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B.A./B.Sc. (General) 3rd Semester

(1129)

MATHEMATICS

Paper : III (Statics)

Time Allowed : Three Hours] [Maximum Marks : 30

Note :— Attempt **FIVE** questions in all, selecting at least **TWO** questions from each section. Each question carries 6 marks.

SECTION—I

1. (a) The resultant of two forces P and Q trisects the angle between them, show that if P > Q, the angle between them is $3\cos^{-1}\left(\frac{P}{2Q}\right)$ and the resultant is $\frac{P^2 - Q^2}{Q}$.

   (b) If a force is resolved into two components one of which is perpendicular to the force and is equal to it in magnitude then find the magnitude and direction of the other component. 3,3

2. (a) Find a point O in the plane of a triangle ABC so that forces represented by OA, OB, and OC completely, may be in equilibrium.

(b) The ends of a light, inelastic and 17 cm long string are attached to two points 13 cm apart at same horizontal level. Find the maximum weight that can be suspended from the string at a distance of 5 cm from one end, it being given that the string cannot bear a tension greater than 1 kg. 3,3

3. (a) ABCDEF is a regular hexagon. Show that the magnitude of the resultant of forces represented completely by AB, 2AC, 3AD, 4AE and 5AF is $\sqrt{351}$ AB and it makes an angle $\tan^{-1}\frac{7}{\sqrt{3}}$ with AB.

(b) Two weights P and Q are suspended from a fixed point O by strings OA and OB, which are kept apart by a light rod AB. If the strings make angles α and β with the rod then show that the angle θ which the rod makes with the vertical is given by $\tan\theta = \frac{P+Q}{P\cot\alpha - Q\cot\beta}$. 3,3

4. (a) A rod AB of length a + b weight W has its centre of gravity at a distance a from A. It rests on parallel knife edges at a distance c apart in the same horizontal plane, so that equal portions of the rod project beyond each knife edge. Show that the pressures on knife edges are

$$\frac{b-a+c}{2c}W \text{ and } \frac{a-b+c}{2c}W.$$

(b) P and Q are the magnitudes of two like parallel forces. If the Q is moved parallel to itself through a distance x then show that the resultant moves through a distance $\frac{Qx}{P+Q}$. 3,3

SECTION—II

5. (a) State and prove Varignon's theorem on moments.

(b) Three parallel forces of magnitude 3N, 4N and 5N act at the angular points A, D, C of a square ABCD each of whose side is 4 cm. Find the position of centre of these forces. What will be the position of the resultant when a fourth parallel force of magnitude 2N acts at B ? 3,3

6. (a) A system of forces acting in the plane of ΔABC is equivalent to a single force acting at A along the internal bisector of $\angle BAC$ and a couple of moment G_1. If the moments of the system about B and C are G_2 and G_3 respectively, then show that $bG_2 + cG_3 = (b + c)G_1$.

(b) The constituent forces of a couple of moment G act at points A and B. If their lines of action are turned through a right angle, they form a couple of moment H. Show that when they act at right angle to AB then they form a couple of moment $\sqrt{G^2 + H^2}$. 3,3

7. (a) A uniform rod of length 2a rests in equilibrium against a smooth vertical wall and upon a smooth peg at a distance b from the wall. Prove that the rod is inclined to vertical at an angle θ given by $\sin^3\theta = \frac{b}{a}$.

(b) A uniform rod AB of weight W, movable about a hinge at A, rests with the other end against a smooth vertical wall. If α be the inclination of rod to the vertical then show that the magnitude of reaction at hinge A is $\frac{1}{2}W\sqrt{4+\tan^2\alpha}$. 3,3

8. (a) If a force acting parallel to a rough plane of inclination α to the horizontal which is just sufficient to draw a weight up the plane be n times the force that will just support the same weight on the same plane then show that $\tan\alpha = \mu\frac{n+1}{n-1}$, μ being coefficient of friction.

(b) A uniform ladder rests with its upper end against a rough wall and the lower and against an equally rough horizontal floor. Show that in position of limiting equilibrium the inclination of the ladder to the horizontal is given by $\tan\theta = \frac{1-\mu^2}{2\mu}$. 3,3

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