Roll No. .....

(12/24)

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 Section. Q. No. 1 is compulsory.

1. (i) State the parallelogram law of vectors and hence give the magnitude and direction of the resultant of two forces acting at a point.

(ii) Describe the laws of :

(a) Statical friction

(b) Limiting friction

(c) Dynamical friction.

(iii) Find the centre of gravity of a thin uniform rod.

(iv) Describe the units of work.

(v) Define and explain null lines, null planes and null point.

(vi) Define stable, unstable and neutral equilibrium. $2\times6=12$

Section I

2. (a) The resultant of two forces P and Q is R. The resolved part of R in the direction of P is of magnitude Q. Show that the angle between the forces is $2\sin^{-1}\sqrt{\frac{P}{2Q}}$. 3

(b) Two like parallel forces P and Q (P > Q) act upon a rigid body at A and B Respectively. Let P and Q be interchanged in position, then show that the point of application of the resultant will be displaced through a distance x along AB given by $x=\frac{P-Q}{P+Q}AB$. 4

3. (a) Forces P, Q, R act along the sides BC, AC, BA respectively of an equilateral triangle. If their resultant is a force parallel to BC through the centroid of the triangle, prove that Q = R = P/2. 3

(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. 4

Section II

4. (a) If three forces acting on a rigid body keep it in equilibrium, show that they must be coplanar. 3

(b) A weight can be just supported on a rough inclined plane by a force P acting along the plane or by a force Q acting horizontally; show that the weight is $\frac{PQ}{\sqrt{Q^2 \sec^2 \phi - P^2}}$, where ϕ is the angle of friction. 4

5. (a) Find the centre of gravity of a right circular solid cone. 3

(b) Find the centre of gravity of the arc of the astroid $x^{2/3} + y^{2/3} = a^{2/3}$ lying in the first quadrant. 4

Section III

6. (a) Show that the virtual work done by the thrust in a virtual extension of a Light rod from length l to $l + \delta l$ is $T\delta l$, where T is the thrust in the rod. 2

(b) A heavy uniform rod of length $2a$ 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 the principle of virtual work that :

$$\tan\theta = \frac{1}{2}(\cot\alpha - \cot\beta).$$ 5

7. (a) Find the equations of the central axis of any given system of forces acting on a rigid body. 3

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

Section IV

8. (a) If P and Q be two non-intersecting forces whose directions are perpendicular, show that the ratio of distance of the central axis from their lines of action are Q^2 to P^2. 3

(b) Find the null point of the plane $lx + my + nz = 1$ for the system of forces (X, Y, Z; L, M, N). 4

9. (a) Find the condition that the straight line $\frac{x-f}{l} = \frac{y-g}{m} = \frac{z-h}{n}$ may be a null line for the force system (X, Y, Z; L, M, N). 3

(b) A heavy body, the section of which is a cycloid, rests on a rough horizontal plane and has its C.G. at the centre of curvature of the curve at the point of contact. Show that the equilibrium is unstable. 4