53 (ME 201) ENMC

2013 C

(December)

ENGINEERING MECHANICS

Paper : ME 201

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* Explain the term 'Force' and list its characteristics. 3

   (b) State and explain Newton's three laws of motion. 5

   (c) Explain the terms-concurrent and non-concurrent force system; planar and non-planar system of forces. 4

   (d) State triangle law of forces and polygon law of forces. 4

(e) What do you mean by system of forces ? State the effects of a force. 1+3=4

2. (a) A push of $180N$ and pull of $350N$ act simultaneously at a point. Find the resultant of the forces, if the angle between them be 135°. 4

(b) The resultant of two forces P and Q is R. If Q is doubled, the new resultant is perpendicular to P. Prove that $Q = R$. 5

(c) The resultant of two forces one of which is 3 times the other is $300N$. When the direction of smaller force is reversed, the resultant is $200N$. Determine the two forces and the angle between them. 6

(d) The following forces act at a point :

(i) $30N$ inclined at 30° towards North of East.

(ii) $35N$ towards North.

(iii) $40N$ inclined at 40° towards North of West.

(iv) $45N$ inclined at 40° towards South of West.

Find the magnitude and direction of the resultant force using Graphical Method. 5

3. *(a)* A cylindrical wooden log of weight $11.772kN$ is kept within inclined planes, which are mutually perpendicular *fig (i)*. Considering contact surfaces smooth, determine the forces of reaction. 5

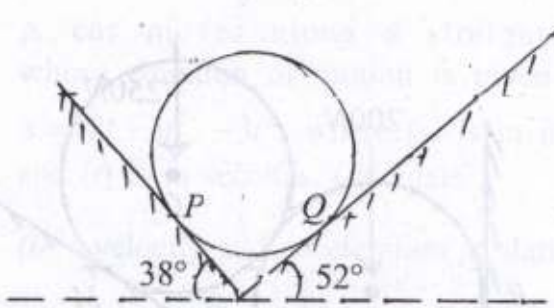


fig (i)

(b) A traffic signal of mass $50kg$ is hung with the help of two strings, as shown in *fig (ii)*. Find the forces induced in the strings. 5

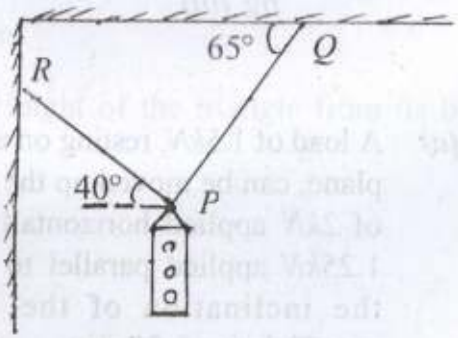


fig (ii)

(c) Two spheres are kept within a conical channel, as shown in *fig (iii)*. All contact surfaces are smooth. Determine all contact reactions. Size of spheres are same but with different weight 10

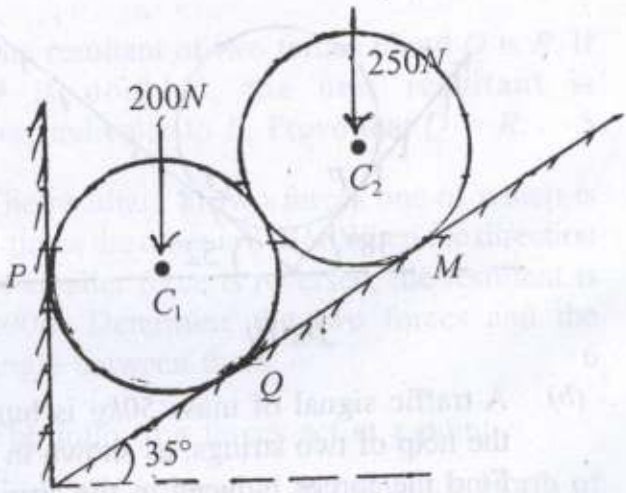


fig (iii)

4. (a) A load of $1.5kN$, resting on an inclined rough plane, can be moved up the plane by a force of $2kN$ applied horizontally or by a force $1.25kN$ applied parallel to the plane. Find the inclination of the plane and the co-efficient of friction. 8

(b) A square jack has a square thread of 4.5*cm* mean diameter and a pitch of 0.5*cm*. If the co-efficient of friction is 0.1, calculate the force required to be applied at the end of the lever, which is 70*cm* long *(a)* to lift a load of 4*kN*, and *(b)* to lower it. 7

(c) A car moves along a straight line whose equation of motion is given by : $s = 12t + 3t^2 - 3t^3$, where (s) is in meters and (t) is in seconds. Calculate :

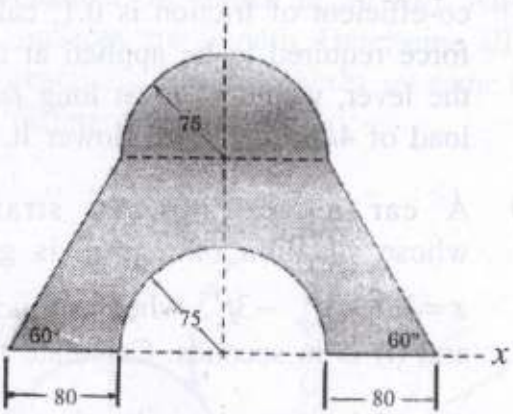
(i) velocity and acceleration at start and

(ii) acceleration, when the velocity is zero. 5

5. (a) What do you mean by centre of mass ? Prove that the centroid of a triangle area is $\bar{y} = \frac{h}{3}$, where,

h = Height of the triangle from its base 1+5=6

(b) Find the y-co-ordinates of the centroid of the shaded area as shown in *figure-(iv)*. 5



Dimensions in milimeters

Figure-(iv)

(c) Find the x-co-ordinate of the centroid of the shaded area as shown in the figure-*(v)*. 4

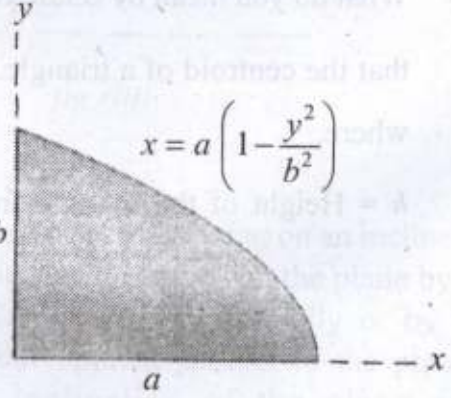


Figure-(v)

(d) Distinguish between the centre of gravity and centroid. How many centre of gravity and centroid body has? 3+1=4

6. (a) Prove that according to the parallel axis theorem the moment of inertia (M. I.) of a body from a reference axis is 3

$$I_X = \bar{I}_X + d_X^2 A$$

where,

I_X = M. I. about OX-axis

$\bar{I}_X$ = M. I. about the centroid axis

A = Area of a body and

d_X = distance of centroid from OX-axis

(b) Find the moment of inertia (M.I.) of rectangle area about the centroidal axis. 2

(c) Determine the M. I. of the shaded area of the following *figure-(vi)* about x_0-and y_0-centroidal axis 8

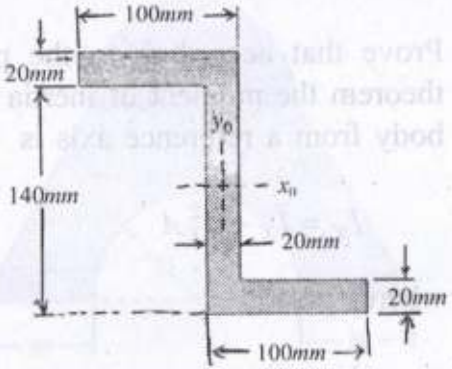


figure-(vi)

(d) Find the M. I. of the following shaded area about the given reference axes 7

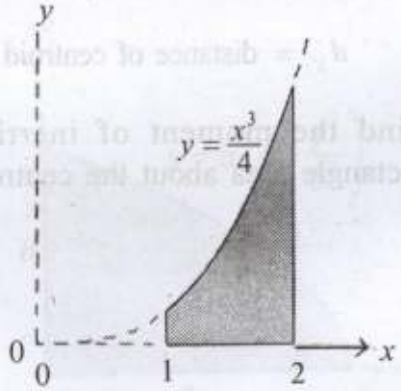


figure-(vii)

7. *(a)* Determine the forces in each member of the truss as shown in *figure-(viii)* and *(ix)*.

8+12=20

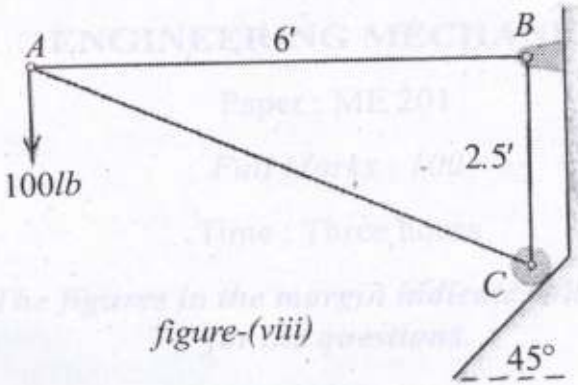


figure-(viii)

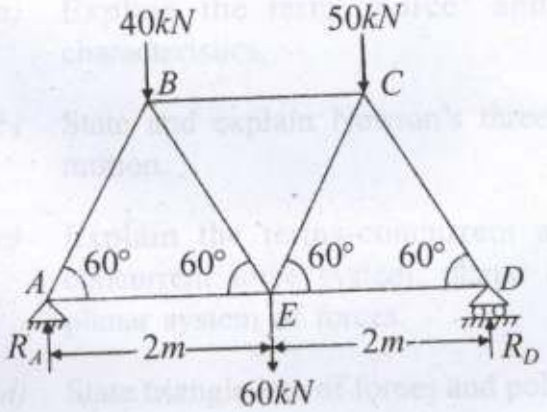


figure-(ix)