Finite Element Method for Electromagnetics

ANTENNAS, MICROWAVE CIRCUITS, AND SCATTERING APPLICATIONS

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Finite Elements For Wave Electromagnetics Methods And Techniques

Yu Zhu,Andreas C. Cangellaris

Finite Elements For Wave Electromagnetics Methods And Techniques:

Finite Elements for Wave Electromagnetics IEEE Antennas and Propagation Society,1994   *Finite Element Method Electromagnetics* John L. Volakis,Arindam Chatterjee,Leo C. Kempel,1998-06-15 Employed in a large number of commercial electromagnetic simulation packages the finite element method is one of the most popular and well established numerical techniques in engineering This book covers the theory development implementation and application of the finite element method and its hybrid versions to electromagnetics FINITE ELEMENT METHOD FOR ELECTROMAGNETICS begins with a step by step textbook presentation of the finite method and its variations then goes on to provide up to date coverage of three dimensional formulations and modern applications to open and closed domain problems Worked out examples are included to aid the reader with the fine features of the method and the implementation of its hybridization with other techniques for a robust simulation of large scale radiation and scattering The crucial treatment of local boundary conditions is carefully worked out in several stages in the book Sponsored by IEEE Antennas and Propagation Society   *Quick Finite Elements for Electromagnetic Waves* Giuseppe Pelosi,Roberto Coccioli,Stefano Selleri,2009 The classic 1998 Artech House book Quick Finite Elements for Electromagnetic Waves has now been revised and expanded to bring you up to date with the latest developments in the Field You find brand new discussions on finite elements in 3D 3D resonant cavities and 3D waveguide devices Moreover the second edition supplies you with MATLAB code making this resource easier to comprehend and use for your projects in the field This practical book and accompanying software enables you to quickly and easily work out challenging microwave engineering and high frequency electromagnetic problems using the finite element method FEM Using clear concise text and dozens of real world application examples the book provides a detailed description of FEM implementation while the software provides the code and tools needed to solve the three major types of EM problems guided propagation scattering and radiation With this unique book and software set in hand you can compute the dispersion diagram of arbitrarily shaped inhomogeneous isotropic lossless or lossy guiding structures analyze E and H plane waveguide discontinuities and devices and understand the reflection from and transmission through simple 2D and 3D inhomogeneous periodic structures CD ROM Included Easy to use finite element software contains ready made MATLAB and FORTRAN source code that you can use immediately to solve a wide range of microwave and EM problems The package is fully compatible with Internet freeware so you can perform advanced engineering functions without having to purchase expensive pre and post processing tools   The Finite Element Method in Electromagnetics Jian-Ming Jin,2014-03-31 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 *The Finite Element Method in Electromagnetics* Jian-Ming Jin,2015-02-18 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

Multigrid Finite Element Methods for Electromagnetic Field Modeling Yu Zhu,Andreas C. Cangellaris,2006-02-17 This is the first comprehensive monograph that features state of the art multigrid methods for enhancing the modeling versatility numerical robustness and computational efficiency of one of the most popular classes of numerical electromagnetic field modeling methods the method of finite elements The focus of the publication is the development of robust preconditioners for

the iterative solution of electromagnetic field boundary value problems BVPs discretized by means of finite methods Specifically the authors set forth their own successful attempts to utilize concepts from multigrid and multilevel methods for the effective preconditioning of matrices resulting from the approximation of electromagnetic BVPs using finite methods Following the authors careful explanations and step by step instruction readers can duplicate the authors results and take advantage of today s state of the art multigrid multilevel preconditioners for finite element based iterative electromagnetic field solvers Among the highlights of coverage are Application of multigrid multilevel and hybrid multigrid multilevel preconditioners to electromagnetic scattering and radiation problems Broadband robust numerical modeling of passive microwave components and circuits Robust finite element based modal analysis of electromagnetic waveguides and cavities Application of Krylov subspace based methodologies for reduced order macromodeling of electromagnetic devices and systems Finite element modeling of electromagnetic waves in periodic structures The authors provide more than thirty detailed algorithms alongside pseudo codes to assist readers with practical computer implementation In addition each chapter includes an applications section with helpful numerical examples that validate the authors methodologies and demonstrate their computational efficiency and robustness This groundbreaking book with its coverage of an exciting new enabling computer aided design technology is an essential reference for computer programmers designers and engineers as well as graduate students in engineering and applied physics **Analytical and Computational Methods in Electromagnetics** Ramesh Garg,2008 This authoritative resource offers you clear and complete explanation of this essential electromagnetics knowledge providing you with the analytical background you need to understand such key approaches as MoM method of moments FDTD Finite Difference Time Domain and FEM Finite Element Method and Green s functions This comprehensive book includes all math necessary to master the material **The Finite Element Method in Charged Particle Optics** Anjam Khursheed,2012-12-06 In the span of only a few decades the finite element method has become an important numerical technique for solving problems in the subject of charged particle optics The situation has now developed up to the point where finite element simulation software is sold commercially and routinely used in industry The introduction of the finite element method in charged particle optics came by way of a PHD thesis written by Eric Munro at the University of Cambridge England in 1971 1 shortly after the first papers appeared on its use to solve Electrical Engineering problems in the late sixties Although many papers on the use of the finite element method in charged particle optics have been published since Munro s pioneering work its development in this area has not as yet appeared in any textbook This fact must be understood within a broader context The first textbook on the finite element method in Electrical Engineering was published in 1983 2 At present there are only a handful of other books that describe it in relation to Electrical Engineering topics 3 let alone charged particle optics This is but a tiny fraction of the books dedicated to the finite element method in other subjects such as Civil Engineering The motivation to write this book comes from the need to redress this imbalance There is also

another important reason for writing this book   **Numerical Techniques in Electromagnetics, Second Edition** Matthew N.O. Sadiku,2000-07-12 As the availability of powerful computer resources has grown over the last three decades the art of computation of electromagnetic EM problems has also grown exponentially Despite this dramatic growth however the EM community lacked a comprehensive text on the computational techniques used to solve EM problems The first edition of Numerical Techniques in Electromagnetics filled that gap and became the reference of choice for thousands of engineers researchers and students The Second Edition of this bestselling text reflects the continuing increase in awareness and use of numerical techniques and incorporates advances and refinements made in recent years Most notable among these are the improvements made to the standard algorithm for the finite difference time domain FDTD method and treatment of absorbing boundary conditions in FDTD finite element and transmission line matrix methods The author also added a chapter on the method of lines Numerical Techniques in Electromagnetics continues to teach readers how to pose numerically analyze and solve EM problems give them the ability to expand their problem solving skills using a variety of methods and prepare them for research in electromagnetism Now the Second Edition goes even further toward providing a comprehensive resource that addresses all of the most useful computation methods for EM problems   **Electromagnetics through the Finite Element Method** José Roberto Cardoso,2016-10-03 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   **Finite Element and Finite Difference Methods in Electromagnetic Scattering** M.A. Morgan,2013-10-22 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 *MATLAB-based Finite Element Programming in Electromagnetic Modeling* Özlem Özgün,Mustafa Kuzuoğlu,2018-09-03 This book is a self contained programming oriented and learner centered book on finite element method FEM with special emphasis given to developing MATLAB programs for numerical modeling of electromagnetic boundary value problems It provides a deep understanding and intuition of FEM programming by means of step by step MATLAB programs with detailed descriptions and eventually enabling the readers to modify adapt and apply the provided programs and formulations to develop FEM codes for similar problems through various exercises It starts with simple one dimensional static and time harmonic problems and extends the developed theory to more complex two or three dimensional problems It supplies sufficient theoretical background on the topic and it thoroughly covers all phases pre processing main body and post processing in FEM FEM formulations are obtained for boundary value problems governed by a partial differential equation that is expressed in terms of a generic unknown function and then these formulations are specialized to various electromagnetic applications together with a post processing phase Since the method is mostly described in a general context readers from other disciplines can also use this book and easily adapt the provided codes to their engineering problems After forming a solid background on the fundamentals of FEM by means of canonical problems readers are guided to more advanced applications of FEM in electromagnetics through a survey chapter at the end of the book Offers a self contained and easy to understand introduction to the theory and programming of finite element method Covers various applications in the field of static and time harmonic electromagnetics Includes one two and three dimensional finite element codes in MATLAB Enables readers to develop finite element programming skills through various MATLAB codes and exercises Promotes self directed learning skills and provides an effective instruction tool Advances in Time-Domain Computational Electromagnetic Methods Qiang Ren,Su Yan,Atef Z. Elsherbeni,2022-11-15 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 **Computational Electromagnetics for RF and Microwave Engineering** David B. Davidson,2005-02-24 The numerical approximation of Maxwell s equations Computational Electromagnetics CEM has emerged as a crucial enabling technology for radio frequency microwave and wireless engineering The three most popular full wave methods the Finite Difference Time Domain Method the Method of Moments and the Finite Element Method are introduced in this book by way of one or two dimensional problems Commercial or public domain codes implementing these methods are then applied to complex real world engineering problems and a careful analysis of the reliability of the results obtained is performed along with a discussion of the many pitfalls which can result in inaccurate and misleading solutions The book will empower readers to become discerning users of CEM software with an understanding of the underlying methods and confidence in the results obtained It also introduces readers to the art of code development Aimed at senior undergraduate graduate students taking CEM courses and practising engineers in the industry Mathematical and Numerical Approaches for Multi-Wave Inverse Problems Larisa Beilina,Maïtine Bergounioux,Michel Cristofol,Anabela Da Silva,Amelie Litman,2020-06-30 This proceedings volume gathers peer reviewed selected papers presented at the Mathematical and Numerical Approaches for Multi Wave Inverse Problems conference at the Centre Internacional de Rencontres Math matiques CIRM in Marseille France in April 2019 It brings the latest research into new reliable theoretical approaches and numerical techniques for solving nonlinear and inverse problems arising in multi wave and hybrid systems Multi wave inverse problems have a wide range of applications in acoustics electromagnetics optics medical imaging and geophysics to name but a few In turn it is well known that inverse problems are both nonlinear and ill posed two factors that pose major challenges for the development of new numerical methods for solving these problems which are discussed in detail These papers will be of interest to all researchers and graduate students working in the fields of nonlinear and inverse problems and its applications Theory and Computation of Electromagnetic Fields Jian-Ming Jin,2015-08-26 Reviews the fundamental concepts behind the theory and computation of electromagnetic fields The book is divided in two parts The first part covers both fundamental theories such as vector analysis Maxwell s equations boundary condition and transmission line

theory and advanced topics such as wave transformation addition theorems and fields in layered media in order to benefit students at all levels The second part of the book covers the major computational methods for numerical analysis of electromagnetic fields for engineering applications These methods include the three fundamental approaches for numerical analysis of electromagnetic fields the finite difference method the finite difference time domain method in particular the finite element method and the integral equation based moment method The second part also examines fast algorithms for solving integral equations and hybrid techniques that combine different numerical methods to seek more efficient solutions of complicated electromagnetic problems Theory and Computation of Electromagnetic Fields Second Edition Provides the foundation necessary for graduate students to learn and understand more advanced topics Discusses electromagnetic analysis in rectangular cylindrical and spherical coordinates Covers computational electromagnetics in both frequency and time domains Includes new and updated homework problems and examples Theory and Computation of Electromagnetic Fields Second Edition is written for advanced undergraduate and graduate level electrical engineering students This book can also be used as a reference for professional engineers interested in learning about analysis and computation skills

Numerical Techniques in Electromagnetics with MATLAB Matthew N.O. Sadiku,2018-10-08 Despite the dramatic growth in the availability of powerful computer resources the EM community lacks a comprehensive text on the computational techniques used to solve EM problems The first edition of Numerical Techniques in Electromagnetics filled that gap and became the reference of choice for thousands of engineers researchers and students This third edition of the bestselling text reflects the continuing increase in awareness and use of numerical techniques and incorporates advances and refinements made in recent years Most notable among these are the improvements made to the standard algorithm for the finite difference time domain FDTD method and treatment of absorbing boundary conditions in FDTD finite element and transmission line matrix methods The author also has added a chapter on the method of lines Numerical Techniques in Electromagnetics with MATLAB Third Edition continues to teach readers how to pose numerically analyze and solve EM problems to give them the ability to expand their problem solving skills using a variety of methods and to prepare them for research in electromagnetism Now the Third Edition goes even further toward providing a comprehensive resource that addresses all of the most useful computation methods for EM problems and includes MATLAB code instead of FORTRAN

The Nystrom Method in Electromagnetics Mei Song Tong,Weng Cho Chew,2020-07-06 A comprehensive step by step reference to the Nystr m Method for solving Electromagnetic problems using integral equations Computational electromagnetics studies the numerical methods or techniques that solve electromagnetic problems by computer programming Currently there are mainly three numerical methods for electromagnetic problems the finite difference time domain FDTD finite element method FEM and integral equation methods IEMs In the IEMs the method of moments MoM is the most widely used method but much attention is being paid to the Nystr m method as another IEM because it possesses

some unique merits which the MoM lacks This book focuses on that method providing information on everything that students and professionals working in the field need to know Written by the top researchers in electromagnetics this complete reference book is a consolidation of advances made in the use of the Nystr m method for solving electromagnetic integral equations It begins by introducing the fundamentals of the electromagnetic theory and computational electromagnetics before proceeding to illustrate the advantages unique to the Nystr m method through rigorous worked out examples and equations Key topics include quadrature rules singularity treatment techniques applications to conducting and penetrable media multiphysics electromagnetic problems time domain integral equations inverse scattering problems and incorporation with multilevel fast multiple algorithm Systematically introduces the fundamental principles equations and advantages of the Nystr m method for solving electromagnetic problems Features the unique benefits of using the Nystr m method through numerical comparisons with other numerical and analytical methods Covers a broad range of application examples that will point the way for future research The Nystrom Method in Electromagnetics is ideal for graduate students senior undergraduates and researchers studying engineering electromagnetics computational methods and applied mathematics Practicing engineers and other industry professionals working in engineering electromagnetics and engineering mathematics will also find it to be incredibly helpful   Electromagnetic Fields in Mechatronics, Electrical and Electronic Engineering Andrzej Krawczyk,Sławomir Wiak,Xose M. Lopez-Fernandez,2006 More and more researchers engage into investigation of electromagnetic applications especially these connected with mechatronics information technologies medicine biology and material sciences It is readily seen when looking at the content of the book that computational techniques which were under development during the last three decades and are still being developed serve as good tools for discovering new electromagnetic phenomena It means that the field of computational electromagnetics belongs to an application area rather than to a research area This publication aims at joining theory and practice thus the majority of papers are deeply rooted in engineering problems being simultaneously of high theoretical level The editors hope to touch the heart of the matter in electromagnetism The book focuses on the following issues Computational Electromagnetics Electromagnetic Engineering Coupled Field and Special Applications Micro and Special Devices Bioelectromagnetics and Electromagnetic Hazard and Magnetic Material Modelling Abstracted in Inspec   Advanced Computational Electromagnetic Methods Wenhua Yu,Wenxing Li,Atef Elsherbeni,Yahya Rahmat-Samii,2015-03-01 This new resource covers the latest developments in computational electromagnetic methods with emphasis on cutting edge applications This book is designed to extend existing literature to the latest development in computational electromagnetic methods which are of interest to readers in both academic and industrial areas The topics include advanced techniques in MoM FEM and FDTD spectral domain method GPU and Phi hardware acceleration metamaterials frequency and time domain integral equations and statistics methods in bio electromagnetics

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