Dynamic Simulation of Electrical Machines and Drive Systems Using MATLAB GUI

Viliam Fedák, Tibor Balogh and Pavel Záskalický

1. Introduction

Since the first appearance, the fields of electrical machine and drive systems have been continuously enriched by introduction of many important topics. Progress in power electronics, microcontrollers, new materials and advances in numerical modeling have led to development of new types of electrical machines and in field of electrical drives to realization of complex control algorithms. Their verification is usually done by simulation during system design, thus the effort is concentrated to development of simulation models.

MATLAB offers almost infinite possibilities for easy development of system models. MATLAB GUI (Graphic User Interface) in connection with Simulink and specialized toolboxes present a suitable and easy programmable tool for development of purpose-oriented virtual model of any dynamical system. Easy and comfortable change of parameters by control elements in MATLAB GUIDE (GUI Development Environment), such as push- and radio- buttons, text boxes, and easy visualization of results, enable to develop virtual models without deep knowledge of their substance nor without a tedious programming and debugging the models.

Well-elaborated models of electrical drives and machines available on-line were developed by (Riaz, n.d.). (Saadat, 2012) presented application of MATLAB GUI for electrical engineering subjects, available online and MATLAB GUI was utilized in (Petropol-Serb et al, 2007) for development of virtual model of induction machine.

Our contribution aims to present methodology and results in development of unified series of virtual models for electrical machines and drive systems using MATLAB GUI. The organization of the contribution is as follows: after brief description of tasks at virtual models design in GUI MATLAB (chapter 2) in the third chapter we describe development of few typical GUI oriented models of (more complex) electrical machines starting from a

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Dynamic Simulation of Electrical Machines and Drive Systems Using MATLAB GUI. Viliam Fedák,Pavel Záskalický,Tibor Balogh,2012 *Dynamic Simulation of Electric Machinery* Chee-Mun Ong,1998 This book and its accompanying CD ROM offer a complete treatment from background theory and models to implementation and verification techniques for simulations and linear analysis of frequently studied machine systems Every chapter of Dynamic Simulation of Electric Machinery includes exercises and projects that can be explored using the accompanying software A full chapter is devoted to the use of MATLAB and SIMULINK and an appendix provides a convenient overview of key numerical methods used Dynamic Simulation of Electric Machinery provides professional engineers and students with a complete toolkit for modeling and analyzing power systems on their desktop computers *Permanent Magnet Synchronous and Brushless DC Motor Drives* Ramu Krishnan,2017-12-19 Despite two decades of massive strides in research and development on control strategies and their subsequent implementation most books on permanent magnet motor drives still focus primarily on motor design providing only elementary coverage of control and converters Addressing that gap with information that has largely been disseminated only in journals and at conferences Permanent Magnet Synchronous and Brushless DC Motor Drives is a long awaited comprehensive overview of power electronic converters for permanent magnet synchronous machines and control strategies for variable speed operation It introduces machines power devices inverters and control and addresses modeling implementation control strategies and flux weakening operations as well as parameter sensitivity and rotor position sensorless control Suitable for both industrial and academic audiences this book also covers the simulation low cost inverter topologies and commutation torque ripple of PM brushless DC motor drives Simulation of the motor drives system is illustrated with MATLAB codes in the text This book is divided into three parts fundamentals of PM synchronous and brushless dc machines power devices inverters PM synchronous motor drives and brushless dc motor drives With regard to the power electronics associated with these drive systems the author Explores use of the standard three phase bridge inverter for driving the machine power factor correction and inverter control Introduces space vector modulation step by step and contrasts with PWM Details dead time effects in the inverter and its compensation Discusses new power converter topologies being considered for low cost drive systems in PM brushless DC motor drives This reference is dedicated exclusively to PM ac machines with a timely emphasis on control and standard and low cost converter topologies Widely used for teaching at the doctoral level and for industrial audiences both in the U S and abroad it will be a welcome addition to any engineer s library **Electric Machines and Drives** Shaahin Filizadeh,2013-02-20 Electric machines have a ubiquitous presence in our modern daily lives from the generators that supply electricity to motors of all sizes that power countless applications Providing a balanced treatment of the subject Electric Machines and Drives Principles Control Modeling and Simulation takes a ground up approach that emphasizes fundamental principles The author carefully deploys physical insight

mathematical rigor and computer simulation to clearly and effectively present electric machines and drive systems Detailing the fundamental principles that govern electric machines and drives systems this book Describes the laws of induction and interaction and demonstrates their fundamental roles with numerous examples Explores dc machines and their principles of operation Discusses a simple dynamic model used to develop speed and torque control strategies Presents modeling steady state based drives and high performance drives for induction machines highlighting the underlying physics of the machine Includes coverage of modeling and high performance control of permanent magnet synchronous machines Highlights the elements of power electronics used in electric drive systems Examines simulation based optimal design and numerical simulation of dynamical systems Suitable for a one semester class at the senior undergraduate or a graduate level the text supplies simulation cases that can be used as a base and can be supplemented through simulation assignments and small projects It includes end of chapter problems designed to pick up on the points presented in chapters and develop them further or introduce additional aspects The book provides an understanding of the fundamental laws of physics upon which electric machines operate allowing students to master the mathematical skills that their modeling and analysis requires

Power Quality in Power Systems, Electrical Machines, and Power-Electronic Drives Ewald F. Fuchs,Mohammad A. S. Masoum,2023-02-13 Power Quality in Power Systems Electrical Machines and Power Electronic Drives uses current research and engineering practices guidelines standards and regulations for engineering professionals and students interested in solving power quality problems in a cost effective reliable and safe manner within the context of renewable energy systems The book contains chapters that address power quality across diverse facets of electric energy engineering including AC and DC transmission and distribution lines end user applications such as electric machines transformers inductors capacitors wind power and photovoltaic power plants and variable speed variable torque power electronic drives The book covers nonsinusoidal waveshapes voltage disturbances harmonic losses aging and lifetime reductions single time events such as voltage dips and the effects of variable speed drives controlled by PWM converters The book also reviews a corpus of techniques to mitigate power quality problems such as the optimal design of renewable energy storage devices including lithium ion batteries and fuel cells for automobiles serving as energy storage and the optimal design of nonlinear loads for simultaneous efficiency and power quality Provides theoretical and practical insights into power quality problems related to future smart grid renewable hybrid electric power systems electric machines and variable speed variable torque power electronic drives Contains a highly varied corpus of practical applications drawn from current international practice Designed as a self study tool with end of chapter problems and solutions designed to build understanding Includes very highly referenced chapters that enable readers to save time and money in the research discovery process for critical research articles regulatory standards and guidelines   **Linear Electric Machines, Drives, and MAGLEVs Handbook** Ion Boldea,2023-07-31 Linear motion is richly present in various industries from direct electric propulsion in urban and

interurban people movers on wheels or on magnetic cushions MAGLEVs to indoor transport of goods conveyors etc through plunger solenoids to open hotel doors and as electromagnetic power switches to compressor drives by linear oscillatory permanent magnet PM motors smart phones integrated microphone and loudspeakers and controlled vehicles suspension etc Besides the traditional rotary motor drives with mechanical transmissions which mean friction limitations weather dependent in traction heavy vehicles more losses positioning errors backlash in the process and higher maintenance costs to handle them linear motion in industry by direct electromagnetic forces is free of friction limitations for traction free of mechanical transmission and thus more efficient with less maintenance cost and fewer positioning errors backlash This explains why they are used in so many applications already since the dramatic advancement of power electronics and digital control in the last four decades Modeling performance design control and testing of linear electric machines LEMs show notable differences with respect to rotary electric motor drives which warrant a dedicated treatment of these aspects The Second Edition First Edition 2013 concentrates on the above technical aspects of various types of LEMs in close relationship with specific applications via numerical examples of modeling design control and testing with ample representative results from literature industry and some of the author s contributions such as Technical field and circuit modeling of linear induction motors in flat configurations for low and high speeds with and without dynamic end effects and in tubular configurations short travel design control and testing Linear synchronous motor LSM drives in dc excited homopolar reluctance and superconducting excitation configurations for urban and interurban high speed vehicles propulsion and integrated propulsion and levitation in MAGLEVs modeling design and control with full scale numerical examples with emphasis on lower KWh passenger Km at high speeds Flat and tubular linear permanent magnet PM synchronous motors L PMSMs mainly destined to industrial indoor transport for automation at high efficiency in clean rooms Linear flux modulation motors new breed suitable for very low speed applications due to higher thrust density Plunger solenoids in various applications including new valve PM actuators with millisecond response time Linear resonant PM oscillatory motors design control and testing mainly destined to compressors for higher efficiency in compact drives Attraction and repulsive force suspension levitation systems for MAGLEVs Active and passive guideway MAGLEVs in urban and superhigh speed interurban transport at lower Kwh per passenger km in lighter vehicles without wheels The numerous numerical design and control examples with practical specifications throughout the 23 chapters of the book allow the reader deep and fast access to a practical but thorough unitary good for comparisons methodology in designing and controlling LEMs for various applications **International Conference on Electrical Machines and Drives** ,1997 <u>Automotive NVH Technology</u> Anton Fuchs,Eugenius Nijman,Hans-Herwig Priebsch,2015-10-31 This book presents seven chapters examining selected noise vibration and harshness NVH topics that are highly relevant for automotive vehicle development These include applications following the major trends toward increased passenger comfort vehicle electrification and lightweight design The authors of the seven

chapters all of which are experts from the automotive industry and academia present the foremost challenges and potential solutions in this demanding field Among others applications for sound optimization in downsized engines noise optimization in electric powertrains weight reduction options for exhaust systems porous materials description and the vibro acoustic analysis of geared systems are discussed   Electrical Machines and Drives Peter Vas,1992 The operation and simulation of a c and d c machines and a large number of variable speed drives including some of the most recently introduced modern drives are discussed here and a general theory applicable during their steady state and transient operation is presented Although the detailed mathematical analysis given relies mainly on space vector theory the relationship to other theories including the matrix theory of generalized machine theory is also emphasized Many of the equations are given in their state variable or analytical forms so that they can be used directly for computer simulations or for hand calculations Novel features of this book include descriptions of the exact and simplified performance analysis of a c machines and a large number of variable speed drives both large and small signal equations magnetic saturation effects are incorporated into the different models of smooth air gap and salient pole machines and extension of the space vector model to the double cage induction machine and the salient pole synchronous machine It is also demonstrated how all the various machine models used in the matrix model of electrical machines can be obtained without having to use matrix transformations while a systematic approach is given for the a priori deduction of all the transformations used in general machine theory Electrical Machines and Drives can be used without any prior knowledge of space vector or other theories it is aimed at students teachers and those researchers in industry and universities who require a deep understanding of the various aspects of the operation and the theories of electrical machines and drives and their simulation   **Power Quality in Power Systems and Electrical Machines** Ewald F. Fuchs,Mohammad A. S. Masoum,2015-07-14 The second edition of this must have reference covers power quality issues in four parts including new discussions related to renewable energy systems The first part of the book provides background on causes effects standards and measurements of power quality and harmonics Once the basics are established the authors move on to harmonic modeling of power systems including components and apparatus electric machines The final part of the book is devoted to power quality mitigation approaches and devices and the fourth part extends the analysis to power quality solutions for renewable energy systems Throughout the book worked examples and exercises provide practical applications and tables charts and graphs offer useful data for the modeling and analysis of power quality issues Provides theoretical and practical insight into power quality problems of electric machines and systems 134 practical application example problems with solutions 125 problems at the end of chapters dealing with practical applications 924 references mostly journal articles and conference papers as well as national and international standards and guidelines   Introduction to Electric Power and Drive Systems Paul C. Krause,Oleg Wasynczuk,Maher Hasan,Timothy O'Connell,2016-12-27 An introduction to the analysis of electric machines power electronic circuits electric drive

performance and power systems This book provides students with the basic physical concepts and analysis tools needed for subsequent coursework in electric power and drive systems with a focus on Tesla s rotating magnetic field Organized in a flexible format it allows instructors to select material as needed to fit their school s power program The first chapter covers the fundamental concepts and analytical methods that are common to power and electric drive systems The subsequent chapters offer introductory analyses specific to electric machines power electronic circuits drive system performance and simulation and power systems In addition this book Provides students with an analytical base on which to build in advanced follow on courses Examines fundamental power conversions dc dc ac dc and dc ac harmonics and distortion Describes the dynamic computer simulation of a brushless dc drive to illustrate its performance with both a sinusoidal inverter voltage approximation and more realistic stator six step drive applied voltages Includes in chapter short problems numerous worked examples and end of chapter problems to help readers review and more fully understand each topic Paul C Krause is Board Chairman of PC Krause and Associates Inc PCKA and a retired Professor of Electrical and Computer Engineering at Purdue University He has authored or co authored more than 100 technical papers and is the co author of Analysis of Electric Machinery and Drive Systems Third Edition Wiley IEEE Press and Electromechanical Motion Devices Second Edition Wiley IEEE Press He is a Life Fellow of the IEEE and was the 2010 recipient of the IEEE Nikola Tesla Award Oleg Wasynczuk is Professor of Electrical and Computer Engineering at Purdue University and Chief Technical Officer of PCKA He has authored or co authored more than 100 technical papers and is the co author of Analysis of Electric Machinery and Drive Systems Third Edition Wiley IEEE Press and Electromechanical Motion Devices Second Edition Wiley IEEE Press He is a Fellow of the IEEE and was the 2008 recipient of the IEEE PES Cyril Veinott Electromechanical Energy Conversion Award Timothy O Connell is a Senior Lead Engineer at PCKA where he leads a multi member industry modeling and simulation team supporting the design and analysis of more electric aircraft He has authored or co authored over 20 technical papers on electric machine analysis and design aerospace power systems and modeling and simulation He is a Senior Member of IEEE Maher Hasan is a Senior Lead Engineer at PCKA where he has led several software development efforts for the simulation of circuits and electromechanical and power systems and is involved in modeling and simulation in support of multiple efforts He has authored or co authored several technical papers in the fields of dynamic simulation and numerical methods

Advanced Electrical Drives Rik W. De Doncker,Duco W.J. Pulle,André Veltman,2020-08-21 This book provides a unique approach to derive model based torque controllers for all types of Lorentz force machines i e DC synchronous and induction machines The rotating transformer model forms the basis for the generalized modeling approach of rotating field machines which leads to the development of universal field oriented control algorithms Contrary to this direct torque control algorithms using observer based methods are developed for switched reluctance machines Tutorials are included at the end of each chapter and the reader is encouraged to execute these tutorials in order to gain familiarity with the dynamic behavior

of drive systems This updated edition uses PLECS simulation and vector processing tools that were specifically adopted for the purpose of these hands on tutorials Hence Advanced Electrical Drives encourages learning by doing and the experienced drive specialist may find the simulation tools useful to design high performance torque controllers Although it is a powerful reference in its own right when used in conjunction with the companion texts Fundamentals of Electrical Drives and Applied Control of Electrical Drives this book provides a uniquely comprehensive reference set that takes readers all the way from understanding the basics of how electrical drives work to deep familiarity with advanced features and models to a mastery of applying the concepts to actual hardware in practice Teaches readers to perform insightful analysis of AC electrical machines and drives Introduces new modeling methods and modern control techniques for switched reluctance drives Updated to use PLECS simulation tools for modeling electrical drives including new and more experimental results Numerous tutorials at end of each chapter to learn by doing step by step Includes extra material featuring build and play lab modules for lectures and self study   *Analysis and Control of Electric Drives* Ned Mohan,Siddharth Raju,2020-08-27 A guide to drives essential to electric vehicles wind turbines and other motor driven systems Analysis and Control of Electric Drives is a practical and comprehensive text that offers a clear understanding of electric drives and their industrial applications in the real world including electric vehicles and wind turbines The authors noted experts on the topic review the basic knowledge needed to understand electric drives and include the pertinent material that examines DC and AC machines in steady state using a unique physics based approach The book also analyzes electric machine operation under dynamic conditions assisted by Space Vectors The book is filled with illustrative examples and includes information on electric machines with Interior Permanent Magnets To enhance learning the book contains end of chapter problems and all topics covered use computer simulations with MATLAB Simulink and Sciamble Workbench software that is available free online for educational purposes This important book Explores additional topics such as electric machines with Interior Permanent Magnets Includes multiple examples and end of chapter homework problems Provides simulations made using MATLAB Simulink and Sciamble Workbench free software for educational purposes Contains helpful presentation slides and Solutions Manual for Instructors simulation files are available on the associated website for easy implementation A unique feature of this book is that the simulations in Sciamble Workbench software can seamlessly be used to control experiments in a hardware laboratory Written for undergraduate and graduate students Analysis and Control of Electric Drives is an essential guide to understanding electric vehicles wind turbines and increased efficiency of motor driven systems   *Modeling and High Performance Control of Electric Machines* John Chiasson,2005-04-07 Any electrical device that transmits or modifies energy to perform or assist in the performance of human tasks is an electric machine This technology is used daily in all industries around the world The author emphasizes in this book the modeling and methods for high performance control of electric machines based on elementary classical physics with an emphasis on high performance control methods A major reason for writing this book was

to make the modeling assumptions as clear as possible and to show that the magnetic and electric fields satisfy Maxwell s equations Midwest   **Seventh International Conference on Electrical Machines and Drives, 11-13 September 1995** ,1995 Over 100 papers cover electric vehicle drives induction machines and drives direct current machines analysis and simulation condition monitoring special machines reluctance machines synchronous machines and generators linear machines brushless direct current permanent magnet excited machines generators for wind power thermal effects an

Eighth International Conference on Electrical Machines and Drives ,1997   *Brushless Permanent-magnet and Reluctance Motor Drives* Timothy John Eastham Miller,1989 A presentation of the theory of brushless d c drives to help engineers appreciate the potential of such motors and apply them more widely by taking into account developments in permanent magnet materials power semiconductors electronic control and motor design   *Electrical Machines and Converters* H. Buyse,Jean Robert,1984   **Proceedings of ... International Conference on Power Electronics and Drive Systems** ,1999   Electrical Machines and Drives John Hindmarsh,1985

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