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Nota di contenuto	Intro -- Electromagnetic and Photonic Simulation for the Beginner: Finite-Difference Frequency-Domain in MATLAB® -- Contents -- Foreword -- Preface -- Introduction -- Chapter 1 MATLAB Preliminaries -- 1.1 Basic Structure of an FDFD Program in MATLAB -- 1.1.1 MATLAB Code for Ideal Structure of a Program -- 1.2 MATLAB and Linear Algebra -- 1.2.1 Special Matrices -- 1.2.2 Matrix Algebra -- 1.3 Setting Up a Grid in MATLAB -- 1.3.1 MATLAB Array Indexing -- 1.3.2 Parameters Describing a Grid in MATLAB -- 1.3.3 Calculating the Grid Parameters -- 1.4 Building Geometries onto Grids -- 1.4.1 Adding Rectangles to a Grid -- 1.4.2 The Centering Algorithm -- 1.4.3 The Meshgrid -- 1.4.4 Adding Circles and Ellipses to a Grid -- 1.4.5 Grid Rotation -- 1.4.6 Boolean Operations -- 1.5 Three-Dimensional Grids -- 1.6 Visualization Techniques -- 1.6.1 Visualizing Data on Grids -- 1.6.2 Visualizing Three-Dimensional Data -- 1.6.3 Visualizing Complex Data -- 1.6.4 Animating the Fields Calculated by FDFD -- Reference -- Chapter 2 Electromagnetic Preliminaries -- 2.1 Maxwell's Equations -- 2.2 The Constitutive Parameters -- 2.2.1 Anisotropy, Tensors, and Rotation

Matrices -- 2.2.2 Rotation Matrices and Tensor Rotation -- 2.3
Expansion of Maxwell's Curl Equations in Cartesian Coordinates -- 2.4
The Electromagnetic Wave Equation -- 2.5 Electromagnetic Waves in
LHI Media -- 2.5.1 Wave Polarization -- 2.6 The Dispersion Relation
for LHI Media -- 2.7 Scattering at an Interface -- 2.7.1 Reflectance
and Transmittance -- 2.8 What is a Two-Dimensional Simulation? --
2.9 Diffraction from Gratings -- 2.9.1 The Grating Equation -- 2.9.2
Diffraction Efficiency -- 2.9.3 Generalization to Crossed Gratings --
2.10 Waveguides and Transmission Lines -- 2.10.1 Waveguide Modes
and Parameters -- 2.10.2 Transmission Line Parameters -- 2.11
Scalability of Maxwell's Equations.
2.12 Numerical Solution to Maxwell's Equations -- References --
Chapter 3 The Finite-Difference Method -- 3.1 Introduction -- 3.2
Finite-Difference Approximations -- 3.2.1 Deriving Expressions for
Finite-Difference Approximations -- 3.2.2 Example #1-Interpolations
and Derivatives from Three Points -- 3.2.3 Example #2-Interpolations
and Derivatives from Two Points -- 3.2.4 Example #3-Interpolations
and Derivatives from Four Points -- 3.3 Numerical Differentiation --
3.4 Numerical Boundary Conditions -- 3.4.1 Dirichlet Boundary
Conditions -- 3.4.2 Periodic Boundary Conditions -- 3.5 Derivative
Matrices -- 3.6 Finite-Difference Approximation of Differential
Equations -- 3.7 Solving Matrix Differential Equations -- 3.7.1
Example-Solving a Single-Variable Differential Equation -- 3.8 Multiple
Variables and Staggered Grids -- 3.8.1 Example-Solving a
Multivariable Problem -- References -- Chapter 4 Finite-Difference
Approximation of Maxwell's Equations -- 4.1 Introduction to the Yee
Grid Scheme -- 4.2 Preparing Maxwell's Equations for FDFD Analysis --
4.3 Finite-Difference Approximation of Maxwell's Curl Equations -- 4.4
Finite-Difference Equations for Two-Dimensional FDFD -- 4.4.1
Derivation of E Mode Equations When Frequency Is Not Known -- 4.4.2
Derivation of H Mode Equations When Frequency Is Not Known -- 4.4.3
Derivation of E Mode Equations When Frequency Is Known -- 4.4.4
Derivation of H Mode Equations When Frequency Is Known -- 4.5
Derivative Matrices for Two-Dimensional FDFD -- 4.5.1 Derivative
Matrices Incorporating Dirichlet Boundary Conditions -- 4.5.2 Periodic
Boundary Conditions -- 4.5.3 Derivative Matrices Incorporating
Periodic Boundary Conditions -- 4.5.4 Relationship Between the
Derivative Matrices -- 4.6 Derivative Matrices for Three-Dimensional
FDFD -- 4.6.1 Relationship Between the Derivative Matrices.
4.7 Programming the YEEDER2D() Function in MATLAB -- 4.7.1 Using
the yeeder2d() Function -- 4.8 Programming the YEEDER3D() Function
in MATLAB -- 4.8.1 Using the yeeder3d() Function -- 4.9 The 2x Grid
Technique -- 4.10 Numerical Dispersion -- References -- Chapter 5
The Perfectly Matched Layer Absorbing Boundary -- 5.1 The Absorbing
Boundary -- 5.2 Derivation of the UPML Absorbing Boundary -- 5.3
Incorporating the UPML into Maxwell's Equations -- 5.4 Calculating the
UPML Parameters -- 5.5 Implementation of the UPML in MATLAB --
5.5.1 Using the addupml2d() Function -- 5.6 The SCPML Absorbing
Boundary -- 5.6.1 MATLAB Implementation of calcpml3d() -- 5.6.2
Using the calcpml3d() Function -- References -- Chapter 6 FDFD for
Calculating Guided Modes -- 6.1 Formulation for Rigorous Hybrid
Mode Calculation -- 6.2 Formulation for Rigorous Slab Waveguide
Mode Calculation -- 6.2.1 Formulation of E Mode Slab Waveguide
Analysis -- 6.2.2 Formulation of H Mode Slab Waveguide Analysis --
6.2.3 Formulations for Slab Waveguides in Other Orientations -- 6.2.4
The Effective Index Method -- 6.3 Implementation of Waveguide Mode
Calculations -- 6.3.1 MATLAB Implementation of Rib Waveguide
Analysis -- 6.3.2 MATLAB Implementation of Slab Waveguide Analysis

-- 6.3.3 Animating the Slab Waveguide Mode -- 6.3.4 Convergence -- 6.3.5 MATLAB Implementation for Calculating SPPs -- 6.4 Implementation of Transmission Line Analysis -- References -- Chapter 7 FDFD for Calculating Photonic Bands -- 7.1 Photonic Bands for Rectangular Lattices -- 7.2 Formulation for Rectangular Lattices -- 7.3 Implementation of Photonic Band Calculation -- 7.3.1 Description of MATLAB Code for Calculating Photonic Band Diagrams -- 7.3.2 Description of MATLAB Code for Calculating IFCs -- References -- Chapter 8 FDFD for Scattering Analysis -- 8.1 Formulation of FDFD for Scattering Analysis. 8.1.1 Matrix Wave Equations for Two-Dimensional Analysis -- 8.2 Incorporating Sources -- 8.2.1 Derivation of the QAAQ Equation -- 8.2.2 Calculating the Source Field $f_{src}(x,y)$ -- 8.2.3 Calculating the SF Masking Matrix Q -- 8.2.4 Compensating for Numerical Dispersion -- 8.3 Calculating Reflection and Transmission for Periodic Structures -- 8.4 Implementation of the FDFD Method for Scattering Analysis -- 8.4.1 Standard Sequence of Simulations for a Newly Written FDFD Code -- 8.4.2 FDFD Analysis of a Sawtooth Diffraction Grating -- 8.4.3 FDFD Analysis of a Self-Collimating Photonic Crystal -- 8.4.4 FDFD Analysis of an OIC Directional Coupler -- References -- Chapter 9 Parameter Sweeps with FDFD -- 9.1 Introduction to Parameter Sweeps -- 9.2 Modifying FDFD for Parameter Sweeps -- 9.2.1 Generic MATLAB Function to Simulate Periodic Structures -- 9.2.2 Main MATLAB Program to Simulate the GMRF -- 9.2.3 Main MATLAB Programs to Analyze a Metal Polarizer -- 9.3 Identifying Common Problems in FDFD -- References -- Chapter 10 FDFD Analysis of Three-Dimensional and Anisotropic Devices -- 10.1 Formulation of Three-Dimensional FDFD -- 10.1.1 Finite-Difference Approximation of Maxwell's Curl Equations -- 10.1.2 Maxwell's Equations in Matrix Form -- 10.1.3 Interpolation Matrices -- 10.1.4 Three-Dimensional Matrix Wave Equation -- 10.2 Incorporating Sources into Three-Dimensional FDFD -- 10.3 Iterative Solution for FDFD -- 10.4 Calculating Reflection and Transmission for Doubly Periodic Structures -- 10.5 Implementation of Three-Dimensional FDFD and Examples -- 10.5.1 Standard Sequence of Simulations for a Newly Written Three-Dimensional FDFD Code -- 10.5.2 Generic Three-Dimensional FDFD Function to Simulate Periodic Structures -- 10.5.3 Simulation of a Crossed-Grating GMRF -- 10.5.4 Simulation of a Frequency Selective Surface. 10.5.5 Parameter Retrieval for a Left-Handed Metamaterial -- 10.5.6 Simulation of an Invisibility Cloak -- References -- Appendix A -- A.1 Best Practices for Building Devices onto Yee Grids -- A.2 Method Summaries -- List of Acronyms and Abbreviations -- About the Author -- Index.

Sommario/riassunto

This book teaches the finite-difference frequency-domain (FDFD) method from the simplest concepts to advanced three-dimensional simulations. It uses plain language and high-quality graphics to help the complete beginner grasp all the concepts quickly and visually. This single resource includes everything needed to simulate a wide variety of different electromagnetic and photonic devices. The book is filled with helpful guidance and computational wisdom that will help the reader easily simulate their own devices and more easily learn and implement other methods in computational electromagnetics. Special techniques in MATLAB are presented that will allow the reader to write their own FDFD programs. Key concepts in electromagnetics are reviewed so the reader can fully understand the calculations happening in FDFD. A powerful method for implementing the finite-difference method is taught that will enable the reader to solve entirely new

differential equations and sets of differential equations in mere minutes. Separate chapters are included that describe how Maxwell's equations are approximated using finite-differences and how outgoing waves can be absorbed using a perfectly matched layer absorbing boundary. With this background, a chapter describes how to calculate guided modes in waveguides and transmission lines. The effective index method is taught as way to model many three-dimensional devices in just two-dimensions. Another chapter describes how to calculate photonic band diagrams and isofrequency contours to quickly estimate the properties of periodic structures like photonic crystals. Next, a chapter presents how to analyze diffraction gratings and calculate the power coupled into each diffraction order. This book shows that many devices can be simulated in the context of a diffraction grating including guided-mode resonance filters, photonic crystals, polarizers, metamaterials, frequency selective surfaces, and metasurfaces. Plane wave sources, Gaussian beam sources, and guided-mode sources are all described in detail, allowing devices to be simulated in multiple ways. An optical integrated circuit is simulated using the effective index method to build a two-dimensional model of the 3D device and then launch a guided-mode source into the circuit. A chapter is included to describe how the code can be modified to easily perform parameter sweeps, such as plotting reflection and transmission as a function of frequency, wavelength, angle of incidence, or a dimension of the device. The last chapter is advanced and teaches FDTD for three-dimensional devices composed of anisotropic materials. It includes simulations of a crossed grating, a doubly-periodic guided-mode resonance filter, a frequency selective surface, and an invisibility cloak. The chapter also includes a parameter retrieval from a left-handed metamaterial. The book includes all the MATLAB codes and detailed explanations of all programs. This will allow the reader to easily modify the codes to simulate their own ideas and devices.--
