ELECTROMAGNETICS

Edward J. Rothwell
Michael J. Cloud

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ELECTROMAGNETICS

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ELECTROMAGNETICS

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Preface

This book is intended as a text for a first-year graduate sequence in engineering electromagnetics. Ideally such a sequence provides a transition period during which a student can solidify his or her understanding of fundamental concepts before proceeding to specialized areas of research.

The assumed background of the reader is limited to standard undergraduate topics in physics and mathematics. Worthy of explicit mention are complex arithmetic, vector analysis, ordinary differential equations, and certain topics normally covered in a "signals and systems" course (e.g., convolution and the Fourier transform). Further analytical tools, such as contour integration, dyadic analysis, and separation of variables, are covered in a self-contained mathematical appendix.

The organization of the book is in six chapters. In Chapter 1 we present essential background on the field concept, as well as information related specifically to the electromagnetic field and its sources. Chapter 2 is concerned with a presentation of Maxwell's theory of electromagnetism. Here attention is given to several useful forms of Maxwell's equations, the nature of the four field quantities and of the postulate in general, some fundamental theorems, and the wave nature of the time-varying field. The electrostatic and magnetostatic cases are treated in Chapter 3. In Chapter 4 we cover the representation of the field in the frequency domains: both temporal and spatial. Here the behavior of common engineering materials is also given some attention. The use of potential functions is discussed in Chapter 5, along with other field decompositions including the solenoidal–lamellar, transverse–longitudinal, and TE–TM types. Finally, in Chapter 6 we present the powerful integral solution to Maxwell's equations by the method of Stratton and Chu. A main mathematical appendix near the end of the book contains brief but sufficient treatments of Fourier analysis, vector transport theorems, complex-plane integration, dyadic analysis, and boundary value problems. Several subsidiary appendices provide useful tables of identities, transforms, and so on.

We would like to express our deep gratitude to those persons who contributed to the development of the book. The reciprocity-based derivation of the Stratton–Chu formula was provided by Prof. Dennis Nyquist, as was the material on wave reflection from multiple layers. The groundwork for our discussion of the Kronig–Kramers relations was provided by Michael Havrilla, and material on the time-domain reflection coefficient was developed by Jungwook Suk. We owe thanks to Prof. Leo Kempel, Dr. David Infante, and Dr. Ahmet Kizilay for carefully reading large portions of the manuscript during its preparation, and to Christopher Coleman for helping to prepare the figures. We are indebted to Dr. John E. Ross for kindly permitting us to employ one of his computer programs for scattering from a sphere and another for numerical Fourier transformation. Helpful comments and suggestions on the figures were provided by Beth Lannon–Cloud.

Thanks to Dr. C. L. Tondo of T & T Techworks, Inc., for assistance with the LaTeX macros that were responsible for the layout of the book. Finally, we would like to thank the staff members of CRC Press — Evelyn Meany, Sara Seltzer, Elena Meyers, Helena Redshaw, Jonathan Pennell, Joette Lynch, and Nora Konopka — for their guidance and support.

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Electrical Engineering

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Electromagnetics provides a smooth transition from basic undergraduate EM courses to advanced and often specialized graduate studies. Emphasizing concepts over problem-solving techniques, it focuses on the topics most important to EM research and those most troublesome to beginning graduate students. The authors cover the required mathematical background and introduce the primary physical principles, building from a well-posed postulate to a coherent description of the EM field. Stressing both a physical understanding and a detailed mathematical description of each topic, this text provides an account of EM theory that is in-depth, lucid, and accessible.

Highly engaging prose, clear, concise explanations, and numerous examples relating concepts to modern engineering applications create a comfortable atmosphere that enhances the reader's grasp of the material. *Electromagnetics* thus builds a foundation that allows readers to proceed with confidence to advanced EM studies, research, and applications.

Features

- Provides the ideal transition between introductory EM courses and advanced graduate studies
- Gives readers a keen understanding of EM fields, building progressively from simple background material to the most significant concepts
- Covers each fundamental principle with clear, concise explanations
- Includes many examples linking fundamental principles with engineering applications
- Solidifies fundamental principles with numerous end-of-chapter problems

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