ELECTROMAGNETICS

Course Code:13EE1103

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Course Educational Objectives:

To gain basic understanding of electric and magnetic field laws and to clearly understand Maxwell's equations and solve simple problems in both electric and magnetic fields.

Course Outcomes:

After completion of the course, the student should be able to solve problems in electromagnetics and able to apply the concepts in simple practical electromagnetic devices.

UNIT-I (12 Lectures)

ELECTROSTATICS:

Electrostatic Fields – Coulomb's Law – Electric Field Intensity (EFI) – EFI due to a line and a Surface Charge – Work done in moving a Point charge in an electrostatic field – Electric Potential – Properties of Potential Function – Potential Gradient – Gauss's Law, Application of Gauss's Law – Maxwell's first equation $\nabla \cdot D = r_v$, Maxwell's second equation $\nabla \times E = 0$.

Laplace's and Poisson's Equations – Solution of Laplace's Equation in one variable. Electric dipole – Dipole Moment – Potential and EFI due to an electric dipole – Behavior of conductors in an electric field – Conductors and Insulators.

Electric Field inside a dielectric material – Polarization – Dielectric – Conductor and Dielectric – Dielectric Boundary Conditions, Capacitance – Capacitance of Parallel Plate and Spherical and co-axial capacitors with composite dielectrics – 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.

UNIT-II (12 Lectures)

MAGNETOSTATICS:

Static Magnetic fields – Biot – Savart's Law – Oesterd's Experiment – Magnetic Field Intensity (MFI) – MFI due to circular and solenoid current carrying wire – Relation between magnetic flux, magnetic flux density and MFI – Maxwell's Equation $\nabla . B = 0$

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 Equation Curl(H) = $J + \partial D / \partial t$,

Field due to circular loop of wire.

UNIT-III (12 Lectures)

FORCE IN MAGNETIC FIELDS:

Magnetic Force – Moving charges in Magnetic Field – Lorentz force Equation – Force on a current element in Magnetic field – Force on a straight and a long current carrying conductor in 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

UNIT-IV (12 Lectures)

MAGNETIC POTENTIAL:

Scalar Magnetic Potential and its limitations – vector magnetic potential and its properties – vector magnetic potential due to simple configurations – vector Poisson's equations. Self and Mutual Inductances – Neuman's formulae – determination of self-inductance of solenoid and toroid and mutual inductance between a straight long wire and square loop wire in the same plane – Energy stored and Energy Density in a magnetic field. Introduction to Permanent Magnets, their characteristics and applications.

UNIT-V (12 Lectures)

TIME VARYING FIELDS:

Time Varying Fields – Faraday's Laws of Electromagnetic Induction – Its integral and Point Forms – Maxwell's Equation – Statically and Dynamically Induced EMF's – Simple problems. Modification of Maxwell's equations for time varying fields – Displacement Current – Poynting theorem

TEXT BOOKS:

1. William H. Hayt & John. A. Buck, *"Engineering Electromagnetics"* 7th Edition. 2006., Mc. Graw – Hill Companies. (UNITS – I, II, V)
2. Sadiku, *"Electro Magnetic Fields"*, 4th Edition, Oxford Publications, 2009. (UNITS – III, IV)

REFERENCES:

1. D J Griffiths, *"Introduction to Electro Dynamics"*, 2nd Edition, Prentice – Hall of India Pvt. Ltd.
2. J.D. Kraus, *"Electromagnetics"*, 4th Edition, Mc Graw-Hill Inc, 1992.
3. N. Narayana Rao, *"Elements of Engineering Electromagnetic"*, Prentice – Hall of India Pvt. Ltd.