Course Name **:** Classical Mechanics

Course Number **:** PH 512

Credits **:** 4-0-0-4

Prerequisites **:** Undergraduate physics courses and faculty consent.

Intended for **:** UG/PG

Distribution **:** Core I-Ph.D/Elective for others

Semester **:** Odd

Preamble **:** Classical mechanics is one of the backbone of physics which deals with understanding the motion of particles. The present course covers, topics beyond the Newtonian mechanics for a proper base to many other branches of physics.

Course Outline **:** The course discusses in an abstraction of the mechanics with introduction to Lagrangian mechanics starting from Newtonian mechanics, variational principles of mechanics, Hamiltons equations of motion, canonical transformations, Poisson brackets and Hamilton-Jacobi equations. The concepts are illustrated using examples such as harmonic oscillator, two-body problem, rigid body dynamics, and small oscillations.

Modules :

Introduction: Mechanics of a system of particles, constraints, DAlemberts Principle and Lagranges Equations, Simple Applications of the Lagrangian Formulation, Hamiltons principle, some techniques of the calculus of variations, derivation of Lagranges equations from Hamiltons principle, conservation theorems and symmetry properties. (12 lecture)

The Central Force Problem: The Equivalent one-dimensional problem, and classification of orbits, the virial theorem, the Kepler problem. (6 lecture)

The Kinematics of Rigid Body motion: Orthogonal transformations, Eulers theorem on the motion of a rigid body, finite rotations, infinitesimal rotations, rate of change of a vector, Angular momentum and kinetic energy of motion, the inertia tensor and the moment of inertia. Euler equation of motion of rigid body. (8 lecture)

Oscillations: Formulation of the problem, the eigenvalue equation and the principal axis transformation, small oscillations, frequencies of free vibration, and normal coordinates. (4 lecture)

The Hamilton Equations of Motion: Legendre Transformations and the Hamilton Equations of Motion, Cyclic Coordinates and Conservation Theorems, The Principle of Least action. (8 lecture)

Canonical Transformations: The examples of canonical transformation Poissons Bracket and canonical invarients, Liouvilles theorem. (8 lecture)

Hamilton-Jacobi theory and Action-Angle Variables The Hamilton-Jacobi equation for Hamiltons characteristic function, Separation of variables in the Hamilton-Jacobi Equation, Ignorable coordinates and the Kepler problem, Action-Angle Variables in systems of one degree of freedom. (8 lecture)

Textbooks:

1. Classical Mechanics by H. Goldstein, (Pearson Education; 3 edition (2011))

2. The Variational Principles of Mechanics by Cornelius Lanczos (Dover Publications Inc. 1986)

3. Classical Mechanics by N.C. Rana and P.S. Joag, McGraw Hill Education (India) Private Limited; 1 edition (16 February 2001)

References:

1. Classical Dynamics: A contemporary Approach by J.V.Jose and E.J. Saletan, (Cambridge University Press 2002)

2. Mechanics by L.D. Landau and E.M. Lifshitz, (Butterworth-Heinemann Ltd; 3rd Revised edition edition (29 January 1982))

3. Classical dynamics D T Greenwood (Dover Publications Inc.; New edition edition (21 October 1997))

4. Introduction to Dynamics by I.C. Percival and D. Richards (Cambridge University Press (2 December 1982))

5. A treatise on the analytical dynamics of particles and rigid bodies by E.T. Whittaker, (Forgotten Books (27 September 2015))

6. Classical mechanics by John R Taylor (University Science Books (15 September 2004))

7. Classical Dynamics of particles and systems by Thorton and Marion (Cengage; 05 edition (17 December 2012))