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Total number of printed pages – 4

B.Tech
BE 2104

Second Semester Examination – 2012

MECHANICS

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any **five** from the rest.
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 × 10
- (a) Draw the free body diagram of a ladder leaning against a wall.
 - (b) What is the effect of force and moment on a body ?
 - (c) A force of 60 kN is acting at point A as shown in Figure 1. Determine the moment of this force about O.

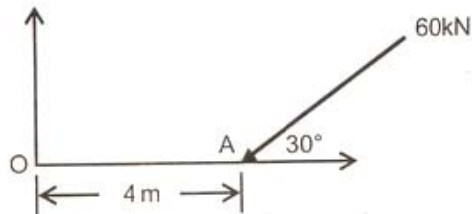
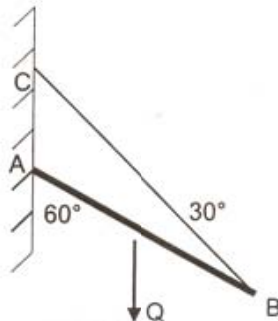


Figure 1

- (d) Draw the free body diagram of a strut in compression.
- (e) Show the differences between 'method of section' and 'method of joints'.
- (f) What are various types of support ? Show the reactions at a hinge support.

P.T.O.

- (g) What do you mean by 'limiting force of friction' ?
- (h) A particle starting from rest moves in a straight line whose equation of motion is $s = 2t^2 - 3t - 1$. What will be the velocity and acceleration of the particle after five seconds ?
- (i) How does D' Alembert's principle differ from Newton's law ?
- (j) What do you mean by coefficient of restitution? What are its values for different types of impact ?
2. (a) A man of weight $W = 1 \text{ kN}$ holds one end of a rope that passes over a pulley vertically above his head and to the other end of which is attached a weight $Q = 614 \text{ N}$. Find the force with which the man's feet press against the floor. 2
- (b) What do you mean by 'equilibrium of three forces' ? How can they be in equilibrium? 3
- (c) A prismatic bar AB of weight $Q = 20 \text{ kN}$ is hinged to a vertical wall at A and supported at B by a cable BC (Figure 2). Determine the magnitude and direction of the reaction R_a at the hinge A and the tension force S in the cable BC. The directions of the bar and cable are shown in Figure 2. 5



(Figure 2)

3. A pin jointed truss of 12 m span is hinged at A, supported on a roller at B and loaded as shown in Fig. 3. Find the forces in the members of the truss.

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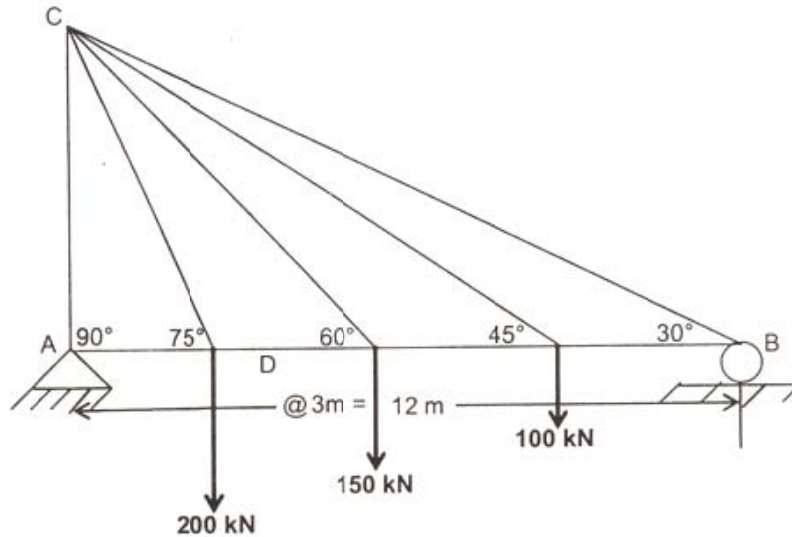


Figure 3

4. (a) A uniform ladder of weight 300 N and of length 5 m rests on a horizontal ground and leans against a rough vertical wall. The coefficient of friction at all contact points is 0.25. When a weight of 1 kN is placed on the ladder at a distance of 3 m from the bottom of the ladder, the ladder is at the point of sliding. Determine :
- Reactions at the foot and top of the ladder; and
 - The angle made by the ladder with the horizontal
- (b) Locate the centroid of the shaded three quarters of the area of a square dimension 6 cm as shown in Figure 4.

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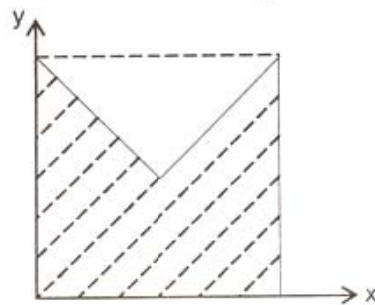


Figure 4

5. (a) Calculate the moment of inertia I_{xx} of a homogeneous rectangular parallelepiped of uniform density having dimensions a, b, c , with respect to a centroidal axis parallel to the edges of length a . 5
- (b) For the shaded area shown in Figure 4, find the moment of inertia about the centroidal X axis. 5
6. (a) A train starting from rest, is uniformly accelerated. The acceleration at any instant is $12/(v + 1) \text{ m/sec}^2$, where v is the velocity of the train in m/sec at the instant. Find the distance, in which the train will attain a velocity of 36 Km per hour. 5
- (b) A train moving at 40 kilometers per hour, is struck by a stone, moving at right angles to the train with a velocity of 25 kilometers per hour. Find the velocity and direction with which the stone appears to strike the train to a person sitting in the train. 5
7. (a) A projectile is aimed at a mark on the horizontal plane through the point of projection and falls 10 m short when the angle of projection is 20° , while it overshoots the mark by 20 m when the same angle is 60° . Find the angle of projection to hit the mark. Assume no air resistance. Take the velocity of projection constant in all cases. 5
- (b) Determine the work done by an electric motor in winding up a uniform cable which hangs from a hoisting drum if its free length is 12 m and weight is 400 N. The drum is rotated by the motor. 5
8. (a) A flexible but inextensible chain of 5 m length and unit weight of 0.5 kN per meter length is held on a smooth table with an initial overhang of 1.5 m from the table top. Calculate velocity v with which the chain will leave the table if released. 5
- (b) A homogeneous sphere, of radius $r = 200 \text{ mm}$ and weight $W = 400 \text{ N}$, can rotate freely about a diameter. If it starts from rest and gains, with constant angular acceleration, an angular speed $n = 200 \text{ rpm}$ in 15 revolutions, find the active moment M . 5