LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

FIRST SEMESTER – **APRIL 2016**

PH 1817 - CLASSICAL MECHANICS

Date: 02-05-2016 Dept. No. Max. : 100 Marks
Time: 01:00-04:00

PART A

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

1. State and prove the law of conservation of linear momentum for a system of particles.
2. What is a central force?
3. Give the expression for angular momentum in terms of inertia tensor.
4. Find out the nature of the force, conservative or non-conservative $F = x^2\, yz\, \hat{\imath} - xyz^2 \hat{k}$
5. Determine $[p_x, L_z]$
6. Write the equations of motion in Poisson bracket form.
7. What is the nature of the new set of variables when there is a transformation from (p_k, q_k) to (P_k, Q_k) and the Hamiltonian is zero?
8. Show that Poisson bracket has antisymmetry property.
9. Explain Hamilton's principal function S.
10. Distinguish between stable and unstable equilibrium.

PART B

Answer any FOUR questions **(4 x 7.5 = 30 marks)**

11. What is Hamilton's principle? Derive the Lagrange's equations of motion from Hamilton's principle.
12. Write down the Hamiltonian and equation of motion for a simple pendulum.
13. Show that the kinetic energy of a rotating rigid body in a coordinate system of principal axes given by $T = \frac{1}{2}\,(I_1\omega_1^2 + I_2\omega_2^2 + I_3\omega_3^2)$
14. State and prove Hamilton Jacobi equation for Hamilton's principal function.
15. The motion of the system during an interval of time may be regarded as an infinitesimal contact transformation generated by the Hamiltonian. Explain.
16. From the theory of small oscillations obtain the eigenvalues for a double pendulum.

PART C

Answer any FOUR questions **(4 x 12.5 = 50 marks)**

17. Derive the Lagrangian for a charged particle moving in an electromagnetic field.
18. a) State and prove the virial theorem
    b) Show that for a particle moving under a central force f®, the equation of the orbit is given by $\frac{d^2u}{d\theta^2} + u = -\frac{m^2}{j^2u^2} f\left(\frac{1}{u}\right)$
19. Discuss the theory of a spinning symmetrical top under gravity.
20. A particle slides from rest at one point on a frictionless wire in a vertical plane to another point under the influence of earth's gravitational field. If the particle travels in the shortest time. Show that the path followed by it is a cycloid.
21. Applying the theory of small oscillations, determine the eigenvalues and eigenvectors for a linear triatomic molecule. Discuss the different modes of vibrations of the molecule.
22. What are action angle variables? Explain how they can be used to obtain the frequencies of periodic motion.

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