Reg. No .... Name **20P1018**

M. Sc. DEGREE END SEMESTER EXAMINATION - OCT 2020 : FEBRUARY 2021

SEMESTER 1 : PHYSICS

COURSE : **16P1PHYT02 : CLASSICAL MECHANICS**

(For Regular - 2020 Admission and Supplementary - 2016/2017/2018/2019 Admissions)

Time : Three Hours Max. Marks: 75

PART A
Answer All (1 mark each)

1. For a cyclic co-ordinate 'q_j' associated with Lagrangian, the following statement is valid
   (a) The generalised momentum p_j is cyclic
   (b) The generalised momentum p_j is a constant of motion
   (c) The cyclic co-ordinate q_j is zero
   (d) The Hamiltonian is a constant of motion
2. Which of the following equation does not represent Hamilton's principle for a conservative system
   (a) $\delta \int pdq = 0$ (b) $\delta \int Tdt = 0$ (c) $\delta H > 0$ (d) $\delta S = 0$
3. Poisson bracket of two constants of motion is
   (a) zero (b) infinity (c) a constant (d) Lagrange bracket
4. If a rigid body is rotating with an angular velocity 'w' about an instantaneous axis through a fixed point in the body, the angular momentum vector $\vec{J}$ about the same point
   (a) will be always in the direction of w
   (b) can be in the direction of w
   (c) will always perpendicular to 'w'
   (d) will never be in the direction of w.
5. Lyapunov exponent of a chaotic system is
   (a) Always positive (b) Sometimes negative (c) Complex (d) Imaginary

(1 x 5 = 5)

PART B
Answer any 7 (2 marks each)

6. State and explain the principle of least action.
7. Why Hamilton's equations are called canonical equations?
8. Generalised co-ordinates need not have dimensions of length . Likewise components of generalised force do not neccesarily have the dimensions of force. Justify your answer.
9. The fundamental Poisson bracket provide the most convenient way to decide whether a given transformation is canonical. Discuss.
10. What is the role of action-angle variables in transition from classical to quantum theory?
11. State Kepler’s laws of planetary motion. If the law of gravitation were different from the inverse square law, which of the Kepler’s laws would still remain valid?
12. Explain an orthogonal transformation.
13. Show that infinitesimal rotations commute.
14. What are the pre-requisites for chaos in a system?
15. What is "butterfly effect" in chaos?

(2 x 7 = 14)

PART C
Answer any 4 (5 marks each)

16. Setup Hamilton's equations of motion for a projectile in space. Neglect the effects of earth's rotation.
17. Show that the transformations $q = \sqrt{2P}\sin Q$ and $p = \sqrt{2P}\cos Q$ is canonical. Obtain the generator of the transformation.
18. Show that the function $S = \int Ldt$, satisfies the Hamilton-Jacobi equation.
19. Use Hamilton's equation to prove that the areal velocity is constant in planetary motion.
20. Using suitable figures, explain the three cases of nutation.
21. Explain logistic map in chaos.

(5 x 4 = 20)

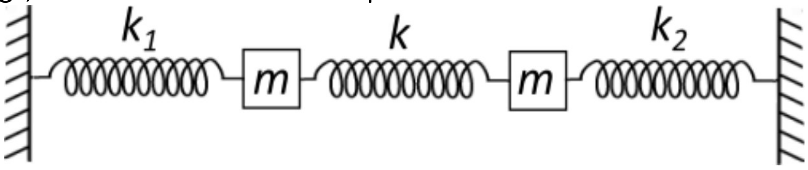
PART D
Answer any 3 (12 marks each)

22.1. Prove that, if Lagrangian is not an explicit function of time, Hamiltonian is conserved. Prove also that Hamiltonian represents the total energy if the system is conservative.

OR

2. Deduce Hamilton's principle from D'Alembert's principle. Derive Lagrange's equation from it.

23.1. A system of two coupled oscillators is shown in figure. Find expressions for normal mode frequencies. If the force constant of the middle spring is the geometric mean of the side springs, what are the modified expressions for the normal mode frequencies.



OR

2. Obtain Kepler's laws of planetary motion.

24.1. Discuss the general features of orbits in central force problem for repulsive and attractive cases.

OR

2. What are the properties of a chaotic system? Explain universality of chaos.

(12 x 3 = 36)