Total number of printed pages–7

53 (ME 201) ENMC

2019

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)* State and explain the polygon law of forces. 4

   (b) State the specifications required to define a force. 3

   (c) State the principles of equilibrium. 5

   (d) What is Lami's theorem ? State and explain. 1+4=5

Contd.

(e) Show that the moment of a force about a point is equal to twice the area of the triangle formed by joining the point with two ends of the force represented by a straight line as magnitude. 3

2. (a) The sum of two concurrent forces P and Q is $270N$ and their resultant is $180N$. The angle between the force (P) and resultant (R) is $90°$. Find the magnitude of each force and angle between them. 6

(b) Two forces F and $2F$ act on a particle. If the first force is increased by $12kN$ and the second force is doubled, the direction of their resultant remains unchanged. Find the value of F. 5

(c) Find the magnitude and direction of the resultant force, if $30N$, $40N$, $50N$ and $60N$ forces are acting along the lines joining the centre of a square of side $2m$ to its vertices. 6

(d) State the conditions of equilibrium for a set of coplanar forces. 3

3. (a) A force of $1000N$ acts on a bracket as shown in *fig. (i)*. Determine the moment of the force about Q. 5

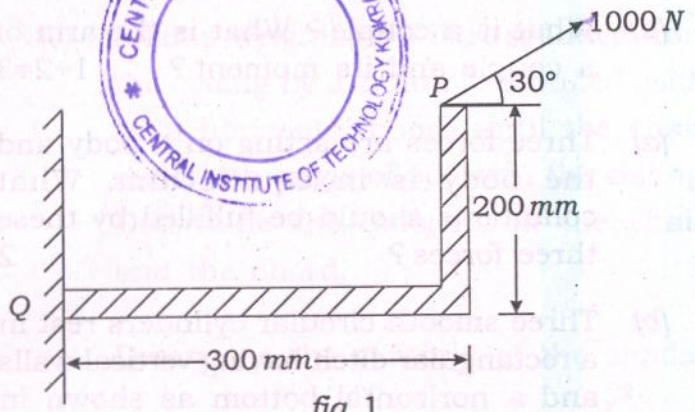

fig. 1

(b) Four forces are acting on a body as shown in *fig.* (ii). Determine the magnitude and position of the resultant force. 5

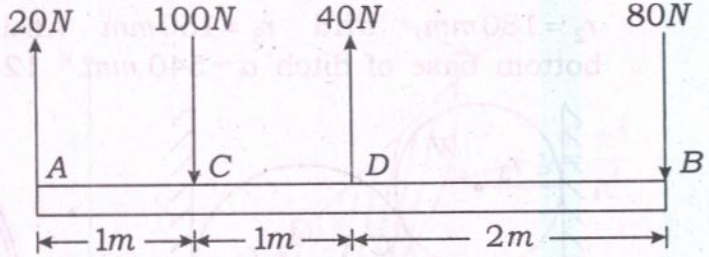

fig. (ii)

(c) $ABCD$ is a square, each side being 20 *cm* and E is the middle point of AB. Forces of $7N$, $8N$, $12N$, $5N$, $9N$ and $6N$ act on the lines of directions AB, EC, BC, BD, CA and DE respectively. Find the magnitude direction and position of the resultant force. 7

(d) What is a couple? What is the arm of a couple and its moment? 1+2=3

4. (a) Three forces are acting on a body and the body is in equilibrium. What conditions should be fulfilled by these three forces? 2

(b) Three smooth circular cylinders rest in a rectangular ditch having vertical walls and a horizontal bottom as shown in *fig. (iii)*. Neglecting friction, determine the reactions at contact points *A, B, C* and *D*. The weights of the cylinders, *P, Q* and *W* are $200N$, $400N$, $300N$ respectively with radii, $r_1 = 120mm$, $r_2 = 180mm$, and $r_3 = 150mm$ and bottom base of ditch $a = 540\ mm$. 12

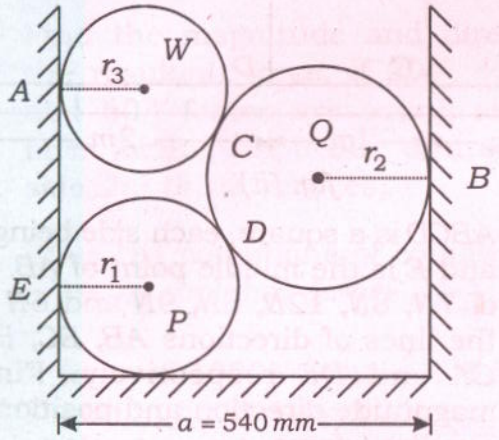

fig. (iii)

(c) 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. 6

5. (a) Determine the centroid of the shaded area between the parabola $y = \frac{x^2}{4}$ and the straight line $y = x$ as shown in *fig. (iv)*. 10

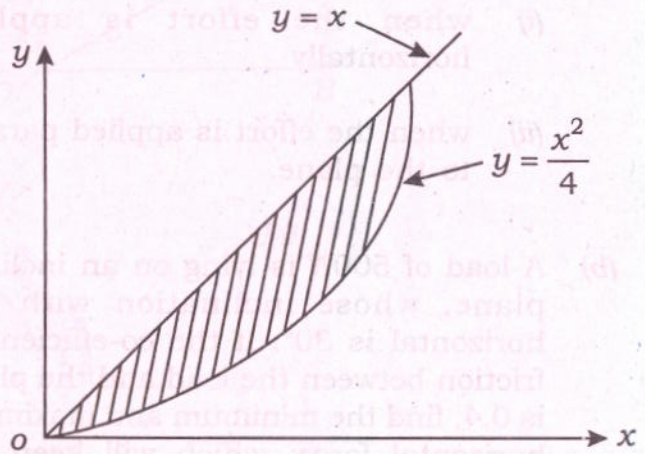

fig. (iv)

(b) Prove that *(i)* Moment of inertia of a triangular section about its base is $\frac{bh^3}{12}$ and *M.I.* of triangular section about an axis passing through the C-G and parallel to the base is $\frac{bh^3}{36}$. 10

6. *(a)* A rough inclined plane, co-efficient of friction = μ, rises 1 *cm* for every 5 *cm* of its length. Calculate the effort require to drag a body weighing 100*N* up the plane : 5+5=10

i) when the effort is applied horizontally

ii) when the effort is applied parallel to the plane.

(b) A load of 500*N* is lying on an inclined plane, whose inclination with the horizontal is 30°. If the co-efficient of friction between the load and the plane is 0.4, find the minimum and maximum horizontal force, which will keep the load in equilibrium. 5

(c) What do you mean by angle of friction and angle of repose? 5

7. Determine the axial forces in all the bars of the plane truss loaded as shown in *fig. (v)*. 20

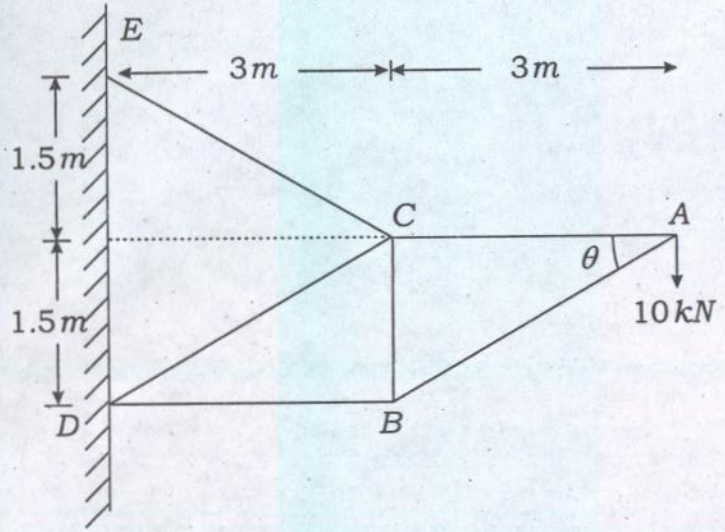

fig. (v)