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the Transmission-Line Equations -- 2.2 The Per-Unit-Length Parameters -- 2.2.1 Wire-Type Lines -- 2.2.2 Lines of Rectangular Cross Section -- 2.3 The General Solutions for the Line Voltage and Current -- 2.4 Wave Tracing and Reflection Coefficients -- 2.5 The SPICE (PSPICE) Exact Transmission-Line Model -- 2.6 Lumped-Circuit Approximate Models of the Line -- 2.7 Effects of Reactive Terminations on Terminal Waveforms -- 2.7.1 Effect of Capacitive Terminations -- 2.7.2 Effect of Inductive Terminations -- 2.8 Matching Schemes for Signal Integrity -- 2.9 Bandwidth and Signal Integrity: When Does the Line Not Matter? -- 2.10 Effect of Line Discontinuities -- 2.11 Driving Multiple Lines -- Problems -- 3 Frequency-Domain Analysis of Two-Conductor Lines -- 3.1 The Transmission-Line Equations for Sinusoidal, Steady-State Excitation of the Line -- 3.2. The General Solution for the Terminal Voltages and Currents -- 3.3 The Voltage Reflection Coefficient and Input Impedance to the Line -- 3.4 The Solution for the Terminal Voltages and Currents -- 3.5 The SPICE Solution -- 3.6 Voltage and Current as a Function of Position on the Line -- 3.7 Matching and VSWR -- 3.8 Power Flow on the Line -- 3.9 Alternative Forms of the Results. 3.10 The Smith Chart -- 3.11 Effects of Line Losses -- 3.12 Lumped-Circuit Approximations for Electrically Short Lines -- 3.13 Construction of Microwave Circuit Components Using Transmission Lines -- Problems -- PART II THREE-CONDUCTOR LINES AND CROSSTALK -- 4 The Transmission-Line Equations for Three-Conductor Lines -- 4.1 The Transmission-Line Equations for Three-Conductor Lines -- 4.2 The Per-Unit-Length Parameters -- 4.2.1 Wide-Separation Approximations for Wires -- 4.2.2 Numerical Methods -- Problems -- 5 Solution of the Transmission-Line Equations for Three-Conductor Lossless Lines -- 5.1 Decoupling the Transmission-Line Equations with Mode Transformations -- 5.2 The SPICE Subcircuit Model -- 5.3 Lumped-Circuit Approximate Models of the Line -- 5.4 The Inductive-Capacitive Coupling Approximate Model -- Problems -- 6 Solution of the Transmission-Line Equations for Three-Conductor Lossy Lines -- 6.1 The Transmission-Line Equations for Three-Conductor Lossy Lines -- 6.2 Characterization of Conductor and Dielectric Losses -- 6.2.1 Conductor Losses and Skin Effect -- 6.2.2 Dielectric Losses -- 6.3 Solution of the Phasor (Frequency-Domain) Transmission-Line Equations for a Three-Conductor Lossy Line -- 6.4 Common-Impedance Coupling -- 6.5 The Time-Domain to Frequency-Domain (TDFD) Method -- Problems -- Appendix. A Brief Tutorial on Using PSPICE -- Index.

Sommario/riassunto

A much-needed primer on all aspects of transmission lines for electric and computer engineering graduates. Most of today's electrical engineering and computer engineering graduates lack a critically important skill: the analysis of transmission lines. They need this basic knowledge in order to be able to design high-speed digital and high-frequency analog systems—and this problem will only get worse as the speeds and frequencies of these systems continue to increase. This important text is the remedy. It prepares readers for increasingly difficult design problems in today's ever-changing high-speed digital world, focusing on signal integrity and crosstalk. Class-tested under the author's expert guidance at Mercer University, the book starts by reviewing the fundamental concepts of waves, wavelength, time delay, and electrical dimensions, as well as the bandwidth of digital signals and its relation to the pulse rise/fall times. It then explains two-conductor transmission lines and designing for signal integrity, addressing the time-domain analysis of those transmission lines and the corresponding analysis in the frequency domain. The terminal

voltages and currents of lines with various source waveforms and resistive terminations are computed by hand via wave tracing. This gives considerable insight into the general behavior of transmission lines in terms of forward- and backward-traveling waves and their reflections. The effect of line losses including skin effect in the line conductors and dielectric losses in the surrounding dielectric are increasingly becoming critical, and their detrimental effects are discussed. Next, the book repeats these topics for three-conductor lines in terms of the important detrimental effects of crosstalk between transmission lines, explaining the transmission-line equations for lossless lines, the important per-unit-length matrices of the inductance and capacitance of the lines, and the solution of three-conductor, lossless lines via mode decoupling. The final chapter concludes by investigating the effects of the line losses on the crosstalk of these three-conductor lines. Each chapter concludes with numerous problems for the reader to practice his/her understanding of the material. An Appendix contains a brief tutorial on SPICE (PSPICE), an important computational tool that is used extensively throughout the book. The included CD features several computer programs used and described in this book for computing the per-unit-length parameter matrices and a subcircuit model for three-conductor lines, as well as two MATLAB programs for computing the Fourier components of a digital waveform and two versions of PSPICE. This book is intended as a textbook for a senior/first-year graduate-level course in transmission lines in electrical engineering and computer engineering curricula. It is also essential for industry professionals as a compact review of transmission line fundamentals.
