

Roll No. 223112320007
Hari

Exam Code : M-24

Subject Code—61375

B. Sc. EXAMINATION

(Main) (Batch 2022 Onwards)

(Fourth Semester)

MATHEMATICS

CML-407

Mechanics-I

Time : 3 Hours

Maximum Marks : 80

Note : Attempt *Five* questions in all, selecting *one* question from each Unit. Q. No. 1 is compulsory. All questions carry equal marks.

(Compulsory Question)

1. (i) What are the maximum and minimum values of the resultant of two forces acting at a point ?

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- (ii) State Varignon's theorem on moments about a line.
- (iii) State the Newton's second law of motion and discuss its relation with momentum of an object.
- (iv) Define the moment of a force about a point.
- (v) The rate of change of direction of a particle moving in a cycloid is constant, then find normal acceleration of the particle.
- (vi) State the Triangle law of forces.
- (vii) Explain the terms 'Screw' and 'Wrench'.
- (viii) Discuss the definitions of null lines, null plane and null point. $8 \times 2 = 16$

Unit I

2. (i) AB and AC are two strings 9 m and 12 m long attached to pegs B and C at a horizontal distance 15 m apart. Find the tensions in the strings when a weight of 10 kg is suspended from A. 8

- (ii) Two unlike parallel forces P and Q ($P > Q$) act at A and B respectively. If P and Q are both increased by x , show that the resultant will move through a

distance $\frac{x \cdot AB}{P - Q}$. 8

3. (i) Forces P , Q and R act respectively along the sides BC , CA , AB of a triangle ABC . Show that if their resultant passes through the orthocentre, then :

$$\sec A + Q \sec B + R \sec C = 0. \quad 8$$

- (ii) Show that a system of coplanar forces acting in one plane at different points of a rigid body can be reduced to a single force acting at any arbitrary point of the body together with the couple. 8

Unit II

4. (i) Find the equations of the central axis of any given system of forces acting on a rigid body. 8

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- (ii) A force P acts along the axis of x and another force nP along a generator of the cylinder $x^2 + y^2 = r^2$. Show that the central axis lies on the cylinder :

$$n^2(nx - z)^2 + (1 + n^2)^2 y^2 = n^4 r^2. \quad 8$$

5. (i) Prove that any wrench may be resolved into two wrenches, whose axes intersect at right angles, in an infinite number of ways. 8
- (ii) Show that among the null lines of any system of forces, two are generators of any hyperboloid, two belonging to one system of generators and two to the others. 8

Unit III

6. (i) A point P moves with a constant angular velocity about O , where O is the pole of the equiangular spiral $r = ae^\theta$. Obtain the radial and transverse acceleration of P . 8

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- (ii) A particle describes the cycloid $s = 4a \sin \psi$ with uniform speed v . Find its acceleration at any point. 8

7. (i) To a person travelling due east, the wind appears to come from the north east, but when he doubles his speed, it appears to come from a direction $\tan^{-1}\left(\frac{2}{3}\right)$ north of east. Find the direction of the wind. 8

- (ii) A particle executing S.H.M. has amplitude b . Show that the distance of the point from the centre at which the velocity is half of the maximum velocity is $\frac{\sqrt{3}b}{2}$. 8

Unit IV

8. (i) A mass of 4 kg is drawn across a rough horizontal table by means of a string passing over a smooth pulley fixed at an

edge of the table and supports a mass of 2 kg at the other end. If the coefficient of friction be $\frac{5}{16}$, find the acceleration of the masses. 8

(ii) A train whose mass is 20 tons moves at the rate of 60 m.p.h. After steam is shut off, it is brought to rest by brakes in 500 yds. Find the retarding force, assuming it to be uniform. 8

9. (i) In every central orbit, prove that the areal velocity is constant and the linear velocity varies inversely as the perpendicular from the centre upon the tangent to the path. 8

(ii) Show that an unresisted particle falling to the earth's surface from the great distance would acquire a velocity $\sqrt{2ga}$, where a is the radius of the earth and g is the acceleration due to gravity. 8