

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.

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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 $t = 5$ s is

- a) 214m/s^2 b) 110m/s^2
- c) -214m/s^2 d) 220m/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.



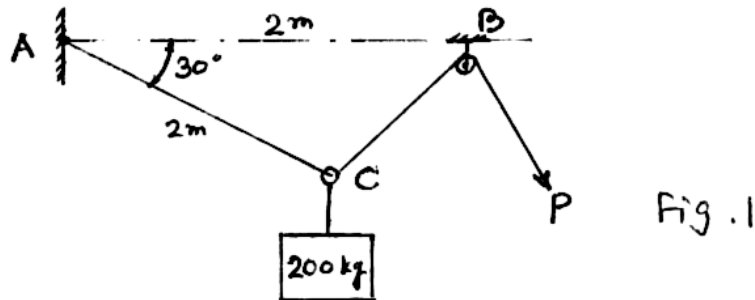
GROUP – B

(Short Answer Type Questions)

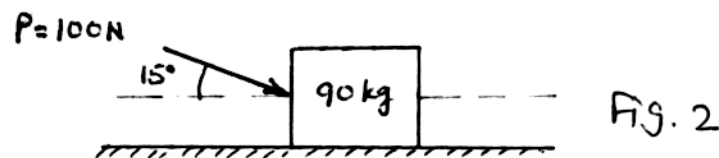
Answer any *three* of the following.

$3 \times 5 = 15$

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.

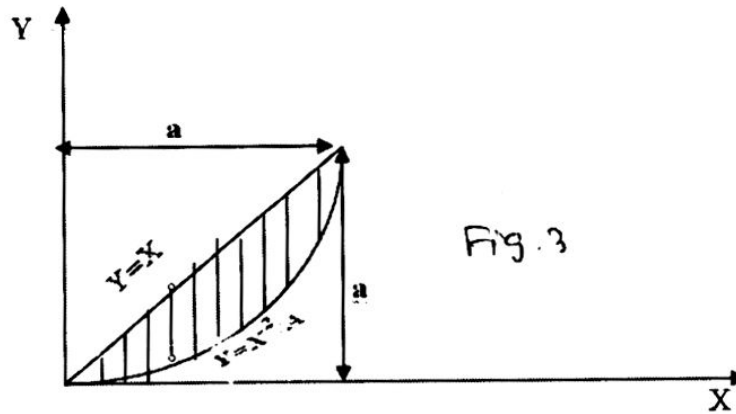


3. The force P is applied to the 90 kg crate, which is stationary before the force is applied. Determine the magnitude and direction of friction force F exerted by the horizontal surface on the crate. $\mu_s = 0.30$; $\mu_k = 0.20$.





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



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 $t = 1\text{ s}$ is found to be 14.75 m and $6.33/\text{s}$ respectively. Find the distance travelled and velocity of the particle at $t = 3\text{ s}$.
6. A bar 5 m long and $150 \times 250\text{ mm}^2$ in section is subjected to a pull of 100 kN . Determine the stress produced and the strain energy stored in the bar. Take $E = 20\text{ kN/mm}^2$.



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.

$3 \times 15 = 45$

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 .

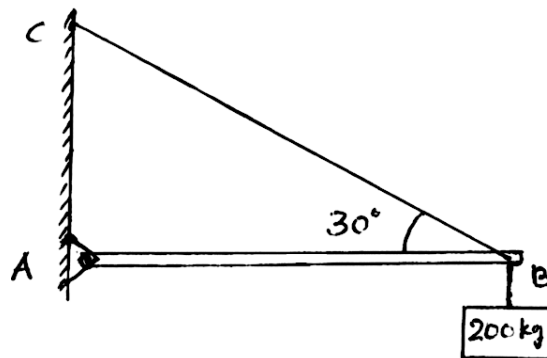


Fig. 4

- b) Calculate the area moment of inertia of the figure as shown in figure about its centroidal axis.

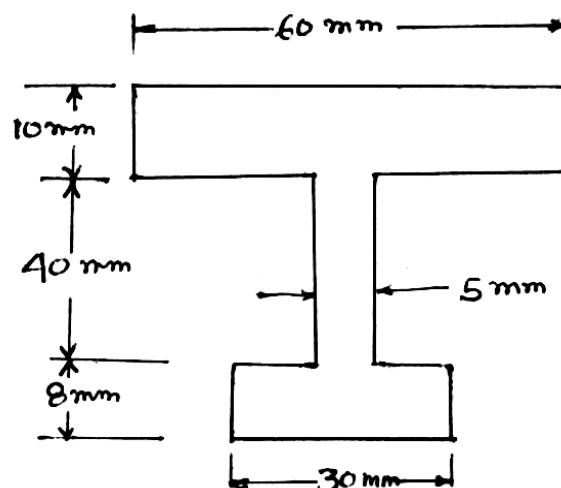
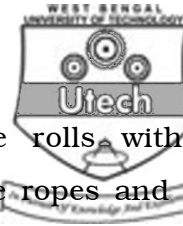


Fig. 5



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

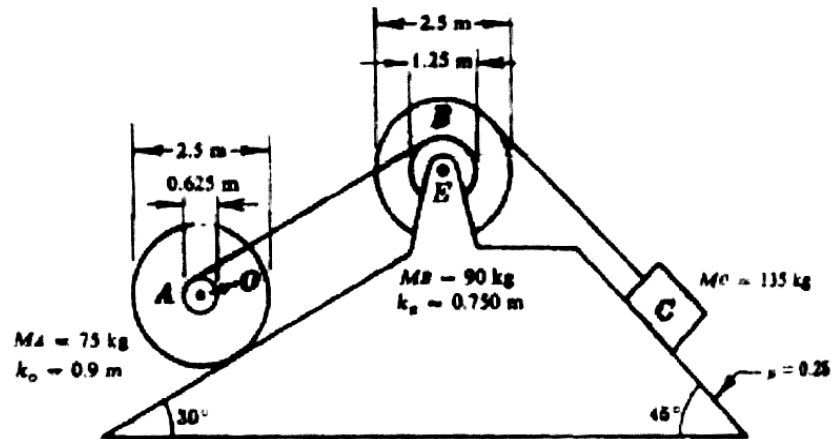


Fig. 6

- 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

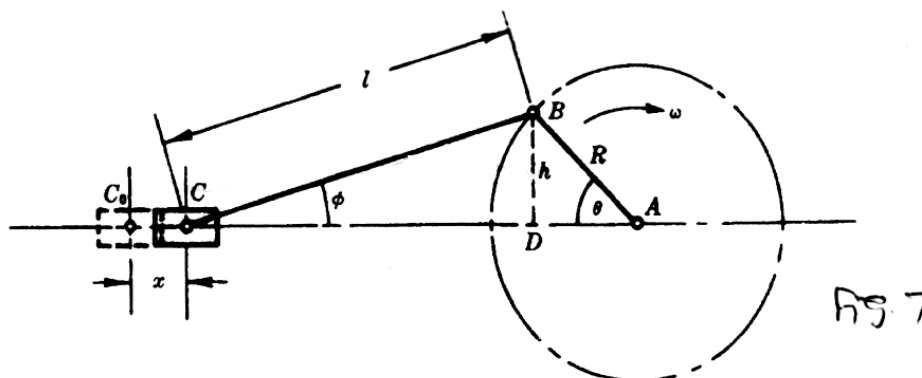
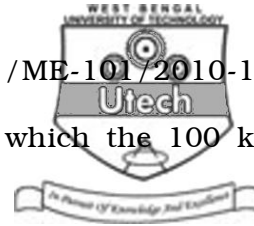


Fig. 7



9. a) Determine the range of mass m for which the 100 kg block will be in equilibrium. The coefficient of friction is

$$\mu_s = 0.30.$$

8

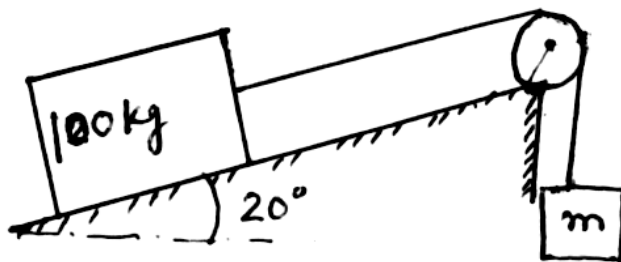


Fig. 8

- 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,

- Total time of flight
- Horizontal range of the bullet
- 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 $\Delta = 2.5 \text{ mm}$. Find the temperature at which the compressive stress in the bar will be $\sigma = 35 \text{ MPa}$. Use $\alpha = 18 \times 10^{-6} / \text{mm}^\circ \text{C}$ & $E = 80 \text{ GPa}$.

7

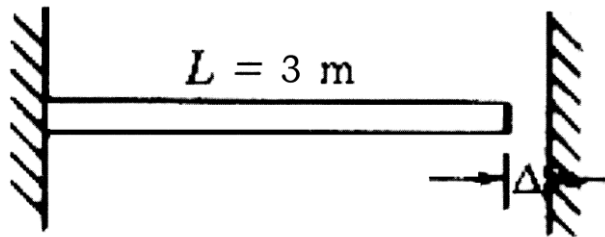


Fig. 9

- b) A jet of water is discharged from 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

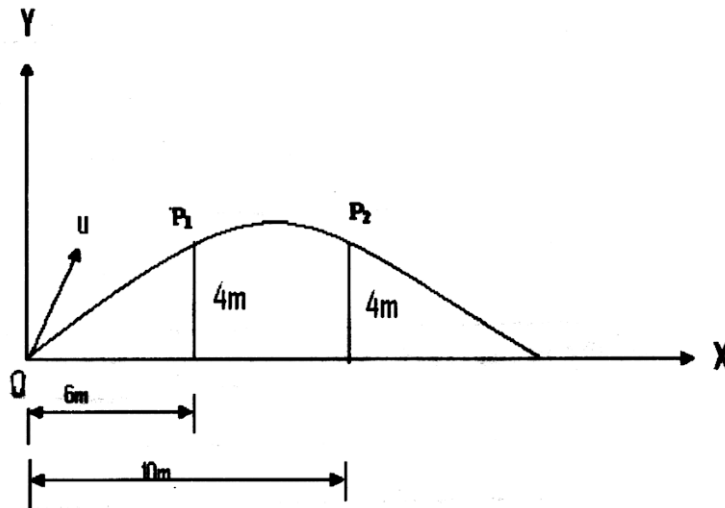


Fig. 10



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 $y = (gt/n) + (g/2n^2)t^2$, where ' t ' is the time of trailing drop in motion. Neglect air resistance. 10
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