(i) Printed Pages : **4]** Roll No. .....

(ii) Questions : **9]** **Sub. Code :** 3 7 0 3

Exam. Code : 0 4 7 2

M.Sc. 1st Semester Examination

1127

PHYSICS

(Classical Mechanics)

Paper : PHY–6002

Time : 3 Hours] **[Max. Marks : 60**

Note :– Attempt *five* questions in all, selecting *one* question from each Unit I to IV. Unit V is compulsory.

Unit–I

1. (a) Obtain equation of motion for Atwood's machine using Lagrangian method.

   (b) Show that the Lagrange's equations in the form :

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_j}\right)-\frac{\partial T}{\partial q_j}=Q_j$$

can also be written as :

$$\frac{\partial \dot{T}}{\partial \dot{q}_j} - 2\frac{\partial T}{\partial \dot{q}_j} = Q_j \qquad 6,6$$

2. (a) Using variational principle, derive expression for growth of current in LR circuit.

   (b) Discuss the superiority of Lagrangian approach over Newtonian approach.

   (c) The position of the particle of mass m is given by Cartesian co-ordinates (x, y, z), the potential energy function

$$v = \frac{1}{2}k\ (x^2 + y^2 + z^2)$$

   and a constraints described by $2\dot{x} + 3\dot{y} + 4\dot{z} + 5 = 0$. Find the differential equation of motion. 6,3,3

Unit–II

3. (a) What are Euler angles ? Represent a general rotation matrix as a product of three simple rotation matrices.

   (b) What are infinitesimal rotations ? Show that a set of infinitesimal rotations forms a vector. 6,6

4. Describe in detail the motion of heavy Symmetrical top. 12

Unit–III

5. (a) Find the frequency and normal co-ordinates of vibration of a linear triatomic molecule considering small displacement from the mean position.

   (b) Explain briefly small oscillations and their applications.

   (c) State Jacobi's form of least action principle. 6,4,2

6. (a) What are Legendre transformations ? Using Legendre transformations obtain Hamilton's equations of motion from Lagrange's equations of motion.

   (b) What is Δ-variation ? Discuss, how it differs from δ variation ?

   (c) What are cyclic coordinates ? Show that if a given coordinate is cyclic in Lagrangian, it will also be cyclic in Hamiltonian. 6,3,3

Unit–IV

7. (a) What are canonical transformations ? Give the condition for the transformation to be canonical.

   (b) Find the Hamilton's principal function S for the free particle problem with Hamiltonian $H = \frac{p^2}{2m}$.

   Use principal function S to obtain $q(t)$ and $p(t)$ for this problem. 6,6

8. (a) Let F be the generating function dependent only on Q_j, P_j, t. Prove that

$$P_j = -\frac{\partial F}{\partial Q_j}, \; Q_j = -\frac{\partial F}{\partial P_j} \text{ and } k = -\frac{\partial F}{\partial t} + H.$$

(b) For what values of m and n do the transformation equations $Q = q^m \cos np$ and $p = q^m \sin np$ are canonical transformations. Obtain the generating function. 6,6

Unit–V

9. (a) Explain the term virtual displacement and state the principle of virtual work.

(b) The Lagrangian of a system is $L = \frac{1}{2}m\dot{q}^2 - \frac{1}{2}kq^2$. Obtain Hamiltonian and Hamilton equation of motion.

(c) Prove that the Poisson Bracket of a constant of motion with Hamitonian is zero.

(d) Define action and angle variables.

(e) Why the cyclones rotate clockwise in Northern Hemisphere ? 3,3,2,2,2