Registration No. : | | | | | | | | | | |

Total number of printed pages – 4

B. Tech

BE 2104 (New)

Second Semester (Back) Examination – 2013

MECHANICS

BRANCH : ALL

QUESTION CODE : B482

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) Show how a force acting on a body can be replaced by an equivalent force-couple system.

   (b) Explain a free body diagram with a suitable example and sketch.

   (c) How the connections and members in truss members are idealized ?

   (d) What are the units of coefficients of static and sliding frictions ? What is angle of repose ?

   (e) Define the terms (i) centroid (ii) centre of volume (iii) center of mass and (iii) centre of gravity.

   (f) In virtual work principle, what is the work done by a body of weight 5 N when its centre of gravity moves horizontally by a distance of 1 mm ?

   (g) How will be the shape of a velocity ~ time diagram when a particle moves with constant acceleration ?

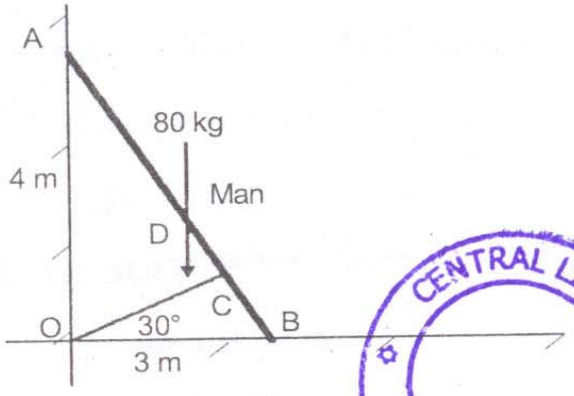
   (h) Explain the term inertia of a body. What do you mean by inertial force and inertial torque ?

   (i) Derive the relationship between impulse and linear momentum.

   (j) Prove that for a perfectly elastic impact, two equal masses participating in collision exchange their velocities.

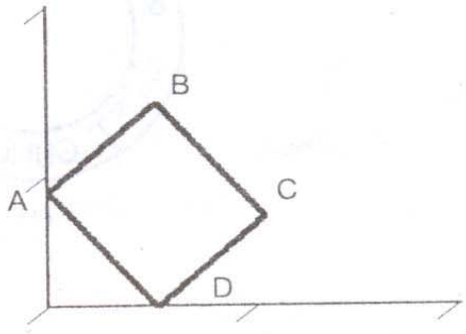
P.T.O.

2. (a) A 80 kg man stands on the middle rung of a ladder AB of weight 30 kg, which is supported on smooth wall and smooth floor. A string OC holds the ladder in position preventing it from slipping (Fig. 1). Determine the tension in the string and the reaction at the supports. 5



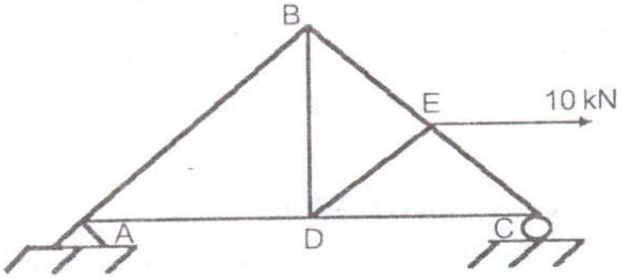
(Figure 1)

(b) A uniform square plate ABCD rests on one of its corner A on a rough horizontal floor having coefficients of friction 0.3 and another corner B on rough vertical wall having coefficient of friction 0.2 (Fig. 2). At limiting equilibrium, find the inclination of the edge AD of the plate with the horizontal floor. 5



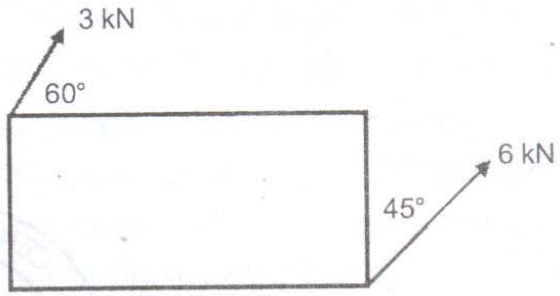
(Figure 2)

3. A pin jointed simply supported truss ABC is hinged at A and supported on a roller at C. It is loaded as shown in Fig. 3. AB = BC = CA = 3 m. D and E are mid points of AC and BC. Find the forces in the members of the truss. 10



(Figure 3)

4. (a) A 2 m × 4 m rectangular plate is subjected to a system of two coplanar forces as shown in Fig. 4. Determine the equivalent action at the centroid of the plate that may replace the force system. 5

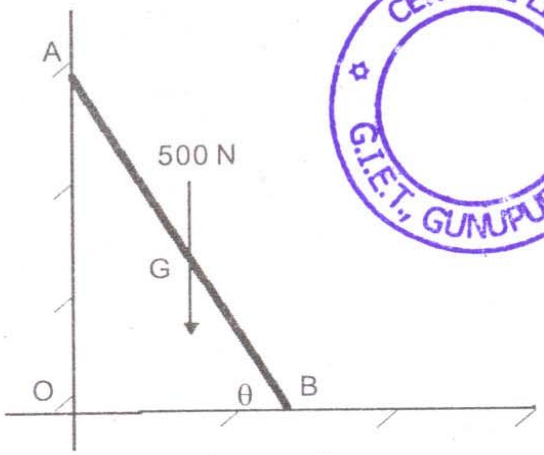


(Figure 4)

(b) Determine the centroid of the area between curves $y = x^3/4$ and $x = y^3/2$. 5

5. (a) Determine the moment of inertia about the centroidal x-axis and y-axis of the area enclosed by the ellipse $4x^2 + 9y^2 = 1$. Also determine the radii of gyration. 5

(b) A solid uniform bar of weight 500 N rests at its one end on rough floor and other end on smooth wall. Using the method of virtual work, find the frictional force at floor. 5



(Figure 5)

6. (a) A ball is dropped vertically from a tower-top. During last 1 second of motion, it falls through 60% of the height. Determine the height of the tower. 5

(b) A ball is projected on horizontal plane at an angle of 45° with an initial velocity of 120 m/sec. Determine the (i) horizontal range, (ii) maximum height attained by the particle, (iii) total time of flight, and (iv) time taken to reach the highest position of path. 5

7. (a) A bar of length 1 m has its end A supported on a wall and the end B supported on floor. At a particular instant, the inclination of the bar is 30° with the horizontal and the end B moves with constant velocity of 5 m/sec horizontally. Determine the angular velocity of the bar, velocity of the end A and velocity of the midpoint C of the bar at that instant. 5

(b) A wheel that can rotate freely about an axle, but cannot move in any other way. It is initially spinning at a rate of ω = 20 rad/sec but the friction at the axle produces a torque T= 10 Nm about the axle. How long does it take the wheel to come to a stop ? Mass of the wheel is 6 kg and radius of gyration is 1 m. 5

8. (a) A block made up of pine wood of mass M is penetrated by a high end bullet of mass m by an amount of thickness t. Prove that, when the block is allowed to move freely, the thickness of penetration will be [Mt / (M + m)]. 5

(b) A tennis ball is dropped from a 3.1 m high ceiling of a room. After bouncing twice, the ball attains a height of 0.775 m measured from the floor. Determine the coefficient of restitution in this situation. 5