No. of Printed Pages : 11

**BME-016**

**B.Tech. MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING) / B.Tech. (AEROSPACE ENGINEERING) (BTAE)**

**Term-End Examination**

01450

**June, 2014**

## BME-016 : ENGINEERING MECHANICS

*Time : 3 hours* *Maximum Marks : 70*

***Note :*** *Attempt any **seven** questions. Use of calculator is permitted. All questions carry equal marks.*

**1.** (a) A vehicle of mass 600 kg and moving with a velocity of 12 m/sec strikes another vehicle of mass 400 kg, moving at 9 m/sec in the same direction. Both the vehicles get coupled together after the impact. Find the common velocity with which the two vehicles will move. Also find the loss of kinetic energy due to impact.

(b) Two forces act at an angle of 120°. The bigger force is of 40 N and the resultant is perpendicular to the smaller one. Find the smaller one and the resultant force. *5+5*

**2.** (a) A particle is projected with a velocity of 20 m/s in air at an angle $\alpha$ with the horizontal. The X and Y co-ordinates of a point lying on the trajectory of the particle with respect to point of projection are 20 m and 8 m respectively. Find the angle of projection of the particle.

(b) A train of weight 1960 kN starts from rest and attains a speed of 120 km/hr in 5 minutes. If the frictional resistance of the track is 10 N per kN of the train weight, find the average pull required. Take $g = 9{\cdot}8\ m/s^2$. *5+5*

**3.** (a) A 7 m ladder weighing 250 N is being pushed by force F as shown in Figure 1. What is the minimum force needed to get the ladder to move ? The static coefficient of friction for all contact surfaces is 0·4.

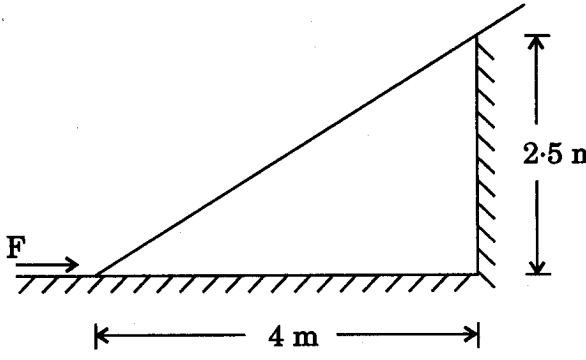


*Figure 1*

(b) A block of weight $W_1$ = 1290 N rests on a horizontal surface and supports another block of weight $W_2$ = 570 N on top of it as shown in Figure 2. Block of weight $W_2$ is attached to a vertical wall by an inclined string AB. Find the force 'P' applied to the lower block, that will be necessary to cause the slipping to impend. Coefficient of friction between blocks 1 and 2 = 0·25 coefficient of friction between block 1 and horizontal surface = 0·40. *5+5*

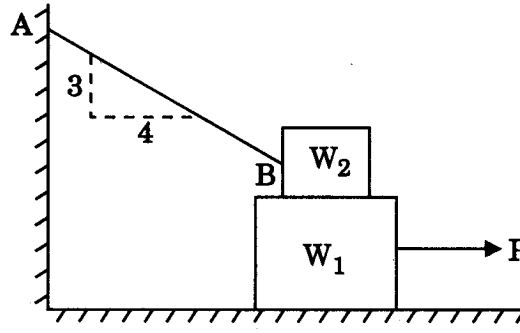


*Figure 2*

4. (a) Locate centroid for the volume as shown in Figure 3.

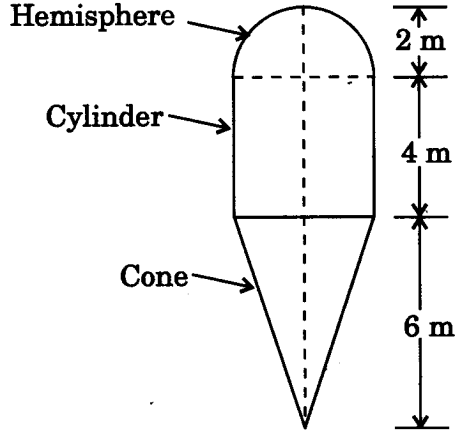


*Figure 3*

(b) Calculate the moment of inertia of the section shown in Figure 4 about the 'x-x' and 'y-y' axis through the centroid. *5+5*

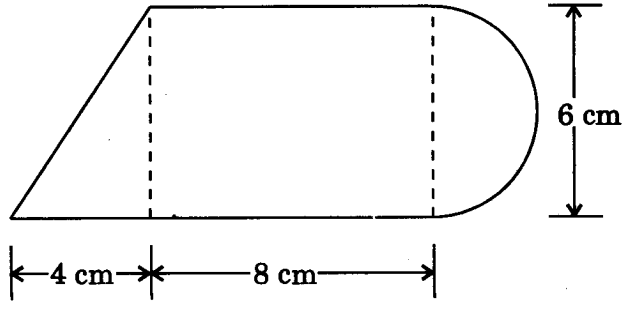


*Figure 4*

5. (a) Two blocks of masses $M_1$ = 2 kg, and $M_2$ = 5 kg are moving in the same direction along a frictionless surface with speeds 10 $ms^{-1}$ and 3 $ms^{-1}$ respectively as shown in Figure 5, $M_2$ being ahead of $M_1$. An initial spring with K = 1120 $Nm^{-1}$ is attached to the back side of block $M_2$. Find the maximum compression of the spring when the blocks collide.

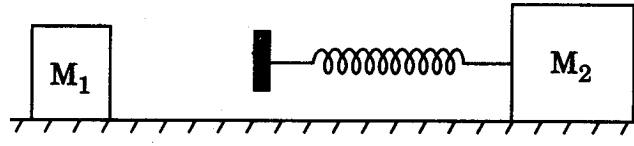


*Figure 5*

(b) A particle falls from a height 'h' upon a fixed horizontal plane. If the coefficient of restitution is 'e', show that

(i) the whole distance described by the particle before it has finished rebounding is $\left(\frac{1+e^2}{1-e^2}\right)h$.

(ii) the time that elapsed is $\left[\left(\frac{1+e}{1-e}\right)\right]\sqrt{\frac{2h}{g}}$. *5+5*

**6.** (a) The five forces $F_1$, $F_2$, $F_3$, $F_4$ and $F_5$ are acting at a point on a body as shown in Figure 6 and the body is in equilibrium. If $F_1 = 18$ N, $F_2 = 22{\cdot}5$ N, $F_3 = 15$ N and $F_4 = 30$ N, find the force $F_5$ in magnitude and direction.

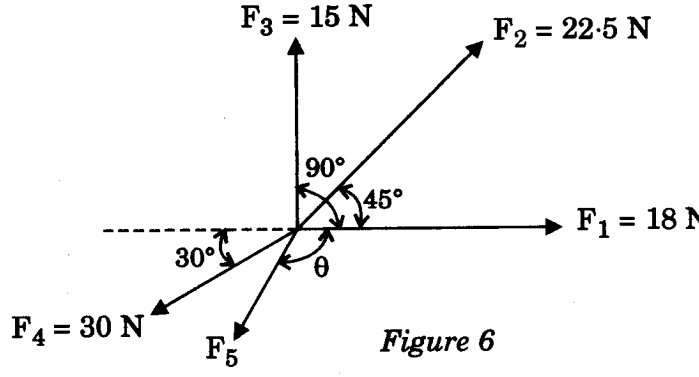


*Figure 6*

(b) A pull of 20 N inclined at 25° to the horizontal plane, is required just to move a body placed on a rough horizontal plane. But the push required to move the body is 25 N. If the push is inclined at 25° to the horizontal, find the weight of the body and the coefficient of friction. *5+5*

7. (a) A uniform wheel of 600 mm diameter, weighing 5 kN rests against a rigid rectangular block of 150 mm height as shown in Figure 7. Find the least pull, through the centre of the wheel, required just to turn the wheel over the corner A of the block. Also find the reaction of the block. Take all the surfaces to be smooth.

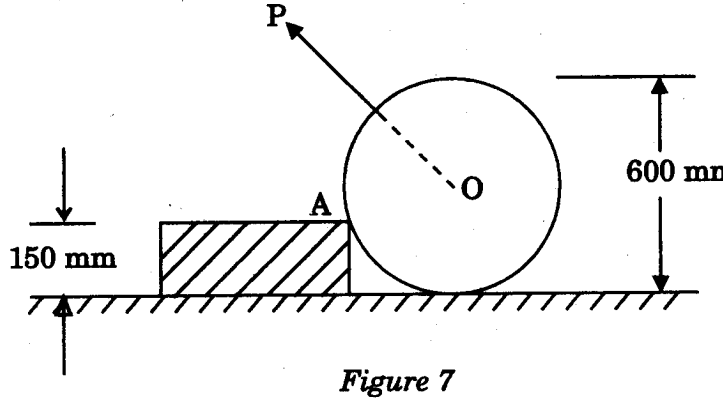


*Figure 7*

(b) Find the reactions at supports A and C of a loaded beam AB as shown in Figure 8. *5+5*

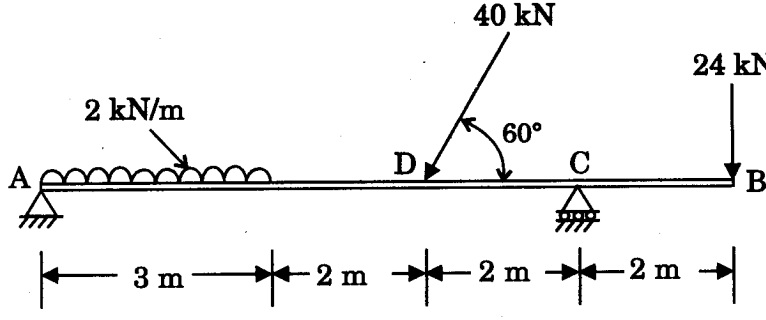


*Figure 8*

8. (a) The velocities of two steel balls before impact are as shown in Figure 9. If, after impact, the velocity of ball 'B' is observed to be 7 m/s to the right, determine the coefficient of restitution between the two balls.

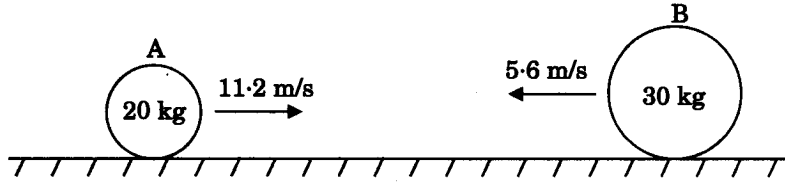


*Figure 9*

(b) Using the method of sections, analyse the truss as shown in Figure 10 regarding forces in members ED, DF and FC. *5+5*

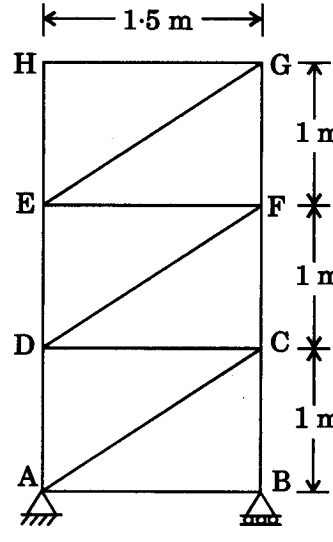


*Figure 10*

**9.** (a) Determine the forces in all the members of a cantilever truss as shown in Figure 11.

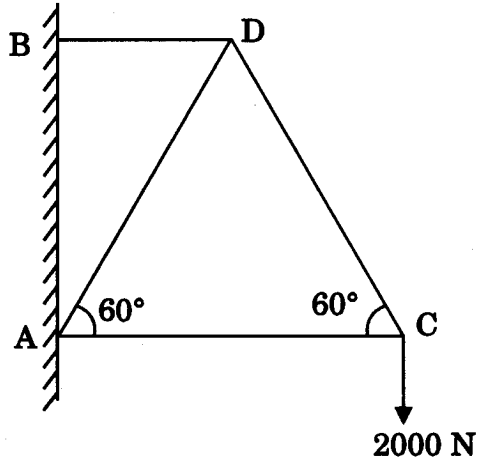


*Figure 11*

(b) A wagon weighing 50 kN is moving with a velocity of 36 km/hr on a level track with negligible track resistance as shown in Figure 12. At the end of track A, main bumper shield with a spring constant of 2 kN/mm is provided. Two auxiliary bumper shields each of spring constant 1 kN/mm are provided 200 mm before main shield. Determine the maximum

compression in main bumper. Also compute, how much share of energy is transmitted to auxiliary springs. Assume $g = 10\ ms^{-2}$. *5+5*

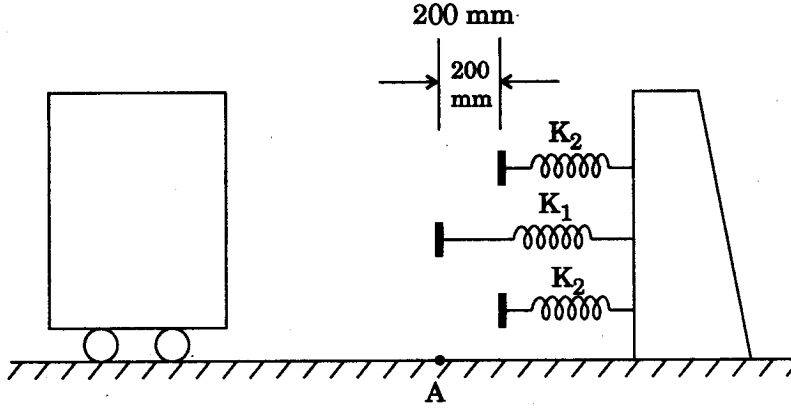


*Figure 12*

**10.** (a) Two forces of magnitude 20 N and 40 N are acting on a particle such that the angle between the two is 135°. If both these forces are acting away from the particle, calculate their resultant and find its direction.

(b) A particle is projected in air with a uniform velocity 80 m/s at an angle of 45° with the horizontal.

Find :

(i) horizontal range

(ii) the maximum height attained by the particle, and

(iii) the time of flight. *5+5*