Preface

". . . I am talking about the areas of science and learning that have been at the heart of what we know and what we do, that which has supported and guided us and which is fundamental to our thinking. It is electromagnetism in all its many forms that has been so basic, that haunts us and guides us. . . ."

—Nick Holonyak, Jr., the John Bardeen Endowed Chair Professor of Electrical and Computer Engineering and Physics at the University of Illinois at Urbana–Champaign, and the inventor of the semiconductor visible LED, laser, and quantum-well laser

"The electromagnetic theory, as we know it, is surely one of the supreme accomplishments of the human intellect, reason enough to study it. But its usefulness in science and engineering makes it an indispensable tool in virtually any area of technology or physical research."

—George W. Swenson, Jr., Professor Emeritus of Electrical and Computer Engineering, University of Illinois at Urbana–Champaign

The above quotes from two of my distinguished colleagues at the University of Illinois underscore the fact that electromagnetics is all around us. In simple terms, every time we turn on a switch for electrical power or for electronic equipment, every time we press a key on our computer keyboard or on our cell phone, or every time we perform a similar action involving an everyday electrical device, electromagnetics comes into play. It is the foundation for the technologies of electrical and computer engineering, spanning the entire electromagnetic spectrum, from d.c. to light. As such, in the context of engineering education, it is fundamental to the study of electrical and computer engineering. While the fundamentals of electromagnetic fields remain the same, the manner in which they are taught may change with the passing of time owing to the requirements of the curricula and shifting emphasis of treatment of the fundamental concepts with the evolution of the technologies of electrical and computer engineering.

Three decades ago, I wrote a one-semester textbook, the first edition of *Elements of Engineering Electromagnetics*, dictated solely by the reduction in the curricular requirement in electromagnetics at the University of Illinois from a three-semester required sequence to a one-semester course, owing to the pressure of increasing areas of interest and fewer required courses. The approach used for the one-semester book was to deviate from the historical treatment and base it upon dynamic fields and their engineering applications, in view of the student's earlier exposure in engineering physics to

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the traditional approach of static fields and culminating in Maxwell's equations. Less than ten years after that, a relaxation of the curricular requirements coupled with the advent of the PC resulted in an expanded second edition of the book for two-semester usage. Subsequent editions have essentially followed the second edition.

Interestingly, the approach that broke with the tradition with the first edition has become increasingly relevant from a different context, because with the evolution of the technologies of electrical and computer engineering over time, the understanding of the fundamental concepts in electromagnetics based on dynamic fields has become increasingly important. Another feature of the first edition of *Elements of Engineering Electromagnetics* was the treatment of the bulk of the material through the use of the Cartesian coordinate system. This was relaxed in the subsequent editions, primarily because of the availability of space for including examples involving the geometries of cylindrical and spherical coordinate systems, although the inclusion of these examples is not essential to the understanding of the fundamental concepts.

This book, which is a one-semester textbook, combines the features of the first edition of *Elements of Engineering Electromagnetics* with the treatment of the fundamental concepts in keeping with the evolution of technologies of electrical and computer engineering. Specifically, the approach of beginning with Maxwell's equations to introduce the fundamental concepts is combined with the treatment of the different categories of fields as solutions to Maxwell's equations and using the thread of statics-quasistatics-waves to bring out the frequency behavior of physical structures. Thus, some of the salient features of the first nine chapters of the book consist of the following:

1. Using the Cartesian coordinate system for the bulk of the material to keep the geometry simple and yet sufficient to learn the physical concepts and mathematical tools, while employing other coordinate systems where necessary
2. Introducing Maxwell's equations for time-varying fields first in integral form and then in differential form early in the book
3. Introducing uniform plane wave propagation by obtaining the field solution to the infinite plane current sheet of uniform sinusoidally time-varying density
4. Introducing material media by considering their interaction with uniform plane wave fields
5. Using the thread of statics-quasistatics-waves to bring out the frequency behavior of physical structures, leading to the development of the transmission line and the distributed circuit concept
6. Covering the essentials of transmission-line analysis both in frequency domain and time domain in one chapter
7. Introducing metallic waveguides by considering the superposition of obliquely propagating uniform plane waves and dielectric waveguides following the discussion of reflection and refraction of plane waves
8. Obtaining the complete solution to the Hertzian dipole fields through a successive extension of the quasistatic field solution so as to satisfy simultaneously the two Maxwell's equations, and then developing the basic concepts of antennas

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The final chapter is devoted to six supplementary topics, each based on one or more of the previous six chapters. It is intended that the instructor will choose one or more of these topics for discussion following the corresponding previous chapter(s). Material on cylindrical and spherical coordinate systems is presented in appendices so that it can be studied either immediately following the discussion of the corresponding material on the Cartesian coordinate system or only when necessary.

From considerations of varying degrees of background preparation at different schools, a greater amount of material than can be covered in an average class of three semester-hour credits is included in the book. Worked-out examples are distributed throughout the text, and in some cases, extend the various concepts. Summary of the material and a number of review questions are included for each chapter to facilitate review of the chapters.

I wish to express my gratitude to the numerous colleagues at the University of Illinois at Urbana–Champaign (UIUC) who have taught from my books over a period of 35 years, beginning with my first book in 1972, and to the numerous users of my books worldwide. Technological advances in which electromagnetics continues to play a major role have brought changes in this span of time beginning with the introduction of the computer engineering curriculum in my department at UIUC in 1972, followed by the name change of the department from electrical engineering to electrical and computer engineering in 1984, to transforming the way of life in the present-day world from "local" to "global."

The title of this book is a recognition of the continuing importance of a core course in electromagnetics in both electrical engineering and computer engineering curricula, in this high-speed era. My joint affiliation with UIUC, my "home" institution in the United States in the West, and Amrita Vishwa Vidyapeetham in my "homeland" of India in the East is a gratifying happening owing to the state of the world that, with the transformation from "local" to "global," East is no longer just East, and West is no longer just West, and the twain have met!

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