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

GSM/D-20 **893**

STATICS

Paper - BM-233

Time allowed : 3 Hours *Maximum Marks : 27*

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

Compulsory Question

1. (i) Find the resolved part of a force equal to 60 kg. in a direction making an angle equal to $\tan^{-1}\left[\frac{3}{4}\right]$ with its direction. 1½

(ii) Find center of gravity of a thin uniform rod. 1½

(iii) Write the condition when the system of forces in three dimension reduces to a single force. 1½

(iv) Find the equation of the conjugate line of the given line

$$\frac{x-f}{l}=\frac{y-g}{m}=\frac{z-h}{n}.$$ 1½

(v) Define like and unlike forces. 1

UNIT-I

2. (i) The resultant of two forces P and Q is of magnitude Q. Show that if the force Q be doubled, P remaining same, the new resultant will be at right angle to P and its magnitude will be $\sqrt{4Q^2 - P^2}$. 2½

(ii) Forces each equal to P act at a point parallel to the sides of a triangle ABC. Show that their resultant is given by,

$P\sqrt{3 - 2\cos A - 2\cos B - 2\cos C}$. 2½

3. (i) Forces 2, 3, 4, 5 kg. wt. respectively act along the sides of a square ABCD taken in order. Find the magnitude, direction and line of action of the resultant. 2½

(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 5kg. wt. respectively. Show that the system reduces to a couple and find its moment. 2½

UNIT-II

4. (i) Show that a system of coplanar forces acting in one plane at different points of a rigid body can be reduced to a single force through any given point and a single couple. 2½

(ii) One end of a uniform rod is attached to a hinge and 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 is the weight of the rod, show that the reaction at the hinge is : $\frac{W}{4}\sqrt{8 + \text{cosec}^2\theta}$. Also find the tension of the string. 2½

5. (i) 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 $\frac{\mu r}{\sqrt{1 + \mu^2}}$. 2½

(ii) Find centre of gravity of a uniform parallelogram lamina. 2½

UNIT-III

6. (a) Four equal jointed rods each of length a, are hung from an angular point which is connected by an elastic string with the opposite point. If the rods hung in the form of a square and if the modulus of elasticity of the string be equal to the weight of a rod,

Show that the natural length of the string is $\frac{a\sqrt{2}}{3}$. 2½

(ii) A solid hemisphere is supported by a string fixed to a point on its rim and to a point on a smooth vertical wall with which the curved surface is in contact. If θ and α are the inclination of the string and the plane base of the hemisphere to the vertical, show that :

$tan\alpha = \frac{3}{8} + tan\theta$ 2½

7. (i) 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 :

$n^2(nx - z)^2 + (1 + n^2)^2 y^2 = n^4 a^2$. 2½

(ii) Determine the conditions in order that a general system of forces in space can be reduce to a single force. 2½

UNIT-IV

8. (i) If P and Q be two non-intersecting forces whose direction are perpendicular, show that the ratio of distance of the central axis from their lines of action are Q^2 to P^2. 2½

(ii) Find the equation of the null plane of a given point (a, b, c) reffered to any axes OX, OY, OZ. 2½

9. (i) Show that every given system of forces acting on a rigid body can be reduced to a Wrench. 2½

(ii) A uniform beam, of thickness 2b, rests symmetrically on a perfectly rough horizontal cylinder of radius a. Show that equilibrium of the beam will be stable or unstable according as b is less or greater body. 2½