



Electromagnetic Fields

By U.A.Bakshi, A.V.Bakshi

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Static Electric Fields Introduction to co-ordinate system - Rectangular - Cylindrical and spherical co-ordinate system - Introduction to line, Surface and volume integrals - Definition of curl, Divergence and gradient - Meaning of Stokes theorem and divergence theorem. Coulomb's law in vector form - Definition of electric field intensity - Principle of superposition - Electric field due to discrete charges - Electric field due to continuous charge distribution - Electric field due to charges distributed uniformly on an infinite and finite line - Electric field on the axis of a uniformly charged circular disc-Electric field due to an infinite uniformly charged sheet. Electric scalar potential - Relationship between potential and electric field - Potential due to infinite uniformly charged line - Potential due electrical dipole - Electric flux density - Gauss law - Proof of Gauss law - Applications. Static Magnetic Field The Biot-Savart law in vector form - Magnetic field intensity due to a finite and infinite wire carrying a current I - Magnetic field intensity on the axis of a circular and rectangular loop carrying a current I - Ampere's circuital law and simple applications. Magnetic flux density - The Lorentz force equation for a moving charge and applications - Force on a wire carrying a current I placed in a magnetic field - Torque on a loop carrying a current I - Magnetic moment - Magnetic vector potential. Electric and Magnetic Fields in Materials Poisson's and Laplace's equation - Electric polarization - Nature of dielectric materials - Definition of capacitance - Capacitance of various geometries using Laplace's equation - Electrostatic energy and energy density - Boundary conditions for electric fields - Electric current- Current density - Point form of Ohm's law - Continuity equation for current. Definition of inductance - Inductance of loops and solenoids - Definition of mutual inductance - Simple examples. Energy density in magnetic fields - Nature of magnetic materials - Magnetization and permeability - Magnetic boundary conditions. Time Varying Electric and Magnetic Fields Faraday's law - Maxwell's second equation in integral form from Faraday's law - Equation expressed in point form. Displacement current - Ampere's circuital law in integral form - Modified form of Ampere's circuital law as Maxwell's first equation in integral form - Equation expressed in point form. Maxwell's four equations in integral form and differential form. Poynting vector and the flow of power - Power flow in a co-axial cable-Instantaneous average and complex poynting vector. Electromagnetic Waves Derivation of wave equation - Uniform plane waves - Maxwell's equation in phasor form - Wave equation in phasor form - Plane waves in free space and in a homogeneous material. Wave equation for a

conducting medium - Plane waves in lossy dielectrics - Propagation in good conductors - Skin effect. Linear, elliptical and circular polarization - Reflection of plane wave from a conductor - Normal incidence - Reflection of plane waves by a perfect dielectric - Normal and oblique incidence. Dependence on polarization. Brewster angle.

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Electromagnetic Fields By U.A.Bakshi, A.V.Bakshi Bibliography

- Sales Rank: #14859309 in Books
- Published on: 2007-06-01
- Binding: Paperback
- 702 pages

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