

Roll No.

Exam Code : M-23

Subject Code—59291

B.Sc. EXAMINATION

(Main/Reappear) (Batch 2018 Onwards)

(Fourth Semester)

MATHEMATICS

CML-407

Mechanics-I

Time : 3 Hours

Maximum Marks : 80

Note : Attempt *Five* questions in all. The question paper will consists of four Sections. Q. No. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and it is compulsory. Each of the four section will contain two questions and students are required to attempt *one* question from each Section. All questions carry equal marks.

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P.T.O.

(Compulsory Question)

1. (a) State triangle law of forces. 2
- (b) Three coplanar forces of 5 kg each act on a particle. If their lines of action make equal angles with each other, determine the resultant. 2
- (c) Define moment of force about a point. 2
- (d) A heavy uniform bar 100 m long balances at a point 30 m from one end when a weight of 300 kg is suspended from the end. Find the weight of the bar. 2
- (e) Define moment of a couple. 2
- (f) The co-ordinates of a moving point at time t are given by $x = a(2t + \sin 2t)$, $y = a(1 - \cos 2t)$. Prove that its acceleration is constant. 3

- (g) A particle describes the curve $r = a \sin n\theta$ under a force F to the pole. Find the law of force. 3

Unit I

2. (a) Find the component of a force P along two directions making angles 45° and 30° with it on opposite sides. 8
- (b) Three like parallel forces $(2P + Q)$, $(4P - 2Q)$ and 8 kg. weight act at the vertices of a triangle. Find P and Q if the resultant of the three forces passes through the centroid of the triangle. 8
3. Three like parallel forces P , Q , R act at the corner of a triangle ABC . If their center is :
- (a) The centroid of the triangle, then $P = Q = R$.
- (b) The orthocentre of the triangle, then

$$\frac{P}{\tan A} = \frac{Q}{\tan B} = \frac{R}{\tan C}. \quad 16$$

Unit II

4. (a) A force P act along the axis of x and another force $3P$ along a generator of the cylinder $x^2 + y^2 = a^2$. Show that the central axis lies on the cylinder $9(3x - z)^2 + 100y^2 = 81a^2$. 8
- (b) Two forces P and Q are such that their central axis is given in position and the line of action of P is given show that the locus of the line of action of Q is conchoid. 8
5. (a) Show that the minimum distance between two forces which are equivalent to a given system (R, K) and which are inclined at a given angle 2α is $\frac{2K}{R} \cot \alpha$ and the forces are then each equal to $\left(\frac{R}{2}\right) \sec \alpha$. 8

- (b) Find the null point of the plane $x + y + z = 0$ for the force system $(X, Y, Z; L, M, N)$. 8

Unit III

6. (a) A particle moves along a circle $r = 2a \cos \theta$ in such a way that its acceleration towards the origin is always zero. Show that the transverse acceleration varies as the fifth power of $\operatorname{cosec} \theta$. 8

- (b) A particle describes an equiangular spiral $r = ae^{m\theta}$ with constant angular velocity. Find its velocity and acceleration. 8

7. (a) Prove that acceleration of a point moving in a curve with uniform speed is

$$\phi \left(\frac{d\psi}{dt} \right)^2. \quad 8$$

- (b) A passenger travelling in a train with velocity 90 km/hr on a straight level track observes that another train which is 180 m long and moving constantly takes 4 seconds to pass by. What is the velocity of the passing train ? 8

Unit IV

8. (a) A body of mass 50 kg, is acted upon by a force of 5 N. How long will it take to attain a velocity of 30 m/sec ? 8
- (b) Find the law of force towards the pole under which the curve $r^2 = 2ap$ is described. 8
9. (a) If the central force varies as the cube of the distance from a fixed point, then find the orbit. 8

- (b) If a planet were suddenly stopped in its orbit when at a distance 'a' from the sun, show that it would fall in the sun in time $\frac{\sqrt{2}\pi a^{3/2}}{4\sqrt{\mu}}$, which is $\frac{\sqrt{2}}{8}$ times the period of planet's revolution. 8