Finite Element Analysis Of Electrical Machines

In Finite Element Analysis of Electrical Machines the author covers two-dimensional analysis, emphasizing the use of finite elements to perform the most common calculations required of machine designers and analysts. The book explains what is inside a finite element program, and how the finite element method can be used to determine the behavior of electrical machines. The material is tutorial and includes several completely worked out examples. The main illustrative examples are synchronous and induction machines. The methods described have been used successfully in the design and analysis of most types of rotating and linear machines. Audience: A valuable reference source for academic researchers, practitioners and designers of electrical machinery.

This book is designed to give the theoretical foundation needed by the new user of finite elements in electrical power engineering, and shows how the equipment designer can benefit from finite element analysis. It is divided into three parts; theory, modelling,and application of the finiteelement method. The first part outlines relevant electromagnetics, including treatment of boundaries, saturation and permanent magnets. It also shows how the finite element equations can be formulated. The presentation throughout is aimed at giving the reader a physical understanding of the process.The second part deals with special aspects of finite element modelling of engineering problems, including problem formulation, data generation and post processing and emphasises the importance of engineering judgement. The final part is an assembly of 'real' magnetic and electric field problemssolved by finite elements, including application to turbine generators, permanent magnet machines, switched reluctance drives, induction motors, transformers and bushings.

Demystifies the operation of electric machines by bridging electromagnetic fields, electric circuits, numerical analysis, and computer programming. Ideal for graduates and senior undergraduates taking courses on all aspects of electric machine design and control, and accompanied by downloadable Python code and instructor solutions.

Finite Element Analysis of Electrical Nerve Stimulation

Electric Machines

The Finite Element Method Applied to Rotating Electrical Machines

Combination of two-dimensional finite element analysis of electrical machines with circuit simulation techniques

Finite Element Analysis Of Electrical Machines

This Second Edition extensively covers advanced issues/subjects in electric machines, starting from principles, to applications and case studies with ample graphical (numerical) results. This textbook is intended for second (and third) semester courses covering topics such as modeling of transients, control principles, electromagnetic and thermal finite element analysis, and optimal design (dimensioning). Notable recent knowledge with stro industrialization potential has been added to this edition, such as: Orthogonal models of multiphase a.c. machines Thermal Finite Element Analysis of (FEA) electric machines FEA–based–only optimal design of a PM motor case study Line start synchronizing premium efficiency PM induction machines Induction machines (three and single phase), synchronous machines with DC excitation, with PM-excitation, and with magnetically salient ro and a linear Pm oscillatory motor are all investigated in terms of transients, electromagnetic FEM analysis and control principles. Case studies, numerical examples, and lots of discussion of FEM results for PMSM and IM are included throughout the book. The optimal design is treated in detail using Hooke–Jeeves and GA algorithms with case comparison studies in dedicated chapters for IM and PMSM. Numerous computer simulation programs in MATLAB® and Simulink® are available online that illustrate performance characteristics present in the chapters, and the FEM and optimal design case studies (and codes) may be used as homework to facilitate a deeper understanding of fundamental issues.

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 methodica 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 ir 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 f professionals in the field.

Advanced topics of research in field computation are explored in this publication. Contributions have been sourced from international experts, ensuring a comprehensive specialist perspective. A unity of style has been achieved by the editor, who has specifically inserted appropriate cross-references throughout the volume, plus a single collected set of references at the end. The book provides a multi-faceted overview of the power and effec of computation techniques in engineering electromagnetics. In addition to examining recent and current developments, it is hoped that it will stimulate further research in the field.

The Finite Element Method in Electromagnetics

Applications in Nonlinear Electromagnetics and Power Systems

A Primer

Finite Element Analysis of Electrical Machines, Transformers and Electromagnetic Actuators

Theory and Analysis Using the Finite Element Method

Designed for a one-semester course in Finite Element Method, this compact and well-organized text presents FEM as a tool to find approximate solutions to differential equations. This provides the student a better perspective on the technique and its wide range of applications. This approach reflects the current trend as the present-day applications range from structures to biomechanics to electromagnetics, unlike in conventional texts that view FEM primarily as an extension of matrix methods of structural analysis. After an introduction and a review of mathematical preliminaries, the book gives a detailed discussion on FEM as a technique for solving differential equations and variational formulation of FEM. This is followed by a lucid presentation of one-dimensional and two-dimensional finite elements and finite element formulation for dynamics. The book concludes with some case studies that focus on industrial problems and Appendices that include mini-project topics based on near-real-life problems. Postgraduate/Senior undergraduate students of civil, mechanical and aeronautical engineering will find this text extremely useful; it will also appeal to the practising engineers and the teaching community.

Finite Element Analysis of Electrical MachinesSpringer Science & Business Media

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.

Electrical and Magnetic Fields

Finite Element Analysis of Stator Winding Losses in Large Rotating Electrical Machines

Finite Elements, Electromagnetics and Design

Finite-element Analysis of Nonlinear Fields in Electric Machines

Finite elements - the basic concepts and an application to 3-D magnetostatic problems. The fundamental equations of eletric and magnetic fields. Shape functions. Software engineering aspects of finite elements. Finite element solution of magnetic and electric field problems in electrical machines and devices. Numerical analysis of Eddy-Current problems. The high-order polynomial finite element method in electromagnetic field computation. Transient solution of the diffusion equation by discrete Fourier transformation. Mutually constrained partial differential and integral equation field formulations. Applications of integral equation methods to the numerical solution of magnetostatic and Eddy-Current problems.

This third edition of the principal text on the finite element method for electrical engineers and electronics specialists presents the method in a mathematically undemanding style, accessible to undergraduates who may be encountering it for the first time. Like the earlier editions, it begins by deriving finite elements for the simplest familiar potential fields, and then formulates finite elements for a wide range of applied electromagnetics problems. These include wave propagation, diffusion, and static fields; open-boundary problems and nonlinear materials; axisymmetric, planar and fully three-dimensional geometries; and scalar and vector fields. A wide selection of demonstration programs allows the reader to follow the practical use of the methods. Besides providing all that is needed for the beginning undergraduate student, this textbook is also a valuable reference text for professional engineers and research students.

The finite element method (FEM) has been understood, at least in principle, for more than 50 years. The integral formulation on which it is based has been known for a longer time (thanks to the work of Galerkin, Ritz, Courant and Hilbert,1.4 to mention the most important). However, the method could not be applied in a practical way since it involved the solution of a large number of linear or non-linear algebraic equations. Today it is quite common, with the aid of computers, to solve non-linear algebraic problems of several thousand equations. The necessary numerical methods and programming techniques are now an integral part of the teaching curriculum in most engineering schools. Mechanical engineers, confronted with very complicated structural problems, were the first to take advantage of advanced computational methods and high level languages (FORTRAN) to transform the mechanical models into algebraic equations (1956). In recent times (1960), the FEM has been studied by applied mathematicians and, having received rigorous treatment, has become a part of the more general study of partial differential equations, gradually replacing the finite difference method which had been considered the universal tool to solve these types of problems.

Finite Element Analysis

Finite Element Method Electromagnetics

Finite Element Analysis of Electrical Transformers

Finite Element Analysis with Embedded Global Optimization Method for Optimal Design of Electric Devices

Finite Element Analysis of Structures through Unified Formulation

This book is devoted to students, PhD students, postgraduates of electrical engineering, researchers, and scientists dealing with the analysis, design, and optimization of electrical machine properties. The purpose is to present methods used for the analysis of transients and steady-state conditions. In three chapters the following methods are presented: (1) a method in which the parameters (resistances and inductances) are calculated on the basis of geometrical dimensions and material properties made in the design process, (2) a method of general theory of electrical machines, in which the transients are investigated in two perpendicular axes, and (3) FEM, which is a mathematical method applied to electrical machines to investigate many of their properties.

The finite element method (FEM) is a computational tool widelyused to design and analyse complex structures. Currently,there are a number of different approaches to analysis using theFEM that vary according to the type of structure being analysed:beams and plates may use 1D or 2D approaches, shells and solids 2Dor 3D approaches, and methods that work for one structure aretypically not optimized to work for another. Finite Element Analysis of Structures Through UnifiedFormulation deals with the FEM used for the analysis of themechanics of structures in the case of linear elasticity. Thenovelty of this book is that the finite elements (FEs) areformulated on the basis of a class of theories of structures knownas the Carrera Unified Formulation (CUF). It formulates 1D, 2D and3D FEs on the basis of the same 'fundamental nucleus' that comesfrom geometrical relations and Hooke's law, and presents both 1Dand 2D refined FEs that only have displacement variables as in 3Delements. It also covers 1D and 2D FEs that make use of 'real'physical surfaces rather than 'artificial' mathematicalsurfaces which are difficult to interface in CAD/CAE software. Key features: Covers how the refined formulation can be easily andconveniently used to analyse laminated structures, such as sandwichand composite structures, and to deal with multifield problems Shows the performance of different FE models through the 'besttheory diagram' which allows different models to be compared interms of accuracy and computational cost Introduces an axiomatic/asymptotic approach that reduces thecomputational cost of the structural analysis without affecting theaccuracy Introduces an innovative 'component-wise' approach to deal withcomplex structures Accompanied by a website hosting the dedicated software packageMUL2 (www.mul2.com) Finite Element Analysis of Structures Through UnifiedFormulation is a valuable reference for researchers andpractitioners, and is also a useful source of information forgraduate students in civil, mechanical and aerospaceengineering.

The book discusses the underlying physical principles of piezoelectric materials, important properties of ferroelectric/piezoelectric materials used in today's transducer technology, and the principles used in transducer design. It provides examples of a wide range of applications of such materials along with the appertaining rationales. With contributions from distinguished researchers, this is a comprehensive reference on all the pertinent aspects of piezoelectric materials.

Piezoelectric and Acoustic Materials for Transducer Applications

Analysis of Electrical Machines

TEXTBOOK OF FINITE ELEMENT ANALYSIS

Finite Element Analysis with Personal Computers

Electromagnetic Modeling by Finite Element Methods

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

An introduction to the practice of the Finite Element Method and a comparison of solutions via its various methods including software used in industry.

Written by specialists of modeling in electromagnetism, this book provides a comprehensive review of the finite element method for low frequency applications. Fundamentals of the method as well as new advances in the field are described in detail. Chapters 1 to 4 present general 2D and 3D static and dynamic formulations by the use of scalar and vector unknowns and adapted interpolations for the fields (nodal, edge, face or volume). Chapter 5 is dedicated to the presentation of different macroscopic behavior laws of materials and their implementation in a finite element context: anisotropy and hysteretic properties for magnetic sheets, iron losses, non-linear permanent magnets and superconductors. More specific formulations are then proposed: the modeling of thin regions when finite elements become misfit (Chapter 6), infinite domains by using geometrical transformations (Chapter 7), the coupling of 2D and 3D formulations with circuit equations (Chapter 8), taking into account the movement, particularly in the presence of Eddy currents (Chapter 9) and an original approach for the treatment of geometrical symmetries when the sources are not symmetric (Chapter 10). Chapters 11 to 13 are devoted to coupled problems: magneto-thermal coupling for induction heating, magneto-mechanical coupling by introducing the notion of strong and weak coupling and magneto-hydrodynamical coupling focusing on electromagnetic instabilities in fluid conductors. Chapter 14 presents different meshing methods in the context of electromagnetism (presence of air) and introduces self-adaptive mesh refinement procedures. Optimization techniques are then covered in Chapter 15, with the adaptation of deterministic and probabilistic methods to the numerical finite element environment. Chapter 16 presents a variational approach of electromagnetism, showing how Maxwell equations are derived from thermodynamic principles.

Finite Elements for Electrical Engineers

Finite Elements in Electrical and Magnetic Field Problems

Electrical Machine Theory Through Finite Element Analysis

Three Dimensional Finite Element Analysis of Electrical and Magnetic Stimulation of the Cerebral Cortex

The Finite Element Method in Engineering

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.

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.

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 electrical, mechanical, nuclear, aeronautics, and transportation industries. Electromagnetic Modeling by Finite Element Methods offers a wide range of examples, including torque, vibration, and iron loss calculation; coupling of the FEM with mechanical equations, circuits, converters, and thermal effects; material modeling; and proven methods for hysteresis implementation into FEM codes. Providing experimental results and comparisons from the authors' personal research, Electromagnetic Modeling by Finite Element Methods supplies techniques to implement FEM for solving Maxwell's equations, analyze electrical and magnetic losses, determine the behavior of electrical machines, evaluate force distribution on a magnetic medium, simulate movement in electrical machines and electromagnetic devices fed by external circuits or static converters, and analyze the vibrational behavior of electrical machines.

Electrical Machine Analysis Using Finite Elements

The Finite Element Method for Electromagnetic Modeling

Parallel Finite-element Analysis and Optimization of Electrical Defibrillation

Electromagnetics through the Finite Element Method

Finite element analysis of electrical devices coupled to electric circuits

From the fan motor in your PC to precision control of aircraft, electrical machines of all sizes, varieties, and levels of complexity permeate our world. Some are very simple, while others require exacting and application-specific design. Electrical Machine Analysis Using Finite Elements provides the tools necessary for the analysis and design of any type of electrical machine by integrating mathematical/numerical techniques with analytical and
Building successively from simple to complex analyses, this book leads you step-by-step through the procedures and illustrates their implementation with examples of both traditional and innovative machines. Although the examples are of specific devices, they demonstrate how the procedures apply to any type of electrical machine, introducing a preliminary theory followed by various considerations for the unique circumstance. The author
background underlying the analysis, but emphasizes application of the techniques, common strategies, and obtained results. He also supplies codes for simple algorithms and reveals analytical methodologies that universally apply to any software program. With step-by-step coverage of the fundamentals and common procedures, Electrical Machine Analysis Using Finite Elements offers a superior analytical framework that allows you to ada
any software platform, and to any specific requirements that you may encounter.
The first book applying HBFEM to practical electronic nonlinear field and circuit problems • Examines and solves wide aspects of practical electrical and electronic nonlinear field and circuit problems presented by HBFEM • Combines the latest research work with essential background knowledge, providing an all-encompassing reference for researchers, power engineers and students of applied electromagnetics analysis • There are very few
solution of nonlinear electric- power-related problems • The contents are based on the authors' many years' research and industry experience; they approach the subject in a well-designed and logical way • It is expected that HBFEM will become a more useful and practical technique over the next 5 years due to the HVDC power system, renewable energy system and Smart Grid, HF magnetic used in DC/DC converter, and Multi-pulse trans
supply • HBFEM can provide effective and economic solutions to R&D product development • Includes Matlab exercises
This book addresses the history of finite element analysis (FEA) and why FEA is becoming a necessary tool for the solution of a wide variety of problems encountered in the professsional engineer's career. It helps the user to solve general classes of problems with FEA on personal computers.
A Simplified Approach Using Maxwell's Equations
Harmonic Balance Finite Element Method
Finite Element Methods in Electrical Power Engineering
Finite Element Analysis of Electrical Machines
Antennas, Microwave Circuits, and Scattering Applications
Like the earlier editions, this text begins by deriving finite elements for the simplest familiar potential fields, then advances to formulate finite elements for a wide range of applied electromagnetics problems. A wide selection of demonstration programs allows the reader to follow the practical use of the methods.
Three Dimensional Finite Element Analysis of Electromagnetic Fields in Electrical Devices
Conbination of Two-dimensional Finite Element Analysis of Electrical Machines with Circuit Simulation Techniques
Transients, Control Principles, Finite Element Analysis, and Optimal Design with MATLAB®
Some Applications of the Finite Element Method in Electrical Engineering Design
Finite Element Methods in CAD