Electrodynamics Simulator

Levent Sevgi

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.

Electromagnetic Modeling and Simulation Levent Sevgi,2014-03-13 This unique book presents simple, easy-to-use, but effectiveshort codes as well as virtual tools that can be used byelectrical, electronic, communication, and computer engineers in abroad range of electrical engineering problems Electromagnetic modeling is essential to the design and modelingof antenna, radar, satellite, medical imaging, and otherapplications. In this book, author Levent Sevgi explains techniquesfor solving real-time complex physical problems using MATLAB-basedshort scripts and comprehensive virtual tools. Unique in coverage and tutorial approach, ElectromagneticModeling and Simulation covers fundamental analytical andnumerical models that are widely used in teaching, research, andengineering designs—including mode and ray summationapproaches with the canonical 2D nonpenetrable parallel platewaveguide as well as FDTD, MoM, and SSPE scripts. The book alsoestablishes an intelligent balance among the essentials of EMMODSIM: The Problem (the physics), The Theory and Models(mathematical background and analytical solutions), and TheSimulations (code developing plus validation, verification, andcalibration). Classroom tested in graduate-level and short courses,Electromagnetic Modeling and Simulation: Clarifies concepts through numerous worked problems and quizzesprovided throughout the book Features valuable MATLAB-based, user-friendly, effectiveengineering and research virtual design tools Includes sample scenarios and video clips recorded duringcharacteristic simulations that visually impactlearning—available on wiley.com Provides readers with their first steps in EM MODSIM as welltools for medium and high-level code developers and users Electromagnetic Modeling and Simulation thoroughly coversthe physics, mathematical background, analytical solutions, andcode development of electromagnetic modeling, making it an idealresource for electrical engineers and researchers.

Electromagnetic Pulse Simulations Using Finite-Difference Time-Domain Method Shahid Ahmed,2021-04-20 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.

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.

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.

Complex Electromagnetic Problems and Numerical Simulation Approaches Levent Sevgi,2003-06-10 Today, engineering problems are very complex, requiring powerful computer simulations to power them. For engineers, observable-based parameterization as well as numerically computable formsâ??with rapid convergent properties if in a seriesâ??are essential. Complex Electromagnetic Problems and Numerical Simulation Approaches, along with its companion FTP site, will show you how to take on complex electromagnetic problems and solve them in an accurate and efficient manner. Organized into two distinct parts, this comprehensive resource first introduces you to the concepts, approaches, and numerical simulation techniques that will be used throughout the book and then, in Part II, offers step-by-step guidance as to their practical, real-world applications. Self-contained chapters will enable you to find specific solutions to numerous problems. Filled with in-depth insight and expert advice, Complex Electromagnetic Problems and Numerical Simulation Approaches: Describes ground wave propagation Examines antenna systems Deals with radar cross section (RCS) modeling Explores microstrip network design with FDTD and TLM techniques Discusses electromagnetic compatibility (EMC) and bio-electromagnetics (BEM) modeling Presents radar simulation Whether you're a professional electromagnetic engineer requiring a consolidated overview of the subject or an academic/student who wishes to use powerful simulators as a learning tool, Complex Electromagnetic Problems and Numerical Simulation Approaches - with its focus on model development, model justification, and range of validity - is the right book for you.

Real-Time Electromagnetic Transient Simulation of AC-DC Networks Venkata Dinavahi,Ning Lin,2021-06-22 Explore a comprehensive and state-of-the-art presentation of real-time electromagnetic transient simulation technology by leaders in the field Real-Time Electromagnetic Transient Simulation of AC-DC Networks delivers a detailed exposition of field programmable gate array (FPGA) hardware based real-time electromagnetic transient (EMT) emulation for all fundamental equipment used in AC-DC power grids. The book focuses specifically on detailed device-level models for their hardware realization in a massively parallel and deeply pipelined manner as well as decomposition techniques for emulating large systems. Each chapter contains fundamental concepts, apparatus models, solution algorithms, and hardware emulation to assist the reader in understanding the material contained within. Case studies are peppered throughout the book, ranging from small didactic test circuits to realistically sized large-scale AC-DC grids. The book also provides introductions to FPGA and hardware-in-the-loop (HIL) emulation procedures, and large-scale networks constructed by the foundational components described in earlier chapters. With a strong focus on high-voltage direct-current power transmission grid applications, Real-Time Electromagnetic Transient Simulation of AC-DC Networks covers both system-level and device-level mathematical models. Readers will also enjoy the inclusion of: A thorough introduction to field programmable gate array technology, including the evolution of FPGAs, technology trends, hardware architectures, and programming tools An exploration of classical power system components, e.g., linear and nonlinear passive power system components, transmission lines, power transformers, rotating machines, and protective relays A comprehensive discussion of power semiconductor switches and converters, i.e., AC-DC and DC-DC converters, and specific power electronic apparatus such as DC circuit breakers An examination of decomposition techniques used at the equipment-level as well as the large-scale system-level for real-time EMT emulation of AC-DC networks Chapters that are supported by simulation results from well-defined test cases and the corresponding system parameters are provided in the Appendix Perfect for graduate students and professional engineers studying or working in electrical power engineering, Real-Time Electromagnetic Transient Simulation of AC-DC Networks will also earn a place in the libraries of simulation specialists, senior modeling and simulation engineers, planning and design engineers, and system studies engineers.

Microwave Circuit Modeling Using Electromagnetic Field Simulation Daniel G. Swanson,Wolfgang J. R. Hoefer,2003 Annotation This practical how to book is an ideal introduction to electromagnetic field-solvers. Where most books in this area are strictly theoretical, this unique resource provides engineers with helpful advice on selecting the right tools for their RF (radio frequency) and high-speed digital circuit design work

Electromagnetism and Interconnections Stephane Charruau,2013-03-01 This book covers the theoretical problems of modeling electrical behavior of the interconnections encountered in everyday electronic products. The coverage shows the theoretical tools of waveform prediction at work in the design of a complex and high-speed digital electronic system. Scientists, research engineers, and postgraduate students interested in electromagnetism, microwave theory, electrical engineering, or the development of simulation tools software for high speed electronic system design automation will find this book an illuminating resource.

Power Systems Electromagnetic Transients Simulation Neville Watson,Jos Arrillaga,J. Arrillaga,2003 Electromagnetic transients simulation (EMTS) has become a universal tool for the analysis of power system electromagnetic transients in the range of nanoseconds to seconds. This book provides a thorough review of EMTS and many simple examples are included to clarify difficult concepts. This book will be of particular value to advanced engineering students and practising power systems engineers.

Time Domain Methods in Electrodynamics Peter Russer,Uwe Siart,2008-09-26 This book consists of contributions given in honor of Wolfgang J.R. Hoefer. Space and time discretizing time domain methods for electromagnetic full-wave simulation have emerged as key numerical methods in computational electromagnetics. Time domain methods are versatile and can be applied to the solution of a wide range of electromagnetic field problems. Computing the response of an electromagnetic structure to an impulsive excitation localized in space and time provides a comprehensive characterization of the electromagnetic properties of the structure in a wide frequency range. The most important methods are the Finite Difference Time Domain (FDTD) and the Transmission Line Matrix (TLM) methods. The contributions represent the state of the art in dealing with time domain methods in modern engineering electrodynamics for electromagnetic modeling in general, the Transmission Line Matrix (TLM) method, the application of network concepts to electromagnetic field modeling, circuit and system applications and, finally, with broadband devices, systems and measurement techniques.

Electricity and Magnetism Simulations Robert Ehrlich,1995 The Consortium for Upper Level Physics Software (CUPS) has developed a comprehensive series of Nine Book/Software packages that Wiley will publish in FY '95 and '96. CUPS is an international group of 27 physicists, all with extensive backgrounds in the research, teaching, and development of instructional software. The project is being supported by the National Science Foundation (PHY-9014548), and it has received other support from the IBM Corp., Apple Computer Corp., and George Mason University. The Simulations being developed are: Astrophysics, Classical Mechanics, Electricity & Magnetism, Modern Physics, Nuclear and Particle Physics, Quantum Mechanics, Solid State, Thermal and Statistical, and Waves and Optics.

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.

Electrodynamics Tutorials with Python Simulations Taejoon Kouh,Minjoon Kouh,2024-04-30 This book provides an accessible introduction to intermediate-level electrodynamics with computational approaches to complement a traditional mathematical treatment of the subject. It covers key topics in electrodynamics, such as electromagnetic fields, forces, potentials, and waves as well as Special Theory of Relativity. Through intuition-building examples and visualizations in the Python programming language, it helps readers to develop technical computing skills in numerical and symbolic calculations, modeling and simulations, and visualizations. Python is a highly readable and practical programming language, making this book appropriate for students without extensive programming experience. This book can serve as an electrodynamics textbook for undergraduate physics and engineering students in their second or third years, who are studying intermediate- or advanced-level electrodynamics and who want to learn techniques for scientific computing at the same time. This book will also appeal to computer science students who want to see how their computer programming skills may be applied to science, particularly to physics, without needing too much background physics knowledge. Key features ● Major concepts in classical electrodynamics are introduced cohesively through computational and mathematical treatments. ● Computational examples in Python programming language guide students on how to simulate and visualize electrodynamic principles and phenomena for themselves. Taejoon Kouh is a Professor of Nano and Electronic Physics at Kookmin University, Republic of Korea. He earned his B.A. in physics from Boston University and Sc.M. and Ph.D. degrees in physics from Brown University. After his study in Providence, RI, he returned to Boston, MA, and worked as a postdoctoral research associate in the Department of Aerospace and Mechanical Engineering at Boston University. He is a full faculty member in the Department of Nano and Electronic Physics at Kookmin University in Seoul, Korea, teaching and supervising undergraduate and graduate students. His current research involves the dynamics of nanoelectromechanical systems and the development of fast and reliable transduction methods and innovative applications based on tiny motion. Minjoon Kouh is a program scientist for a philanthropic initiative. He was a Professor of Physics and Neuroscience at Drew University, USA, where he taught more than 30 distinct types of courses. He holds Ph.D. and B.S. degrees in physics from MIT and an M.A. from UC Berkeley. He completed a postdoctoral research fellowship at the Salk Institute for Biological Studies in La Jolla, CA. His research includes computational modeling of the primate visual cortex, information-theoretic analysis of neural responses, machine learning, and pedagogical innovations in undergraduate science education.

Power Systems Electromagnetic Transients Simulation Neville Watson,Jos Arrillaga,2019-01-30 Accurate knowledge of electromagnetic power system transients is crucial to the operation of an economic, efficient and environmentally friendly power systems network without compromising on the reliability and quality of electrical power supply. Electromagnetic transient (EMT) simulation has therefore become a universal tool for the analysis of power system electromagnetic transients in the range of nanoseconds to seconds, and is the backbone for the design and planning of power systems, as well as for the investigation of problems. In this fully revised and updated new edition of this classic book, a thorough review of EMT simulation is provided, with many simple examples included to clarify difficult concepts. Topics covered include analysis of continuous and discrete systems; state variable analysis; numerical integrator substitution; the root-matching method; transmission lines and cables; transformers and rotating plant; control and protection; power electronic systems; frequency-dependent network equivalents; steady-state assessment; mixed time-frame simulation; transient simulation in real-time; and applications.

Advances in FDTD Computational Electrodynamics Allen Taflove,Ardavan Oskooi,Steven G. Johnson,2013 Advances in photonics and nanotechnology have the potential to revolutionize humanity's ability to communicate and compute. To pursue these advances, it is mandatory to understand and properly model interactions of light with materials such as silicon and gold at the nanoscale, i.e., the span of a few tens of atoms laid side by side. These interactions are governed by the fundamental Maxwell's equations of classical electrodynamics, supplemented by quantum electrodynamics. This book presents the current state-of-the-art in formulating and implementing computational models of these interactions. Maxwell's equations are solved using the finite-difference time-domain (FDTD) technique, pioneered by the senior editor, whose prior Artech House books in this area are among the top ten most-cited in the history of engineering. This cutting-edge resource helps readers understand the latest developments in computational modeling of nanoscale optical microscopy and microchip lithography, as well as nanoscale plasmonics and biophotonics.

Computational Electromagnetic Transients R. Ramanujam,2014-07-30 Provides the theory, models, solution methods and simulation techniques evolved for several versions of EMTP over the last five decades. The focus is on one particular version - Microtran. The focus of the book is modelling and simulation algorithms for digital simulation and computation.

Computational Electrodynamics Wim Schoenmaker,2022-09-01 Computational Electrodynamics is a vast research field with a wide variety of tools. In physics the principle of gauge invariance plays a pivotal role as a guide towards a sensible formulation of the laws of nature as well as computing the properties of elementary particles using the lattice formulation of gauge theories, yet the gauge principle has played a much less pronounced role in performing computation in classical electrodynamics. In this work the author will demonstrate that starting from the gauge formulation of electrodynamics using the electromagnetic potentials leads to computational tools that can very well compete with the conventional electromagnetic field-based tools. Once accepting the formulation based on gauge fields, the computational code is very transparent due to the mimetic mapping of the electrodynamic variables on the computational grid. Although the illustrations and applications originate from microelectronic engineering, the method has a much larger range of applicability. Therefore this book is of interest to everyone having interest in computational electrodynamics. The volume is organized as follows: In part 1, a detailed introduction and overview is presented of the Maxwell equations as well as the derivation of the current and charge densities is different materials. Semiconductors are responding to electromagnetic fields in a non-linear way and the induced complications are discussed in detail. In part 2, the transition of the theory of electrodynamics, using the gauge potentials, to a formulation that can serve as the gateway to computational code is presented. In part 3, the feasibility and success of the methods of part 2 are demonstrated by a collection of microelectronic device designs. Part 4 focuses on a set of topical themes that brings the reader to the frontier of research in building the simulation tools using the gauge principle in computational electrodynamics. Technical topics discussed in the book include:Electromagnetic Field EquationsConstitutive RelationsDiscretization and Numerical AnalysisFinite Element and Finite Volume MethodsDesign of Integrated Passive Components

Co-simulations of Microwave Circuits and High-Frequency Electromagnetic Fields Mei Song Tong,Xiao Yu Li,2024-03-10

This book aims to provide many advanced application topics for microwave circuits and high-frequency electromagnetic (EM) fields by using advanced design system (ADS) and high-frequency structure simulator (HFSS) as simulation platforms. In particular, it contains the latest multidisciplinary co-simulation guidance on the design of relevant components and devices. Currently, the circuit/field design and performance analysis and optimization strongly rely on various kinds of robust electronic design automation (EDA) software. RF/microwave engineers must grasp two or more types of related simulation design software. ADS by Keysight and HFSS by Ansys are the representative for circuit simulations and for field and structural simulations of microwave devices, respectively. At present, these two types of software are widely used in enterprises, universities, and research institutions. The main purpose of this book is to enable readers, who are interested in microwave engineering and applied electromagnetics, to master the applications of these two tools. It also helps readers expand their knowledge boundaries behind those types of software and deepen their understanding of developing interdisciplinary technologies by co-simulations. The book is divided into three parts. The first part introduces the two latest versions of ADS and HFSS and helps readers better understand the basic principles and latest functions better. It also advises how to choose appropriate simulation tools for different problems. The second part mainly describes co-simulations for high-frequency EM fields, microwave circuits, antenna designs, EM compatibility (EMC), and thermal and structural analyses. It provides guides and advices on performing co-simulations by ADS and HFSS incorporated with other types of software, respectively. The last part narrates the automation interfaces and script programming methods for co-simulations. It primarily deals with the Advanced Extension Language (AEL), Python Data Link (PDL), and MATLAB interface in ADS. For HFSS, it discusses VBScript, IronPython scripting, and Application Programming Interface (APIs) based on MATLAB. Each topic contains practical examples to help readers understand so that they can gain a solid knowledge and skills regarding automated interfaces and scripting methods based on these kinds of software. Concisely written in combination with practical examples, this book is very suitable as a textbook in introductory courses on microwave circuit and EM simulations and also as a supplementary textbook in many courses on electronics, microwave engineering, communication engineering, and related fields. As well, it can serve as a reference book for microwave engineers and researchers.

   The 3D Electrodynamic Wave Simulator Christian Hafner,Lars Henning Bomholt,1993-11-02 Based on the Generalized Multipole Technique (GMT), the Multiple Multipole Program (MMP) includes a large number of analytic solutions of Maxwell equations and, because it is implemented in a flexible way, future developments and adaptations can be made easily. Written in standard FORTRAN, it includes excellent graphic input and output interfaces for PCs under DOS to Windows/3. Can run on simple PC workstations, mainframes and supercomputers.

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Electrodynamics Simulator Introduction

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