Category-IV

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**COMMON POOL OF GENERIC ELECTIVES (GE) COURSES
OFFERED BY THE DEPARTMENTS**

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Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism GE – 11	4	3	0	1	Class XII pass	NIL

LEARNING OBJECTIVES

This course begins with theorems of network analysis which are required to perform the associated experiments in the laboratory. Then course delves into the elementary vector analysis, an essential mathematical tool for understanding static electric field and magnetic field. By the end of the course, the student should appreciate Maxwell's equations.

LEARNING OUTCOMES

At the end of this course the student will be able to,
- Apply Coulomb's law to line, surface, and volume distributions of charges.
- 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 and calculate the vector potential and magnetic field of arbitrary current distribution
- Understand the concept of bound currents and ferromagnetism in magnetic materials

SYLLABUS OF GE – 11

THEORY COMPONENT

Unit 1:   **(15 Hours)**
Network Analysis: Superposition, Thevenin, Norton theorems and their applications in DC and AC circuits with more than one source, Maximum Power Transfer theorem for AC circuits
Mathematical Preliminaries: Concept of scalar and vector fields, Gradient of a scalar field, Divergence and curl of vector fields and their physical interpretation, Conservative forces and Laplace and Poisson equations.
Concept of a line integral of a scalar and vector field, surface integral of vector fields and volume integral, Gauss's theorem, Stoke's theorem.

Unit 2:   **(15 Hours)**
Electric Field and Electric Potential for continuous charge distributions: Electric field due to a line charge, surface charge and volume charge distributions, Electric field vector as negative gradient of scalar potential, Ambiguities of Electric potential, Differential and integral forms of Gauss's Law, Applications of Gauss's Law to various charge distributions with spherical, cylindrical and planar symmetries, Uniqueness theorem

Electric Field in Matter: Bound charges due to polarization and their physical interpretation. Average electric field inside a dielectric, Electric Field in spherical and cylindrical cavities of a dielectric, Displacement vector and its boundary conditions, Gauss' Law in the presence of dielectrics, Linear dielectrics: electric susceptibility and dielectric constant, Boundary value problems with linear dielectrics.

Unit 3:   **(15 Hours)**
Magnetic Field: Divergence and curl of magnetic field B, Magnetic field due to arbitrary current distribution using Biot-Savart law, Ampere's law, integral and differential forms of Ampere's Law, Vector potential and its ambiguities.

Magnetic Properties of Matter: Magnetization vector, Bound Currents, Magnetic Intensity, Differential and integral form of Ampere's Law in the presence of magnetised materials, Magnetic susceptibility and permeability, Ferromagnetism (Hund's rule)

Electrodynamics: Faraday's Law, Lenz's Law, inductance, Electromotive force, Ohm's Law ($\vec{J} = \sigma \vec{E}$), Energy stored in a Magnetic Field. Charge Conservation, Continuity equation, Differential and integral forms of Maxwell's equations in matter.

References:
Essential Readings:
1) Introduction to Electrodynamics, D. J. Griffiths, 4th Edn., 2015, Pearson Education India Learning Private Limited.
2) Schaum's Outlines of Electromagnetics, M. Nahvi and J. A. Edminister, 2019, McGraw-Hill Education.
3) Electromagnetic Fields and Waves, Paul Lorrain and Dale Corson, 1991, W. H. Freeman.
4) Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
5) Network, Lines and Fields, John D. Ryder, 2nd Edn., 2015, Pearson.
6) Introductory Circuit Analysis, R. Boylestead, 2016, Pearson.
7) Electricity and Magnetism, Tom Weideman, University of California Davis.
   [url: https://zhu.physics.ucdavis.edu/Physics9C-
   C_2021/Physics%209C_EM%20by%20Tom%20Weideman.pdf]

Additional Readings:
1) Feynman Lectures Vol. 2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
2) Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
3) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley
PRACTICAL COMPONENT- 30 Hours
Learning Outcome:

- To understand working of Arduino Microcontroller System
- To use Arduino to measure time, count events and time between events
- To use Arduino to measure voltage/current/resistance
- To use Arduino to measure various physical parameters like magnetic field

Unit I (Mandatory): Arduino Programming
Introduction to Arduino Microcontroller platform. Getting acquainted with the Arduino IDE and Basic Sketch structure. Digital Input and output. Measuring time and events. Measuring analog voltage. Generating analog voltage using Pulse Width Modulation. Serial communication and serial monitor. Programming using Interrupts.

Unit II: Exploring electrical properties of matter using Arduino (at least one experiment)
- To study the characteristics of a series RC Circuit.
- To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, Impedance at resonance, (c) Quality factor Q, and (d) Band width.
- Diode Characteristics:
    - To study characteristics of diode and estimate Boltzman constant.
    - To study characteristics of LED and estimate Planck's constant

Unit III: Exploring magnetic properties of matter using Arduino
- To verify Faraday's law and Lenz's law by measuring induced voltage across a coil subjected to varying magnetic field. Also, estimate dipole moment of the magnet.

Unit IV: DC and AC Bridges (at least one experiment)
- To compare capacitances using de Sauty Bridge
- To determine a Low Resistance by Carey - Foster Bridge

Unit V: Network Theorems
(at least one experiment)
- To verify the Thevenin and Norton theorems
- To verify the Superposition, and Maximum Power Transfer Theorems

References (for Laboratory Work):
1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed.2011, Kitab Mahal
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.