2/4 B.Tech. THIRD SEMESTER

EE3T5 ELECTROMAGNETIC FIELDS Credits: 3

Lecture: 3 periods/week Internal assessment: 30marks

Tutorial: 1 period/week Semester end examination: 70marks

Course Objective:

The objective of this course is to introduce the concepts of electric field and magnetic fields and their applications which will be utilized in the development of the theory for power transmission lines and electrical machines.

Course Outcomes:

1. Compute electric and magnetic fields for symmetrical charge and current configurations.
2. Determine voltage gradients for simple charge and current configurations and the force between charges and currents.
3. Calculate capacitance and inductance of common conductor configurations and the energy stored.
4. Examine time varying fields for torque developed, emf induced and energy stored.

UNIT I

ELECTROSTATICS -I

Review of vector calculus, Cartesian, cylindrical and spherical co-ordinate systems.

Coulomb's law - Electric field due to different charge distributions - Electric flux and flux density - Gauss's Law - Applications of Gauss's Law - Divergence - Maxwell's first Law.

Electrostatic Energy - Electric Potential - Potential Gradient - Calculation of Electric field through Electric Potential for given charge configuration - Energy stored and Energy density in static Electric Field, Laplace's and Poison's equations - Solution of Laplace's equation in one variable.

UNIT II

Electric Dipole - Dipole Moment - Potential and Electric Field due to Dipole - Torque on an Electric Dipole in an Electric field, Conductors.

Behaviour of conductors in an electric field, Current density – conduction and Convection current densities – Ohm's law in point form – Equation of continuity.

Electric field inside dielectric material - concept of Polarization - Boundary conditions between dielectric and conductor - between two dielectrics.

Capacitance - Capacitance of parallel plate – Spherical - Co-axial capacitors with Composite Dielectric.

UNIT III

MAGNETOSTATICS

Static magnetic fields — Oesterd's experiment - Biot-Savart's law -Magnetic field intensity (MFI) – MFI due to a straight current carrying filament – MFI due to circular, square and solenoid current – Carrying wire – Relation between magnetic flux, magnetic flux density and MFI – Maxwell's second Equation, div(B)=0.

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, Curl (H)=Jc.

UNIT IV

MAGNETIC FORCES

Magnetic force - Moving charges in a Magnetic field – Lorentz force equation – force on a current element in a magnetic field – Force on a straight and a long current carrying conductor in a magnetic field – Force between two straight long 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.

SELF AND MUTUTAL INDUCTANCE

Self and Mutual inductance – 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 density in a magnetic field. Circuit representation of coupled coils and its analysis.

UNIT V

TIME VARYING FIELDS

Time varying fields – Faraday's laws of electromagnetic induction – Its integral and point forms – Maxwell's fourth equation, Curl (E)=-∂B/∂t – Statically and Dynamically induced EMFs – Simple problems -Modification of Maxwell's equations for time varying fields – Displacement current – Poynting Theorem and Poynting vector.

Learning Resources

Text Books:

1. "Engineering Electromagnetics" by William H. Hayt & John. A. Buck Mc. Graw-Hill Companies, 7th Editon.2006.
2. "Elements of Electromagnetics", Mathew NO Sadiku, Oxford University Press.

Reference Books:

1. "Introduction to Electro Dynamics" by D J Griffiths, Prentice-Hall of India Pvt.Ltd, 2nd editon
2. "Electromagnetics" by J. D Kraus Mc Graw-Hill Inc. 4th edition 1992.
3. "Electromagnetism-Theory and Applications" by Ashutosh Pramanik, PHI, 2003