

Computational Electromagnetic Modeling And Experimental

The book will cover the past, present and future developments of field theory and computational electromagnetics. The first two chapters will give an overview of the historical developments and the present the state-of-the-art in computational electromagnetics. These two chapters will set the stage for discussing recent progress, new developments, challenges, trends and major directions in computational electromagnetics with three main emphases: a. Modeling of ever larger structures with multi-scale dimensions and multi-level descriptions (behavioral, circuit, network and field levels) and transient behaviours b. Inclusions of physical effects other than electromagnetic: quantum effects, thermal effects, mechanical effects and nano scale features c. New developments in available computer hardware, programming paradigms (MPI, Open MP, CUDA and Open CL) and the associated new modeling approaches These are the current emerging topics in the area of computational electromagnetics and may provide readers a comprehensive overview of future trends and directions in the area. The book is written for students, research scientists, professors, design engineers and consultants who engaged in the fields

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of design, analysis and research of the emerging technologies related to computational electromagnetics, RF/microwave, optimization, new numerical methods, as well as accelerator simulator, dispersive materials, nano-antennas, nano-waveguide, nano-electronics, terahertz applications, bio-medical and material sciences. The book may also be used for those involved in commercializing electromagnetic and related emerging technologies, sensors and the semiconductor industry. The book can be used as a reference book for graduates and post graduates. It can also be used as a text book for workshops and continuing education for researchers and design engineers.

Human Interaction with Electromagnetic Fields: Computational Models in Dosimetry presents some highly rigorous and sophisticated integral equation techniques from computational electromagnetics (CEM), along with practical techniques for the calculation and measurement of internal dosimetry. Theory is accompanied by numerical modeling algorithms and illustrative computational examples that range from academic to full real-world scenarios. Covers both deterministic and stochastic modeling Presents implementations of integral equation approaches, overcoming the limitations of the FDTD approach Presents various biomedical applications

Electromagnetic Pulse Simulations Using Finite-

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Difference Time-Domain Method Discover the utility of the FDTD approach to solving electromagnetic problems with this powerful new resource

Electromagnetic Pulse Simulations Using Finite-Difference Time-Domain Method delivers a comprehensive overview of the generation and propagation of ultra-wideband electromagnetic pulses. The book provides a broad cross-section of studies of electromagnetic waves and their propagation in free space, dielectric media, complex media, and within guiding structures, like waveguide lines, transmission lines, and antennae. The distinguished author offers readers a fresh new approach for analyzing electromagnetic modes for pulsed electromagnetic systems designed to improve the reader's understanding of the electromagnetic modes responsible for radiating far-fields. The book also provides a wide variety of computer programs, data analysis techniques, and visualization tools with state-of-the-art packages in MATLAB® and Octave. Following an introduction and clarification of basic electromagnetics and the frequency and time domain approach, the book delivers explanations of different numerical methods frequently used in computational electromagnetics and the necessity for the time domain treatment. In addition to a discussion of the Finite-difference Time-domain (FDTD) approach, readers will also enjoy: A thorough introduction to electromagnetic pulses

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(EMPs) and basic electromagnetics, including common applications of electromagnetics and EMP coupling and its effects An exploration of time and frequency domain analysis in electromagnetics, including Maxwell's equations and their practical implications A discussion of electromagnetic waves and propagation, including waves in free space, dielectric mediums, complex mediums, and guiding structures A treatment of computational electromagnetics, including an explanation of why we need modeling and simulations Perfect for undergraduate and graduate students taking courses in physics and electrical and electronic engineering, *Electromagnetic Pulse Simulations Using Finite-Difference Time-Domain Method* will also earn a place in the libraries of scientists and engineers working in electromagnetic research, RF and microwave design, and electromagnetic interference. 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

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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. This book expands on the subject matter of 'Computational Electromagnetics and Model-Based Inversion: A Modern Paradigm for Eddy-Current Nondestructive Evaluation.' It includes (a) voxel-based inversion methods, which are generalizations of model-based algorithms; (b) a complete electromagnetic model of advanced composites (and other novel exotic materials), stressing the highly anisotropic nature of these materials, as well as giving a number of applications to nondestructive evaluation; and (c) an up-to-date discussion of stochastic integral equations and propagation-of-uncertainty models in nondestructive evaluation. As such, the book combines research started twenty-five years ago in advanced composites and voxel-based algorithms, but published in scattered journal articles, as well as recent research in stochastic integral equations. All of these areas are of considerable interest to the aerospace, nuclear power, civil infrastructure, materials characterization and biomedical industries. The book covers the topic of computational electromagnetics in eddy-current

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nondestructive evaluation (NDE) by emphasizing three distinct topics: (a) fundamental mathematical principles of volume-integral equations as a subset of computational electromagnetics, (b) mathematical algorithms applied to signal-processing and inverse scattering problems, and (c) applications of these two topics to problems in which real and model data are used. It is therefore more than an academic exercise and is valuable to users of eddy-current NDE technology in industries as varied as nuclear power, aerospace, materials characterization and biomedical imaging.

Unlike any other source in the field, this valuable reference clearly examines key aspects of the finite element method (FEM) for electromagnetic analysis of low-frequency electrical devices. The authors examine phenomena such as nonlinearity, mechanical force, electrical circuit coupling, vibration, heat, and movement for applications in the elect

Presents current research into electromagnetic computation theories with particular emphasis on Finite-Difference Time-Domain Method This book is the first to consolidate current research and to examine the theories of electromagnetic computation methods in relation to lightning surge protection. The authors introduce and compare existing electromagnetic computation methods such as the method of moments (MOM), the partial element

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equivalent circuit (PEEC), the finite element method (FEM), the transmission-line modeling (TLM) method, and the finite-difference time-domain (FDTD) method. The application of FDTD method to lightning protection studies is a topic that has matured through many practical applications in the past decade, and the authors explain the derivation of Maxwell's equations required by the FDTD, and modeling of various electrical components needed in computing lightning electromagnetic fields and surges with the FDTD method. The book describes the application of FDTD method to current and emerging problems of lightning surge protection of continuously more complex installations, particularly in critical infrastructures of energy and information, such as overhead power lines, air-insulated substations, wind turbine generator towers and telecommunication towers. Both authors are internationally recognized experts in the area of lightning study and this is the first book to present current research in lightning surge protection. Examines in detail why lightning surges occur and what can be done to protect against them. Includes theories of electromagnetic computation methods and many examples of their application. Accompanied by a sample printed program based on the finite-difference time-domain (FDTD) method written in C++ program. More and more researchers engage into

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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

This hands-on introduction to computational electromagnetics (CEM) links theoretical coverage of the three key methods - the FDTD, MoM and FEM - to open source MATLAB codes (freely available online) in 1D, 2D and 3D, together with many practical hints and tips gleaned from the author's 25 years of experience in the field. Updated and

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extensively revised, this second edition includes a new chapter on 1D FEM analysis, and extended 3D treatments of the FDTD, MoM and FEM, with entirely new 3D MATLAB codes. Coverage of higher-order finite elements in 1D, 2D and 3D is also provided, with supporting code, in addition to a detailed 1D example of the FDTD from a FEM perspective. With running examples through the book and end-of-chapter problems to aid understanding, this is ideal for professional engineers and senior undergraduate/graduate students who need to master CEM and avoid common pitfalls in writing code and using existing software.

This book introduces the state-of-the-art research progress of system-level EMC, including theories, design technologies, principles and applications in practice. The engineering design, simulation, prediction, analysis, test, stage control as well as effectiveness evaluation are discussed in detail with extensive project experiences, making the book an essential reference for researchers and industrial engineers.

This is the first book that comprehensively addresses the issues relating to the effects of radio frequency (RF) signals and the environment of electrical and electronic systems. It covers testing methods as well as methods to analyze radio frequency. The generation of high-powered electromagnetic (HP EM) environments, including

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moderate band damped sinusoidal radiators and hyperband radiating systems is explored. HPEM effects on component, circuit, sub-system electronics, as well as system level drawing are discussed. The effects of HPEM on experimental techniques and the standards which can be used to control tests are described. The validity of analytical techniques and computational modeling in a HPEM effects context is also discussed. Insight on HPEM effects experimental techniques and the standards which can be used to control tests is provided, and the validity of analytical techniques and computational modeling in a HPEM effects context is discussed. This book dispels myths, clarifies good experimental practice and ultimately draws conclusions on the HPEM interaction with electronics. Readers will learn to consider the importance of HPEM phenomena as a threat to modern electronic based technologies which underpin society and to therefore be pre-emptive in the consideration of HPEM resilience.

Mathematical and numerical modelling of engineering problems in medicine is aimed at unveiling and understanding multidisciplinary interactions and processes and providing insights useful to clinical care and technology advances for better medical equipment and systems. When modelling medical problems, the engineer is confronted with multidisciplinary problems of

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electromagnetism, heat and mass transfer, and structural mechanics with, possibly, different time and space scales, which may raise concerns in formulating consistent, solvable mathematical models. Computational Medical Engineering presents a number of engineering for medicine problems that may be encountered in medical physics, procedures, diagnosis and monitoring techniques, including electrical activity of the heart, hemodynamic activity monitoring, magnetic drug targeting, bioheat models and thermography, RF and microwave hyperthermia, ablation, EMF dosimetry, and bioimpedance methods. The authors discuss the core approach methodology to pose and solve different problems of medical engineering, including essentials of mathematical modelling (e.g., criteria for well-posed problems); physics scaling (homogenization techniques); Constructal Law criteria in morphing shape and structure of systems with internal flows; computational domain construction (CAD and, or reconstruction techniques based on medical images); numerical modelling issues, and validation techniques used to ascertain numerical simulation results. In addition, new ideas and venues to investigate and understand finer scale models and merge them into continuous media medical physics are provided as case studies. Presents the fundamentals of mathematical and numerical modeling of engineering problems in

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medicine Discusses many of the most common modelling scenarios for Biomedical Engineering, including, electrical activity of the heart hemodynamic activity monitoring, magnetic drug targeting, bioheat models and thermography, RF and microwave hyperthermia, ablation, EMF dosimetry, and bioimpedance methods Includes discussion of the core approach methodology to pose and solve different problems of medical engineering, including essentials of mathematical modelling, physics scaling, Constructal Law criteria in morphing shape and structure of systems with internal flows, computational domain construction, numerical modelling issues, and validation techniques used to ascertain numerical simulation results

.. Eleventh International Conference on Advanced Computational Methods and Experimental Measurements in Heat Transfer and Mass Transfer held in Tallinn, Estonia in 2010"--Pref.

This unique book presents simple, easy-to-use, but effective short codes as well as virtual tools that can be used by electrical, electronic, communication, and computer engineers in a broad range of electrical engineering problems. Electromagnetic modeling is essential to the design and modeling of antenna, radar, satellite, medical imaging, and other applications. In this book, author Levent Sevgi explains techniques for solving real-time complex physical problems using MATLAB-based short scripts

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and comprehensive virtual tools. Unique in coverage and tutorial approach, *Electromagnetic Modeling and Simulation* covers fundamental analytical and numerical models that are widely used in teaching, research, and engineering designs—including mode and ray summation approaches with the canonical 2D nonpenetrable parallel plate waveguide as well as FDTD, MoM, and SSPE scripts. The book also establishes an intelligent balance among the essentials of EMMODSIM: The Problem (the physics), The Theory and Models (mathematical background and analytical solutions), and The Simulations (code developing plus validation, verification, and calibration). Classroom tested in graduate-level and short courses, *Electromagnetic Modeling and Simulation*: Clarifies concepts through numerous worked problems and quizzes provided throughout the book. Features valuable MATLAB-based, user-friendly, effective engineering and research virtual design tools. Includes sample scenarios and video clips recorded during characteristic simulations that visually impact learning—available on wiley.com. Provides readers with their first steps in EM MODSIM as well as tools for medium and high-level code developers and users. *Electromagnetic Modeling and Simulation* thoroughly covers the physics, mathematical background, analytical solutions, and code

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development of electromagnetic modeling, making it an ideal resource for electrical engineers and researchers.

The book extends the von Hippel text to include data on additional non-conducting dielectrics; semiconducting, conducting, and magnetic materials; and composites composed of two or more molecularly distinct compounds that range in size from nanometers to centimeters. This fully revised engineering and scientific handbook offers complete coverage of electromagnetic modeling and explains the characterization of composite materials from the theoretical, computational, and experimental points of view.

Global Demand for Streamlined Design and Computation The explosion of wireless communications has generated a tidal wave of interest and development in computational techniques for electromagnetic simulation as well as the design and analysis of RF and microwave circuits. **Learn About Emerging Disciplines, State-of-the-Art Methods** **2-D Electromagnetic Simulation of Passive Microstrip Circuits** describes this simple procedure in order to provide basic knowledge and practical insight into quotidian problems of microstrip passive circuits applied to microwave systems and digital technologies. The text dissects the latest emerging disciplines and methods of microwave circuit analysis, carefully balancing theory and state-

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of-the-art experimental concepts to elucidate the process of analyzing high-speed circuits. The author covers the newer techniques – such as the study of signal integrity within circuits, and the use of field map interpretations – employed in powerful electromagnetic simulation analysis methods. But why and how does the intrinsic two-dimensional simulation model used here reduce numerical error? Step-by-Step Simulation Provides Insight and Understanding The author presents the FDTD electromagnetic simulation method, used to reproduce different microstrip test circuits, as well as an explanation of the complementary electrostatic method of moments (MoM). Each reproduces different microstrip test circuits that are physically constructed and then studied, using a natural methodological progression to facilitate understanding. This approach gives readers a solid comprehension and insight into the theory and practical applications of the microstrip scenario, with emphasis on high-speed interconnection elements. The effort described here describes a set of outdoor experiments performed on the AH-1S Cobra helicopter in order to validate and compare to the computational electromagnetic models of the bulk structure of the airframe in the frequency bands up to 4 GHz. Also included in this were coupling measurements to wires and cables inside of the airframe and various cavity to HPM pulse in this

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frequency range as part of other activities.

Additionally, the low power modeling compression will be completed in this time frame.

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

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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.

Computational Electromagnetism refers to the modern concept of computer-aided analysis, and design, of virtually all electric devices such as motors, machines, transformers, etc., as well as of the equipment in the currently booming field of telecommunications, such as antennas, radars, etc. The present book is uniquely written to enable the reader-- be it a student, a scientist, or a practitioner-- to successfully perform important simulation techniques and to design efficient computer software for electromagnetic device analysis. Numerous illustrations, solved exercises, original ideas, and an extensive and up-to-date bibliography make it a

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valuable reference for both experts and beginners in the field. A researcher and practitioner will find in it information rarely available in other sources, such as on symmetry, bilateral error bounds by complementarity, edge and face elements, treatment of infinite domains, etc. At the same time, the book is a useful teaching tool for courses in computational techniques in certain fields of physics and electrical engineering. As a self-contained text, it presents an extensive coverage of the most important concepts from Maxwells equations to computer-solvable algebraic systems-- for both static, quasi-static, and harmonic high-frequency problems. Benefits To the Engineer A sound background necessary not only to understand the principles behind variational methods and finite elements, but also to design pertinent and well-structured software. To the Specialist in Numerical Modeling The book offers new perspectives of practical importance on classical issues: the underlying symmetry of Maxwell equations, their interaction with other fields of physics in real-life modeling, the benefits of edge and face elements, approaches to error analysis, and "complementarity." To the Teacher An expository strategy that will allow you to guide the student along a safe and easy route through otherwise difficult concepts: weak formulations and their relation to fundamental conservation principles of physics, functional spaces, Hilbert spaces,

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approximation principles, finite elements, and algorithms for solving linear systems. At a higher level, the book provides a concise and self-contained introduction to edge elements and their application to mathematical modeling of the basic electromagnetic phenomena, and static problems, such as eddy-current problems and microwaves in cavities. To the Student Solved exercises, with "hint" and "full solution" sections, will both test and enhance the understanding of the material. Numerous illustrations will help in grasping difficult mathematical concepts. Electromagnetic Modeling and Simulation John Wiley & Sons

Containing edited versions of most of the papers presented at the Fourteenth International Conference on Computational Methods and Experimental Measurements, this book reviews the latest work on these two approaches, and the interaction between them.

Offers a comprehensive overview of the recent advances in the area of computational electromagnetics Computational Method in Electromagnetic Compatibility offers a review of the most recent advances in computational electromagnetics. The authors—*noted experts in the field*—examine similar problems by taking different approaches related to antenna theory models and transmission line methods. They discuss various solution methods related to boundary integral

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equation techniques and finite difference techniques. The topics covered are related to realistic antenna systems including antennas for air traffic control or ground penetrating radar antennas; grounding systems (such as grounding systems for wind turbines); biomedical applications of electromagnetic fields (such as transcranial magnetic stimulation); and much more. The text features a number of illustrative computational examples and a reference list at the end of each chapter. The book is grounded in a rigorous theoretical approach and offers mathematical details of the formulations and solution methods. This important text: Provides a trade-off between a highly efficient transmission line approach and antenna theory models providing analysis of high frequency and transient phenomena Contains the newest information on EMC analysis and design principles Discusses electromagnetic field coupling to thin wire configurations and modeling in bioelectromagnetics Written for engineering students, senior researchers and practicing electrical engineers, *Computational Method in Electromagnetic Compatibility* provides a valuable resource in the design of equipment working in a common electromagnetic environment.

Computer Field Models of Electromagnetic Devices, volume 34 in the book series *Studies in Applied Electromagnetics and Mechanics* is devoted to modeling and simulation, control systems, testing,

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measurements, monitoring, diagnostics and advanced software

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.

The 41st Annual International Conference of the IEEE EMBS, took place between July 23 and 27, 2019, in Berlin, Germany. The focus was on "Biomedical engineering ranging from wellness to intensive care."

This conference provided an opportunity for researchers from academia and industry to discuss a variety of topics relevant to EMBS and hosted the 4th Annual Invited Session on Computational Human Models. At this session, a bevy of research related to the development of human phantoms was presented, together with a substantial variety of practical applications explored through simulation.

Containing papers presented at the seventeenth in a series of biennial meetings organised by the Wessex Institute and first held in 1984, this book includes the latest research from scientists who perform experiments,

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researchers who develop computer codes, and those who carry out measurements on prototypes and whose work may interact. Progress in the engineering sciences is dependent on the orderly and concurrent development of all three fields. Continuous improvement in computer efficiency, coupled with diminishing costs and rapid development of numerical procedures have generated an ever-increasing expansion of computational simulations that permeate all fields of science and technology. As these procedures continue to grow in magnitude and complexity, it is essential to be certain of their reliability, i.e. to validate their results. This can be achieved by performing dedicated and accurate experiments. At the same time, current experimental techniques have become more complex and sophisticated so that they require the exploitation of computers, both for running experiments as well as acquiring and processing the resulting data. The papers contained in the book address advances in the interaction between these three areas. They cover such topics as: Computational and Experimental Methods; Fluid Flow; Structural and Stress Analysis; Materials Characterisation; Heat Transfer and Thermal Processes; Advances in Computational Methods; Automotive Applications; Applications in Industry; Process Simulations; Environmental Modelling and Applications; Computer Modelling; Validation of Computer Modelling; Computation in Measurements; Data Processing of Experiments; Virtual Testing and Verification; Simulation and Forecasting; Measurements in Engineering. Provides a detailed and systematic description of the

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Method of Moments (Boundary Element Method) for electromagnetic modeling at low frequencies and includes hands-on, application-based MATLAB® modules with user-friendly and intuitive GUI and a highly visualized interactive output. Includes a full-body computational human phantom with over 120 triangular surface meshes extracted from the Visible Human Project® Female dataset of the National Library of Medicine and fully compatible with MATLAB and major commercial FEM/BEM electromagnetic software simulators. This book covers the basic concepts of computational low-frequency electromagnetics in an application-based format and hones the knowledge of these concepts with hands-on MATLAB® modules. The book is divided into five parts. Part 1 discusses low-frequency electromagnetics, basic theory of triangular surface mesh generation, and computational human phantoms. Part 2 covers electrostatics of conductors and dielectrics, and direct current flow. Linear magnetostatics is analyzed in Part 3. Part 4 examines theory and applications of eddy currents. Finally, Part 5 evaluates nonlinear electrostatics. Application examples included in this book cover all major subjects of low-frequency electromagnetic theory. In addition, this book includes complete or summarized analytical solutions to a large number of quasi-static electromagnetic problems. Each Chapter concludes with a summary of the corresponding MATLAB® modules. Combines fundamental electromagnetic theory and application-oriented computation algorithms in the form of stand alone MATLAB® modules. Makes use of the three-dimensional

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Method of Moments (MoM) for static and quasistatic electromagnetic problems Contains a detailed full-body computational human phantom from the Visible Human Project® Female, embedded implant models, and a collection of homogeneous human shells Low-Frequency Electromagnetic Modeling for Electrical and Biological Systems Using MATLAB® is a resource for electrical and biomedical engineering students and practicing researchers, engineers, and medical doctors working on low-frequency modeling and bioelectromagnetic applications. Sergey N. Makarov is a Professor in the Department of Electrical and Computer Engineering at Worcester Polytechnic Institute (WPI). Gregory M. Noetscher is a Senior Research Electrical Engineer at the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) in Natick, MA. Ara Nazarian is an Assistant Professor of Orthopaedic Surgery, Harvard Medical School, Center for Advanced Orthopaedic Studies, Beth Israel Deaconess Medical Center (BIDMC).

3.1.4 Boundary Conditions -- 3.2 Auxiliary Potentials --
3.2.1 Magnetic Vector Potential A and Electric Scalar Potential e -- 3.2.2 Electric Vector Potential F and Magnetic Scalar Potential m -- 3.2.3 Important Fundamental Relationships -- 3.3 Wave Equations and Their Solutions -- 3.3.1 Wave Equations for E and H -- 3.3.2 Wave Equations for A , F , and e -- 3.3.3 Solution of the Helmholtz Equation -- 3.3.4 Electric Field Integral Equation -- 3.4 Green's Function -- 3.4.1 Notation Used for Wave Number and Fourier Transform -- 3.4.2 Full Wave Free Space Green's Function -- 3.5 Equivalence

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Principles -- 3.5.1 Volume Equivalence Principle -- 3.5.2 Huygens' Equivalence Principle -- 3.6 Numerical Solution of Integral Equations -- Problems -- References -- Chapter 4 Capacitance Computations -- 4.1 Multiconductor Capacitance Concepts -- 4.2 Capacitance Models -- 4.2.1 Capacitance Models for Multiconductor Geometries -- 4.2.2 Short Circuit Capacitances -- 4.2.3 Coefficient of Potential Matrix P_p -- 4.2.4 Capacitance of Conductor Systems -- 4.2.5 Elimination of a Floating Conductor Node -- 4.2.6 Floating or Reference Free Capacitances -- 4.3 Solution Techniques for Capacitance Problems -- 4.3.1 Differential Equation (DE) Methods for Capacitance Computations -- 4.4 Meshing Related Accuracy Problems for PEEC Model -- 4.4.1 Impact of Meshing on Capacitances and Stability and Passivity -- 4.5 Representation of Capacitive Currents for PEEC Models -- 4.5.1 Quasistatic Capacitance-based Model -- 4.5.2 Current Source-Based Model for the Capacitances -- 4.5.3 Potential-Based Model for the Capacitances -- Problems -- References -- Chapter 5 Inductance Computations -- 5.1 Loop Inductance Computations -- 5.1.1 Loop Inductance Computation in Terms of Partial Inductances -- 5.1.2 Circuit Model for Partial Inductance Loop

New possibilities have recently emerged for producing optical beams with complex and intricate structures, and for the non-contact optical manipulation of matter.

Structured Light and Its Applications fully describes the electromagnetic theory, optical properties, methods and applications associated with this new technology.

Detailed discussions are given of unique beam

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characteristics, such as optical vortices and other wavefront structures, the associated phase properties and photonic aspects, along with applications ranging from cold atom manipulation to optically driven micromachines. Features include: Comprehensive and authoritative treatments of the latest research in this area of nanophotonics, written by the leading researchers Accounts of numerous microfluidics, nanofabrication, quantum informatics and optical manipulation applications Coverage that fully spans the subject area, from fundamental theory and simulations to experimental methods and results Graduate students and established researchers in academia, national laboratories and industry will find this book an invaluable guide to the latest technologies in this rapidly developing field. Comprehensive and definitive source of the latest research in nanotechnology written by the leading people in the field From theory to applications - all is presented in detail Editor is Chair of the SPIE Nanotechnology Technical Group and is leading the way in generation and manipulation of complex beams

In vivo magnetic resonance imaging (MRI) has evolved into a versatile and critical, if not 'gold standard', imaging tool with applications ranging from the physical sciences to the clinical '-ology'. In addition, there is a vast amount of accumulated but unpublished inside knowledge on what is needed to perform a safe, in vivo MRI. The goal of this comprehensive text, written by an outstanding group of world experts, is to present information about the effect of the MRI environment on the human body, and tools and methods to quantify such

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effects. By presenting such information all in one place, the expectation is that this book will help everyone interested in the Safety and Biological Effects in MRI find relevant information relatively quickly and know where we stand as a community. The information is expected to improve patient safety in the MR scanners of today, and facilitate developing faster, more powerful, yet safer MR scanners of tomorrow. This book is arranged in three sections. The first, named 'Static and Gradient Fields' (Chapters 1-9), presents the effects of static magnetic field and the gradients of magnetic field, in time and space, on the human body. The second section, named 'Radiofrequency Fields' (Chapters 10-30), presents ways to quantify radiofrequency (RF) field induced heating in patients undergoing MRI. The effect of the three fields of MRI environment (i.e. Static Magnetic Field, Time-varying Gradient Magnetic Field, and RF Field) on medical devices, that may be carried into the environment with patients, is also included. Finally, the third section, named 'Engineering' (chapters 31-35), presents the basic background engineering information regarding the equipment (i.e. superconducting magnets, gradient coils, and RF coils) that produce the Static Magnetic Field, Time-varying Gradient Magnetic Field, and RF Field. The book is intended for undergraduate and post-graduate students, engineers, physicists, biologists, clinicians, MR technologists, other healthcare professionals, and everyone else who might be interested in looking into the role of MRI environment on patient safety, as well as those just wishing to update their knowledge of the state of MRI safety. Those, who

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are learning about MRI or training in magnetic resonance in medicine, will find the book a useful compendium of the current state of the art of the field.

Emerging Topics in Computational Electromagnetics in Computational Electromagnetics presents advances in Computational Electromagnetics. This book is designed to fill the existing gap in current CEM literature that only cover the conventional numerical techniques for solving traditional EM problems. The book examines new algorithms, and applications of these algorithms for solving problems of current interest that are not readily amenable to efficient treatment by using the existing techniques. The authors discuss solution techniques for problems arising in nanotechnology, bioEM, metamaterials, as well as multiscale problems. They present techniques that utilize recent advances in computer technology, such as parallel architectures, and the increasing need to solve large and complex problems in a time efficient manner by using highly scalable algorithms.

This practical new resource provides you with a much wider choice of analytical solutions to the everyday problems you encounter in electromagnetic modeling. The book enables you to use cutting-edge method-of-moments procedures, with new theories and techniques that help you optimize computer performance in numerical analysis of composite metallic and dielectric structures in the complex frequency domain.

Through several case study problems from industrial and scientific research laboratory applications, Mathematical and Experimental Modeling of Physical

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and Biological Processes provides students with a fundamental understanding of how mathematics is applied to problems in science and engineering. For each case study problem, the authors discuss why a model is needed and what goals can be achieved with the model. Exploring what mathematics can reveal about applications, the book focuses on the design of appropriate experiments to validate the development of mathematical models. It guides students through the modeling process, from empirical observations and formalization of properties to model analysis and interpretation of results. The authors also describe the hardware and software tools used to design the experiments so faculty/students can duplicate them. Integrating real-world applications into the traditional mathematics curriculum, this textbook deals with the formulation and analysis of mathematical models in science and engineering. It gives students an appreciation of the use of mathematics and encourages them to further study the applied topics. Real experimental data for projects can be downloaded from CRC Press Online. Presents numerical algorithms, procedures, and techniques required to solve engineering problems relating to the interactions between electromagnetic fields and fluid flow and interdisciplinary technology for aerodynamics, electromagnetics, chemical-physic kinetics, and plasmadynamics Integrates interlinking computational model and simulation techniques of

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aerodynamics and electromagnetics Combines classic plasma drift-diffusion theory and electron impact ionization modeling for electromagnetic-aerodynamic interactions Describes models of internal degrees of freedom for vibration relaxation and electron excitations

This text combines the fundamentals of electromagnetics with numerical modeling to tackle a broad range of current electromagnetic compatibility (EMC) problems, including problems with lightning, transmission lines, and grounding systems. It sets forth a solid foundation in the basics before advancing to specialized topics, and allows readers to develop their own EMC computational models for applications in both research and industry.

An important resource that examines the physical aspects of wireless communications based on mathematical and physical evidence The Physics and Mathematics of Electromagnetic Wave Propagation in Cellular Wireless

Communication describes the electromagnetic principles for designing a cellular wireless system and includes the subtle electromagnetic principles that are often overlooked in designing such a system. This important text explores both the physics and mathematical concepts used in deploying antennas for transmission and reception of electromagnetic signals and examines how to select the proper methodology from a wide range of

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scenarios. In this much-needed guide, the authors—noted experts in the field—explore the principle of electromagnetics as developed through the Maxwellian principles and describe the properties of an antenna in the frequency domain. The text also includes a review of the characterization of propagation path loss in a cellular wireless environment and examines ultrawideband antennas and the mechanisms of broadband transmission of both power and information. This important resource: Includes a discussion of the shortcomings of a MIMO system from both theoretical and practical aspects Demonstrates how to deploy base station antennas with better efficiency Validates the principle and the theoretical analysis of electromagnetic propagation in cellular wireless communication Contains results of experiments that are solidly grounded in mathematics and physics Written for engineers, researchers, and educators who are or plan to work in the field, *The Physics and Mathematics of Electromagnetic Wave Propagation in Cellular Wireless Communication* offers an essential resource for understanding the principles underpinning wireless communications. Co-authored by an international research group with a long-standing cooperation, this book focuses on engineering-oriented electromagnetic and thermal field modeling and application. It presents important contributions, including advanced and efficient finite

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element analysis used in the solution of electromagnetic and thermal field problems for large and multi-scale engineering applications involving application script development; magnetic measurement of both magnetic materials and components under various, even extreme conditions, based on well-established (standard and non-standard) experimental systems; and multi-level validation based on both industrial test systems and extended TEAM P21 benchmarking platform. Although these are challenging topics, they are useful for readers from both academia and industry. [Copyright: 14e2376220bb03e532ef43c30920b72b](#)