Syllabus

MPHY CC 6: Electrodynamics and Plasma Physics (5 Credits)

Unit 1: Electromagnetic wave equation and field vectors
Maxwell's equations in free space, Plane wave in free space. Dispersion of electromagnetic waves, Poynting vector in free space. Polarization of electromagnetic waves, electric field vector in terms of scalar and vector potential, Wave equation in terms of scalar and vector potential.

Unit 2: Electromagnetic waves and its Interaction with matter on macroscopic scale
Electromagnetic waves (EMW) in free space, propagation of EMW-in isotropic, anisotropic dielectrics, in conducting media; Boundary conditions, reflection and refraction of EM W, Fresnel formulae, Brewster's law and degree of polarization, total internal reflection and critical angle, reflection from a metallic surface, Propagation of EM W between conducting planes, Wave guides: TE and TM mode, Transmission lines, rectangular and cylindrical wave guides, cavity resonator.

Unit 3: Fields of moving charges and Radiating System
Retarded Potentials, Lienard Wiechert potentials, field of a point charge in uniform rectilinear motion, in arbitrary motion, Radiation from an accelerated charged particle at low and high velocity. Radiating System: Oscillating electric dipole, radiation from an oscillating dipole, from a small current element, from a linear antenna, Antenna arrays.

Unit 4: Relativistic Electrodynamics
Transformation equation for current density and charge density, vector potential and scalar potentials, the electromagnetic field tensor, transformation equation for electric and magnetic field, Covariance of Maxwell equation in four tensor form, covariance of Maxwell and transformation law of Lorentz force.

Unit 5: Plasma Physics
Elementary concepts of plasma, derivation of moment equations from Boltzmann equation. Plasma oscillation, Debye shielding, plasma confinement, magneto plasma. Fundamental equations, hydromagnetic waves: magnetosonic waves, Alfven waves, wave propagation parallel and perpendicular to magnetic field.

References:

l. Introduction to Electrodynamics, David J. Griffiths, Prentice-Hall of India, 3rd Edition, 2009.
2. Classical Electrodynamics, J. D. Jackson, Wiley Publishing, New York, 3rd Edition, 2002.
3. J. A. Bittencourt, Fundamentals of Plasma Physics, 3rd Edition, Springer Publication, 2004.