Roll No. ..... Total Pages : 3

GSM/D-21 889

STATICS

Paper–BM-233

Time Allowed : 3 Hours] [Maximum Marks : 27

Note : Attempt **five** questions in all, selecting **one** question from each Unit. Question No. **1** is compulsory.

Compulsory Question

1. (i) Resultant of two forces P and V are at right angle to P. Show that the angle between the forces is : 2½

$$\cos^{-1}\left(-\frac{P}{V}\right)$$

(ii) If a force F be resolved into two component forces and if one component be at right angles to F and equal to $\sqrt{3}$ F in magnitude, find the direction and magnitude of the other component. 2½

(iii) Find the equation of the conjugate line of the given line : 2

$$\frac{n-f}{l} = \frac{y-g}{m} = \frac{z-h}{n}$$

UNIT-I

2. (a) Five forces acting at a point O are in equilibrium. Four of them whose magnitudes are 3, 4, 4, 3 kg wt act along the co-planar lines OA, OB, OC, OD respectively, such that $\angle AOB=15°$, $\angle BOC=60°$, $\angle COD = 15°$; find the direction and magnitude of the fifth force. 2½

(b) A uniform rod 6m and weighing 18 kg is placed in a horizontal position upon two pegs 3m apart. If the breaking pressure of each peg is 10 kg wt., find the greatest length of the portion of the rod that may project beyond either peg. 2½

3. (a) A heavy uniform bar 100m long balances at a point 3m from one end when a weight of 300 kg is suspended from the end. Find the weight of the bar. 2½

(b) Forced of 9, 12, 17 kg wt. act along BC, CA, AB the sides of a triangles 3, 4, 5m respectively. Show that their resultant is a single force acting parallel to AB and find its magnitudes. 2½

UNIT-II

4. (a) A square uniform plate is suspended at one of its vertices and a weight equal to half that of the plate is suspended from the adjacent vertex of the square. Find the position of equilibrium of the plate. 2½

(b) A uniform rod rests in limiting equilibrium within a rough vertical circle. If the rod subtends an angle 2α at the centre of the circle and if λ be the angle of friction, show that the angle of inclination of the rod to the vertical is : 2½

$$\tan^{-1}\left(\frac{\cos 2\alpha + \cos 2\lambda}{\sin 2\lambda}\right)$$

5. (a) A particle is at rest on the inner surface of a sphere of radius r. If the coefficient of friction be μ, show that the greatest distance of the particle from the vertical diameter is : 2½

$$\frac{\mu r}{\sqrt{1+\mu^2}}$$

(b) Find C.G. of area bounded by the parabola $y^2 = 4ax$, the axis of x and the latus rectum. 2½

UNIT-III

6. (a) Four uniform rods are freely joined at their extremities and form a parallelogram ABCD, which is suspended by the joint A and is kept in a shape by a string AC. Prove that the Tension of the string is equal to half the whole weight. 2½

(b) Three forces each equal to P act on a body, one at the point (a, 0, 0) parallel to OY, the second at point (0, b, 0) parallel to OZ and the third at the point (0, 0, c) parallel to OX, the axes being rectangular. Find the resultant wrench in magnitude and position. 2½

7. (a) An endless chain of weight W rests in he form of a circular band around a smooth vertical cone which has its vertex upwards. Find the tension in the chain due to its weight, assuming the vertical angle of the cone is 2α. 2½

(b) Three forces each magnitude P acting in positive direction of the axes have their lines of action $-y = z = a$; $-z = x = a$; $-x = y = a$. Prove that they are equivalent to force $P\sqrt{3}$ at the origin and a couple. 2½

UNIT-IV

8. (a) Prove that the surface which is traced out by the axes of principle moment at points lying on a straight line which intersects at right angles to the Poinsot's axis of given system of forces is a hyperbolic paraboloid. 2½

(b) A uniform cubical box of edge '*a*' is placed on the top of a fixed sphere, the centre of the face of the cube being in contact with the highest point of the sphere. What is the least radius of the sphere for which the equilibrium will be stable. 2½

9. (a) A smooth ellipse is fixed with its axis vertical and in it is placed a beam with its ends resting on the arc of the ellipse. If the length the beam be not less than the latus rectum of the ellipse. Show that when it is in stable equilibrium, it will pass through the focus. 2½

(b) Two forces P and Q are such that their central axis is given in position and the line of action of P is given. Show hat the locus of the line of action of Q is conicoid. 2½