ENGINEERING ELECTROMAGNETICS

Course Code: 22EE1102 **L T P C**

3 0 0 3

Prerequisites: Physics

Course Outcomes: At the end of the Course the student shall be able to

CO1: Explain the laws concerning static electric fields

CO2: Evaluate the boundary conditions in conductors and dielectrics

C03: Examine the equations concerned with static magnetic fields

C04: Evaluate the energy stored and energy density in electromagnetic fields

C05: Summarize Maxwell's equations

UNIT-I 10 Lectures

STATIC ELECTRIC FIELDS

Electrostatic Fields - Coulomb's Law - Electric Field Intensity (EFI) due to Line, Surface and Volume charges- Work Done in Moving a Point Charge in Electrostatic Field-Electric Potential due to point charges, line charges and Volume Charges - Potential Gradient - Gauss's Law-Application of Gauss's Law-Maxwell's First equation – Numerical Problems. Laplace's Equation and Poisson's Equations - Solution of Laplace's Equation in one Variable.

Electric Dipole - Dipole Moment - Potential and EFI due to Electric Dipole - Torque on an Electric Dipole in an Electric Field –Numerical Problems.

Learning Outcomes: The students will be able to

1. Understand electrostatic fields and various applicable laws. (L2)
2. Understand the concept of the electric field and to calculate electric fields from given charge distributions. (L2)
3. Understand that the electrostatic potential obeys the equations of Laplace and Poisson under appropriate circumstances(L2)

UNIT-II 10 Lectures

BEHAVIOR OF CONDUCTORS AND INSULATORS IN ELECTRIC FIELD

Behaviour of Conductors in an Electric Field-Conductors and Insulators – Electric Field Inside a Dielectric Material – Polarization – Dielectric Conductors and Dielectric Boundary Conditions – Capacitance-Capacitance of Parallel Plate, Spherical & Co-axial capacitors – Energy Stored and Energy Density in a Static Electric Field – Current Density – Conduction and Convection Current Densities – Ohm's Law in Point Form – Equation of Continuity – Numerical Problems

Learning Outcomes: The students will be able to

1. explain the important properties of conductors as arising from their electric charge (L2)
2. become familiar with the concept of a capacitor and its capacitance (L1)

3. define the boundary conditions for different situations (L1)

UNIT-III 10 Lectures
MAGNETOSTATICS

Static Magnetic Fields – Biot-Savart Law – Oersted's experiment – Magnetic Field Intensity (MFI) due to a Straight, Circular & Solenoid Current Carrying Wire – Maxwell’s Second Equation. Ampere’s Circuital Law and its Applications Viz., MFI Due to an Infinite Sheet of Current and a Long Current Carrying Filament – Point Form of Ampere’s Circuital Law – Maxwell’s Third Equation – Numerical Problems.

Magnetic Force — Lorentz Force Equation – Force on Current Element in a Magnetic Field - Force on a Straight and Long Current Carrying Conductor in a Magnetic Field - Force Between two Straight and Parallel Current Carrying Conductors – Magnetic Dipole and Dipole moment – A Differential Current Loop as a Magnetic Dipole – Torque on a Current Loop Placed in a Magnetic Field – Numerical Problems

Learning Outcomes: Students should be able to

1. become familiar with the Biot-Savart law and calculate the magnetic field and magnetic forces (L1)
2. devise methods to calculate torque on a current loop (L5)
3. compare forces between current carrying conductors in different directions.(L4)

UNIT-IV 10 Lectures
MAGNETIC POTENTIAL

Scalar Magnetic Potential and Vector Magnetic Potential and its Properties - Vector Magnetic Potential due to Simple Configuration – Vector Poisson’s Equations. Self and Mutual Inductances – Neumann’s Formula – Determination of Self Inductance of a Solenoid and Toroid and Mutual Inductance Between a Straight, Long Wire and a Square Loop Wire in the Same Plane – Energy Stored and Intensity in a Magnetic Field – Numerical Problems

Learning Outcomes: Students should be able to

1. understand the concept of magnetic potential for given charge distributions. (L2)
2. calculate self and mutual inductance of a solenoid, toroid (L3)

UNIT-V 10 Lectures
TIME VARYING FIELDS

Faraday’s Law of Electromagnetic Induction – It’s Integral and Point Forms – Maxwell’s Fourth Equation. Statically and Dynamically Induced E.M.F’s – Simple Problems – Modified Maxwell’s Equations for Time Varying Fields – Displacement Current. Wave Equations – Uniform Plane Wave Motion in Free Space, Poynting Theorem – Poynting Vector and its Significance

Learning Outcomes: Students should be able to

1. appraise Faraday’s law of electromagnetics (L1)
2. interpret the time varying fields(L6)

TEXT BOOKS:

1. Sadiku, Kulkarni, Principles of Electromagnetics, 6th Edition, OXFORD University Press, 2015.

2. W H Hayt, J A Buck, M Jaleel Akthar, Engineering Electromagnetics, Mcgraw Hill Education, Special Indian Edition, 2014, 8e,New Delhi /(Kindle Edition)

REFERENCES:

1. Krauss/Fleisch, Electromagnetics with applications, , Mcgraw Hill International, 1998
2. C.L.Wadhwa, Engineering Electromagnetics, New Age International Publishers, 2012,New Delhi.
3. GSN Raju, Electromagnetic field theory and transmission lines, Dorling Kindersley Publications, 2006, New Delhi
4. Nannapeni Narayana Rao, "Elements of Engineering Electromagnetics", Prentice Hall of India Pvt. Ltd, 2004
5. D J Griffiths, "Introduction to Electro Dynamics", 4th Edition, Prentice – Hall of India Pvt. Ltd, 2015