53 (ME 201) ENMC

2017

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)* Define a Force. State the specifications required to define a force. 1+2=3

   (b) State the law of equilibrium and explain. 5

   (c) What is a free body diagram ? Illustrate it with the help of figures. 4

(d) Write down the conditions of equilibrium of the coplanar concurrent force system. 2

(e) Explain clearly the procedure of finding out the resultant force analytically as well as graphically. 6

2. (a) The resultant of two forces when they act at right angles is $10N$, whereas when they act at an angle of $60°$ the resultant is $\sqrt{148}$. Determine the magnitude of the two forces. 6

(b) Four forces of magnitudes $20N$, $30N$, $40N$ and $50N$ are acting respectively along the four sides of a square taken in order. Determine the magnitude, direction and position of the resultant force. 7

(c) A particle is acted upon by three forces equal to $50N$, $100N$ and $130N$ along the three sides of an equilateral triangle, taken in order. Find graphically the magnitude and direction of the resultant force. Also check the result analytically. 7

3. (a) A beam AB of length $5m$ supported at A and B carries two point loads W_1 and W_2 of $3kN$ and $5kN$ which are $1m$ apart. If the reaction at B is $2kN$ more than that at A, find the distance between the support A and the load $3kN$. 6

(b) Two loads are suspended from flexible cable $APQD$ as shown in *Fig. (i)*. Neglecting self weight of cable, determine the tension in segments AP, PQ and QD. Also determine the values of β and x. 6

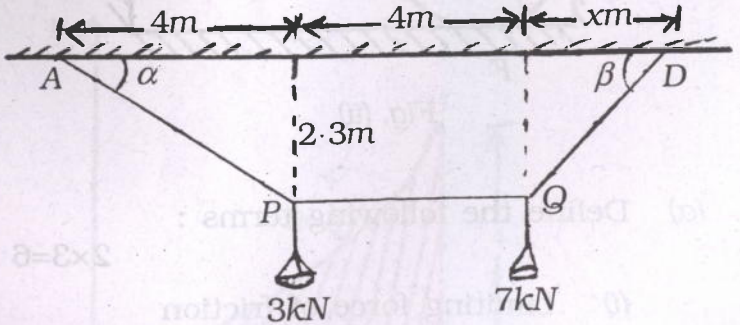

Fig. (i)

(c) Two cylinders *A* and *B* rest in a box as shown in *Fig. (ii)*. *A* has a diameter of 300*mm* and weighs 1200*N*. *B* has a diameter of 200*mm* and weighs 360*N*. The box is 450*mm* wide at the bottom. Assume that all the surfaces are smooth. Find the reactions at the supporting surfaces. 8

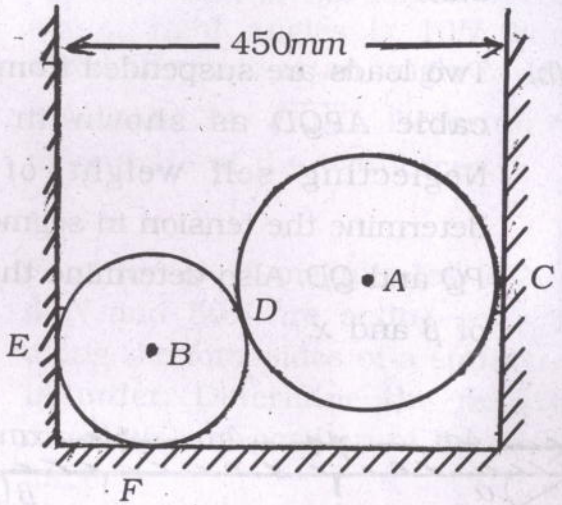

Fig. (ii)

4. *(a)* Define the following terms : 2×3=6

(i) Limiting force of friction

(ii) Angle of friction

(iii) Angle of reprose.

(b) A pull of 60*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 75*N*. If the push is inclined at 25° to the horizontal, find the weight of the body and co-efficient of friction. 7

(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 horizontally. 7

5. *(a)* Determine the co-ordinates of the C-G of the area *OAB* shown in *Fig. (iii)*, if the curve *OB* represents the equation of a parabola, given by $y = kx^2$ in which *OA* = 6 units and *AB* = 4 units. 8

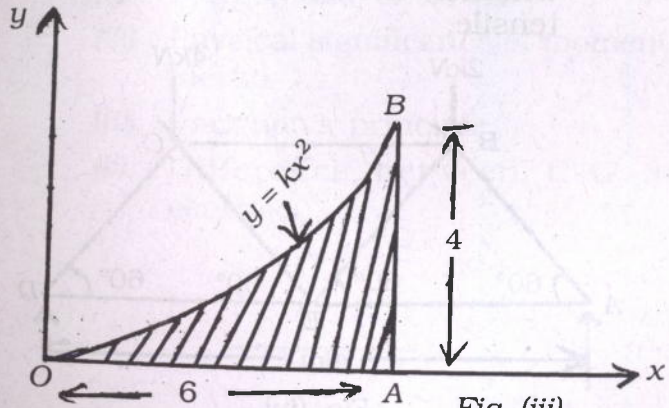

Fig. (iii)

(b) Prove that moment of inertia of a triangular section about the base of the

section $= \frac{bh^3}{2}$

where b = base of triangular section

h = height of triangular section. 8

(c) Find the moment of inertia of a hollow rectangular section about its centre of gravity, if the external dimensions are 40*mm* deep and 30*mm* wide and internal dimensions are 25*mm* deep and 15*mm* wide. 4

6. (a) *Fig. (iv)* shows a Warren girder consisting of seven members each of 3*m* length freely supported at its end points. The girder is loaded at *B* and *C* as shown. Find the forces in all the members of the girder, indicating whether the force is compressive or tensile. 14

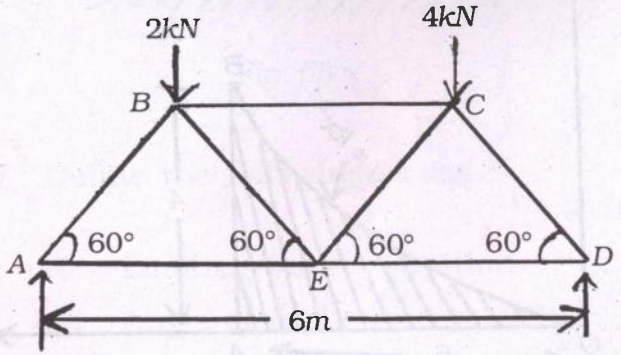

Fig. (iv)

(b) What is a 'frame'? Discuss its classification. 6

7. (a) A particle moves along a straight line with a velocity given by the equation

$$V = 2t^3 - t^2 - 2t + 4$$

where (V) is the velocity in *m/s* and (t) is time in *sec*. When $t = 2$ seconds, the particle is found to be at a distance of 10*m* from a station *A*. Determine :

(i) the acceleration and

(ii) displacement of the particle after 6 seconds. 8

(b) Write short notes on : ***(any four)*** 3×4=12

(i) Laws of friction

(ii) Polygon law of forces

(iii) Physical significance of moment of inertia

(iv) Varignon's principle

(v) Difference between C-G and centroid.