writing Quality & Format (5%)	Exceptional writing quality. Perfect adherence to format guidelines. Excellent organization and clarity.	Very good writing quality. Minor format deviations. Well-organized and clear.	Satisfactory writing quality. Some format issues. Generally organized and understandable.	Poor writing quality. Significant format issues. Lacks organization or clarity.	Unsatisfactory writing quality. Major format violations. Disorganized and unclear.

Appendix 4E: Assignment 4 - Capstone Design Project Report Grading Rubric

Combined and Used for Assignment 4

Criteria	Outstanding (5)	Above Average (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Preamble (5%)	Perfect formatting of all required elements (title page, TOC, lists, acronyms, symbols).	Well-organized with minor formatting issues.	All elements present but some formatting inconsistencies.	Missing elements or significant formatting issues.	Severely incomplete or improper formatting.
Project Purpose (5%)	Clearly articulates field, problem, and benefits with strong references and context.	Clear purpose and benefits with minor gaps in context or references.	Adequate description of purpose but lacks depth or strong references.	Unclear or incomplete description, missing key context.	Purpose is missing or fails to articulate key elements.
Objectives & Functional Requirements (5%)	Comprehensive objectives with success levels, CONOPS diagrams, and rationale.	Well-defined objectives and functional requirements with minor gaps.	Basic objectives and requirements stated with some clarity.	Vague or incomplete objectives with unclear requirements.	Objectives and requirements absent or poorly defined.
Design Process & Outcome (20%)	Exceptional design analysis, trade studies, and clear requirements flow-down with strong visuals.	Strong design process with good documentation and minor omissions.	Basic design process described with some rationale and visuals.	Limited design process discussion, missing key design decisions.	Poor design documentation, missing rationale and visuals.
Manufacturing (20%)	Comprehensive manufacturing scope, challenges, and solutions with excellent integration details.	Good description of manufacturing process and integration with minor gaps.	Adequate manufacturing discussion with basic challenges addressed.	Limited description of manufacturing and integration, missing key details.	Poor or missing manufacturing documentation.
Verification & Validation (25%)	Comprehensive test documentation with clear methodology, results, and connection to requirements.	Well-documented testing with minor omissions in linking to requirements.	Adequate testing discussion but lacks clarity, depth, or strong analysis.	Limited testing discussion with weak results analysis.	Testing and validation missing or insufficiently explained.
Risk Assessment & Mitigation (5%)	Comprehensive risk analysis with clear mitigation strategies and impact assessment.	Good risk assessment with minor gaps in tracking or mitigation discussion.	Basic risk analysis provided but lacks thoroughness.	Limited discussion of risks and mitigation strategies.	No risk assessment or mitigation strategies included.
Project Planning (5%)	Outstanding organizational chart, WBS, Gantt chart, and budget with clear rationale for critical tasks.	Well-documented planning components with minor omissions.	Basic planning elements included but lacking depth or clarity.	Minimal planning discussion with weak rationale for critical tasks.	Fails to include or explain planning components adequately.
Lessons Learned (5%)	Insightful lessons with valuable recommendations for future projects.	Clear lessons learned with good recommendations.	Basic lessons provided but lacks depth or applicability.	Limited or vague lessons with minimal connection to project experience.	No meaningful lessons or recommendations.
Overall Writing Quality (5%)	Professional, clear, concise writing with well-integrated visuals and technical terminology.	Generally clear and professional writing with minor errors.	Writing is satisfactory but lacks organization or clarity.	Unclear or unprofessional writing with significant errors.	Poor writing quality with major issues in clarity and technical accuracy.