

A Work in Progress: The Impact of AI-Driven Tools on Learning in Engineering Economy Courses

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Abstract

The rapid development of Artificial Intelligence (AI) presents both opportunities and challenges for engineering education. As AI tools like ChatGPT become more accessible, students increasingly use them to complete assignments, prompting educators to evaluate whether to integrate AI as a learning aid or restrict its usage. This study explores the potential of AI to enhance student learning outcomes in an engineering economics course. Specifically, we utilize ChatGPT, which provides detailed explanations of economic theories, guidance on microeconomic principles, example problems, and real-world economic insights.

In this case study, we compare two sections of an engineering economics course at our institution. One section incorporates AI-enhanced teaching methods, while the other serves as a control group with traditional instruction. Both sections are taught by the same instructor, with identical lectures and assignments. However, in the AI-enhanced section, students engage with AI-generated supplementary assignments and decision-making scenarios, allowing them to explore the consequences of economic decisions through AI-driven feedback.

This paper presents several case studies demonstrating how AI tools were integrated into the classroom and examines the impact on student learning outcomes. We also highlight student perspectives on using AI in their coursework. By leveraging AI, this study contributes to ongoing discussions about innovative teaching methods and the future of engineering economic education.

Introduction

Artificial Intelligence (AI) is rapidly transforming industries and society, and its influence in higher education, particularly engineering education, is becoming increasingly significant. AI technologies are reshaping how knowledge is imparted and how students engage with complex concepts. The integration of generative AI, such as large language models like ChatGPT, presents new opportunities to enhance personalized learning, improve problem-solving skills, and foster more interactive educational experiences. As AI continues to advance, it is crucial that educational systems adapt, ensuring that students are equipped with the skills necessary to thrive in an AI-driven world. This growing integration of AI tools into curricula promises to drive innovation in teaching methods, assessment, and the broader educational ecosystem, preparing future engineers to navigate and contribute to an AI-powered landscape.

Recent studies highlight the growing integration of Artificial Intelligence (AI) tools in engineering education, reflecting both their potential and challenges. For instance, Subramanian

and Vidalis [1] explore AI-powered tools, including generative models like ChatGPT, that facilitate interactive, personalized learning experiences in engineering classrooms shortly after they are becoming readily available to the public. They highlight AI's role in providing real-time feedback, simulating real-world scenarios, and solving complex problems, thus preparing students for industry challenges. Additionally, Harris and Kittur [2] emphasize the need for undergraduate engineering students to leverage generative AI, such as large language models, to stay competitive in the rapidly evolving technological landscape. However, concerns about the ethical use and accuracy of AI-generated content persist, suggesting that AI's integration into curricula must be carefully managed to avoid undermining academic integrity [3], [4]. For example, Peuker [4] investigates the utilization of generative AI among first-year mechanical engineering students, showing that while students recognize the potential of AI for enhancing learning, they also acknowledge risks such as academic dishonesty.

However, majority of studies point out that AI tools not only support students' academic tasks but also promote active engagement and self-regulation [5], [6], [7], [8]. The use of AI for idea generation and educational support was prevalent, with students expressing a preference for responsible AI usage [4]. For example, Ely and Rezvani Rad [6] explore how AI tools in engineering technical writing courses can provide students with instant feedback, enhancing their writing skills but also raise concerns about the loss of originality and creativity. These findings illustrate that while AI tools can significantly improve learning outcomes, their effective integration depends on ensuring ethical usage, supporting critical thinking, and fostering creativity among students [9], [10].

In this case study, we analyze two sections of an engineering economics course at our institution. One section integrates AI-supported teaching methods, while the other follows a traditional instructional approach, acting as a control group. Both sections are taught by the same instructor, covering the same lectures and assignments. However, in the AI-integrated section, students participate in AI-generated supplementary assignments and decision-making scenarios, enabling them to examine the outcomes of economic decisions with AI-provided feedback.

Implementation

EGR 303 - Engineering Economics at the University of Massachusetts Dartmouth (UMD) is 3 credit hour course designed to equip students with the knowledge and tools to evaluate engineering projects using economic principles. The course includes two 1 hour and 15 minutes lectures each week. The course emphasizes time value of money, rate of return evaluation, and decision-making techniques such as present worth analysis and breakeven analysis similar to micro economic courses. In addition to satisfy university study requirements at UMD, it includes topics on the global considerations on engineering decisions and introduces students to the fundamentals of international trade, with a focus on trade policies, exchange rates, and global market dynamics. Students engage in active learning, including quizzes, problem-solving assignments, and a term project that incorporates environmental, sustainability, and tax considerations. The course is structured to foster a deep understanding of economic decision-making in engineering, preparing students to make informed choices that balance profitability, global impacts, and societal responsibility. Figure 1 includes the tentative schedule of the course.

Session	Date	Chapter (Text 1)	Chapter (Text 2)	Topic	Assignments
1	Sep. 5, 2024	1		Introduction to Engineering Economy	
2	Sep. 10, 2024	2		Cost Concepts and Design Economics	HW 1
3	Sep. 12, 2024	4		The Time Value of Money	
4	Sep. 17, 2024	4		The Time Value of Money	HW 2, Quiz 1
5	Sep. 19, 2024	4		The Time Value of Money	
6	Sep. 24, 2024	4		The Time Value of Money	HW 3, Quiz 2
7	Sep. 26, 2024	5		Evaluating a Single Project	
8	Oct. 1, 2024	5		Evaluating a Single Project	HW 4
9	Oct. 3, 2024	6		Comparison and Selection Among Alternatives	
10	Oct. 8, 2024			<i>Midterm Exam 1</i>	CH 1-5
11	Oct. 10, 2024	6		Comparison and Selection Among Alternatives	HW 5, Quiz 3
12	Oct. 15, 2024	7		Depreciation and Income Taxes	
13	Oct. 17, 2024	7		Depreciation and Income Taxes	HW 6, Quiz 4
14	Oct. 22, 2024	7		Depreciation and Income Taxes	HW 7, Quiz 5
15	Oct. 24, 2024	8		Exchange Rates and the Foreign Exchange Market	Proposal for Term Project
16	Oct. 29, 2024			No class. Following Wednesday Class Schedule	HW 8
17	Oct. 31, 2024		1, 15	Introduction to Global Economics and Trade	
18	Nov. 5, 2024			<i>Midterm Exam 2</i>	
19	Nov. 7, 2024	10		Evaluating Projects with the Benefit-Cost Ratio	

Session	Date	Chapter (Text 1)	Chapter (Text 2)	Topic	Assignments
20	Nov. 12, 2024	10		Evaluating Projects with the Benefit-Cost Ratio	HW 9, Quiz 6
21	Nov. 14, 2024		6, 7	International Economics: GDP and Trades	
22	Nov. 19, 2024		8, 9	International Economics: Trade Policies	
23	Nov. 21, 2024		8, 9	International Economics: Trade Policies	HW 10, Quiz 7
24	Nov. 26, 2024			Developing Countries, Financial Globalization	Class Discussion, Quiz 8
25	Nov. 28, 2024			<i>No Class: Thanksgiving Recess</i>	
26	Dec. 3, 2024			Project Presentation	
27	Dec. 5, 2024			Project Presentation	
28	Dec. 10, 2024			Project Presentation	

Figure 1 Tentative schedule of the course. Textbook 1: "Engineering Economy" by William G. Sullivan, Elin M. Wicks, and C. Patrick Koelling. Textbook 2: "International Economics: Theory and Policy" by Steve Suranovic, George Washington University. Available free of charge at Open Textbook Library.

The course includes three exams, and we used the exam results to evaluate the effectiveness of the AI-enhanced activities. To ensure there were no significant differences in students' backgrounds between the two sections, we conducted a background multiple-choice survey at the beginning of the year. Additionally, the AI-enhancements were introduced only after the first exam. Table 1 summarizes the results of the background survey for both sections, showing no significant differences in students' backgrounds. For Exam 1, Section 1 had an average score of 77/100 with a standard deviation of 9.9, while Section 2 had an average score of 75/100 with a standard deviation of 12.6. These results indicate no notable differences in students' preparedness and familiarity with the topics covered in the course. Section 1 had an enrollment of 49 students, while Section 2 had an enrollment of 50 students.

Table 1 Background Survey results. Section 1: 39/49 students participated in the survey. Section 2:49/50 students participated in the survey.

Survey Question	Section 1 Results	Section 2 Results	Difference Between sections (S2-S1)/S2
Understanding Investment: If you spend money on a new tool for your project, what do you hope to achieve?	95%	96%	1%
Costs and Benefits: If a project costs more money than it makes, what do you think you should do?	82%	90%	9%
Borrowing Money: If you borrow money to start a project, what do you need to do?	90%	92%	2%
Time Value of Money: If you have \$100 today and someone offers you \$100 a year from now, which would you prefer?	77%	80%	4%
Cost Comparison: When comparing two items to buy, which of the following should you consider?	100%	98%	-2%
Understanding Profits: What does it mean if a company makes a profit?	97%	96%	-1%
Risk and Reward: When starting a new project, why is it important to think about risks?	95%	98%	3%
Understanding Inflation: If prices increase over time, what happens to the value of your money?	92%	92%	0%
Understanding Interest: What happens when you leave money in a savings account that earns interest?	95%	96%	1%
Understanding Budgeting: Why is it important to create a budget for a project?	100%	98%	-2%
Buying Things from Other Countries: If the price of products from another country goes up, do you think:	87%	88%	1%
Understanding Trade: Why do you think countries trade with each other?	82%	90%	9%

After Exam 1, we began incorporating AI into Section 1 during lecture hours. We chose to introduce AI in two stages: a soft introduction followed by a hard introduction. In the soft introduction phase, AI was used primarily to solve and discuss problems during the lectures. Students were encouraged to use AI as a tutoring tool outside of class, but its use was not required for completing assignments. After the second exam, we advanced the AI integration by requiring students to complete a homework assignment and a study guide before the final exam. Examples of these materials are provided in the appendix and discussed in the results section of the study. The design of this study aimed to explore whether simply informing students about AI and allowing them to use it without specific training or structured guidance could enhance their understanding of the course topics. This approach was particularly relevant as our institution, like many others, is debating whether to limit student use of AI tools.

Results

We started the study with the soft introduction phase. Examples are selected from the course textbook(s) and are solved using Chat GPT-4o and AP- Microeconomics bot. We created a new paid account and used it only for the study. This was done since ChatGPT keeps track of user data and uses it to generate new responses. As an example, we asked the bot to create a picture of the user at the end based on the interactions shown in Figure 2. Students had the option to use the free version or paid version. They were not required to create a new account.

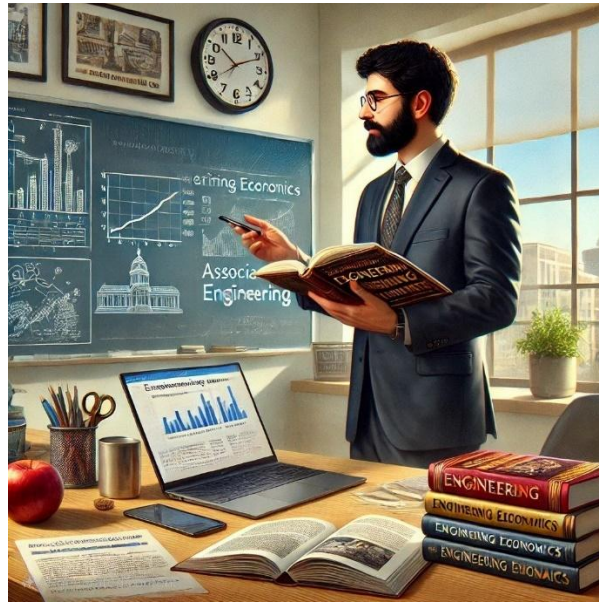


Figure 2 ChatGPT response to prompt: Create a picture of me based on my interactions with you.

A sample question selected from the textbook is shown in Figure 3, along with a sample response generated by AI. For the examples discussed during class, we aimed to use a straightforward prompt to engage the AI. An example of such a prompt is: “I want you to help me understand how I can solve this example from the textbook *Engineering Economy* by William G. Sullivan, Elin M. Wicks, and C. Patrick Koelling. Please act as a professor and tutor me through the steps.” This prompt served as the starting point for the conversation, and based on the students' questions, we followed up with additional queries to the AI to deepen the explanation or address specific points of confusion.

In Section 2, the same problem was solved on the board without the aid of AI, allowing for a direct comparison between AI-assisted and traditional lecturing. Overall, the AI was able to solve the problems accurately in most cases. However, there were instances where the AI required additional guidance or clarification to correct its solution, indicating that while it can effectively assist in problem-solving, it may not always provide perfect solutions without human intervention. This experience allowed students to observe how AI could be integrated into the learning process and reminded them that they should not fully trust AI and there are times that further refinement or guidance is needed for optimal results.

Example

3:00

- A retrofitted space-heating system is being considered for a small office building. The system can be purchased and installed for \$110,000, and it will save an estimated 300,000 kilowatt-hours (kWh) of electric power each year over a six-year period. A kilowatt-hour of electricity costs \$0.10, and the company uses a MARR of 15% per year in its economic evaluations of refurbished systems. The market value of the system will be \$8,000 at the end of six years, and additional annual operating and maintenance expenses are negligible. **Use the PW method to determine whether this system should be installed.**



1

Problem Breakdown:

- Initial Cost:** The system costs \$110,000.
- Savings:** The system will save 300,000 kWh/year. At \$0.10/kWh, the savings are:
Savings/year = 300,000 × 0.10 = 30,000 per year.
- Salvage Value:** The system's value at the end of 6 years is \$8,000.
- Analysis Period:** 6 years.
- Minimum Attractive Rate of Return (MARR):** 15% per year.
- Negligible Operating and Maintenance Costs:** We can ignore additional costs in the analysis.
- Objective:** Use the Present Worth (PW) method to determine if the project is economically viable.

Steps to Solve:

Step 1: Calculate Present Worth of Savings

The annual savings are uniform (\$30,000/year), so we use the **Present Worth Factor for a Uniform Series (P/A)**. From the table, for $N = 6$ years and $i = 15\%$, the factor is 3.784.
The Present Worth of savings is:

2

$$PW_{\text{savings}} = 30,000 \times (P/A, 15\%, 6)$$

$$PW_{\text{savings}} = 30,000 \times 3.784 = 113,520 \text{ (dollars).}$$

Step 2: Calculate Present Worth of Salvage Value

The salvage value is a single amount (\$8,000) received at the end of 6 years. We use the **Present Worth Factor for a Single Payment (P/F)**. From the table, for $N = 6$ years and $i = 15\%$, the factor is 0.432.

The Present Worth of the salvage value is:

$$PW_{\text{salvage}} = 8,000 \times (P/F, 15\%, 6)$$

$$PW_{\text{salvage}} = 8,000 \times 0.432 = 3,456 \text{ (dollars).}$$

Step 3: Calculate Total Present Worth (PW)

The total PW is the sum of the Present Worth of savings and salvage value, minus the initial cost:

$$PW_{\text{total}} = PW_{\text{savings}} + PW_{\text{salvage}} - \text{Initial Cost.}$$

3

Substitute the values:

$$PW_{\text{total}} = 113,520 + 3,456 - 110,000 = 6,976 \text{ (dollars).}$$

Step 4: Decision

Since the total Present Worth (\$6,976) is **positive**, the system **should be installed** because it meets the economic criteria at the given MARR.

Key Points to Remember:

- Use the **correct factor from the table** based on the type of cash flow (e.g., uniform series or single payment).
 - Always subtract the initial cost to calculate the net Present Worth.
 - A positive PW indicates the investment is economically viable.
- Would you like me to clarify any of these steps further or provide additional practice problems?

Figure 3 A sample problem from the textbook with ChatGPT solution.

Table 2 presents the exam 2 results for Section 1 (AI-enhanced), while Table 3 shows the results for Section 2. The average score for Section 1 is 62.4 out of 90, with a standard deviation of 14.1. In comparison, Section 2 has an average score of 64.2 out of 90, with a standard deviation of 16.0. Although Section 2 has a slightly higher average score, it also exhibits greater variability. However, we did not observe a notable statistical difference between the two sections. Section 2 has a slightly higher average with higher variability.

Table 2. Exam 2 grade distribution for Section 1. 39 students completed exam 2, with 10 withdrawals.

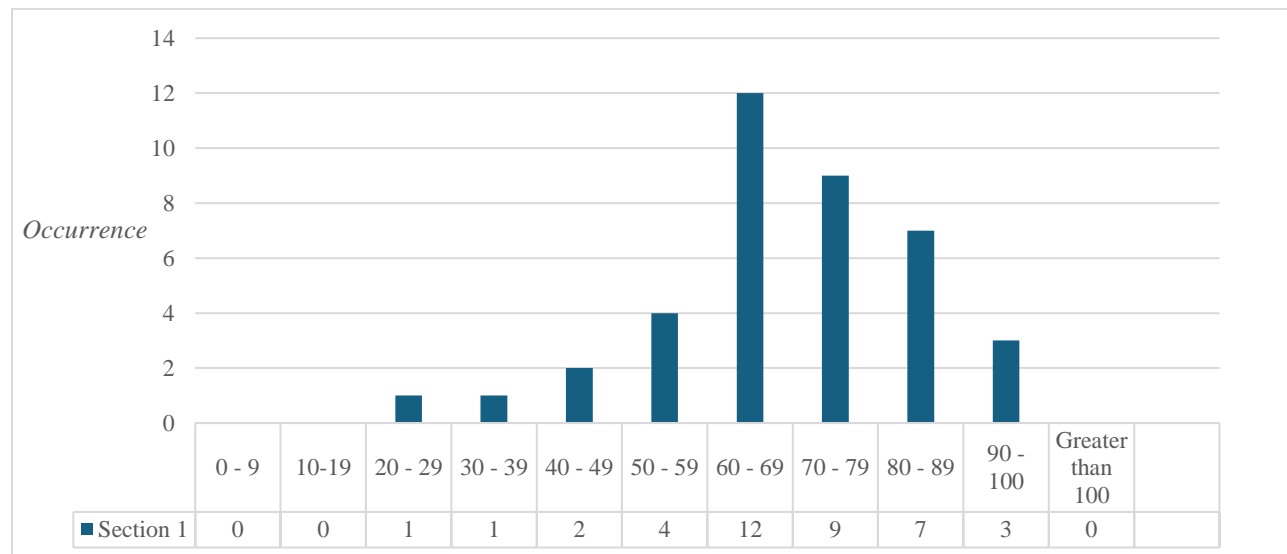
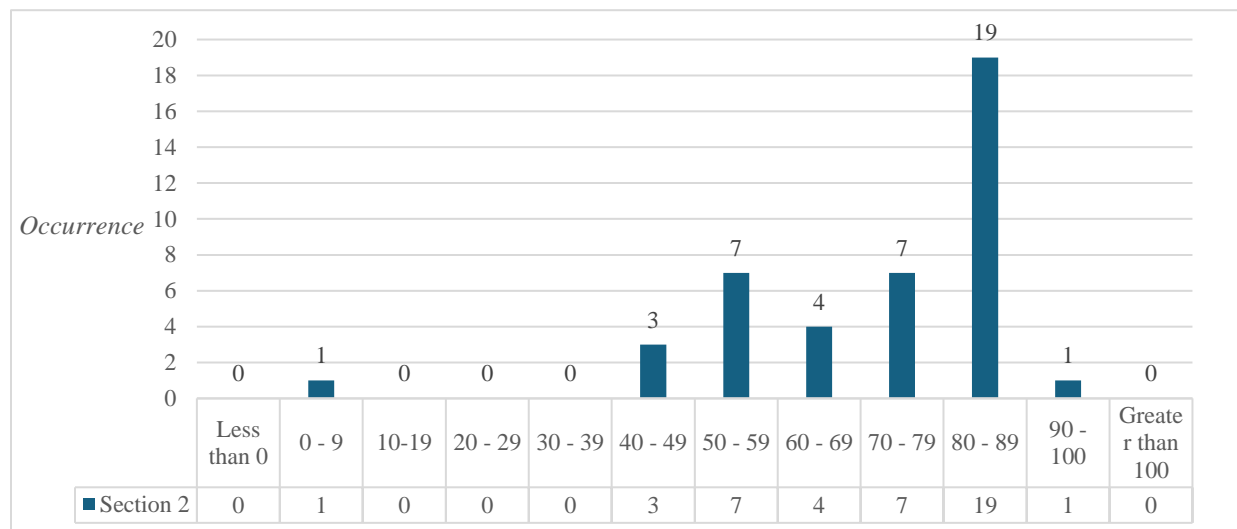


Table 3. Exam 2 grade distribution for Section 2. 43 students completed exam 2, with 7 withdrawals.



After the second exam, we further advanced the integration of AI by requiring students to complete homework assignments with the assistance of AI. Some problems for these assignments were selected directly from the textbook, while others were generated using AI. A sample of an AI-generated assignment is provided in Appendix 1. Additionally, students were asked to complete a study guide prior to the final exam. Participation in the study guide was optional, giving students the freedom to choose whether or not to take part. For those who opted to participate, we administered a survey to gather feedback on their experiences using AI as a learning tool. This allowed us to assess how students perceived the AI's impact on their learning and whether it helped them prepare more effectively for the final exam.

Table 4 shows the distribution of students grades for Section 1 while Table 5 shows the results for Section 2. The average score for Section 1 is 67.4 out of 100, with a standard deviation of 15.0. In comparison, Section 2 has an average score of 63.7 out of 100, with a standard deviation of 17.2. Section 1 has a slightly higher average score (67.4) compared to Section 2 (63.7). This suggests that students in Section 1 performed better on the exam overall, despite both sections having relatively similar distributions in the lower grades. Section 2 has a higher standard deviation (17.2) compared to Section 1 (15.0), indicating more variability in student performance in Section 2. This suggests that there were more extreme scores (both high and low) in Section 2, while Section 1's scores were more tightly clustered around the average. It appears that the use of AI slightly enhanced the student's performance in Section 1.

Table 4 Grade distribution for Section 1: 37 students completed the final exam, with 2 receiving an incomplete.

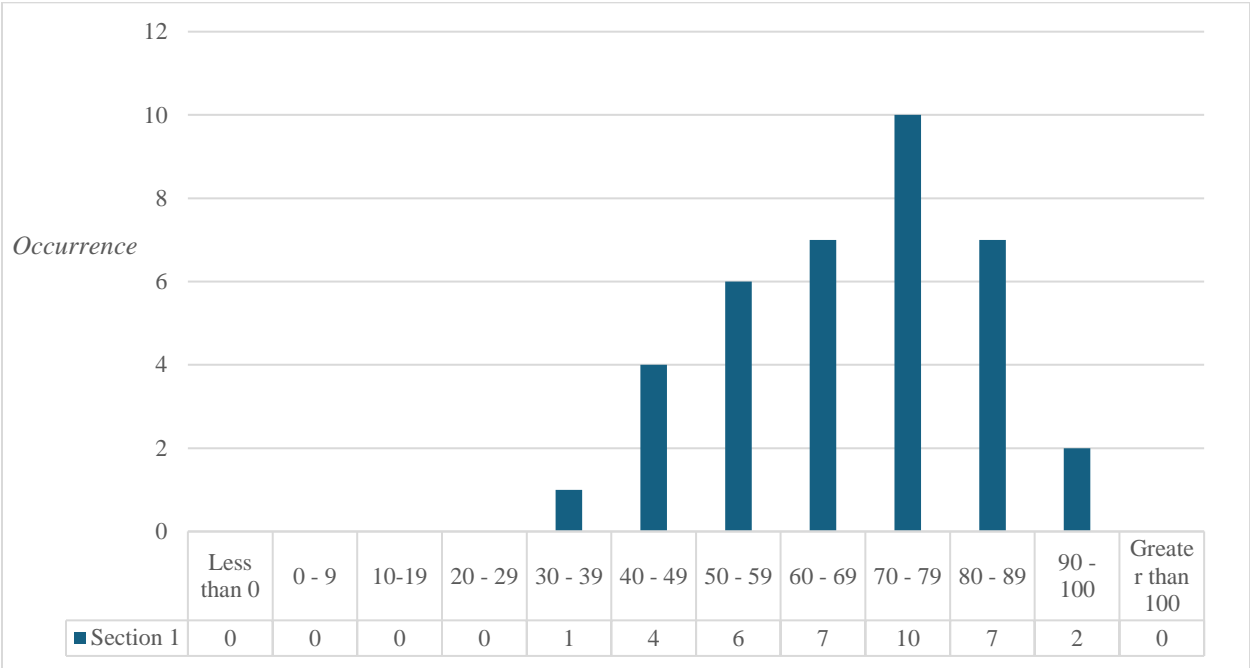
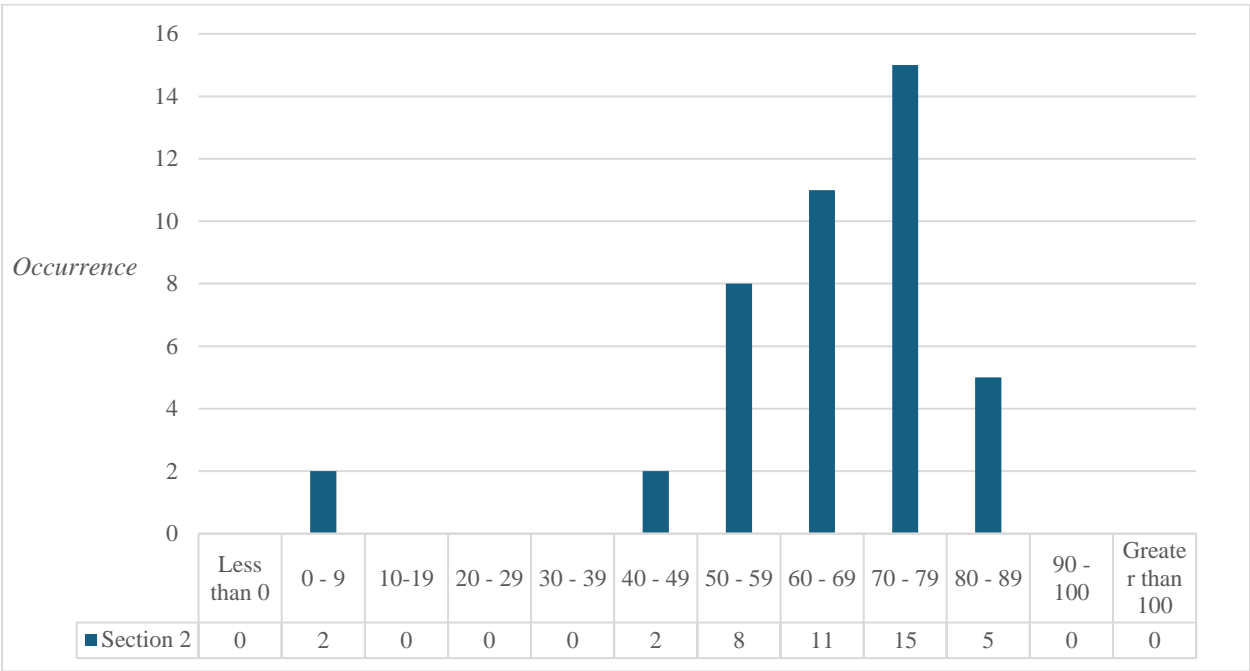


Table 5 Grade distribution for Section 1: 43 students completed the final exam.



For the final exam, we utilized ChatGPT to create an AI-enhanced study guide. We uploaded our traditional study guide to ChatGPT and prompted it to generate an enhanced version for students.

Section 2 received the traditional study guide, while Section 1 had the option to choose between the traditional version and the AI-enhanced study guide. A copy of the AI-enhanced study guide can be found in Appendix 2. However, only 8 out of 37 students from Section 1 opted to complete the study guide and the accompanying survey, which indicates relatively low participation.

The students were asked to rate their interactions with the AI-enhanced study guide on a scale from 1 to 5. The survey aimed to gauge their perceptions of the study guide's effectiveness in helping them understand key concepts. Table 6 summarizes the results of the survey, showing the average scores for various aspects of the study guide. The responses suggest that, overall, the students found the AI-enhanced study guide to be a helpful and effective learning tool. The average ratings were high across most questions, indicating that students found the study guide valuable in reinforcing concepts like cost terminology, price-demand relationships, breakeven analysis, and more.

Table 6 Averaged survey scores for various aspects of the study guide on a scale from 1 to 5.

Question	Average Score
The study guide effectively explained cost terminology.	4.9
I understood the price-demand relationship better through the study guide.	4.4
The examples helped me learn breakeven and profit analysis.	4.7
The study guide made the time value of money concept clear.	4.7
I could follow the examples for cash flow diagrams and compounding.	4.6
The study guide helped me compare alternatives using PW, FW, and AW.	4.9
I felt confident solving problems involving IRR and Payback Period.	4.2
The study guide clarified incremental analysis.	4.7
I understood the approaches for alternatives with unequal lives.	4.7
The study guide explained tax depreciation methods clearly.	4.8
The after-tax cash flow analysis examples were helpful.	4.8
I gained a good understanding of inflation and deflation.	4.8
The foreign exchange rate section was clear and useful.	4.6
The study guide effectively explained the B-C ratio methods.	4.6
Incremental B-C analysis was clearly demonstrated.	4.6
The study guide helped me calculate breakeven points accurately.	4.4
I understood the role of sensitivity analysis in decision-making.	4.6
The Gravity Model of trade was well-explained.	4.4
I understood the supply and demand relationships better.	4.7
The impact of tariffs was demonstrated effectively.	4.7

Conclusions and Future Directions

As this is a work in progress, we encountered several challenges in implementing the study. One of the main difficulties stemmed from the lack of clear guidelines or specific directions regarding

the use of large language models, such as ChatGPT. This uncertainty made it challenging to properly design class activities around the tool. In some instances, the AI generated hallucinated or incorrect responses, which led to confusion among students and undermined their trust in the tool's accuracy.

Additionally, universities are still grappling with whether to ban or allow the use of AI tools like ChatGPT, and there remains ambiguity around what constitutes plagiarism when using these technologies. Given these concerns, we decided to keep all activities as voluntary as possible. This approach allowed us to focus more on creating assignments and activities that could be used in future iterations of the study, once clearer guidelines are established. However, because many of the activities were voluntary, participation was limited. For example, only 8 out of 39 students chose to engage with the final exam study guide, making it difficult to draw definitive conclusions about the effectiveness of AI in enhancing student learning. Despite the limited participation, the final survey results indicated that those who did use the AI tool perceived it as highly effective in supporting their learning.

Throughout the process, we also discovered other AI tools, such as Google NotebookLM and Gemini, which provided more accurate and detailed explanations than ChatGPT in some cases. This has prompted us to consider integrating these tools into future iterations of the study. Moving forward, we plan to develop more structured and clearly defined activities for students, with the aim of repeating the study in the following year. By then, we anticipate that universities will have clearer instructions and policies regarding the use of AI in classroom settings, which will help us refine the design and execution of the study.

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Appendix 1: Sample HW assignment using AI

Instructions:

- Use ChatGPT to solve this problem that you worked on during the class hours.
- Copy your conversation to a word document and submit it on MyCourses.
- Start with the following prompt. “ can you please teach me step by step how to solve this problem? This is a problem from my engineering economic course. The objective problem is to teach me how engineering decisions can change based on the available information. After selecting an option, I will provide you with the consequence of that decisions.: here is the first part of the problem:”
- Ask follow up questions about things that can change your decision or clarification on different parts.
- Investigate different options.
- Write up a quick reflective essay at the end summarizing your conversations with AI and whether it helped you to gain better understanding of present worth calculations.

Upgrading Manufacturing Equipment

Your engineering firm manufactures electronic components. You face critical decisions about upgrading your production equipment while managing costs and capacity. Your goal is to maximize your firm's **Present Worth (PW)** over a 5-year period. You will be offered options which you need to decide. Once you have made the decision talk to your instructor and you will receive a consequence card based on your decision. For each decision, create a table of Revenue and Expenses for each end of year.

Your first engineering Decision:

Stage 1: Should You Upgrade Equipment?

Current equipment costs \$100,000 per year to maintain and produces 1,000 units/day.

- **Option 1: Keep current equipment.**
 - Maintenance: \$100,000/year.
 - Production: 1,000 units/day.
 - No capital investment.
 - Emergency replacement risk after 2 years.
- **Option 2: Upgrade to advanced equipment.**
 - Initial cost: \$500,000.
 - Maintenance: \$25,000/year.
 - Production: 1,500 units/day.

- Expected revenue boost: \$100,000/year from new contracts.

Decide which option to take, and then receive a **Consequence Card**. Show your calculations for the options here.

Option 1: Consequence 1

You decided on “Option 1: Keep current equipment” as your first decision. Now you face these two options:

You are at year 2:

Option 1.1: Repair the equipment

- After 2 years, the old equipment breaks down and requires an emergency repair costing \$300,000, which halts production for 3 weeks. You lose \$100,000 in lost orders.
- Maintenance stays the same: \$100,000/year.
- Production stays the same: 1,000 units/day.

Option 1.2: Upgrade to advanced equipment

- Initial cost: \$500,000.
- Maintenance: \$25,000/year.
- Production: 1,500 units/day.
- Expected revenue boost: \$150,000/year from new contracts.

Decide which option to take, and then receive a **Consequence Card**. Show your calculations for the options here.

Option 1: Consequence 2

If you decided on **option 1.1 Repair the equipment**, you have lost the game! You lost approximately (\$795,759.46).

If you decided on **option 1.2 Upgrade to advanced equipment**, now you face these two options:

Option 1.2.1: Expand operations

- Assume an additional revenue of \$150,000/year, however you need to hire Additional labor cost: \$100,000/year.

Option 1.2.2: Focusing on Cost Savings

- You decided to not hire additional labor and forfeit the potential additional revenue of \$150,000/year.

Option 2: Consequence 1

You decided on “Option 2: Upgrade to advanced equipment.” as your first decision. Now you face these two options:

Option 2.1: Expand operations

- Assume an additional revenue of \$150,000/year, you need to hire Additional labor cost: \$100,000/year.

Option 2.2: Focusing on Cost Savings

- You decided to not hire additional labor and forfeit the potential additional revenue of \$150,000/year.

Option 2: Consequence 2

If you decided on **Option 2.2: Focusing on Cost Savings**, you have lost the game! You lost approximately (\$608,236.92). You still lost less than selecting option 1!

If you decided on **Option 2.1: Expand operations**, now you face these two options:

Option 2.1.1: Taking a short-term loan to cover the initial investment

- Interest rate of 3% for three years, i.e. higher yearly payments.

Option 2.1.1: Taking a long-term loan to cover the initial investment

- Interest rate of 8% for five years, i.e. lower yearly payments.

Appendix 2: Study Guide

Engineering Economics Study guide¹

Objective:

This assignment is designed to help you understand key engineering economic concepts. You will use ChatGPT to enhance your learning by asking questions, clarifying concepts, and working through examples. Document your interactions with ChatGPT and summarize your learning outcomes.

I would like to see interactions at least on three different chapters.

Submit the following documents on MyCourses to receive three additional bonus points towards your final exam grade.

- Copy of your interactions with ChatGPT. This can be screenshot, links, or copy and past to a word document.
- A one-page reflective essay summarizing your interactions with AI and whether it helped you to learn more about engineering economics, please provide examples.
- Complete this survey: <https://forms.office.com/r/cw4Q6H2KFV>

Please note that the purpose of this assignment is to understand students' experiences, attitudes, and expectations regarding the use of Artificial Intelligence (AI) tools in academic settings. Your responses will provide valuable insights into the role of AI in higher education and its impact on student learning. All results will be only reported in aggregate form, ensuring that no individual responses can be identified.

There are no anticipated risks associated with participating in this assignment. While there may be no direct benefit to you, your participation will help shape future policies and resources to support students' use of AI in academic settings.

While AI tools, such as ChatGPT, can be valuable resources for enhancing learning and exploring ideas, it's important to remember that AI can sometimes provide incorrect answers or "hallucinate" information that isn't accurate. Always critically evaluate the responses you receive, cross-check them with reliable sources, and seek clarification when necessary. AI should be used as a supplement to your learning, not as a substitute for thorough research and critical thinking.

By submitting this assignment, you are acknowledging that you have read and understood the information provided above. You voluntarily agree to participate, and you understand that you can withdraw from the assignment at any time.

¹ AI is used in preparing this document.

CH 02:

Part 1: Exploring Cost Terminology

1. Fixed Cost vs. Variable Cost:

- Define each term in your own words with the help of ChatGPT.
- Ask ChatGPT for real-world examples of fixed and variable costs in a manufacturing setting. Write down the examples it provides and explain why they fit the definitions.

2. Incremental Cost:

- Ask ChatGPT: *"Can you explain incremental cost with a practical example?"*
- Summarize its explanation and provide your own example of an incremental cost.

3. Direct and Indirect (Overhead) Costs:

- Ask ChatGPT to list differences between direct and indirect costs in an engineering project.
- Reflect on how overhead costs might be distributed in a project, based on ChatGPT's input.

4. Standard Cost:

- Use ChatGPT to understand how standard costs are used in budgeting or performance evaluation.
- Ask: *"What is an example of a standard cost in product manufacturing?"*

Part 2: Price-Demand Relationship

1. Understanding the Model:

- Ask ChatGPT to explain the equation $p = a - bD$, where p is price, D is demand, a is the y-intercept, and b is the slope.
- Use ChatGPT to derive an example of a price-demand equation for a product, substituting hypothetical values for a and b .
- Plot the price-demand graph based on the example and explain the relationship between price and demand in your own words.

2. Calculating Total Revenue (TR):

- Define total revenue ($TR = p \times D$) with the help of ChatGPT.
- Ask ChatGPT: *"Can you calculate total revenue if the price-demand equation is $p = 100 - 2D$?"*
- Document the total revenue curve and explain the behavior of TR as demand increases.

3. Maximum Total Revenue:

- Use ChatGPT to explain how to find the demand (D) that maximizes total revenue.
- Confirm the derivation $D=a/(2b)$ for maximum TR with ChatGPT and apply it to your example.

4. Defining Profit:

- Define profit ($\text{Profit}=\text{TR}-\text{TC}$) using ChatGPT.
- Provide an example where $\text{TC}=\text{CF}+\text{CV}\times\text{D}$ (fixed cost + variable cost per unit times demand).
- Ask ChatGPT to help you calculate profit for different demand levels, using your price-demand equation and a given cost structure.

5. Maximum Profit and Breakeven Points:

- Ask ChatGPT: *"How can I calculate the demand level that provides maximum profit?"*
- Work with ChatGPT to calculate the breakeven points where total revenue equals total cost.
- Plot the total revenue, total cost, and profit curves on a graph. Highlight the breakeven points and maximum profit.

Reflection that you can include in your submission.

1. Summarize what you learned about the price-demand relationship, total revenue, and profit.
2. Reflect on how ChatGPT helped you derive equations, understand concepts, and solve problems.
3. Provide feedback on how engaging with ChatGPT influenced your learning process.

CH 04

This study guide aims to enhance your understanding of the time value of money, cash flow diagrams, compounding factors, interest rates, and cash flow analysis. You will leverage ChatGPT to clarify concepts, solve problems, and improve your learning experience.

Part 1: Time Value of Money

1. Understanding the Concept:

- Use ChatGPT to explain the time value of money. Ask:
"Why does money have a time value, and how is this concept applied in engineering economics?"
- Write a summary of ChatGPT's explanation in your own words.

2. Simple vs. Compound Interest:

- Ask ChatGPT to differentiate between simple and compound interest.
- Use ChatGPT to calculate the future value of \$1,000 invested for 5 years at a 6% annual interest rate using both simple and compound interest methods.

Part 2: Cash Flow Diagrams

1. Creating a Cash Flow Diagram:

- Ask ChatGPT:
"How do I create a cash flow diagram for a project with uniform cash inflows and an initial investment?"
- Draw the diagram based on ChatGPT's guidance and describe its components.

2. Types of Cash Flows:

- Use ChatGPT to explain the differences between uniform, gradient, and irregular cash flows.
- Provide an example of each cash flow type, asking ChatGPT for help with calculations.

Part 3: Compounding Factors

1. Discrete Compounding Factors:

- Ask ChatGPT to explain the purpose of discrete compounding factors using Table 4-3 from your textbook.
- Practice converting a future value to a present value using $P = F(P/F, i, N)$, where $i = 5\%$ and $N = 10$. Ask ChatGPT to verify your work.

2. Continuous vs. Discrete Compounding:

- Use ChatGPT to compare continuous and discrete compounding.
- Calculate the future value of \$1,000 for 5 years at 6% annual interest using both methods.

Part 4: Nominal and Effective Interest Rates

1. Understanding APR and Effective Rates:

- Ask ChatGPT:
"What is APR, and how do I calculate the effective annual rate from the nominal rate?"
- Solve a problem where the nominal annual rate is 12%, compounded monthly.

Part 5: Advanced Cash Flow Analysis

1. Deferred Annuities:

- Use ChatGPT to explain deferred annuities. Ask:
"How do I calculate the present value of an annuity starting after 3 years?"
- Solve an example problem using $P/A, i, NP/A, i, NP/A, i, N$ factors.

TABLE 4-3 Discrete Compounding-Interest Factors and Symbols^a

To Find:	Given:	Factor by which to Multiply "Given" ^a	Factor Name	Factor Functional Symbol ^b
<i>For single cash flows:</i>				
F	P	$(1+i)^N$	Single payment compound amount	$(F/P, i\%, N)$
P	F	$\frac{1}{(1+i)^N}$	Single payment present worth	$(P/F, i\%, N)$
<i>For uniform series (annuities):</i>				
F	A	$\frac{(1+i)^N - 1}{i}$	Uniform series compound amount	$(F/A, i\%, N)$
P	A	$\frac{(1+i)^N - 1}{i(1+i)^N}$	Uniform series present worth	$(P/A, i\%, N)$
A	F	$\frac{i}{(1+i)^N - 1}$	Sinking fund	$(A/F, i\%, N)$
A	P	$\frac{i(1+i)^N}{(1+i)^N - 1}$	Capital recovery	$(A/P, i\%, N)$

^a i equals effective interest rate per interest period; N , number of interest periods; A , uniform series amount (occurs at the end of each interest period); F , future equivalent; P , present equivalent.

^b The functional symbol system is used throughout this book.

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2. Equivalence Calculations and Gradients:

- Ask ChatGPT to guide you through an equivalence calculation involving multiple interest formulas.
- Use ChatGPT to solve a uniform gradient problem, such as determining the equivalent annual worth of a series of cash flows increasing by \$100 per year.

CH 05

This study guide will help you understand and apply methods to compare alternatives, including Present Worth (PW), Future Worth (FW), Annual Worth (AW), Internal Rate of Return (IRR), External Rate of Return (ERR), and Payback Period. You will use ChatGPT to clarify concepts, solve example problems, and reflect on your learning.

Part 1: Present Worth (PW) Method

1. Conceptual Understanding:

- Use ChatGPT to explain the PW method and its significance in comparing alternatives.
Ask: *"Why is the Present Worth Method important in engineering economics?"*

2. Solving an Example Problem:

- Provide ChatGPT with an example problem: *"Calculate the PW of a project with an initial cost of \$10,000 and annual revenues of \$3,000 for 5 years at an interest rate of 8%."*
- Summarize ChatGPT's solution in your own words.

Part 2: Future Worth (FW) Method

1. Understanding FW:

- Ask ChatGPT to explain the relationship between PW and FW.
Question: *"How can I calculate FW from PW?"*

2. Example Problem:

- Solve a problem using ChatGPT: *"Calculate the FW of the same project from Part 1 using an interest rate of 8%."*

Part 3: Annual Worth (AW) Method

1. AW Method Basics:

- Ask ChatGPT to explain the Annual Worth Method and how it relates to capital recovery.
Prompt: *"What is the capital recovery factor, and how is it used in the AW method?"*

2. Practice Problem:

- Use ChatGPT to calculate the AW of a project with the same parameters as in Part 1.
Prompt: *"Find the annual worth of the project using a 5-year analysis period and an 8% interest rate."*

Part 4: Internal Rate of Return (IRR) Method

1. Understanding IRR:

- Ask ChatGPT: *"What is the Internal Rate of Return (IRR), and how is it determined?"*

- Explore the trial-and-error method with ChatGPT to solve an IRR problem.

2. Finding IRR Using Tables:

- Ask ChatGPT to guide you in finding IRR using factor tables.
Example: *"Find the IRR for a project with an initial cost of \$5,000 and annual benefits of \$1,200 over 5 years."*

Part 5: External Rate of Return (ERR) Method

1. Understanding ERR:

- Ask ChatGPT: *"What is the External Rate of Return (ERR), and how does it differ from IRR?"*

2. Example Problem:

- Solve an ERR problem using guidance from ChatGPT.
Prompt: *"Calculate the ERR for a project with multiple cash flows over time."*

Part 6: Payback Period Method

1. Defining the Payback Period:

- Ask ChatGPT: *"What is the Payback Period Method, and how is it calculated?"*

2. Example Problem:

- Calculate the payback period for a project with the help of ChatGPT.
Example: *"A project costs \$20,000 and generates annual cash inflows of \$4,000. How long will it take to recover the investment?"*

CH 06

This study guide will help you learn how to compare alternatives using various methods (PW, FW, AW, IRR), analyze alternatives with equal and unequal lives, understand incremental analysis, and apply the study period concept. You will leverage ChatGPT to clarify concepts, solve example problems, and reflect on your learning process

Part 1: Differentiating Investment and Cost Alternatives

1. Understanding the Difference:

- Use ChatGPT to explain the difference between investment alternatives and cost alternatives.
Ask: "What are the key differences between investment and cost alternatives, and how do they influence decision-making?"
- Provide examples of each type of alternative and describe the differences in your own words.

Part 2: Comparing Alternatives with Equal Lives

1. Methods for Comparison:

- Use ChatGPT to explain how to compare alternatives with equal lives using the following methods:
 - Present Worth (PW)
 - Future Worth (FW)
 - Annual Worth (AW)
 - Internal Rate of Return (IRR)
- For each method, ask ChatGPT to solve a sample problem:
 - Example: *"Compare two alternatives, A and B, with equal lives of 5 years. Alternative A has an initial cost of \$10,000 and annual benefits of \$3,000. Alternative B has an initial cost of \$15,000 and annual benefits of \$4,500. Use a discount rate of 8%."*

Part 3: Incremental Analysis

1. Using Incremental Analysis:

- Ask ChatGPT: *"What is incremental analysis, and how is it used to compare multiple alternatives?"*
- Solve a problem with multiple alternatives, where you evaluate the incremental costs and benefits between options.
Example: "Three alternatives have the following costs and benefits. Perform an incremental analysis to identify the best option."

Part 4: Understanding the Study Period

1. Definition of Study Period:

- Use ChatGPT to explain the concept of the study period and its importance in economic analysis.

Ask: *"What is a study period, and how does it affect the evaluation of alternatives?"*

2. Example Application:

- Work with ChatGPT to solve a problem where the study period is limited, and only part of the useful life of an alternative is used.

Example: *"Evaluate a 10-year project when the study period is only 5 years. Use a discount rate of 6%."*

Part 5: Comparing Alternatives with Unequal Lives

1. Repeatability and Co-Terminated Assumptions:

- Use ChatGPT to explain the differences between the repeatability assumption (AW) and the co-terminated assumption.

Ask: *"What are the repeatability and co-terminated assumptions, and when should they be used?"*

2. Expanding and Truncating Lives:

- Ask ChatGPT: *"How do I expand or truncate the life of a project to match the study period under the co-terminated assumption?"*
- Solve an example problem with unequal lives:

- Alternative A: Life = 4 years, Cost = \$8,000, Benefits = \$3,000/year
- Alternative B: Life = 6 years, Cost = \$12,000, Benefits = \$4,000/year
- Discount rate = 10%

Things to reflect on:

Summarize your understanding of each concept and method covered in this chapter.

Reflect on how ChatGPT helped you understand the material:

- Which concepts were clarified most effectively?
- Were there any challenges or limitations in using ChatGPT?

CH 07

This study guide will help you understand accounting terminology, apply tax depreciation techniques, use recovery tables, and analyze the impact of taxes on economic decisions. You will leverage ChatGPT to clarify concepts, solve example problems, and reflect on your learning process.

Part 1: Accounting Terminology

1. Understanding Key Terms:

- Use ChatGPT to define the following terms:
 - Book Value
 - Recovery Rate
 - Other relevant terms from your textbook
- Ask: *"What is book value, and how does it change over time with depreciation?"*

2. Practical Example:

- Create a hypothetical example (e.g., an asset costing \$50,000) and calculate its book value over 5 years using the Straight Line (SL) method.
- Verify your solution with ChatGPT.

Part 2: Tax Depreciation Techniques

1. Depreciation Methods:

- Use ChatGPT to explain the following methods with examples:
 - Straight Line (SL)
 - Declining Balance (DB) (200% and 150%)
 - DB with Switchover to SL
 - General Depreciation System (GDS)
 - Alternative Depreciation System (ADS)

2. Practice Problems:

- Solve an example problem for each method.
Example: *"An asset costs \$50,000, has a salvage value of \$5,000, and a useful life of 5 years. Calculate depreciation using SL and 200% DB methods."*

Part 3: Tables and Half-Year Rule

1. Understanding Tables:

- Use ChatGPT to explain how to read and use GDS and ADS tables.

- Ask: "How can I use MACRS tables to calculate depreciation deductions?"

TABLE 7-2 MACRS Class Lives and Recovery Periods*

Asset Class	Description of Assets	Class Life	Recovery Period	
			GDS ^b	ADS
00.11	Office furniture and equipment	10	7	10
00.12	Information systems, including computers	6	5	5
00.22	Automobiles, taxis	3	5	5
00.23	Buses	9	5	9
00.241	Light general purpose trucks	4	5	5
00.242	Heavy general purpose trucks	6	5	6
00.26	Tractor units for use over the road	4	3	4
01.1	Agriculture	10	7	10
10.0	Mining	10	7	10
13.2	Production of petroleum and natural gas	14	7	14
13.3	Petroleum refining	16	10	16
15.0	Construction	6	5	6
22.3	Manufacture of carpets	9	5	9
24.4	Manufacture of wood products and furniture	10	7	10
28.0	Manufacture of chemicals and allied products	9.5	5	9.5
30.1	Manufacture of rubber products	14	7	14
32.2	Manufacture of cement	20	15	20
34.0	Manufacture of fabricated metal products	12	7	12
36.0	Manufacture of electronic components, products, and systems	6	5	6
37.11	Manufacture of motor vehicles	12	7	12
37.2	Manufacture of aerospace products	10	7	10
48.12	Telephone central office equipment	18	10	18
49.13	Electric utility steam production plant	28	20	28
49.21	Gas utility distribution facilities	35	20	35
79.0	Recreation	10	7	10

TABLE 7-4 MACRS (GDS) Property Classes and Primary Methods for Calculating Depreciation Deductions

GDS Property Class and Depreciation Method	Class Life (Useful Life)	Special Rules
3-year, 200% DB with switchover to SL	Four years or less	Includes some race horses and tractor units for over-the-road use.
5-year, 200% DB with switchover to SL	More than 4 years to less than 10	Includes cars and light trucks, semiconductor manufacturing equipment, qualified technological equipment, computer-based central office switching equipment, some renewable and biomass power facilities, and research and development property.
7-year, 200% DB with switchover to SL	10 years to less than 16	Includes single-purpose agricultural and horticultural structures and railroad track. Includes office furniture and fixtures, and property not assigned to a property class.
10-year, 200% DB with switchover to SL	16 years to less than 20	Includes vessels, barges, tugs, and similar water transportation equipment.
15-year, 150% DB with switchover to SL	20 years to less than 25	Includes sewage treatment plants, telephone distribution plants, and equipment for two-way voice and data communication.
20-year, 150% DB with switchover to SL	25 years or more	Excludes real property of 27.5 years or more. Includes municipal sewers.
27.5 year, SL	N/A	Residential rental property.
39-year, SL	N/A	Nonresidential real property.

TABLE 7-3 GDS Recovery Rates (r_k) for the Six Personal Property Classes

Year	Depreciation Rate for Recovery Period					
	3-year ^a	5-year ^a	7-year ^a	10-year ^a	15-year ^b	20-year ^b
1	0.3333	0.2000	0.1429	0.1000	0.0500	0.0375
2	0.4445	0.3200	0.2449	0.1800	0.0950	0.0722
3	0.1481	0.1920	0.1749	0.1440	0.0855	0.0668
4	0.0741	0.1152	0.1249	0.1152	0.0770	0.0618
5		0.1152	0.0893	0.0922	0.0693	0.0571
6		0.0576	0.0892	0.0737	0.0623	0.0528
7			0.0893	0.0655	0.0590	0.0489
8			0.0446	0.0655	0.0590	0.0452
9				0.0656	0.0591	0.0447
10				0.0655	0.0590	0.0446
11				0.0328	0.0591	0.0446
12					0.0590	0.0446
13					0.0591	0.0446
14					0.0590	0.0446
15					0.0591	0.0446
16					0.0295	0.0446
17						0.0446
18						0.0446
19						0.0446
20						0.0446
21						0.0223

2. Half-Year Rule:

- Ask ChatGPT to clarify the half-year rule and provide an example where it applies.
- Solve a problem involving the half-year rule: "An asset with a cost of \$40,000 is placed in service in June. Calculate the first year's depreciation using GDS with a 5-year recovery period."

Part 4: Income Taxes

1. Federal and State Income Taxes:

- Ask ChatGPT to explain the difference between federal and state income taxes and their impact on engineering economic analysis.
- Work through an example where you calculate taxable income for a project.

2. Taxable Income Formulas:

- Use ChatGPT to verify the formula for taxable income: $\text{Taxable Income} = R_k - E_k - d_k$

Part 5: Disposal of Assets

1. Gain (Loss) on Disposal of Assets:

- Ask ChatGPT: "What is the tax liability (or credit) for a gain or loss on asset disposal?"
- Solve a problem involving the sale of an asset at a value different from its book value.
Example: "An asset with a book value of \$10,000 is sold for \$15,000. Calculate the gain and the tax liability if the tax rate is 25%."

Part 6: After-Tax Economic Analysis

1. General Procedure for After-Tax Analysis:

- Use ChatGPT to explain the general steps for conducting an after-tax economic analysis.
- Apply these steps to a project example:
"A project generates \$20,000 in annual revenue, has \$5,000 in expenses, and depreciation of \$3,000. Calculate the after-tax cash flow if the tax rate is 30%."

2. Using Formulas:

- Use ChatGPT to clarify and verify formulas for after-tax cash flows: $d_{kATCFk} = (1 - t)(Rk - Ek) + t \cdot dk$

Reflect on how ChatGPT helped you clarify concepts and solve problems.

What were the most helpful ChatGPT interactions?

Were there any challenges?

CH 08

This study guide will help you understand inflation and deflation, use price indices, differentiate between actual and real dollars, work with market and real interest rates, and analyze foreign exchange rates. ChatGPT will assist you in clarifying these concepts and solving example problems.

Part 1: Inflation and Deflation

1. Definitions:

- Use ChatGPT to define inflation and deflation.
Ask: "What is the difference between inflation and deflation, and how do they affect purchasing power?"

2. Price Index:

- Ask ChatGPT:
"How is the price index used to measure inflation or deflation?"
 - Solve a problem where you calculate the rate of inflation using the formula:
$$\frac{(Index)_k - (Index)_{k-1}}{(Index)_{k-1}} (100\%)$$
 - Example: *"Calculate the inflation rate when the price index increases from 120 to 132."*
-

Part 2: Actual vs. Real Dollars

1. Understanding the Difference:

- Use ChatGPT to explain the difference between actual dollars and real dollars.
Ask: "How are actual dollars converted to real dollars using the inflation rate?"

2. Formula Application:

- Work with ChatGPT to solve a problem using the formula:
$$\begin{aligned}(R\$)_k &= (A\$)_k \left(\frac{1}{1+f} \right)^{k-b} \\ &= (A\$)_k (P/F, f\%, k-b)\end{aligned}$$
 - Example: *"Convert \$1,000 of actual dollars in year 5 to real dollars in year 0 with an annual inflation rate of 3%."*
-

Part 3: Market vs. Real Interest Rates

1. Understanding the Difference:

- Ask ChatGPT: *"What is the difference between market and real interest rates, and when is each used?"*

2. Converting Interest Rates:

- Use ChatGPT to verify the formula: $1+i_m=(1+i_r)(1+f)$
 - Solve a problem: *"If the real interest rate is 4% and the inflation rate is 2%, calculate the market interest rate."*
-

Part 4: Base Time Period for Real Dollars

1. Defining the Base Time Period:

- Use ChatGPT to clarify what the base time period means for real dollars.
Ask: *"Why is the base time period important when calculating real dollars?"*

2. Example Problem:

- Solve a problem involving real dollars and the base time period:
"Convert actual dollars to real dollars for a base year using a given price index series."
-

Part 5: Foreign Exchange Rates

1. Understanding the Formula:

- Use ChatGPT to explain the relationship between exchange rates and interest rates:
$$1 + i_{US} = \frac{1 + i_{fm}}{1 + f_e}$$
- Ask: *"What do the terms in the foreign exchange rate formula represent, and how are they used in economic analysis?"*

2. Example Problem:

- Solve a problem using the formula:
"If the US interest rate is 5%, the foreign interest rate is 8%, and the exchange rate is 2%, verify the consistency of these value

CH 10:

This study guide will help you understand public projects, apply the benefit-cost ratio (B-C ratio) method for single and mutually exclusive projects, and conduct incremental B-C analysis. ChatGPT will assist you in clarifying these concepts and solving example problems.

Part 1: Public Projects

1. Definition of Public Projects:

- Use ChatGPT to define public projects and their key characteristics.
Ask: "What are public projects, and how do they differ from private projects?"

2. Types of Public Projects:

- Ask ChatGPT: *"What are common types of public projects, and what are their objectives?"*
- Provide examples, such as infrastructure development, public health programs, or environmental conservation initiatives.

Part 2: Benefit-Cost Ratio Method for a Single Project

1. Conventional B-C Ratio:

- Use ChatGPT to explain the conventional B-C ratio and its calculation using:
 - Present Worth (PW)
 - Annual Worth (AW)
- *Ask: "How do I calculate the conventional B-C ratio for a project?"*

2. Modified B-C Ratio:

- Ask ChatGPT to explain the modified B-C ratio and how it differs from the conventional method.
 - *Example Question: "When is the modified B-C ratio preferred over the conventional B-C ratio?"*

3. Practice Problems:

- Solve a problem where you calculate both conventional and modified B-C ratios using PW and AW.
Example: "A project costs \$1,000,000, generates benefits of \$200,000 annually, and incurs operating costs of \$50,000 annually over 10 years. The discount rate is 8%. Calculate the B-C ratios."

Part 3: Incremental B-C Analysis for Mutually Exclusive Projects

1. Steps for Incremental Analysis:

- Use ChatGPT to clarify the three required steps for incremental B-C analysis:
 1. Rank alternatives
 2. Set the baseline (with $B-C > 1$ for the individual alternative)
 3. Determine the incremental B-C ratio ($\Delta B / \Delta C$)

2. Practice Problem:

- Solve an example problem involving three mutually exclusive projects:
 - Project A: Cost = \$1,000, Benefits = \$1,500
 - Project B: Cost = \$1,200, Benefits = \$1,600
 - Project C: Cost = \$1,400, Benefits = \$2,000
 - Discount rate = 5%
- Use ChatGPT to rank the projects, determine the baseline, and calculate the incremental B-C ratio.

Part 4: Reflection

1. Summarize what you learned about public projects, benefit-cost ratio methods, and incremental analysis.
2. Reflect on how ChatGPT helped you understand and apply these methods:
 - Which aspects were easiest or hardest to grasp with ChatGPT's guidance?
 - Provide feedback on your overall learning experience.

CH 11

This study guide will help you understand how to calculate breakeven points for two alternatives and conduct sensitivity analysis to assess the impact of changes in investment estimates, revenue estimates, and the Minimum Attractive Rate of Return (MARR). ChatGPT will assist you in clarifying these concepts and solving example problems.

Part 1: Breakeven Analysis for Two Alternatives

1. Steps for Breakeven Analysis:

- Use ChatGPT to outline the steps for finding the breakeven point between two alternatives:
 1. Identify alternatives.
 2. Find equivalent worth (e.g., PW, AW, or FW) for each alternative.
 3. Set the equivalent worth expressions equal to each other and solve for the breakeven variable (e.g., years, unit price, etc.).

2. Example Problem:

- Solve a breakeven problem using ChatGPT:
 - *"Two machines are available for a project. Machine A costs \$50,000 and has annual operating costs of \$10,000. Machine B costs \$70,000 and has annual operating costs of \$7,000. The useful life of both machines is 5 years, and the MARR is 8%. Determine the breakeven point in terms of years to justify Machine B over Machine A."*

3. Reflection:

- Ask ChatGPT to explain how changes in the MARR affect the breakeven point.

Part 2: Sensitivity Analysis

1. Understanding Sensitivity Analysis:

- Ask ChatGPT: *"What is sensitivity analysis, and why is it important in economic decision-making?"*
- Use ChatGPT to explore the effect of changing study factors (investment, revenue, MARR) on project profitability.

2. Example Problem:

- Work through a problem using ChatGPT:
 - *"A project has an initial investment of \$100,000, annual revenues of \$30,000, and annual operating costs of \$10,000. The project lasts 10 years, and the MARR is 10%. Conduct sensitivity analysis to determine how profitability changes if:*

- Investment increases by 20%.
- Revenue decreases by 15%.
- MARR increases to 12%."

3. Graphical Representation:

- Ask ChatGPT how to create sensitivity graphs to visualize the impact of changes in variables.
- Plot sensitivity curves for at least one parameter using your findings.

Part 3: Reflection

1. Summarize what you learned about breakeven and sensitivity analysis.
2. Reflect on how ChatGPT supported your learning:
 - Which steps or concepts were clarified effectively with ChatGPT?
 - Were there any challenges in using ChatGPT for these tasks?

Part 1: Gravity Model of Trade

1. Understanding GDP in Trade:

- Use ChatGPT to explain the role of GDP in international trade.
Ask: "How does the GDP of two countries influence their trade volume?"

2. The Gravity Model Formula:

- Use ChatGPT to break down the Gravity Model equation:

$$T_{ij} = \frac{A \times Y_i \times Y_j}{D_{ij}}$$

- $T_{\{ij\}}$: Value of trade between countries i and j
- Y_i : GDP of country i
- Y_j : GDP of country j
- $D_{\{ij\}}$: Distance between the countries
- Example Problem:
"Country A has a GDP of \$1 trillion, and Country B has a GDP of \$500 billion. The distance between them is 1,000 km. If $A=100A = 100A=100$, calculate the trade value between the two countries."

3. Reflection on Size and Distance:

- Ask ChatGPT: "Why do larger economies and closer distances tend to trade more?"

4. Multiple Choice Practice Questions:

- Develop 5 multiple-choice questions on the Gravity Model with ChatGPT.
Example:
 - Which of the following factors increases trade between two countries?
 - a) Larger GDPs
 - b) Greater distance
 - c) Lower tariffs
 - d) Both a and c

Part 2: Supply and Demand Relationships - Understanding Surplus and Shortage:

- Use ChatGPT to explain the concepts of surplus and shortage in supply and demand.
Ask: "What happens when prices are above or below the equilibrium price?"

2. Graphical Analysis:

- Ask ChatGPT to help you sketch supply and demand curves with surplus and shortage zones labeled.
- Example Problem:
"If the equilibrium price of a product is \$10 and the current price is \$15, describe the market condition and its effects."

3. Multiple Choice Practice Questions:

- Develop 5 multiple-choice questions on supply and demand relationships with ChatGPT.
Example:
 - If the price of a good is below its equilibrium price, the result is:
 - a) A surplus
 - b) A shortage
 - c) No change in market dynamics
 - d) None of the above

Part 3: Tariffs and Their Impacts

1. Effect of Tariffs on Supply and Demand:

- Use ChatGPT to explain how tariffs impact supply and demand in domestic and international markets.
Ask: "What are the effects of tariffs on consumer surplus, producer surplus, and government revenue?"

2. Cost and Benefit Analysis of Tariffs:

- Work with ChatGPT to calculate the effects of tariffs using the graphs provided in the slides.
- Example Problem:
"If a tariff increases the domestic price from PWP_WPW to PTP_TPT, calculate the changes in consumer surplus, producer surplus, and government revenue."

Effect of a Tariff in a Single Industry

Context:

- Tariffs are taxes imposed by a home country on imports from foreign countries.
- They alter the equilibrium price and quantities in the home and foreign markets.
- The price in the world market (pre-tariff and post-tariff) is influenced by the interaction of supply and demand from both the home and foreign markets.

Key Components of Tariff Analysis

1. Home Market:

- Supply curve (S_H): Quantity supplied domestically.
- Demand curve (D_H): Quantity demanded domestically.
- With a tariff, the price of imports rises, reducing imports and increasing domestic production.

2. Foreign Market:

- Supply curve (S_F): Quantity supplied by the foreign exporter.
- Tariff decreases demand for foreign goods, reducing foreign exports.

3. World Market:

- Equilibrium price in the world market (P_W): Determined by the intersection of export supply (XS) and import demand (MD).
- A tariff shifts the import demand curve downward, creating a new equilibrium price (P_T).

Steps to Calculate the Price of the World Before and After a Tariff

Step 1: Pre-Tariff Equilibrium

1. Find Import Demand (MD):

$$MD = D_H - S_H$$

(Quantity home country demands minus what it supplies domestically).

2. Find Export Supply (XS):

$$XS = S_F - D_F$$

(Quantity foreign country supplies minus its domestic demand).

3. Set $MD = XS$ to Determine P_W :

Solve the equations for MD and XS to find the pre-tariff equilibrium price in the world market (P_W).

Step 2: Post-Tariff Equilibrium

1. Adjust Import Demand Curve:

Tariff increases the price of imports in the home market by t (tariff per unit).

The new effective price for imports is $P_T = P_W + t$.

2. Recalculate Import Demand (MD_t):

With higher import prices, domestic demand for imports decreases:

$$MD_t = D_H - S_H$$

(Recalculate based on the new price).

3. **Find New Export Supply (XS_t):**

Export supply is adjusted as foreign exporters react to reduced demand.

4. **Set $MD_t = XS_t$ to Determine P_T :**

Solve for the new world price after the tariff (P_T).

5. **Solve an example problem.**

Analysis of Tariff Impact

1. **Home Market:**

- Reduced imports, increased domestic production.
- Consumer surplus decreases, producer surplus increases, and government revenue is generated.

2. **Foreign Market:**

- Reduced exports, lower prices for foreign suppliers.

3. **World Market:**

- Tariff distorts the global equilibrium, reducing overall trade volume.