Roll No. ..... Total Pages : 5

GSM/D-20 **915**

STATICS

Paper - BM-233

Time allowed : 3 Hours *Maximum Marks : 40*

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

Compulsory Question

1. (i) Find the resultant of two unlike parallel forces 40N and 5N acting at A and B respectively where AB = 40 cm. 2

   (ii) If a force F be resolved into 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. 2

   (iii) Prove that a given system of forces may be replaced by two forces, one of which acts along a given line OA. 2

   (iv) State converse of Lame's theorem. 1

   (v) Define coefficient of friction. 1

UNIT-I

2. (i) Three forces P, Q, R acting at a point O are in equilibrium and the angle between P and Q is double the angle between P and R. show that $R^2 = Q(Q - P)$. 4

(ii) Forces P, 3P, 2P, 5P act along the sides AB, BC, CD and DA of the square ABCD. Find the magnitude and direction of their resultant and prove that it meets AD produced at a point E such that AE : DE = 5 : 4. 4

3. (i) A uniform rod of length $2l$ and weight w is laying across two pegs on the same level d metre apart. If neither peg can stand a stress greater than T, show that : 4

$$l - \frac{d\,(W - T)}{W}$$

(ii) ABCD is a rectangle with AB = 4m and BC = 3m. Along AB, BC, CD, DA and AC act forces 2, 7, 6, 10 and 5 kg. respectively. Show that the system reduces to a couple and find its moment. 4

UNIT-II

4. (i) A beam whose centre of gravity divides it into two portions a and b is placed inside a smooth sphere. Show that if θ be its inclination to the horizon in the position of equilibrium and 2α be the angle subtended by the beam at the centre of the sphere then

$$\tan\theta = \frac{b-a}{b+a}\tan\alpha.$$ 4

(ii) A heavy body is placed on a rough inclined plane of inclination α greater than the angle of friction, being acted upon by a force parallel to the plane and along a line of greatest slope, to find the limits between which the force must lie. 4

5. (i) One end of a uniform rod is attached to a hinge and the other end is supported by a string attached to the extremity of the rod; the rod and the string are inclined at the same angle θ to the horizontal. If W be the weight of the rod, show that the reaction at the hinge is $\frac{1}{4}W\sqrt{8+\text{cosec}^2\theta}$. Also find the tension in the string. 4

UNIT-III

6. A heavy uniform rod of length 2α rests with its ends in contact with two smooth inclined planes of inclination α and β to the horizon. If θ be the inclination of the rod to the horizon, prove by principle of virtual work that

$\tan\theta = \frac{1}{2}[\cot\alpha - \cot\beta]$. 8

7. A force P acts along the axis of x and another force nP along a generator of the cylinder $x^2 + y^2 = a^2$. Show that the central axis lies on the cylinder

$n^2(nx - z)^2 + (1 + n^2)^2y^2 = n^4a^2$. 8

UNIT-IV

8. Wrenches of the same pitch p act along the edges of a regular tetrahedron $ABCD$ of side a. If the intensities of the wrenches along AB, DC are the same and also those along BC, DA and DB, CA; show that the pitch of the equivalent wrench is

$\left(p + \frac{a}{2\sqrt{2}}\right)$ 8

9. (i) To find the equation to the null plane of a given point (a, b, c) referred to any axis Ox, Oy, Oz. 4

(ii) A heavy uniform rod rests with one end against a smooth vertical wall and with a point in its length resting on a smooth peg. Find the position of equilibrium and show that it is unstable. 4