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THE IMPACT OF ARTIFICIAL INTELLIGENCE IN THE TEACHING OF MECHANICS

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Abstract: *The emergence of the idea of using artificial intelligence in everyday life has led to the development of AI assistants in various fields of activity. Thus, in November 2022, ChatGPT was launched, and the following years brought attention to other assistants as well. Some assistants have already reached the 5th version.*

The paper aims to analyze how AI can be used in teaching the subject of Mechanics at the university level. The paper presents the results obtained with three AI assistants. The example was made for calculating the centers of gravity in the case of homogeneous flat plates.

Keywords: Mechanics, artificial intelligence, higher education

1. Introduction

The development of artificial intelligence systems has allowed their integration into higher education. Although there is a tendency to claim that AI takes over human work, recent developments have shown that it can be a valuable partner in daily activities (1).

The combination of education and AI promises the personalization of the learning process, administrative optimization, and expanded access to various resources. At the same time, responsible management of potential risks is necessary. Therefore, human supervision is required to guarantee fairness and the quality of the educational process. Among the benefits that AI offers in education are:

- **Personalization:** Each student receives support adapted to their own pace and learning style. Adaptive platforms analyze students' responses and adjust content in real time. Intelligent tutors provide personalized explanations, identify misunderstood concepts, and propose additional exercises.
- **Automation:** Reduces the time spent on grading and course planning. Tools such as Gradescope automatically scan and evaluate tests, generating individualized feedback. Scheduling applications optimize timetables and manage resources (rooms, teachers) to avoid conflicts.
- **Accessibility:** Provides learning opportunities for people with disabilities and those from remote areas. Assistive technologies (e.g. Notta) transcribe speech into text, helping people with hearing impairments. Analytical platforms (Knewton Alta) collect data about students' progress, highlight learning gaps, and enable early interventions.
- **Innovation:** Integrates virtual and augmented reality into experiments and simulations. Generative tools (Magic School AI, Eduaide.ai) create lesson plans, exercises, and tests. Virtual laboratories (Labster) simulate physical, chemical, or medical experiments, while virtual and augmented reality (VR/AR) place students in practical scenarios

2. Practical applications

At the global level, there are various AI assistants that can be used in the educational process (ChatGPT, Google Gemini, NotebookLM, Microsoft Copilot, Claude by Anthropic, Meta AI, and Grok by xAI). In the present study, we conducted a comparison of how these AI assistants respond to students' requests. Thus, for the study of the **centers of gravity of plane plates**, we asked three AI assistants ChatGPT (2), Google Gemini (3), and Claude(4) to generate a problem based on the same prompt. There are different ways of writing prompts (5), each leading to results that closely resemble the real method of solving problems.

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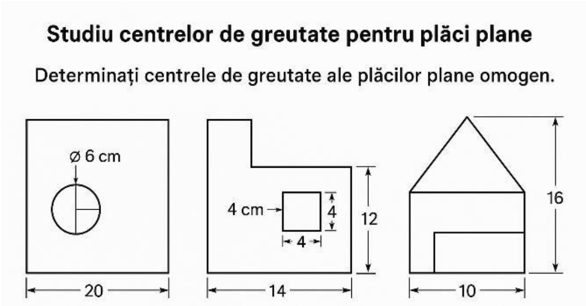
Example 1.
I am a Mechanics professor. Generate a problem concerning the study of centers of gravity for plane plates. Also generate the associated image. The plates should include different cut-out geometric shapes, and each element should be dimensioned. The problem is intended for students aged 18–20.
ChatGPT



Gemini
Problem Statement: Determination of the Center of Gravity of a Composite Plane Plate
Determine the coordinates of the center of gravity (x_G, y_G) for a homogeneous plane plate of constant thickness, as represented in the figure below. The plate consists of a main rectangular section from which a circular and a triangular area have been cut out (removed). The coordinate system xOy is considered with its origin at the bottom-left corner of the plate, as indicated in the figure. All dimensions are expressed in centimeters (cm).
No image was generated

Claude.ai
I have created a complete mechanics problem on determining the center of gravity for a plane plate with multiple cutouts. The problem includes:

1. **A clear and structured statement** – a rectangular steel plate with three cutouts (a triangle, a circle, and a rectangle).
2. **A dimensioned technical drawing** – all measurements are indicated:
    - Base plate: 500 × 400 mm
    - Triangular cutout: base 150 mm, height 150 mm
    - Circular cutout: diameter Ø140 mm
    - Rectangular cutout: 120 × 120 mm
3. **Specific requirements:**
    - Determination of the coordinates of the center of gravity (x_G, y_G)
    - Calculation of the total mass
    - Graphical representation of the center's position
4. **Methodological guidelines for solving**

The problem is suitable for students aged 18–20, requiring the application of the method of decomposition into simple geometric figures and the consideration of cutouts as negative areas. The difficulty level is medium to high, demanding careful calculation of the coordinates for each geometric element. *Answer*:

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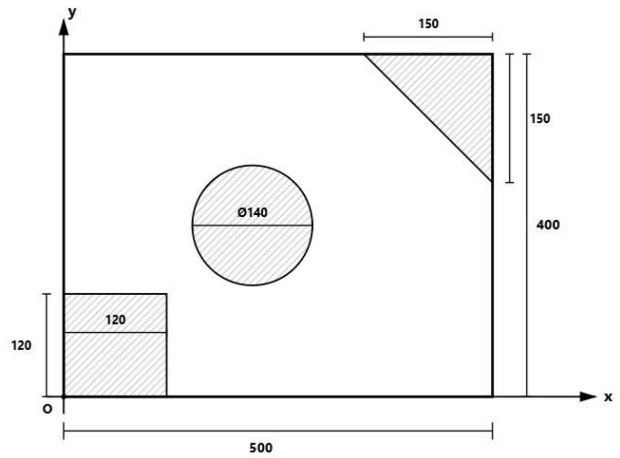

Guidelines
Use the method of decomposition into simple geometric figures.
Consider the cutouts as figures with negative area. Formulas
for the center of gravity:

$$x_G = \frac{\sum A_i x_i}{\sum A_i}, \; y_G = \frac{\sum A_i y_i}{\sum A_i}$$

For a right triangle, the centroid is located at one-third of the distance from the hypotenuse.
Mass formula:

$$m = \rho \times V = \rho \times A \times h$$

Note: All dimensions are given in millimeters. The plate has a constant thickness of h = 10 mm.

Example 2
The same problem and the same AI assistants were used, but the prompt was modified to also include the coordinates of the cutout elements.
Problem statement:
I am a Mechanics professor. We are Co-workers. Generate a problem concerning the study of centers of gravity for plane plates. Also generate the associated image. The plates should include different cut-out geometric shapes, and each element should be dimensioned. The positions of the elements relative to the origin should also be indicated. The problem is intended for students aged 18–20.

Chat GPT
Problem: Study of the Centers of Gravity for Homogeneous Plane Plates
Three homogeneous plane plates made of the same material are given, each containing different geometric cutouts.
Determine the coordinates of the center of gravity (G) of each plate with respect to the origin O(x_0, y_0) indicated in the diagram.

Plate 1 – Rectangle with a Circular Cutout

- Total dimensions: 20 × 12 cm
- Cutout: Circle of diameter Ø6 cm, with its center located at coordinates (x = 10 cm, y = 8 cm) relative to the bottom-left corner, considered the origin.
- Origin: Bottom-left corner of the rectangle.

Task: Determine the coordinates of the center of gravity, taking into account the negative mass of the cutout.

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Plate 2 – L-Shaped Plate with a Square Cutout

- Outer dimensions: 14 × 12 cm
- Cutout: Square of 4 × 4 cm located with its bottom-left corner at (x = 6 cm, y = 4 cm).
- Origin: Bottom-left corner of the plate.

Task: Determine the coordinates of the center of gravity, considering the negative mass of the cutout and using decomposition into rectangles.

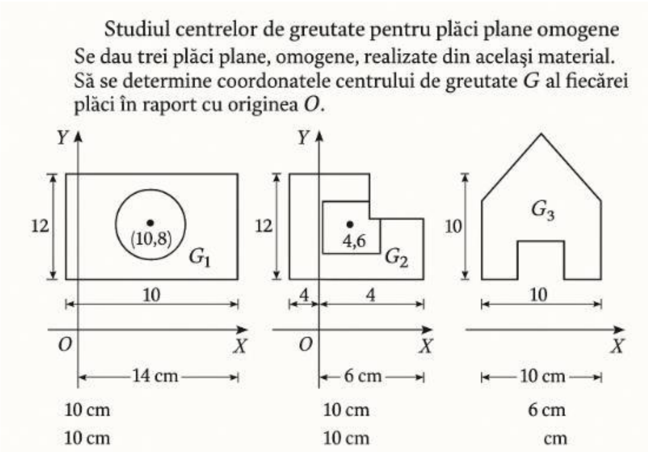
Plate 3 – House-Shaped Plate (Rectangle + Isosceles Triangle)

- Rectangle base: 10 × 10 cm
- Upper triangle: Height 6 cm, sharing the same base as the rectangle.
- Lower cutout: Rectangular hole of 6 × 4 cm, located centrally.
- Origin: Bottom-left corner of the base.

Task: Determine the overall center of gravity using the formula:

$$x_G = \frac{\sum A_i x_i}{\sum A_i}, \quad y_G = \frac{\sum A_i y_i}{\sum A_i}$$

where negative areas correspond to cutouts.



Claude

Proposition

A flat, homogeneous plate with a constant thickness h = 10 mm is made from a steel sheet (density ρ = 7850 kg/m³) with total dimensions 500 mm × 400 mm. From the original rectangular plate, the following geometric shapes have been cut out:

- **Rectangle A**: dimensions 150 mm × 100 mm, positioned with its lower-left corner at coordinates (80, 80) mm relative to the origin
- **Circle B:** diameter D = 100 mm (radius R = 50 mm), with its center positioned at coordinates (350, 280) mm relative to the origin
- **Right triangle C:** legs of 80 mm (horizontal) and 120 mm (vertical), with the right-angle vertex positioned at coordinates (280, 80) mm relative to the origin

Requirements

- Determine the coordinates $(\bar{x}_0, \bar{y}_0)$ of the centroid of the initial complete plate.
- Calculate the area and centroid coordinates for each cut-out element (A, B, C).
- Using the negative area method, determine the coordinates $(\bar{x}_x, \bar{y}_x)$ of the centroid of the final plate after the cut-outs.
- Compute the displacement distance d between the initial and final centroid positions.

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- Determine the mass of the final plate and its position relative to the origin for stable equilibrium.

Data and Conventions

- Coordinate system: origin O(0,0) at the bottom-left corner of the original plate
- OX axis: horizontal, oriented to the right
- OY axis: vertical, oriented upward
- The material is homogeneous (constant density throughout the plate) • All linear dimensions are expressed in millimeters [mm] • Centroid formulas:
    - Rectangle: (L/2, l/2)
    - Circle: (center) ○ Right triangle: (a/3, b/3)

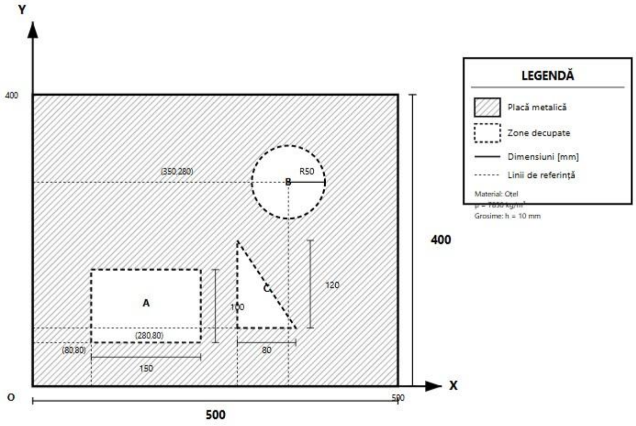

Figura 1: Placă metalică cu elemente decupate - vedere din plan

3. Conclusions

The paper analyzes how AI can be used in university education by both professors and students.

Thus, in addition to planning courses and materials, AI can also generate problems that will be used for consolidating and deepening knowledge. While professors can use AI to create teaching materials, exercises, and tests, students can use AI to search for explanations and to generate problems for the purpose of better understanding and reinforcing concepts.

By using AI as a co-worker, new opportunities arise for the development of all participants (students and professors). New student-centered materials can be developed, tailored to their individual needs.

Regardless of who uses AI assistants (professor or student), it is essential to manage risks responsibly and maintain human oversight to ensure fairness and the quality of the educational process. All the examples presented are AI-generated results, without any corrections or interventions from the user.

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