PHY-215 Electricity and Magnetism

Credit Hrs: 2-1

Prerequisite: None

Course Objectives: It is a basic undergraduate course, which aims to make students understand the basics of electricity and magnetism introduce students to the concept of electric field, electric potential and magnetic field and various laws associated with them.

Core Contents: Vector analysis, Electrostatics, Electric field, Electric potential, Work and energy in Electrostatics, Conductors and its basic properties, Electrostatics boundary condtion, Magnetostatics, Magnetic fields, Magnetic forces, Currents, Divergence and curl of magnetic field, Vector Potential, Magnetostatics boundary conditions

Detailed Course Contents: Vector Algebra, differential calculus, integral calculus, curvilinear coordinates, Dirac delta Function, Helmholtz theorem, potentials, Columb's law, electric field, computation of electric field using Columb's law, divergence of electric field, Gauss's law and its applications, Electric potential, Poisson's equations and Laplace's equation, boundary conditions, work and energy in electrostatics, conductors, Lorentz force law: magnetic fields, magnetic forces, currents, the Bio-Savart law, steady currents, the magnetic field of a steady current, Straight line currents, the divergence and curl of B, applications of Ampere's law, comparison of magneto statics and electrostatics, magnetic vector potential, magneto statics boundary conditions, Special techniques: Laplace's equation as special technique, the method of images, separation of variables,

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

- understand the application of vector calculus as a fundamental tool in formulating and analyzing the theory of electromagnetism.
- understand the concept of electric field and various methods of calculating it for different charge distributions.
- understand the behavior of conductors in electrostatics and use this understanding to define a capacitor and explain its ability to store electric charge and energy.

- understand magnetic field and vector potential and the laws associated with it.
- understand how to calculate electric potential by solving Laplace's and Poisson's equations in electrostatic problems.

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

Reference Books:

1. *Foundations of Electromagnetic theory, 4thed.*
   Author: F. J. Milford and R. W. Christy
   Publisher: Addison-Wesley 2008.

2. *Physics for Scientists and Engineers*
   Author: R. A. Serway and J. W. Jewett
   Publisher: Golden Sunburst Series, 8th ed., 2010.

Weekly Breakdown

Week	*Section*	*Topics*
1	DG 1.1-1.2	Review of Vector Calculus
2	DG 1.3,1.5	Integral calculus, The Dirac Delta function, The one-dimensional Dirac Delta function, The three dimensional Dirac Delta function
3	DG 2.1	Electric field, Columb's law, Principle of superposition, Applying Columb's law using Discrete point charges
4	DG 2.1	Introducing point charge in terms of Dirac Delta function, Applying Columb's law for continuous charge distribution, such as Electric field due to line of charge, Electric field due to surface charge
5	DG 2.1	Electric field due to volume charge, problems related to non-uniform charge distributions.
6	DG 2.2	Field lines, Electric flux, The divergence of Electric field
7	DG 2.2	Gauss's law and its applications, The curl of electric field

8	DG 2.3	Introduction to Electric potential, Poisson's and Laplace equation
9	DG 2.3	Computation of electric potential for discrete and continuous charge distribution
10	DG 2.4	Electrostatic Boundary conditions, The Work Done to Move a Charge, The Energy of a Point Charge Distribution
11	DG 2.4-2.5	The Energy of a Continuous Charge Distribution, Conductors and its basic properties,
12	DG 2.5	Capacitors, Capacitance due to parallel plate capacitor, Capacitance of spherical capacitor, Capacitance of cylindrical capacitor
13	DG 5.1, 5.2	The Lorentz force law: magnetic fields, magnetic forces, currents
14	DG 5.2	The Bio-Savart law, steady currents, the magnetic field of a steady current, Straight line currents
15	DG 5.3	The divergence and curl of B, applications of Ampere's law
16.	DG 5.3	comparison of magnetostatics and electrostatics