IC121 Mechanics of Particles and waves

Credit: 2.5-0.5-0-3

Prerequisite: Consent of the faculty member

Students intended for: B.Tech

Elective or Core: Core Semester: Even/Odd

Course content:

Part I – Classical mechanics

- Vectors and vector calculus: gradient, divergence and curl, line, surface and volume integrals - Helmholtz theorem. Gauss divergence, Stokes theorem - Generalized coordinates, Jacobian, Cartesian, cylindrical, and spherical coordinates. Introduction to Cartesian tensors. Vectors and vector spaces. [5 Lectures]
- Newtonian mechanics conservation laws: linear, angular momentum, energy- single and many particle systems. [3Lectures]
- Oscillations as application of Newtonian mechanics, Driven damped and forced oscillations, generalized vector spaces, Fourier expansion and oscillations under periodic forces, coupled oscillations and normal modes. Nonlinear oscillations. LC circuit, simple pendulum, coupled pendulum. [4 Lectures]
- Potentials and fields, Fundamental interactions in nature. Gravitational and electrostatic potentials by point particles and extended objects. Multi-pole expansion. Poisson and Laplace equation in electrostatics. [4 Lectures]
- Constraints and generalized coordinates - Lagrangian- Lagrange's equation of motion - relation to Newtonian mechanics - Two body problem - type of orbitals Variational principle of mechanics. [7 Lectures]
- Legendre transform, Hamiltonian mechanics, phase space representation Introduction to many body mechanics. [5 Lectures]

Part II Introduction to Quantum Mechanics

- Inadequacy of classical mechanics, Black body radiation, photo-electric effect, Classical unstable atoms, Bohr model of hydrogen atom, Frank-Hertz experiment. [3 Lectures]
- Uncertainty principle, Phase space and Hilbert space, Postulates of quantum mechanics, Schrödinger equation, observations and measurements, principle of superposition, operators and state functions, expectation value. [5 Lectures]
- Applications of Schrödinger equation, Particle in an infinite square well potentials, Harmonic oscillator, rigid rotor and two body (Hydrogen atom) problem. [4 Lectures]

Textbook

Classical dynamics of Particles and systems by S T Thorton and J B Marion

Introductory Quantum mechanics by Liboff

Quantum physics of atoms, molecules by Eisberg and Resnick

Reference

The Feynman Lectures on Physics Vol. I by R P Feynman

Mechanics : Berkley Physics course I by C. Kittel, W D Knight, M A Ruderman

Classical mechanics by R Douglas Gregory

Classical mechanics by T W B Kibble and F H Berkshire

Introduction to classical mechanics with problems and solutions by D Morin

Introduction to quantum mechanics by D J Griffiths

Quantum mechanics for scientists and engineers by D A B Miller

Quantum mechanics Vol. I by C Cohen-Tannoudji, B