

**U.G. 2nd Semester Examination - 2025****PHYSICS****[MAJOR]****Course Code : PHY-MJ-T-02****(Mechanics)****[NEP-2020]**

Full Marks : 40

Time :  $2\frac{1}{2}$  Hours*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.***GROUP-A**

1. Answer any five questions :  $2 \times 5 = 10$
- State Galilean invariance and give one example.
  - Define conservative force. Give one condition to identify such a force.
  - What is the kinetic energy of rotation?
  - State the law of conservation of angular momentum with one practical example.
  - Define elastic potential energy.
  - What is geosynchronous orbit? State one of its applications.
  - What is Coriolis force?
  - State the principle of mass-energy equivalence.

*[Turn over]*

## GROUP-B

2. Answer any **two** questions :  $5 \times 2 = 10$
- a) Derive the expression for the velocity of efflux of a liquid using Bernoulli's theorem. 5
  - b) Define coefficient of restitution. Show that in an elastic collision, both momentum and kinetic energy are conserved. 1+2+2
  - c) A thin uniform rod of length  $L$  and mass  $M$  rotates about one end perpendicular to its length. Calculate its moment of inertia and angular momentum when rotating with angular velocity  $\omega$ . 5
  - d) Derive the differential equation of damped oscillation and discuss the condition for critical damping. 5

## GROUP-C

- Answer any **two** questions :  $10 \times 2 = 20$
3. a) Derive an expression for the moment of inertia of a solid sphere about a diameter. 4
- b) State and prove the perpendicular axis theorem. 4
- c) Explain why a ballet dancer spins faster when she folds her arms. 2

4. a) Derive Poiseuille's law for the steady flow of liquid through a capillary tube. 5
- b) Show that  $Y = 3K(1 - 2\sigma)$ , where  $Y$  is Young's modulus,  $K$  is Bulk modulus and  $\sigma$  is Poisson's ratio. 5
5. a) State Kepler's laws of planetary motion. Deduce the law of areas from Newton's law of gravitation. 2+3
- b) Derive an expression for the orbital period of a satellite revolving very close to the Earth's surface. Hence, calculate its orbital period in minutes.  
Given,  
Altitude of the satellite = 800 km  
Universal Gravitational constant,  $G = 6.67 \times 10^{-11}$  (SI)  
Mass of the Earth,  $M = 5.9 \times 10^{24}$  kg. 3+2
6. a) State the postulates of Special Theory of Relativity. 2
- b) Why can no material particles travel faster than light according to Special Theory of Relativity? 2
- c) Show that relativistic kinetic energy tends to the classical expression when  $v \ll c$ . 2
- d) Starting from the Lorentz transformations, derive the time-dilation formula and explain the meaning of proper time. 4