



The Finite-Difference Time-Domain Method for Electromagnetics with MATLAB® Simulations

2nd Edition

Atef Z. Elsherbeni and Veysel Demir

Finite Difference Time Domain Method For Electromagnetics

Shahid Ahmed



Finite Difference Time Domain Method For Electromagnetics:

Introduction to the Finite-Difference Time-Domain (FDTD) Method for Electromagnetics Stephen Gedney, 2022-05-31
Introduction to the Finite Difference Time Domain FDTD Method for Electromagnetics provides a comprehensive tutorial of the most widely used method for solving Maxwell's equations the Finite Difference Time Domain Method This book is an essential guide for students researchers and professional engineers who want to gain a fundamental knowledge of the FDTD method It can accompany an undergraduate or entry level graduate course or be used for self study The book provides all the background required to either research or apply the FDTD method for the solution of Maxwell's equations to practical problems in engineering and science Introduction to the Finite Difference Time Domain FDTD Method for Electromagnetics guides the reader through the foundational theory of the FDTD method starting with the one dimensional transmission line problem and then progressing to the solution of Maxwell's equations in three dimensions It also provides step by step guides to modeling physical sources lumped circuit components absorbing boundary conditions perfectly matched layer absorbers and sub cell structures Post processing methods such as network parameter extraction and far field transformations are also detailed Efficient implementations of the FDTD method in a high level language are also provided Table of Contents
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The Finite Difference Time Domain Method for Electromagnetics Karl S. Kunz, Raymond J. Luebbers, 2018-05-04 The Finite Difference Time domain FDTD method allows you to compute electromagnetic interaction for complex problem geometries with ease The simplicity of the approach coupled with its far reaching usefulness create the powerful popular method presented in The Finite Difference Time Domain Method for Electromagnetics This volume offers timeless applications and formulations you can use to treat virtually any material type and geometry The Finite Difference Time Domain Method for Electromagnetics explores the mathematical foundations of FDTD including stability outer radiation boundary conditions and different coordinate systems It covers derivations of FDTD for use with PEC metal lossy dielectrics gyrotropic materials and anisotropic materials A number of applications are completely worked out with numerous figures to illustrate the results It also includes a printed FORTRAN 77 version of the code that implements the technique in three dimensions for lossy dielectric materials There are many methods for analyzing electromagnetic interactions for problem geometries With The Finite Difference Time Domain Method for Electromagnetics you will learn the simplest most useful of these methods from the basics through to the practical applications

[Parallel Finite-difference Time-domain Method](#)
Wenhua Yu, 2006 The finite difference time domain FTDT method has revolutionized antenna design and electromagnetics engineering This book raises the FDTD method to the next level by empowering it with the vast capabilities of parallel computing It shows engineers how to exploit the natural parallel properties of FDTD to improve the existing FDTD method

and to efficiently solve more complex and large problem sets Professionals learn how to apply open source software to develop parallel software and hardware to run FDTD in parallel for their projects The book features hands on examples that illustrate th Computational Electrodynamics Allen Taflove,1995 This work represents a university text and professional research reference on the finite difference time domain computational solution method for Maxwell s equations Sections cover numerical stability numerical dispersion and dispersive nonlinear and gain methods of FD TD and antenna analysis

The Finite-Difference Time-Domain Method for Electromagnetics with MATLAB® Simulations Atef Z.

Elsherbeni,Veysel Demir,2015-11-25 This is one of the best books on computational electromagnetics both for graduate students focusing on electromagnetics problems and for practicing engineering professionals in industry and government It is designed as an advanced textbook and self study guide to the FDTD method of solving EM problems and simulations This latest edition has been expanded to include 5 entirely new chapters on advanced topics in the mainstream of FDTD practice In addition to advanced techniques it also includes applications and examples and some tricks and traps of using MATLAB to achieve them Compared to the previous version the second edition is more complete and is a good reference for someone who is performing FDTD research This book is part of the ACES Series on Computational Electromagnetics and Engineering Supplementary material can be found at the IET s ebook page Supplementary materials for professors are available upon request via email to books@iet.org **Electromagnetic Simulation Using the FDTD Method** Dennis M.

Sullivan,2013-05-17 A straightforward easy to read introduction to the finite difference time domain FDTD method Finite difference time domain FDTD is one of the primary computational electrodynamics modeling techniques available Since it is a time domain method FDTD solutions can cover a wide frequency range with a single simulation run and treat nonlinear material properties in a natural way Written in a tutorial fashion starting with the simplest programs and guiding the reader up from one dimensional to the more complex three dimensional programs this book provides a simple yet comprehensive introduction to the most widely used method for electromagnetic simulation This fully updated edition presents many new applications including the FDTD method being used in the design and analysis of highly resonant radio frequency RF coils often used for MRI Each chapter contains a concise explanation of an essential concept and instruction on its implementation into computer code Projects that increase in complexity are included ranging from simulations in free space to propagation in dispersive media Additionally the text offers downloadable MATLAB and C programming languages from the book support site <http://booksupport.wiley.com> Simple to read and classroom tested **Electromagnetic Simulation Using the FDTD Method** is a useful reference for practicing engineers as well as undergraduate and graduate engineering students Advances in Computational Electrodynamics Allen Taflove,1998 Finite Difference Time Domain FD TD modeling is arguably the most popular and powerful means available to perform detailed electromagnetic engineering analyses Edited by the pioneer and foremost authority on the subject here is the first book to assemble in one resource the latest techniques and results of the

leading theoreticians and practitioners of FD TD computational electromagnetics modeling

Electromagnetic Simulation Using the FDTD Method with Python Jennifer E. Houle, Dennis M. Sullivan, 2020-01-15 Provides an introduction to the Finite Difference Time Domain method and shows how Python code can be used to implement various simulations This book allows engineering students and practicing engineers to learn the finite difference time domain FDTD method and properly apply it toward their electromagnetic simulation projects Each chapter contains a concise explanation of an essential concept and instruction on its implementation into computer code Included projects increase in complexity ranging from simulations in free space to propagation in dispersive media This third edition utilizes the Python programming language which is becoming the preferred computer language for the engineering and scientific community Electromagnetic Simulation Using the FDTD Method with Python Third Edition is written with the goal of enabling readers to learn the FDTD method in a manageable amount of time Some basic applications of signal processing theory are explained to enhance the effectiveness of FDTD simulation Topics covered in include one dimensional simulation with the FDTD method two dimensional simulation and three dimensional simulation The book also covers advanced Python features and deep regional hyperthermia treatment planning Electromagnetic Simulation Using the FDTD Method with Python Guides the reader from basic programs to complex three dimensional programs in a tutorial fashion Includes a rewritten fifth chapter that illustrates the most interesting applications in FDTD and the advanced graphics techniques of Python Covers peripheral topics pertinent to time domain simulation such as Z transforms and the discrete Fourier transform Provides Python simulation programs on an accompanying website An ideal book for senior undergraduate engineering students studying FDTD Electromagnetic Simulation Using the FDTD Method with Python will also benefit scientists and engineers interested in the subject

Introduction to the Finite-difference Time-domain (FDTD) Method for Electromagnetics Stephen D. Gedney, 2011 Provides a comprehensive tutorial of the most widely used method for solving Maxwell s equations the Finite Difference Time Domain Method This book is an essential guide for students researchers and professional engineers The book provides all the background required to either research or apply the FDTD method for the solution of Maxwell s equations to practical problems in engineering and science

Electromagnetic Pulse Simulations Using Finite-Difference Time-Domain Method Shahid Ahmed, 2021-04-14 Electromagnetic Pulse Simulations Using Finite Difference Time Domain Method Discover the utility of the FDTD approach to solving electromagnetic problems with this powerful new resource Electromagnetic Pulse Simulations Using Finite Difference Time Domain Method delivers a comprehensive overview of the generation and propagation of ultra wideband electromagnetic pulses The book provides a broad cross section of studies of electromagnetic waves and their propagation in free space dielectric media complex media and within guiding structures like waveguide lines transmission lines and antennae The distinguished author offers readers a fresh new approach for analyzing electromagnetic modes for pulsed electromagnetic systems designed to improve the reader

s understanding of the electromagnetic modes responsible for radiating far fields The book also provides a wide variety of computer programs data analysis techniques and visualization tools with state of the art packages in MATLAB and Octave Following an introduction and clarification of basic electromagnetics and the frequency and time domain approach the book delivers explanations of different numerical methods frequently used in computational electromagnetics and the necessity for the time domain treatment In addition to a discussion of the Finite difference Time domain FDTD approach readers will also enjoy A thorough introduction to electromagnetic pulses EMPs and basic electromagnetics including common applications of electromagnetics and EMP coupling and its effects An exploration of time and frequency domain analysis in electromagnetics including Maxwell s equations and their practical implications A discussion of electromagnetic waves and propagation including waves in free space dielectric mediums complex mediums and guiding structures A treatment of computational electromagnetics including an explanation of why we need modeling and simulations Perfect for undergraduate and graduate students taking courses in physics and electrical and electronic engineering Electromagnetic Pulse Simulations Using Finite Difference Time Domain Method will also earn a place in the libraries of scientists and engineers working in electromagnetic research RF and microwave design and electromagnetic interference [Time Domain Techniques in Computational Electromagnetics](#) Dragan Poljak,2004 A state of the art review from invited contributors Subjects covered include time domain analysis of electromagnetic wave fields by boundary integral equation method and transient analysis of thin wires and related time domain energy measures **Numerical Electromagnetics** Umran S. Inan,Robert A. Marshall,2011-04-07 Beginning with the development of finite difference equations and leading to the complete FDTD algorithm this is a coherent introduction to the FDTD method the method of choice for modeling Maxwell s equations It provides students and professional engineers with everything they need to know to begin writing FDTD simulations from scratch and to develop a thorough understanding of the inner workings of commercial FDTD software Stability numerical dispersion sources and boundary conditions are all discussed in detail as are dispersive and anisotropic materials A comparative introduction of the finite volume and finite element methods is also provided All concepts are introduced from first principles so no prior modeling experience is required and they are made easier to understand through numerous illustrative examples and the inclusion of both intuitive explanations and mathematical derivations [Electromagnetic Pulse Simulations Using Finite-Difference Time-Domain Method](#) Shahid Ahmed,2021-04-13 Electromagnetic Pulse Simulations Using Finite Difference Time Domain Method Discover the utility of the FDTD approach to solving electromagnetic problems with this powerful new resource Electromagnetic Pulse Simulations Using Finite Difference Time Domain Method delivers a comprehensive overview of the generation and propagation of ultra wideband electromagnetic pulses The book provides a broad cross section of studies of electromagnetic waves and their propagation in free space dielectric media complex media and within guiding structures like waveguide lines transmission lines and antennae The distinguished author offers readers a fresh new

approach for analyzing electromagnetic modes for pulsed electromagnetic systems designed to improve the reader's understanding of the electromagnetic modes responsible for radiating far fields. The book also provides a wide variety of computer programs, data analysis techniques, and visualization tools with state-of-the-art packages in MATLAB and Octave. Following an introduction and clarification of basic electromagnetics and the frequency and time domain approach, the book delivers explanations of different numerical methods frequently used in computational electromagnetics and the necessity for the time domain treatment. In addition to a discussion of the Finite Difference Time Domain (FDTD) approach, readers will also enjoy a thorough introduction to electromagnetic pulses (EMPs) and basic electromagnetics including common applications of electromagnetics and EMP coupling and its effects. An exploration of time and frequency domain analysis in electromagnetics including Maxwell's equations and their practical implications, a discussion of electromagnetic waves and propagation including waves in free space, dielectric mediums, complex mediums, and guiding structures, and a treatment of computational electromagnetics including an explanation of why we need modeling and simulations. Perfect for undergraduate and graduate students taking courses in physics and electrical and electronic engineering, *Electromagnetic Pulse Simulations Using Finite Difference Time Domain Method* will also earn a place in the libraries of scientists and engineers working in electromagnetic research, RF and microwave design, and electromagnetic interference.

Advances in Time-Domain Computational Electromagnetic Methods Qiang Ren, Su Yan, Atef Z. Elsherbeni, 2022-12-01

Advances in Time Domain Computational Electromagnetic Methods Discover state-of-the-art time domain electromagnetic modeling and simulation algorithms. *Advances in Time Domain Computational Electromagnetic Methods* delivers a thorough exploration of recent developments in time domain computational methods for solving complex electromagnetic problems. The book discusses the main time domain computational electromagnetics techniques including finite difference time domain (FDTD), finite element time domain (FETD), discontinuous Galerkin time domain (DGTD), time domain integral equation (TDIE), and other methods in electromagnetic multiphysics modeling and simulation and antenna designs. The book bridges the gap between academic research and real engineering applications by comprehensively surveying the full picture of current state-of-the-art time domain electromagnetic simulation techniques. Among other topics, it offers readers discussions of automatic load balancing schemes for DG-FETD/SETD methods and convolution quadrature time domain integral equation methods for electromagnetic scattering. *Advances in Time Domain Computational Electromagnetic Methods* also includes introductions to cylindrical, spherical, and symplectic FDTD, as well as FDTD for metasurfaces with GSTC and FDTD for nonlinear metasurfaces. Explorations of FETD for dispersive and nonlinear media and SETD/DDM for periodic/quasi-periodic arrays. Discussions of TDIE including explicit marching on in time solvers for second-kind time domain integral equations, TD-SIE/DDM, and convolution quadrature time domain integral equation methods for electromagnetic scattering. Treatments of deep learning including time domain electromagnetic forward and inverse modeling using a differentiable programming platform. Ideal for

undergraduate and graduate students studying the design and development of various kinds of communication systems as well as professionals working in these fields **Advances in Time Domain Computational Electromagnetic Methods** is also an invaluable resource for those taking advanced graduate courses in computational electromagnetic methods and simulation techniques

The Finite-difference Time-domain Method for Electromagnetics with MATLAB Simulations Atef Z. Elsherbeni, Veysel Demir, 2009 Helping students to construct a program with sufficient functionality to solve some basic problems this book presents the construction of equations accompanied by 3D illustrations It also explains the transformation of the concepts into programming

Introduction to Time Domain Numerical Methods for Solving Electromagnetic Problems Shunchuan Yang, Zhizhang (David) Chen, 2016-09-15 This book introduces the time domain numerical methods to solve electromagnetic problems including finite difference time domain FDTD method the finite element method FEM and method of moment MOM It also presents emerging methods in the recent ten years for electromagnetics simulations All these methods can be unified under a single mathematic framework This is one of the few books to unify and compare different time domain methods and clarify their respective advantages and disadvantages

An Investigation of the Finite-difference Time-domain Method in Electromagnetics Jose Luis Chavez, 1991

Electromagnetic Simulation Techniques Based on the FDTD Method W. Yu, 2009-09-15 Bridges the gap between FDTD theory and the implementation of practical simulation techniques This is the first publication that guides readers step by step through the implementation of electromagnetic simulation techniques based on FDTD methods These simulation techniques serve as an essential bridge between FDTD methods and their applications Moreover the book helps readers better understand the underlying logic of FDTD methods so that they can design FDTD projects using either commercial electromagnetic software packages or their own codes in order to solve practical engineering problems The book begins with two chapters that introduce the basic concepts of the 3 D Cartesian FDTD method followed by discussions of advanced FDTD methods such as conformal techniques dispersive media circuit elements and near to far field transformation Next the book Presents basic concepts of parallel processing techniques and systems including parallel FDTD techniques and systems Explores simulation techniques based on FDTD methods Illustrates practical simulation techniques using engineering applications Introduces advanced simulation techniques Each chapter concludes with references to help readers investigate particular topics in greater depth Each chapter also includes problem sets that challenge readers to put their new FDTD and simulation skills into practice By bridging the gap between FDTD theory and practical simulation techniques this publication is an invaluable guide for students and engineers who need to solve a wide range of design problems in RF antenna and microwave engineering

Multiresolution Time Domain Scheme for Electromagnetic Engineering Yinchao Chen, Qunsheng Cao, Raj Mittra, 2005-01-28 The rapid development of computer techniques and information technologies in recent decades has fueled the need for efficient tools for electromagnetic modeling of millimeter wave integrated circuits high speed and high density

VLSI circuits including computer chips and wireless computer applications **Time-Domain Computer Analysis of Nonlinear Hybrid Systems** Wenquan Sui,2018-10-08 The analysis of nonlinear hybrid electromagnetic systems poses significant challenges that essentially demand reliable numerical methods In recent years research has shown that finite difference time domain FDTD cosimulation techniques hold great potential for future designs and analyses of electrical systems Time Domain Computer Analysis of Nonlinear Hybrid Systems summarizes and reviews more than 10 years of research in FDTD cosimulation It first provides a basic overview of the electromagnetic theory the link between field theory and circuit theory transmission line theory finite difference approximation and analog circuit simulation The author then extends the basic theory of FDTD cosimulation to focus on techniques for time domain field solving analog circuit analysis and integration of other lumped systems such as n port nonlinear circuits into the field solving scheme The numerical cosimulation methods described in this book and proven in various applications can effectively simulate hybrid circuits that other techniques cannot By incorporating recent new and previously unpublished results this book effectively represents the state of the art in FDTD techniques More detailed studies are needed before the methods described are fully developed but the discussions in this book build a good foundation for their future perfection

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