U.G. 6th Semester Examination - 2026

MATHEMATICS

[MAJOR-VIII]

Course Code : MATH-M-T-08

(Mechanics-I)

[NEP-2020]

Full Marks : 60 Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.
The notations and symbols have their usual meanings.

1. Answer any **ten** questions: 2×10=20

a) The law of motion in a straight line being $s = vt^2$, show that the acceleration is constant.

b) Prove that at an apse, the planet moves at right angle to the radius vector.

c) What is an impulsive force? How is it measured?

d) The velocity of a particle moving in a straight line is given by $\dot{s} = ks^2 + k$, prove that its acceleration varies as the distance from a fixed point in the line.

e) When is the equilibrium of a heavy body resting on a fixed body said to be unstable?

[Turn over]

f) Find the moment of inertia of the perimeter of a circle about a tangent.

g) Obtain the relation between the rate of change of angular momentum of a moving particle and the force acting on it.

h) A particle describes a curve $r = ae^{\theta}$ with constant angular velocity. Show that its transverse acceleration varies as the distance from the pole.

i) Define angular momentum of a particle.

j) Explain the terms "apse" and "apsidal angle" related to a central orbit.

k) Obtain the relation between the rate of change of angular momentum of a moving particle and the force acting on it.

l) What is meant by central force? Give one example.

m) What is a compound pendulum?

n) State the conditions of equilibrium of a rigid body under coplanar forces.

o) Define impulse of a force.

2. Answer any **four** questions: 5×4=20

a) Discuss the contexts where the terms *terminal velocity* and *escape velocity*, appear respectively. 5

b) A particle describes a central orbit under an attractive force F per unit mass. Establish the differential equation of its path in the form $\frac{d^2u}{d\theta^2} + u = \frac{F}{h^2u^2}$. 5

c) If V_1 and V_2 are the velocities of a planet when nearest and farthest from the sun, prove $(1-e)V_1 = (1+e)V_2$ where e is the eccentricity 5

d) Write down the expressions of potential energy and kinetic energy of a simple pendulum of length l oscillating in a uniform gravitational field. 5

e) Prove that a particle moving under a central force describes equal areas in equal times. 5

f) Obtain the time period of a simple pendulum. 5

g) Show that for inverse square law of attraction the orbit is a conic section. 5

3. Answer any **two** questions: 10×2=20

a) A particle moves in a plane such that its tangential and normal accelerations are always equal and the velociry varies as the arc length from a fixed point. Obtain the path. 10

b) Find the moment of inertia of a uniform rod about an axis through one end perpendicular to its length. Hence obtain the kinetic energy of rotation. 10

c) A body of mass $(m_1 + m_2)$ is split into two parts by an internal explosion generating kinetic energy E. If the parts move in the same line as before, show that their relative velocity is $\sqrt{\frac{2E(m_1+m_2)}{m_1 m_2}}$. 10

d) Obtain tangential and normal components of velocity and acceleration of a particle moving along a plane curve. 10