PHY-306 Electromagnetic theory

Credit Hours: 3-0

Pre-requisite: PHY-215 Electricity and Magnetism

Course Objectives: It is an advanced undergraduate course, which aims to make students understand the basics of fields and potentials associated with charges and currents. It also gives insight into electric and magnetic fields in matter and Maxwell's equations with sources in free space and matter. The Maxwell's equations finally lead us to the concept of light as an electromagnetic wave and its propagation through matter.

Core Contents: Vector analysis, Electric potential, multipole expansion, relation between electric and magnetic fields of moving charges, Maxwell's equations in free space and in matter, light as EM waves and its propagation.

Detailed Course Contents: potentials, Electric potential, multipole expansion of scalar and vector potential, Maxwell's equations, displacement current, electrical conductivity and Ohm's law, Maxwell's equations in matter, Light and its propagation through a dielectric and conductors and transmission lines

Course Outcomes: At the end of the course, students will be able to:

- understand electric and magnetic fields and vector potential and the multipole expansion
- understand magnetic fields inside matter and various types of magnetization
- understand how to apply Maxwell's equations and what to infer from them.

Textbook: David F. Griffiths, Electrodynamics, 4th ed. Prentice Hall Inc., 1989 (Referred as DG)

Reference Book: F. J. Milford, R W. Christy, Foundations of Electromagnetic theory, 4th edition, Addison-Wesley, 2008.

Weekly Breakdown		
Week	Section	Topics
1	DG 3.1-3.2	Laplace's equation in one two and three dimensions, The method of images
2	DG 3.3	Separation of variables: Cartesian and spherical coordinates
3	DG 3.4	Multipole Expansion: Approximate Potentials at Large Distances, The Monopole and Dipole Terms
3	DG 4.1-4.2	Polarization, dielectrics and the field inside, induced dipoles, alignment of polar molecules, bound charges
4	DG 4.3-4.4	Gauss's law in the presence of dielectrics, a deceptive parallel, boundary conditions, linear dielectrics and their susceptibility, permittivity and dielectric constant,

		boundary value problem with linear dielectrics, energy and forces on dielectrics
5	DG 5.4	Magnetic vector potential, magneto statics boundary conditions, multipole expansion of vector potential
6	DG 6.1-6.2	Magnetization, diamagnets, paramagnets, Ferro magnets, torques and forces on magnetic dipoles, effect of magnetic field on atomic orbits, bound currents, magnetic field inside matter
7	DG 6.3-6.4	Ampere's law in magnetized materials, a deceptive parallel, boundary conditions, magnetic susceptibility and permeability, ferromagnetism
8	DG 7.1-7.2	Electromagnetic induction, Faraday's law, the induced electric field, inductance, energy in magnetic fields
		Midterm Exam
9	DG 7.3	Maxwell's equations: Electrodynamics before Maxwell, fixing Ampere's law, magnetic charge, Maxwell's equations in matter, boundary conditions
10	DG 8.1	Charge and energy, the continuity equation, Poynting's theorem
11	DG 8.2	Newton's third law in electrodynamics, Maxwell's stress tensor, conservation of momentum, Conservation of angular momentum,
12	DG 9.1	Electromagnetic Waves: The wave equation
13	DG 9.2	EM waves in vacuum: the wave equation for E and B, monochromatic plane waves, energy and momentum in electromagnetic waves
14	DG 9.3	EM waves in matter, propagation in linear media, reflection and transmission at normal and oblique incidence
15	DG 9.4	EM waves in conductors, reflection at conducting surface, the frequency dependence of permittivity
16	DG 9.5	Wave guides, transverse electric waves in rectangular wave guide, the coaxial transmission line