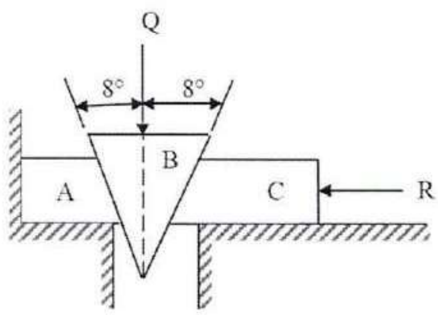
KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B.Sc. Engineering 1st year 2nd Term Special Examination (COVID-19), 2020
ME 1209
(Engineering Mechanics I)

Time: 3 Hours | Total Marks: 210

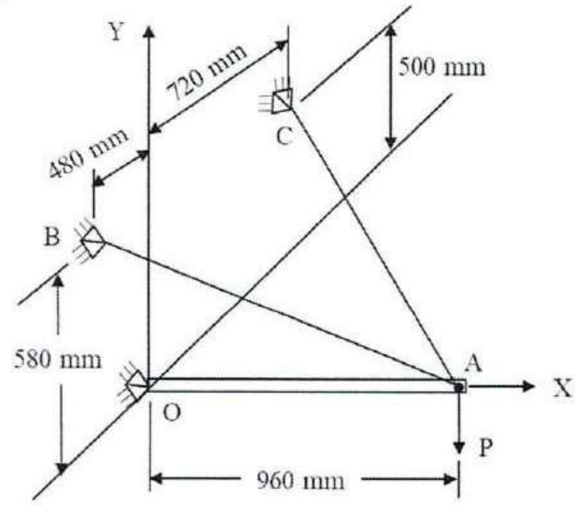
N.B.: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION – A

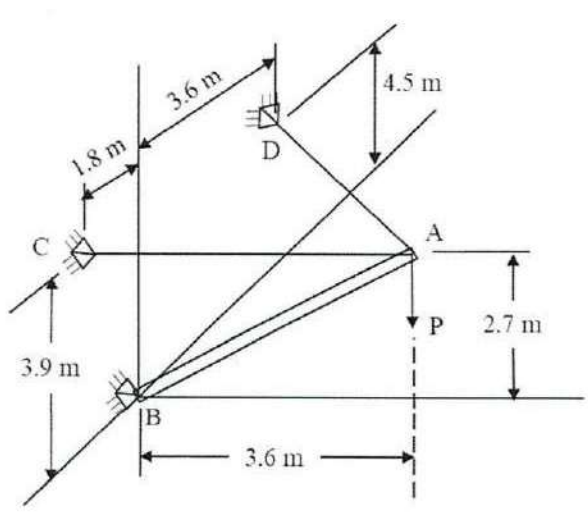
1(a) In Fig., let $m_A = 1000$ kg, $m_B = 250$ kg, $m_C = 2500$ kg and force $R = 36$ kN. Neglecting friction at all surfaces, find the force Q on the top of the wedge, the reactions at the supports. Assume reaction at A has two components. 17



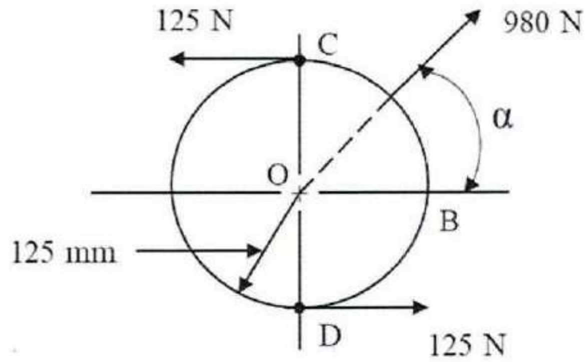
1(b) The boom OA carries a load P and is supported by two cables as shown. Knowing that the tension in cable AB is 732 N and that the resultant of the load P and of the forces exerted at A by the two cables must be directed along OA, determine the tension in cable AC. 18



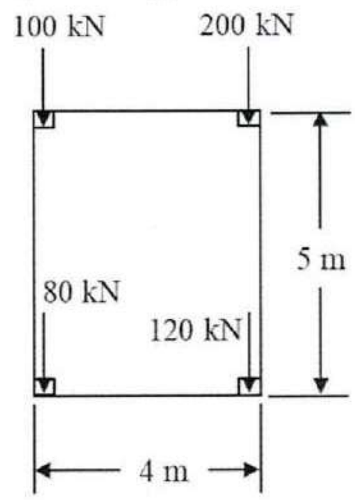
2(a) Knowing that the tension in cable AD is 540 N, determine (i) the angle between cable AD and the boom AB, (ii) the projection on AB of the force exerted by cable AD at point A. 17



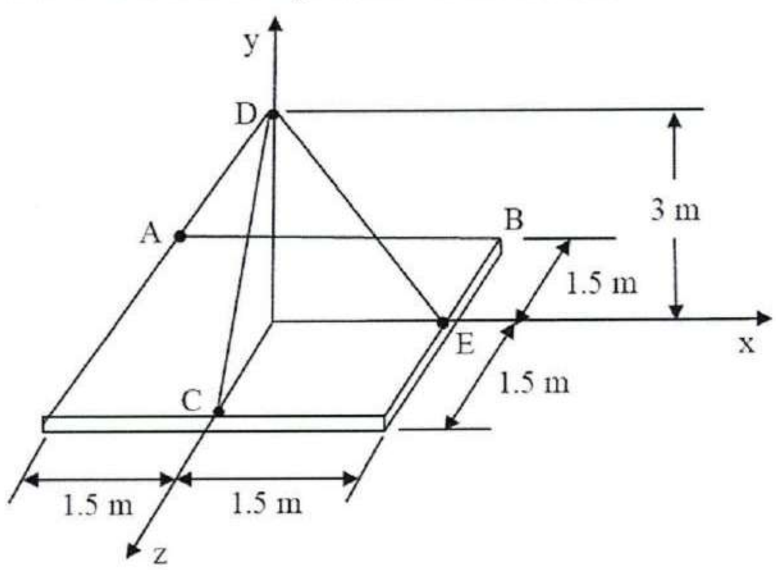
2(b) The force and couple shown are to be replaced by an equivalent single force. Determine the required value of α so that the line of action of the single equivalent force will pass through point B and point D. 18



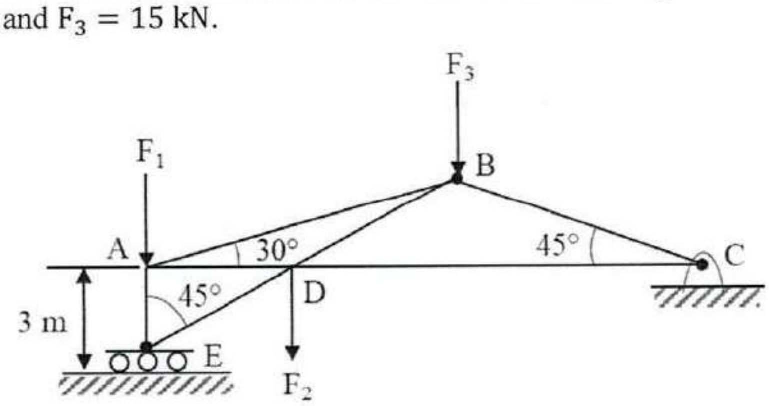
3(a) A rectangular concrete foundation mat supports four column loads as shown. Determine the magnitude and point of application of the resultant of the four loads. 17



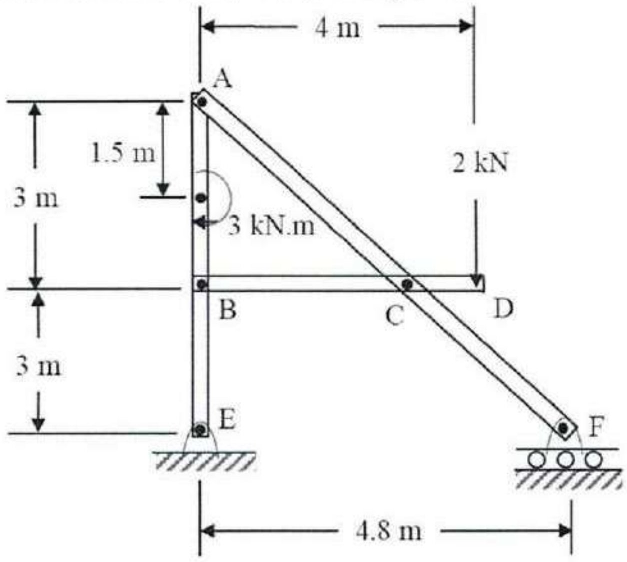
3(b) A 3 m by 3 m plate of mass 650 kg is lifted by three cables which are joined at point D directed above the center of the plate. Determine the tension in each cable. 18



4(a) Determine the forces in each member of the truss as shown in Fig. when $F_1 = 10$ kN, $F_2 = 11$ kN and $F_3 = 15$ kN. 17

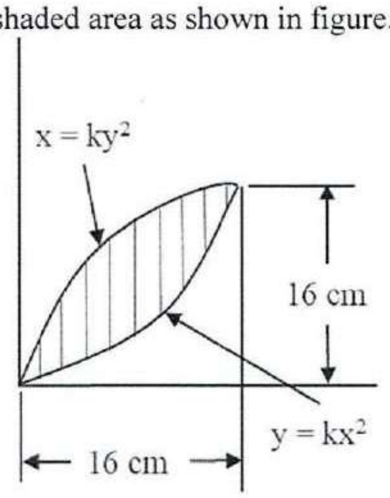


4(b) Draw the free body diagram of each link for the frame shown below and also calculate the external reactions and internal forces at each joints. 18

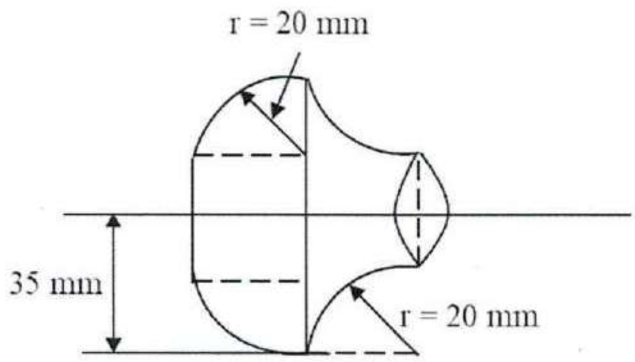


SECTION – B

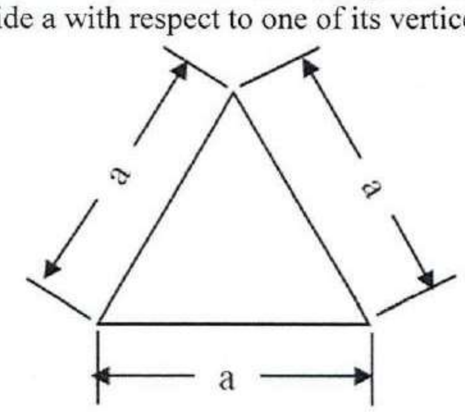
5(a) Locate the centroid of the shaded area as shown in figure. 18



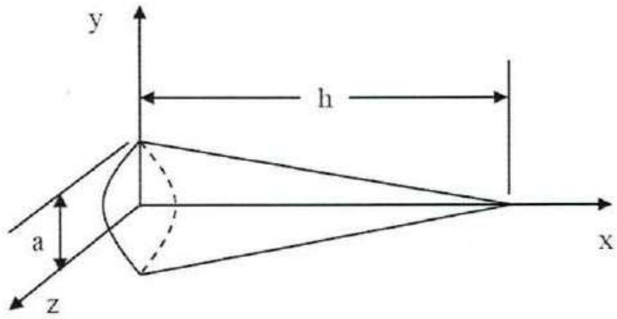
5(b) Determine the total surface area and volume of the solid brass knob as shown in Fig. 17



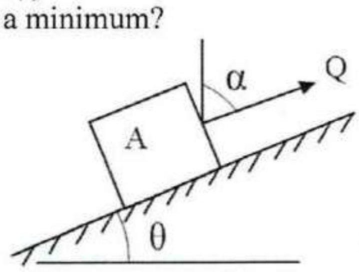
6(a) Determine the polar moment of inertia and the polar radius of gyration of an equilateral triangle of side a with respect to one of its vertices. 17



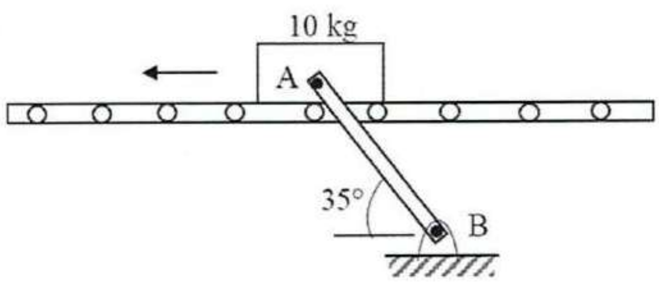
6(b) Determine by direct integration the mass moment of inertia and the radius of gyration of the right circular cone with respect to the z-axis, assuming a uniform density and a mass m. 18



7(a) A body A weighing W rests upon a rough plane inclined at an angle θ with the horizontal. A force Q acts as shown with an angle α with the vertical. The coefficient of friction is $\mu = tan\varphi$. (i) Show that the value of Q which causes motion impending up the plane is $Q = \frac{Wsin(\theta+\varphi)}{\sin(\alpha+\theta+\varphi)}$. Assume that the body does not tip over, (ii) What is the angle α which makes Q a minimum? 17



7(b) The 10 kg block is attached to link AB and rests on a conveyor belt which is moving to the left. Knowing that the coefficients of friction between the block and the belt are $\mu_s = 0.3$ and $\mu_k = 0.25$ and neglecting the weight of the link, determine (i) the force in link AB, (ii) the horizontal force P which should be applied to the belt to maintain its motion. 18



8(a) For a V-belt, derive the expression for the tensions in the two sides of the belt. Assume belt angle α, and the contact angle β and the coefficient of friction as μ. 17

8(b) Assuming that the pressure between the surface of contact is uniform, show that the magnitude M of the couple required to overcome frictional resistance for the conical pivot shown is, $M = \frac{2}{3}\frac{\mu_k P}{sin\theta}.\frac{R_2^3-R_1^3}{R_2^2-R_1^2}$. 18