MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : ME-101

ENGINEERING MECHANICS

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 any *ten* of the following : $10 \times 1 = 10$

   i) The principal stresses at a point in an elastic material are 60 N/nm^2 tensile, and 50 N/nm^2 compressive. Calculate the volumetric strain. Take $E = 100 \times 10^3$ N/mm^2 and $\mu = 0{\cdot}3$.

   a) $1{\cdot}6 \times 10^{-4}$ b) $1{\cdot}8 \times 10^{-4}$

   c) $1{\cdot}2 \times 10^{-4}$ d) $1{\cdot}0 \times 10^{-4}$.

[Turn over

ii) Two forces of 100 N and 150 N are acting simultaneously at a point. What is the resultant of these two forces, if the angle between them is 45° ?

a) 212 b) 222

c) 232 d) 242.

iii) A force of 15 N is applied at an angle of 60° to the edge of a 0·8 m wide door. Find the moment about the hinge of that door.

a) 10 N-m b) 10·2 N-m

c) 10·4 N-m d) 10·6 N-m.

iv) Null vector is known as

a) negative vector b) unit vector

c) zero vector d) none of these.

v) Centre of gravity of solid cone lies on the axis at the height

a) 1/4 th of the total height above the base

b) 1/3 rd of the total height above the base

c) 1/2 of the total height above the base

d) 3/8 th of the total height above the base.

vi) The differential equation of a free falling body is

a) $\ddot{x} = 0,\ \ddot{y} = 0$ b) $\ddot{x} = c,\ \ddot{y} = g$

c) $\ddot{x} = 0,\ \ddot{y} = g$ d) none of these.

vii) The velocity of a body on reaching the ground from a height h, is given by

a) $v = 2gh$ b) $v = 2gh^2$

c) $v = \sqrt{2gh}$ d) $v = \frac{h^2}{2g}$.

viii) The time variation of the position of a particle in rectilinear motion is given by $X = 2t^3 + t^2 + 2$. If 'v' is the velocity and 'a' the acceleration of the particle in consistent units, the motion started with

a) $v = 0, a = 0$ b) $v = 0, a = 2$

c) $v = 2, a = 0$ d) $v = 2, a = 2$.

ix) The maximum strain energy that can be stored in a body is known as

a) impact energy

b) resilience

c) proof resilience

d) modulus of resilience.

x) If the momentum of a body is doubled, its kinetic energy will

a) increase by two times

b) increase by four times

c) remain same

d) get halved.

xi) Three forces $\sqrt{3}P$, P and $2P$ acting on a particle are in equilibrium. If the angle between the first and second be 90°, the angle between the second and third will be

a) 30° b) 60°

c) 120° d) 150°.

xii) The dot product of two orthogonal vectors is

a) one

b) no definite value

c) zero

d) none of these.

GROUP – B

(Short Answer Type Questions)

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

2. What do you mean by a free body diagram ? Draw the FBD from the given fig.1

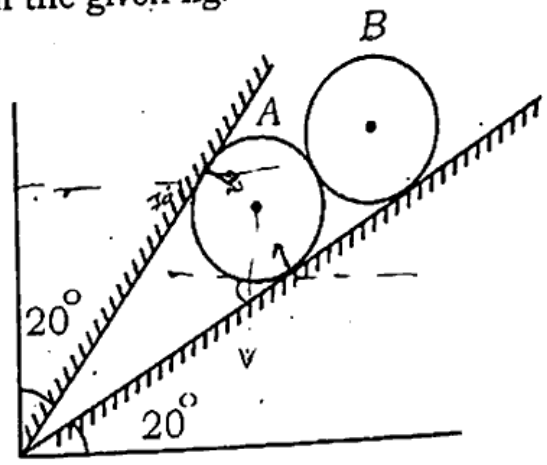

Fig.1

3. Locate the centroid of the shaded area as shown in Fig.2. All the dimensions are in mm.

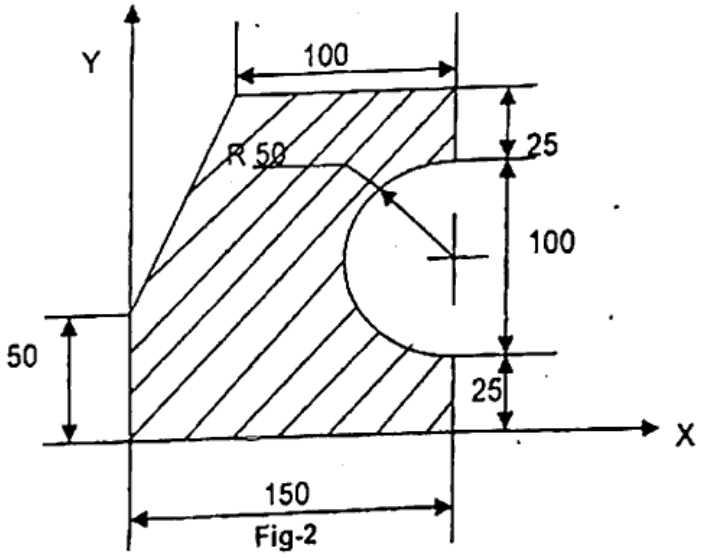

Fig-2

4. A block A of weight 100 n is placed on an inclined plane which makes an angle 30° to the horizontal, an extensible string is connected to block A and is passed over a smooth pulley. Another block B is hung freely at the other end of the string as shown in fig. 3. Determine the range of weight of block B, such that the block A has motion neither up the plane nor down the plane. Take $\mu = 0{\cdot}3$ for all contact surfaces.

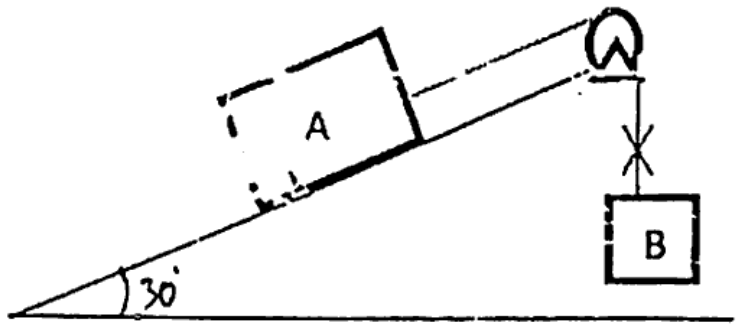

Fig.3

5. Moment of a certain force abut the point P (3, 7, –2) is $(10\hat{i}-8\hat{j}+40\hat{k})$ kN-m. Find the moment of the same force about the line PQ. Co-ordinate of Q is (5, 8, 1).

6. The acceleration of a particle along a straight line is given by the equation $a = 4 - \frac{t^2}{9}$. If the particle starts with zero initial velocity from a position $x = 0$, find (i) its velocity after 6 sec and (ii) distance travelled in 6 sec.

7. Determine the reactions at supports *A* and *C* in the structure shown in the Fig. 4.

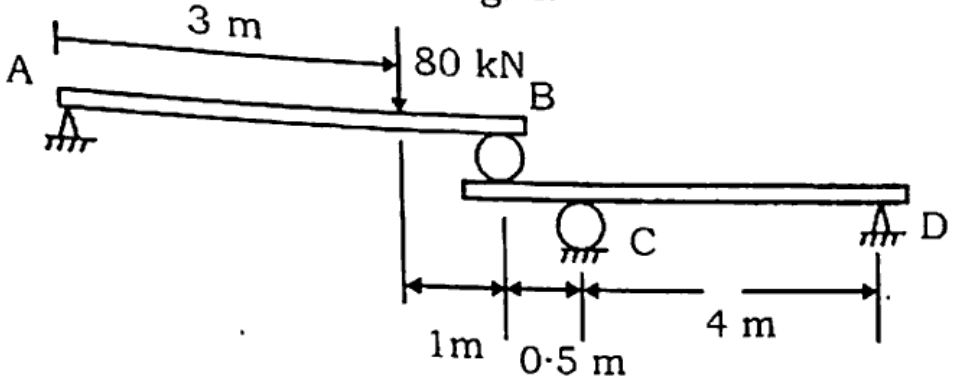

Fig. 4

GROUP – C

(Long Answer Type Questions)

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

8. a) A roller of radius r = 304·8 mm and weight Q = 2225 N is to be rolled over a curb of height h = 152·4 mm by a horizontal force P applied to the end of a string wound around the circumference of the roller, Fig. 5. Find the magnitude of P required to start the roller over the curb. There is sufficient friction between the roller surface and the edge of the curb to prevent slip at *A*. 8

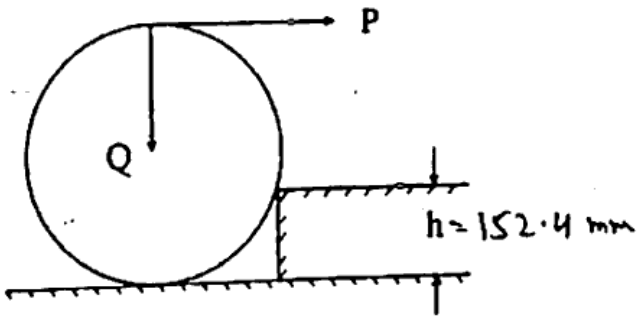

Fig. 5

b) Two beams *AB* and *DE* are arranged and supported as shown in Fig. 6. Find the magnitude of the reaction *RE* at *E* due to the force *P* = 890 N applied at *B* as shown. 7

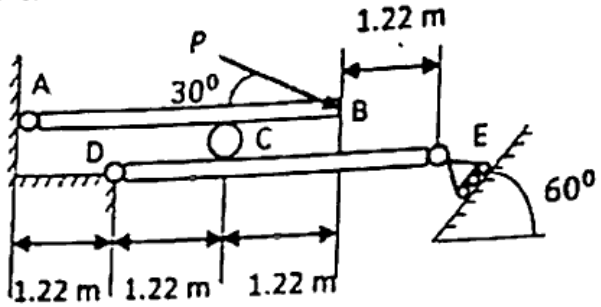

Fig. 6

9. a) Two equal loads of 2500 N are supported by a flexible string *ABCD* at points *B* and *D* as shown in the Fig. 7. Find the tensions in the portions *AB*, *BC* and *CD* of the string. 7

b) Two blocks connected by a horizontal link *AB* are supported on two rough planes as shown in fig. 8. The coefficient of friction for block *A* on the horizontal plane is $\mu = 0{\cdot}4$. The angle of friction for block *B* on the inclined plane is 15°. What is the smallest weight of the block *A* for which equilibrium will exist ? 8

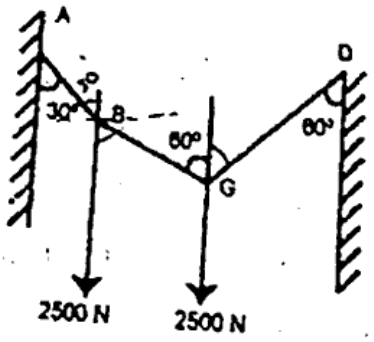

Fig. 7

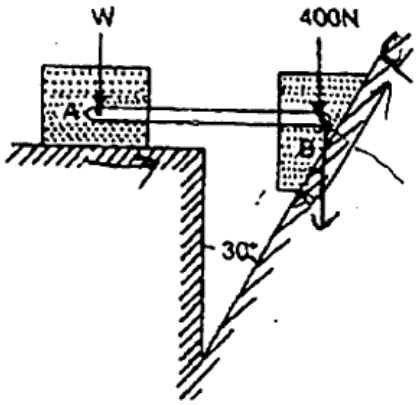

Fig. 8

10. a) A steel bar of 20 mm diameter is loaded as shown in fig. 9. Determine the stresses in each part and the total elongation. Take $E = 2 \times 10^5$ N/nm^2. 7

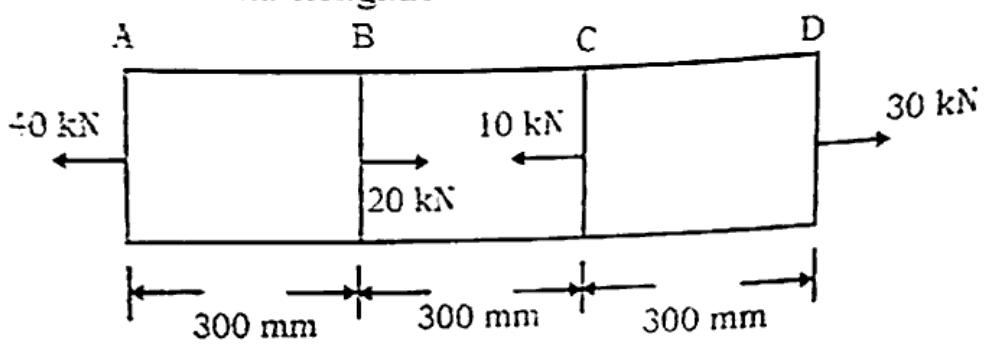

Fig. 9

b) A force $F = 50\ i + 75\ j + 100\ k$. acts through E as shown in Fig.10. Determine the moment of force about x, y and z axes respectively. 8

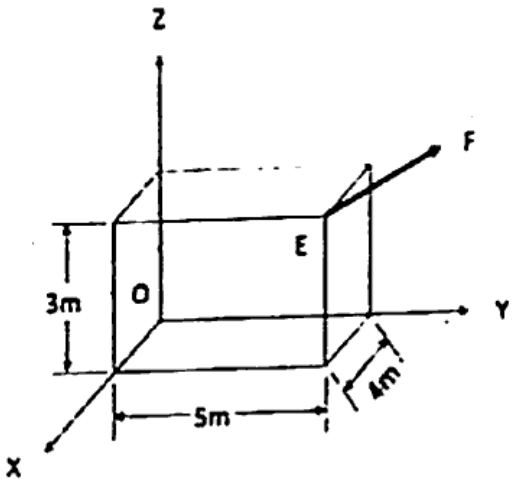

Fig. 10

11. a) A rope AB is attached at B to a small block and passes over a small pulley C so that its free end A hangs 5m above the ground as shown in the Fig. 11. The end A is moved horizontally following a

straight line with uniform velocity V_0. Establish a relationship between velocities of the block with time. 7

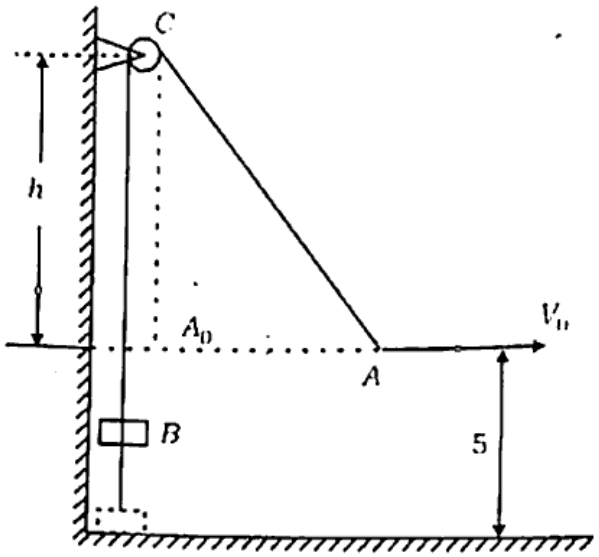

Fig. 11

b) Two blocks A and B Fig. 11 weighing $W_A = 45$ N and $W_B = 90$N respectively are placed side by side on an inclined plane having inclination angle $\alpha = 30°$ as shown in Fig.12 so that they can slide together. If the coefficient of friction between the blocks and the plane are $\mu_A = 0{\cdot}15$ and $\mu_B = 0{\cdot}30$ respectively, find the contact thrust existing between the blocks under motion.

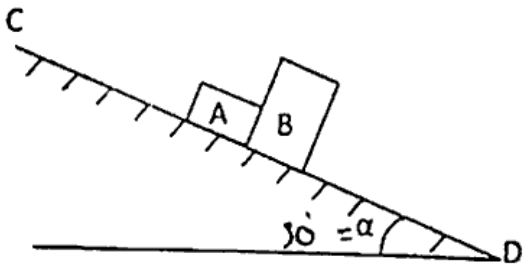

Fig. 12 8

12. a) Block B has rightward velocity of 1·2m/s as shown in Fig.13. Find the velocity of the block A. 8

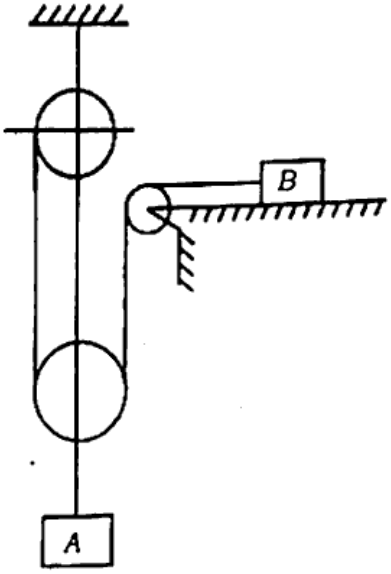

Fig. 13

b) A shot is fired with a bullet with an initial velocity of 40 m/sec from a point 20 m in front of a vertical wall 10 m. high as shown in Fig. 14. Find the angle of projection with horizontal to enable the shot to just clear the wall.

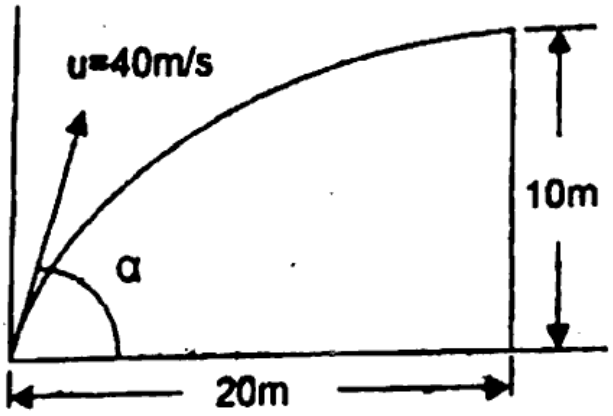

Fig. 14 7