

Leveraging ChatGPT 4.0's Image Processing Feature for Enhanced Problem-Solving Support in Mechanical Engineering Courses

Prof. Milad Rezvani Rad, University of Southern Indiana

Dr. Milad Rad is an Assistant Professor in the Engineering Department at the University of Southern Indiana. He earned his Ph.D. in Mechanical Engineering from the University of Alberta in Canada. Besides his specialization in functional thermally sprayed coatings, he explores innovative AI-driven approaches to enhance student engagement in the classroom.

Dr. Julian Ly Davis, University of Southern Indiana

Jul Davis is an Associate Professor of Engineering at the University of Southern Indiana in Evansville, Indiana. He received his PhD in 2007 from Virginia Tech in Engineering Mechanics where he studied the vestibular organs in the inner ear using finite element models and vibration analyses. After graduating, he spent a semester teaching at a local community college and then two years at University of Massachusetts (Amherst) studying the biomechanics of biting in bats and monkeys, also using finite element modeling techniques. In 2010, he started his career teaching in all areas of mechanical engineering at the University of Southern Indiana. He loves teaching all of the basic mechanics courses, and of course his Vibrations and Finite Element Analysis courses.

Leveraging ChatGPT 4.0's Image Processing Feature for Enhanced Problem-Solving Support in Mechanical Engineering Courses

Abstract

The introduction of ChatGPT 4.0 has brought about an intriguing new feature—image processing—which allows users to copy and paste screenshots of problems for solutions. This capability offers a significant advantage for students struggling with how to begin solving mechanical engineering problems. In many cases, ChatGPT's problem solving methodology is correct; however, calculation and fundamental conceptual errors can prevent the generation of the correct final answer. Nevertheless, the tool could be particularly beneficial for those struggling to initiate problem-solving processes or determining the correct procedure to follow. To assess the effectiveness of ChatGPT in helping students, in-class quizzes were conducted, asking students to compare their confidence in their own work with ChatGPT's solutions in a Statics and a Dynamics course. Additionally, student surveys were administered to gather feedback on the tool's utility. Preliminary results indicate that while some students find ChatGPT 4.0 helpful for double-checking their approach and method, some are reluctant to rely solely on the tool for final numerical answers, preferring to use it as a supplementary aid rather than a primary solution source.

Keywords: ChatGPT 4.0, Image Processing, Mechanical Engineering Education, Problem-Solving Support, Student Feedback

Introduction

The incorporation of cutting-edge technology into education has profoundly reshaped modern learning environments. Among these advancements, ChatGPT 4.0, which is an advanced language model developed by OpenAI, has gained substantial recognition across various educational fields. This AI-driven tool, formally known as the Conditional Generative Pre-Trained Transformer, has witnessed widespread adoption since its public release in November 2022 [1]. The continuous evolution of AI-powered solutions, exemplified by ChatGPT, represents a major milestone in artificial intelligence, influencing multiple facets of daily life, communication, and academic instruction [2].

Artificial intelligence plays a critical role in education by broadening access to diverse learning resources, including digital courses and virtual laboratories, thus enhancing students' opportunities for academic growth. Additionally, advancements in AI have facilitated the development of dynamic teaching aids, such as interactive multimedia courseware and intelligent classroom management systems, which promote student engagement and optimize instructional strategies. Furthermore, emerging assessment technologies—such as AI-driven analytics and automated evaluation tools—allow educators to provide timely feedback, tailor their guidance, and improve overall learning effectiveness [3].

Despite its potential, ChatGPT's role in education is met with both enthusiasm and skepticism, particularly concerning academic integrity and the authenticity of student learning [1]. Within engineering education, ChatGPT offers valuable support in areas such as language refinement, virtual tutoring, and problem-solving guidance [4]. However, a key challenge arises from the

inherent limitations of AI systems, which generates errors that could lead to significant misunderstandings. As a result, it is crucial to educate engineering students about the risks associated with over-reliance on ChatGPT and emphasize the importance of critical evaluation. While it is not recommended to use ChatGPT as the sole resource for computational tasks, its explanations and methodological guidance generally provide valuable insights for problem-solving [5], although this was not the case in our observations in Dynamics. Additionally, further research is needed to assess how ChatGPT impacts student motivation and engagement [6], as meaningful learning occurs when students actively identify and address their own misconceptions. Studies suggest that when used appropriately, ChatGPT 4.0 can support the development of essential skills such as algorithmic thinking, critical reasoning, problem-solving, and both basic and advanced programming techniques [7]. Therefore, exploring how AI-powered tools like ChatGPT can enhance student motivation and performance remains a significant area of interest. This study examined ChatGPT 4.0's image processing capabilities in solving Mechanics problems. Existing research indicates that ChatGPT 4.0 performs well in analyzing and interpreting visual data, demonstrating strong pattern recognition, object identification, and contextual understanding across various image formats. However, limitations remain in handling complex visual reasoning and personalized recognition, emphasizing the need for further advancements in AI-driven image analysis [8].

In this context, this paper examines the integration of ChatGPT 4.0 in teaching mechanics courses, evaluating its effectiveness in promoting active learning, engaging students, and assisting with the comprehension of complex engineering principles.

Methodology

Students in two engineering fundamental courses, Statics (26 students) and Dynamics (8 students), with different professors were asked to participate in a quiz-based activity to evaluate their problem-solving skills and confidence in their solutions. The quizzes consisted of one or two problems, and students were tasked with solving these problems and providing detailed solutions. After completing each problem, they were asked to indicate their confidence in their solution by responding “yes” or “no” to the question, “Are you confident that your solution is correct?”

The papers were collected after approximately 15–20 minutes per question. Following this, students were provided with a second sheet containing ChatGPT 4.0's solution to the same problem. Students were then asked to evaluate the ChatGPT-generated solution and respond “yes” or “no” to the question, “Are you confident that ChatGPT's solution is correct?” If they identified any errors in ChatGPT's solution, they were instructed to circle the incorrect parts and briefly explain the issues with the provided solution.

Students in Statics were additionally instructed to utilize AI tools with image-processing capabilities to tackle two challenging problems, such as creating shear force and bending moment diagrams for a beam under various loads as a class project. They then compared their solutions with those generated by the AI. Following this exercise, students were asked to identify discrepancies between their responses and the AI-generated results and reflect on the AI's performance. This activity provided them with valuable knowledge and deeper insights into the

strengths and limitations of AI tools, particularly ChatGPT 4.0. In the Dynamics class, students only participated in the comparison of their hand calculations and Chat GPT's solution.

Students were eventually tasked with completing online surveys to evaluate their familiarity with and interest in using ChatGPT 4.0 for solving problems in Statics and Dynamics courses. Administered through Google Forms, the surveys were made easily accessible via a Blackboard hyperlink and a QR code provided on paper for convenience. Of the 34 students invited, 29 participated, resulting in an 85% response rate, as detailed in Appendix A. While students in the Dynamics course had limited exposure to ChatGPT, those in the Statics course were more experienced, having used the tool for a class project and presentation focused on solving Statics problems. This difference in exposure led to expected variations in survey responses.

The survey aimed to explore multiple facets of integrating AI-powered tools into engineering education. Questions covered students' experiences with ChatGPT, their outlook on the future of AI, and their detailed reflections on using the tool. The manuscript highlights the most impactful and insightful comments shared by the participants. In the upcoming Spring semester, the same methodology will be applied to a Dynamics course comprising 24 students. This expansion aims to increase the sample size from 34 to 60, thereby enhancing the credibility of the findings and providing a more comprehensive analysis of which types of Dynamics problems are most effectively addressed using ChatGPT. Each student will independently solve two moderately challenging problems manually. Subsequently, they will use ChatGPT to solve the same problems and conduct a detailed, line-by-line comparison between their solutions and those generated by the AI. This exercise is designed to help students identify errors, understand discrepancies, and evaluate how AI can assist in their problem-solving processes. The findings from this extended study can then be shared during the in-person presentation.

Results and Discussions

One of the survey questions asked: "*How often do you use ChatGPT 4.0 for solving engineering problems?*" The results show that students in the Dynamics class had minimal experience with the tool, with one-third of the class having never used it, as shown in Figure 1. In contrast, the majority of students in the Statics class engaged with ChatGPT 4.0 regularly, with 8.7% using it daily and 56.5% using it weekly. This significant difference in usage is important, as it influences how effectively students can leverage ChatGPT 4.0 to support their learning.

Figure 2 illustrates students' perceptions of the accuracy of ChatGPT 4.0's solutions in their respective classes. A clear distinction is evident between the responses. In the Statics class, 43.5% of students considered the answers "somewhat accurate," whereas Dynamics students had a more negative outlook, with one-third rating the responses as "very inaccurate".

One factor contributing to AI's weaker performance in Dynamics compared to Statics was the complexity of the problems. While ChatGPT was able to solve many problems in both subjects, its success depended on the problem's complexity. Simpler two-dimensional problems, or those requiring only differentiation or integration without referencing images such as calculating acceleration at a specific time from a given velocity function were generally handled well. In contrast, problems involving complex details or requiring diagrams like free body diagrams, kinetic diagrams, or momentum and impulse diagrams were less successfully addressed.

Moreover, in the absence of these diagrams, the explanations provided were often unclear and less helpful for students.

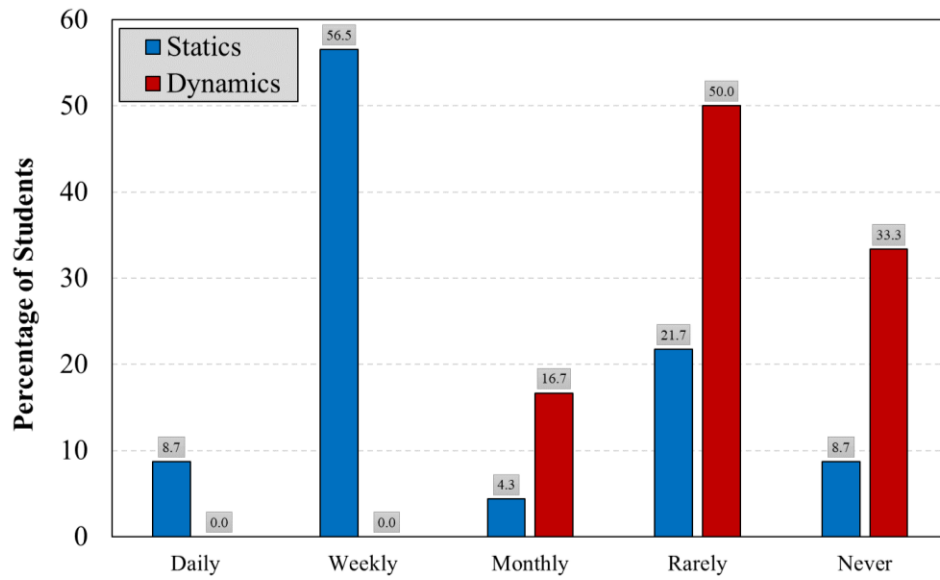


Figure 1: Frequency of ChatGPT 4.0 usage among students.

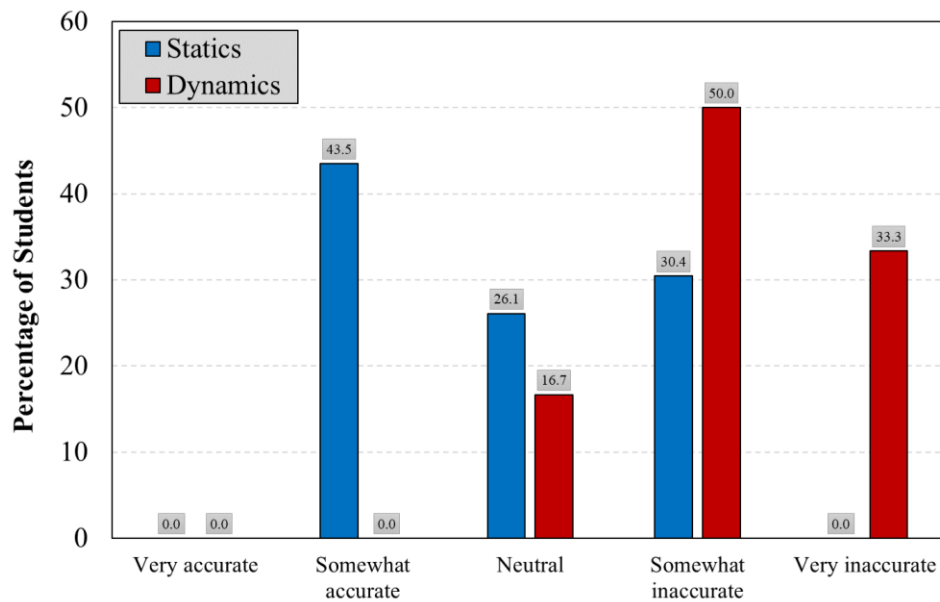


Figure 2: Perceived accuracy of solutions provided by ChatGPT 4.0.

One of the most significant advancements in the latest version of ChatGPT, and a key focus of this research, is its image processing capability. This feature has made it much easier for students to simply take a screenshot of a problem and paste it into ChatGPT to receive a solution. When students were asked about the perceived accuracy of this function—considering its various applications—they shared their experiences regarding how accurately ChatGPT interprets image

details and processes the information that can be observed in Figure 3. Students did not find this capability flawless and generally noted that some crucial details required for solving problems were often missed. However, the extent to which details were overlooked by ChatGPT 4.0 varied depending on the problem and how the information was presented within the image. For problems assigned to the Statics class, ChatGPT 4.0 successfully captured a greater portion of the information compared to other cases. In the Dynamics problem, there were clear mistakes in the ChatGPT solution that may have also been made by an untrained student but were easily identified by students experienced with the solution process. This is true even for students who may not have been successful in the class at the end of the semester.

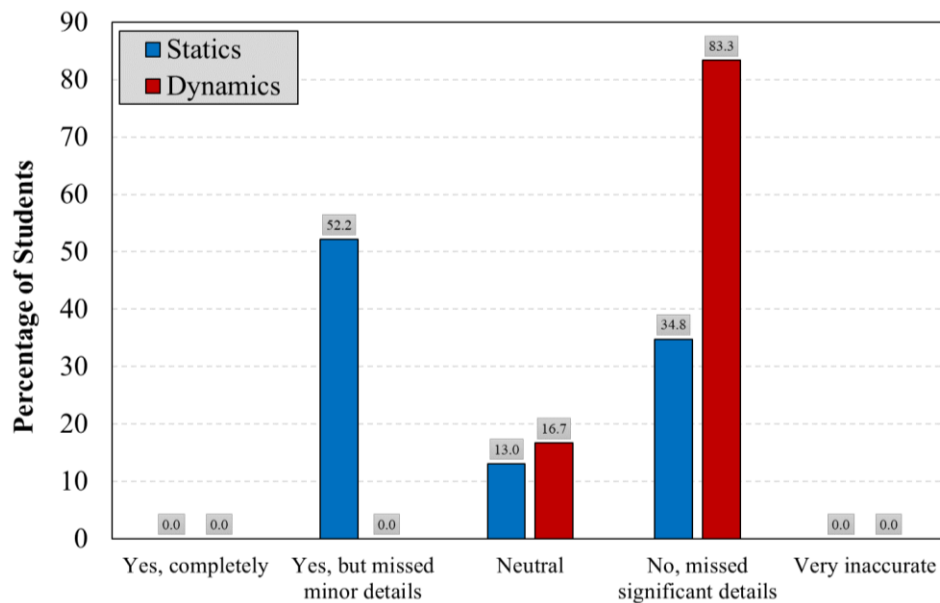


Figure 3: Perceived accuracy of ChatGPT 4.0's image processing.

It is generally agreed that studying and solving problems with classmates can enhance learning. In this context, ChatGPT can be viewed similarly to working through homework with a friend. Students are typically encouraged to first solve problems individually, then compare solutions to identify mistakes. Now, ChatGPT seems to be replacing the classmate, though errors must still be found in both hand-written and AI-generated solutions. One of the survey questions asked students about the impact of ChatGPT 4.0 on improving their understanding of Mechanics concepts. Figure 4 illustrates students' level of agreement with this statement. As shown, the majority of students in the Statics class recognized its benefits, with 8.7% strongly agreeing and 47.8% agreeing that the tool enhances their understanding. In contrast, students in the Dynamics class, largely disagreed, likely due to the unsatisfactory results they encountered. Half of the students disagreed, while 16.7% strongly disagreed with the statement.

To understand students' learning objectives for using AI, they were asked: *"What specific learning goals or objectives do you aim to achieve when using ChatGPT for engineering-related topics?"*

Below are the students' responses:

- **Dynamics Class:**
"Find answers to problems or just get the general idea of how to solve a problem."
"Realizing parts of the problem that may have been skipped while solving."
- **Statics Class:**
"It explains the information in a different way that can sometimes be more helpful."
"I aim to understand the step-by-step processes ChatGPT uses to solve the problems and see if there are any alternatives."

Students were asked about the perceived reliability of ChatGPT 4.0 for learning Mechanics concepts, and a similar pattern emerged. As shown in Figure 5, Statics students, who used the tool for classwork, quizzes, and a project, responded positively. Dynamics students, who had less exposure and primarily used it for an in-class quizz did not respond positively. Although a significant portion of the Statics class viewed ChatGPT 4.0 as reliable, with 4.3% considering it very reliable and 34.8% finding it reliable, Dynamics students had a contrasting perception, with 66.7% deeming it unreliable and 16.7% labeling it very unreliable. There appears to be a strong relationship between students' experience with ChatGPT 4.0 and their ability to formulate questions properly, which directly impacts their success rate in obtaining accurate responses. There are several cases in which ChatGPT will not get the correct answer and will have to be prompted, and coaxed, several times before it can get to a correct answer. Additionally, users can provide input when figure details, such as vector directions or numerical values, are unclear, or correct ChatGPT when it misreads images or makes minor sign errors, helping refine its solution.

To gain insights into students' perspectives, they were asked: *"What are your suggestions for improving the use of ChatGPT in solving mechanics problems?"*

Below are the responses from both classes:

- **Dynamics Class:**
"I personally think that another AI will come along and become more reliable to compute mechanics problems. I see AI as another tool, much like a calculator, it is important to be able to critically think about the problem so you know what to ask and how to distil the information."

"Not make wrong assumptions about so many things"
- **Statics Class:**
"Try it multiple times. ChatGPT tends to vary its answers and sometimes can catch a mistake it may have made, making it easier to spot where it went wrong."

"The best way I have used it is asking it to solve one step at a time where I do most of the work and have ChatGPT check it. If it gets the same answer as me I move on. If not, then I check its work and my own."

“It just needs more exposure to more difficult problem types to allow it to learn. It can do well with simpler forces problems, but sheer diagrams and some centroid problems it struggles with.”

“It would be nice if it provided free body diagrams.”

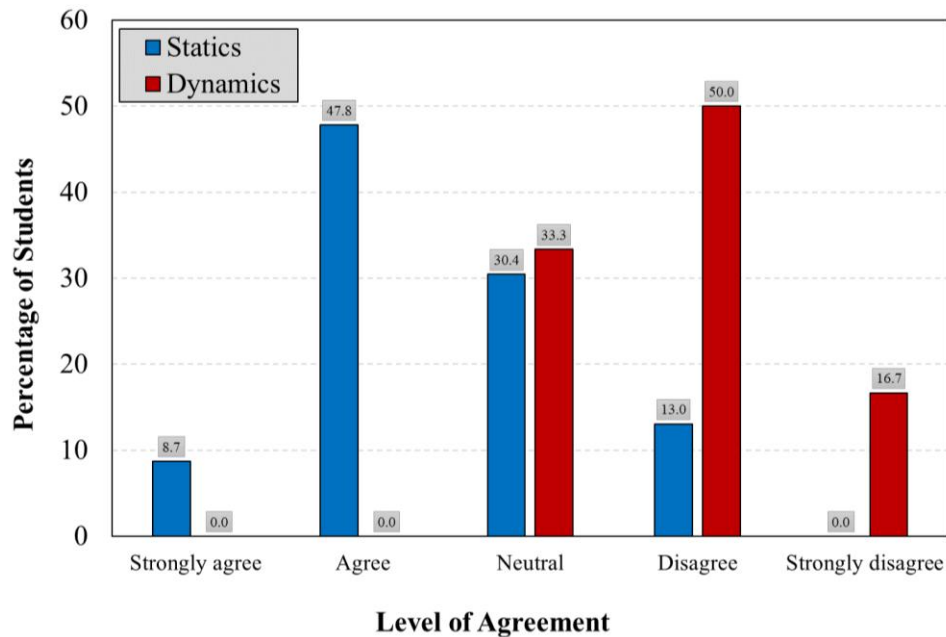


Figure 4: Impact of ChatGPT 4.0 on Enhancing Students' Understanding of Mechanics Concepts.

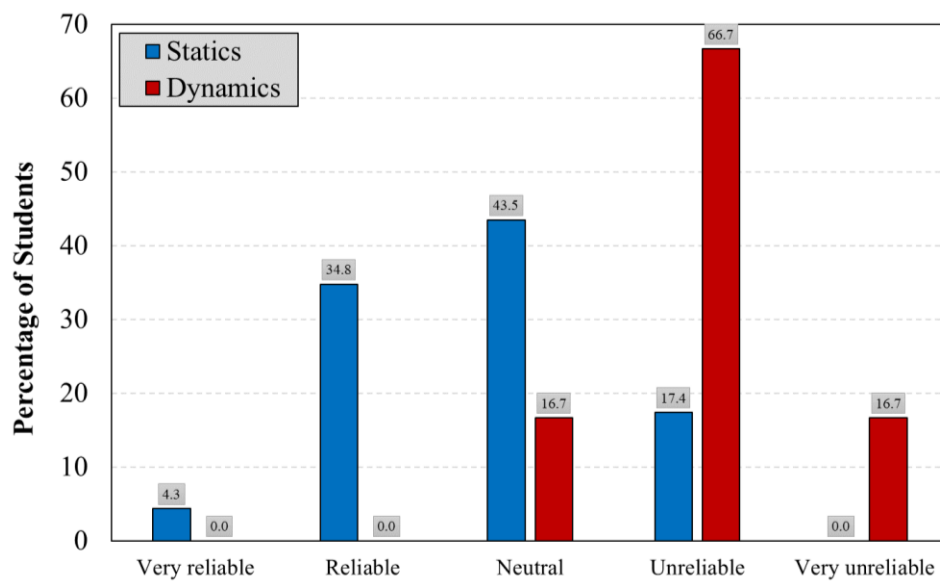


Figure 5: Perceived Reliability of ChatGPT 4.0 for learning Mechanics concepts.

Several students from Statics, who extensively used ChatGPT 4.0, shared during in-class discussions that its explanations are generally correct, with minor calculation errors often leading to incorrect final answers. These small mistakes commonly occur when solving systems of equations or interpreting angles and directions from figures. While some students remain cautious about relying on ChatGPT's final answers, they find its detailed explanations and problem-solving methodology highly beneficial. From Figure 6, it is evident that the Statics students had a significantly more positive view, with 65.2% rating the explanations as "Good, mostly clear and detailed," and an additional 4.3% considering them "Excellent, very clear and detailed." In contrast, a notable portion of Dynamics students (50%) found the explanations "Poor, unclear, or missing details". These students were able to identify calculations that were clearly incorrect based on the problem figure in which vectors were misidentified and kinematics of rigid bodies were ignored.

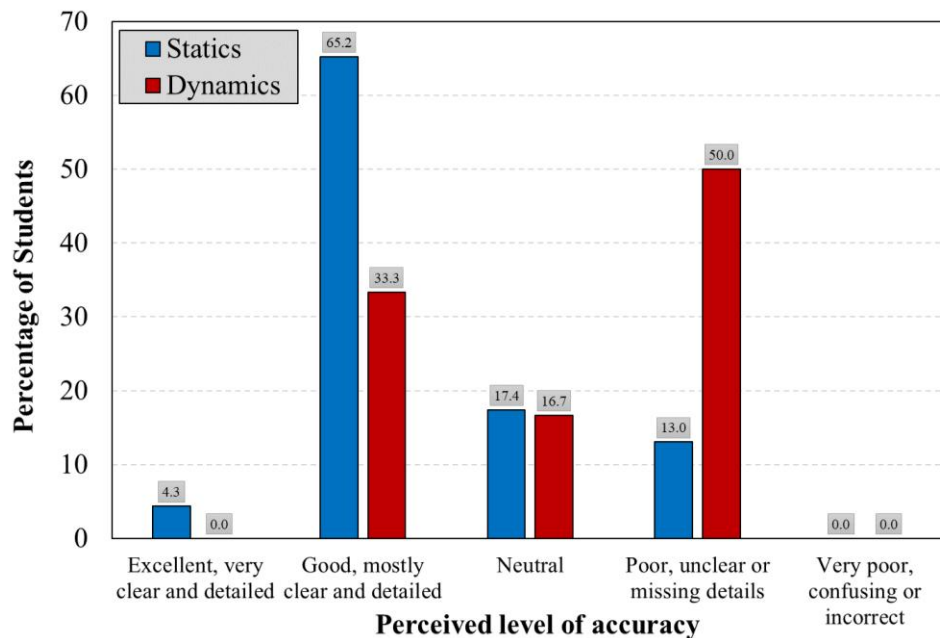


Figure 6: Perceived clarity and accuracy of ChatGPT 4.0's explanations.

To gain insights into students' experiences, they were asked: *"What challenges did you encounter when using ChatGPT to solve mechanics problems?"*

Below are the responses from both classes:

- **Dynamics Class:**

"ChatGPT makes assumptions for numbers that should be calculated, not assumed."

"It made a lot of assumptions"

"It makes many wrong assumptions"

"Skips steps"

- **Statics Class:**

“GPT is very good at solving easier, more common questions but struggles with unique and more complex problems.”

“ChatGPT frequently uses incorrect values when processing images but analyzing its process and identifying mistakes helps improve understanding of mechanics.”

Figure 7 presents students' level of optimism about the future of AI-powered technology, highlighting differences between Statics and Dynamics classes. Statics students generally expressed greater confidence in AI's future, with 17.4% being highly optimistic and 56.5% optimistic, meaning nearly three-quarters of the class foresee AI-powered technology as a positive force in the future. During in-class discussions, several students conveyed optimism about future versions of ChatGPT, recognizing the significant advancements made in recent years. They expressed hope that minor calculation errors and missing details from figures seen in the current model would be addressed in upcoming versions, possibly in the near future. Dynamics students also showed optimism, but with more caution. Half were optimistic, while none were highly optimistic. Instead, 16.7% were neutral, and a notable 33.3% were cautious, suggesting a degree of skepticism. Very few students expressed concern about AI's future. Only 4.3% of Statics students were cautious, and no students in either class identified as pessimistic or highly pessimistic.

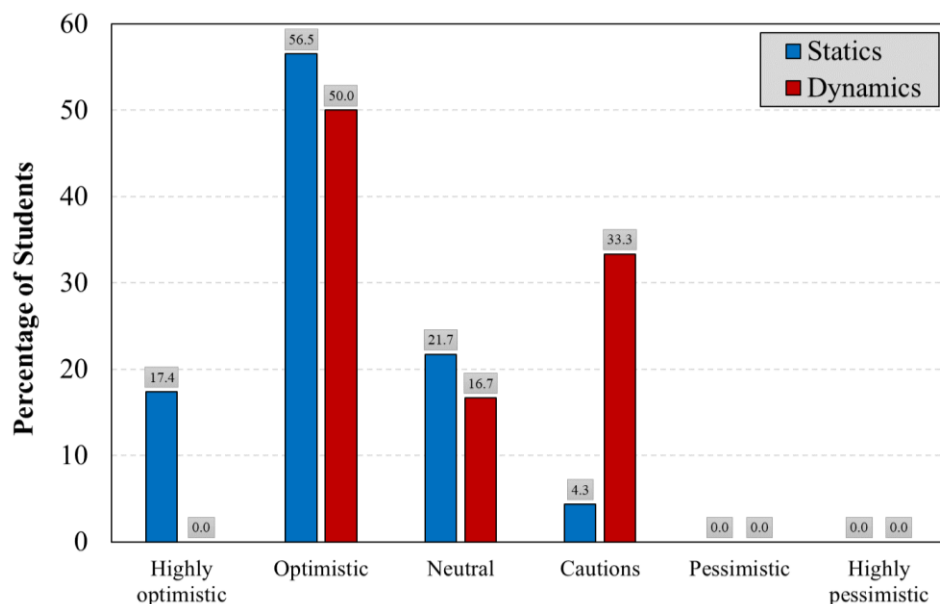


Figure 7: Students' Optimism About the Future of AI Technology.

To better illustrate the errors in ChatGPT's solutions, successful and unsuccessful responses from ChatGPT 4.0 are presented in Appendix B. An interesting concern that emerged was the presence of simple calculation mistakes during the solution process, which often resulted in misleading final answers. This issue raised doubts about relying on ChatGPT 4.0 as a standalone tool for solving

complex Statics and Dynamics problems. Another key limitation observed was ChatGPT 4.0's difficulty in handling systems of equations. The model frequently struggled to solve multiple equations simultaneously, leading to small errors midway through the process, which ultimately produced inaccurate final answers.

Beyond calculation mistakes, students also expressed some frustration with ChatGPT 4.0's ability to interpret values from images, process illustrations, and analyze vector directions, all of which are essential in Statics and Dynamics problems. Some students even struggled to find basic problems that ChatGPT 4.0 could solve accurately without additional user intervention. Based on student feedback and practical experience, integrating AI into traditional instruction can enhance engagement and foster problem-solving skills. However, it's crucial to avoid overdependence on AI tools. There is growing concern among educators and researchers about students becoming too dependent on AI tools for academic work. Studies suggest that overusing these tools may hinder the development of critical thinking, memory retention, and problem-solving skills [9].

In this case, one co-author is still very skeptical of using AI in mechanics classes because of the serious errors that it can make and how those errors could be interpreted by students who are not yet confident with the topic. In fundamental classes where students are developing their understanding of the material and problem-solving skills, AI explanations can at some times mislead and at other times simply be incorrect. In such classes where it is already hard for students to find the correct path to a final solution, trust in AI can misdirect students focus and further frustrate/discourage from students to develop trust in their *OWN* thought process and conceptual understanding of tough material.

Therefore, it is encouraging to see that students are still not yet fully trusting of AI solutions, however, this one co-author wonders if students had not yet been taught this material, if they could have convinced themselves that the AI solution *was* correct and “backed” their way into their own “understanding” how the solution came about. This is dangerous – and is worrisome.

Understandably, as is the case with any modern technology, it must be continuously developed and have trust built over time. However, a fundamental course in which student knowledge and skills are still being developed, may not be the place to “test” this new technology – yet.

It is essential to emphasize that this research is ongoing, and the authors intend to conduct further surveys to gain deeper insights into students' preferences. At this stage, the authors are not fully convinced that educators should integrate AI tools into their curricula to improve student learning outcomes. Further research is needed to carefully assess the potential benefits and drawbacks. Considering ChatGPT 4.0's impressive proofreading capabilities, it was utilized to eliminate grammatical and spelling errors and ensure the clarity of the text [10].

Conclusions

The major insights from this study on the use of ChatGPT in fundamental mechanics courses can be summarized as follows:

- While ChatGPT's accuracy in Statics and Dynamics is not perfect, some students remain hopeful about its future potential. Some students expressed confidence that upcoming versions will address its current limitations and errors.
- Students with greater experience using ChatGPT 4.0 had a more positive outlook on its effectiveness. According to their feedback, they learned to refine their questions and provide additional details, which led to more accurate and relevant responses.
- According to students' responses, caution is essential when using ChatGPT 4.0 for engineering problem-solving, as minor calculation errors can result in misleading outcomes. While students value the step-by-step explanations, they emphasize the importance of verifying computational results for accuracy.
- According to students' responses, ChatGPT 4.0 still struggles with accurately extracting problem details from images when solving mechanics problems. Frequently, critical information is overlooked, causing ChatGPT to make unwarranted assumptions, which often lead to incorrect solutions.
- According to students' feedback, a key area for improvement in ChatGPT 4.0 is its ability to draw and analyze free-body diagrams, which are crucial for solving Statics and Dynamics problems.
- It could be that the difficulty of the course has the greatest influence on the effectiveness of ChatGPT 4.0 to find a correct final solution. Using ChatGPT to solve a Statics problem will be a lot more reliable than using it for a Dynamics problem because there is so much more interpretation that a student must do, or intuition that a student must use, to find the right path to the end of a Dynamics problem. Dynamics is just harder!

Appendix

A. Survey questions on the use of ChatGPT 4.0 for enhancing comprehension in Mechanics courses, specifically Statics and Dynamics.

- 1) What is your age?
- 2) Which engineering discipline are you studying?
 - a. Mechanical
 - b. Civil
 - c. Electrical
 - d. Manufacturing
 - e. General Engineering
- 3) What is your current academic classification?
 - a. Freshman
 - b. Sophomore
 - c. Junior
 - d. Senior
- 4) How often do you use ChatGPT 4.0 for learning and understanding engineering concepts?
 - a. Daily
 - b. Weekly
 - c. Monthly
 - d. Rarely
 - e. Never
- 5) Prior to this course, had you used ChatGPT 4.0 for solving problems?
 - a. Yes, frequently
 - b. Yes, occasionally
 - c. No
- 6) How would you evaluate the accuracy of ChatGPT 4.0 in solving mechanics problems?
 - a. Very accurate
 - b. Somewhat accurate
 - c. Neutral
 - d. Somewhat inaccurate
 - e. Very inaccurate
- 7) Did ChatGPT 4.0 correctly process and interpret the images you provided?
 - a. Yes, completely
 - b. Yes, but missed minor details
 - c. Neutral
 - d. No, missed significant details

- e. No, could not process the images at all
- 8) Did ChatGPT 4.0 improve your understanding of the Statics/Dynamics concepts?
- a. Strongly agree
 - b. Agree
 - c. Neutral
 - d. Disagree
 - e. Strongly disagree
- 9) What challenges did you encounter when using ChatGPT 4.0 to solve mechanics problems?
- 10) Do you think ChatGPT 4.0 is a reliable tool for learning and problem-solving in mechanics?
- a. Very reliable
 - b. Reliable
 - c. Neutral
 - d. Unreliable
 - e. Very unreliable
- 11) How would you evaluate ChatGPT 4.0's explanations of mechanics problems?
- a. Excellent, very clear and detailed
 - b. Good, mostly clear and detailed
 - c. Neutral
 - d. Poor, unclear or missing details
 - e. Very poor, confusing or incorrect
- 12) Would you recommend using ChatGPT 4.0 for mechanics-related problems to other students?
- a. Yes
 - b. No
- 13) Do you plan to continue using ChatGPT 4.0 for learning engineering concepts in the future?
- a. Yes
 - b. No
- 14) What are your suggestions for improving the use of ChatGPT 4.0 in solving mechanics problems?
- 15) What specific learning goals or objectives do you aim to achieve when using ChatGPT 4.0 for engineering-related topics?
- 16) Do you find that ChatGPT 4.0 helps you achieve a deeper understanding of the engineering topics you're studying?
- a. Strongly agree
 - b. Agree
 - c. Neutral

- d. Disagree
- e. Strongly disagree

17) In your personal experience, how do you assess the dependability of answers generated by ChatGPT 4.0?

- a. Highly pessimistic
- b. Pessimistic
- c. Neutral
- d. Optimistic
- e. Highly optimistic

18) Have you encountered any challenges or limitations when using ChatGPT for learning engineering concepts? If so, please describe.

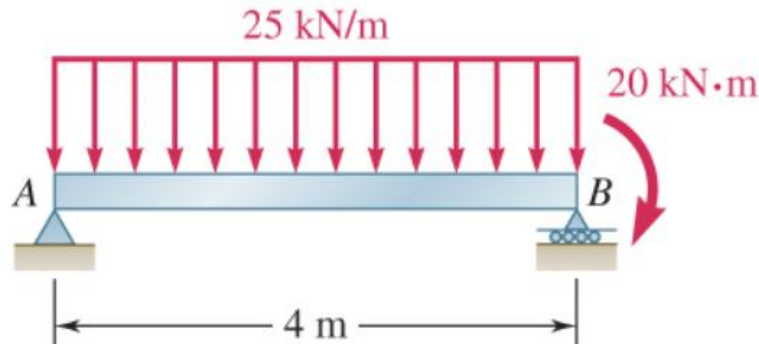
19) How do you evaluate the future of AI-powered technology?

- a. Highly optimistic - I believe AI-powered technology will revolutionize industries and improve our lives significantly.
- b. Optimistic - I have positive expectations for AI-powered technology, but I acknowledge potential challenges.
- c. Neutral - I have a balanced view, with neither particularly high nor low expectations for AI-powered technology.
- d. Cautious - I am concerned about potential risks and uncertainties associated with AI-powered technology.
- e. Pessimistic - I have significant doubts about the future impact of AI-powered technology and its potential risks.
- f. Highly pessimistic - I believe AI-powered technology poses substantial risks and may have detrimental effects on society.

B. Full Responses Generated by ChatGPT

1. Problem for which ChatGPT provided *correct* responses. This includes the question entered into ChatGPT and subsequent answer from ChatGPT.

Question: For the beam and loading shown, (a) draw the shear and bending-moment diagrams, (b) determine the magnitude and location of the maximum absolute value of the bending moment [11].



ChatGPT Answer:

To solve this beam problem, we need to:

1. Determine the support reactions at points A and B.
2. Draw the shear force diagram (SFD).
3. Draw the bending moment diagram (BMD).
4. Find the maximum absolute bending moment and its location.

Step 1: Support Reactions

The beam is simply supported at A and has a roller support at B, meaning it has two reaction forces:

- A vertical reaction at A: R_A
- A vertical reaction at B: R_B
- A moment of 20 kN·m is applied at B.

Alright! Let's solve this **step-by-step** carefully:

Step 1: Support Reactions

We have:

- A **simply supported beam** (pin at A and roller at B).
- Uniform distributed load (UDL): 25 kN/m over the entire span of **4 m**.
- A **20 kN·m clockwise couple** at support B.

First, calculate the total load due to the UDL:

$$w_{\text{total}} = 25 \times 4 = 100 \text{ kN}$$

This acts **at the center** of the beam (i.e., 2 m from both A and B).

Now, apply **equilibrium equations**:

1. $\sum M_A = 0$ (taking moment about A)

Clockwise moments are positive:

$$-100(2) + R_B(4) - 20 = 0$$

$$-200 + 4R_B - 20 = 0$$

$$4R_B = 220$$

$$R_B = 55 \text{ kN}$$

2. $\sum F_y = 0$ (vertical forces)

$$R_A + R_B = 100$$

$$R_A = 100 - 55 = 45 \text{ kN}$$

Thus:

✓ $R_A = 45 \text{ kN}$ upward

✓ $R_B = 55 \text{ kN}$ upward

Step 2: Shear Force Diagram (V)

Start from left (A) and move right:

1. At A, immediately after support:

$$V = +45 \text{ kN}$$

2. Under UDL, the shear decreases linearly with slope -25 kN/m .

At distance x from A:

$$V(x) = 45 - 25x$$

Specifically:

- At $x = 4 \text{ m}$ (just before B):

$$V(4^-) = 45 - 25(4) = 45 - 100 = -55 \text{ kN}$$

3. At B, add reaction force $+55 \text{ kN}$:

$$V(4^+) = -55 + 55 = 0$$

✓ The shear diagram goes from $+45 \text{ kN}$ down linearly to -55 kN , then jumps up to 0 at B.

Step 3: Bending Moment Diagram (M)

Now integrate the shear diagram:

Start from A:

- At A, $M_A = 0$ (pinned).

The moment at any distance x from A is:

$$M(x) = 45x - \frac{25x^2}{2}$$

Specifically:

- At $x = 0$: $M(0) = 0$ (at A).
- At $x = 4$:

$$M(4) = 45(4) - \frac{25(4)^2}{2} = 180 - \frac{25(16)}{2} = 180 - 200 = -20 \text{ kN} \cdot \text{m}$$

But remember there is also a **20 kN·m clockwise couple at B** which will drop the moment another 20 kN·m to:

$$M_B = -20 - 20 = -40 \text{ kN} \cdot \text{m}$$

✓ So $M_B = -40 \text{ kN} \cdot \text{m}$.

Step 4: Find Maximum Moment

To find the **maximum absolute value** of the bending moment, set $V(x) = 0$ (because maximum/minimum bending moments occur where shear = 0):

$$45 - 25x = 0$$

$$x = 1.8 \text{ m}$$

Now plug back into $M(x)$:

$$\begin{aligned} M(1.8) &= 45(1.8) - \frac{25(1.8)^2}{2} \\ &= 81 - \frac{25(3.24)}{2} \\ &= 81 - 40.5 \\ &= 40.5 \text{ kN} \cdot \text{m} \end{aligned}$$

✓ Thus, **maximum moment** = $+40.5 \text{ kN} \cdot \text{m}$ at $x = 1.8 \text{ m}$ from A.

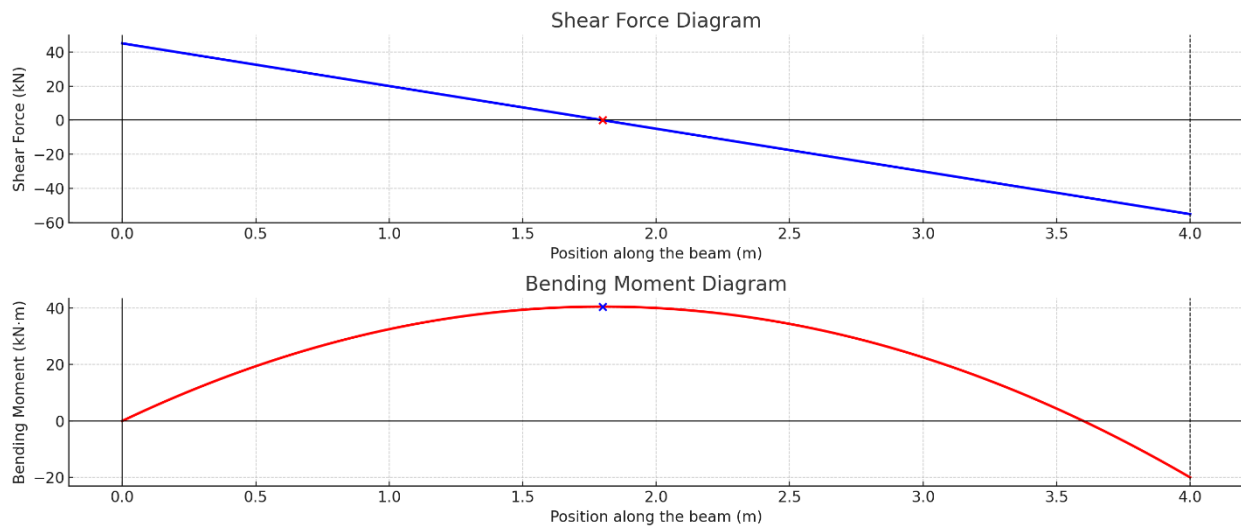
Step 5: Draw Diagrams

Shear Force Diagram (V):

- Starts at $+45 \text{ kN}$ at A
- Decreases linearly (slope -25 kN/m) to -55 kN at B
- Jumps back to 0 at B

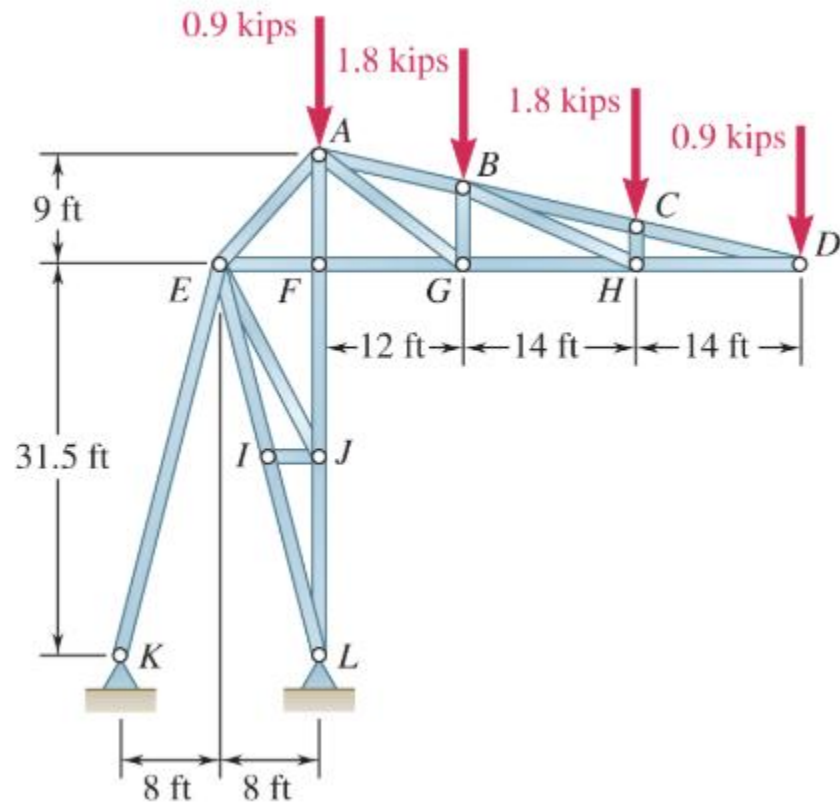
Bending Moment Diagram (M):

- Starts at $0 \text{ kN} \cdot \text{m}$ at A
- Parabolic curve (since under uniform load) reaching $+40.5 \text{ kN} \cdot \text{m}$ at $x = 1.8 \text{ m}$
- Decreases to $-20 \text{ kN} \cdot \text{m}$ just before B
- Drops to $-40 \text{ kN} \cdot \text{m}$ after applying the $20 \text{ kN}\cdot\text{m}$ clockwise couple at B



2. Problems for which ChatGPT provided *misleading* responses. This includes the question entered into ChatGPT and subsequent answer from ChatGPT

Question: A stadium roof truss is loaded as shown. Determine the force in members AB, AG, and FG [11].



ChatGPT Answer:

GPT 4.0-Generated Solution:

GPT used incorrect distance values for the forces on the top of the truss when calculating moment about K. This equation should be

$$\sum M_K = 0 = R_L(16) - 0.9(16) - 1.8(28) - 1.8(42) - 0.9(56)$$

GPT used incorrect signs for R_K and R_L . If R_L generated positive moment and the forces on the right generate negative moments, then R_K should be opposite to R_L . GPT also added an extra 1.8 kN force. The equation should be

$$\sum F_y = 0 = -R_K + R_L - 0.9 - 1.8 - 1.8 - 0.9$$

GPT finds moment about F incorrectly. GPT should not include the forces on the right side of the cut, doesn't include the y component of F_{AE} , ignores moment from R_K , and uses incorrect distances. The equation should be

$$\sum M_F = 0 = R_K(16) - F_{AE} \left(\frac{9}{\sqrt{9^2 + 8^2}} \right) (8)$$

GPT sets up vertical equilibrium incorrectly. There is no vertical component of F_{EF} , and GPT ignores R_L and F_{FJ} . The equation should be

$$\sum F_y = 0 = -R_K + R_L - F_{FJ} + F_{AE} \left(\frac{9}{\sqrt{9^2 + 8^2}} \right)$$

GPT sets up horizontal equilibrium incorrectly. There is no horizontal component of F_{FJ} , and F_{EF} is not at an angle. The equation should be

$$\sum F_x = 0 = F_{AE} \left(\frac{8}{\sqrt{9^2 + 8^2}} \right) - F_{EF}$$

Step 1: Identify the Section

We will cut through members AE , EF , and FJ . This divides the truss into two parts. We will analyze the left side of the cut for simplicity.

The cut allows us to solve for the forces in these members using the equations of equilibrium:

1. $\sum F_x = 0$ (horizontal forces),
2. $\sum F_y = 0$ (vertical forces),
3. $\sum M = 0$ (moments about a point).

Step 2: Determine the Support Reactions

We begin by calculating the reactions at supports K and L using equilibrium equations.

Taking Moments About K :

$$\begin{aligned} \sum M_K = 0 &\Rightarrow R_L \cdot 16 - (0.9 \cdot 8) - (1.8 \cdot 20) - (1.8 \cdot 34) - (0.9 \cdot 48) = 0 \\ R_L &= \frac{(0.9 \cdot 8) + (1.8 \cdot 20) + (1.8 \cdot 34) + (0.9 \cdot 48)}{16} \\ R_L &= 6.975 \text{ kips} \end{aligned}$$

Vertical Equilibrium:

$$\begin{aligned} \sum F_y = 0 &\Rightarrow R_K + R_L - 0.9 - 1.8 - 1.8 - 0.9 = 0 \\ R_K &= 7.2 - 6.975 = 0.225 \text{ kips} \end{aligned}$$

Step 3: Take Moments About Point F

To find F_{AE} , we take moments about point F , as this eliminates the forces in members EF and FJ :

$$\begin{aligned} \sum M_F = 0 &\Rightarrow -F_{AE} \cdot 12 + 0.9 \cdot 24 + 1.8 \cdot 12 = 0 \\ F_{AE} &= \frac{0.9 \cdot 24 + 1.8 \cdot 12}{12} = 3.6 \text{ kips} \end{aligned}$$

Step 4: Vertical Equilibrium ($\sum F_y = 0$)

Using the left section, the vertical forces are:

$$\begin{aligned} R_K + F_{AE} \sin \theta - F_{EF} \sin \theta &= 0 \\ 0.225 + 3.6 \cdot \frac{31.5}{33.7} - F_{EF} \cdot \frac{31.5}{33.7} &= 0 \end{aligned}$$

Solve for F_{EF} :

$$F_{EF} = \frac{0.225 + 3.6 \cdot \frac{31.5}{33.7}}{\frac{31.5}{33.7}}$$

Step 5: Horizontal Equilibrium ($\sum F_x = 0$)

The horizontal forces are:

$$\begin{aligned} F_{AE} \cos \theta - F_{EF} \cos \theta + F_{FJ} &= 0 \\ F_{FJ} &= F_{EF} \cdot \frac{12}{33.7} - F_{AE} \cdot \frac{12}{33.7} \end{aligned}$$

The forces in the members are as follows:

- $F_{EF} = 3.84$ kips (tension),
- $F_{FJ} = 0.086$ kips (tension).

Question: (Highlighted below in red boxes are errors in ChatGPT's assumptions. The direction of the restriction for the velocity and acceleration of the slider is never considered.)

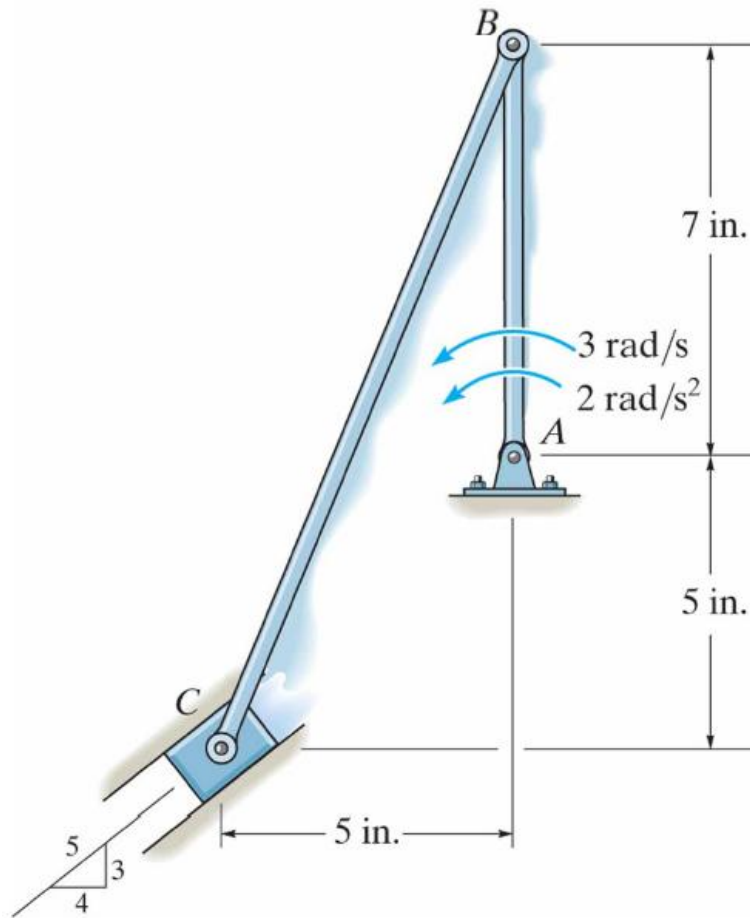


Figure 2: Crank-Slider

Find: Determine the

1. The velocity and acceleration of the slider block C at this instant (Leave you answer in vector form)
2. Plot the linkage (AB, BC, AC).

Thus, the position of C with respect to A is:

$$\vec{r}_{C/A} = \vec{r}_{B/A} + \vec{r}_{C/B} = 5\hat{j} + (3\hat{i} + 4\hat{j}) = 3\hat{i} + 9\hat{j}$$

Step 2: Velocity Analysis

To find the velocity of C , we use the relationship:

$$\vec{v}_C = \vec{v}_B + \vec{v}_{C/B}$$

Velocity of B :

The velocity of point B due to the rotation of AB is:

$$\vec{v}_B = \omega_{AB} \times \vec{r}_{B/A}$$

Since $\omega_{AB} = 3 \text{ rad/s}$, and $\vec{r}_{B/A} = 5\hat{j}$:

$$\vec{v}_B = 3\hat{k} \times 5\hat{j} = -15\hat{i} \text{ in/s}$$

Velocity of C relative to B ($\vec{v}_{C/B}$):

Since BC is a rigid link, point C has no velocity relative to B along the direction of the link BC , so:

$$\vec{v}_{C/B} = 0$$

Therefore, the velocity of C is simply:

$$\vec{v}_C = \vec{v}_B = -15\hat{i} \text{ in/s}$$

Step 3: Acceleration Analysis

To find the acceleration of C , we use the relationship:

$$\vec{a}_C = \vec{a}_B + \vec{a}_{C/B}$$

Acceleration of B :

The acceleration of B consists of two components:

1. **Tangential acceleration** due to α_{AB} :

$$\vec{a}_{tB} = \alpha_{AB} \times \vec{r}_{B/A} = 2\hat{k} \times 5\hat{j} = -10\hat{i} \text{ in/s}^2$$

2. **Normal (centripetal) acceleration** due to ω_{AB} :

$$\vec{a}_{nB} = -\omega_{AB}^2 \times \vec{r}_{B/A} = -(3)^2 \times 5\hat{j} = -45\hat{j} \text{ in/s}^2$$

Thus, the total acceleration of B is:

$$\vec{a}_B = \vec{a}_{tB} + \vec{a}_{nB} = -10\hat{i} - 45\hat{j} \text{ in/s}^2$$

Acceleration of C relative to B ($\vec{a}_{C/B}$):

Since C moves along the link BC , its relative acceleration with respect to B is only due to the rotation of link BC .

Let's assume that link BC has an angular acceleration α_{BC} and angular velocity ω_{BC} (unknown). However, without additional information on α_{BC} , we assume no angular acceleration. Therefore:

$$\vec{a}_{C/B} = 0$$

So, the total acceleration of C is:

$$\vec{a}_C = \vec{a}_B = -10\hat{i} - 45\hat{j} \text{ in/s}^2$$

Final Answers:

1. **Velocity of C :**

$$\vec{v}_C = -15\hat{i} \text{ in/s}$$

2. **Acceleration of C :**

$$\vec{a}_C = -10\hat{i} - 45\hat{j} \text{ in/s}^2$$

These are the velocity and acceleration of slider block C in vector form.

References

- [1] B. Memarian and T. Doleck, "ChatGPT in education: Methods, potentials and limitations," *Computers in Human Behavior: Artificial Humans*, vol. 1, no. 2, p. 100022, Oct. 2023, doi: <https://doi.org/10.1016/j.chbah.2023.100022>.
- [2] E. L. Hill-Yardin, M. R. Hutchinson, R. Laycock, and S. J. Spencer, "A Chat(GPT) about the future of scientific publishing," *Brain, Behavior, and Immunity*, vol. 110, Mar. 2023, doi: <https://doi.org/10.1016/j.bbi.2023.02.022>.
- [3] H. Yu, "Reflection on whether Chat GPT should be banned by academia from the perspective of education and teaching," *Frontiers in Psychology*, vol. 14, p. 1181712, 2023, doi: <https://doi.org/10.3389/fpsyg.2023.1181712>.
- [4] J. Qadir, "Engineering Education in the Era of ChatGPT: Promise and Pitfalls of Generative AI for Education," 2023 IEEE Global Engineering Education Conference (EDUCON), May 2023, doi: <https://doi.org/10.1109/educon54358.2023.10125121>.
- [5] S. Nikolic et al., "ChatGPT versus engineering education assessment: a multidisciplinary and multi-institutional benchmarking and analysis of this generative artificial intelligence tool to investigate assessment integrity," pp. 1–56, May 2023, doi: <https://doi.org/10.1080/03043797.2023.2213169>.
- [6] C. Stokel-Walker and R. Van Noorden, "What ChatGPT and generative AI mean for science," *Nature*, vol. 614, no. 7947, pp. 214–216, Feb. 2023, doi: <https://doi.org/10.1038/d41586-023-00340-6>.
- [7] R. Yilmaz and F. G. Karaoglan Yilmaz, "The effect of generative artificial intelligence (AI)-based tool use on students' computational thinking skills, programming self-efficacy and motivation," *Computers and Education: Artificial Intelligence*, vol. 4, p. 100147, Jan. 2023, doi: <https://doi.org/10.1016/j.caeai.2023.100147>.
- [8] Victor, Johnson & Alyasiri, Osamah & Akhtom, Dua'A & Johnson, Olabisi. (2023). Image Analysis through the lens of ChatGPT-4. *Journal of Applied Artificial Intelligence*. 4. 32-46. 10.48185/jaai.v4i2.870.
- [9] Y. K. Dwivedi *et al.*, Opinion Paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy, *International Journal of Information Management*, Volume 71, 2023, 102642, ISSN 0268-4012, <https://doi.org/10.1016/j.ijinfomgt.2023.102642>.
- [10] OpenAI. (2022). ChatGPT (Version 3.5). OpenAI. <https://openai.com/>
- [11] Beer, F. P. (2024). *Vector Mechanics: Statics and Dynamics with Media Updates*. McGraw-Hill.