K23P 3282

Reg. No. : .....

Name : .....

**First Semester M.Sc. Degree (CBSS – Supple. (One Time Mercy Chance)/Imp.) Examination, October 2023**
**(2014 to 2022 Admissions)**
**PHYSICS**
**PHY 1C02 : Classical Mechanics**

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** questions (either **a** or **b**). **Each** question carries **12** marks. **(2×12=24)**

1. a) Explain Kepler problem, describe possible bound and unbound motion. Obtain the solution for a bound trajectory in the form of a (quadrature) integral.

OR

b) Explain Hamilton-Jacobi method and, using it, provide a solution for simple harmonic oscillator.

2. a) Explain what is an Infinitesimal Canonical Transformation (ICT). Express rotation as an ICT, identify the generators and evaluate their Poisson brackets.

OR

b) Write down the relevant Euler equations and describe the motion of a symmetric top.

SECTION – B

Answer **any four** questions. (**1** mark for Part **a**, **3** marks for Part **b**, **5** marks for Part **c**). **(4×9=36)**

3. a) What is meant by degeneracy of normal mode frequencies ?

b) Can a particle of unit mass experiencing a potential $V(x) = x - x^3$ execute small oscillations ? If yes, find the frequency for oscillations.

P.T.O.



c) The matrix $V - \omega^2 T$ for an oscillating system of particles has the form

$$\begin{pmatrix} 8 & -3 & -3 \\ -3 & 8 & -3 \\ -3 & -3 & 8 \end{pmatrix}$$

Find the normal mode frequencies and corresponding oscillations.

4. a) State the principle of least action.

b) State true or false with reason : We cannot have two different Lagrangians describing the same problem in mechanics.

c) Find the least value of the action integral $S = \int_{t_1}^{t_2} L dt$ for a free particle of unit mass in one dimension moving from the point $x(t_1 = 0) = 0$ to the final point $x(t_2 = 2) = 4$.

5. a) How do we obtain Hamiltonian of a system from its Lagrangian ?

b) Obtain the Hamiltonian for a charged particle in electromagnetic field from its Lagrangian.

c) Describe what is a isotropic harmonic oscillator in two dimensions by writing its Hamiltonian in Cartesian coordinates (x, y) and provide the Hamilton's equations.

6. a) State true or false with reason ; If the Poisson bracket of a Hamiltonian H with angular momentum component $L_z$ vanishes, then the Hamiltonian does not depend on the cartesian x, y coordinates.

b) Find the generating function for a canonical transformation that does a translation of coordinate $q_1 \rightarrow q_1 + a$.

c) Let r be the position vector of a particle that moves in a constant magnetic field $B = B\hat{i}$. If $A = \frac{1}{2} r \times B$, find the Poisson brackets $[A_i, L_j]$ of its components with the angular momentum components $L_j$ where $(i, j = 1, 2, 3)$. Is A a system vector ?



7. a) Define differential scattering cross section.

b) Explain what is centre of mass and centre of mass coordinate system (CM frame). In the scattering of two particles, find the momentum of the centre of mass in the CM frame.

c) For a beam of charged particles A with energy E scattered through an angle $\Theta$ by a fixed heavier charged particle B, the scattering cross section is found to be $\sigma(\Theta)$. When the experiment is repeated with the energy 2E and we get the same $\sigma(\Theta)$, what will be the new scattering angle ?

8. a) Describe what are Euler engles.

b) Explain how many degrees of freedom are required to describe the motion of a rigid body.

c) Describe what is a coriolis force by deriving an expression for it. What will be the coriolis force acting on a freely falling body in the northern hemisphere ?