LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION - **PHYSICS**

FIRST SEMESTER – **NOVEMBER 2013**

PH 1817 - CLASSICAL MECHANICS

Date : 05/11/2013 Dept. No. Max. : 100 Marks
Time : 1:00 - 4:00

PART - A

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

01. What is meant by generalized coordinates?
02. Write the Lagrangian for a free particle in cylindrical coordinates.
03. Show that the kinetic energy T for a torque free motion of rigid body is a constant.
04. When **L** = **r** x **p** and **N** = **r** x **F**, show that **N** = d**L**/dt
05. What is a Coroilis force ? Give one example.
06. State the principle of least action.
07. Show that the generating function F_1 = q Q generates a transformation that interchanges the momenta and coordinates.
08. Show that $[q_i, p_j]_{q,p} = 0$ for $i \neq j$ and 1 for $i=j$.
09. Show that the Hamilton's principal function S differs from the indefinite time integral of the Lagrangian by a constant.
10. What is meant by secular equation?

PART - B

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

11. Show that the charged particle in an electromagnetic field has a potential U = qϕ - q**A.v**
12. Solve the Euler's equations of motion for a symmetric top $I_1 = I_2 \neq I_3$ with no torque acting on it.
13. Using the basic definition of the Hamiltonian H(q,p,t), obtain Hamilton's canonical equations of motion
14. Show that the transformation Q=q +i p and P = Q – i p is not canonical. Suppose the size of the units used to measure the coordinates and momentum are changed to Q' and P' such that Q' = μQ and P' = υP then show the transformation equations are canonical.
15. Solve by the Hamilton-Jacobi method the motion of a particle in a plane under the action of a central potential V(r) to obtain the equation of orbit.

PART - C

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

16. a) A particle of mass m is attached to the mid point of a weightless rod of length L. The ends of the rod are constrained to move along the x and y axes without friction. Write the Lagrangian and solve for the equation of motion assuming g acts in the negative y direction. (7.5)

    b) A mass m is attached to a spring of stiffness constant k and capable of motion along the x direction. Using Hamilton's canonical equations find the equation of motion for the mass. (5)
17. a) Show that Q = log(sin p) /q and P = q cot p is canonical using Hamilton's canonical equations. (7.5)

    b. Show that the transformation given by $2P = p^2 + q^2$ and $Q = \tan^{-1} q/p$ is canonical. (5)

18. Set up the Hamiltonian for the one dimensional harmonic oscillator and using the method of separation of variables evaluate S and hence obtain the solution for the oscillators $(2\alpha/k)^{1/2}\cos \omega(t+\beta)$. Using the initial conditions at $t = 0$ $q = q_0$, $p = p_0$ and $\beta = 0$ prove that $S = \int L \, dt$ for the linear harmonic oscillator.
19. Set up the Lagrangian for the linear triatomic molecule and solve for the normal modes of vibrations.
20. Write notes on any <u>Two</u> of the following
    i) Lagrange's equation from the variational principle. ii)Theory of Hamilton –Jacobi method.
    iii) Invariance of Poisson's brackets in a canonical transformation.

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