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11802/NJ

O–6/2111

MECHANICS–I

Paper–502/504

Semester–V

(Common for MC & B.Sc.

Hons. in Mathematics Part–II) Sem.–V

Time Allowed : 3 Hours] [Maximum Marks : 70

Note : The candidates are required to attempt **two** questions each from Sections A and B carrying 10 marks each and the entire Section C consisting of 10 short answer type questions carrying 3 marks each.

SECTION—A

1. The resultant of two forces P and Q acting at angle θ is equal to $(2m+1)\sqrt{P^2+Q^2}$; when they act at an angle $\frac{\pi}{2}-\theta$, the resultant is $(2m-1)\sqrt{P^2+Q^2}$.

   Show that $\tan\theta = \frac{m-1}{m+1}$. 10

2. Six coplanar forces act on a rigid body along the sides AB, BC, CD, DE, EF and FA of a regular hexagon of side 1 unit. Their magnitudes are 10, 20, 30, 40, P and Q units respectively. Find P and Q so that the system reduces to a couple and show that the moment of couple is $75\sqrt{3}$ units. 10

3. Two forces P and Q acting at a point have a resultant R. If P is doubled, R is doubled and if Q is doubled and reversed in direction, even then R is doubled. Show that $P : Q : R :: \sqrt{6} : \sqrt{2} : \sqrt{5}$. 10

4. A force F acts at a point (3, 4) of the XY-plane. The force is directed away from the origin and inclined at 60° to the X-axis. The horizontal component of F is 5 kg. wt.

   (a) Determine the force F.

   (b) Using Varignon's theorem, calculate the moment of F about the origin.

   (c) Find the perpendicular distance of the origin from the line of action of F. 10

SECTION—B

5. Two equal beams AB and AC, each of weight W connected by a hinge at A are placed in a vertical plane with their extremities B and C resting on a smooth horizontal plane, they are kept from falling by strings connecting B and C with the mid-points of opposite sides. Show that the tension of either string is $\frac{1}{8}W\sqrt{1+9\cot^2\alpha}$ where α is the inclination of either beam to the horizontal. Also, show that the action of the hinge on the either beam is $\frac{3}{4}W\cot\alpha$. 10

6. A light string of length l is fastened to two points A and B at the same level at distance 'a' apart. A ring of weight W can slide on the string and horizontal force P is applied to it such that it is in equilibrium vertically below B. Show that $P=\frac{aW}{l}$ and tension in the string is $\frac{W\left(l^2+a^2\right)}{2l^2}$. 10

7. Equal weights P and P are attached to two strings ACP and BCP passing over a smooth peg C. AB is a heavy beam of weight W, whose CG is a c meters from A and d meters from B, show that AB is inclined to the horizontal at an angle :

$$\tan^{-1}\left[\frac{c-d}{c+d}\tan\left(\sin^{-1}\frac{W}{2P}\right)\right].$$ 10

8. A body of weight W can just be sustained on a rough inclined place by a force P and just dragged up the plane by a force Q, P and Q both acting up the line of the greatest slope. Show that coefficient of friction is :

$$\frac{Q-P}{\sqrt{4W^2-(P+Q)^2}}.$$ 10

SECTION—C

9. Write in brief the following : 10×3=30

(i) State Varignon's theorem.

(ii) A 120 kg force is resolved into components along AB and AC making angle 45° and α respectively. If the component along AC is of magnitude 120 kg., determine the angle α and the component along AB.

(iii) State Lami's theorem.

(iv) State $\lambda - \mu$ theorem.

(v) The resolved part of a force 32 kg. wt., in a direction is half of it. Find its inclination with the force and also find the other resolved part.

(vi) A bar AB weighs 10 kg. It is placed horizontally on two smooth pegs, one at A and the other at C. An upward vertical force P is applied at the end B. Show that if P = 10 kg., the equilibrium of the bar is not possible.

(vii) ABC is a triangular and G its centroid. Prove that the forces represented completely by GA, GB and GC are in equilibrium.

(viii) State generalized theorem of a resolved parts.

(ix) State laws of limiting friction.

(x) Find Centre of gravity of uniform rod.