Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (OLD)/SEM-1/ME-101/2010-11

2010-11
MECHANICAL SCIENCES

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 the following : $10 \times 1 = 10$

   i) Principle of transmissibility states that when a force is acting on a body,

      a) the external effect of the force does not depend on the point of application of the force

      b) depends on the point of application of the force

      c) both the external effect and internal effect of the force do not depend on the point of application of the force

      d) none of these.

ii) Modulus of rigidity of a shaft (a circular cross-section) is dependent on

a) Shear stress b) Shear strain

c) Tensile stress d) Both (a) and (b).

iii) The conditions of equilibrium for coplanar non-concurrent force are

a) $\sum F_x = 0,\ \sum F_y = 0$

b) $\sum F_x = 0,\ \sum M = 0$

c) $\sum F_y = 0,\ \sum M = 0$

d) $\sum F_x = 0,\ \sum F_y = 0,\ \sum M = 0.$

iv) Free body diagram can be applied only in

a) dynamic equilibrium problem

b) static equilibrium problem

c) both dynamic and static equilibrium problems

d) none of these.

v) In projectile motion

a) velocity is constant along x direction and acceleration is constant along y direction

b) velocity is constant along y direction and acceleration is constant along x direction

c) velocity and acceleration both are constant along y direction

d) velocity and acceleration both are constant along x direction.

vi) The motion of a particle is defined by the relation $x = t^4 - 3t^3 + 2t^2 - 8$ where x is in meter and t is in seconds. The acceleration of the particle at t = 5s is

a) $214 m/s^2$ b) $110 m/s^2$

c) $-214 m/s^2$ d) $220 m/s^2$.

vii) Conservation of momentum means

a) momentum is maximum

b) momentum is minimum

c) momentum is constant

d) momentum is zero.

viii) Area moment of inertia of a circle about an axis passing through its centroid is

a) $\pi d^4/64$ b) $\pi r^4/64$

c) $\pi d^4/4$ d) $\pi d^4/32$.

ix) The coefficient of friction depends upon

a) area of contact between two surfaces

b) shape of the surfaces

c) strength of the surfaces

d) nature of the surfaces.

x) The ratio of lateral strain to longitudinal strain within elastic limit is called

a) Modulus of elasticity b) Bulk modulus

c) Modulus of rigidity d) Poisson's Ratio.

GROUP – B

(Short Answer Type Questions)

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

2. Determine the force *P* required to maintain the 200 kg block in the position for which $\alpha = 30^\circ$. The diameter of the pulley at *B* is negligible.

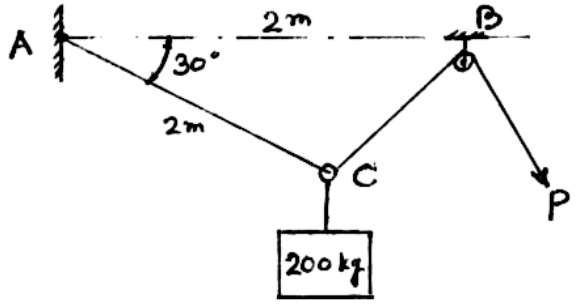

Fig. 1

3. The force *P* is applied to the 90 kg crate, which is stationary before the force is applied. Determine the magnitude and direction of friction force *F* exerted by the horizontal surface on the crate. $\mu_s = 0{\cdot}30$; $\mu_k = 0{\cdot}20$.

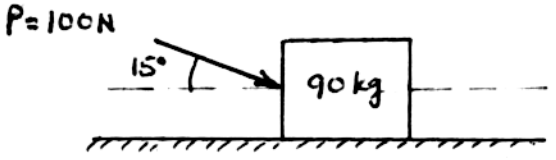

Fig. 2

4. Determine the C.G. of the given shaded area shown in figure.

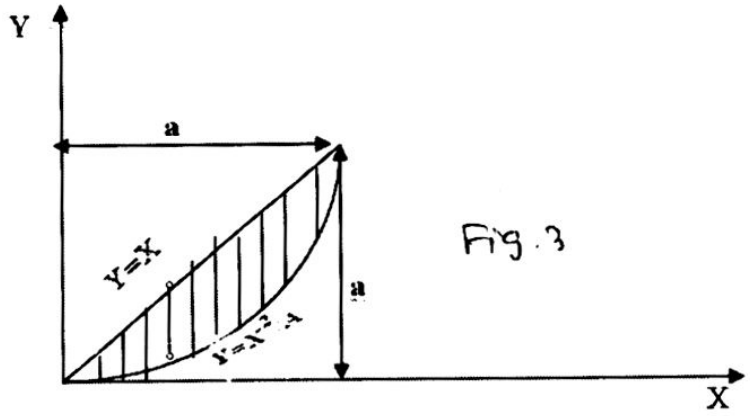

Fig. 3

5. The acceleration of particle is defined by the relation $a = t^2 - 2t + 2.$, where a is in m/s^2 and t is in seconds. The displacements and velocity of the particle at t = 1s is found to be 14·75 m and 6·33/s respectively. Find the distance travelled and velocity of the particle at t = 3s.

6. A bar 5 m long and 150×250 mm^2 in section is subjected to a pull of 100 kN. Determine the stress produced and the strain energy stored in the bar. Take $E = 20$ kN/mm^2.

GROUP – C

(Long Answer Type Questions)

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

7. a) A Horizontal beam *AB* is pinned to a vertical wall at *A* and supported by a tie rod *BC* as shown in figure. The beam carries a block of mass 200 kg at *B*. The self weight of the beam is 300 N. Calculate the tension developed in the rope and the reaction at *A*. 7

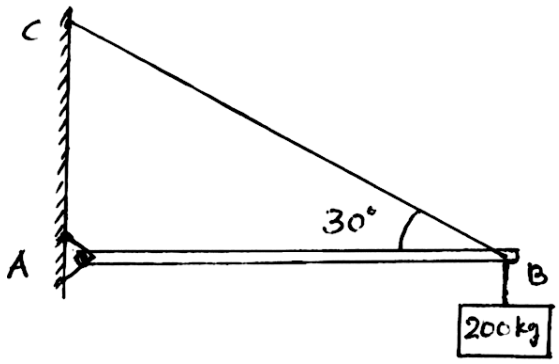

Fig. 4

b) Calculate the area moment of inertia of the figure as shown in figure about is centrodal axis. 8

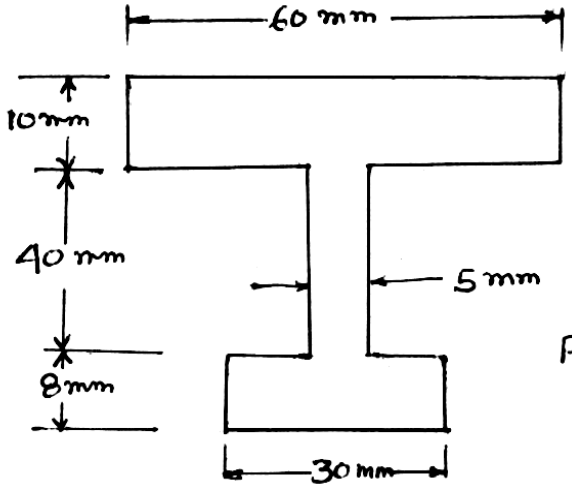

Fig. 5

8. a) Assume that the disk in the figure rolls without slipping. Determine the tensions in the ropes and the acceleration of the mass centre of disk *A*. 8

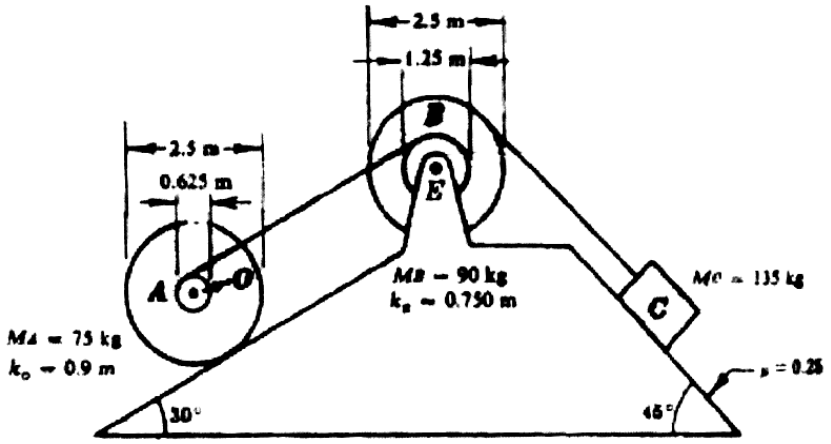

Fig. 6

b) Determine the linear displacement, velocity and acceleration of the crosshead *C* in the slider crank mechanism as shown in figure for any position of the crank *R* which is rotating at a constant angular velocity ω rad/s. 7

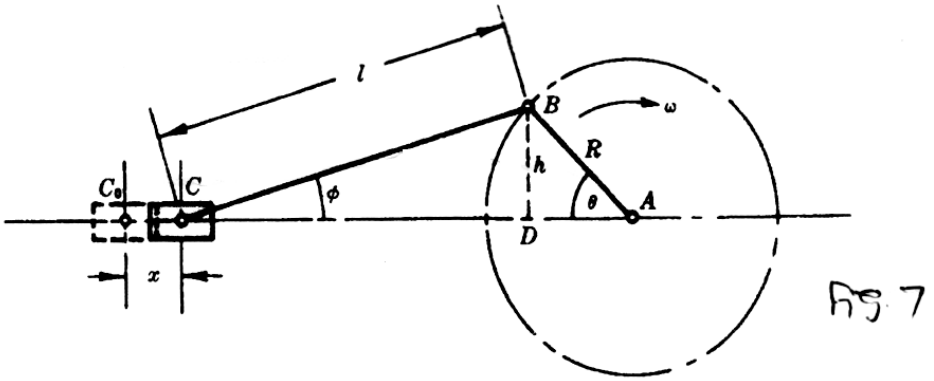

Fig. 7

9. a) Determine the range of mass m for which the 100 kg block will be in equilibrium. The coefficient of friction is $\mu_s = 0 \cdot 30$. 8

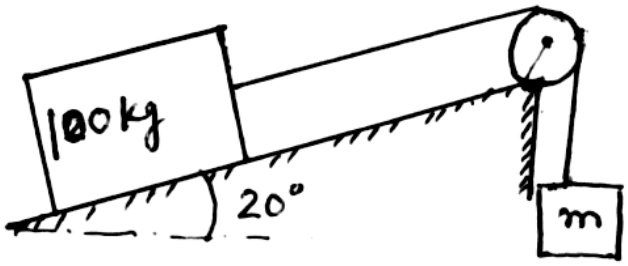

Fig. 8

b) A bullet is fired from a height of 120 m from the ground at a velocity of 360 km/hr at an angle of 30° upwards. Neglecting air resistance, find,

i) Total time of flight

ii) Horizontal range of the bullet

iii) Final velocity of the bullet before touching the ground. 7

10. a) A bronze bar 23 m long & cross-sectional area of 320 mm^2 is placed between two rigid walls as shown in figure. At a temperature of – 20° C, the gap Δ = 2·5 mm. Find the temperature at which the compressive stress in the bar will be σ = 35 MPa. Use $\alpha = 18 \times 10^{-6}/mm°C$ & E = 80 GPa. 7

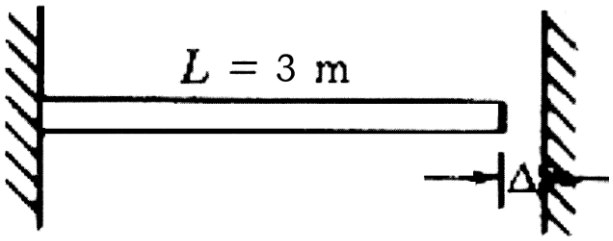

Fig. 9

b) A jet of water is discharged form a point 'O' as shown in figure. Two points P_1 & P_2 lie on the path of the jet at the same height of 4 m above 'O' & at horizontal distance 6 m and 10 m from 'O'. Determine the velocity & angle at which the jet is projected. 8

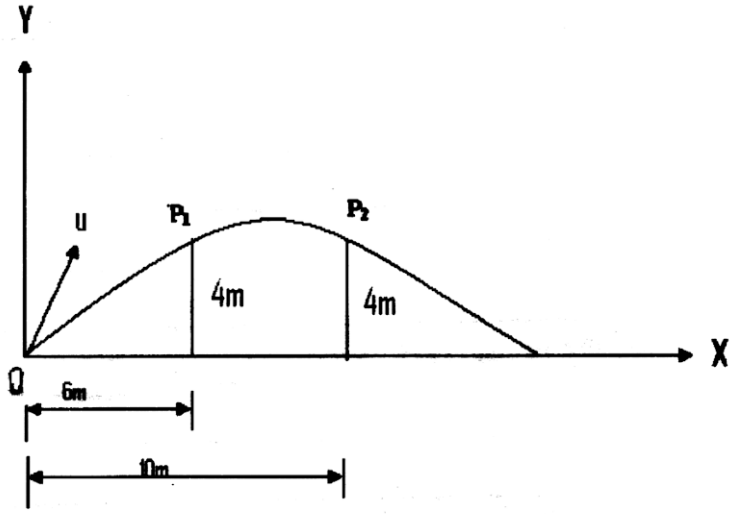

Fig. 10

11. a) Derive the expression "$V^2 = U^2 + 2as$". $2\frac{1}{2}$

b) Explain 'D Alemberts' principle with neat sketches for both rectilinear & curvilinear motions. $2\frac{1}{2}$

c) Water drops from a tap at a uniform rate of 'n' drops per second. If the distance between two adjacent drops is 'y', when the trailing drop has been in motion, show that $y = (gt/n) + \left(g/2n^2\right)$, where '$t$' is the time of trailing drop in motion. Neglect air resistance. 10