M1PHY02-CT02: Classical Mechanics

External: 80 Marks | Internal: 20 marks

Lectures: 40hrs | Tutorials : 10 hrs

Additional Contact Hours : 10 (seminars, quiz, assignments, group discussion etc.)

UNIT-I

Many particle systems; conservation laws, Constraints; their classification; degrees of freedom, D'Alembert's principle, generalized coordinates, Lagrange's equations from D'Alembert's principle, velocity dependent potentials and dissipative forces, Jacobi integral. (8L)

UNIT-II

Gauge invariance, generalized momenta, cyclic coordinates, integrals of motion, Symmetries of space and time with conservation laws (2L)

Rotating frames : transformation equations, pseudo (fictitious) forces, Rigid body dynamics: Angular momentum and Kinetic energy of motion about a point , Moment of intertia tensor, (6L)

UNIT-III

Central force: definition and characteristics; properties, closure and stability of circular orbits, Two-body collisions, scattering in laboratory frame, scattering centre-of-mass frame (4L)

Variational principles: Techniques of the calculus of variations, Example of use of the variational principle to find the shortest distance between two points, Hamiltons principle: derivation of Lagrange's equations from Hamilton's principle, equations of motion. (4L)

UNIT-IV

Canonical transformation: generating functions, Hamilton-Jacobi equation; solution: Hamilton's principal function, Solution of harmonic oscillator problem by H-J method (4L)

Poisson brackets: fundamental PB, some properties, Poisson theorems, Angular momentum PBs, Invariance of PB under canonical transformations, relation of PB to quantum mechanics (4L)

UNIT-V

Types of equilibria, Periodic motion, small oscillations and normal modes, Free vibrations of a symmetric linear triatomic ,Special theory of relativity, Lorentz transformations, Velocity transformations, mass energy equivalence, Four vectors : velocity and acceleration 4 vectors. (8L)

TUTORIALS (10 T)

Principle of virtual work, problems related to conservation laws, Application of Lagrange eqns : Simple pendulum, two connected mass with string over pulley, rolling mass inside or outside a circular ring, Foucault's pendulum, examples of coriolis force on earth, Example of how energy can be conserved while H need not and vice versa

Infinitesimal contact transformation, Example of application of canonical transformation for a harmonic oscillator

In addition to the above problems, students are expected to solve examples and problems given in the text as assignments.

Reference Books:

Herbert Goldstein: Classical Mechanics

Rana and Joag, Classical Mechanics