

Roll No.

Total Pages : 3

CMDE/D-23

4435

CLASSICAL MECHANICS

Paper-PHY-102

Time Allowed : 3 Hours]

[Maximum Marks : 60

Note : Attempt **five** questions in all, selecting **one** question from each Unit. Question No. **1** is compulsory. All questions carry equal marks.

Compulsory Question

1. (a) What do you understand by a Virtual displacement of a system? How it differs from real displacement? 2
- (b) What is Hamilton's principle? 2
- (c) Distinguish between point transformation and scale transformation. 2
- (d) Show that $[p_z, L_y] = -p_x$. 2
- (e) Show that the Motion of a particle under central force takes place in a plane. 2
- (d) Distinguish linear and nonlinear systems. 2

UNIT-I

2. (a) Obtain Lagrangian equations of Motion for non-holonomic system. 9

- (b) Discuss the Physical significance of generalized coordinates in Classical Mechanics. 3

3. (a) Discuss conservation theorems using Hamiltonian formulation. 6

- (b) A dynamical system has the Lagrangian : 6

$$L = \dot{q}_1^2 + \frac{\dot{q}_2^2}{a + b\dot{q}_1^2} + k_1 q_1^2 + k_2 \dot{q}_1 \dot{q}_2.$$

Where a, b, k_1 and k_2 are constants. Find the equation of motion in the Hamiltonian formulation.

UNIT-II

4. Derive the transformation equations between the variables (q, p) and (Q, P) with $F_3(p, Q, t)$ and $F_4(p, P, t)$ as generating functions. 12
5. (a) Two similar Harmonic oscillators are coupled together. Find the equations of motion and general solutions. Describe the two normal modes. 8
- (b) Express Hamilton's equations in terms of Poisson bracket. 4

UNIT-III

6. (a) Show that in central force motion, the conservation of angular momentum implies the constancy of the areal velocity. 6

- (b) Distinguish between Libration and Rotation periodic motions considering simple pendulum as an example.

6

7. (a) Discuss the Hamilton-Jacobi theory for Hamilton characteristic function.

6

- (b) Discuss how action-angle variable can be used to obtain the frequency of a periodic system of one degree of freedom. Find the frequency of oscillation in case of One-Dimensional harmonic oscillator.

6

UNIT-IV

8. Explain the stability analysis of Cubic anharmonic oscillator and undamped pendulum.

12

9. (a) What is the significance of Kolmogorov-Arnold-Moser (KAM) theorem for the breakdown of regularity?

4

- (b) Give a detailed analysis of Logistic equation to describe the characteristics of chaos.

8