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Methods For Maxwells Equations In
Metamaterials Springer Series In Computational
Mathematics

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Electromagnetics through the Finite Element
MethodFinite Element Modeling Methods for
PhotonicsIntroduction to the Finite Element Method in
ElectromagneticsThe Finite Element Method in
ElectromagneticsHarmonic Balance Finite Element
MethodIntroduction to the Finite-difference Time-
domain (FDTD) Method for ElectromagneticsTime
Domain Finite Element Method for Linear and
Nonlinear Models in Electromagnetics and OpticsFinite
Element and Discontinuous Galerkin Methods for
Transient Wave EquationsThe Mathematical
Foundations of the Finite Element Method with
Applications to Partial Differential EquationsHigher-
Order Finite Element MethodsTime-domain Finite
Elements in Optimal Control with Application to
Launch-vehicle GuidanceThe Finite Element Method in
EngineeringFrequency Domain Hybrid Finite Element
Methods for ElectromagneticsMoving Finite Element
MethodSmoothed Finite Element MethodsA Time
Domain Vector Finite Element Method for the Full
Wave Simulation of Nonlinear Photonic DevicesFinite
Element and Finite Difference Methods in
Electromagnetic ScatteringAutomated Solution of
Differential Equations by the Finite Element
MethodFinite Element Methods for Maxwell's

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EquationsTheFinite-Difference Time-Domain Method
for Electromagnetics with MATLAB® SimulationsThe
Mathematical Theory of Finite Element MethodsFinite
Element Analysis of Antennas and ArraysExtended
Finite Element MethodSpectral Finite Element
MethodTime Domain ElectromagneticsThe Finite
Difference Time Domain Method for
ElectromagneticsThe Finite Element Method: Theory,
Implementation, and ApplicationsTime-Domain Finite
Element Methods for Maxwell's Equations in
MetamaterialsFinite Element ProceduresParallel Finite-
difference Time-domain MethodFinite Element
Methods for Maxwell's Equationsfinite element
methodsMatrix Algorithms Volume 2The Finite
Element Method: Its Basis and
FundamentalsComputational Acoustics of Noise
Propagation in Fluids - Finite and Boundary Element
MethodsFinite Element Method Simulation of 3D
Deformable SolidsThe Finite Element Method Set2020
International Applied Computational Electromagnetics
Society Symposium (ACES)Finite Element Analysis of
Antennas and ArraysModern EMC Analysis Techniques

Electromagnetics through the Finite Element Method

This second edition of The Finite Element Method in Engineering reflects the new and current developments in this area, whilst maintaining the format of the first edition. It provides an introduction and exploration into the various aspects of the finite element method (FEM) as applied to the solution of

problems in engineering. The first chapter provides a general overview of FEM, giving the historical background, a description of FEM and a comparison of FEM with other problem solving methods. The following chapters provide details on the procedure for deriving and solving FEM equations and the application of FEM to various areas of engineering, including solid and structural mechanics, heat transfer and fluid mechanics. By commencing each chapter with an introduction and finishing with a set of problems, the author provides an invaluable aid to explaining and understanding FEM, for both the student and the practising engineer.

Finite Element Modeling Methods for Photonics

The first book applying HBFEM to practical electronic nonlinear field and circuit problems • Examines and solves wide aspects of practical electrical and electronic nonlinear field and circuit problems presented by HBFEM • Combines the latest research work with essential background knowledge, providing an all-encompassing reference for researchers, power engineers and students of applied electromagnetics analysis • There are very few books dealing with the solution of nonlinear electric- power-related problems • The contents are based on the authors' many years' research and industry experience; they approach the subject in a well-designed and logical way • It is expected that HBFEM will become a more useful and practical technique over the next 5 years due to the HVDC power system, renewable energy system and

Smart Grid, HF magnetic used in DC/DC converter,
and Multi-pulse transformer for HVDC power supply •
HBFEM can provide effective and economic solutions
to R&D product development • Includes Matlab
exercises

Introduction to the Finite Element Method in Electromagnetics

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: Introduction / 1D FDTD Modeling of the Transmission Line Equations / Yee Algorithm for Maxwell's Equations / Source Excitations / Absorbing Boundary Conditions / The Perfectly Matched Layer (PML) Absorbing Medium / Subcell Modeling / Post Processing

The Finite Element Method in Electromagnetics

The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations is a collection of papers presented at the 1972 Symposium by the same title, held at the University of Maryland, Baltimore County Campus. This symposium relates considerable numerical analysis involved in research in both theoretical and practical aspects of the finite element method. This text is organized into three parts encompassing 34 chapters. Part I focuses on the mathematical foundations of the finite element method, including papers on theory of approximation, variational principles, the problems of perturbations, and the eigenvalue problem. Part II covers a large number of important results of both a theoretical and a practical nature. This part discusses the piecewise analytic interpolation and approximation of triangulated polygons; the Patch test for convergence of finite elements; solutions for Dirichlet problems; variational crimes in the field; and superconvergence result for

the approximate solution of the heat equation by a collocation method. Part III explores the many practical aspects of finite element method. This book will be of great value to mathematicians, engineers, and physicists.

Harmonic Balance Finite Element Method

The finite-difference time-domain (FDTD) 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.

Introduction to the Finite-difference Time-domain (FDTD) Method for Electromagnetics

The Most Complete, Up-to-Date Coverage of the Finite Element Analysis and Modeling of Antennas and Arrays Aimed at researchers as well as practical engineers—and packed with over 200 illustrations including twenty-two color plates—Finite Element Analysis of Antennas and Arrays presents: Time- and frequency-domain formulations and mesh truncation techniques Antenna source modeling and parameter

calculation Modeling of complex materials and fine geometrical details Analysis and modeling of narrowband and broadband antennas Analysis and modeling of infinite and finite phased-array antennas Analysis and modeling of antenna and platform interactions Recognizing the strengths of other numerical methods, this book goes beyond the finite element method and covers hybrid techniques that combine the finite element method with the finite difference time-domain method, the method of moments, and the high-frequency asymptotic methods to efficiently deal with a variety of complex antenna problems. Complemented with numerous examples, this cutting-edge resource fully demonstrates the power and capabilities of the finite element analysis and its many practical applications.

Time Domain Finite Element Method for Linear and Nonlinear Models in Electromagnetics and Optics

Finite Element and Discontinuous Galerkin Methods for Transient Wave Equations

Time Domain Electromagnetics deals with a specific technique in electromagnetics within the general area of electrical engineering. This mathematical method has become a standard for a wide variety of applications for design and problem solving. This method of analysis in electromagnetics is directly related to advances in cellular and mobile

communications technology, as well as traditional EM areas such as radar, antennas, and wave propagation. Most of the material is available in the research journals which is difficult for a non-specialist to locate, read, understand, and effectively use for the problem at hand. Only book currently available to practicing engineers and research scientists exclusively devoted to this subject Includes contributions by the world's leading experts in electromagnetics Presents the most popular methods used in time domain analysis are included at one place with thorough discussion of the methods in an easily understandable style In each chapter, many simple and practical examples are discussed thoroughly to illustrate the salient points of the material presented All chapters are written in a consistent style that allows the book to be of use for self-study by professionals as well as for use in a graduate-level course in electrical engineering

The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations

Higher-Order Finite Element Methods

Shelving Guide: Electrical Engineering Since the 1980s more than 100 books on the finite element method have been published, making this numerical method the most popular. The features of the finite element method gained worldwide popularity due to its flexibility for simulating not only any kind of physical phenomenon described by a set of

differential equations, but also for the possibility of simulating non-linearity and time-dependent studies. Although a number of high-quality books cover all subjects in engineering problems, none of them seem to make this method simpler and easier to understand. This book was written with the goal of simplifying the mathematics of the finite element method for electromagnetic students and professionals relying on the finite element method for solving design problems. Filling a gap in existing literature that often uses complex mathematical formulas, *Electromagnetics through the Finite Element Method* presents a new mathematical approach based on only direct integration of Maxwell's equation. This book makes an original, scholarly contribution to our current understanding of this important numerical method.

Time-domain Finite Elements in Optimal Control with Application to Launch-vehicle Guidance

Generating a quality finite element mesh is difficult and often very time-consuming. Mesh-free methods operations can also be complicated and quite costly in terms of computational effort and resources.

Developed by the authors and their colleagues, the smoothed finite element method (S-FEM) only requires a triangular/tetrahedral mesh to achieve more accurate results, a generally higher convergence rate in energy without increasing computational cost, and easier auto-meshing of the problem domain. Drawing on the authors' extensive

research results, Smoothed Finite Element Methods presents the theoretical framework and development of various S-FEM models. After introducing background material, basic equations, and an abstracted version of the FEM, the book discusses the overall modeling procedure, fundamental theories, error assessment matters, and necessary building blocks to construct useful S-FEM models. It then focuses on several specific S-FEM models, including cell-based (CS-FEM), node-based (NS-FEM), edge-based (ES-FEM), face-based (FS-FEM), and a combination of FEM and NS-FEM (α FEM). These models are then applied to a wide range of physical problems in solid mechanics, fracture mechanics, viscoelastoplasticity, plates, piezoelectric structures, heat transfer, and structural acoustics. Requiring no previous knowledge of FEM, this book shows how computational methods and numerical techniques like the S-FEM help in the design and analysis of advanced engineering systems in rapid and cost-effective ways since the modeling and simulation can be performed automatically in a virtual environment without physically building the system. Readers can easily apply the methods presented in the text to their own engineering problems for reliable and certified solutions.

The Finite Element Method in Engineering

The emphasis is on finite element methods for scattering problems that involve the solution of Maxwell's equations on infinite domains. Suitable

variational formulations are developed and justified mathematically. An error analysis of edge finite element methods that are particularly well suited to Maxwell's equations is the main focus of the book.

Frequency Domain Hybrid Finite Element Methods for Electromagnetics

The Sixth Edition of this influential best-selling book delivers the most up-to-date and comprehensive text and reference yet on the basis of the finite element method (FEM) for all engineers and mathematicians. Since the appearance of the first edition 38 years ago, The Finite Element Method provides arguably the most authoritative introductory text to the method, covering the latest developments and approaches in this dynamic subject, and is amply supplemented by exercises, worked solutions and computer algorithms.

- The classic FEM text, written by the subject's leading authors
- Enhancements include more worked examples and exercises
- With a new chapter on automatic mesh generation and added materials on shape function development and the use of higher order elements in solving elasticity and field problems

Active research has shaped The Finite Element Method into the pre-eminent tool for the modelling of physical systems. It maintains the comprehensive style of earlier editions, while presenting the systematic development for the solution of problems modelled by linear differential equations. Together with the second and third self-contained volumes (0750663219 and 0750663227), The Finite Element Method Set (0750664312) provides a formidable

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resource covering the theory and the application of FEM, including the basis of the method, its application to advanced solid and structural mechanics and to computational fluid dynamics. The classic introduction to the finite element method, by two of the subject's leading authors Any professional or student of engineering involved in understanding the computational modelling of physical systems will inevitably use the techniques in this key text

Moving Finite Element Method

Introduces the theory and applications of the extended finite element method (XFEM) in the linear and nonlinear problems of continua, structures and geomechanics Explores the concept of partition of unity, various enrichment functions, and fundamentals of XFEM formulation. Covers numerous applications of XFEM including fracture mechanics, large deformation, plasticity, multiphase flow, hydraulic fracturing and contact problems Accompanied by a website hosting source code and examples

Smoothed Finite Element Methods

The purpose of this book is to provide an up-to-date introduction to the time-domain finite element methods for Maxwell's equations involving metamaterials. Since the first successful construction of a metamaterial with both negative permittivity and permeability in 2000, the study of metamaterials has attracted significant attention from researchers

across many disciplines. Thanks to enormous efforts on the part of engineers and physicists, metamaterials present great potential applications in antenna and radar design, sub-wavelength imaging, and invisibility cloak design. Hence the efficient simulation of electromagnetic phenomena in metamaterials has become a very important issue and is the subject of this book, in which various metamaterial modeling equations are introduced and justified mathematically. The development and practical implementation of edge finite element methods for metamaterial Maxwell's equations are the main focus of the book. The book finishes with some interesting simulations such as backward wave propagation and time-domain cloaking with metamaterials.

A Time Domain Vector Finite Element Method for the Full Wave Simulation of Nonlinear Photonic Devices

The International Applied Computational Electromagnetics Society Symposium serves as a forum for developers, analysts, and users of computational techniques applied to electromagnetic field problems for all frequency ranges

Finite Element and Finite Difference Methods in Electromagnetic Scattering

The sixth editions of these seminal books deliver the most up to date and comprehensive reference yet on the finite element method for all engineers and

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mathematicians. Renowned for their scope, range and authority, the new editions have been significantly developed in terms of both contents and scope. Each book is now complete in its own right and provides self-contained reference; used together they provide a formidable resource covering the theory and the application of the universally used FEM. Written by the leading professors in their fields, the three books cover the basis of the method, its application to solid mechanics and to fluid dynamics. * This is THE classic finite element method set, by two the subject's leading authors * FEM is a constantly developing subject, and any professional or student of engineering involved in understanding the computational modelling of physical systems will inevitably use the techniques in these books * Fully up-to-date; ideal for teaching and reference

Automated Solution of Differential Equations by the Finite Element Method

The emphasis in on finite element methods for scattering problems that involve the solution of Maxwell's equations on infinite domains. Suitable variational formulations are developed and justified mathematically. An error analysis of edge finite element methods that are particularly well suited to Maxwell's equations is the main focus of the book.

Finite Element Methods for Maxwell's Equations

This monograph presents numerical methods for

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solving transient wave equations (i.e. in time domain). More precisely, it provides an overview of continuous and discontinuous finite element methods for these equations, including their implementation in physical models, an extensive description of 2D and 3D elements with different shapes, such as prisms or pyramids, an analysis of the accuracy of the methods and the study of the Maxwell's system and the important problem of its spurious free approximations. After recalling the classical models, i.e. acoustics, linear elastodynamics and electromagnetism and their variational formulations, the authors present a wide variety of finite elements of different shapes useful for the numerical resolution of wave equations. Then, they focus on the construction of efficient continuous and discontinuous Galerkin methods and study their accuracy by plane wave techniques and a priori error estimates. A chapter is devoted to the Maxwell's system and the important problem of its spurious-free approximations. Treatment of unbounded domains by Absorbing Boundary Conditions (ABC) and Perfectly Matched Layers (PML) is described and analyzed in a separate chapter. The two last chapters deal with time approximation including local time-stepping and with the study of some complex models, i.e. acoustics in flow, gravity waves and vibrating thin plates. Throughout, emphasis is put on the accuracy and computational efficiency of the methods, with attention brought to their practical aspects. This monograph also covers in details the theoretical foundations and numerical analysis of these methods. As a result, this monograph will be of interest to practitioners, researchers, engineers and graduate

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

The objective of this two-volume book is the systematic and comprehensive description of the most competitive time-domain computational methods for the efficient modeling and accurate solution of contemporary real-world EMC problems. Intended to be self-contained, it performs a detailed presentation of all well-known algorithms, elucidating on their merits or weaknesses, and accompanies the theoretical content with a variety of applications. Outlining the present volume, the analysis covers the theory of the finite-difference time-domain, the transmission-line matrix/modeling, and the finite integration technique. Moreover, alternative schemes, such as the finite-element, the finite-volume, the multiresolution time-domain methods and many others, are presented, while particular attention is drawn to hybrid approaches. To this aim, the general aspects for the correct implementation of the previous algorithms are also exemplified. At the end of every section, an elaborate reference on the prominent pros and possible cons, always in the light of EMC modeling, assists the reader to retrieve the gist of each formulation and decide on his/her best possible selection according to the problem under investigation.

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**The Mathematical Theory of Finite
Element Methods**

A new edition of the leading textbook on the finite element method, incorporating major advancements and further applications in the field of electromagnetics The finite element method (FEM) is a powerful simulation technique used to solve boundary-value problems in a variety of engineering circumstances. It has been widely used for analysis of electromagnetic fields in antennas, radar scattering, RF and microwave engineering, high-speed/high-frequency circuits, wireless communication, electromagnetic compatibility, photonics, remote sensing, biomedical engineering, and space exploration. The Finite Element Method in Electromagnetics, Third Edition explains the method's processes and techniques in careful, meticulous prose and covers not only essential finite element method theory, but also its latest developments and applications—giving engineers a methodical way to quickly master this very powerful numerical technique for solving practical, often complicated, electromagnetic problems. Featuring over thirty percent new material, the third edition of this essential and comprehensive text now includes: A wider range of applications, including antennas, phased arrays, electric machines, high-frequency circuits, and crystal photonics The finite element analysis of wave propagation, scattering, and radiation in periodic structures The time-domain finite element method for analysis of wideband antennas and transient electromagnetic phenomena Novel

domain decomposition techniques for parallel computation and efficient simulation of large-scale problems, such as phased-array antennas and photonic crystals Along with a great many examples, The Finite Element Method in Electromagnetics is an ideal book for engineering students as well as for professionals in the field.

Finite Element Analysis of Antennas and Arrays

The finite element method has always been a mainstay for solving engineering problems numerically. The most recent developments in the field clearly indicate that its future lies in higher-order methods, particularly in higher-order hp-adaptive schemes. These techniques respond well to the increasing complexity of engineering simulations and

Extended Finite Element Method

This lecture is written primarily for the non-expert engineer or the undergraduate or graduate student who wants to learn, for the first time, the finite element method with applications to electromagnetics. It is also designed for research engineers who have knowledge of other numerical techniques and want to familiarize themselves with the finite element method. Finite element method is a numerical method used to solve boundary-value problems characterized by a partial differential equation and a set of boundary conditions. Author Anastasis Polycarpou provides the reader with all

information necessary to successfully apply the finite element method to one- and two-dimensional boundary-value problems in electromagnetics. The book is accompanied by a number of codes written by the author in Matlab. These are the finite element codes that were used to generate most of the graphs presented in this book. Specifically, there are three Matlab codes for the one-dimensional case (Chapter 1) and two Matlab codes for the two-dimensional case (Chapter 2). The reader may execute these codes, modify certain parameters such as mesh size or object dimensions, and visualize the results. The codes are available on the Morgan & Claypool Web site at <http://www.morganclaypool.com>.

Spectral Finite Element Method

The term photonics can be used loosely to refer to a vast array of components, devices, and technologies that in some way involve manipulation of light. One of the most powerful numerical approaches available to engineers developing photonic components and devices is the Finite Element Method (FEM), which can be used to model and simulate such components/devices and analyze how they will behave in response to various outside influences. This resource provides a comprehensive description of the formulation and applications of FEM in photonics applications ranging from telecommunications, astronomy, and sensing, to chemistry, imaging, and biomedical R&D. This book emphasizes practical, problem-solving applications and includes real-world examples to assist readers in understanding how

mathematical concepts translate to computer code for finite element-based methods applicable to a range of photonic structures. In addition, this is the perfect support to anyone using the COMSOL Multiphysics© RF Module.

Time Domain Electromagnetics

The Finite Difference Time Domain Method for Electromagnetics

This book is a tutorial written by researchers and developers behind the FEniCS Project and explores an advanced, expressive approach to the development of mathematical software. The presentation spans mathematical background, software design and the use of FEniCS in applications. Theoretical aspects are complemented with computer code which is available as free/open source software. The book begins with a special introductory tutorial for beginners. Following are chapters in Part I addressing fundamental aspects of the approach to automating the creation of finite element solvers. Chapters in Part II address the design and implementation of the FEniCS software. Chapters in Part III present the application of FEniCS to a wide range of applications, including fluid flow, solid mechanics, electromagnetics and geophysics.

The Finite Element Method: Theory, Implementation, and Applications

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Time-Domain Finite Element Methods for Maxwell's Equations in Metamaterials

The Most Complete, Up-to-Date Coverage of the Finite Element Analysis and Modeling of Antennas and Arrays Aimed at researchers as well as practical engineers—and packed with over 200 illustrations including twenty-two color plates—Finite Element Analysis of Antennas and Arrays presents: Time- and frequency-domain formulations and mesh truncation techniques Antenna source modeling and parameter calculation Modeling of complex materials and fine geometrical details Analysis and modeling of narrowband and broadband antennas Analysis and modeling of infinite and finite phased-array antennas Analysis and modeling of antenna and platform interactions Recognizing the strengths of other numerical methods, this book goes beyond the finite element method and covers hybrid techniques that combine the finite element method with the finite difference time-domain method, the method of moments, and the high-frequency asymptotic methods to efficiently deal with a variety of complex antenna problems. Complemented with numerous examples, this cutting-edge resource fully demonstrates the power and capabilities of the finite element analysis and its many practical applications.

Finite Element Procedures

This second volume in the Progress in Electromagnetic Research series examines recent advances in computational electromagnetics, with

emphasis on scattering, as brought about by new formulations and algorithms which use finite element or finite difference techniques. Containing contributions by some of the world's leading experts, the papers thoroughly review and analyze this rapidly evolving area of computational electromagnetics. Covering topics ranging from the new finite-element based formulation for representing time-harmonic vector fields in 3-D inhomogeneous media using two coupled scalar potentials, to the consideration of conforming boundary elements and leap-frog time-marching in transient field problems involving corners and wedges in two and three dimensions, the volume will provide an indispensable reference source for practitioners and students of computational electromagnetics.

Parallel Finite-difference Time-domain Method

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.

Finite Element Methods for Maxwell's Equations

A rigorous and thorough mathematical introduction to the subject; A clear and concise treatment of modern fast solution techniques such as multigrid and domain decomposition algorithms; Second edition contains two new chapters, as well as many new exercises; Previous edition sold over 3000 copies worldwide

finite element methods

This book focuses on process simulation in chemical engineering with a numerical algorithm based on the moving finite element method (MFEM). It offers new tools and approaches for modeling and simulating time-dependent problems with moving fronts and with moving boundaries described by time-dependent convection-reaction-diffusion partial differential

equations in one or two-dimensional space domains. It provides a comprehensive account of the development of the moving finite element method, describing and analyzing the theoretical and practical aspects of the MFEM for models in 1D, 1D+1d, and 2D space domains. Mathematical models are universal, and the book reviews successful applications of MFEM to solve engineering problems. It covers a broad range of application algorithm to engineering problems, namely on separation and reaction processes presenting and discussing relevant numerical applications of the moving finite element method derived from real-world process simulations.

Matrix Algorithms Volume 2

This book serves as a practical guide to simulation of 3D deformable solids using the Finite Element Method (FEM). It reviews a number of topics related to the theory and implementation of FEM approaches: measures of deformation, constitutive laws of nonlinear materials, tetrahedral discretizations, and model reduction techniques for real-time simulation. Simulations of deformable solids are important in many applications in computer graphics, including film special effects, computer games, and virtual surgery. The Finite Element Method has become a popular tool in many such applications. Variants of FEM catering to both offline and real-time simulation have had a mature presence in computer graphics literature. This book is designed for readers familiar with numerical simulation in computer graphics, who would like to obtain a cohesive picture of the various

FEM simulation methods available, their strengths and weaknesses, and their applicability in various simulation scenarios. The book is also a practical implementation guide for the visual effects developer, offering a lean yet adequate synopsis of the underlying mathematical theory. Chapter 1 introduces the quantitative descriptions used to capture the deformation of elastic solids, the concept of strain energy, and discusses how force and stress result as a response to deformation. Chapter 2 reviews a number of constitutive models, i.e., analytical laws linking deformation to the resulting force that has successfully been used in various graphics-oriented simulation tasks. Chapter 3 summarizes how deformation and force can be computed discretely on a tetrahedral mesh, and how an implicit integrator can be structured around this discretization. Finally, chapter 4 presents the state of the art in model reduction techniques for real-time FEM solid simulation and discusses which techniques are suitable for which applications. Topics discussed in this chapter include linear modal analysis, modal warping, subspace simulation, and domain decomposition.

The Finite Element Method: Its Basis and Fundamentals

These proceedings originated from a conference commemorating the 50th anniversary of the publication of Richard Courant's seminal paper, Variational Methods for Problems of Equilibrium and Vibration. These papers address fundamental

questions in numerical analysis and the special problems that occur in applying the finite element method to various fields of science and engineering.

Computational Acoustics of Noise Propagation in Fluids - Finite and Boundary Element Methods

This book is the first to apply the Spectral Finite Element Method (SFEM) to inhomogeneous and anisotropic structures in a unified and systematic manner. Readers will gain understanding of how to formulate Spectral Finite Element; learn about wave behaviour in inhomogeneous and anisotropic media; and, be able to design some diagnostic tools for monitoring the health of a structure. Tables, figures and graphs support the theory and case studies are included.

Finite Element Method Simulation of 3D Deformable Solids

This book provides a brief overview of the popular Finite Element Method (FEM) and its hybrid versions for electromagnetics with applications to radar scattering, antennas and arrays, guided structures, microwave components, frequency selective surfaces, periodic media, and RF materials characterizations and related topics. It starts by presenting concepts based on Hilbert and Sobolev spaces as well as Curl and Divergence spaces for generating matrices, useful in all engineering simulation methods. It then proceeds to present applications of the finite element

and finite element-boundary integral methods for scattering and radiation. Applications to periodic media, metamaterials and bandgap structures are also included. The hybrid volume integral equation method for high contrast dielectrics and is presented for the first time. Another unique feature of the book is the inclusion of design optimization techniques and their integration within commercial numerical analysis packages for shape and material design. To aid the reader with the method's utility, an entire chapter is devoted to two-dimensional problems. The book can be considered as an update on the latest developments since the publication of our earlier book (Finite Element Method for Electromagnetics, IEEE Press, 1998). The latter is certainly complementary companion to this one.

The Finite Element Method Set

This book introduces the powerful Finite-Difference Time-Domain method to students and interested researchers and readers. An effective introduction is accomplished using a step-by-step process that builds competence and confidence in developing complete working codes for the design and analysis of various antennas and microwave devices. This book will serve graduate students, researchers, and those in industry and government who are using other electromagnetics tools and methods for the sake of performing independent numerical confirmation. No previous experience with finite-difference methods is assumed of readers. Key features Presents the fundamental techniques of the FDTD method at a

graduate level, taking readers from conceptual understanding to actual program development. Full derivations are provided for final equations. Includes 3D illustrations to aid in visualization of field components and fully functional MATLAB® code examples. Completely revised and updated for this second edition, including expansion into advanced techniques such as total field/scattered field formulation, dispersive material modeling, analysis of periodic structures, non-uniform grid, and graphics processing unit acceleration of finite-difference time-domain method.

2020 International Applied Computational Electromagnetics Society Symposium (ACES)

This is the second volume in a projected five-volume survey of numerical linear algebra and matrix algorithms. It treats the numerical solution of dense and large-scale eigenvalue problems with an emphasis on algorithms and the theoretical background required to understand them. The notes and reference sections contain pointers to other methods along with historical comments. The book is divided into two parts: dense eigenproblems and large eigenproblems. The first part gives a full treatment of the widely used QR algorithm, which is then applied to the solution of generalized eigenproblems and the computation of the singular value decomposition. The second part treats Krylov sequence methods such as the Lanczos and Arnoldi algorithms and presents a new treatment of the

Jacobi-Davidson method. These volumes are not intended to be encyclopedic, but provide the reader with the theoretical and practical background to read the research literature and implement or modify new algorithms.

Finite Element Analysis of Antennas and Arrays

The book provides a survey of numerical methods for acoustics, namely the finite element method (FEM) and the boundary element method (BEM). It is the first book summarizing FEM and BEM (and optimization) for acoustics. The book shows that both methods can be effectively used for many other cases, FEM even for open domains and BEM for closed ones. Emphasis of the book is put on numerical aspects and on treatment of the exterior problem in acoustics, i.e. noise radiation.

Modern EMC Analysis Techniques

This book gives an introduction to the finite element method as a general computational method for solving partial differential equations approximately. Our approach is mathematical in nature with a strong focus on the underlying mathematical principles, such as approximation properties of piecewise polynomial spaces, and variational formulations of partial differential equations, but with a minimum level of advanced mathematical machinery from functional analysis and partial differential equations. In principle, the material should be accessible to students with

only knowledge of calculus of several variables, basic partial differential equations, and linear algebra, as the necessary concepts from more advanced analysis are introduced when needed. Throughout the text we emphasize implementation of the involved algorithms, and have therefore mixed mathematical theory with concrete computer code using the numerical software MATLAB is and its PDE-Toolbox. We have also had the ambition to cover some of the most important applications of finite elements and the basic finite element methods developed for those applications, including diffusion and transport phenomena, solid and fluid mechanics, and also electromagnetics.

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