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May-2026

B.Sc. (Physics) VIth Semester

Classical Mechanics–I (BPH24-604T)

Time: 3 Hours]

[Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART–A

1. (a) State Hamilton's principle. (1.5)

   (b) Find the equation of motion of a system described by the time-dependent Lagrangian $L = e^{\gamma t} [1/2\ m\dot{x}^2 - V(x)]$.

   (c) State Poisson theorem. (1.5)

   (d) Find the Poisson bracket of $[L_x, L_y]$ where L_x and L_y are angular momentum components.

   (e) Compare briefly Newtonian, Lagrangian and Hamiltonian mechanics. (1.5)

(f) Define generalized momentums. (1.5)

(g) Prove that for Poisson brackets

$[X, Y + Z] = [X, Y] + [X, Z]$. (1.5)

(h) Show that the following transformation is canonical

$p = m\omega q \cot Q$ and $P = m\omega q^2/2 \sin 2Q$. (1.5)

(i) Write the expression of Hamiltonian of a simple pendulum. (1.5)

(j) The Lagrangian of a particle moving in a plane is given by $L = 1/2m [\dot{x}^2 + \dot{y}^2] + a [x\dot{y} - y\dot{x}]$. Find the expressions of canonical momenta. (1.5)

PART–B

2. (a) Write down the expression of Lagrangian and Lagrange's equation of motion for one-dimensional harmonic oscillator. (10)

(b) Define cyclic coordinates. What is its physical significance. (5)

3. (a) Set up the Hamiltonian for the motion of a particle in central force and hence deduce the equations of motion. (8)

(b) For a particle the kinetic energy and potential energy is given by respectively, $T = \frac{1}{2} m\dot{r}^2$ and $V = 1/r(1 + \dot{r}^2/c^2)$. Find the Hamiltonian H and determine whether $H = T + V$ i.e. H represents total energy. (7)

4. What are Poisson and Lagrange's brackets? Write their properties and deduce the relation between them. (15)

5. (a) Write equations of motion in Poisson Bracket form. (5)

(b) Prove that for any three functions F, G and K of p_k and q_k, the following relation holds true: $[F, [G, K]] + [G, [K, F]] + [K, [F, G]] = 0$. (10)

6. (a) Show that the Poisson Bracket of any two functions is invariant under canonical transformations. (10)

(b) The Lagrangian for a system is given $L = \dot{x}^2/2x - V(x)$. Find the corresponding Hamiltonian and Hamilton's equation of motion. (5)

7. Write short notes on the following :

(a) Constraints and its types with some examples.

(b) Physical significance of Hamiltonian.

(c) Principle of least action. (15)