MINOR COURSE- 1B	Electricity and Magnetism	(Theory Credit -03) (Total Marks=60+15)

Course Objective:

This course provides students with fundamental concepts of electricity and magnetism, including electrostatics, dielectrics, magnetostatics, and electromagnetic wave propagation. It emphasizes problem-solving and mathematical techniques to understand electric and magnetic fields and their interaction with matter.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. **Understand electric fields and potentials**, including the derivation of Laplace's and Poisson's equations and their applications.
2. **Apply the Uniqueness Theorem** to solve electrostatic boundary value problems.
3. **Analyze electric dipoles**, their potential, field, force, and torque in an electrostatic field.
4. **Calculate electrostatic energy** for different charge distributions, including charged spheres and systems of charges.
5. **Explain the behavior of conductors in an electrostatic field**, including surface charge distributions and forces.
6. **Determine capacitance for different configurations**, such as parallel-plate, spherical, and cylindrical capacitors.
7. **Understand dielectric properties of matter**, including polarization, polarization charges, susceptibility, and dielectric constants.
8. **Apply Gauss's Law in dielectric materials** and analyze relations between **E, P, and D** fields.
9. **Describe the magnetic field using Biot-Savart's Law** and apply it to straight wires and current loops.
10. **Explain the concept of a current loop as a magnetic dipole** and its analogy with electric dipoles.
11. **Use Ampere's Law** to calculate magnetic fields in symmetric configurations.
12. **Analyze the properties of the magnetic field**, including divergence, curl, and the vector potential.
13. **Calculate magnetic forces on moving charges and current-carrying wires**, and understand torque on current loops.
14. **Understand magnetization and magnetic intensity** and their relation to **B, H, and M** in materials.
15. **Explain ferromagnetism and study the B-H curve and hysteresis phenomena.**
16. **Understand the principles of the ballistic galvanometer**, including torque, current sensitivity, damping, and logarithmic decay.
17. **Review Maxwell's equations** and apply them to derive the electromagnetic wave equation.
18. **Understand displacement current and gauge transformations** (Lorentz and Coulomb gauge).
19. **Analyze electromagnetic waves in dielectric media**, including boundary conditions.
20. **Apply the Poynting theorem** to understand electromagnetic energy density and energy flow.

This course provides a foundational understanding of electromagnetism, preparing students for advanced studies in electrodynamics, optics, and applied physics.

Course Contents:

Electric Field and Electric Potential (10 HRS). Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor.

Dielectric Properties of Matter (08 HRS): Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics.

Magnetic Field (10 HRS): Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application. Properties of B: curl and divergence. Vector Potential. Magnetic Force on point charge, current carrying wire and between current elements. Torque on a current loop in a uniform Magnetic Field.

Magnetic Properties of Matter (05 HRS): Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis.

Ballistic Galvanometer (03 HRS): Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

Maxwell Equations (09 HRS): Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Vector and Poynting Theorem. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density.

Reference Books:

1. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
2. Concepts of Electromagnetic Theory, K. Mamta, Raj Kumar Singh and J. N. Prasad, 1st Edn 2021, Wiley/I. K. International Publishing House, New Delhi
3. Electricity and Magnetism, P. K. Chakraborty, New Age International Pvt. Ltd.
4. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
5. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
6. Feynman Lectures Vol.2, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
7. Fundamental of Magnetism and Electricity, by D. N. Vasudiva.

MINOR COURSE- 1B	Electricity and Magnetism	(Practical Credit -01) (Total Marks=25)

1. Measurement of field strength B & its variation in a Solenoid (Determine dB/dx).
2. Magnetic field in the centre of a current carrying wire.
3. Determination of Self-Induction Coefficient (L) of a Coil.
4. To study B-H curves for different ferromagnetic materials using C.R.O.
5. To determine the frequency of A.C. main using Sonometer.
6. To determine the resistance of an electrolyte for AC current and study its concentration dependence.
7. To study the magnetic field produced by a current carrying solenoid using a pick-up coil and to find the value of permeability of air.
8. Determination of constants of a ballistic galvanometer.
9. Determination of figure of merit of a moving coil galvanometer.

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint & H. T. Worsnop, 1971, Asia Publishing House.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.