**Total No. of Questions : 12]** **[Total No. of Printed Pages : 8**

# [3761]-18

## F. E. Examination - 2010

## ENGINEERING MECHANICS

**(2003 Course)**

**Time : 3 Hours]** **[Max. Marks : 100**

***Instructions :***

*(1) Answer **any three** questions from each section.*

*(2) Answers to the **two sections** should be written in **separate books**.*

*(3) Black figures to the right indicate full marks.*

*(4) Neat diagrams must be drawn wherever necessary.*

*(5) Your answers will be valued as a whole.*

*(6) Use of electronic pocket calculator is allowed.*

*(7) Assume suitable data, if necessary.*

---

## SECTION - I

**Q.1)** (A) Five forces are acting at a point 'O'. Find values of forces $P_1$ and $P_2$ required to keep point 'O' in equilibrium. Refer Fig.1. **[09]**

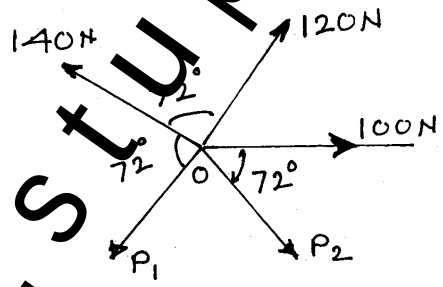



**Fig. 1**

(B) A person whose mass is 70 kg, represented by 'M', holds 25 kg mass as shown in Fig. 2. The pulley is assumed frictionless. The platform on which the person is standing is suspended by two ropes at 'A' and two ropes at 'B'. What is the tension in one rope at points A and B ? **[08]**

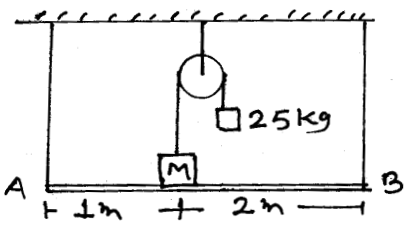



**Fig. 2**

www.stupidsid.com

**Q.2)** (A) A wedge A of 50N is to be driven between inclined plane and block B of 2000N as shown in Fig. 3. The coefficient of friction between all surfaces of contact is 0.30. Determine magnitude of the force 'P' required to start motion of the wedge A. **[09]**

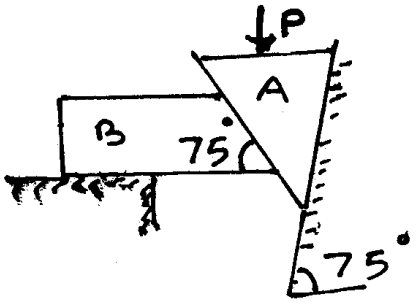



**Fig. 3**

(B) A semicircle of radius 60mm is removed from a trapezium. Locate centroid of the shaded portion that remained. Refer Fig. 4. All dimensions are in mm. **[08]**

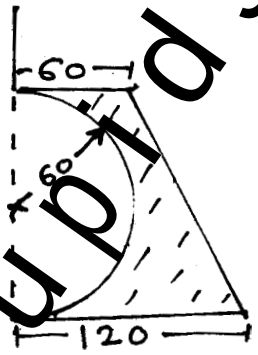



**Fig. 4**

**Q.3)** (A) Horizontal and Vertical Links are hinged to a wheel and force 'P' is applied to the link as shown in Fig. 5. Determine value of 'P' and reaction at 'A' for equilibrium. **[08]**

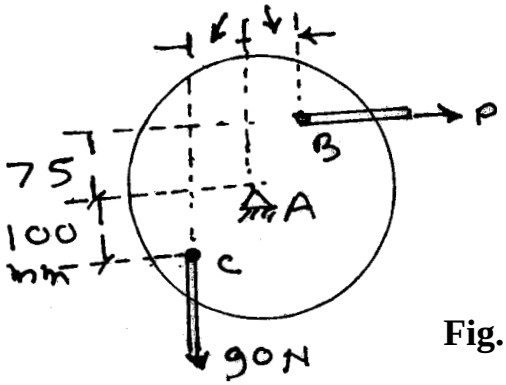



**Fig. 5**

www.stupidsid.com

(B) Find forces in all members of truss due to vertical force of 500N at C and horizontal force at B as shown in Fig. 6. **[08]**

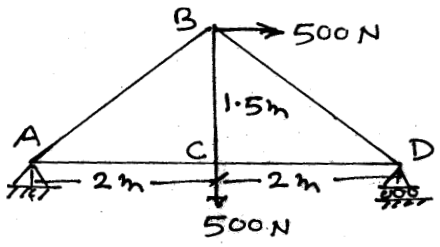



**Fig. 6**

**Q.4)** (A) A rectangular plate of 0.6m × 0.8m is kept such that, one of its diagonals is horizontal, as shown in Fig. 7. Locate resultant of this force system w.r.t. line AB. **[08]**

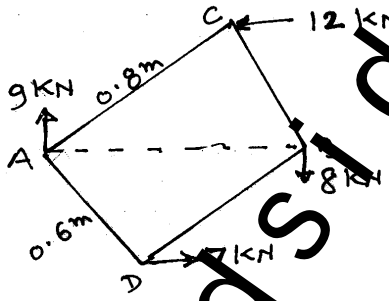



**Fig. 7**

(B) Derive relation between tight side and slack side of the flat belt using usual notations. **[08]**

**Q.5)** (A) Using Virtual Work Method find support reactions of the beam shown in Fig. 8. **[08]**

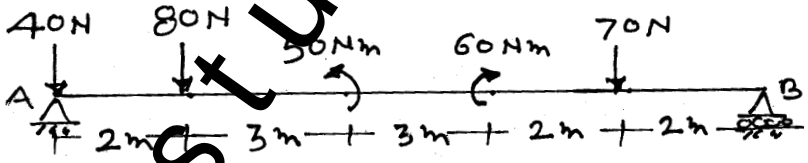



**Fig. 8**

(B) The circular table, 1.8m in diameter shown in Fig. 9, supports a load of 400N, located at point D on a diameter through the support A and 300mm from centre on the opposite side of $R_A$. The support reaction $R_A$, $R_B$, $R_C$ are equally spaced along the circumference. Determine magnitude of the reactions. **[09]**

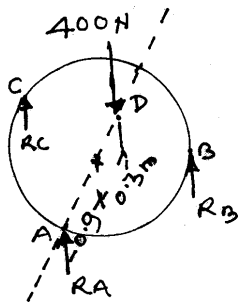



**Fig. 9**

www.stupidsid.com

**Q.6)** (A) A homogeneous ladder having a mass 'm' and length 'L' is held in equilibrium by the horizontal force 'P' as shown in Fig. 10. Using Virtual Work Method only, express force 'P' in terms of mass 'm'. **[08]**

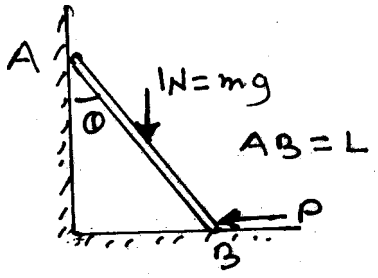



**Fig. 10**

(B) A 80 kg mass as shown in Fig. 11, is supported by three wires concurrent at D(2, 0, –1). The wires are attached to the point A(1, 3, 0), B(3, 3, –4) and C(4, 3, 0). Determine tension in each wire. **[09]**

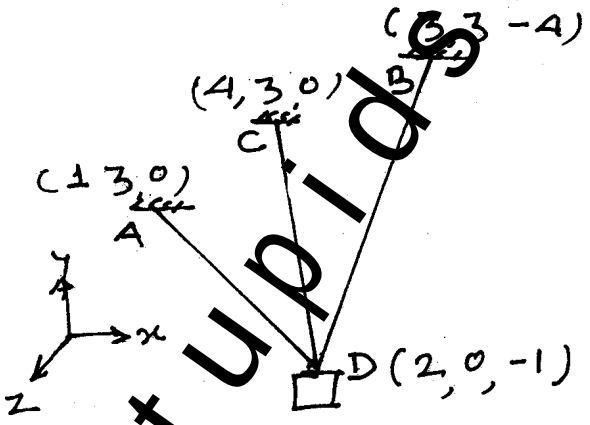



**Fig. 11**

## SECTION - II

**Q.7)** (A) The motion of a particle is defined by the relation $x = t^3 - 6t^2 + 9t + 5$, where x, m, t in sec.

Find :

(1) When the velocity is zero.

(2) At t = 8, position and acceleration.

(3) Total distance travelled in 0 to 8 sec. **[09]**

www.stupidsid.com

(B) A bag having 8 kg mass is released from rest from a position 'A' when $\theta = 0$. It strikes a box 'B' of mass 20 kg when $\theta = 90^{o}$. Find velocities of bag 'A' and box 'B' after impact, if the coefficient of restitution is half. **[08]**

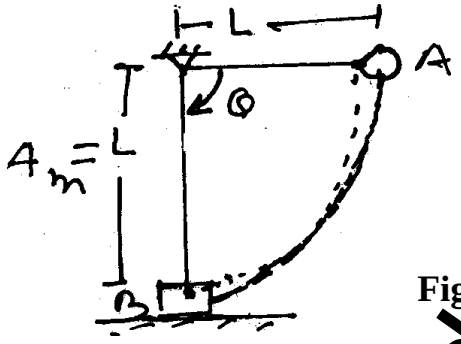



**Fig. 12**

**Q.8)** (A) Ships 'A' and 'B' leave a port at the same time. The ship 'A' is travelling North West at 36 kmph and ship 'B' at $40^{o}$ South of West at 24 kmph.

Determine :

(1) Speed of ship 'B' relative to 'A'.

(2) At what time they will be 160 km apart ? **[08]**

(B) Three blocks A, B, C of weight 250N, 1000N, 500N respectively are connected by inextensible string. Determine constant force 'P' that will give system of blocks shown in Fig., a velocity of 3m/s after moving a distance of 4.5m from rest. All the blocks are moving with constant acceleration. Take coefficient of friction = 0.20 and assume pulleys as frictionless. **[09]**

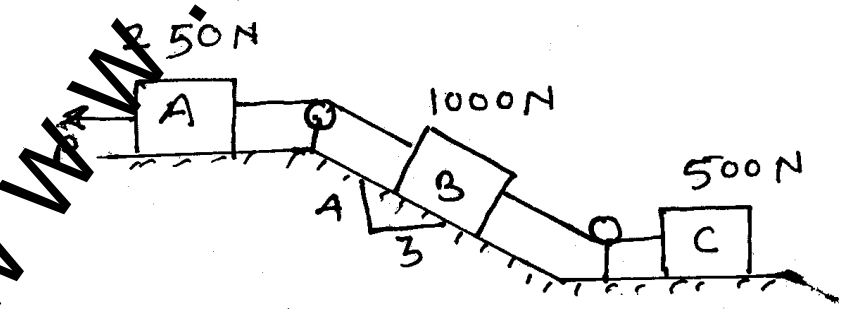



**Fig. 13**

www.stupidsid.com

**Q.9)** (A) A projectile is fired with an initial velocity of 260m/s at a target B, located at 700m above the ground, at a horizontal distance of 3600m from the gun as shown in Fig. 14. Neglecting air resistance, determine values of the firing angle $\alpha$. **[08]**

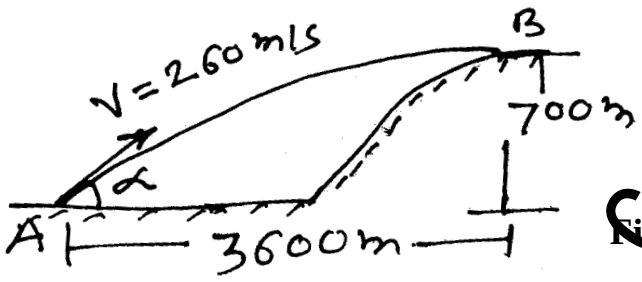



**Fig. 14**

(B) A ball of weight 10N starts from rest from the origin 'O' of the curve OAB and rolls under gravity as shown in Fig. 15. Find reaction exerted on the ball at a point A, if curve is defined by the equation $y = \sin\left(\frac{x}{L}\right)$ **[08]**

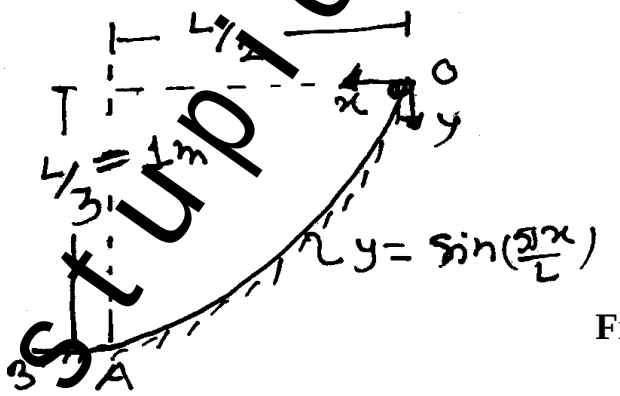



**Fig. 15**

**Q.10)** (A) A particle moving along a path defined by the polar co-ordinate $r = (3\sin t)$ ..... m and $\theta = 2t^3$ ..... rad where 't' is in seconds and argument for the sinC is in radians. Determine components of its velocity and acceleration, when t = 1 sec. **[08]**

www.studyindsrd.com

(B) A block assumed to be a particle and weighing 40N rests on a plane which can turn about the y axis as shown in Fig. 16. The length of cord is 2m. What is the tension in the cord when angular velocity of the plane and the block is 10 rev./min. **[08]**

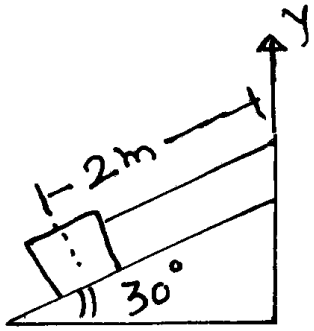
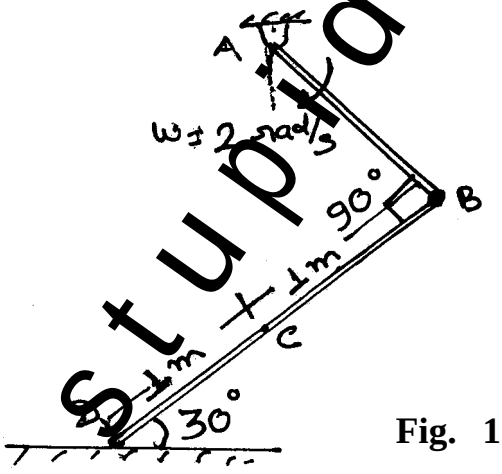



**Fig. 16**

**Q.11)**(A) As shown, rod AB of 1m length is rotating clockwise at 2 rad/s. End 'D' of the rod BD = 2m length, is free to move on a horizontal surface. Determine linear velocity of the points in its magnitude and direction for : (i) midpoint of BD. (ii) point D. **[09]**




AB = 1m
BC = CD = 1m

**Fig. 17**

(B) Derive expression for mass moment of inertia of a bar about an axis through one end and perpendicular to the bar whose length is L. Assume that the mass 'm' and the cross section is small in comparison with length. **[04]**

(C) Explain concept of Dynamic Equilibrium in case of rigid body motion. **[04]**

www.stupidsid.com

**Q.12)**(A) Explain equations defining the rotation of rigid body about a fixed axis with angular displacement 'θ' in time 't' in the following cases :

(1) Uniform Rotation

(2) Uniform Accelerated Rotation

(3) Variable Acceleration 'α' **[08]**

(B) In Fig. 18, a box 'C' of weight W is accelerating down at the rate of 5 $m/s^2$. It is connected by weightless, flexible, inextensible rope which passes over a smooth drum to homogenous cylinder B of weight 250N. The cylinder is acted upon by a moment M = 50Nm counterclockwise. Determine weight 'W' of the box 'C' and components of reactions at A on the cylinder. **[09]**

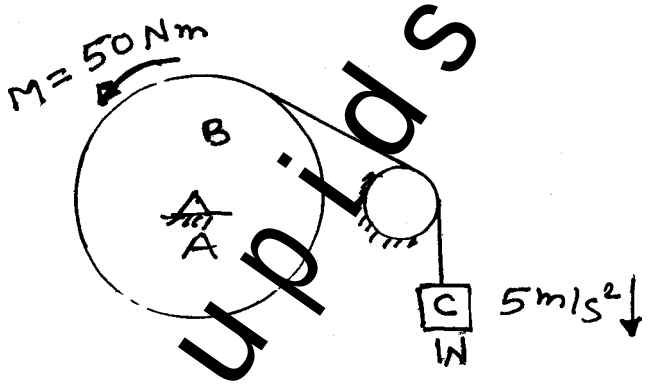



**Fig. 18**

www.stupidsid.com