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

2012
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) According to principle of transmissibility of forces, the effect of a force on a body is
      a) maximum when it acts at the centre of gravity of a body
      b) minimum when it acts at the centre of gravity of a body
      c) same at every point in its line of action
      d) none of these.

   ii) Moment of inertia of a circular area whose diameter is d about an axis perpendicular to the area passing through its centre is given by
      a) $\frac{\pi d^4}{64}$ b) $\frac{\pi d^4}{32}$
      c) $\frac{\pi d^4}{16}$ d) $\frac{\pi d^4}{4}$.

iii) If rain is falling in the opposite direction of the movement of a pedestrian, he has to hold his umbrella
   a) more inclined when moving
   b) less inclined when moving
   c) more inclined when standing
   d) none of these.

iv) The ratio between tensile stress and tensile strain or compressive stress and compressive strain is termed as
   a) Modulus of elasticity
   b) Modulus of rigidity
   c) Bulk modulus of elasticity
   d) None of these.

v) Temperature stress develop in a bar depends upon
   a) Co-efficient of linear expansion
   b) Change of temperature
   c) Young's modulus
   d) All of these..

vi) Equation of motion of a particle is $s = 2t^3 - t^2 - 2$ where s is the displacement in metres and t is time in seconds. Acceleration of the particle after 1 second will be
   a) $8\ \text{m/sec}^2$ b) $9\ \text{m/sec}^2$
   c) $10\ \text{m/sec}^2$ d) $5\ \text{m/sec}^2$.

vii) If the velocity of projection is u m/sec and the angle of projection is $\alpha°$, the time of flight of the projectile is
   a) $\frac{u^2 \cos^2 \alpha}{2g}$ b) $\frac{2u \sin \alpha}{g}$
   c) $\frac{2u \cos \alpha}{g}$ d) $\frac{u^2 \sin^2 \alpha}{2g}$.

viii) Frictional force encountered after commencement of motion is known as

a) sliding friction b) kinematic friction

c) dynamic friction d) frictional resistance.

ix) D' Alembert's Principle is used for

a) reducing the problem of kinetics to equivalent static problem

b) stability of floating bodies

c) solving kinematic problems

d) none of these.

x) If two bodies, one light and the other heavy have equal kinetic energy, which one has a greater linear momentum ?

a) The lighter body

b) The heavy body

c) Both have equal momentum

d) None of these.

GROUP – B

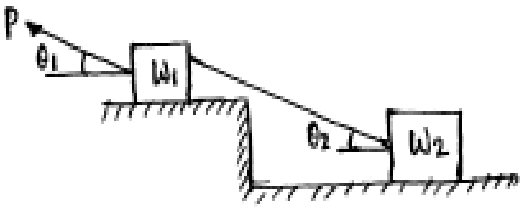
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. A bar of length l cross-sectional area A is rigidly fixed at one end. Find the elongation of the bar due its self weight if density of the bar material is ρ kg/m^3.

3. a) What is FBD ?

   b) Draw the FBD of the given figure considering rough surface.



1 + 4

4. Prove that area moment of inertia of any area is minimum about its centroidal axis.

   Again prove that for an axisymmetric area centroid lies on axis of symmetry. 2 + 3

5. A particle moves along a curvilinear path defined by $y = ax^2$ where x and y are in metres. The velocity and acceleration of the particle at a point (5 m, 2·5 m) are respectively 5 m/sec and 2 m/sec^2. Determine that total acceleration of the particle at the point.

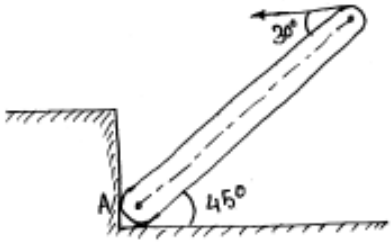
6. A force $P = P_x\ i + P_y\ j$ acts at a point of co-ordinates x and y. Derive an expression for the perpendicular distance d from the line of action of P to the origin O of the system of co-ordinates.

GROUP – C

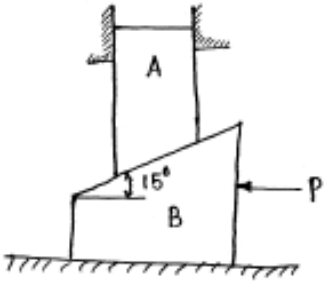
(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) A joint of length 4 m and weighing 300 N is raised by pulling a rope as shown. Determine the tension in the rope and reaction at *A* of joint.

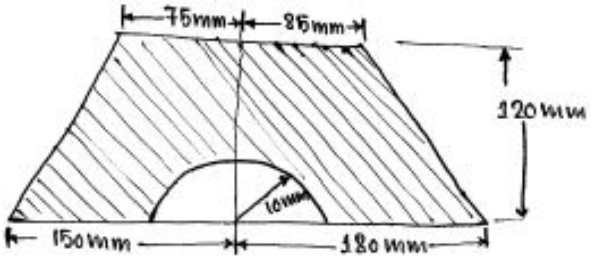


b) A block weighing 2000 N is to be raised by forcing the wedge under it. Determine the required force *P* to lift the block *A*. Assume the weight of block-*B* as 1000N and the angle of friction of all connected system to be 10°.

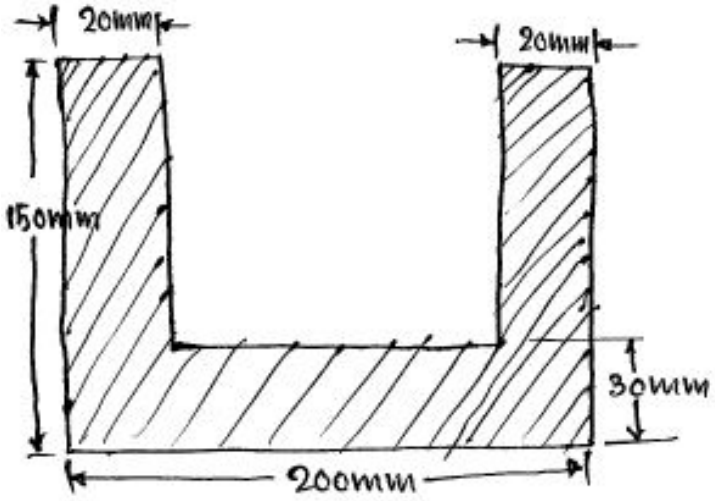


7 + 8

8. a) Find the centroid of the shaded area as shown below.

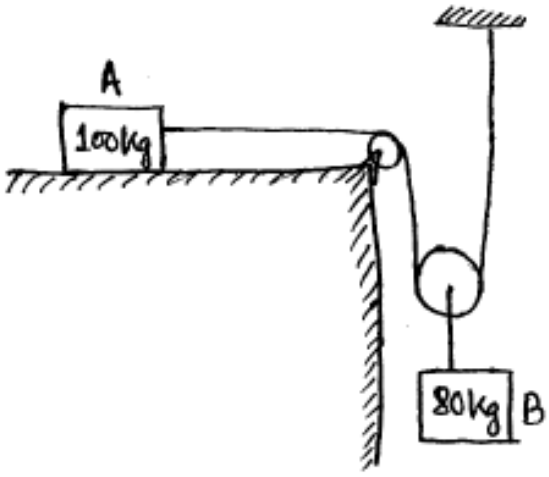


b) Find the moment of inertia of shaded area about the centroidal axis parallel to *X*.

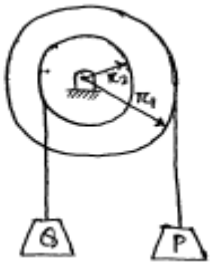


8 + 7

9. a) Two blocks of mass 100 kg and 80 kg are connected by a light inextensible string as shown in figure. Using the D' Alembert's principle find the acceleration of the blocks and tension in the string. Asseme co-efficient of friction $\mu = 0{\cdot}3$.



b) Two weights P and Q are hung and initially at rest as shown in figure. Find the velocity of the falling weight P when it covers a vertical distance of 3 metres. Given P = Q = 10N, $r_2 = 100$ mm and $r_1 = 50$ mm. 8 + 7

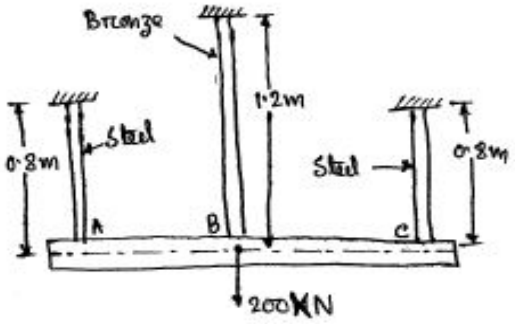


10. a) Find the volumetric strain for a triaxial stress system.

b) A rigid bar ABC weighing 180 kN is supported by three rods placed symmetrically as shown in figure. Assuming the bar to remain horizontal, determine the stress in each rod after a temperature rise of 25°C. The lower ends of the rods are assumed to be at the same level before the bar is attached and the change in temperature.

Given : Area of steel rod = 800 mm^2; Area of bronze rod = 1400 mm^2; E_{st} = 2 × 10^5 N/mm^2; E_{br} = 0·8 × 10^5 N/mm^2; α_{st} = 12 × 10^{-6}/°C; α_{br} = 20 × 10^{-6}/°C

What will be the stress in each rod if the weight of the bar is 120 kN only ?



11. a) Explain the principle of transmissibility and parallelogram law.

    b) A bus is starting to move with an acceleration of 0·5 m/sec^2. A man standing 21 m behind the bus runs at constant speed of 5 m/sec. Find the time at which the man will overtake the bus.

    c) During a free kick, a football player kicks a football of 250 g mass, which is at rest and it leaves his foot with a velocity of 25 m/sec at an angle of 25° with respect to the ground level. Determine the force exerted by the player if the duration of the strike is 1/60th of a second.

5 + 5 + 5