Multigrid Finite Element Methods for Electromagnetic Field Modeling

Yu Zhu and Andreas Cangellaris

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Yu Zhu,Andreas C. Cangellaris

Multigrid Finite Element Method For Electromagnetic Field Modeling:

    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   *Electromagnetic Fields* Jean G. Van Bladel,2007-05-23 Professor Jean Van Bladel an eminent researcher and educator in fundamental electromagnetic theory and its application in electrical engineering has updated and expanded his definitive text and reference on electromagnetic fields to twice its original content This new edition incorporates the latest methods theory formulations and applications that relate to today s technologies With an emphasis on basic principles and a focus on electromagnetic formulation and analysis Electromagnetic Fields Second Edition includes detailed discussions of electrostatic fields potential theory propagation in waveguides and unbounded space scattering by obstacles penetration through apertures and field behavior at high and low frequencies   **The Nystrom Method in Electromagnetics** Mei Song Tong,Weng Cho Chew,2020-06-29 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   *Theory and Computation of Electromagnetic Fields in Layered Media* Vladimir Okhmatovski,Shucheng Zheng,2024-04-23 Explore the algorithms and numerical methods used to compute electromagnetic fields in multi layered media In Theory and Computation of Electromagnetic Fields in Layered Media two distinguished electrical engineering researchers deliver a detailed and up to date overview of the theory and numerical methods used to determine electromagnetic fields in layered media The book begins with an introduction to Maxwell s equations the fundamentals of electromagnetic theory and concepts and definitions relating to Green s function It then moves on to solve canonical problems in vertical and horizontal dipole radiation describe Method of Moments schemes discuss integral equations governing electromagnetic fields and explains the Michalski Zheng theory of mixed potential Green s function representation in multi layered media Chapters on the evaluation of Sommerfeld integrals procedures for far field evaluation and the theory and application of hierarchical matrices are also included along with A thorough introduction to free space Green s functions including the delta function model for point charge and dipole current Comprehensive explorations of the traditional form of layered medium Green s function in three dimensions Practical discussions of electro quasi static and magneto quasi static fields in layered media including electrostatic fields in two and three dimensions In depth examinations of the rational function fitting method including direct spectra fitting with VECTFIT algorithms Perfect for scholars and students of electromagnetic analysis in layered media Theory and Computation of Electromagnetic Fields in

Layered Media will also earn a place in the libraries of CAD industry engineers and software developers working in the area of computational electromagnetics   Electromagnetic Vortices Zhi Hao Jiang,Douglas H. Werner,2021-12-09 Discover the most recent advances in electromagnetic vortices In Electromagnetic Vortices Wave Phenomena and Engineering Applications a team of distinguished researchers delivers a cutting edge treatment of electromagnetic vortex waves including their theoretical foundation related wave properties and several potentially transformative applications The book is divided into three parts The editors first include resources that describe the generation sorting and manipulation of vortex waves as well as descriptions of interesting wave behavior in the infrared and optical regimes with custom designed nanostructures They then discuss the generation multiplexing and propagation of vortex waves at the microwave and millimeter wave frequencies Finally the selected contributions discuss several representative practical applications of vortex waves from a system perspective With coverage that incorporates demonstration examples from a wide range of related sub areas this essential edited volume also offers Thorough introductions to the generation of optical vortex beams and transformation optical vortex wave synthesizers Comprehensive explorations of millimeter wave metasurfaces for high capacity and broadband generation of vector vortex beams as well as orbital angular momentum OAM detection and its observation in second harmonic generations Practical discussions of microwave SPP circuits and coding metasurfaces for vortex beam generation and OAM based structured radio beams and their applications In depth examinations and explorations of OAM multiplexing for wireless communications wireless power transmission as well as quantum communications and simulations Perfect for students of wireless communications antenna RF design optical communications and nanophotonics Electromagnetic Vortices Wave Phenomena and Engineering Applications is also an indispensable resource for researchers in academia at large defense contractors and in government labs   **Electromagnetic Fields in Cavities** David A. Hill,2009-10-27 A thorough and rigorous analysis of electromagnetic fields in cavities This book offers a comprehensive analysis of electromagnetic fields in cavities of general shapes and properties Part One covers classical deterministic methods to conclude resonant frequencies modal fields and cavity losses quality factor mode bandwidth and the excitation of cavity fields from arbitrary current distributions for metal wall cavities of simple shape Part Two covers modern statistical methods to analyze electrically large cavities of complex shapes and properties Electromagnetic Fields in Cavities combines rigorous solutions to Maxwell s equations with conservation of energy to solve for the statistics of many quantities of interest penetration into cavities and shielding effectiveness field strengths far from and close to cavity walls and power received by antennas within cavities It includes all modes and shows you how to utilize fairly simple statistical formulae to apply to your particular problem whether it s interference calculations electromagnetic compatibility testing in reverberation chambers measurement of shielding materials using multiple cavities or efficiency of test antennas Electromagnetic Fields in Cavities is a valuable resource for researchers engineers professors and graduate students in electrical engineering   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 **Vehicle, Mechatronics and Information Technologies II** X.D. Yu,M.Y. Zhang,M.Q. Zhu,K.H. Xu,Q.C. Xiang,2014-03-24 Selected peer reviewed papers from the 2014 International Conference on Vehicle Mechanical Engineering and Information Technology VMEIT 2014 February 19 20 2014 Beijing China **Multigrid Methods** Ulrich Trottenberg,W. Hackbusch,1986 **Foundations of Molecular Modeling and Simulation** Peter T. Cummings,Phillip Ray Westmoreland,Brice Carnahan,2001 Transactions of the American Society of Civil Engineers American Society of Civil Engineers,1997 Vols 29 30 include papers of the International Engineering Congress Chicago 1893 v 54 includes papers of the International Engineering Congress St Louis 1904 Modelling Uncertain Data Hans Bandemer,1992 Mathematics of Computing Miscellaneous *Newsletter* ,2004 **Journal of Numerical Mathematics** ,2005 **Conference Proceedings** ,1998 **1995 URSI International Symposium on Signals, Systems, and Electronics** ,1995 *Government Reports Announcements & Index* ,1996 **The Software Encyclopedia** ,1986 **SIAM Journal on Scientific Computing** ,2009 The Engineering Index Annual ,1993 Since its creation in 1884 Engineering Index has covered virtually every major engineering innovation from around the world It serves as the historical record of virtually every major engineering innovation of the 20th century Recent content is a vital resource for current awareness new production information technological forecasting and competitive intelligence The world s most comprehensive interdisciplinary engineering database Engineering Index contains over 10 7 million records Each year over 500 000 new abstracts are added from over 5 000 scholarly journals trade magazines and conference proceedings Coverage spans over 175 engineering disciplines from over 80 countries Updated weekly

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