Canonical quantization of scalar field: Creation, annihilation operators, Commutation relations. Interpretation of the quantized field – number operator, connection with harmonic oscillator.

**(12 Lectures)**

***Expected learning outcomes:*** *At the end of this course the students are expected to learn applications of time-dependent perturbation theory, WKB approximation, Scattering by spherically symmetric potentials, partial waves, Born approximation and its validity, relativistic formulation of Quantum Mechanics, Dirac spinors, fine structure of hydrogen atom, interpretation of negative energy solution, Concept of systems with infinite degrees of freedom, Classical fields and Canonical quantization of scalar field.*

**Reference Books:**

i. Introduction to Quantum Mechanics, David J. Griffiths, Cambridge India.
ii. R. L. Liboff, Introductory Quantum Mechanics, Pearson Education (2006).
iii. Quantum Mechanics, Vol. 1 and 2: Claude Cohen-Tannoudji, Bernard Diu, Frank Laloe.
iv. L.I. Schiff, Quantum Mechanics, McGraw Hill (1998).
v. A.K. Ghatak and S. Lokanathan: Quantum Mechanics, Macmillan (2000).
vi. J.J. Sakurai, Modern Quantum Mechanics, Addison-Wesley (1990).
vii. E. Merzbacher, Quantum Mechanics, John Wiley & Sons (1999).
viii. Satya Prakash, Advanced Quantum Mechanics, Kedar Nath (1990).
ix. V.K. Thankappan, Quantum Mechanics, New Age Intl. Pub (1996).
x. S. Gasiorowiz, Quantum Mechanics, Wiley (1995).
xi. P M Mathews and S Venkateswan, Quantum Mechanics, Tata McGraw Hill (1976).
xii. N Zettili, Quantum Mechanics, John Wiley (2001).
xiii. John L Powell and B Crasemann, Quantum Mechanics, Narosa (1991).

## PHYDSC452T

## ELECTROMAGNETIC THEORY

**Contact Hours: 60**

**Full Marks = 100 [ESE (70) CCA(30)]**

***Course objective:*** *This course gives emphasis on Electromagnetic field tensor, Motion of a charged particle in electromagnetic field, Saha's equation of ionization, Plasma oscillations, Plasma Parameters, Radiation from an accelerated point charge, Retarded potentials, Dipole radiation, Quadrupole and magnetic dipole radiation and electromagnetic scattering formulations.*

### Unit 1: Covariant formalism of electromagnetism

Minkowski space-time, Four vector, Lorentz Transformation matrix, Lorentz transformation of electric and magnetic fields, Lorentz invariant quantities involving $\vec{E}$ and $\vec{B}$ $\left(\text{i.e. } E^2 - B^2 \text{ and } \vec{E}.\vec{B}\right)$, Electromagnetic field tensor, current density 4-vector, 4-vector potential, Maxwell's equations in terms of field tensor. **(12 Lectures)**

**Unit 2: Motion of a charge particle in electromagnetic field**

Motion of charged particle in a) uniform electric field b) uniform magnetic field and c) combined uniform electric and magnetic field. Grad B drift, curvature drift. Particle in a non-uniform magnetic field, Particle in a non-uniform electric field and uniform magnetic field, Particle in time varying electric and magnetic fields. **(12 Lectures)**

**Unit 3: Fluid description of plasma**

Saha's equation of ionization (No derivation), Fluid description of plasma: Equation of motion for fluid, Equation of continuity, Plasma approximation, Plasma oscillations, Electron plasma wave, Ion wave, Magneto Sonic and Alfven waves, Collision parameters and diffusion parameters in the diffusion process of plasma, ambipolar diffusion and its coefficient.

**(12 Lectures)**

**Unit 4: Radiation from an accelerated charge**

Retarded potentials, Lienard-Wiechert potentials, field of a system of charges at large distances. Electric Dipole radiation, Quadrupole and magnetic dipole radiation. Derivation of Larmor formula of radiation for accelerated charged particles. **(12 Lectures)**

**Unit 5: Scattering**

Scattering: coulomb collision due to a harmonically bound charge, Thomson scattering, Rayleigh scattering, Mie Scattering and phase function formulation – consideration of a large particle - Other scattering formulations (expressions only): T-matrix, Discrete Dipole Approximation. **(12 Lectures)**

***Expected learning outcomes:*** *At the end of this course the students are expected to learn Lorentz transformation in 4-dimensional Space, Covariant formalism of electromagnetism, Motion of a charged particle in electromagnetic field, Saha's equation of ionization, Plasma oscillations, Plasma Parameters, Radiation from an accelerated point charge, Retarded potentials, dipole radiations and electromagnetic scattering formulations.*

**Reference Books:**


i. J.D. Jackson, Classical Electrodynamics, Wiley Eastern, 1989.
ii. Griffiths, Introduction of Electrodynamics, Prentice Hall.
iii. L.D. Landau & E. M Lifshitz, The classical theory of fields, Butterworth Heinemann Ltd.Oxford.
iv. Miah M.A.W, Fundamentals of Electromagnetic, Tata Mc Graw Hill.
v. Cook D.M, Theory of Electromagnetic Fluids, Prentice Hall.
vi. Lorrain & Corson, Electromagnetic field and waves, Freeman & Company Sanfrancisco.