

DEPARTMENT OF SCIENCES

FIRST SEMESTER M.Sc (PHYSICS) END SEMESTER EXAMINATION, DECEMBER 2023

SUB: CLASSICAL MECHANICS (PHY- 5152)

TIME: 2 HRS.

DATE: 05-12-2023

MAX. MARKS: 40

[2]

NOTE: ANSWER ANY FOUR FULL OUESTIONS OUT OF FIVE

- Obtain expressions for velocity and acceleration using polar coordinate 1A. system. [3] **1B.** What do you mean 'Terminal velocity'? Explain. [2] **1C.** Show that a projectile motion in a resistive medium is described by $x = \frac{U}{k} \left(1 - e^{-kt} \right) \text{ and } \quad y = -\frac{gt}{k} + \frac{kV+g}{k^2} \left(1 - e^{-kt} \right),$ where x = U, y = V when t = 0, k = resistive force per unit velocity per unit mass. Obtain an expression for its time of flight when the air resistance is small. [5] 2A. How does a two-body problem will reduce to a one-body problem in a central force field? Explain. [4]
- **2B.** Discuss the motion of a particle in an arbitrary potential field. [3]
- 2C. In a conservative central force field, show that the total energy of a system of two bodies is constant. [3]
- **3A.** Explain the motion of the Earth. [3]
- **3B.** State any two properties of Lagrangian. [2]
- 3C. What is Alembert's principle? Derive Lagrange's equations of motion from it for a holonomic conservative system. How will results be modified for the non-conservative system? [5]
- **4A.** Show that the kinetic energy of a rotating rigid body in a coordinate system of principal axes is given by

$$T = \frac{1}{2} (I_{x} \omega_{x}^{2} + I_{y} \omega_{y}^{2} + I_{z} \omega_{z}^{2})$$

- 4B. What do you mean by phase space? Explain. Derive Hamilton's equation of motion using Lagrange's equations. [5]
- 4C. Using Euler-Lagrange equation show that the shortest distance between two points in a plane is a straight line. [3]
- **5A.** What you mean by 'Canonical Transformation'? Explain. [2]
- **5B.** A transformation $P_i = P_i(q_i, p_i, t)$ & $Q_i = Q_i(q_i, p_i, t)$ is canonical only if the expression

$$\sum_{i} p_i dq_i - \sum_{i} P_i dQ_i \text{ or } \sum_{i} q_i dp_i - \sum_{i} Q_i dP_i$$

Initial. [3]

is an exact differential.

5C. Show that [u+v, w] = [u, w] + [v, w] using Poisson Brackets.

Prove that Poisson Brackets of 2 constants of motion is itself a constant of motion. [5]