2012 C
2013
(May)

ENGINEERING MECHANICS

Paper : ME 201

Full Marks : 100

Pass Marks : 30

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* Define the term force. What are the various characteristics of a force ? 1+3=4

   (b) What do you mean by system of forces ? Define *any five* systems of forces. 1+5=6

   *(c)* State parallelogram law of forces and polygon law of forces. 4

(d) Explain clearly the difference between clockwise moments and anticlockwise moments. 3

(e) What do you understand by the term 'parallel forces' ? Discuss their classifications. 3

2. (a) What do you understand by the term friction ? State the laws of friction.

$$1+6=7$$

(b) Find the angle between two equal forces P, when their resultant is equal to (i) P and (ii) $P/2$. $2+2=4$

(c) Four forces of $25N$, $20N$, $15N$ and $10N$ are acting simultaneously along straight lines OA, OB, OC and OD such that $\angle AOB = 45°$; $\angle BOC = 100°$ and $\angle COD = 125°$. Find magnitude and direction of the resultant force. 5

(d) Two forces act at an angle of $120°$. The bigger force is of $40N$ and the resultant is perpendicular to the smaller one. Find the smaller force. 4

3. (a) A ball is supported on a smooth wall by tieing a string, as in fig.(a). Find the tension in the tie string and support of the wall. Take radius of ball 5cm, length of the rod 13cm and weight 120N.   4


fig.(a)
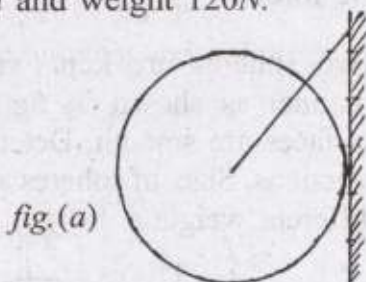
(b) A string ABCD, attached to fixed points A and D has two equal weights of 1000N attached to it at B and C. The weights rest with the portions AB and CD inclined at angles as shown in fig.(b). Find the tensions in the portions AB, BC and CD of the string, if the inclination of the portion BC with the vertical is 120°.   6

fig.(b)
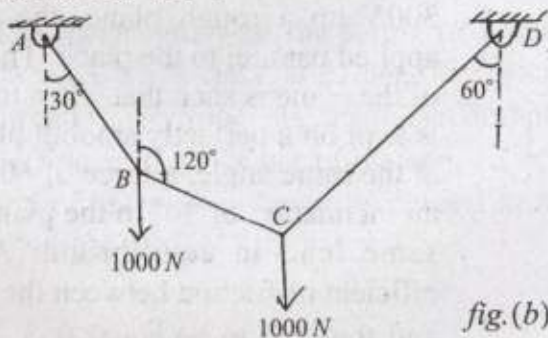
(c) Three forces acting on a particle are in equilibrium. The angles between the first and second is $90°$ and that between the second and third is $120°$. Find the ratio of the forces. 4

(d) Two spheres are kept with in a conical channel as shown in *fig.(c)*. All contact surfaces are smooth. Determine all contact reactions. Size of spheres are same but with different weight. 6

fig.(c)
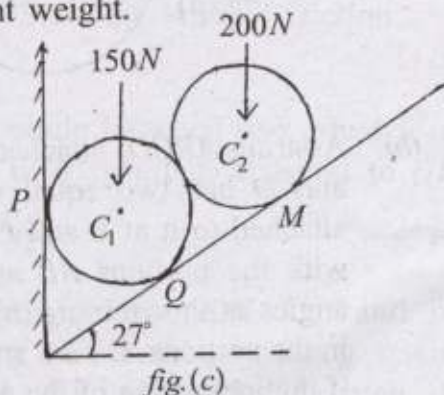
4. (a) Find the force required to move a load of $300N$ up a rough plane, the force being applied parallel to the plane. The inclination of the plane is such that when the same load is kept on a perfectly smooth plane inclined at the same angle, a force of $60N$ applied at an inclination of $30°$ to the plane, keeps the same load in equilibrium. Assume co-efficient of friction between the rough plane and the load to be equal $0·3$. 7

(b) Two loads, W_1 (equal to $1kN$) and W_2 resting on two inclined rough planes OA and OB are connected by a horizontal link PQ as shown in fig. (d). Find the maximum and minimum values of W_2 for which the equilibrium can exist. Take angle of friction for both the planes as $20°$. 7
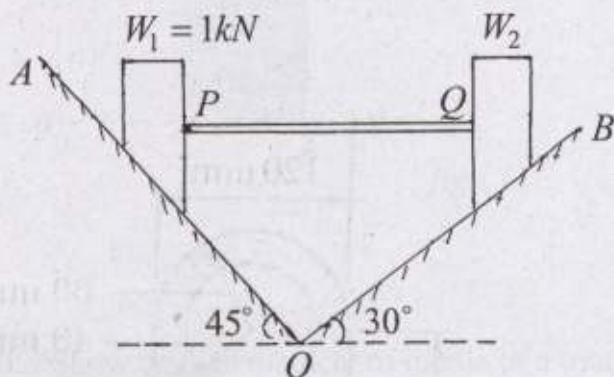

fig. (d)

(c) The mean radius of the screw of a square threaded screw jack is $25mm$. The pitch of thread is $7·5mm$. If the co-efficient of friction is $0·12$, what effort applied at the end of lever $60cm$ length is needed to raise a weight of $2kN$? 6

5. (a) What do you mean by "first moment of area"? Prove that the centroid of the area of a circular sector is

$$\bar{x} = \frac{2}{3} \frac{r \sin \alpha}{\alpha}$$

$1+5=6$

(b) Determine the co-ordinates of the centroid of shaded area of the following figures :
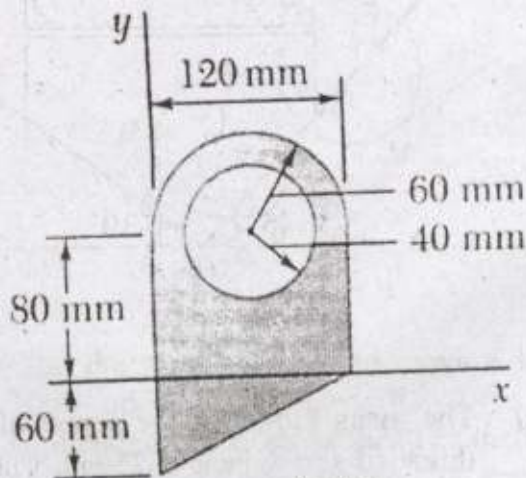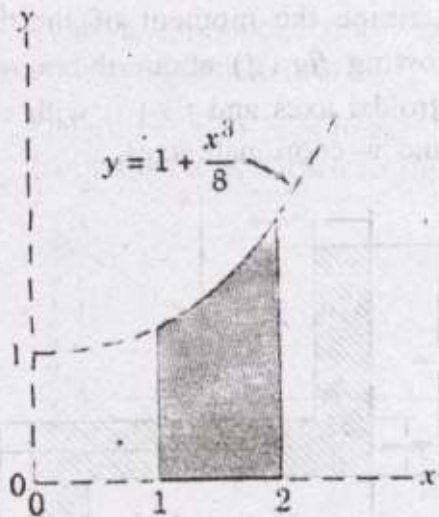
$8+6=14$

fig.(e)

$$y = 1 + \frac{x^3}{8}$$

fig. (f)

6. (a) Show that the moment of inertia of a triangle with respect to its base is

$$I_X = \frac{bh^3}{12}$$

where $b =$ length of the base,
$h =$ altitude of the triangle.
And hence find the moment of inertia about the centroidal axis.   4+1=5

(b) Determine the moment of inertia of the following fig. (g) about the x_0- and y_0-centroidal axes and fig. (h) with respect to x- and y- coordinate axes. $7+8=15$
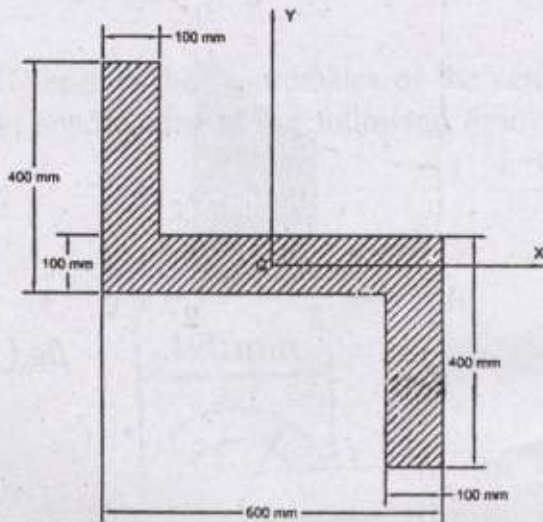
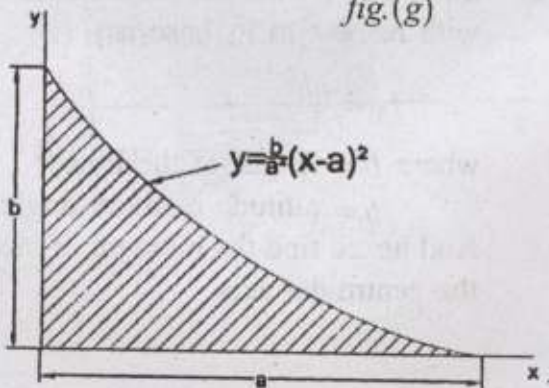

fig. (g)

$$y = \frac{b}{a^2}(x-a)^2$$

fig. (h)

7. (a) What is a perfect frame ? Define deficient and redundant frames.   3

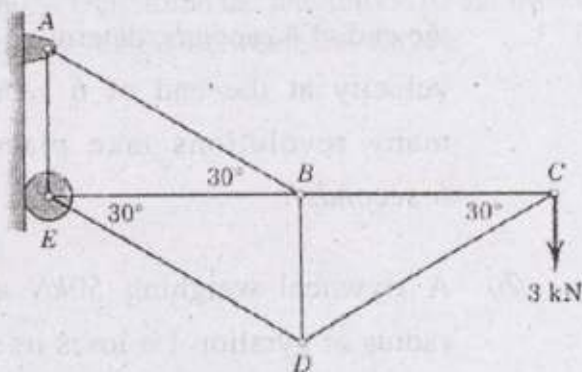   (b) Determine the forces in each member of the loaded truss as shown in *fig.* (*i*).   12

fig. (i)

   (c) Determine the reaction at '*D*' and hence find the forces in members '*DC*' and '*DE*' of the following *fig.* (*j*)   5
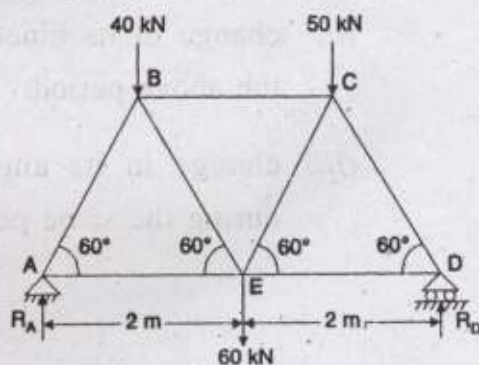

fig. (j)

8. (a) The angular acceleration of a flywheel is given by $\alpha = 12 - t$, where (α) is in rad/s^2 and (t) is in seconds. If the angular velocity of the flywheel is $60\, rad/sec$ at the end of 4 *seconds*, determine the angular velocity at the end of 6 *seconds*. How many revolutions take place in these 6 *seconds* ?   7

   (b) A flywheel weighing $50kN$ and having radius of gyration $1m$ loses its speed from $400\, rpm$ to $280\, rpm$ in 2 *mins*.

   Calculate—

   (i) the retarding torque acting on it.

   (ii) change in its kinetic energy during the above period.

   (iii) change in its angular momentum during the same period.   7

(c) The resultant of two forces, one of which is double the other is 260N. If the direction of the larger force is reversed and the other remains unaltered, the resultant reduces to 180N. Determine the magnitude of the forces and the angle between the forces. 6