

Name : .....  
 Roll No. : .....  
 Invigilator's Signature : .....

**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) $\frac{\pi d^4}{4}$

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- iii) If rain is falling in the opposite direction of the movement of a pedestrian, he has to hold his umbrella
- more inclined when moving
  - less inclined when moving
  - more inclined when standing
  - none of these.
- iv) The ratio between tensile stress and tensile strain or compressive stress and compressive strain is termed as
- Modulus of elasticity
  - Modulus of rigidity
  - Bulk modulus of elasticity
  - None of these.
- v) Temperature stress develop in a bar depends upon
- Co-efficient of linear expansion
  - Change of temperature
  - Young's modulus
  - 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
- $8 \text{ m/sec}^2$
  - $9 \text{ m/sec}^2$
  - $10 \text{ m/sec}^2$
  - $5 \text{ m/sec}^2$ .
- vii) If the velocity of projection is  $u \text{ m/sec}$  and the angle of projection is  $\alpha^\circ$ , the time of flight of the projectile is
- $\frac{u^2 \cos^2 \alpha}{2g}$
  - $\frac{2u \sin \alpha}{g}$
  - $\frac{2u \cos \alpha}{g}$
  - $\frac{u^2 \sin^2 \alpha}{2g}$ .

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- viii) Frictional force encountered after commencement of motion is known as
- sliding friction
  - kinematic friction
  - dynamic friction
  - frictional resistance.
- ix) D' Alembert's Principle is used for
- reducing the problem of kinetics to equivalent static problem
  - stability of floating bodies
  - solving kinematic problems
  - none of these.
- x) If two bodies, one light and the other heavy have equal kinetic energy, which one has a greater linear momentum ?
- The lighter body
  - The heavy body
  - Both have equal momentum
  - None of these.

### GROUP – B

#### ( Short Answer Type Questions )

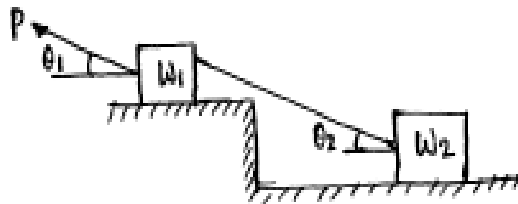
Answer any *three* of the following.  $3 \times 5 = 15$

- 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  $\rho \text{ kg/m}^3$ .

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3. a) What is FBD ?  
 b) Draw the FBD of the given figure considering rough surface.



4. Prove that area moment of inertia of any area is minimum about its centroidal axis. 1 + 4

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<sup>2</sup>. 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.

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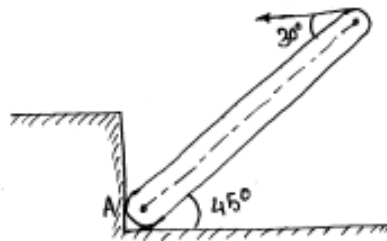
GROUP – C

( Long Answer Type Questions )

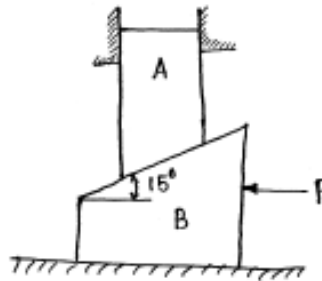
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Answer any *three* of the following.  $3 \times 15 = 45$ 

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.

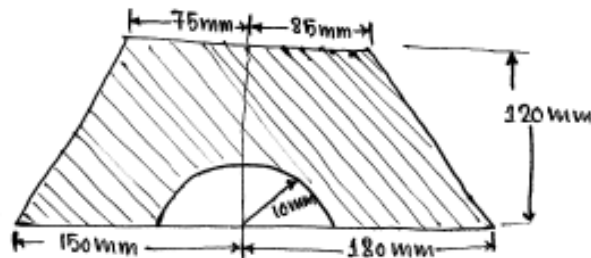


- b) A block weighing 2000 N is to be raised by forcing the wedge under it. Determine the required force  $P$  to lift the block A. Assume the weight of block-B as 1000N and the angle of friction of all connected system to be  $10^\circ$ .



7 + 8

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



1202 (O)

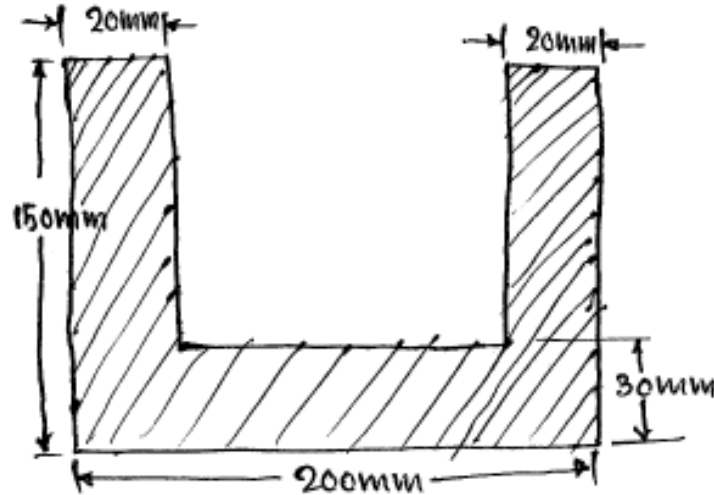
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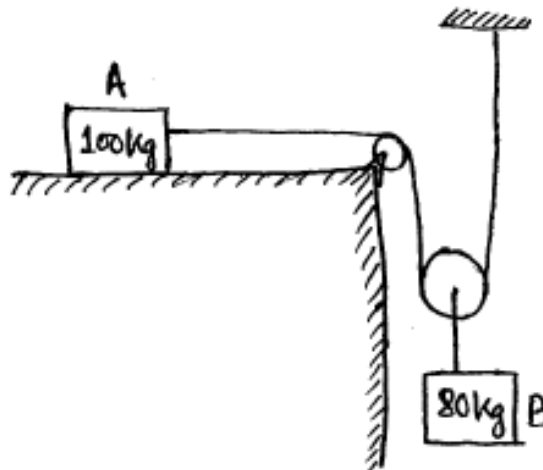


- b) Find the moment of inertia of shaded area about the centroidal axis parallel to  $X$ .



8 + 7

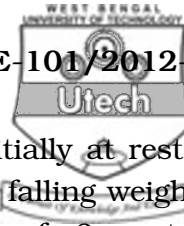
9. a) Two blocks of mass 100 kg and 80 kg are connected by a light inextensible string as shown in figure. Using the D' Alembert's principle find the acceleration of the blocks and tension in the string. Assume co-efficient of friction  $\mu = 0.3$ .



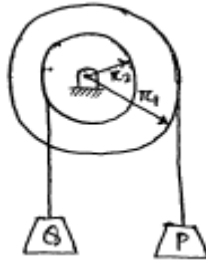
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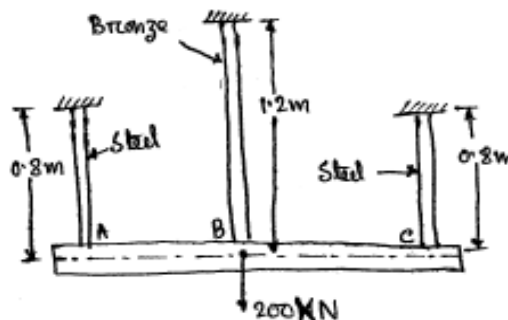
- b) Two weights  $P$  and  $Q$  are hung and initially at rest as shown in figure. Find the velocity of the falling weight  $P$  when it covers a vertical distance of 3 metres. Given  $P = Q = 10\text{ N}$ ,  $r_2 = 100\text{ mm}$  and  $r_1 = 50\text{ mm}$ . 8 + 7



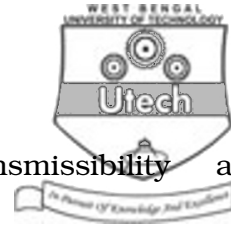
10. a) Find the volumetric strain for a triaxial stress system.  
 b) A rigid bar ABC weighing 180 kN is supported by three rods placed symmetrically as shown in figure. Assuming the bar to remain horizontal, determine the stress in each rod after a temperature rise of  $25^\circ\text{C}$ . The lower 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 =  $800\text{ mm}^2$ ; Area of bronze rod =  $1400\text{ mm}^2$ ;  $E_{st} = 2 \times 10^5\text{ N/mm}^2$ ;  $E_{br} = 0.8 \times 10^5\text{ N/mm}^2$ ;  $\alpha_{st} = 12 \times 10^{-6}/^\circ\text{C}$ ;  $\alpha_{br} = 20 \times 10^{-6}/^\circ\text{C}$

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



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11. a) Explain the principle of transmissibility and parallelogram law.
- b) A bus is starting to move with an acceleration of  $0.5 \text{ m/sec}^2$ . 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  $25^\circ$  with respect to the ground level. Determine the force exerted by the player if the duration of the strike is  $1/60$ th of a second.

5 + 5 + 5

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