National University of Computer and Emerging Sciences

Lahore Campus

Basic Mechanical Engineering (ME2001)

Date: May 31, 2025

Course Instructor(s)

Mohsin Yousuf

Final Exam

Total Time (Hrs): 3

Total Marks: 50

Total Questions: 5

Marks Distribution:

Q1	Q2	Q3	Q4	Q5
10	10	05	10	15

Roll No _____ Section _____ Student Signature _____

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1. **Attempt all the questions, programmable calculators not allowed.**
2. **Show all the steps with the help of diagrams and answers with proper units.**
3. **In questions, hints are mentioned in *italic*.**

CLO # 01: Calculate the moment of a force/couple.

Q1: The sum of the moments about point A due to the forces and couples acting on the bent bar as shown in Fig. 1 is zero. Answer the following: **[10 marks]**

a) **Determine** the magnitude of the couple C using both scalar and vector formulation. **[6]**

b) **Determine** the sum of the components about point B due to the forces and couples acting on the bar. Use the value of C as determined in part (a). **[4]**

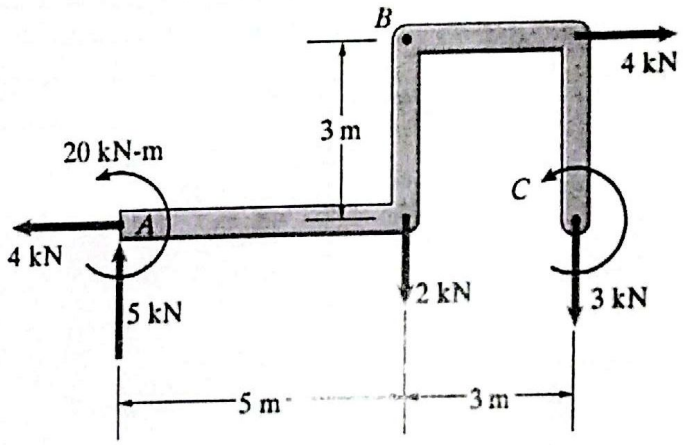

Figure 1. A Bent Bar

CLO # 02: Analyze static equilibrium analysis of a rigid body by applying Newton Laws of Motion and concept of dry friction.

Q2: The car shown in the Figure 1 below is of 1600 kg. The car has all-wheel drive and is just beginning to negotiate the 16° ramp. **Figure out** the minimum coefficient of static friction μ_s. Assume that slipping occurs at A and B simultaneously. **[10 marks]**

Remember to draw its FBD first.

The equations of friction would be using the same coefficient of static friction μ_s.

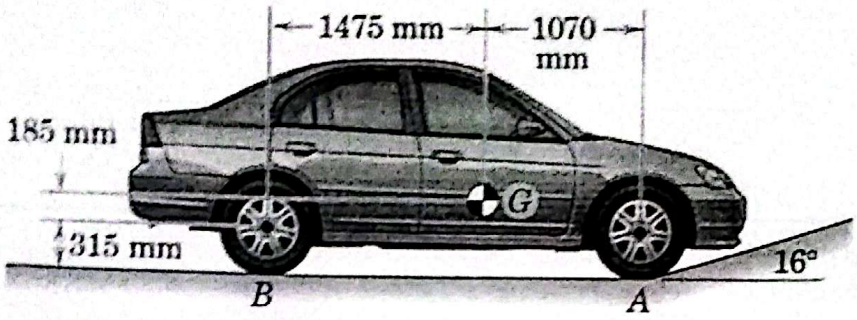

Figure 2. A Car about to drive the ramp at 16° at point A.

CLO # 03: Analyze absolute motion of rigid bodies in general plane motion.

Q3: The bar moves to the left with a constant velocity of v_A at end A as shown in the Fig. 3. **Figure out** the angular velocity ω of the bar as a function of its position x. **[05 marks]**

Hint:
$$\omega = -\left(\frac{r}{x\sqrt{x^2 - r^2}}\right) v_A$$

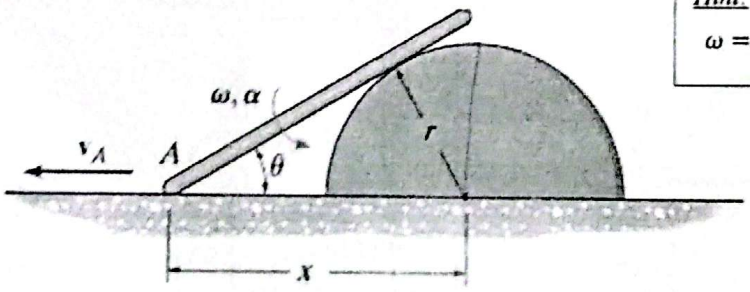

Figure 3. A Slender Bar moving to the left

CLO # 04: Analyze relative motion of rigid bodies in rotation and/or translation.

Q4: Crank CB oscillates about C through a limited arc, causing crank OA to oscillate about O as shown in Fig. 4. When the linkage passes the position shown with CB horizontal and OA vertical, the angular velocity of CB is $2\ rad/s$ counterclockwise. For this instant, **figure out** the angular velocities and angular acceleration of links AB and OA for this position. Solve by using vector algebra. **[10 marks]**

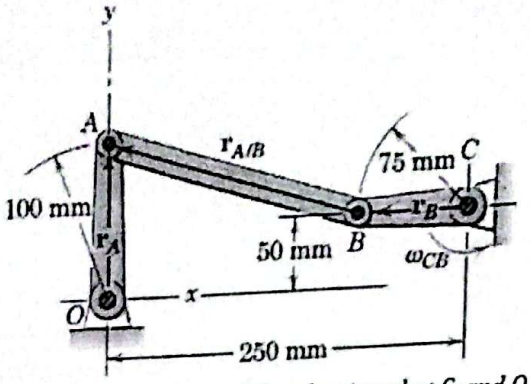

Figure 4. Ripple effect of Cranks pinned at C and O.

CLO # 05: Evaluate the internal forces in the members of a loaded truss and assess safety of the structure.

Q5: The truss supports a 100 kN load at J as shown in the Fig. 5 below. The horizontal members are each 1 m in length. **[15 marks]**

a) **Identify** any zero-force member first by mentioning the rule.
b) Use the method of joints to **evaluate** the axial forces in the members BC, CF, and FG.
c) **Verify** them using method of sections.

There is pin at A and roller support at E.

All members have a circular cross-section having radius of 0.018 m. The ultimate tensile/compressive stress of the material used is 295 MPa.

Comment on the safety of the member **i)** BC and **ii)** the overall structure.

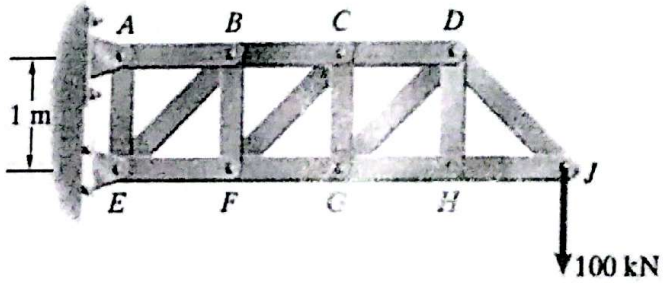

Figure 5. A Plane Truss