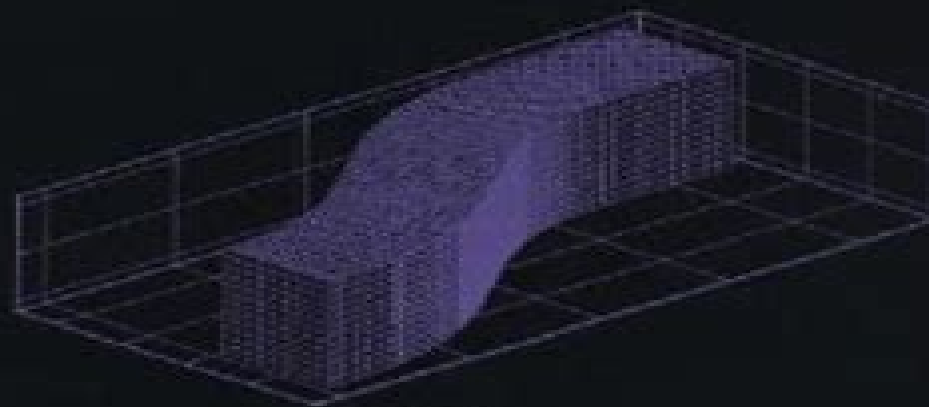


The Finite Element Method in Electromagnetics

SECOND EDITION

Jianming Jin



The Finite Element Method In Electromagnetics 2nd Edition

Matthew N.O. Sadiku



The Finite Element Method In Electromagnetics 2nd Edition:

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

Introduction to the Finite Element Method in Electromagnetics Anastasis C. Polycarpou, 2022-05-31 This series lecture is an introduction to the finite element method with applications in electromagnetics The finite element method is a numerical method that is used to solve boundary value problems characterized by a partial differential equation and a set of boundary conditions The geometrical domain of a boundary value problem is discretized using sub domain elements called the finite elements and the differential equation is applied to a single element after it is brought to a weak integro differential form A set of shape functions is used to represent the primary unknown variable in the element domain A set of linear equations is obtained for each element in the discretized domain A global matrix system is formed after the assembly of all elements This lecture is divided into two chapters Chapter 1 describes one dimensional boundary value problems with applications to electrostatic problems described by the Poisson equation The accuracy of the finite element method is evaluated for linear and higher order elements by computing the numerical error based on two different definitions Chapter 2 describes two dimensional boundary value problems in the areas of electrostatics and electrodynamics time harmonic problems For the second category an absorbing boundary condition was imposed at the exterior boundary to simulate undisturbed wave propagation toward infinity Computations of the numerical error were performed in order to evaluate the accuracy and effectiveness of the method in solving electromagnetic problems Both chapters are accompanied by a number of Matlab codes which can be used by the reader to solve one and two dimensional boundary value problems These codes can be downloaded from the publisher's URL www.morganclaypool.com/page/polycarpou This lecture is written primarily for the nonexpert 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 targeted for research engineers who have knowledge of other numerical techniques and want to familiarize themselves with the finite element method The lecture begins with the basics of the method including formulating a boundary value problem using a weighted residual method and the Galerkin approach and continues with imposing all three types of boundary conditions including absorbing boundary conditions Another important topic of emphasis is the development of shape functions including those of higher order In simple words this series lecture provides the reader with all information necessary for someone to apply successfully the finite element method to one and two dimensional boundary value problems in electromagnetics It is suitable for newcomers in the field of finite elements in electromagnetics

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

Multigrid Finite Element Methods for Electromagnetic Field Modeling Yu Zhu, Andreas C. Cangellaris, 2006-02-03 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

The Finite Element Method in Engineering Singiresu S. Rao, S. S. Rao, 2005 With the revolution in readily available computing power the finite element method has become one of the most important tools for the modern engineer This book offers a comprehensive introduction to the principles involved

Integral Methods in Low-Frequency Electromagnetics Pavel

Solin,Ivo Dolezel,Pavel Karban,Bohus Ulrych,2009-08-11 A modern presentation of integral methods in low frequency electromagnetics This book provides state of the art knowledge on integral methods in low frequency electromagnetics Blending theory with numerous examples it introduces key aspects of the integral methods used in engineering as a powerful alternative to PDE based models Readers will get complete coverage of The electromagnetic field and its basic characteristics An overview of solution methods Solutions of electromagnetic fields by integral expressions Integral and integrodifferential methods Indirect solutions of electromagnetic fields by the boundary element method Integral equations in the solution of selected coupled problems Numerical methods for integral equations All computations presented in the book are done by means of the authors own codes and a significant amount of their own results is included At the book s end they also discuss novel integral techniques of a higher order of accuracy which are representative of the future of this rapidly advancing field Integral Methods in Low Frequency Electromagnetics is of immense interest to members of the electrical engineering and applied mathematics communities ranging from graduate students and PhD candidates to researchers in academia and practitioners in industry *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 *Finite Element Analysis of Antennas and Arrays* Jian-Ming Jin,Douglas J. Riley,2009-02-23 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

Pulsed Electromagnetic Fields Ioan Ernest Lager, Li Jun Jiang, 2013 This book contains the contributions to the workshop Pulsed Electromagnetic Fields Their Potentialities Computation and Evaluation The papers included in this volume cover a very broad range from the physical and mathematical foundations up to operational systems making use of the potentialities arising from the use of pulsed electromagnetic fields In particular this volume offers a valuable overview of state of the art approaches in the computational modeling of pulsed electromagnetic fields in configurations that are representative for road mapping future developments This book is Open Access nbspIOS Press is an

Computational Electromagnetics with MATLAB, Fourth Edition Matthew N.O. Sadiku, 2018-07-20 This fourth edition of the text reflects the continuing increase in awareness and use of computational electromagnetics 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 It teaches the 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 Includes new homework problems in each chapter Each chapter is updated with the current trends in CEM Adds a new appendix on CEM codes which covers commercial and free codes Provides updated MATLAB code

Simulation-driven Design Optimization And Modeling For Microwave Engineering Qi-jun Zhang, 2013-03-14 Computer aided full wave electromagnetic EM analysis has been used in microwave engineering for the past decade Initially its main application area was design verification Today EM simulation driven optimization and design closure become increasingly important due to the complexity of microwave structures and increasing demands for accuracy In many situations theoretical models of microwave structures can only be used to yield the initial designs that need to be further fine tuned to meet given performance requirements In addition EM based design is a must for a growing number of microwave devices such as ultra wideband UWB antennas dielectric resonator antennas and substrate integrated circuits For circuits like these no design ready theoretical models are available so design improvement can only be obtained through geometry adjustments based on repetitive time consuming simulations On the other hand various interactions between microwave devices and their environment such as feeding structures and housing must be taken into

account and this is only possible through full wave EM analysis. Electromagnetic simulations can be highly accurate but they tend to be computationally expensive. Therefore practical design optimization methods have to be computationally efficient so that the number of CPU intensive high fidelity EM simulations is reduced as much as possible during the design process. For the same reasons techniques for creating fast yet accurate models of microwave structures become crucially important. In this edited book the authors strive to review the state of the art simulation driven microwave design optimization and modeling. A group of international experts specialized in various aspects of microwave computer aided design summarize and review a wide range of the latest developments and real world applications. Topics include conventional and surrogate based design optimization techniques, methods exploiting adjoint sensitivity simulation based tuning space mapping and several modeling methodologies such as artificial neural networks and kriging. Applications and case studies include microwave filters, antennas, substrate integrated structures and various active components and circuits. The book also contains a few introductory chapters highlighting the fundamentals of optimization and modeling, gradient based and derivative free algorithms, metaheuristics and surrogate based optimization techniques as well as finite difference and finite element methods.

The Finite Element Method in Heat Transfer and Fluid Dynamics, Second Edition J. N. Reddy, D.K. Gartling, 2000-12-20. The numerical simulation of fluid mechanics and heat transfer problems is now a standard part of engineering practice. The widespread availability of capable computing hardware has led to an increased demand for computer simulations of products and processes during their engineering design and manufacturing phases. The range of fluid mechanics and heat transfer applications of finite element analysis has become quite remarkable with complex realistic simulations being carried out on a routine basis. The award winning first edition of *The Finite Element Method in Heat Transfer and Fluid Dynamics* brought this powerful methodology to those interested in applying it to the significant class of problems dealing with heat conduction, incompressible viscous flows and convection heat transfer. The Second Edition of this bestselling text continues to provide the academic community and industry with up to date authoritative information on the use of the finite element method in the study of fluid mechanics and heat transfer. Extensively revised and thoroughly updated, new and expanded material includes discussions on difficult boundary conditions, contact and bulk nodes, change of phase, weighted integral statements and weak forms, chemically reactive systems, stabilized methods, free surface problems and much more. *The Finite Element Method in Heat Transfer and Fluid Dynamics* offers students a pragmatic treatment that views numerical computation as a means to an end and does not dwell on theory or proof. Mastering its contents brings a firm understanding of the basic methodology, competence in using existing simulation software and the ability to develop some simpler special purpose computer codes.

Introduction to Subsurface Imaging Bahaa Saleh, 2011-03-17. Describing and evaluating the basic principles and methods of subsurface sensing and imaging. *Introduction to Subsurface Imaging* is a clear and comprehensive treatment that links theory to a wide range of real world applications in medicine, biology, security and

geophysical environmental exploration It integrates the different sensing techniques acoustic electric electromagnetic optical x ray or particle beams by unifying the underlying physical and mathematical similarities and computational and algorithmic methods Time domain spectral and multisensor methods are also covered whilst all the necessary mathematical statistical and linear systems tools are given in useful appendices to make the book self contained Featuring a logical blend of theory and applications a wealth of color illustrations homework problems and numerous case studies this is suitable for use as both a course text and as a professional reference *Electromagnetic Waves, Materials, and Computation with MATLAB®*

Dikshitulu K. Kalluri, 2016-04-19 Readily available commercial software enables engineers and students to perform routine calculations and design without necessarily having a sufficient conceptual understanding of the anticipated solution The software is so user friendly that it usually produces a beautiful colored visualization of that solution often camouflaging the fact that t **Low-Dimensional Materials, Systems and Applications, Volume 1** Purushottam

Chakraborty, Dambarudhar Mohanta, 2025-10-01 Low Dimensional Materials Systems and Applications Volume 1 Principles Methods and Approaches in Electronics and Photonics showcases the complexities and uniqueness of low dimensional materials and highlights the most recent discoveries in the fields of electronics and photonics Low dimensional nanoscale materials are challenging as they exhibit properties distinctly different from their bulk counterparts There is an exponential increase of reactivity at the molecular level due to high surface to volume ratios in these materials and not only are their electronic optical and chemical properties different so too are their mechanical characteristics This book highlights the state of the art theoretical and experimental descriptions of the complexities unique properties and latest applications of low dimensional materials with a particular focus on the fields of electronics and photonics The book is primarily for researchers working on the simulation fabrication analysis and uses of low dimensional nanoscale materials including materials scientists electrical engineers condensed matter physicists and chemists Serves as a comprehensive ready reference for beginners researchers and expert practitioners working on the understanding and manipulation of low dimensional structures in electronics and photonics Presents the latest theoretical and experimental approaches and complexities of low dimensional materials research Features contributions from leading experts in the field of low dimensional materials **CRC Handbook**

of Thermal Engineering Raj P. Chhabra, 2017-11-08 The CRC Handbook of Thermal Engineering Second Edition is a fully updated version of this respected reference work with chapters written by leading experts Its first part covers basic concepts equations and principles of thermodynamics heat transfer and fluid dynamics Following that is detailed coverage of major application areas such as bioengineering energy efficient building systems traditional and renewable energy sources food processing and aerospace heat transfer topics The latest numerical and computational tools microscale and nanoscale engineering and new complex structured materials are also presented Designed for easy reference this new edition is a must have volume for engineers and researchers around the globe **Computer Simulation** Dragan Cvetković, 2017-06-07 The

first chapter provides an overview of the development of a novel agent based simulation model of socio environmental innovation diffusion The second chapter shows the study about rendering of colours with three rendering engines The third and fourth chapters are devoted to modelling clothes at different levels The fifth chapter describes the modelling of computer simulation in the optimization of bioprocess technology Chapters 6 and 7 formulate a physical model of deformation of steel and idea of constructing a scientific workshop focused on high temperature processes Chapter 8 formulates surrogate models Chapter 9 shows computer simulation of high frequency electromagnetic fields Chapter 10 proposes the modelling of the task allocation problem by the use of Petri Nets Chapter 11 presents various scenarios whose ranking is done according to defined criteria and weight coefficients Advanced Electromagnetic Computation Dikshitulu K. Kalluri, 2017-11-28

Advanced Electromagnetic Computation with MATLAB discusses commercial electromagnetic software widely used in the industry Algorithms of Finite Differences Moment method Finite Element method and Finite Difference Time Domain method are illustrated Hand computed simple examples and MATLAB coded examples are used to explain the concepts behind the algorithms Case studies of practical examples from transmission lines waveguides and electrostatic problems are given so students are able to develop the code and solve the problems Two new chapters including advanced methods based on perturbation techniques and three dimensional finite element examples from radiation scattering are included

Electromagnetism Tamer Becherrawy, 2013-05-21 This book deals with electromagnetic theory and its applications at the level of a senior level undergraduate course for science and engineering The basic concepts and mathematical analysis are clearly developed and the important applications are analyzed Each chapter contains numerous problems ranging in difficulty from simple applications to challenging The answers for the problems are given at the end of the book Some chapters which open doors to more advanced topics such as wave theory special relativity emission of radiation by charges and antennas are included The material of this book allows flexibility in the choice of the topics covered Knowledge of basic calculus vectors differential equations and integration and general physics is assumed The required mathematical techniques are gradually introduced After a detailed revision of time independent phenomena in electrostatics and magnetism in vacuum the electric and magnetic properties of matter are discussed Induction Maxwell equations and electromagnetic waves their reflection refraction interference and diffraction are also studied in some detail Four additional topics are introduced guided waves relativistic electrodynamics particles in an electromagnetic field and emission of radiation A useful appendix on mathematics units and physical constants is included

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