Basic Electromagnetics With Applications

Contents

PREFACE

1 - VECTOR ANALYSIS

- 1.1 Some Simple Rules
- 1.2 Coordinate Systems
- 1.3 Components of Vectors
- 1.4 Scalar and Vector Fields
- 1.5 Differentiation of Vectors
- 1.6 The Gradient
- 1.7 Volume, Surface, and Line Integrals
- 1.8 Divergence and the Divergence Theorem
- 1.9 Curl and Stokes' Theorem
- 1.10 The Laplacian
- 1.11 Some Useful Vector Relations
- Problems

2 - THE STATIC ELECTRIC FIELD

- 2.1 The Electric Field Concept
- 2.2 Coulomb's Law
- 2.3 The Electric Field of Point Charges
- 2.4 The Electric Field of Continuous Charge Distributions
- 2.5 Direction Lines
- 2.6 Gauss' Law in Integral Form
- 2.7 Gauss' Law in Differential Form (Maxwell's Divergence Equation for the Electric Field)
- 2.8 Potential Difference
- 2.9 The Potential Field of Point Charges
- 2.10 The Potential Field of Continuous Charge Distributions
- 2.11 Maxwell's Curl Equation for the Static Electric Field

2.12 - The Relationship Between Electric Field Intensity and Potential Problems

3 - THE STATIC MAGNETIC FIELD

- 3.1 The Magnetic Field Concept
- 3.2 Force on a Current Element
- 3.3 Ampere's Law of Force
- 3.4 The Magnetic Field of Filamentary Currents
- 3.5 The Magnetic Field of Current Distributions
- 3.6 Ampere's Circuital Law in Integral Form

3.7 - Ampere's Circuital Law in Differential Form (Maxwell's Curl Equation for the Static Magnetic Field)

- 3.8 Magnetic Vector Potential
- 3.9 Maxwell's Divergence Equation for the Magnetic Field

3.10 - Summary and Further Discussion of Static Electric and Magnetic Field Laws and Formulas

Problems

4 - THE ELECTROMAGNETIC FIELD

4.1 - The Lorentz Force Equation

4.2 - Faraday's Law in Integral Form

4.3 - Faraday's Law in Differential Form (Maxwell's First Curl Equation for the Electromagnetic Field)

4.4 - The Dilemma of Ampere's Circuital Law and the Displacement Current Concept; Modified Ampere's Circuital Law in Integral Form

4.5 - Modified Ampere's Circuital Law in Differential Form (Maxwell's Second Curl Equation for the Electromagnetic Field) and the Continuity Equation

4.6 - Energy Storage in an Electric Field

4.7 - Energy Storage in a Magnetic Field

4.8 - Power Flow in an Electromagnetic Field; the Poynting Vector

4.9 - The Phasor Concept and the Phasor Representation of Sinusoidally Time-Varying Fields and Maxwell's Equations for Sinusoidally Time-Varying Fields 4.10 - Power and Energy Considerations for Sinusoidally Time-Varying Electromagnetic Fields 4.11 - Summary of Electromagnetic Field Laws and Formulas

Problems

5 - MATERIALS AND FIELDS

- 5.1 Conduction and Nonmagnetic Materials
- 5.2 Conduction Current Density, Conductivity, and Ohm's Law
- 5.3 Conductors in Electric Fields
- 5.4 Polarization in Dielectric Materials
- 5.5 Dielectrics in Electric Fields; Polarization Charge and Current
- 5.6 Displacement Flux Density and Relative Permittivity
- 5.7 Magnetization and Magnetic Materials
- 5.8 Magnetic Materials in Magnetic Fields; Magnetization Current
- 5.9 Magnetic Field Intensity, Relative Permeability, and Hysteresis
- 5.10 Summary of Maxwell's Equations and Constitutive Relations
- 5.11 Power and Energy Considerations for Material Media
- 5.12 Boundary Conditions

Problems

6 - APPLIED ELECTROMAGNETICS

Part 1. Statics, Quasistatics, and Distributed Circuits

- 6.1 Poisson's Equation
- 6.2 Laplace's Equation
- 6.3 The Method of Images
- 6.4 Conductance, Capacitance, and Inductance
- 6.5 Magnetic Circuits
- 6.6 Quasistatics; The Field Basis of Low-Frequency Circuit Theory
- 6.7 Transmission-Line Equations; The Distributed Circuit Concept

Part 2. Electromagnetic Waves

- 6.8 The Wave Equation; Uniform Plane Waves and Transmission-Line Waves
- 6.9 Traveling Waves in Time Domain
- 6.10 Traveling Waves in Sinusoidal Steady State; Standing Waves
- 6.11 Transmission-Line Matching; The Smith Chart
- 6.12 Waveguides; Dispersion and Group Velocity
- 6.13 Waves in Imperfect Dielectrics and Conductors; Attenuation and the Skin Effect
- 6.14 Resonators; Laser Oscillation

6.15 - Waves in Plasma; Ionospheric Propagation6.16 - Radiation of Electromagnetic Waves-Problems

APPENDIX: UNITS AND DIMENSIONS

BIBLIOGRAPHY

ANSWERS TO ODD-NUMBERED PROBLEMS

INDEX