Electromagnetics

A.R. Đorđević, *Electromagnetics*, Academic Mind, Belgrade, 2008 (in Serbian).

This textbook is prepared for the Electromagnetic Field course, which is taught at the second or third year (at the bachelor level) at the School of Electrical Engineering, University of Belgrade. The course has 3 hours of lectures and 2 hours of recitations per week, during 15 weeks of a semester. Prerequisite for the course are the courses in Fundamentals of Electrical Engineering.

The book is concise, yet it covers in-depth the classical engineering electromagnetics, starting from electrostatics and culminating with Maxwell's equations in differential form. Rigorous derivations are given at most places (e.g., uniqueness theorem, reciprocity, Poynting theorem, etc.). Engineering applications of various fields are also emphasized. The book covers in detail uniform plane waves, transmission lines (including transients and multiconductor lines), and antennas. The book also gives an introduction to the electromagnetic compatibility.

Major titles in the textbooks are as follows:

1. Introduction
2. Electrostatic field
    - 2.1. Introduction
    - 2.2. Electrostatic field in a vacuum
        - 2.2.1. Coulomb law and electric-field vector
        - 2.2.2. Potential
        - 2.2.3. Basic equations for electrostatic field in a vacuum
        - 2.2.4. Poisson and Laplace equations
        - 2.2.5. Electrostatic dipoles
    - 2.3. Conductors in electrostatic field
        - 2.3.1. Image theorem
    - 2.4. Electrostatic field in dielectrics
        - 2.4.1. Dielectric polarization
        - 2.4.2. Bound charges
        - 2.4.3. Displacement vector
        - 2.4.4. Boundary conditions
        - 2.4.5. Distribution of bound charges in linear dielectrics
        - 2.4.6. Analysis of systems with dielectrics
    - 2.5. Capacitances
    - 2.6. Energy of electrostatic field
        - 2.6.1. Theorems
    - 2.7. Applications of electrostatic fields
3. Stationary field
    - 3.1. Introduction
    - 3.2. Stationary current field
        - 3.2.1. Introduction
        - 3.2.2. Current density
        - 3.2.3. Joule effect
        - 3.2.4. Impressed currents and impressed electric field
        - 3.2.5. Continuity equation
        - 3.2.6. Boundary conditions
        - 3.2.7. Charge distribution in stationary field
        - 3.2.8. Analogy between stationary current field and electrostatic field
        - 3.2.9. Lossy transmission lines
        - 3.2.10. Point current source
        - 3.2.11. Image theorem
        - 3.2.12. Buried conductors
    - 3.3. Stationary magnetic field
        - 3.3.1. Introduction
        - 3.3.2. Magnetic-induction vector and Biot-Savart law
        - 3.3.3. Magnetic vector-potential
        - 3.3.4. Basic equations for magnetic field in a vacuum
        - 3.3.5. Magnetic dipole
        - 3.3.6. Ferromagnetic materials in magnetic field

3.3.7. Ampere currents
3.3.8. Magnetic-field vector
3.3.9. Boundary conditions
3.3.10. Image theorem
3.4. Applications of stationary electromagnetic field
4. Quasistationary field
4.1. Introduction
4.2. Basic equations of quasistationary field
4.3. Inductances
4.4. Energy of magnetic field
4.4.1. Theorems
4.4.2. Evaluation of inductance form energy
4.5. Applications of quasistationary field
5. Dynamic field
5.1. Introduction
5.2. Maxwell's' equations and Lorenz potentials
5.2.1. Maxwell's equations in differential form
5.2.2. Lorenz potentials
5.2.3. Maxwell's equations in integral form and boundary conditions
5.2.4. Continuity equation for filaments
5.3. Complex vectors
5.4. Poynting theorem
5.5. Uniqueness theorem
5.6. Electric circuits at high frequencies
5.7. Applications of dynamic fields
6. Uniform plane electromagnetic waves
6.1. Introduction
6.2. Uniform plane waves in ideal dielectric
6.3. Uniform plane waves in lossy media
6.4. Reflection and refraction of uniform plane waves
6.4.1. Reflection from perfectly-conducting plane
6.4.2. Reflection and refraction at the interface between two media
6.4.3. Propagation in ionized gas
7. Transmission lines
7.1. Introduction
7.2. Transmission lines with homogeneous dielectric
7.3. Transmission lines with inhomogeneous dielectrics
7.4. Printed transmission lines
7.5. Phase and group velocity
7.6. Telegraphers' equations
7.7. Transients on transmission lines
7.8. Multiconductor transmission lines
8. Radiation and antennas
8.1. Introduction
8.2. Hertz dipole
8.3. Magnetic dipole
8.4. Transmitting antenna
8.4.1. Radiation pattern, directivity, and gain
8.4.2. Antenna above ground plane
8.5. Receiving antenna
8.5.1. Effective area
8.5.2. Friis formula
8.5.3. Radar range
8.6. Antenna arrays
9. Electromagnetic compatibility
9.1. Introduction
9.2. Sources of interference
9.3. Propagation of interference
9.4. Victims of interference
9.5. Electromagnetic hardening

10. Appendix. Elements of vector analysis
- 10.1. Scalar and vector fields
- 10.2. Spatial derivatives
  - 10.2.1. Gradient
  - 10.2.2. Divergence
  - 10.2.3. Curl
  - 10.2.4. Nabla operator
  - 10.2.5. Laplacian
  - 10.2.6. Spatial derivatives in orthogonal coordinate systems
- 10.3. Gaussian theorem
- 10.4. Stokes theorem
- 10.5. Some identities of vector analysis