B.Sc.Engg. (ME)/1st Sem. 13 April 2026 (Group-B, Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination
Course No: ME 4103
Course Title: Statics

Winter Semester : A.Y. 2024-2025
Time : 2 Hour
Full Marks : 120

Answer all questions. Each question carries equal marks. The symbols have their usual meanings. Draw the free-body diagram if required. The right column also indicates the course objective (CO) and Program outcome (PO), and WK, WP, and EA addressed by each question

Q-01(a). Determine the force in members **HI, FI,** and **EF** of the truss, and state if the members are in tension or compression.

15 (CO3) (PO2) WK2

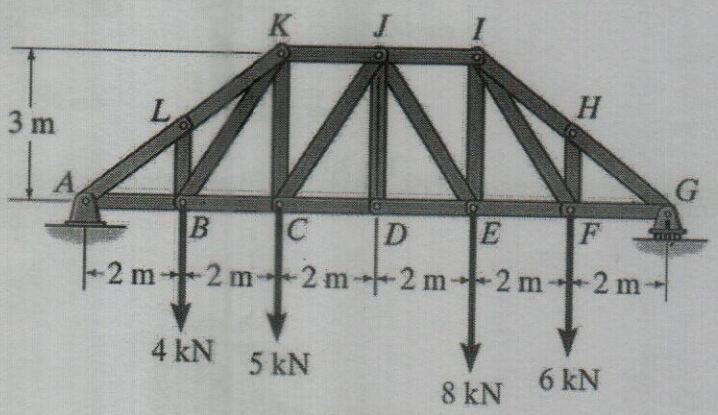


Fig. 1(a)

Q-01(b). Determine the force in each member of the truss and state if the members are in tension or compression. Set $\mathbf{P_1 = 6\ kN}$ and $\mathbf{P_2 = 9\ kN}$.

15 (CO3) (PO2) WK2

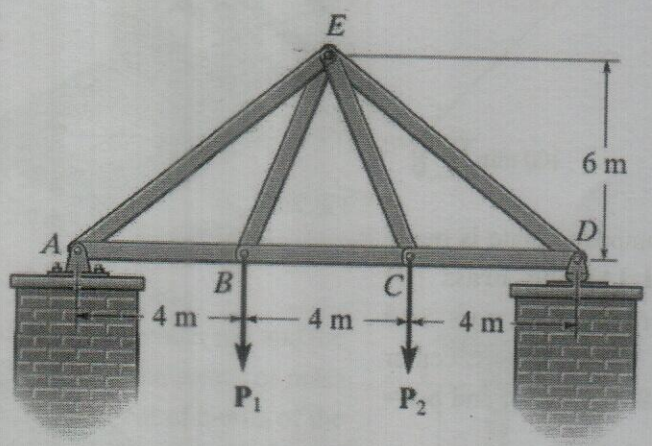


Fig. 1(b)

Q-02(a). Blocks **A** and **B** weigh **50 lb** and **30 lb**, respectively. Using the coefficients of static friction indicated, determine the greatest weight of block **D** without causing motion.

15 (CO3) (PO2) WK2

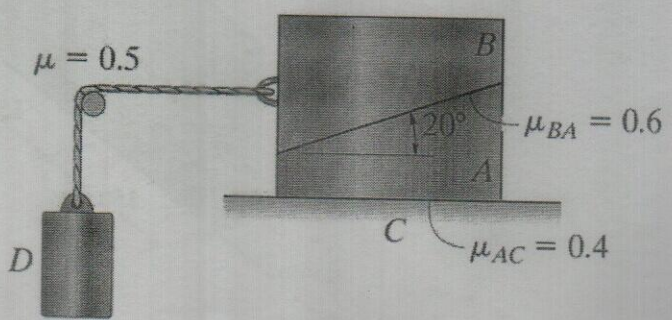


Fig. 2(a)

Q-02(b). Beam **AB** has a negligible mass and thickness and supports the **200 kg** uniform block. It is pinned at **A** and rests on the top of a post, having a mass of **20 kg** and negligible thickness. Determine the two coefficients of static friction at **B** and at **C** so that when the magnitude of the applied force is increased to **P = 300 N**, the post slips at both B and C simultaneously.

15 (CO3) (PO2) WK2

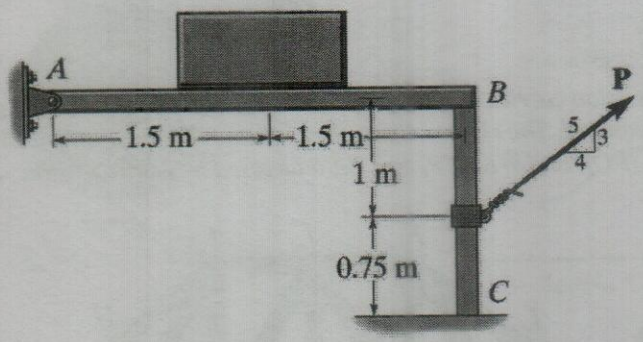


Fig. 2(b)

Q-03(a). Determine the location $(\bar{x}, \bar{y}, \bar{z})$ of the centroid of the homogeneous rod.

15 (CO4) (PO2) WK2

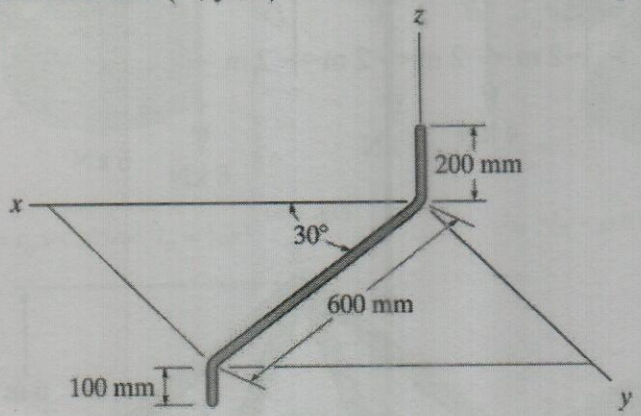


Fig. 3(a)

Q-03(b). The composite plate is made from both **steel (A)** and **brass (B)** segments. Determine the mass and location $(\bar{x}, \bar{y}, \bar{z})$ of its mass center **G**. Take $\rho_{st} = 7.85\ Mg/m^3$ of and $\rho_{br} = 8.74\ Mg/m^3$.

15 (CO4) (PO2) WK2

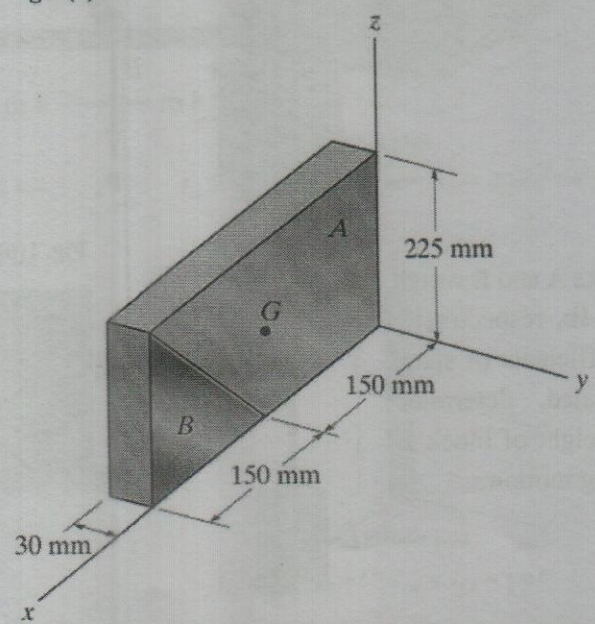


Fig. 3(b)

Q-04(a). Determine the mass moment of inertia of the overhung crank about the x and x' axis. The material is steel having a density of $\rho = 7.85\ Mg/m^3$. 10 (CO4) (PO2) WK2

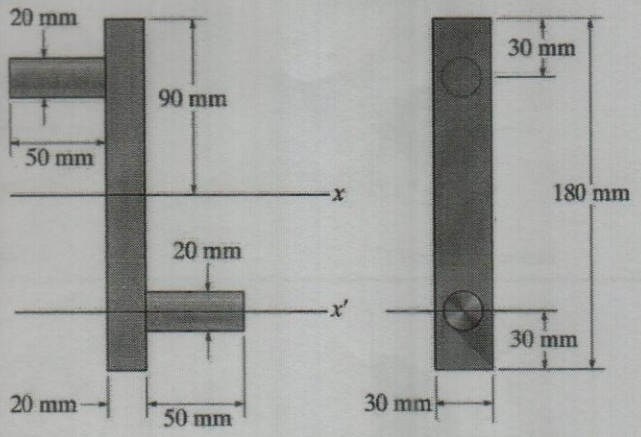


Fig. 4(a)

Q-04(b). The thin plate has a mass per unit area of **10 kg/m²**. Determine its mass moment of inertia about the **y** and **z** axis. 10 (CO4) (PO2) WK2

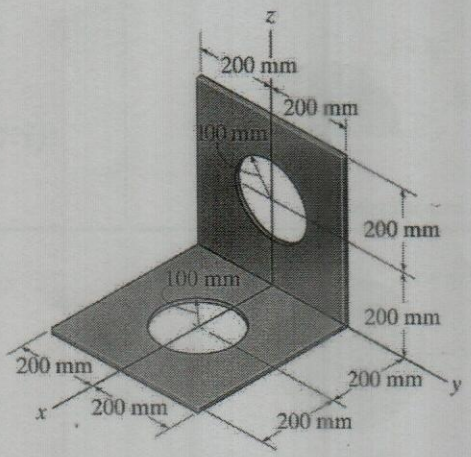


Fig. 4(b)

Q-04(c). The pendulum consists of the **3 kg** slender rod and the **5 kg** thin plate. Determine the location $\bar{y}$ of the center of mass **G** of the pendulum; then find the mass moment of inertia of the pendulum about an axis perpendicular to the page and passing through **G**. 10 (CO4) (PO2) WK2

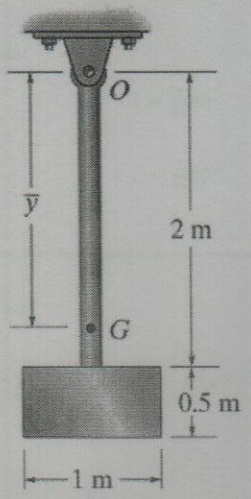
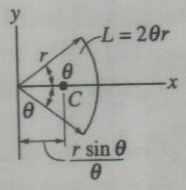
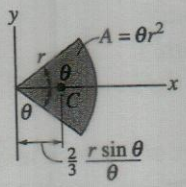
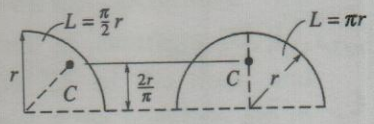
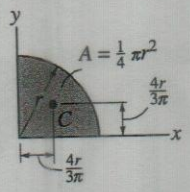
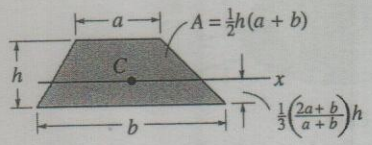
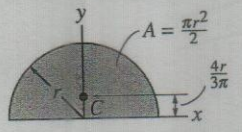
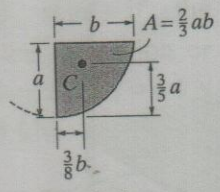
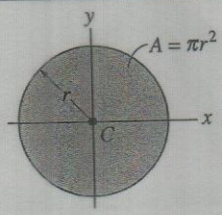
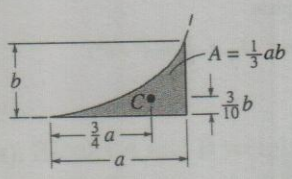
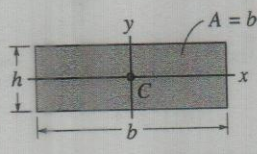
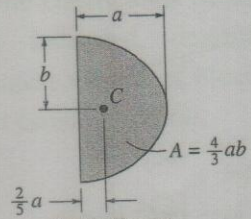
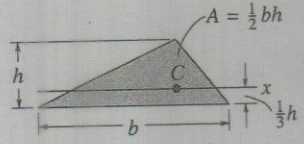
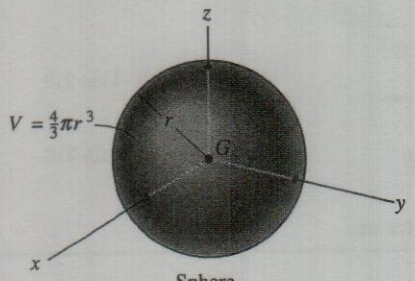


Fig. 4(c)

Geometric Properties of Line and Area Elements

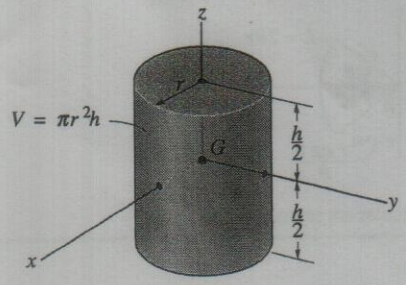
Centroid Location	Centroid Location	Area Moment of Inertia
 Circular arc segment	 Circular sector area	$I_x = \frac{1}{4}r^4(\theta - \frac{1}{2}\sin 2)\theta$ $I_y = \frac{1}{4}r^4(\theta + \frac{1}{2}\sin 2)\theta$
 Quarter and semicircle arcs	 Quarter circle area	$I_x = \frac{1}{16}\pi r^4$ $I_y = \frac{1}{16}\pi r^4$
 Trapezoidal area	 Semicircular area	$I_x = \frac{1}{8}\pi r^4$ $I_y = \frac{1}{8}\pi r^4$
 Semiparabolic area	 Circular area	$I_x = \frac{1}{4}\pi r^4$ $I_y = \frac{1}{4}\pi r^4$
 Exparabolic area	 Rectangular area	$I_x = \frac{1}{12}bh^3$ $I_y = \frac{1}{12}hb^3$
 Parabolic area	 Triangular area	$I_x = \frac{1}{36}bh^3$

Center of Gravity and Mass Moment of Inertia of Homogeneous Solids



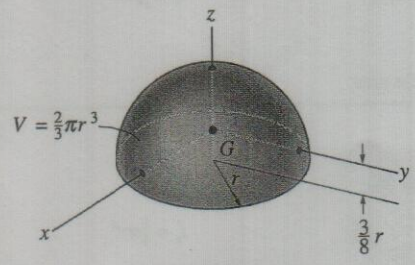
Sphere

$I_{xx} = I_{yy} = I_{zz} = \frac{2}{5} mr^2$



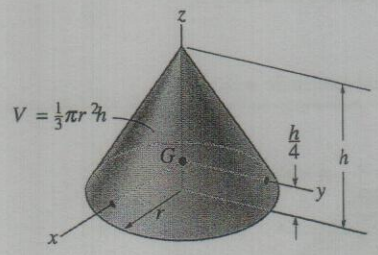
Cylinder

$I_{xx} = I_{yy} = \frac{1}{12} m(3r^2 + h^2)$ $I_{zz} = \frac{1}{2} mr^2$



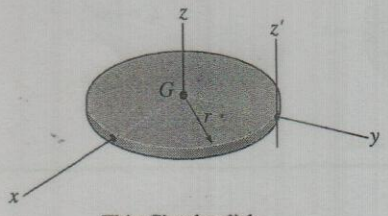
Hemisphere

$I_{xx} = I_{yy} = 0.259mr^2$ $I_{zz} = \frac{2}{5} mr^2$



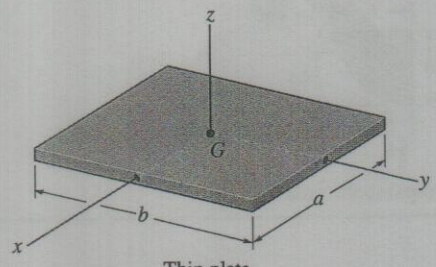
Cone

$I_{xx} = I_{yy} = \frac{3}{80} m(4r^2 + h^2)$ $I_{zz} = \frac{3}{10} mr^2$



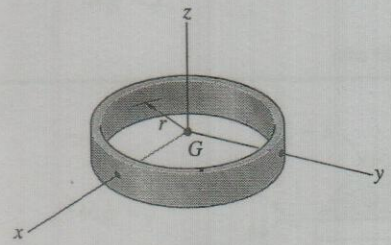
Thin Circular disk

$I_{xx} = I_{yy} = \frac{1}{4} mr^2$ $I_{zz} = \frac{1}{2} mr^2$ $I_{z'z'} = \frac{3}{2} mr^2$



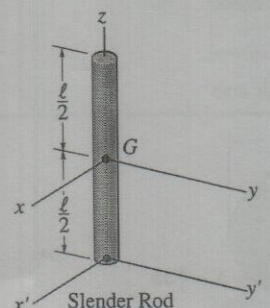
Thin plate

$I_{xx} = \frac{1}{12} mb^2$ $I_{yy} = \frac{1}{12} ma^2$ $I_{zz} = \frac{1}{12} m(a^2 + b^2)$



Thin ring

$I_{xx} = I_{yy} = \frac{1}{2} mr^2$ $I_{zz} = mr^2$



Slender Rod

$I_{xx} = I_{yy} = \frac{1}{12} m\ell^2$ $I_{x'x'} = I_{y'y'} = \frac{1}{3} m\ell^2$ $I_{z'z'} = 0$