2023
M.Sc.
First Semester
CORE – 01
PHYSICS
Course Code: MPHC 1.11
(Classical Mechanics)

Total Mark: 70 *Pass Mark: 28*
Time: 3 hours

Answer five questions, taking one from each unit.

UNIT–I

1. (a) Construct a diagram to depict the various paths of a particle moving from point 1 to point 2. Formulate the theory of the calculus of variation to include other paths apart from a straight-line path. 7
   (b) Apply the calculus of variation to evaluate the geodesic in a plane. 7

2. (a) Formulate the Lagrange equation of motion for a bead sliding on a uniformly rotating wire in a force free space. 8
   (b) Apply the Euler- Lagrange equation of motion to obtain the time period of a linear harmonic oscillator. 6

UNIT –II

3. (a) Apply the Lagrange equation of motion to show that a two-body problem can be reduced to an equivalent one body problem. 7
   (b) Apply the Lagrange equation of motion to show that the areal velocity of a planet is always a constant. 7

4. (a) Construct an orthogonal space set of axes with its respective unit vector so as to carry out a transformation from space set of axes to body set of axes. Obtain the representation to show that the matrix of a complete transformation is the product of three successive matrix of transformation. 8

(b) Construct a matrix to represent a certain system of body axes with respect to which only the diagonal elements remain in the representation for inertia. Hence obtain the secular equation of inertia tensor. 6

UNIT–III

5. (a) Depict the graphs to represent stable and unstable equilibrium in terms of its potential energy. Explain how the condition of its potential energy can result in different types of equilibrium. 4

   (b) Formulate the theory of small oscillation by applying the Lagrange equation of motion. Show that there are n simultaneous linear homogeneous equation and can be solved for $(n-1)$ unknowns, if and only the determinant of the coefficient vanishes. 10

6. (a) Calculate the potential energy of a mechanical system about a point of stable equilibrium. 5

   (b) Apply the theory of small oscillation to evaluate the normal coordinates for a parallel pendulum. 9

UNIT–IV

7. (a) Formulate the Lorentz transformation equation by using the concept of Kronecker delta function when the transformation in the Minkowski space is similar to the orthogonal transformation in three-dimensional space for two uniformly moving systems whose origin coincides at the initial time. 10

   (b) Write a short note on metric tensor. 4

8. (a) Formulate the modified Lagrange equation of motion for a function that doesn't contain generalised velocities corresponding to ignorable coordinates. 8

   (b) Formulate the Hamilton's equation of motion for a simple pendulum and obtain its time-period. 6

UNIT–V

9. (a) What are Poisson brackets? Explain briefly three properties of Poisson brackets. 2+3=5

(b) Formulate the Hamilton-Jacobi equation for a transformation of independent coordinates and momenta to a new set of corresponding coordinates and momenta. Obtain its solution to show that we can arrive at the solution itself while obtaining the transformation equation. 5+4=9

10. (a) Explain briefly the Liouville's theorem in classical mechanics. 3

(b) Apply the Hamilton-Jacobi method to evaluate the solution of a Harmonic oscillator problem. 11