

Exploring Student Perceptions of Learning Experience in Fundamental Mechanics Courses Enhanced by ChatGPT

Dr. 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.

Exploring Student Perceptions of Learning Experience in Fundamental Mechanics Courses Enhanced by ChatGPT

Abstract

Enhancing the engagement and boosting the learning experience of students in foundational mechanics courses have always been among the top priorities of professors. The rapid recent technological advancements of artificial intelligence (AI) have brought about promising pedagogical opportunities for engineering faculty and students with potentially more efficient learning tools. This manuscript aims to study the prospects and obstacles in using a state-of-the-art natural language processing (NLP) model for obtaining a deeper understanding of core engineering courses. In this regard, several engineering examples were explored for analyzing the accuracy of quantitative results obtained from ChatGPT. In-class surveys were also conducted to assess the enthusiasm of students and enhanced interactivity of implementing ChatGPT-powered educational platform in solving engineering problems. We discovered that students can noticeably benefit from the key beneficial features offered by artificial intelligence including, but not limited to, real-time assistance, personalized feedback, and dynamic content generation. Survey results highlight the positive impact of implementation of ChatGPT on engineering students' scholarly performance and their broader learning experience. Despite all the undeniable advantages AI offers, it is essential to exercise caution and thorough analysis when evaluating the final results because the final outcomes are not always correct. Not only can incorrect results be discouraging, but they can also mislead students and hinder their ability to engage in deep, critical thinking. Regardless of the accuracy of the results, it is beyond doubt that ChatGPT is a valuable tool for educators in the field of engineering mechanics who are enthusiastic in offering an innovative approach to foster deep understanding and interest and engage critical thinking in fundamental engineering concepts. The limitations of the current ChatGPT model can be addressed and rectified in future iterations of the model, making the future of AI-driven education more promising, and eventually establishing the generative models as flawless and reliable resources for both students and educators in STEM fields.

Introduction

The integration of advanced technologies into educational practices has been a transformative force in shaping contemporary learning environments. One such technology that has gained prominence in various educational domains is ChatGPT, a state-of-the-art language model developed by OpenAI. This publicly accessible AI model, Conditional Generative Pre-Trained Transformer, commonly referred to as ChatGPT has seen remarkable popularity since its initial release in November 2022 [1]. The innovative progress of intelligent technology, embodied by ChatGPT, signifies a new era in artificial intelligence. This technology significantly impacts various aspects of society, including lifestyle, communication, and education [2]. Artificial intelligence (AI) holds a pivotal role in the education sector. It facilitates access to abundant information resources, like online learning and virtual laboratories, expanding students' learning opportunities. Furthermore, technological advancements have led to innovative teaching tools such as multimedia courseware and intelligent teaching systems, improving classroom management, and fostering student engagement. Simultaneously, progress in technology has introduced more

thorough and objective assessment methods, including data analysis and intelligent evaluation. These methods aid teachers in providing prompt guidance to students and enhancing learning outcomes based on evaluation feedback, thereby elevating the overall quality and effectiveness of education [3].

Both optimism and concerns surround the use of ChatGPT in education, with the primary priority being to safeguard student learning and academic integrity from compromise [1]. ChatGPT has the potential to enhance engineering education by assisting in language editing, virtual tutoring, and problem-solving [4]. However, a significant concern arises from the imperfections of ChatGPT and other AI systems, which can result in unpredictable errors with potentially serious consequences. Hence, it is crucial to advise engineering students about the potential risks and implications of relying solely on ChatGPT without careful consideration. Although it's not advisable to depend on ChatGPT as the only source for calculation-based tasks, the guidance and instructions offered by ChatGPT for approaching problems is generally accurate and helpful [5]. Furthermore, it is essential to investigate the influence of ChatGPT on student motivation and engagement [6]. This is crucial because learning occurs when students invest time and effort in identifying and rectifying their learning errors. It is demonstrated that when used properly, ChatGPT can enhance multiple aspects of students' abilities including, but not limited to, algorithmic thinking, critical thinking, problem-solving, simple programming tasks, and complex programming tasks [7]. Therefore, it is essential to investigate how interactions with chatbots and programs can enhance students' motivation and performance.

In this regard, this paper explores the potential applications of ChatGPT in the context of teaching mechanics courses, leveraging its capabilities to enhance student engagement, facilitate interactive learning, and provide valuable assistance in complex engineering concepts.

Methodology

Students in two engineering fundamental classes (Statics and Dynamics) were tasked with completing detailed online surveys to gauge their familiarity with and interest in ChatGPT. Surveys were administered through Google Forms. Students were presented with accessibility options via both a hyperlink provided on Blackboard and a QR code printed on paper, facilitating convenient access to the survey link. A total of 24 students (out of 28 students, resulting in an 86% participation rate) actively participated in the survey that is detailed in Appendix A. Although the students in Dynamics had limited knowledge of ChatGPT, the students in Statics class had more experience due to prior exposure as they were assigned an in-class project and presentation that involved utilizing ChatGPT for solving Statics problems. As a result of this deliberate differed exposure, a meaningful difference between the students' responses was observed.

In this survey, students were asked about a variety of aspects to explore the opportunities and challenges of using AI-powered tools for engineering education. In addition to their experience working with ChatGPT, they were also asked about their viewpoint about the future of AI. Students were additionally requested to provide detailed comments about their individual experiences. The most noteworthy and insightful comments have been incorporated in this manuscript.

Results and Discussions

One of the questions posed to students for their response and commentary was, “How often do you use ChatGPT for learning and understanding engineering concepts?”. The findings reveal that participants in the survey had relatively restricted experience working with ChatGPT, ranging from just half an hour to several days as shown in Figure 1. Students’ feedback highlighted a recurring issue where ChatGPT would initiate the solution process but encounter challenges midway due to the complexity of Statics and Dynamics problems.

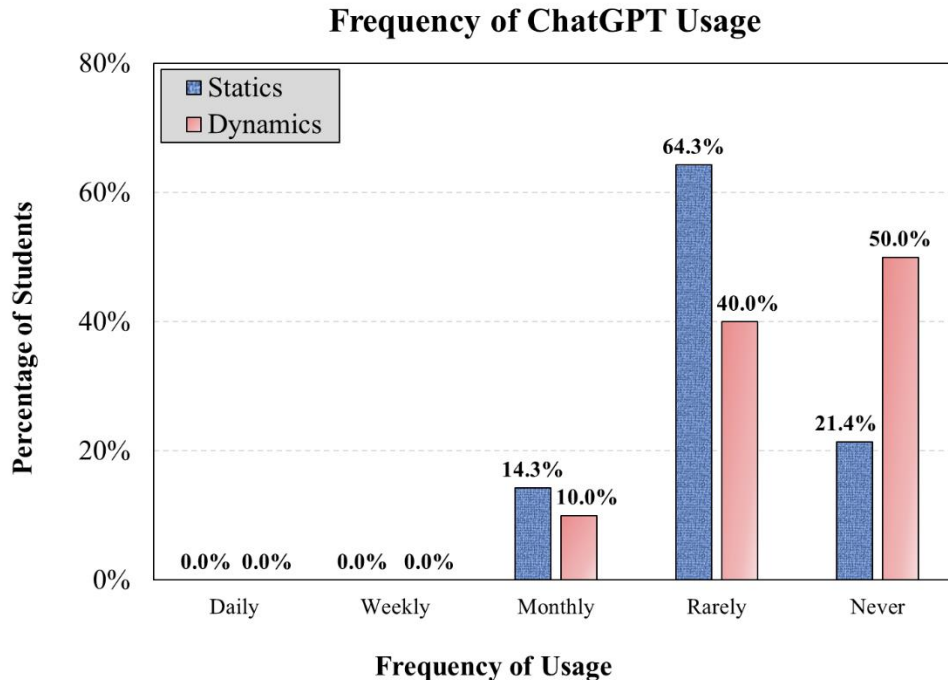


Figure 1: Students' Extent of Exposure to ChatGPT.

Interestingly, a notable concern was the occurrence of simple calculation mistakes during the solution procedure, leading to potentially misleading final answers. This aspect raised concerns about using ChatGPT as a standalone dependable tool for solving complex Statics and Dynamics problems. Another significant limitation observed in the application of ChatGPT to solve Statics and Dynamics problems pertains to addressing systems of equations or long word problems. Frequently, ChatGPT faced challenges in simultaneously solving equations, leading to the generation of minor errors midway through the solution process. These errors, in turn, resulted in users obtaining inaccurate responses. Examples of successful and unsuccessful problem solutions are included below. Full solutions from ChatGPT are included in Appendix B.

- Example problems for which ChatGPT provided *correct* responses:
 - Statics
 - The bending moment on a beam is given by $M = -4x^3 + 3x^2 - 23x + 5$ N.m, calculate the shear force at $x = 3$ m. (**Correct Answer: $V = 113$ N; ChatGPT answer: 113 units [whatever the units of the bending moment are]**)

- Dynamics
 - The position of a particle is given by $s[t] = t^3 - 12t^2 + 44t + 11$ m, calculate the acceleration value at $t = 5$ s. (**Correct Answer: $a = 6$ m/s²; ChatGPT answer: acceleration at t=5s is 6 units [whatever the units of time and displacement are]**)
- Example problems for which ChatGPT provided misleading responses:
 - Statics
 - Four concentric forces are exerted on a post. F_1 has a magnitude of 300 N and is positioned at a 30-degree counterclockwise angle from the positive x -axis. F_2 , with a magnitude of 600 N, is aligned along the positive y -axis. F_3 , measuring 450 N, is situated at a 22.62-degree counterclockwise angle from the negative y -axis. Finally, F_4 , with a magnitude of 250 N, is located at a 60-degree clockwise angle from the negative y -axis. Determine the resultant force vector. (**Correct Answer: $R = 301$ N, $\theta = 44.1^\circ$; ChatGPT answer: 990.4 N $\theta = 75.2^\circ$**)
 - Dynamics
 - A balloon has a total mass of 400 kg including the passengers and ballast. The balloon is rising at a constant velocity of 18 km/h when $h = 10$ m. If the man drops the 40-kg sandbag, determine the velocity of the balloon when the bag strikes the ground. Neglect air resistance. (**Correct Answer: $v = 7.21$ m/s \uparrow ; ChatGPT answer: $v = 5.5$ m/s)**)

In addition to the minor calculation mistakes, students expressed a level of disappointment when encountering tasks requiring graphical descriptions, illustrations, and the manipulation of angles and vector directions that are common elements in Statics and Dynamics problems. Interestingly, students in Statics class who possessed more experience working with ChatGPT, expressed a feeling of discontent with the generated solutions. Many students even faced significant difficulty identifying a simple problem that could be effectively addressed using ChatGPT alone. Another question raised to better understand students' evaluations on this topic was, "In your personal experience, how do you assess the dependability of answers generated by ChatGPT?". Due to the multitude of errors and calculation mistakes made by ChatGPT, students did not perceive it as the most dependable source for addressing engineering problems. This is depicted in Figure 2 and supported by following comments provided by students.

"I have rarely found ChatGPT to correctly solve problems in my engineering classes."

"If ChatGPT could accept pictures or diagrams, I think I would be more likely to start using it."

"Do not use it to solve math problems, only use it for simple questions at least until it gets upgraded and is then able to solve more complex problems."

The recognition of ChatGPT's limitations and the presence of inaccuracies and calculation mistakes contributed to students' reservations about relying on it as a trustworthy tool for solving fundamental engineering problems. Students who possessed greater familiarity with ChatGPT through prior engagement in projects and course assignments demonstrated a more cautious approach when using the tool. They articulated that while they employed ChatGPT for problem-solving, they considered factors beyond the final quantitative results. Instead, these students

emphasized a preference for leveraging the explanations provided and the underlying thought processes generated by ChatGPT, indicating a thoughtful utilization of the tool beyond sole reliance on outcomes.

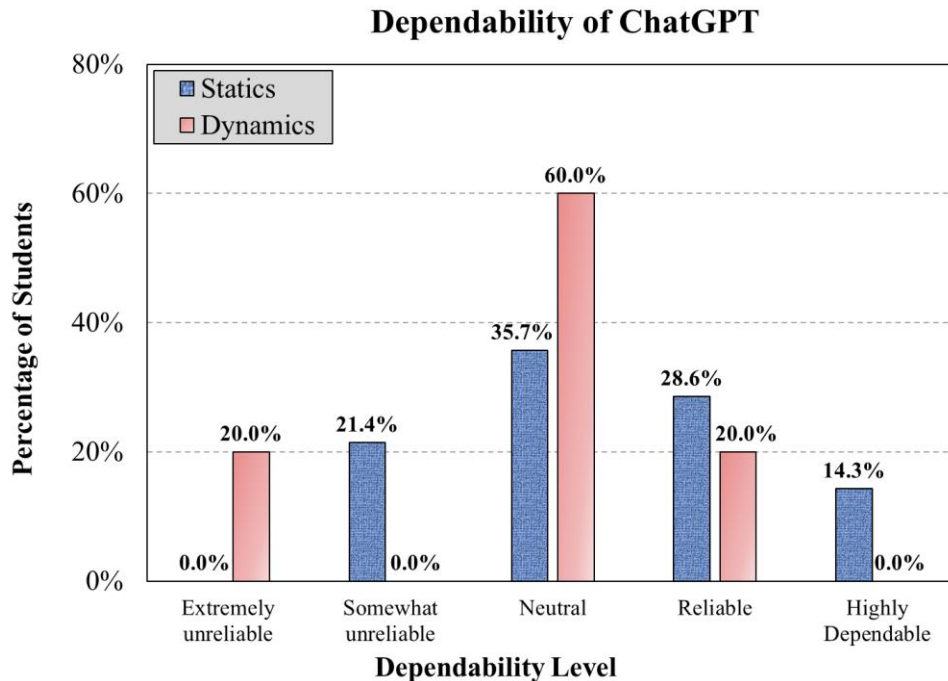


Figure 2: Assessment of ChatGPT result dependability through students' evaluations.

Despite limitations observed in the third iteration of the Generative Pre-trained Transformer from OpenAI (GPT-3.5), students exhibited a high level of optimism regarding the potential of AI-powered tools in the future, especially in the context of education as depicted in Figure 3. When asked “*How do you evaluate the future of AI-powered technology?*”, students acknowledged the noticeable advancements in this field in recent years and expressed optimism about its potential growth and improvement in the forthcoming years. Although students brought attention to the current limitations of ChatGPT in handling certain aspects through their survey responses, they also recognized the AI-powered technology's evolving nature, suggesting potential for future enhancements and refinements. Despite the survey's relatively small sample size (24 students), the percentage of students expressing belief in the overall effectiveness of AI technology in the future is promising.

Another intriguing insight gathered from the in-class surveys was that, despite the less-than-ideal outcomes students experienced with ChatGPT, there was a notable interest in leveraging ChatGPT post-graduation. When asked “*For what purposes do you typically employ ChatGPT most often?*”, students expressed a keen interest in using ChatGPT for concept development and writing tasks rather than complex calculations. This suggests a recognition of the tool's potential usefulness in areas beyond problem-solving, highlighting a future role for ChatGPT in supporting students in written aspects of their professional endeavors after completing their engineering studies as shown in Figure 4. Here are the specific remarks provided by students to bolster this concept:

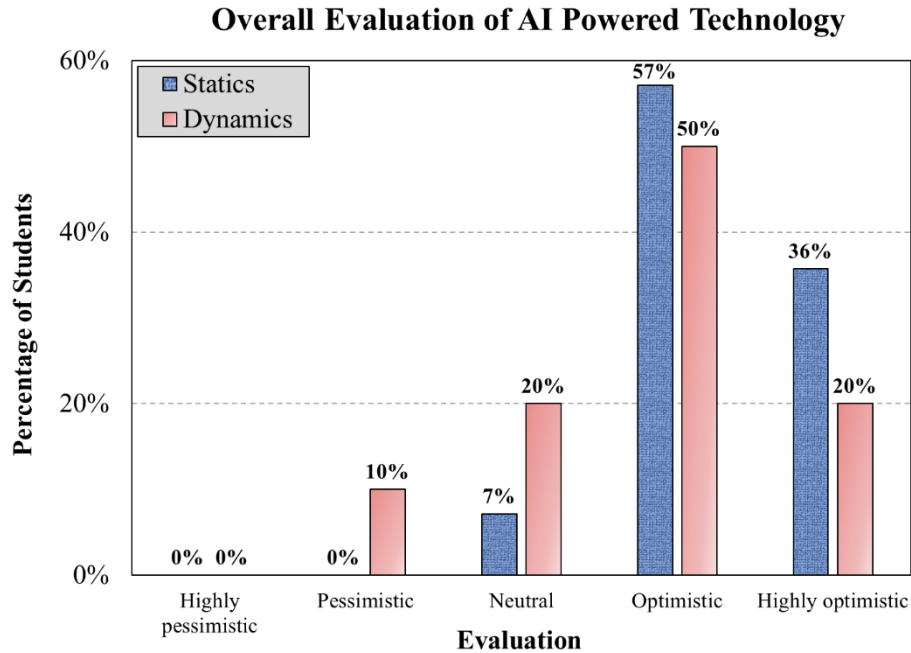


Figure 3: Assessment of students' perceptions toward AI-powered technology.

“It is not very good at solving most mathematical equations I have seen in my classes, but it is a lot better at coming up with ideas and writing essays.”

“It is very limited when it is asked to solve advanced math problems, like differential equations and linear algebra. However, it is very useful to solve coding errors.”

“Sometimes it gives the wrong answer and that causes confusion.”

“I usually use it proofread my papers and summarize articles.”

“Sometimes I use it to reword sentences or choose different vocabulary when I write a report.”

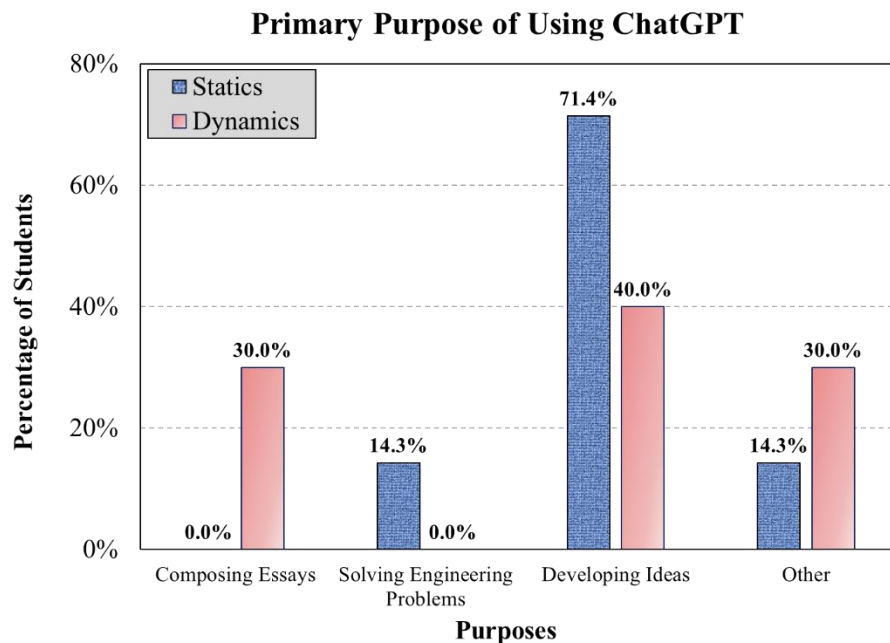


Figure 4: Students' Primary Use of ChatGPT Across Various Purposes.

It is important to highlight that this is an ongoing project, and the authors plan to carry out additional surveys in the future to gain further insight into students' preferences. Ultimately, to demonstrate ChatGPT's effectiveness in crafting well-written essays, it's worth noting that ChatGPT was employed for proofreading this manuscript [8].

Conclusions

The key takeaways derived from this study regarding the application of ChatGPT in fundamental mechanics courses can be summarized as follows:

- While the outcomes achieved through using ChatGPT in mechanics courses like Statics and Dynamics may not be flawless, students maintain an optimistic outlook. They express confidence in the ongoing progress and the potential future enhancements of AI-powered tools for their educational pursuits.
- Students with increased exposure to ChatGPT developed more pragmatic views regarding its use and offered verbal feedback and written comments that demonstrated a deeper understanding of the limitations of ChatGPT.
- According to the survey findings, ChatGPT is widely favored for ideation and concept development. It is less preferred, among students, when it comes to *solving* engineering problems.
- Caution is advised when employing ChatGPT for engineering problem-solving. Minor errors during the solution process may occur, potentially leading to misleading results. While students appreciate the explanations, they emphasize the need for caution regarding the computational outcomes.
- Students anticipate advancements in future generations and versions of the ChatGPT language model, envisioning capabilities where images can also be processed for vector operations and free-body-diagrams.

Appendix

A. Course Surveys Regarding ChatGPT usage.

- 1) Which engineering discipline are you studying?
 - a. Mechanical
 - b. Civil
 - c. Electrical
 - d. Manufacturing
 - e. General Engineering

- 2) What is your current academic classification?
 - a. Freshman
 - b. Sophomore
 - c. Junior
 - d. Senior

- 3) Have you ever used ChatGPT for educational purposes before?
 - a. Yes
 - b. No

- 4) How often do you use ChatGPT for learning and understanding engineering concepts?
 - a. Daily
 - b. Weekly
 - c. Monthly
 - d. Rarely
 - e. Never

- 5) For what purposes do you typically employ ChatGPT most often?
 - a. Composing essays
 - b. Solving engineering problems
 - c. Developing ideas
 - d. Other (please explain)

- 6) Do you find that ChatGPT helps you achieve a deeper understanding of the engineering topics you're studying?
 1. Strongly disagree
 2. Disagree
 3. Neutral
 4. Agree
 5. Strongly agree

- 7) In your personal experience, how do you assess the dependability of answers generated by ChatGPT?
 1. Extremely unreliable
 2. Somewhat unreliable

3. Neutral
4. Reliable
5. Highly Dependable

8) How has your overall learning experience in engineering improved since you started using ChatGPT?

1. Significantly worsened
2. Somewhat worsened
3. No change
4. Somewhat improved
5. Significantly improved

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

10) Do you typically use ChatGPT for quick clarifications, in-depth explanations, or other specific purposes? Please elaborate.

11) Do you have any suggestions or feedback on how ChatGPT could better support engineering students in their learning journeys?

12) Do you plan to continue using ChatGPT as a learning tool for engineering topics in the future?

- a. Yes
- b. No

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

1. Highly pessimistic
2. Pessimistic
3. Neutral
4. Optimistic
5. Highly optimistic

B. Full Responses Generated by ChatGPT

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

Question: The bending moment on a beam is given by $M = -4x^3 + 3x^2 - 23x + 5$ N.m, calculate the shear force at $x = 3$ m.

ChatGPT Answer:



You

The bending moment on a beam is given by $M = -4x^3 + 3x^2 - 23x + 5$ N.m, calculate the shear force at $x = 3$ m.



ChatGPT

To find the shear force at $x = 3$ m, we need to differentiate the bending moment equation with respect to x to get the equation for shear force. The equation for shear force (V) is the negative derivative of the bending moment equation (M) with respect to x .

Given $M = -4x^3 + 3x^2 - 23x + 5$ N.m,

$$V = -\frac{dM}{dx}$$

First, let's find the derivative of M with respect to x :

$$\frac{dM}{dx} = \frac{d}{dx}(-4x^3 + 3x^2 - 23x + 5)$$

$$\frac{dM}{dx} = -12x^2 + 6x - 23$$

Now, let's evaluate this derivative at $x = 3$ m:

$$V = -(-12(3)^2 + 6(3) - 23)$$

$$V = -(-108 + 18 - 23)$$

$$V = -(-113)$$

$$V = 113 \text{ N}$$

So, the shear force at $x = 3$ m is 113 N.

Figure B.1: Successful ChatGPT solution to Statics question

Question: The position of a particle is given by $s = t^3 - 12t^2 + 44t + 11$ m, calculate the acceleration value at $t = 5$ s.

ChatGPT Answer:



You

The position of a particle is given by $s = t^3 - 12t^2 + 44t + 11$ m, calculate the acceleration at $t = 5$ sec.



ChatGPT

To find the acceleration of the particle at $t = 5$ seconds, we need to find the second derivative of the position function $s(t) = t^3 - 12t^2 + 44t + 11$ with respect to time t .

Given $s(t) = t^3 - 12t^2 + 44t + 11$ meters,

First, let's find the first derivative of $s(t)$ with respect to t , which gives us velocity $v(t)$:

$$v(t) = \frac{ds}{dt} = \frac{d}{dt}(t^3 - 12t^2 + 44t + 11)$$

$$v(t) = 3t^2 - 24t + 44$$

Now, let's find the second derivative of $s(t)$ with respect to t , which gives us acceleration $a(t)$:

$$a(t) = \frac{dv}{dt} = \frac{d}{dt}(3t^2 - 24t + 44)$$

$$a(t) = 6t - 24$$

Now, we can calculate the acceleration at $t = 5$ seconds:

$$a(5) = 6(5) - 24$$

$$a(5) = 30 - 24$$

$$a(5) = 6 \text{ m/s}^2$$

So, the acceleration of the particle at $t = 5$ seconds is 6 m/s^2 .

Figure B.2: Successful ChatGPT solution to a Dynamics question

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

Question: Four concentric forces are exerted on a post. F_1 has a magnitude of 300 N and is positioned at a 30-degree counterclockwise angle from the positive x -axis. F_2 , with a magnitude of 600 N, is aligned along the positive y -axis. F_3 , measuring 450 N, is situated at a 22.62-degree counterclockwise angle from y the negative y -axis. Finally, F_4 , with a magnitude of 250 N, is located at a 60-degree clockwise angle from the negative y -axis. Determine the resultant force vector.

ChatGPT Answer:



You

Solve this problem "Four concentric forces are exerted on a post. F_1 has a magnitude of 300 N and is positioned at a 30-degree counterclockwise angle from the positive x -axis. F_2 , with a magnitude of 600 N, is aligned along the positive y -axis. F_3 , measuring 450 N, is situated at a 22.62-degree counterclockwise angle from y the negative y -axis. Finally, F_4 , with a magnitude of 250 N, is located at a 60-degree clockwise angle from the negative y -axis. Determine the resultant force vector."



ChatGPT

To solve this problem, we'll first break down each force vector into its x and y components using trigonometry, and then we'll sum up all the x components and y components separately to find the resultant force vector.

Let's denote:

- $F_1 = 300$ N
- $F_2 = 600$ N
- $F_3 = 450$ N
- $F_4 = 250$ N

Now, let's calculate the x and y components of each force:

1. F_1 :

- Magnitude: 300 N
- Angle: 30 degrees counterclockwise from the positive x -axis

The x -component of $F_1 = F_1 \cdot \cos(30^\circ)$

The y -component of $F_1 = F_1 \cdot \sin(30^\circ)$

Substituting the values:

- x -component of $F_1 = 300 \cdot \cos(30^\circ) = 300 \cdot \frac{\sqrt{3}}{2} \approx 259.81$ N
- y -component of $F_1 = 300 \cdot \sin(30^\circ) = 300 \cdot 0.5 = 150$ N

2. F_2 :

- Magnitude: 600 N
- Aligned along the positive y -axis

The x -component of $F_2 = 0$ (as it's along the y -axis)

The y -component of $F_2 = F_2$

Substituting the values:

- x -component of $F_2 = 0$
- y -component of $F_2 = 600$ N

3. F_3 :

- Magnitude: 450 N
- Angle: 22.62 degrees counterclockwise from the negative y -axis

The x -component of $F_3 = 0$ (as it's along the negative y -axis)

The y -component of $F_3 = F_3 \cdot \cos(22.62^\circ)$

Substituting the values:

- x -component of $F_3 = 0$
- y -component of $F_3 = 450 \cdot \cos(22.62^\circ) \approx 422.32$ N

4. F_4 :

- Magnitude: 250 N
- Angle: 60 degrees clockwise from the negative y -axis

The x -component of $F_4 = 0$ (as it's along the negative y -axis)

The y -component of $F_4 = -F_4 \cdot \sin(60^\circ)$

Substituting the values:

- x -component of $F_4 = 0$
- y -component of $F_4 = -250 \cdot \sin(60^\circ) \approx -216.51$ N

Now, we'll sum up all the x -components and y -components:

- Sum of x -components = 259.81 N + 0 + 0 + 0 = 259.81 N
- Sum of y -components = 150 N + 600 N + 422.32 N - 216.51 N = 955.81 N

Finally, we'll find the magnitude and direction of the resultant force vector:

- Magnitude of the resultant force = $\sqrt{(\text{Sum of } x\text{-components})^2 + (\text{Sum of } y\text{-components})^2}$
 $= \sqrt{(259.81 \text{ N})^2 + (955.81 \text{ N})^2}$
 $\approx \sqrt{(67261.3761 \text{ N}^2) + (913655.1361 \text{ N}^2)}$
 $\approx \sqrt{980916.5122 \text{ N}^2}$
 ≈ 990.4 N (approximately)

To find the direction:

- Direction (θ) = $\tan^{-1}(\text{Sum of } y\text{-components} / \text{Sum of } x\text{-components})$
 $= \tan^{-1}(955.81 \text{ N} / 259.81 \text{ N})$
 $\approx \tan^{-1}(3.6784)$
 $\approx 75.2^\circ$ (approximately)

Therefore, the resultant force vector has a magnitude of approximately 990.4 N and is angled approximately 75.2 degrees counterclockwise from the positive x -axis.

Figure B.3: Misleading ChatGPT solution to a Statics question

Question: A balloon has a total mass of 400 kg including the passengers and ballast. The balloon is rising at a constant velocity of 18 km/h when $h = 10$ m. If the man drops the 40-kg sandbag, determine the velocity of the balloon when the bag strikes the ground. Neglect air resistance.

ChatGPT Answer:



You

Solve this "

A balloon has a total mass of 400 kg including the passengers and ballast. The balloon is rising at a constant velocity of 18 km/h when $h = 10$ m. If the man drops the 40-kg sand bag, determine the velocity of the balloon when the bag strikes the ground. Neglect air resistance. "



ChatGPT

To solve this problem, we can apply the principle of conservation of momentum. Initially, the total momentum of the system (balloon + sandbag) is equal to the momentum after the sandbag is dropped.

Let's denote:

- m_b = mass of the balloon (including passengers and ballast) = 400 kg
- v_i = initial velocity of the balloon = 18 km/h
- m_s = mass of the sandbag = 40 kg
- v_f = final velocity of the balloon after the sandbag is dropped
- h = height at which the sandbag is dropped = 10 m

First, let's convert the initial velocity of the balloon from km/h to m/s:

$$v_i = 18 \text{ km/h} \times \left(\frac{1000 \text{ m}}{1 \text{ km}}\right) \times \left(\frac{1 \text{ h}}{3600 \text{ s}}\right) = 5 \text{ m/s}$$

Now, we can use the principle of conservation of momentum:

Initial momentum = Final momentum

$$(m_b + m_s) \times v_i = m_b \times v_f$$

$$(400 \text{ kg} + 40 \text{ kg}) \times 5 \text{ m/s} = 400 \text{ kg} \times v_f$$

$$440 \text{ kg} \times 5 \text{ m/s} = 400 \text{ kg} \times v_f$$

$$2200 \text{ kg m/s} = 400 \text{ kg} \times v_f$$

$$v_f = \frac{2200 \text{ kg m/s}}{400 \text{ kg}} = 5.5 \text{ m/s}$$

So, the velocity of the balloon when the sandbag strikes the ground is 5.5 m/s.

Figure B.4: Misleading ChatGPT solution to a Dynamics question

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] OpenAI. (2022). ChatGPT (Version 3.5). OpenAI. <https://openai.com/>