PHY-801 Classical Mechanics

Credit Hours: 3-0

Prerequisite: None

Objectives and Goals: This course will provide a base for core physics.

Core Contents: Fundamental concepts of Lagrangian, classical dynamics, Hamiltonian and Hamilton's equations, relativistic classical mechanics

Detailed Course Contents: Survey of elementary principals, mechanics of a particle, mechanics of a system of particles, constraints

Course Outcomes: On successful completion of this course, students will know the basic formalism of classical mechanics, Lagrangian and Hamiltonian and relativistic classical mechanics, D' Alembert's principle and Lagrange's equations, Velocity dependent potentials and dissipation function, simple application of Lagrangian formulation, Calculus of variation, Variational principles and Lagrange's equations, Hamilton's principle, derivation of Lagrange's equations from Hamilton's principle, Extension of Hamilton's principle to nonholonomic system, Advantages of a variational principle formulation, conservation theorems and symmetry properties, Energy functions and the conservation of energy, Oscillations, formulation of the problem, the eigenvalue equation and the principal axis transformation, frequencies of free vibration, and normal coordinates, free vibrations and the effect of dissipative forces , Digression into tensor theory, invariant quantities, tensors, coordinate transformations , The classical mechanics of the special theory of relativity, 1-forms and tensors, forces in the special theory; electromagnetism, relativistic angular momentum , Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, The Hamiltonian formulation of relativistic mechanics, Derivation of Hamilton's Equations from a variational principle, the principal of least action , The equation of canonical transformations, examples of canonical transformations, the harmonic oscillator, Poisson brackets and other canonical invariants, Equations of Motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, the angular momentum Poisson bracket formulation, the angular momentum Poisson bracket relations.

Textbooks:

1. Herbert Goldstein, Classical Mechanics, revised ed. Addison-Wesley Publishing Company 1980. (referred as HG)
2. Asghar Qadir, Special Relativity, World Scientific Publishing Co. 1989. (referred as AQ)

Reference books: Tai l. Chau, Classical Mechanics, Second Edition, Taylor & Francis 2013.

Weekly Breakdown		
Week	***Section***	***Topics***
1	HG Sec. 1.1-1.3	Survey of elementary principals, mechanics of a particle, mechanics of a system of particles, constraints
2	HG Sec. 1.4-1.6	D' Alembert's principle and Lagrange's equations, Velocity dependent potentials and dissipation function, simple application of Lagrangian formulation
3	HG Sec. 2.1-2.2	Calculus of variation, Variational principles and Lagrange's equations, Hamilton's principle, derivation of Lagrange's equations from Hamilton's principle
4	HG Sec. 2.4-2.5	Extension of Hamilton's principle to nonholonomic system, Advantages of a variational principal formulation, conservation theorems and symmetry properties
5	HG Sec. 2.6-2.7	Energy functions and the conservation of energy
6	HG Sec. 6.1-6.3	Oscillations, formulation of the problem, the eigenvalue equation, and the principal axis transformation
7	HG Sec. 6.4-6.5	frequencies of free vibration, and normal coordinates, free vibrations, and the effect of dissipative forces
8	AQ 3.1-3.3	Digression into tensor theory, invariant quantities, tensors, coordinate transformations
9	HG Sec. 7.1-7.3	The classical mechanics of the special theory of relativity, basic postulates of the special theory, Lorentz transformation, velocity addition and Thomas precision
10	HG Sec. 7.5-7.6, 7.8	1-forms and tensors, forces in the special theory; electromagnetism, relativistic angular momentum
11	HG Sec. 7.10-7.11	Covariant Lagrangian formulations, introduction to the general theory of relativity
12	HG Sec.8.1, 8.2, 8.4	Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, The Hamiltonian formulation of relativistic mechanics
13	HG Sec. 8.5-8.6	Derivation of Hamilton's Equations from a variational principle, the principal of least action
14	HG Sec. 9.1-9.5	The equation of canonical transformations, examples of canonical transformations, the harmonic oscillator, Poisson brackets and other canonical invariants
15	HG Sec. 9.6	Equations of Motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, the angular momentum Poisson bracket formulation, the angular momentum Poisson bracket relations