S – 6280

Reg. No. : .....

Name : .....

First Semester M.Sc. Degree Examination, April 2024

Physics/Physics with Specialization in Nano Science/Physics with specialization in Space Physics

PH 211/PHNS 511/PHSP 511 : CLASSICAL MECHANICS

(2020 Admission Onwards)

Time : 3 Hours

Max. Marks : 75

PART – A

Answer any **five** questions. Each question carries **3** marks.

1. What are cyclic co-ordinates? Show that the generalised momentum corresponding to a cyclic co-ordinate is conserved.
2. State and prove the conditions for the Hamiltonian *H* to represent the total energy of the system.
3. What are constraints? Give Examples.
4. What is central force? Explain.
5. What are fundamental Poisson brackets?
6. Explain action-angle variables.
7. What are strange attractors?
8. What is meant by covariant Lagrangian?

(5 × 3 = 15 Marks)

PART – B

Answer **all** questions. Each question carries **15** marks.

9. (a) Derive Lagrange's equations of motion from D'Alembert's principle.

   (b) State and explain Kepler's laws of planetary motion.

OR

10. (a) Discuss the theory of small oscillations.

    (b) Explain normal modes of vibration.

11. (a) Obtain Hamilton's canonical equations of motion using the definition of Hamiltonian

    $H = \sum p_i \dot{q}_i - L$ and show that $H = T + V$.

    (b) State and explain Liouville's theorem.

OR

12. (a) Discuss the harmonic oscillation problem using Hamilton-Jacobi method.

    (b) Evaluate the Poisson brackets

    (i) $[J_x, J_y]$

    (ii) $[J_y, J_z]$.

13. (a) Derive the Euler equation of motion for a rigid body.

    (b) Explain the terms angular momentum and inertia tensor.

OR

14. (a) What are four vectors and tensors?

    (b) Derive the Lorentz transformation equations.

($3 \times 15 = 45$ Marks)

PART – C

Answer any **three** questions. Each question carries **5** marks.

15. A particle of uniform mass moves in a potential $V(x) = ax^2 + \frac{b}{x^2}$ where *a* and *b* are positive constants. Find the angular frequency of small oscillations about the minimum of the potential.

16. If the Lagrangian of a particle moving in one dimension is given by $L = \frac{\dot{x}^2}{2x} - V(x)$, Then find the Hamiltonian of the particle.

17. Evaluate the Poisson bracket $\left\{\left|\vec{H}\right|, \left|\vec{P}\right|\right\}$.

18. A canonical transformation relates the old co-ordinates *(q, p)* to the new ones (Q, P) by the relations $Q = q^2$ and $P = \frac{p}{2q}$. Obtain the corresponding time independent generating function.

19. A constant force F is applied to a relativistic particle of rest mass m. If the particle starts from rest at $t = 0$, obtain its speed after a time *t*.

20. Write down the *KdV* equation and explain the terms involved. What is the importance of its solutions?

(3 × 5 = 15 Marks)