 LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

FIRST SEMESTER – NOVEMBER 2012

# PH 1817 - CLASSICAL MECHANICS

Date : 01/11/2012 Dept. No. Max. : 100 Marks

Time : 1:00 - 4:00

**PART – A**

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

01. What is a non- holonomic constraint? Give an example.

02. Show that Newton’s Second law can be obtained from the Lagrange’s equation.

03. What is an inertia tensor?

04. Show that the kinetic energy T for torque free motion of rigid body is a constant of motion.

05. Show that the generating function F2 = Σqipi generates an identity transformation.

06. Show that [q,H]q,p = and [p,H] q,p =

07. Define a canonical transformation.

08. What are the fundamental Poisson’s brackets?

09. Explain the physical significance of Hamilton’s characteristics function S.

10. What is Hamilton’s characteristic function W?

**PART – B**

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

11. Show that the charged particle in an electromagnetic field has a potential U = qφ - q**A.v**

12. Obtain the expression for the Coriolis effect as 2m(**ω** x **vr** ) where vr is the velocity in the rotational frame of reference. State its importance in the Earth related phenomenon.

13. Considering the scattering of charged particles as a central force problem obtain an expression for the scattering cross-section σ(Θ) ie. Rutherford Scattering formula.

14. Obtain the transformation equations for the generating functions F1(q,Q,t) and F2(q,P,t)

15. Using the Hamilton-Jacobi method obtain the equation of orbit for a particle in a plane under the action of a central potential V(r).

**PART – C**

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

16 a) Set up the Lagrangian for a particle of mass m in a central force using polar coordinates   
(r, θ) and hence obtain the differential equation of orbit of the form:

d2u/dθ2 + u = -m/l2 d/du V(1/u) (7.5)

b) A particle of mass m is constrained to move under gravity without friction on the inside of a paraboloid of revolution whose axis is vertical. Write the Lagrangian and find the equation of motion. What is the condition on the particle’s initial velocity to produce circular motion? Find the period of small oscillations about this circular motion. (5)

17 a) Obtain Euler’s equations of motion for the rigid body acted upon by a torque **N**. (6)

b) Solve the Euler’s equation of motion for a symmetric top I1 = I2 ≠ I3 with no torque acting on it. (6.5)

18 a) Prove the invariance of Poisson’s brackets under a canonical transformation. (6.5)

b) Prove that the infinitesimal canonical transformation does not change the value of the Hamiltonian. (6)

19. Define action and angle variables. Solve the Kepler’s problem in action-angle variables.

20. Write notes on any TWO of the following

i) Euler’s angles ii) Solution of one dimensional oscillator by HJ method

iii) Linear triatomic molecule.