LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc.DEGREE EXAMINATION – **PHYSICS**

FIRSTSEMESTER – APRIL 2018

17/16PPH1MC01/PH1817 - CLASSICAL MECHANICS

Date: 25-04-2018 Dept. No. Max. : 100 Marks
Time: 09:00-12:00

PART A

Answer **ALL** questions (10x2 = 20)

1. Using cartesian coordinates as generalized coordinates, deduce Newton's equations of motion from Lagrange's equation for the motion of a particle of mass m.
2. State D'Alembert's principle.
3. What are moments of inertia and products of inertia?
4. Express rotational kinetic energy of a body in terms of inertia tensor and angular velocity.
5. The Lagrangian for an anharmonic oscillator is given by $L(x,\dot{x}) = \frac{1}{2}\dot{x}^2 - \frac{1}{2}\omega^2 x^2 - ax^3$. Find the Hamiltonian.
6. If the Hamiltonian H is independent of time t explicitly, prove that it is a constant.
7. Define a canonical transformation.
8. What are action, angle variables?
9. Explain the terms stable and unstable equilibrium.
10. What are normal modes of vibration?

PART B

Answer any **FOUR** questions (4x7.5 = 30)

11. Using Lagrangian method, obtain the equations of motion of a system of two masses connected by an inextensible string passing over a small smooth pulley.
12. Establish the relation between inertia tensor and angular momentum vector.
13. Obtain the Hamilton's canonical equations of motion from the variational principle.
14. Prove that $[F, G+K] = [F,G] + [F,K]$
15. Deduce the eigenvalue equation for small oscillations.
16. The motion of the system during an interval of time may be regarded as an infinitesimal contact transformation generated by Hamiltonian. Explain.

PART C

Answer any **FOUR** questions (4x12.5 = 50)

17. What are Kepler's laws of planetary motion? Derive expressions for all the three Kepler's laws of planetary motion.

18. Define Euler's angles and obtain an expression for the complete transformation matrix.
19. A particle slides from rest at one point on a frictionless wire in a vertical plane to another point under the influence of the earth's gravitational field. If the particle travels in the shortest time, show that the path followed by it is a cycloid.
20. Set up the Hamiltonian for an one dimensional harmonic oscillator and using the method of separation of variables evaluate S and hence obtain the solution for the oscillator as $\sqrt{\frac{2\alpha}{k}}\sin\omega(t+\beta)$. Using the initial conditions at t =0 as q = q_0, p = $p_0$and $\beta = 0$, Prove that $S = \int L\,dt$ for the linear harmonic oscillator.
21. Set up the Lagrangian for the linear triatomic molecule and solve for the normal modes of vibrations.
22. Using Legendre transformation, obtain the transformation equations corresponding to all possible generating functions.

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