ELECTROMAGNETIC THEORY AND RELATIVITY
(For students admitted from June 2008)

Semester – II Hours/week: 6 Credits: 4

UNIT 1: ELECTROSTATICS IN VACUUM AND DIELECTRICS

Gauss' law – Electrostatic potential – Poisson's and Laplace's equations – Multipole expansion of potential and energy in an electric field for a charge distribution – Polarization – Electric displacement – Molecular polarisability and electric susceptibility – Clausius–Mossotti equation – Electrostatic energy in dielectric medium.

UNIT 2: BOUNDARY VALUE PROBLEMS IN ELECTROSTATICS

Boundary conditions - First uniqueness theorem – Conductors and second uniqueness theorem - Formal solution of problems with Green's function - Method of images – Point charge in the presence of grounded conducting sphere – Conducting sphere in uniform electric field – Green's function for sphere – Dielectric sphere in a uniform electric field.

UNIT 3: MAGNETOSTATICS:

Biot-Savart law – Divergence and curl of magnetic induction (B) – Magnetic vector potential – Current loops in external fields - magnetic dipole - Magnetic dipole in a non -uniform magnetic field - Vector potential and magnetic induction for a circular current loop –Magnetic moment, force and torque on a current distribution in external magnetic induction – Magnetostatic energy – Magnetic induction and magnetic field in macroscopic media – Boundary conditions – Uniformly magnetized sphere in an external magnetic field.

UNIT 4: MAXWELL'S EQUATIONS:

Maxwell's equations – Poynting's theorem - Vector and scalar potential – Gauge invariance – Coulomb and Lorentz gauges – retarded potentials – Lienard–Wiechert potentials - Fields and radiation of an oscillating dipole.

UNIT 5: PROPAGATION OF PLANE ELECTROMAGNETIC WAVES:

Propagation of plane electromagnetic waves in free space – Non-conducting medium – Conducting medium and in low pressure ionized gases – Reflection and refraction of electromagnetic waves at a dielectric interface.

UNIT 6: RELATIVITY AND RELATIVISTIC ELECTRODYNAMICS:

Lorentz transformations and basic kinematic results of special theory of relativity – Addition of velocities – Relativistic momentum and energy of a particle, space time of special relativity, relativistic electrodynamics in vacuum – Invariance of charge, current density – Vector and scalar potentials in 4-vectors - Transformation equations for field vectors E and B – Covariance of Maxwell's equation in 4-vector form.

Books for Study:

1. Paul Lorrain and Dale R. Corson, *Electromagnetic field and waves*, 2nd edn, W.H. Freeman and Co., (1970).
2. B. B. Laud, Electrodynamics, Wiley Eastern Ltd., (1987).
3. D J Griffiths *Introduction to Electrodynamics*, 3rd edn, Prentice Hall of India, (2003).

Books for Reference:

1. J. D. Jackson, *Classical Electrodynamics*, 2nd edn., Wiley Eastern Ltd., (1975).
2. Feynman, Leighton, R.B, and Mathew Sands, *Feynman Lectures on Physics – Vol II*, Narosa Publishing House, (1964).