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Y—95—2019

FACULTY OF ARTS/SCIENCE

B.A./B.Sc. (Third Year) (Fifth Semester) (Backlog) EXAMINATION

OCTOBER/NOVEMBER, 2019

(CBCS Pattern)

MATHEMATICS

Paper XIV

(Mechanics—I)

(Tuesday, 19-11-2019) **Time : 10.00 a.m. to 12.00 noon**

Time—2 *Hours* *Maximum Marks*—40

N.B. :— (*i*) *All* questions are compulsory.

(*ii*) Figures to the right indicate full marks.

(*iii*) Use of non-scientific/non-programmable calculator is allowed.

1. Attempt any *four* of the following : 8

(*a*) Write an axiom for equilibrium of two forces.

(*b*) Find the resultant of two forces $\vec{P}$ and $\vec{Q}$ when $\measuredangle$ (P, Q) = 0.

(*c*) State the converse of Triangle law of forces.

(*d*) State the conditions of equilibrium of forces acting on a particle.

(*e*) What is difference between Motion of translation and Motion of rotation ?

(*f*) If $\vec{F} = 3\vec{i} + 4\vec{j} + 5\vec{k}$, then find moment of force about X-axis.

P.T.O.

2. Attempt any *two* of the following : 8

(*a*) Find the magnitude and direction when the magnitudes of two forces $\vec{P}$ and $\vec{Q}$ are equal.

(*b*) Show that the resultant of two forces given by $m \cdot \overrightarrow{OA}$ and $n \cdot \overrightarrow{OB}$ is represented by $(m + n)\,\overrightarrow{OC}$, where the point C divides AB internally in the ratio $n : m$.

(*c*) Find the smaller force, when the two forces act at an angle of 120°, the greater force is of 30 kg and resultant is perpendicular to smaller one.

3. Attempt any *one* of the following : 8

(*a*) (*i*) State and prove triangle law of forces.

(*ii*) A and B are two smooth pegs in a horizontal line at a distance 5 m apart. Two light enextensible strings CA and CB of lengths 3 m and 4 m respectively attached to pegs. Find the tensions in the strings, when a weight of 10 kg is suspended from C.

(*b*) (*i*) Prove that if three forces of magnitudes P, Q and R respectively acting on a particle are in equilibrium, each is proportional to the sine of the angle between the other two, i.e.

$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$$

where $\measuredangle(\vec{Q}, \vec{R}) = \alpha$, $\measuredangle(\vec{R}, \vec{P}) = \beta$, $\measuredangle(\vec{P}, \vec{Q}) = \gamma$.

(*ii*) A particle is placed at the centre O of the circle inscribed in a Δ ABC. Force $\vec{P}$, $\vec{Q}$, $\vec{R}$ acting along $\overrightarrow{OA}$, $\overrightarrow{OB}$ and $\overrightarrow{OC}$ respectively are in equilibrium. Prove that :

$$P : Q : R = \cos\frac{A}{2} : \cos\frac{B}{2} : \cos\frac{C}{2}.$$

4. Attempt any *two* of the following : 8

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

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

(*c*) Three forces $\vec{P}$, $\vec{Q}$, $\vec{R}$ act along the sides BC, CA, AB of a Δ ABC, taken in order; prove that if the resultant passes through the incentre of Δ ABC, then P + Q + R = 0, where P, Q, R are magnitudes of the forces.

5. Attempt any *one* of the following : 8

(*a*) Find the resultant of two forces P and Q acting upon a rigid body in case like parallel forces and unlike parallel forces.

(*b*) State Polygon of forces and if D, E, F are the middle points of the sides BC, CA and AB respectively of a Δ ABC. Three forces represented by $\overrightarrow{AD}$, $\frac{2}{3}\overrightarrow{BE}$ and $\frac{1}{3}\overrightarrow{CF}$ act at a point inside the Δ ABC. Then prove that their resultant is represented by $\frac{1}{2}\overrightarrow{AC}$ and its line of action divides BC in the ratio 2 : 1.

(*c*) (*i*) Find the conditions of equilibrium of forces acting on a rigid body in Cartesian form.

(*ii*) Find the vector moment of force $\vec{F}$ of magnitude 10 units acting at a point (1, 2, 3) in the direction of the vector $2\vec{i} + \vec{j} + 2\vec{k}$ about the point (2, 3, 1).