October 2025
B.A./B.Sc.
First Semester
MINOR – 1
PHYSICS
Course Code: PHN 1.11
(Mechanics)

Total Mark: 50   *Pass Mark: 20*
Time: 2 hours

I. Answer <u>three</u> *questions, taking* <u>one</u> *from each unit.*

UNIT–I

1. (a) State Newton's second law of motion and show that Newton's first law is simply a special case of the second law.   3

   (b) Prove that the law of conservation of momentum and energy are invariant under Galilean transformation.   7

   (c) A frame S' is moving with velocity $\left(5\hat{i}+7\hat{j}\right)$ m/s relative to an inertial frame S. A particle is moving with velocity $(t+5)\hat{i}+9\hat{j}$ m/s with respect to S. Find the acceleration of the particle in S'.   2

2. (a) What is a variable mass system? Obtain the expression of net force and thrust acting on a rocket and derive the equation of motion of a rocket.   1+4+2+3=10

   (b) Show that the force $\vec{F} = \left(2xy+z^2\right)\hat{i}+x^2\hat{j}+2xz\hat{k}$ is conservative.   2

UNIT–II

3. (a) Explain moment of inertia and prove that moment of inertia is equal to twice the kinetic energy of rotation of a body when its angular velocity is unity.   4

   (b) Find the moment of inertia of a solid sphere about the diameter and tangent as its axis of rotation.   5

(c) In case of a body rolling along a plane surface, obtain the expression of kinetic energy and find the kinetic energy of a solid spherical ball of radius R. 3

4 (a) Obtain the expression of velocity, acceleration, time-period, and frequency of a simple harmonic oscillator. 5

(b) What is damped oscillation? Write the differential equation of motion of a damped harmonic oscillator and obtain its solution. 7

UNIT–III

5. (a) Find the gravitational potential due to a solid sphere at different points. 5

(b) Write the energy equation under central force and explain it with the help of energy diagram. 7

6 (a) State and explain the postulates of special theory of relativity. 3

(b) Derive the Lorentz transformation equations in special theory of relativity. 7

(c) A clock in a spaceship emits signals at intervals of 1 second as observed by an astronaut in the spaceship. If the spaceship travels with a speed of $3 \times 10^7 \, ms^{-1}$, what is the interval between successive signals as seen by an observer at the control centre on the ground? 2

II. Answer <u>any two</u> *questions from the following.*

UNIT-I

7. Derive the expression of torque on a solid and hollow cylinder. 7

UNIT-II

8. (a) State the theorems of perpendicular and parallel axes. 2

(b) In case of forced oscillations, how does the amplitude and frequency change with respect to the driving force? Define resonance and explain sharpness of resonance. 3+1+1=5

UNIT-III

9. (a) State Kepler's third law of planetary motion and prove it. 5

    (b) Show that the concept of simultaneity has only a relative and not an absolute meaning in relativity. 2

_____