SEMESTER-II

PHYDSC151T

ELECTRICITY AND MAGNETISM

Contact Hours: 45

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *The objective of this course is to review the concepts of electromagnetism learnt earlier from a more advanced perspective and to build new concept on their basis. The course covers static and dynamic electric and magnetic fields due to continuous charge and current distributions respectively. The course also intends to built the concepts of thermoelectricity and its applications along with ideas of various electrical circuits.*

Unit 1: Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions for spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Relation between Electric field intensity and potential difference, Laplace's and Poisson equations. The Uniqueness Theorem (statement only). Potential and Electric Field of an electric dipole. Force and Torque on a dipole. **(9 Lectures)**

Unit 2: Electrostatic energy, capacitance and dielectric properties

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Surface charge and force on a conductor. Capacitance, Principle of a capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations connecting **E, P** and **D**. Gauss' Law in dielectrics. **(10 Lectures)**

Unit 3: Magnetic Field

Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire, circular loop and Helmhotz coil. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid.

Properties of B: curl and divergence. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.
(9 Lectures)

Unit 4: Thermoelectricity

Introduction of thermoelectricity, variation of thermo-emf with temperature, neutral temperature and inversion temperature. Explanation of Seeback effect and Peltier effect, Peltier coefficient. Thomson effect and its prediction. Emf in a thermocouple, law of intermediate temperature and

law of intermediate metals. Thermoelectric power and thermoelectric power diagram. Applications of thermodynamics on thermocouple. **(8 Lectures)**

Unit 5: Electrical Circuits:

AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (i) Resonance, (ii) Power Dissipation and (iii) Quality Factor and (iv) Band Width. Parallel LCR Circuit**.**

Network theorems: Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem.

Ballistic Galvanometer: Working and its Sensitivity. **(9 Lectures)**

Expected learning outcomes: *After completing this course, the students will be able to apply Gauss's law of electrostatics to distribution of charges, understand the effects of electric polarization and concepts of bound charges in dielectric materials, understand the applications of Biot-Savart's law to calculate magnetic field, understand concepts of thermoelectricity along with their applications and also to understand various network theorems for analysing various dc circuits.*

Reference Books:

i. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw.

ii. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.

iii. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

iv. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education.

v. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.

vi. Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

vii. Classical Electromagnetism in a Nutshell, Anupam Garg, 2012, Princeton University Press.