**BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR**

**First Semester B.Arch. Final Examination 2012**

**Subject: Engineering Mechanics (AM 101A)**

**Branch:** Architecture

**Full Marks: 70** **Time: 03 hours**

(i) Take $g = 9.807$ m/s$^2$.

(ii) Assume any other data not given in the question.

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## First Half

*Answer Question No.1 and any THREE from the rest.*

1. A 400 N force is applied to a welded slender member having negligible self weight (Fig.1). The member is fixed to the floor at *O*. Fill in the blanks: (2+2+1)

(a) If $\theta = 20^{\circ}$, The magnitudes of moments developed at *A* and *O* are respectively _____ and _____.

(b) If the moments at *A* and *O* are identical, the values of $\theta$ should be _____ or _____.

(c) The moment at *O* vanishes when the value of $\theta$ is _____ , if $0 \leq \theta \leq 180^{\circ}$.

2(a) The 450 kg uniform I-beam supports a load, having a total mass of 220 kg, shown in Fig.2. Determine the reactions at the supports. (3)

(b) A uniform slender rod having mass $m_1$ is welded centrally (Fig.3) to the horizontal edge of a uniform semi-cylindrical shell having mass $m_2$. The composite body is resting on the horizontal floor. Express $\theta$ in terms of $m_1$ and $m_2$ for which the system is in equilibrium. (7)

3(a) State Coulomb's laws of friction. (2)

(b) Two blocks having weights $W_1$ and $W_2$ are connected by a string and rest on horizontal floors as shown in Fig.4. If the angle of static friction for each block with the floor is $\psi$, determine the magnitude and direction of the minimum force *P* applied to the upper block that will induce sliding. (8)

4 Determine the axial forces induced in the members of the loaded truss shown in Fig.5. (10)

5 A force $P$ is applied at the mid-point $D$ of the member $BC$ (Fig.6). Determine the value of the couple $M$ in terms of $P$ and $R$ such that: (i) the horizontal force transmitted by the pin $B$ is zero. (ii) the vertical force transmitted by the pin $B$ is zero. Both the members are of negligible self weight. (5+5)

6 Determine the centroidal polar moment of inertia of the area bounded by the straight line $x = y$ and the parabola $x = y^2$. (10)

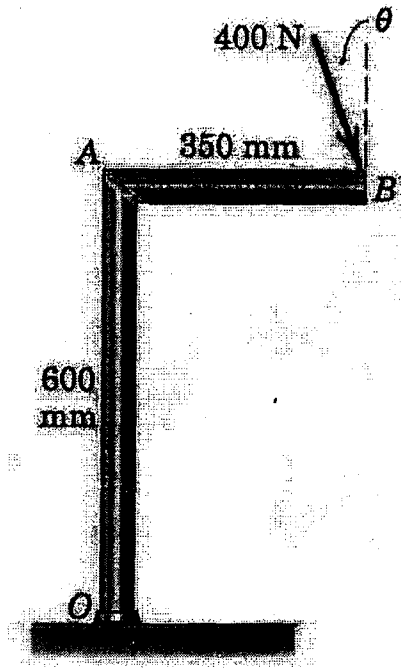



Fig.1.

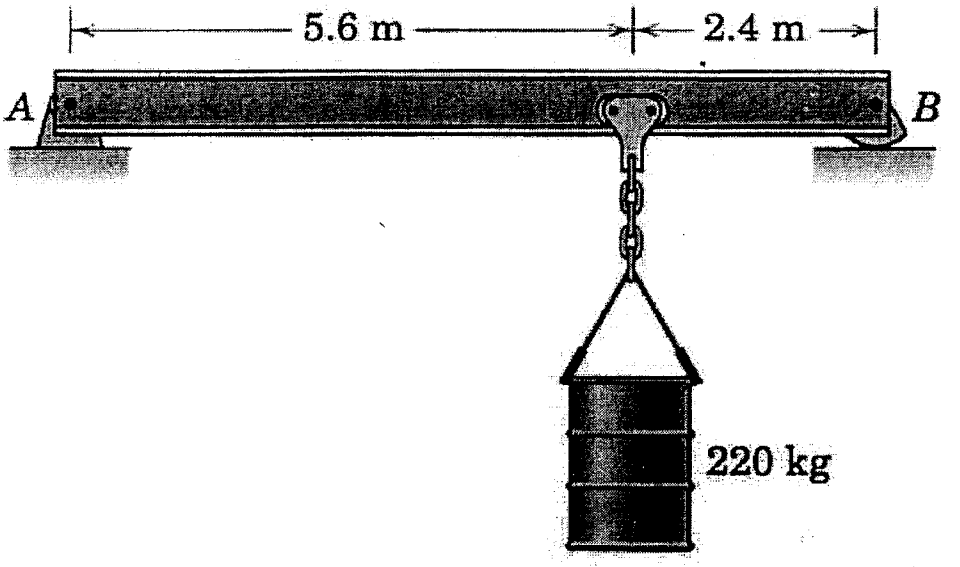



Fig.2.

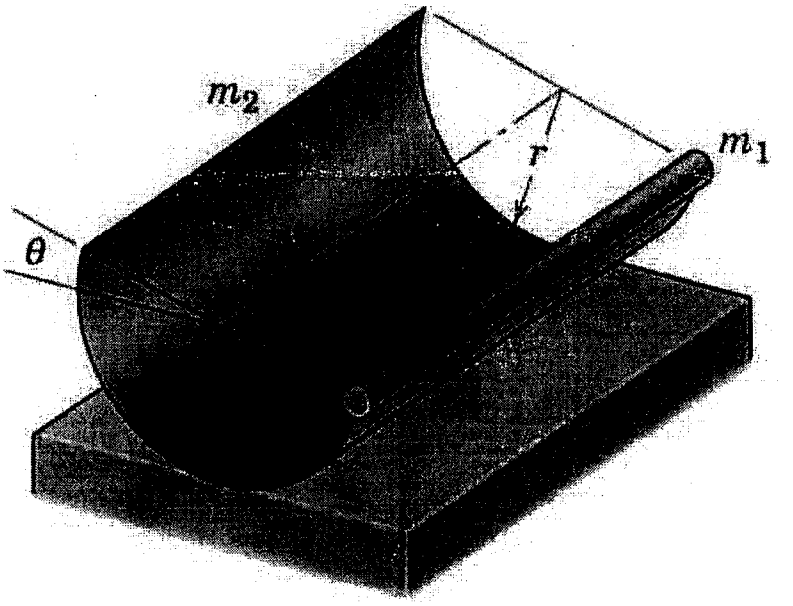



Fig. 3.

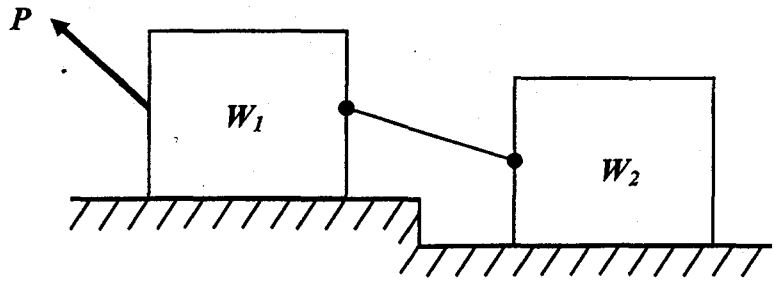



Fig. 4.

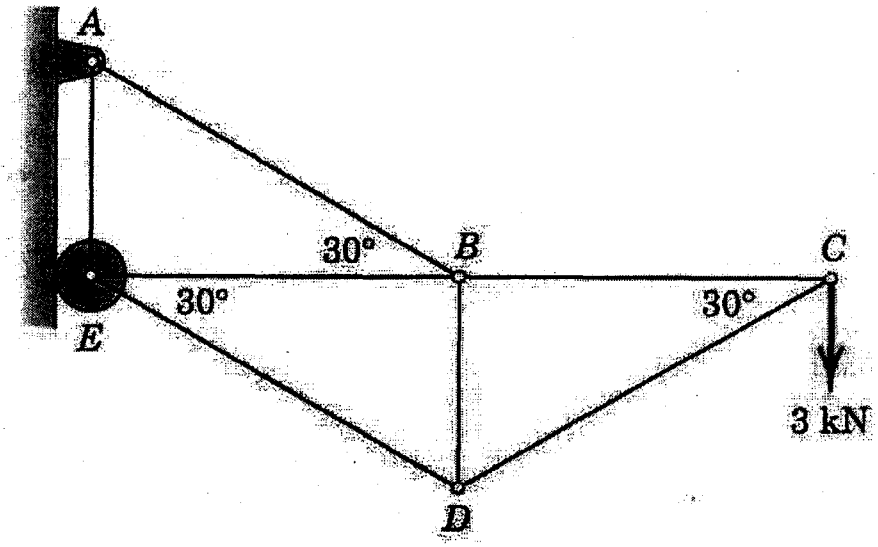



Fig.5.

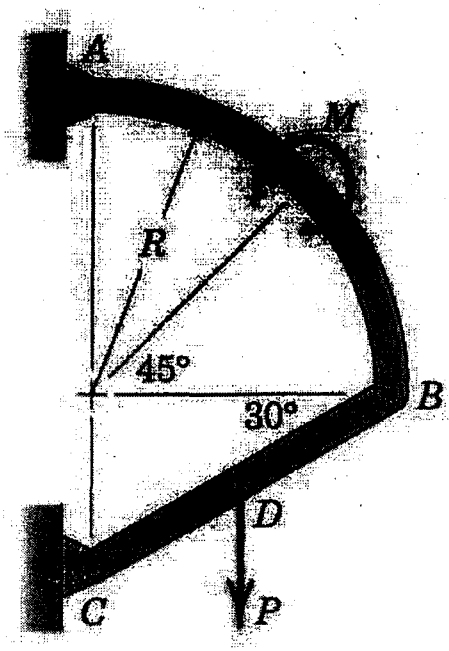



Fig. 6.

## 2ND HALF

Answer Q. 7 & any three from the rest.

Q.7.(a) Explain the following terminologies :
(i) Particle, (ii) Kinetics, (iii) Kinematics.

(b) Deduce and state the principle of conservation of momentum in rectilinear motion of a particle.

Q.8. A system of weights and pulleys is arranged in a vertical plane as shown in Figure Q.8. Neglecting friction and the inertia of the pulleys, find the acceleration of each weight if their magnitudes are in the ratio $w_a : w_b : w_c = 3 : 2 : 1$.

Q.9. A flat car can roll without resistance along a horizontal track as shown in Figure Q.9. Initially, the car together with a man of weight $w$ is moving to the right with speed $v_0$. What increment of velocity $\Delta v$ will the car obtain if the man runs with speed $u$ relative to the floor of the car and jumps off at the left?

Q.10. In Figure Q.10, the bob of a conical pendulum of length $l$ and weight $w$ describes a horizontal circle defined by the equations

$$x = a \cos wt \qquad y = a \sin wt$$

where $a$ is the radius of the circular path and $w$ is constant. Prove that the tension $T$ in the string is constant during such motion and find its magnitude.

Q.11. The arrangement shown in Figure Q.11 rotates about the vertical axis $yy$ at constant rpm. The weight of the vertical bar $AB$, hinged at $C$, is 3 N and the weight of the ball at the top is 6 N. When the system is at rest, the initial tension in the spring $DE$ is 20 N. At what rpm will contact at $A$ be broken? Assume the frame and bar $AB$ to be absolutely rigid.

Q.12. What is the minimum uniform speed that a man and motor cycle of weight $w$ can have in going around the inside of a vertical circular drum of radius $r$ (Figure Q.12) in order to prevent slipping down the wall if the coefficient of friction between the tyres and wall is $\mu$ ? When the motor cycle is running at this speed, what angle $\alpha$ must its middle plane make with the horizontal in order to prevent slipping down?

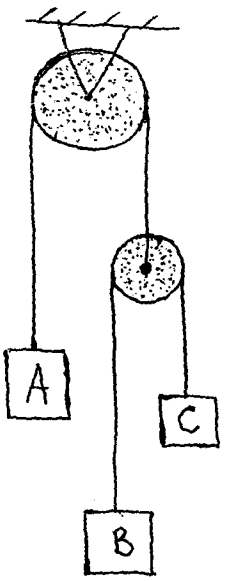



Figure Q8

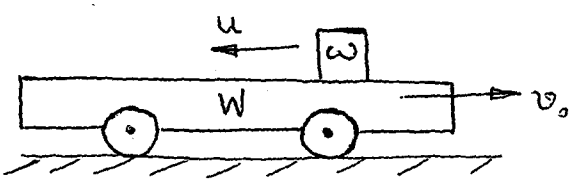



Figure Q9

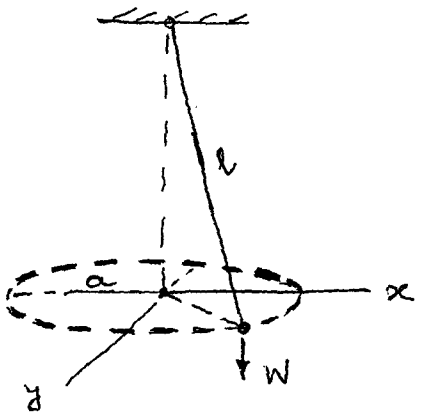
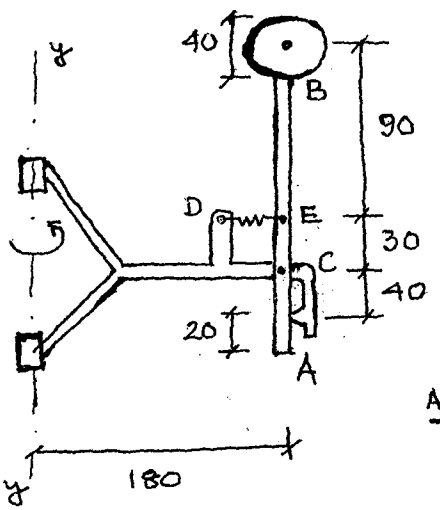



Figure Q10




All dimensions in mm

Figure Q11

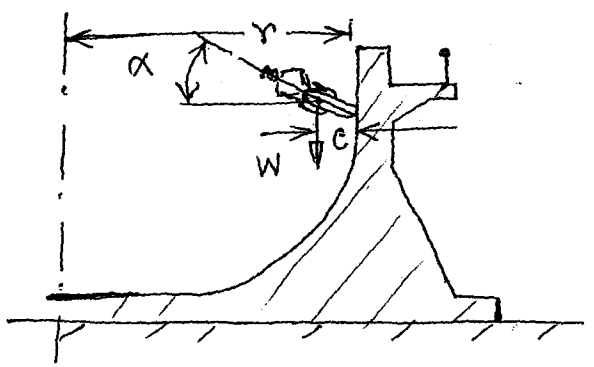



Figure Q 12