TM241815Z

Reg. No :..............................

Name :..............................

MASTER'S DEGREE (C.S.S) EXAMINATION, NOVEMBER 2024

2024 ADMISSIONS REGULAR

SEMESTER I - CORE COURSE PHYSICS

PH1C02TM20 - Classical Mechanics

Time : 3 Hours

Maximum Weight : 30

Part A

I. Answer any Eight questions. Each question carries 1 weight **(8x1=8)**

1. State the conservation theorem in terms of cyclic coordinates.
2. Explain the concept of canonical momentum with an example.
3. Express Hamilton's equations of motion in Poisson bracket formalism.
4. Briefly explain the different types of equilibrium.
5. Consideing $H = \frac{p_r^2}{2m} + \frac{K}{2mr^2} + V$ and V depends only on r, show that K is constant of motion. using Poisson bracket formalism.
6. State and prove parallel axes theorem.
7. How will you assign generalized coordinates of a rigid body?
8. Briefly discuss equation of motion and first integrals.
9. Cite the situation where Hamilton's characteristic function is employed and hence show its physical significance.
10. Define action angle variable.

Part B

II. Answer any Six questions. Each question carries 2 weight **(6x2=12)**

11. A particle of mass m is free to move without friction on the inside of a hemispherical bowl whose axis is aligned along the vertical. The radius of the hemisphere is R and the particle is located by the polar angle θ and the azimuthal angle φ. Set up the equations of motion.
12. The Lagrangian for a simple spring is given by $\frac{1}{2}m\dot{x}^2 - \frac{1}{2}kx^2$. Find the Hamiltonian and the equations of motion using the Hamiltonian formulation. Identify any conserved quantities.
13. Compare and contrast Newtonian, Hamiltonian and Lagrangian formalisms.
14. Show that the transformation defined by $Q = \log\left(1 + \sqrt{q}\cos p\right)$, $P = 2\sqrt{q}\left(1 + \sqrt{q}\cos p\right)\sin p$ is canonical using Poisson Brackets.
15. Obtain Euler's equations of motion for a rotating rigid body with a fixed point.
16. Consider a homogeneous cube of density ρ, mass M and side a. Taking origin O at one corner and axes along the edges of the cube, determine the inertia tensor, the principal axes and their associated moments of inertia.
17. Discuss the significance of HJ Theory in comparison with canonical transformation.
18. Show by Poisson Bracket that for a one dimensional harmonic oscillator, there is a constant of motion u defined as $u(q, p, t) = \ln(p + im\omega q) - i\omega t \, : where \; \omega = \sqrt{\frac{k}{m}}$

Part C

III. Answer any Two questions. Each question carries 5 weight **(2x5=10)**

19. Derive Lagrange's equation from variational principle. What are the advantages of variational principle formalism over the differential formalism?
20. Deduce the Lagrangian equation of motion for a N coupled oscillator in terms of normal coordinates.
21. Derive the equation for orbit of a particle moving under the influence of an inverse square central force field. Also calculate the time period of motion in elliptical orbit.
22. Solve Harmonic Oscillator problem using Hamilton Jacobi theory.