PHY-107 Electricity and Magnetism

Credit Hours: 3-1
Pre-requisite: None

Course Objectives:

This is an undergraduate general physics course aims to make students understand basics of electricity and magnetism. It introduces students to the concept of electric field, electric potential, capacitors, electric current and magnetic field at a basic level. It also gives insight into electric circuits with and without damping.

Core Contents:

Electric charge, Coulomb's law, finding the electric field for point charges, dipole and various charge distributions, Gauss's law and its application in finding electric field, electric potential for various charge distributions, capacitors and capacitance, electric current, Ohm's law, circuit theory, magnetic force, magnetic fields produced by currents, Inductance, alternating fields and currents.

Detailed Course Contents:

Electric charge, conductors and insulators, Coulomb's law, quantization and conservation of charge, the electric field and field lines, electric field due to a point charge, and electric dipole, electric field due to a line charge and charged disk, a point charge and a dipole in an electric field, flux, flux of an electric field, Gauss's law, a charged isolated conductor, applying Gauss's law to cylindrical, planar and spherical symmetry, electric potential energy, electric potential, equipotential surfaces, potential from field, potential due to point charge, dipole and charge distribution, potential of a charged conductor, capacitors, capacitance for various capacitors, capacitors in series and parallel, energy stored in an electric field, capacitor with dielectric, dielectrics and Gauss's law, electric current, current density, resistance and resistivity, Ohm's law, microscopic view, power in electric circuits, semiconductors, superconductors, work, energy and emf, calculating current in a single loop circuit, potential difference between two points, multiloop circuits, the ammeter and voltmeter, RC circuits, discovery of electron, the Hall effect, a circulating charged particle, cyclotrons and synchrotrons, magnetic force on a

current carrying wire, torque on a current loop, the magnetic dipole moment, calculating the magnetic field due to current, force between two parallel currents, Ampere's law, solenoids and toroids, a current carrying coil as magnetic dipole, inductance, Faraday's law of induction, Lenz's law, induced electric fields, induction and energy transfer, inductors and inductance, induced electric fields, self-induction, RL circuits, energy stored in a magnetic field, mutual induction, LC oscillations, damped oscillations in RLC, Alternating current, forced oscillations, resistive capacitive and inductive load, series RLC circuit, power in alternating-current circuits, transformers.

Course Outcomes:

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

- understand the concept of electric charge, electric field, and potential
- understand how magnetic field is associated with current
- understand various electric circuits and laws governing to work out these circuits
- understand the concept of inductance and alternating current
- workout various physical problems related to above mentioned concepts. Emphasis is put on to develop problem solving skills in students

Textbooks:

Fundamentals of Physics, Authors: D. Halliday, R. Resnick and J. Walker (HRW), Publisher: John Wiley Sons, 9th ed., 2011.

Reference Books:

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

University Physics with Modern Physics, Author: R. A. Freedman, H. D. Young, and A. L. Ford (FYF), Publisher: Addison-Wesley-Longman, 13th International ed., 2010.

Weekly Breakdown		
Week	Section	Topics
1	HRW 21.1-21.6	Electric charge, conductors and insulators, Coulomb's law, quantization and conservation of charge
2	HRW 22.1-22.5	The electric field and field lines, electric field due to a point charge, and electric dipole

3	HRW 22.6-22.9	Electric field due to a line charge and charged disk, a point charge and a dipole in an electric field.
4	HRW 23.1-23.6	Flux, flux of an electric field, Gauss's law, a charged isolated conductor
5	HRW 23.7-23.9	Applying Gauss's law to cylindrical, planar and spherical symmetry
6	HRW 24.1-24.12	Electric potential energy, electric potential, equipotential surfaces, potential from field, potential due to point charge, dipole and charge distribution, potential of a charged conductor
7	HRW 25.1-25.8	Capacitors, capacitance for various capacitors, capacitors in series and parallel, energy stored in an electric field, capacitor with dielectric, dielectrics and Gauss's law
8	HRW 26.1-26.9	Electric current, current density, resistance and resistivity, Ohm's law, microscopic view, power in electric circuits, semiconductors, superconductors
		Midterm Exam
9	HRW 27.1-27.6	Work, energy and emf, calculating current in a single loop circuit, potential difference between two points
10	HRW 27.7-28.3	Multiloop circuits, the ammeter and voltmeter, RC circuits, Magnetic field
11	HRW 28.4-28.10	Discovery of electron, the Hall effect, a circulating charged particle, cyclotrons and synchrotrons, magnetic force on a current carrying wire, torque on a current loop, the magnetic dipole moment
12	HRW 29.1-29.6	Calculating the magnetic field due to current, force between two parallel currents, Ampere's law, solenoids and toroids, a current carrying coil as magnetic dipole
13	HRW 30.1-30.7	Inductance, Faraday's law of induction, Lenz's law, induced electric fields, induction and energy transfer, inductors and inductance, induced electric fields
14	HRW 30.8 30.12, 31.1-31.5	Self-induction, RL circuits, energy stored in a magnetic field, mutual induction, LC oscillations, damped oscillations in RLC

15	HRW 31.6-31.11	Alternating current, forced oscillations, resistive capacitive and inductive load, series RLC circuit, power in alternating-current circuits, transformers