Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(N)/SEM-1/ME-101/2012-13

2012
ENGINEERING MECHANICS

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

   i) Two non-collinear parallel equal forces acting in opposite directions

      a) balance each other

      b) constitute a moment

      c) constitute a couple

      d) constitute a moment of a couple.

   ii) The centre of gravity of a uniform lamina lies at the

      a) centre of the heavy portion

      b) bottom surface

      c) midpoint of its axis

      d) all of these.

iii) Materials having the same elastic properties in all directions are called

a) ideal materials

b) isotropic materials

c) elastic materials

d) uniform materials.

iv) Given $\overrightarrow{F_1} = 5\hat{j} + 4\hat{k}$ and $\overrightarrow{F_2} = 3\hat{i} + 6\hat{k}$. The magnitude of the scalar product of these vectors is

a) 15 b) 30

c) 24 d) 12.

v) Moment of inertia of a semicircle of radius R about its centroidal axis x-x is

a) $0{\cdot}22R^4$ b) $0{\cdot}055R^4$

c) $0{\cdot}11R^4$ d) none of these.

vi) The first moment of an area about the centroidal axis of that area is

a) maximum b) minimum

c) zero d) cannot be defined.

vii) A projectile is fired at an angle θ to the vertical. Its horizontal range will be maximum when θ is

a) 0 b) 30°

c) 45° d) 60°.

viii) When a body slides down an inclined surface of inclination θ, the acceleration of the body is given by

a) $f = g$ b) $f = g \sin\theta$

c) $f = g \cos\theta$ d) $f = g / \sin\theta$

ix) A body is resting on a plane inclined at an angle of 30° to the horizontal. What force would be required to slide down, if the coefficient of friction between body and plane is 0·3 ?

a) Zero b) 1 kg

c) 5 kg d) none of these.

x) Poisson's ratio is defined as

a) longitudinal stress and longitudinal strain

b) longitudinal strain and lateral strain

c) lateral stress and longitudinal stress

d) lateral strain and longitudinal strain.

xi) The maximum strain energy that can be stored under elastic limit in a body is known as

a) impact energy b) resilience

c) proof resilience d) toughness.

xii) Coulmb friction is

a) the friction between solids and liquids

b) the friction between dry surfaces

c) the friction between bodies having reactive motion

d) none of these.

xiii) The deformation of a bar per unit length in the direction of force is known as

a) linear strain b) lateral strain

c) shear strain d) volumetric strain.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. a) State D' Alembert's principle.

   b) A smooth circular cylinder of radius 1·5 cm is lying in a groove as shown in figure 1. Find the reactions at the surfaces of contact, if there is no friction and the cylinder weighs 1000 N : 5

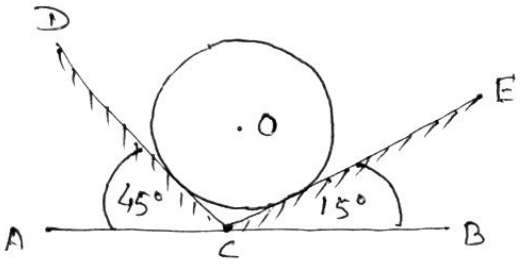

Figure -1

3. A horizontal bar *AB* is hinged to a vertical wall at *A* and supported at its mid-point *C* by a cable *CD* as shown in figure 2. The bar is subjected to a vertical load *P* applied at the free end *B*. The bar maintains horizontal position. Find the tension in the cable and reaction at *a*. Neglect the weight of the bar.

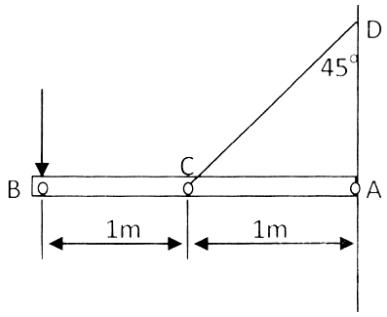

Figure -2

4. a) State the parallel axes theorem of moment of inertia of lamina.

   b) Calculate the location of the centroid of the *L* section shown in figure 3.

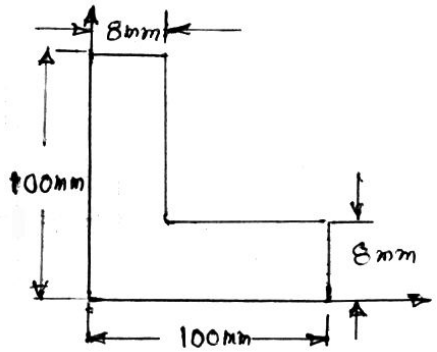

Figure -3

5. A bar of variable cross-sectional areas as shown in figure 4 is subjected to different forces. Find the total elongation of the bar. Take $E = 2 \times 10^5 \text{N/nm}^2$:

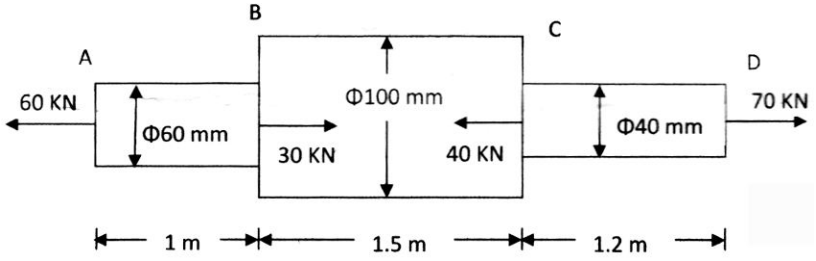

Figure -4

6. The motion of a particle is expressed as $x = x_0 + v_0 t + 1/2\, at^2$. Calculate the displacement and velocity at time t = 5 second. x_0 = 12m, $v_0 = 5$ m/s, $a = 20$ m/s^2.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. *A* cart of mass *M* rolls down a track inclined at an angle θ. The cart starts from rest a distance *l* up the track from a spring, and rolls down to collide with the spring as shown in Figure 5.

   a) Assuming no non-conservative work is done, what is the speed of the cart when it first contacts the spring ? (Express your answer in terms of the given variables and the gravitational acceleration *g*).

   b) Suppose the spring has a force constant *k*. What is the peak force compressing the spring during the collision ?

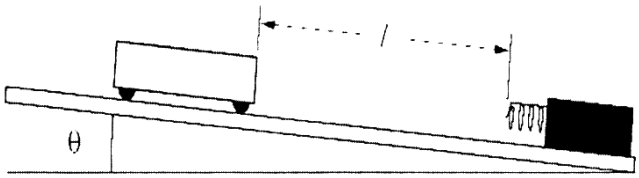

Figure -5

7 + 8

8. A block of weight W_1 = 200 kgf rests on a horizontal surface and supports on top of it another block of weight W_2 = 50 kgf. The block W_2 is attached to a vertical wall by the inclined string *AB*. Find the magnitude of the horizontal force *P* applied to the lower block as shown in Figure 6, that will be necessary to cause slipping to impend the coefficient of static friction for all contiguous surfaces which is μ = 0·3.

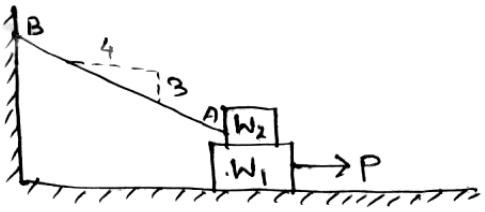

Figure -6

9. a) Determine the moment of inertia of the shaded area with respect to the given axis as shown in figure 7 :

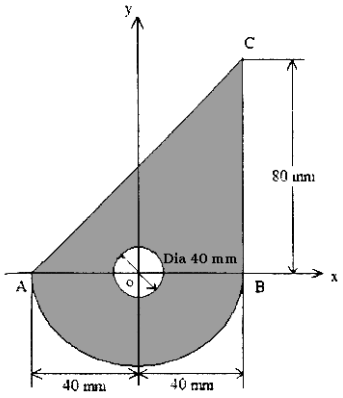

Figure -7

b) Explain D' Alembert's principle.

c) Two shots are fired from a rifle with an initial velocity of 800 m/s from a point 5 km in front of a vertical wall of 1·5 km high. Find the two angles of projection with horizontal to enable the short to just clear the wall. (g = 9·81 m/s^2). 7 + 2 + 6

10. a) In the following figure 8, F = 1000 N while O (0, 0, 0), A (0, 10, 0) and B (5, 0, 4). Calculate the moment of force about O :

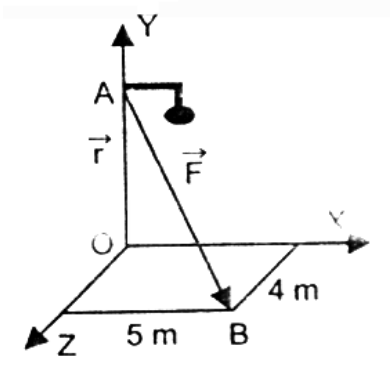

Figure -8

b) Find the perpendicular distance from the point $A(1,2,3)$ to the line joining the origin O and the point $B(2,10,5)$. 10 + 5

11. a) Determine velocity V of falling weight W of the system as shown in Figure 9, as a function of its displacement from the initial position of rest. Assume weight of the cylinder as 2 W.

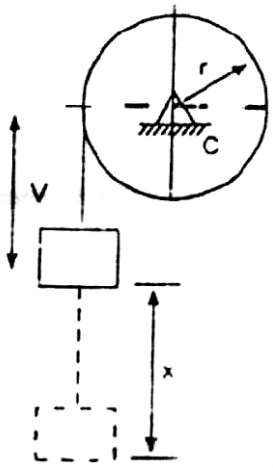

Figure -9

b) From the top of a tower, 60 m high a bullet is fired at an angle of 20° up the horizontal with velocity 120 m/s. Determine :

(i) Time of flight

(ii) Horizontal range of ground

(iii) Maximum height of bullet from ground

(iv) Velocity of bullet after 8 sec.

Assume horizontal ground at the foot of the tower. 5 + 10