

Electromagnetic Finite Element Analysis in Design of Electrical Machines

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Finite element analysis or FEA is a very powerful computational technique that has revolutionised design engineering in recent times. Here I intend to talk about its usefulness in design of Electrical Machines. Consider a region of space and a set of dependent variables which obeys a set of differential equations over that region. Suppose, that region is enclosed by a boundary and the values of those variables at the boundary points are known. Now consider a mathematical problem that asks to compute the values of those variables at every single point of that region. These kind of problems are called *boundary value problems* in mathematics. These are also known as *field problems* and the set of differential equations governing the system are called *field equations*. This is the exact problem that an engineer faces while attempting to design an electrical machine. The field equations here are nothing but the Maxwell's Equations and the variables of interest here are *magnetic field intensity* and *flux density*. Once these quantities are known, all other quantities like flux linkages of different coils, voltages induced, torque and power produced can be easily derived from simple mathematical relations.

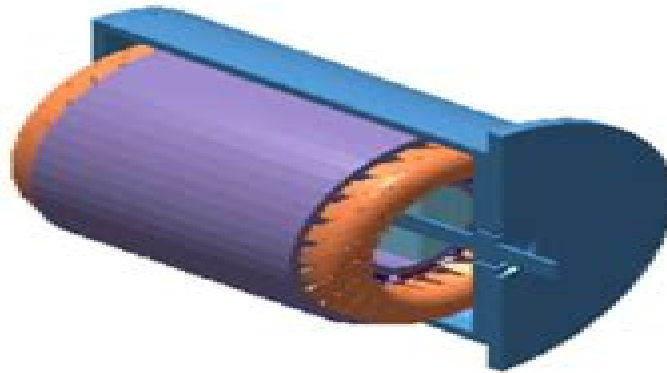


Figure 1: In a practical Electrical Machine, the structure is so complicated that it is almost impossible to solve the field equations by conventional methods.

Finite Element Analysis Of Electrical Machines

Nicola Bianchi



Finite Element Analysis Of Electrical Machines:

Finite Element Analysis of Electrical Machines Sheppard J. Salon, 2012-12-06 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

Finite Element Analysis Of Electrical Machines Sheppard Joel Salon, 2006-10-01 **Electrical Machine Analysis Using Finite Elements** Nicola Bianchi, 2005 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 design methodologies 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 presents the mathematical 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 adapt to any electrical machine to any software platform and to any specific requirements that you may encounter **Finite Elements for Electrical Engineers** Peter Peet Silvester, Ronald L. Ferrari, 1996-09-05 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 *Finite Element Analysis of Electrical Machines, Transformers and Electromagnetic Actuators* Erich Schmidt, 2007 **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 Combination of Two-dimensional Finite Element Analysis of Electrical Machines with Circuit Simulation Techniques Janne Väänänen, 1995 Electric Machines Ion Boldea, Lucian N. Tutelea, 2021-10-08

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Combination of two-dimensional finite element analysis of electrical machines with circuit simulation techniques Janne Väänänen,1995 *Electromagnetic Fields in Mechatronics, Electrical and Electronic Engineering* Andrzej

Krawczyk, Sławomir Wiak, Xose M. Lopez-Fernandez, 2006 More and more researchers engage into investigation of electromagnetic applications especially these connected with mechatronics information technologies medicine biology and material sciences It is readily seen when looking at the content of the book that computational techniques which were under development during the last three decades and are still being developed serve as good tools for discovering new electromagnetic phenomena It means that the field of computational electromagnetics belongs to an application area rather than to a research area This publication aims at joining theory and practice thus the majority of papers are deeply rooted in engineering problems being simultaneously of high theoretical level The editors hope to touch the heart of the matter in electromagnetism The book focuses on the following issues Computational Electromagnetics Electromagnetic Engineering Coupled Field and Special Applications Micro and Special Devices Bioelectromagnetics and Electromagnetic Hazard and Magnetic Material Modelling Abstracted in Inspec **Electric Machines** Ion Boldea, Lucian N. Tutelea, 2021-10-07 This

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Mathematical Models for the Design of Electrical Machines Frédéric Dubas, Kamel Boughrara, 2021-03-15 This book is a comprehensive set of articles reflecting the latest advances and developments in mathematical modeling and the design of electrical machines for different applications The main models discussed are based on the i Maxwell Fourier method i e the formal resolution of Maxwell s equations by using the separation of variables method and the Fourier s series in 2 D or 3 D with a quasi Cartesian or polar coordinate system ii electrical thermal and magnetic equivalent circuit iii hybrid model In these different papers the numerical method and the experimental tests have been used as comparisons or validations

Integration of Finite Element Analysis in Electric Machines and Drives Teaching Studio Nidhishri Tapadia, 2009

Essentials of Electrical Machines Lakshman Kalyan, 2025-02-20 Essentials of Electrical Machines offers a comprehensive exploration of the principles operation and applications of electrical machines tailored for undergraduate students With a focus on clarity and accessibility this book is an indispensable resource for students delving into electrical engineering We cover fundamental concepts such as electromechanical energy conversion magnetic circuits and transformer theory providing a solid foundation for understanding various electrical machines including DC machines synchronous machines and induction machines Through clear explanations illustrative examples and practical applications students gain a deep understanding of electrical machine behavior in real world scenarios Designed to cater to diverse learning styles the book features engaging exercises thought provoking problems and interactive simulations to reinforce concepts and promote active learning Whether pursuing a degree in electrical engineering or related fields readers will find this book to be an invaluable companion in mastering electrical machines With its emphasis on practical relevance and conceptual clarity Essentials of Electrical Machines equips students with the knowledge and skills necessary to tackle challenges in electrical engineering

Electric Machines Dionysios Aliprantis, Oleg Wasynczuk, 2022-08-11 Offering a new perspective this textbook demystifies the operation of electric machines by providing an integrated understanding of electromagnetic fields electric circuits numerical analysis and computer programming It presents fundamental concepts in a rigorous manner emphasising underlying physical modelling assumptions and limitations and provides detailed explanations of how to implement the finite element method to explore

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Electrical Machine Fundamentals with Numerical Simulation using MATLAB / SIMULINK Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, 2021-04-21 A comprehensive text combining all important concepts and topics of Electrical Machines and featuring exhaustive simulation models based on MATLAB Simulink Electrical Machine Fundamentals with Numerical Simulation using MATLAB Simulink provides readers with a basic understanding of all key concepts related to electrical machines including working principles equivalent circuit and analysis It elaborates the fundamentals and offers numerical problems for students to work through Uniquely this text includes simulation models of every type of machine described in the book enabling students to design and analyse machines on their own Unlike other books on the subject this book meets all the needs of students in electrical machine courses It balances analytical treatment physical explanation and hands on examples and models with a range of difficulty levels The authors present complex ideas in simple easy to understand language allowing students in all engineering disciplines to build a solid foundation in the principles of electrical machines This book Includes clear elaboration of fundamental concepts in the area of electrical machines using simple language for optimal and enhanced learning Provides wide coverage of topics aligning with the electrical machines syllabi of most international universities Contains extensive numerical problems and offers MATLAB Simulink simulation models for the covered machine types Describes MATLAB Simulink modelling procedure and introduces the modelling environment to novices Covers magnetic circuits transformers rotating machines DC machines electric vehicle motors multiphase machine concept winding design and details finite element analysis and more Electrical Machine Fundamentals with Numerical Simulation using MATLAB Simulink is a well balanced textbook perfect for undergraduate students in all engineering majors Additionally its comprehensive treatment of electrical machines makes it suitable as a reference for researchers in the field

Industrial Electromagnetics Modelling J. Caldwell, R. Bradley, 2012-12-06 During the past few years the rapid development of computer technology has made high power computing facilities more readily accessible to a greater proportion of our industrial and academic community This development coupled with the recent upsurge in mathematical modelling and computer simulation has led to significant developments in electromagnetic field theory and its applications to industry In view of such developments and the present high interest to both academics and industry the theme chosen for the Polymodel 6 Conference held at Newcastle upon Tyne in May 1983 was Industrial Electromagnetics Modelling To date

the North East Polytechnics Mathematical Modelling and Computer Simulation Group has organised five successful Polymodel conferences each with a different theme The objectives of the Polymodel group include the promotion of collaborative research between Newcastle Sunderland and Teesside Polytechnics and industry in the areas of mathematical modelling and computer simulation The aim of the Polymodel 6 Conference was to call on and use the modelling and computer simulation expertise of eminent academics and industrialists who are deeply involved in the area of electro magnetics These proceedings have a twofold purpose in that they contain current analytical and numerical techniques relevant to electromagnetic field problems and useful ideas on the modelling and simulation techniques which are most appropriate It was also felt important to include implications of computer developments both hardware and software on such work

Combination of Power Electronic Models with the Two-dimensional Finite Element Analysis of Electrical Machines Janne Väänänen,1994

Electromagnetic Modeling by Finite Element Methods João Pedro A. Bastos,Nelson Sadowski,2003-04-01 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

Electrical Machine Theory Through Finite Element Analysis A. Monti,F. Ponci,M. Riva,2007

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