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FACULTY OF SCIENCE & TECHNOLOGY
B.Sc. S. Y. (Sem-III)
Examination November/December- 2022
Mathematics MAT - 303
Mechanics-I

[Time: 1:30 Hours] **[Max. Marks:50]**

N.B "Please check whether you have got the right question paper"

i) All questions are compulsory.
ii) Figures to the right indicate full marks.
iii) Draw well-labelled diagrams whenever necessary.

Q.1 (a) Attempt any one of the following: [08]

i) State and prove Lami's theorem

ii) Show that C divides the line joining the points of application of two like parallel forces internally in the inverse ratio of their magnitudes.

(b) Attempt any one of the following: [07]

i) The forces of magnitudes 2, 3, 4, 5 and 6 kg are acting on one of the angular points of rectangular hexagon towards the other five angular points taken in order. Find the magnitude and direction of the resultant force.

ii) Three forces of the magnitudes P, Q, R acting on a particle are in equilibrium and the angle between P and Q is double the angle between P and R. Show that $R^2 = Q(Q - P)$

Q.2 (a) Attempt any one of the following: [08]

i. Prove that the necessary and sufficient condition that a given system of forces acting upon a rigid body is in equilibrium is that the force force-sum and moment- sum must separately vanish.

ii. Prove that the sum of the vector moments of two like parallel force acting on a rigid body about any point equals to the vector moment of their resultant about the same point.

(b) Attempt any one of the following: [07]

i. A force $\vec{F}$ of magnitude 8 units acts at a point P(2, 3, 4) along the line $\frac{x-2}{3} = \frac{y-3}{4} = \frac{z-4}{5}$
Find the vector moment of the force $\vec{F}$ about y-axis.

ii. A uniform string is bend into the form of a ΔABC with sides a, b, c. Show that the distances of the C.G. of the ΔABC from their sides BC, CA and AB respectively are in the ratio $\frac{b+c}{a} : \frac{c+a}{b} = \frac{a+b}{c}$

Q.3 (a) Attempt any one of the following: [05]

i. Prove that the C.G. of the uniform parallelogram is at the point of intersection of the diagonals of the parallelogram.

ii. A system of the forces acting upon a rigid body is equivalent to a force at any arbitrary point together with a couple.

(b) Attempt any one of the following: [05]

i. Find the vector moment of a force $\vec{F} = \vec{\imath} + 2\vec{\jmath} + 3\vec{k}$ acting at a point (-1, 2, 3) about origin.

ii. Two forces of magnitudes $(P + Q)$ and $(P - Q)$ make an angle 2θ with each other and their resultant force makes an angle α with the bisector of the angle between them. Prove that

$$\frac{P}{Q} = \frac{tan\theta}{\tan\alpha}$$

Q.4 Choose the correct alternative and rewrite the sentence: [10]

(a) If two forces $\vec{P}$ and $\vec{Q}$ acting at an angle θthen the magnitude R of their resultant force is given by -------

i. $R = \sqrt{P^2 + Q^2 - 2PQ\ cos\theta}$
ii. $R = \sqrt{P^2 + Q^2 + 2PQ\ cos\theta}$
iii. $R = \sqrt{P^2 + Q^2 + 2PQ\ sin\theta}$
iv. $R = \sqrt{P^2 + Q^2 - 2PQ\ sin\theta}$

(b) The direction of the resultant of the unlike parallel forces is the same as that of the ----------

i. smaller component
ii. both components
iii. opposite to the smaller component
iv. bigger component

(c) If any number of forces acting on a particle be represented in magnitude and direction by the sides of a polygon taken in order, then the forces are in ----------

i. equal
ii. same direction
iii. equilibrium
iv. opposite direction

(d) If the three forces acting on a particle be represented in magnitude and direction by the three sides of a triangle, taken in order, then ----------
   i. the forces coincide each other
   ii. the forces are in equilibrium
   iii. the forces are non-coplanar
   iv. the forces are not in equilibrium

(e) Centroid of the weighted point ----------
   i. does not exists
   ii. exists but is not unique
   iii. exists and is unique
   iv. does not exists but is unique