Roll No. .....

(01/22-II)

5201

B.A./B.A. (Hons.)/B.Sc. EXAMINATION

(Third Semester)

MATHEMATICS

BM-233

Statics

Time : Three Hours *Maximum Marks :* B.Sc. : 40, B.A. : 27

Note : Attempt *Five* questions in all, selecting *one* question from each Unit. Q. No. **1** is compulsory. All questions carry equal marks.

Compulsory Question

1. (a) The three coplanar forces acting on a particle are in equilibrium. The angle between the first and the second is 60° and that between the second and third is 150°. Find the ratio of the amptitude of forces.

(b) State Varignon's theorem on moments.

(c) Define Equivalence of two couples.

(d) Define Wrench.

Unit I

2. (a) Two forces P and Q have a resultant R. If force P is increased, then the new resultant bisects the angle between R and P. Find the increase in P.

(b) P and Q are two like parallel forces. If P be moved parallel to itself through a distance x, show that their resultant moves through the distance $\frac{Px}{P+Q}$.

3. (a) A heavy uniform rod 4 m long rests horizontally on two pegs which are 1 m apart. A weight of 10 kg suspended from one end or a weight of 4 kg suspended from the other end will just tilt the rod up. Find the weight of the rod and the

distances of the pegs from the centre of the rod.

(b) 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 acting at any arbitrary point of the body together with the couple.

Unit II

4. Two uniform rods AB, BC of length $2a$, $2b$ respectively are rigidly joined at B and are suspended freely from A. If they rest inclined at an angle θ, ϕ respectively to the vertical, prove that :

$$\frac{\sin\theta}{\sin\phi} = \frac{b^2}{a(a+2b)}.$$

5. (a) A system of coplanar forces shall be in equilibrium if the algebraic sum of the moments of all the forces about any three

non-collinear points in their plane vanish separately.

(b) Find the centre of gravity of the arc of the cardioid $r = a(1+\cos\theta)$ lying above the initial line.

Unit III

6. 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 ϕ are the inclinations of the string and the plane base of the hemisphere to the vertical, show that $\tan\phi = \frac{3}{8} + \tan\theta$.

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

Unit IV

8. Show that a given system of forces can be replaced by two forces equivalent to the given system, in an infinite number of ways and that the tetrahedron formed by the two forces is of constant volume.

9. (a) Find the null point of the plane $x+y+z=0$ for the force system. (X, Y, Z; L, M, N).

(b) A heavy uniform cube balances on the highest point of a sphere whose radius is r. If the sphere is rough enough to prevent sliding and if the side of the cube is $\frac{\pi r}{2}$, show that the cube can rock through a right angle without falling.