53 (ME 201) ENMC

2018

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 out of **seven**.*

1. *(a)* State and explain parallelogram law of forces. 4

   (b) State equilibrium conditions for bodies under coplanar non-concurrent forces. 2

   (c) What are laws of static friction ? 4

   (d) Define free body diagram. 2

   (e) State and explain the following terms — 3

   (i) Coefficient of friction

   (ii) Angle of repose.

(f) What do you mean by non-concurrent coplanar force system ? 2

(g) Write down the differences between clockwise moments and anticlockwise moments with the help of suitable sketches. 3

2. (a) Find magnitude of the resultant force, if $30N$, $40N$, $50N$ and $60N$ forces are acting along the lines joining the centre of a square to its vertices. 5

(b) A lamp weighing $5N$ is suspended from the ceiling by a chain. It is pulled aside by a horizontal chord until the chain makes an angle of 60° with the ceiling. Determine the tensions in the chain and the chord. 5

(c) State and prove the Lami's theorem. 7

(d) What is a couple ? What is the arm of a couple and its moment ? 3

3. *(a)* A rope is connected between two points *A* and *B* 120*cm* apart at the same level. A load of 200*N* is suspended from a point *C* on the rope 45*cm* from *A* as shown in *fig (i)*. Find the load, that should be suspended from the rope *D* 30*cm* from *B*, which will keep the rope *CD* horizontal and tensions along *CA*, *CD* and *DB*. 7

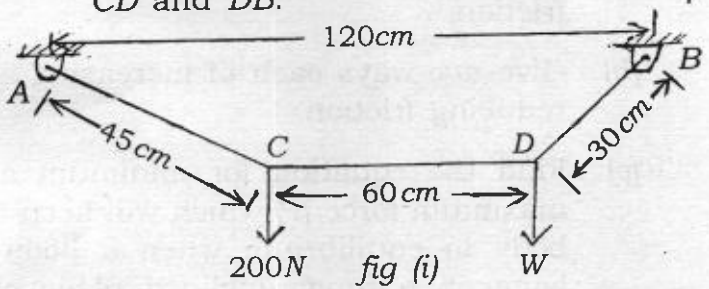

fig (i)

(b) Two spheres, each of weight 50*N* and of radius 10*cm* rest in a horizontal channel of width 36*cm* as shown in *fig (ii)*. Find the reactions on the points of contacts *A*, *B*, *C* and *D*. 7

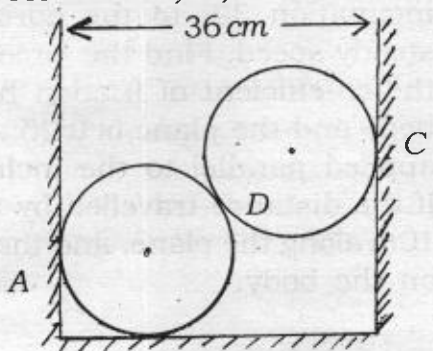

fig (ii)

(c) Two men carry a weight of $2kN$ by means of two ropes fixed to the weight. One rope is inclined at 45° and the other at 30° with their vertices. Find the tension in each rope. 6

4. (a) What is friction ? Write down types of friction. 3

(b) Give *two* ways each of increasing and reducing friction. 3

(c) Find the equation for minimum and maximum force *(P)* which will keep the body in equilibrium when a body is lying on a rough inclined plane and subjected to a force *(P)* acting along the inclined plane. 8

(d) A body of weight $450N$ is pulled up along an inclined plane having inclination 30° to the horizontal at a steady speed. Find the force required if the co-efficient of friction between the body and the plane is 0·25 and force is applied parallel to the inclined plane. If the distance travelled by the body is $10m$ along the plane, find the work done on the body. 6

5. *(a)* Determine the co-ordinates of the C.G. of the shaded area between the parabola $y=\frac{x^2}{4}$ and the straight line $y = x$ as shown in *fig (iii).* 8

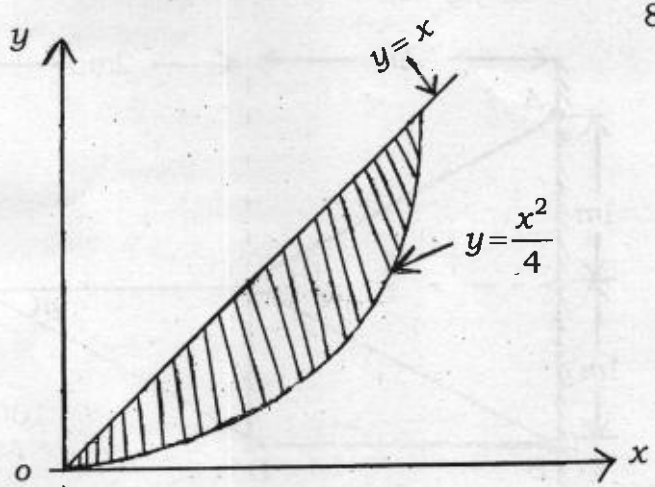

fig (iii)

(b) Derive an expression for the moment of inertia of a triangular section about an axis passing through the C.G. of the section and parallel to the base. 8

(c) Find the centre of gravity of a T-section with flange $150mm \times 10mm$ and web also $150mm \times 10mm$. 4

6. *(a)* Explain briefly the physical significance of moment of inertia. 2

(b) State the difference between a perfect frame and an imperfect frame. 2

(c) Determine the forces in all the members of the cantilever plane truss as shown in *fig (iv)*. 16

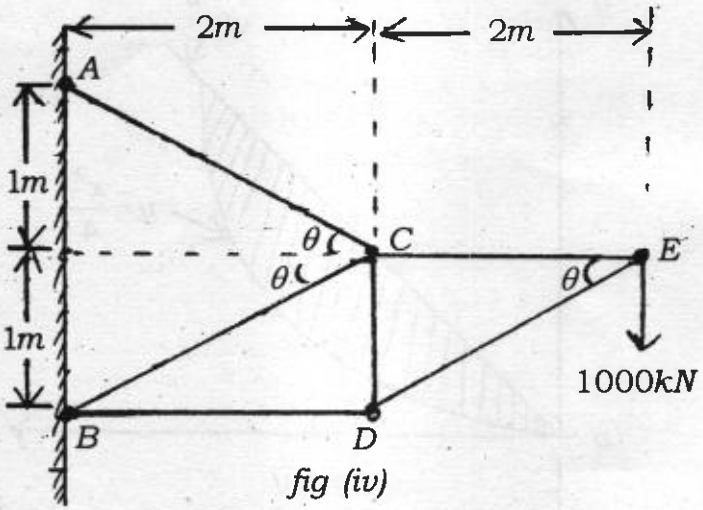

fig (iv)

7. (a) The equation of motion of a particle moving in a straight line is given by —

$$s = 18t + 3t^2 - 2t^3$$

where *(s)* is the total distance covered from the starting point is metres at the end of *(t)* seconds. Find :

(i) the velocity and acceleration at start,

(ii) the time, when the particle reaches its maximum velocity and

(iii) the maximum velocity of the particle. 7

(b) A particle moves along a straight line with an acceleration described by the equation $a = -8s^{-2}$ where *(a)* is in m/s^2 and *(s)* in m. When $t = 1s$, $s = 4m$ and $v = 2m/s$. Determine acceleration when $t=2s$. 7

(c) Write short notes on : ***(any two)*** $3\times2=6$

(i) Perpendicular axis theorem

(ii) Kinematics and Kinetics

(iii) System of forces.