LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

FIRST SEMESTER – NOVEMBER 2016

16PPH1MC01 / PH 1817 - CLASSICAL MECHANICS

Date: 02-11-2016 Dept. No. Max. : 100 Marks

Time: 01:00-04:00

PART A

Answer ALL questions **(2x10 = 20 marks)**

1. If the magnitude of force of attraction between particles of masses m1 and m2 is given by $F = \frac{k m_1 m_2}{r^2}$ where k is a constant and r is the distance between the particles. Determine the potential energy function.
2. What are constraints? What type of difficulties arises due to constraints in the solution of mechanical problems and how are these removed?
3. What is Coriolis force?
4. Find the number of degrees of freedom for a rigid body which a) can move freely in space b) has one point fixed.
5. State the modified Hamilton's principle.
6. The Lagrangian of a particle of mass m moving in a plane is given by $L = \frac{1}{2} m(v_x^2 + v_y^2) + a(x\, v_y - y v_x)$. Find the canonical momenta.
7. Give the dimensions of action and angle variables.
8. Give the equations of motion in Poisson bracket form.
9. Give the potential energy expression for a double pendulum and its V matrix.
10. What are symmetric and antisymmetric modes of vibration?

PART B

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

11. Use Lagrange's equations to find the equation of motion of a compound pendulum in a vertical plane about a fixed horizontal axis. Hence find the period of oscillations of the compound pendulum.
12. Calculate the inertia tensor for the system of four point masses 1g, 2g, 3g and 4g located at the points (1,0,0), (1,1,0), (1,1,1) and (1,1,-1) cm.
13. Derive the Euler-Lagrange's equations of motion using the calculus of variation and hence obtain Lagrange's equations of motion for a system of particles.
14. Write a short note on infinitesimal canonical transformation.
15. Establish the angular momentum poisson bracket relations.
16. Using D' Alembert's principle derive the general equation of the form $\sum \frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_j}\right) - \frac{\partial T}{\partial q_j} = Q_j$

PART C

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

17. Construct the Lagrangian and the equations of motion of a coplanar double pendulum placed in a uniform gravitational field.
18. Explain in detail the inertia tensor? What are principal axes and principal moments of inertia? How will you determine the principal moments of inertia of a rigid body and direction of principal axes?
19. A curve is passing through the fixed points (x_1,y_1) and (x_2,y_2) and it revolves about y axis to form a surface of revolution. Find the equation of curve for which the surface area is minimum.
20. Apply the Hamilton Jacobi method for a one dimensional harmonic oscillator and obtain the solution as $\sqrt{\frac{2\alpha}{k}}\sin\omega\,(t+\beta)$
21. Using the theory of small oscillations discuss the different modes of vibrations of a linear triatomic molecule.
22. Obtain the Lagrangian for a charged particle moving in an electromagnetic field.

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