

Course 4: Electrodynamics

Course code: MSCPH508

Credit: 3

BLOCK – I Electrostatics:

Unit 1: **Electrostatics:** Coulomb's law, electric field, electric potential, charge distributions, electric dipole, electric quadrupole and multipoles, Gauss law and its application, Laplace and Poisson's equation, boundary value problems.

Unit 2: **Electrostatic Field in matters:** Polarisation, dielectrics and conductors, dielectrics constant, permittivity, electric displacement, linear dielectrics, molecular field in dielectrics.

Unit 3: **Magnetostatics:** Magnetic induction, Lorentz force, Biot-Savart law, Ampere law, Faraday law, Divergence and curl of magnetic field, scalar and vector potential, magnetic vector potential, Divergence magnetic vector potential, magnetic scalar potential, gauge invariance, Magnetisation, magnetic susceptibility, hysteresis.

Unit 4: **Electrodynamics:** Current density and equation of continuity, Maxwell's equations, Derivations and explanation of Maxwell's equations, integral form of Maxwell's equations, Maxwell's equations in free space, Maxwell's equations in isotropic medium, boundary conditions at interface, Lorentz invariance of Maxwell's equations.

BLOCK – II Electrodynamics:

Unit 5: **Electromagnetic waves:** Wave equation, electromagnetic waves in free space, electromagnetic waves in conducting and non conducting media, Poynting vector and Poynting vector theorem, wave guide.

Unit 6: **Interaction of Electromagnetic wave with matter:** Boundary condition at the interface of two mediums, reflection and refraction, polarisation, Fresnel's law, interference, coherence and diffraction.

Unit 7: **Electromagnetic Radiation:** Radiation from an accelerated charged particle, Radiation from dipole, Retarding potential, Lienard-wiechert potential, Larmor's radiated power formula and its relativistic generalization, Bremsstrahlung radiation, Cerenkov radiation quantisation of electromagnetic energy.

Unit-8 Four-Vector formalism of Maxwell's Equations

Four vector potential, electromagnetic field tensor, Lorentz invariance, Lorentz force, Covariant form of Maxwell's equations, Four vector current, Continuity equation, Gauge invariance of Maxwell equation, electromagnetic energy-momentum tensor, Motion of charge particle in electromagnetic field, Lorentz force.

Unit 9: **waves Guide:** wave guide, Transmission lines, wave guides and cavities

Reference Books:

1. J.D. Jackson, Classical Electrodynamics, Wiley Eastern Ltd., New Delhi.

2. D.J. Griffiths, Introduction to Electrodynamics, Prentice - Hall of India, New Delhi.

3. J.R. Reitz, F.J. Milford and R.W. Christy, Foundations of Electromagnetic Theory, 3rd Edition, Narosa Publication, New Delhi.

4. Electrodynamics Gupta- Kumar, Pragati publication