ECPE3001 ELECTROMAGNETIC FIELD THEORY (3-0-0)

Course Objectives

This course introduces fundamental concepts of electromagnetic fields, covering coordinate systems, vector calculus, electrostatic and magnetostatic fields, Maxwell's equations, and wave propagation. Students will learn to analyze transmission lines, apply boundary conditions, and solve field-related problems using theoretical principles and mathematical formulations.

Module-I: (06 Hrs.)

Co-ordinate systems & Transformation: Cartesian co-ordinates, circular cylindrical co-ordinates, spherical co-ordinates.

Vector Calculus: Differential length, Area & volume, Line surface and volume Integrals, Del operator, Gradient of a scalar, Divergence of a vector & divergence theorem, curl of a vector & Stoke's theorem, Laplacian of a scalar.

Module-II: (08 Hrs.)

Electrostatic Fields: Coulomb's Law, Electric Field Intensity, Electric Fields due to point, line, surface and volume charge, Electric Flux Density, Gauss's Law – Maxwell's Equation, Applications of Gauss's Law, Electric Potential, Relationship between Electric Potential (E) and Potential Gradient (V) –Maxwell's Equation an Electric Dipole & Flux Lines, Energy Density in Electrostatic Fields.

Electrostatic Boundary – Value Problems: Passion's & Laplace's Equations, Uniqueness theorem, General procedures for solving passions or Laplace's Equation.

Module-III: (08 Hrs.)

Magnetostatic Fields: Biot-Savart's Law, Magnetic Field intensity due to a finite and infinite wire carrying current; Magnetic field intensity on the axis of a circular and rectangular loop carrying current; Magnetic flux Density; Magnetic Vector Potential; Ampere's circuital law and simple applications; Inductance and mutual inductance. Boundary conditions for electric fields and magnetic fields. Conduction current and displacement current densities; Continuity equation for current; Maxwell's Equation in Differential and Integral form from Modified form of Ampere's circuital law, Faraday's Law and Gauss's Law.

Module-IV: (04 Hrs.)

Electromagnetic Fields and Wave Propagation: Faraday's Law, Transformer & Motional Electromagnetic Forces, Displacement Current, Maxwell's Equation in Final forms, Time Varying Potentials, Time-Harmonic Field.

Electromagnetic Wave Propagation: Wave Propagation in lossy Dielectrics, Plane Waves in loss less Dielectrics, Power & pointing vector.

Module-V: (04 Hrs.)

Transmission line: Waves in transmission line, Line parameters, Transmission line equation & solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation. Standing Wave Ratio (SWR), impedance matching. Solution of problems. Electromagnetic interference.

Course Outcomes:

On completion of this course, students are able to:

CO-1: Understand and apply coordinate systems and vector calculus for formulating electromagnetic field problems.

CO-2: Analyse electrostatic fields and apply Gauss's law, electric potential, and energy density in solving field-related problems.

CO-3: Apply magnetostatic laws and principles (Biot–Savart, Ampere's) to compute magnetic fields and understand inductance.

CO-4: Interpret Maxwell's equations for time-varying electromagnetic fields and understand electromagnetic wave propagation.
CO-5: Analyse transmission line behaviour, wave parameters, and use impedance matching techniques to reduce losses and interference.

Text Book(s):

1. Matthew N. O. Sadiku, Principles of Electromagnetics, Oxford University Press, 2015.
2. Hayt W. H. and J. A. Buck, Engineering Electromagnetics, McGraw-Hill, 2011.

Reference Book(s):

1. C. R. Paul, K. W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields, McGraw-Hill Education, 1997.
2. Cheng D K,Fundamentals of Engineering Electromagnetics, Pearson, 1992.