LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

FIRST SEMESTER – **APRIL 2014**

PH 1817 - CLASSICAL MECHANICS

Date : 29/03/2014 Dept. No. Max. : 100 Marks
Time : 09:00-12:00

PART - A

Answer **ALL** questions (10 x 2 = 20)

01. Show that the momentum conjugate to a cyclic coordinate is a constant of motion.
02. State and express Hamilton's variational principle.
03. What are the differences between the Lagrangian and Hamiltonian methods in determining the equations of motion?
04. Using the definition of **L** = m.(**r x v**). Show that **L** = **I.ω**
05. What are Euler's angles?
06. Show that $[p_x, L_z] = -p_y$
07. What are fundmamental poisson brackets?
08. Using the definition of the Hamiltonian show that the total energy of a system is T+V.
09. Define Hamilton's principal function.
10. What are normal modes of vibration?

PART - B

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

11. Using the variational principle obtain Hamilton's canonical equations of motion.
12. Reverse the Legendre's transformation to derive the properties of $L(q,\dot{q},t)$ from $H(q,p,t)$ treating the q_i as independent quantities and show that it leads to the Lagrangian equation of motion
13. Solve the motion of a particle in one dimension whose Hamiltonian is given by $H = p^2/2m + V(q)$ by the Hamilton-Jacobi method.
14. For what values of α and β do the equations $Q = q^\alpha \cos\beta p$ and $P = q^\alpha \sin\beta p$ is canonical? Find the generating function F_3.
15. A particle of mass m moves in one dimension under a potential of V = -k/x. For energies that are negative, the motion is bounded and oscillatory. By the method of action-angle variables find an expression for the period of motion as a function of the particle energy.

PART - C

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

16 a) Show that the Lagrange's equation can be derived from Hamilton's principle for a conservative holonomic system. (6.5)

b) A particle of mass m moves in one dimension such that it has the Lagrangian $L = m^2\dot{x}^4/12 + m\dot{x}^2V(x) - V^2(x)$ where V is some differential function of x. Find the equation of motion for x. (6)

17 a) Solve the equation of the orbit : $\theta = \ell \int dr/r^2\{2m(E- V(r) - \ell^2/2mr^2\}^{½} + \theta'$ for an attractive central potential. Classify the orbits in terms of e and E. (7.5)

b) Show that if a particle describes a circular orbit under the influence of an attractive central force directed at a point on the circle, the force varies as the fifth power of the distance (5)

18 a) Give an account of the theory of canonical transformations. (6.5)

b) Obtain the transformation equations for the generating functions $F_4(p,P,t)$. (6).

19 a) Explain the action-angle variable method. (4)

b) For the Kepler's problem in action-angle variables assume the expression for the action integral as $\mathbf{J}_r = \oint[2mE + 2mk/r - (\mathbf{J}_\theta + \mathbf{J}_\varphi)^2 / 4\pi^2r^2]^{1/2} .dr$. Solve this integral to show that $\tau^2 \propto a^3$ where τ is the time period of any planet with semi-major axis 'a' about the Sun. (8 .5)

20. Write notes on any Two of the following

i) Velocity dependent potential ii) Coriolis Effect.

iii) Infinitesimal canonical transformations.

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