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Reg. No. : .....

Name : .....

First Semester M.Sc. Degree Examination, May 2023

Physics

PH 211 : CLASSICAL MECHANICS

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 75

SECTION – A

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

1. What are holonomic and non holonomic constraints. Give examples.
2. Obtain Hamilton Jacobi equation.
3. Obtain the relativistic Lagrangian in relativistic mechanics.
4. What is logistic map? What is its importance?
5. Show that angular momentum is a constant of motion in any central force problem. Hence show that the areal velocity is also a constant.
6. Use the variational principle to show that the shortest distance between two points in space is a straight line.
7. What is generating function? Why is it called so?
8. Obtain the equation of motion of a system of two masses, connected by an inextensible string passing over a small smooth pulley.

($5 \times 3 = 15$ Marks)

P.T.O.

SECTION – B

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

9. (a) Derive the Euler-Lagrange's equations of motion using the calculus of variations and hence obtain Lagrange's equations of motion for a system of particles.

   (b) State and prove the Brachistochrone problem.

OR

10. (a) Two identical harmonic oscillators are coupled together. Set up the equations of motion and obtain the general solutions. Describe the two normal modes.

    (b) Explain stable, unstable and neutral equilibrium with the help of potential energy curve.

11. (a) Define canonical transformations and obtain the transformation equations corresponding to all possible generating functions.

    (b) Determine the values of α and β so that the equations $Q = q^{\alpha} \cos \beta p$ and $P = q^2 \sin \beta p$ is a canonical transformation.

OR

12. (a) State and prove Liouville's theorem.

    (b) Establish a relation between Lagrange and Poisson bracket.

13. (a) Obtain the transformation equations for momentum four - vector and acceleration four – vector.

    (b) Discuss any two consequences of Lorentz transformations.

OR

14. (a) Discuss the phase trajectories of a non linear conservative system by considering the motion of a mass, attracted towards a fixed point by a non-linear restoring force F(x). If $F(x) = k \sin x$, plot the phase trajectories.

(b) Write a note on the observational evidence to general theory of relativity.

($3 \times 15 = 45$ Marks)

SECTION – C

Answer any **three** of the following questions. Each question carries **5** marks.

15. Show that if E and p are relativistic energy and momentum in S-frame, then $E^2 - p^2c^2 = m_o^2c^4 = E'^2 - p'^2c^2$.

16. A bead slides on a smooth rod which is rotating about one end in a vertical plane with uniform angular velocity ω. Obtain the equation of motion.

17. Write down the Hamiltonian and Hamilton's equations for two dimensional isotropic harmonic oscillator in polar coordinates.

18. Show that the transformation $p = m\omega q \cot Q$ and $P = \dfrac{m\omega q^2}{2 \sin^2 Q}$ is canonical, and obtain the generator of the transformation.

19. Apply the Hamilton Jacobi method to determine the motion of a body falling vertically in a uniform gravitational field.

20. A particle moving in a central force field located at r = 0, describes a spiral $r = e^{-\theta}$. Prove that the magnitude of force is inversely proportional to r^3.

($3 \times 5 = 15$ Marks)

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