Preface

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About This Book

Goals for this book. This book is intended to serve as a primary textbook for a one-semester introductory course in undergraduate engineering electromagnetics, including the following topics: electric and magnetic fields; electromagnetic properties of materials; electromagnetic waves; and devices that operate according to associated electromagnetic principles including resistors, capacitors, inductors, transformers, generators, and transmission lines.

This book employs the “transmission lines first” approach, in which transmission lines are introduced using a lumped-element equivalent circuit model for a differential length of transmission line, leading to one-dimensional wave equations for voltage and current.[1] This is sufficient to address transmission line concepts, including characteristic impedance, input impedance of terminated transmission lines, and impedance matching techniques. Attention then turns to electrostatics, magnetostatics, time-varying fields, and waves, in that order.

What’s new. This version of the book is the *second* public release of this book. The first release, known as “Volume 1 (Beta),” was released in January 2018. Improvements from the beta version include the following:

- Correction of errors identified in the beta version errata and many minor improvements.
- Addition of an index.
- Accessibility features: Figures now include “alt text” suitable for screen reading software.
- Addition of a separate manual of examples and solutions (see the web site).
- Addition of source files for the book (see the web site).

Target audience. This book is intended for electrical engineering students in the third year of a bachelor of science degree program. It is assumed that readers are familiar with the fundamentals of electric circuits and linear systems, which are normally taught in the second year of the degree program. It is also assumed that readers have received training in basic engineering mathematics, including complex numbers, trigonometry, vectors, partial differential equations, and multivariate calculus. Review of the relevant principles is provided at various points in the text. In a few cases (e.g., phasors, vectors) this review consists of a separate stand-alone section.

Notation, examples, and highlights. Section 1.7 summarizes the mathematical notation used in this book. Examples are set apart from the main text as follows:

Example

Example

This is an example.

“Highlight boxes” are used to identify key ideas as follows:

This is a key idea.

What are those little numbers in square brackets? This book is a product of the *Open Electromagnetics Project*. This project provides a large number of sections (“modules”) which are assembled (“remixed”) to create new and different versions of the book. The text “[m0146]” that you see at the beginning of this section uniquely identifies the module within the larger set of modules provided by the project. This identification is provided because different remixes of this book may exist, each consisting of a different subset and arrangement of these modules. Prospective authors can use this identification as an aid in creating their own remixes.

Why do some sections of this book seem to repeat material presented in previous sections? In some remixes of this book, authors might choose to eliminate or reorder modules. For this reason, the modules are written to “stand alone” as much as possible. As a result, there may be some redundancy between sections that would not be present in a traditional (non-remixable) textbook. While this may seem awkward to some at first, there are clear benefits: In particular, it never hurts to review relevant past material before tackling a new concept. And, since the electronic version of this book is being offered at no cost, there is not much gained by eliminating this useful redundancy.

Why cite Wikipedia pages as additional reading? Many modules cite Wikipedia entries as sources of additional information. Wikipedia represents both the best and worst that the Internet has to offer. Most authors of traditional textbooks would agree that citing Wikipedia pages as primary sources is a bad idea, since quality is variable and content is subject to change over time. On the other hand, many Wikipedia pages are excellent, and serve as useful sources of relevant information that is not strictly within the scope of the curriculum. Furthermore, students benefit from seeing the same material presented differently, in a broader context, and with additional references cited by Wikipedia pages. We trust instructors and students to realize the potential pitfalls of this type of resource and to be alert for problems.

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1. Are you an instructor who is not a fan of the "transmission lines first" approach? Then see "**What are those little numbers in square brackets?**" later in this section. ↩

About the Open Electromagnetics Project

The *Open Electromagnetics Project* was established at Virginia Tech in 2017 with the goal of creating no-cost openly-licensed textbooks for courses in undergraduate engineering electromagnetics. While a number of very fine traditional textbooks are available on this topic, we feel that it has become unreasonable to insist that students pay hundreds of dollars per book when effective alternatives can be provided using modern media at little or no cost to the student. This project is equally motivated by

the desire for the freedom to adopt, modify, and improve educational resources. This work is distributed under a Creative Commons BY SA license which allows – and we hope encourages – others to adopt, modify, improve, and expand the scope of our work.

About the Author

Steven W. Ellingson (ellingson@vt.edu) is an Associate Professor at Virginia Tech in Blacksburg, Virginia in the United States. He received PhD and MS degrees in Electrical Engineering from the Ohio State University and a BS in Electrical & Computer Engineering from Clarkson University. He was employed by the US Army, Booz-Allen & Hamilton, Raytheon, and the Ohio State University ElectroScience Laboratory before joining the faculty of Virginia Tech, where he teaches courses in electromagnetics, radio frequency electronics, wireless communications, and signal processing. His research includes topics in wireless communications, radio science, and radio frequency instrumentation. Professor Ellingson serves as a consultant to industry and government and is the author of *Radio Systems Engineering* (Cambridge University Press, 2016).