Direct Methods For Stability Analysis Of Electric Power Systems Theoretical Foundation Bcu Methodologies And Applications

This book treats various methods for stability analysis and controller design of local model networks (LMNs). LMNs have proved to be a powerful tool in nonlinear dynamic system identification. Their system architecture is more suitable for controller design compared to alternative approximation methods. The main advantage is that linear controller design methods can be, at least locally, applied and combined with nonlinear optimization to calibrate stable state feedback as well as PID controller. The calibration of stable state-feedback controllers is based on the closed loop stability analysis methods. Here, global LMIs (Linear Matrix Inequalities) can be derived and numerically solved. For LMN based nonlinear PID controllers deriving global LMIs is not possible. Thus, two approaches are treated in this book. The first approach works iteratively to get LMIs in each iteration step. The second approach uses a genetic algorithm to determine the PID controller parameters where for each individual the stability is checked. It allows simultaneous enhancement of (competing) optimization criteria. About the author Christian Mayr received the M.S. degree in mechanical engineering, the Ph.D. degree in technical sciences from TU Wien, Vienna, Austria, in 2009 and 2013, respectively. Since 2013 he is with AVL List GmbH, Graz, Austria. First as Development Engineer, from 2017 as Project Manager, in 2020 as Team Leader and since 2021 Department Manager for Virtualization Application.

In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy; operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to constraints associated with concepts of causality, memory and stationarity; methods of system representation with an accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and methods for information compression and filtering under condition that a filter model should satisfy restrictions associated with causality and different types of memory. As a result, the book represents a blend of new methods in general computational analysis, and specific, but also generic, techniques for study of systems theory ant its particular branches, such as optimal filtering and information compression. Best operator approximation, Non-Lagrange interpolation, Generic Karhunen-Loeve transform Generalised low-rank matrix approximation Optimal data compression Optimal nonlinear filtering

This research monograph is in some sense a sequel to the author's earlier one (Power System Stability, North Holland, New York 1981) which devoted cons- erable attention to Lyapunov stability theory, construction of Lyapunov fu- tions and vector Lyapunov functions as applied to power systems. This field of research has rapidly grown since 1981 and the more general concept of energy funct ion has found wide spread application in power systems. There have been advances in five distinct areas (i) Developing energy functions for structure preserving models which can incorporate non-linear load models (ii) Energy fu- tions to include detailed model of the generating unit i. e. , the synchronous machine and the excitation system (iii) Reduced order energy functions for large scale power systems, the simplest being the single machine infinite bus system (iv) Characterization of the stability boundary of the post-fault stable eQui- brium point (v) Applications for large power networks as a tool for dynamic security assessment. It was therefore felt appropriate to capture the essential features of these advances and put them in a somewhat cohesive framework. The chapters in the book rough ly fo llow this sequence. It is interesting to note how different research groups come to the same conclusion via different reas- ings.

Evaluation of the Direct Method for Power System Transient Stability Analysis

Stability Regions of Nonlinear Dynamical Systems

Power System Transient Stability Analysis Using the Transient Energy Function Method

Power System Transient Stability Analysis by Using the Direct Method of Lyapunov

Power System Stability and Control

This book explores limiting equations constructed in terms of the Bebutov-Miller-Sell concept, the method of comparison, and Lyapunov's direct method based on scalar, vector and matrix functions. The stability of abstract compacted and uniform dynamic processes, dispersed systems and evolutionary equations in Banach space are also discussed.

Probably the first book to describe computational methods for numerically computing steady state and Hopf bifurcations. Requiring only a basic knowledge of calculus, and using detailed examples, problems, and figures, this is an ideal textbook for graduate students.

This work seeks to provide a solid foundation to the principles and practices of dynamics and stability assessment of large-scale power systems, focusing on the use of interconnected systems - and aiming to meet the requirements of today's competitive and deregulated environments. It contains easy-to-follow examples of fundamental concepts and algorithmic procedures.

Slope Stability and Stabilization Methods

Improvements of BCU-based Direct Methods and Applications of BCU to Line Switching Designs for Enhancing Online Transient Stability of Look-ahead Power Systems

Voltage Stability Analysis of Power System

Direct Methods for Stability Analysis of Electric Power Systems

Selected Papers from the IFAC Symposium, Brussels, Belgium, 5-8 September 1988

Things fall apart

Direct Methods for Stability Analysis of Electric Power SystemsTheoretical Foundation, BCU Methodologies, and ApplicationsJohn Wiley & Sons

Power System Small Signal Stability Analysis and Control, Second Edition analyzes severe outages due to the sustained growth of small signal oscillations in modern interconnected power systems. This fully revised edition addresses the continued expansion of power systems and the rapid upgrade to smart grid technologies that call for the implementation of robust and optimal controls. With a new chapter on MATLAB programs, this book describes how the application of power system damping controllers such as Power System Stabilizers and Flexible Alternating Current Transmission System controllers—namely Static Var Compensator and Thyristor Controlled Series Compensator —can guard against system disruptions. Detailed mathematical derivations, illustrated case studies, the application of soft computation techniques, designs of robust controllers, and end-of-chapter exercises make it a useful resource to researchers, practicing engineers, and post-graduates in electrical engineering. Considers power system small signal stability and provides various techniques to mitigate it Offers a new and straightforward method of finding the optimal location of PSS in a multi-machine power system Includes MATLAB programs and simulations for practical applications

The market liberalization is expected to affect drastically the operation of power systems, which under economical pressure and increasing amount of transactions are being operated much closer to their limits than previously. These changes put the system operators faced with rather different and much more problematic scenarios than in the past. They have now to calculate available transfer capabilities and manage congestion problems in a near on line environment, while operating the transmission system under extremely stressed conditions. This requires highly reliable and efficient software aids, which today are non-existent, or not yet in use. One of the most problematic issues, very much needed but not yet en countered today, is on-line dynamic security assessment and control, enabling the power system to withstand unexpected contingencies without experienc ing voltage or transient instabilities. This monograph is devoted to a unified approach to transient stability assessment and control, called SIngle Machine Equivalent (S1ME).

Power Systems: Modelling and Control Applications

Transient Stability Analysis of Stability Regions for Nonlinear Autonomous Systems Via Direct Methods and Its Application in Power Systems

Transient Stability of Power Systems

An Investigation of Direct Methods for Power System Transient Stability Analysis

Small-signal stability, control and dynamic performance of power systems

Power System Stability

This book describes comprehensively theories and methods of the power system voltage stability. It first introduces the basic theory of the power system and the basic concept and classification of the power system stability and discusses the basic concepts of voltage stability, including the mechanism of voltage stability, and influencing factors of transient and medium-term and long-term voltage stability. This book also describes the elemental characteristics and models of important power system in voltage stability analysis and discusses the theories and methods of analysis on steady, transient and medium-term and long-term voltage stability analysis, respectively. Then, this book introduces the measures to improve the voltage stability. Finally, two examples of voltage stability analysis in engineering applications are introduced. This book is useful as a reference for engineers and technicians who are engaged in dispatching operation, planning, design and scientific research of the power system, and teachers and students of electrical engineering major in colleges and universities.

This book details the state of the art in the development and application of the transient energy function (TEF) method as a tool for power system transient stability assessment. It provides both the analytical foundations of the TEF method and the practical issues involved in the application of the method to analyze power systems. Of primary interest to electric utility engineers who need to understand and apply the technique, as well as engineers in research organizations involved in research and development projects on power system dynamics, and utility engineers interested in the use of the TEF method as a tool for dynamic security assessment.

This book discusses recent research on the stability of various neural networks with constrained signals. It investigates stability problems for delayed dynamical systems where the main purpose of the research is to reduce the conservativeness of the stability criteria. The book mainly focuses on the qualitative stability analysis of continuous-time as well as discrete-time neural networks with delays by presenting the theoretical development and real-life applications in these research areas. The discussed stability concept is in the sense of Lyapunov, and, naturally, the proof method is based on the Lyapunov stability theory. The present book will serve as a guide to enable the reader in pursuing the study of further topics in greater depth and is a valuable reference for young researcher and scientists.

Direct Stability Analysis of Large Electric Power Systems Using Energy Functions

Direct Methods for Transient Stability Analysis of Power Systems

New Methods and Insight

Assessment of Direct Methods in Power System Transient Stability Analysis for On-line Applications

Transient Stability Analysis Using Direct Method of Lyapunov

Direct Methods for Power System Transient Stability Analysis Using BCU Method

A major revision of the comprehensive text/reference Written by world-leading geotechnical engineers who share almost 100 years of combined experience, Slope Stability and Stabilization, Second Edition assembles the background information, theory, analytical methods, design and construction approaches, and practical examples necessary to carry out a complete slope stability project. Retaining the best features of the previous edition, this new book has been completely updated to address the latest trends and methodology in the field. Features include: All-new chapters on shallow failures and stability of landfill slopes New material on probabilistic stability analysis, cost analysis of stabilization alternatives, and state-of-the-art techniques in time-domain reflectometry to help engineers plan and model new designs Tested and FHA-approved procedures for the geotechnical stage of highway, tunnel, and bridge projects Sound guidance for geotechnical stage design and planning for virtually all types of construction projects Slope Stability and Stabilization, Second Edition is filled with current and comprehensive information, making it one of the best resources available on the subject-and an essential reference for today's and tomorrow's professionals in geology, geotechnical engineering, soil science, and landscape architecture.

The structure, layout, and components of the electric power grid are changing rapidly leading to new components, models, and power system static and dynamic behaviors that existing power system analysis tools cannot accommodate. Since electricity is an integral part of our daily lives, it is important that power system analysis and control tools keep up with the changes in the power grid. An existing methodology/tool with the potential to help the power industry keep up with the changing needs for dynamic stability and control of the power system, due to its strong theoretical basis, is the boundary of the stability region based controlling unstable equilibrium point (BCU) method. This thesis develops tools for the online transient stability analysis and control of modern power systems using the BCU method. Towards this goal we first propose a method for improving the robustness of unstable equilibrium point computations using a combination of quotient gradient transformation and the pseudo-transient continuation method. We also extend the application of the BCU method to the assessment of the transient stability of power systems with nonlinear excitation system models. The thesis also studies the dynamics of transmission line switching events under changing loading conditions and proposes and implements a novel BCU-based method for the direct transient stability assessment of transmission switching events. A method based on a three-stage strategy is also proposed for the fast determination of transmission line switching candidates that can be used to enhance the transient stability of multiple contingencies for look-ahead loading conditions of a power system. Finally, a three-stage, fast scenario-based tool for the online transient stability assessments of power systems with load or generation uncertainties under look-ahead load conditions is proposed and implemented.

An in-depth treatment of the transient stability problem, its physical description and formulation. Discusses methods for transient stability analysis, sensitivity assessment and control. Considers conventional and non-conventional techniques including direct and artificial intelligence, system theory, load modeling, evaluation of machine parameters, saturation effects and pattern recognition approaches. Features practical examples and simulation results.

Stability Analysis and Controller Design of Local Model Networks

(Methods of Limiting Equations

Analysis by the Direct Method of Lyapunov

Stability Theory by Liapunov's Direct Method

Theory and Practice

Recent Results

An authoritative treatment by leading researchers covering theory and optimal estimation, along with practical applications.

With contributions from worldwide leaders in the field, Power System Stability and Control, Third Edition (part of the five-volume set, The Electric Power Engineering Handbook) updates coverage of recent developments and rapid technological growth in essential aspects of power systems. Edited by L.L. Grigsby, a respected and accomplished authority in power engineering, and section editors Miroslav Begovic, Prabha Kundur, and Bruce Wollenberg, this reference presents substantially new and revised content. Topics covered include: Power System Protection Power System Dynamics and Stability Power System Operation and Control This book provides a simplified overview of advances in international standards, practices, and technologies, such as small signal stability and power system oscillations, power system stability controls, and dynamic modeling of power systems. This resource will help readers achieve safe, economical, high-quality power delivery in a dynamic and demanding environment. With five new and 10 fully revised chapters, the book supplies a high level of detail and, more importantly, a tutorial style of writing and use of photographs and graphics to help the reader understand the material. New Chapters Cover: Systems Aspects of Large Blackouts Wide-Area Monitoring and Situational Awareness Assessment of Power System Stability and Dynamic Security Performance Wind Power Integration in Power Systems FACTS Devices A volume in the Electric Power Engineering Handbook, Third Edition. Other volumes in the set: K12642 Electric Power Generation, Transmission, and Distribution, Third Edition (ISBN: 9781439856284) K12648 Power Systems, Third Edition (ISBN: 9781439856338) K12650 Electric Power Substations Engineering, Third Edition (9781439856383) K12643 Electric Power Transformer Engineering, Third Edition (9781439856291)

This authoritative treatment covers theory, optimal estimation and a range of practical applications. The first book on the subject, and written by leading researchers, this clear and rigorous work presents a comprehensive theory for both the stability boundary and the stability regions of a range of nonlinear dynamical systems including continuous, discrete, complex, two-time-scale and non-hyperbolic systems, illustrated with numerical examples. The authors also propose new concepts of quasi-stability region and of relevant stability regions and their complete characterisations. Optimal schemes for estimating stability regions of general nonlinear dynamical systems are also covered, and finally the authors describe and explain how the theory is applied in applications including direct methods for power system transient stability analysis, nonlinear optimisation for finding a set of high-quality optimal solutions, stabilisation of nonlinear systems, ecosystem dynamics, and immunisation problems.

Stability by Liapunov's Direct Method with Applications by Joseph L Salle and Solomon Lefschetz

Theoretical Foundation, BCU Methodologies, and Applications

Electric Power Problems

Direct Method of Lyapunov and Transient Stability Analysis

Practical Bifurcation and Stability Analysis

Theory, Estimation, and Applications

Learn how to implement BCU methods for fast direct stabilityassessments of electric power systems Electric power providers around the world rely on stabilityanalysis programs to help ensure uninterrupted service to theircustomers. These programs are typically based on step-by-stepnumerical integrations of power system stability models to simulatesystem dynamic behaviors. Unfortunately, this offline practice isinadequate to deal with current operating environments. For years,direct methods have held the promise of providing real-timestability assessments; however, these methods have presentedseveral challenges and limitations. This book addresses these challenges and limitations with theBCU methods developed by author Hsiao-Dong Chiang. To date, BCUmethods have been adopted by twelve major utility companies in Asiaand North America. In addition, BCU methods are the only directmethods adopted by the Electric Power Research Institute in itslatest version of DIRECT 4.0. Everything you need to take full advantage of BCU methods isprovided, including: Theoretical foundations of direct methods Theoretical foundations of energy functions BCU methods and their theoretical foundations Group-based BCU method and its applications Numerical studies on industrial models and data Armed with a solid foundation in the underlying theory of directmethods, energy functions, and BCU methods, you'll discover how toefficiently solve complex practical problems in stability analysis.Most chapters begin with an introduction and end with concludingremarks, making it easy for you to implement these tested andproven methods that will help you avoid costly and dangerous poweroutages.

A number of methods currently exist for the analysis and design of slopes. This book provides a critical review of these and offers several more appropriate approaches for overcoming numerical convergence and the location of critical failure surfaces in two-dimensional and three-dimensional cases. New concepts in three-dimensional stability analysis, finite element analysis and the extension of slope stability problems to lateral earth pressure problems are also addressed. It gives helpful practical advice and design resources in the form of recommendations for good analysis and design practice, design charts and tables for the engineer. Limitations are detailed of both limit equilibrium and the finite element method in the assessment of the stability of a slope, and guidance is provided for assessing the fundamental assumptions and limitations of stability analysis methods and computer modelling. The book provides ample examples to illustrate how this range of problems should be dealt with. The final chapter touches on design and its implementation on site. The emphasis is on the transfer of the design to its physical implementation on site in a holistic way, taking full account of the latest developments in construction technology. Engineering and construction problems tend to be pigeonholed into different classes of problem such as slope stability, bearing capacity and earth pressure behind retaining structures. This is quite unnecessary. This book offers a unified approach, which is conceptually, practically and philosophically more satisfying.

The control of power systems and power plants is a subject of worldwide interest which continues to sustain a high level of research, development and application. Papers pertaining to areas directly related to power systems and representing the state-of-the-art methods are included in this volume. The topics covered include security analysis, dynamic state estimation, voltage control, power plant control, stability analysis, data communication, expert systems and training simulators for power plants. This interchange between those involved in the research and those involved in the practical applications of new ideas and developments provide a comprehensive reference source for all involved in the power industry.

The Mathematical Challenge : Proceedings of a Conference, Seattle, Washington, March 18-20, 1980

Electric Systems, Dynamics, and Stability with Artificial Intelligence Applications

Stability of Motion of Nonautonomous Systems (Methods of Limiting Equations)

stability analysis in ecology via Liapunov's direct method

Stability Analysis by the Direct Method of Liapunov

A Unified Approach to Assessment and Control

A thorough and exhaustive presentation of theoretical analysis and practical techniques for the small-signal analysis and control of large modern electric power systems as well as an assessment of their stability and damping performance.

This monograph is a collective work. The names appear ing on the front cover are those of the people who worked on every chapter. But the contributions of others were also very important: C. Risito for Chapters I, II and IV, K. Peiffer for III, IV, VI, IX R. J. Ballieu for I and IX, Dang Chau Phien for VI and IX, J. L. Corne for VII and VIII. The idea of writing this book originated in a seminar held at the University of Louvain during the academic year 1971-72. Two years later, a first draft was completed. However, it was unsatisfactory mainly because it was ex cesively abstract and lacked examples. It was then decided to write it again, taking advantage of -some remarks of the students to whom it had been partly addressed. The actual text is this second version. The subject matter is stability theory in the general setting of ordinary differential equations using what is known as Liapunov's direct or second method. We concentrate our efforts on this method, not because we underrate those which appear more powerful in some circumstances, but because it is important enough, along with its modern developments, to justify the writing of an up-to-date monograph. Also excellent books exist concerning the other methods, as for example R. Bellman [1953] and W. A. Coppel [1965].

Direct methods are an alternative for power system transient stability analysis to avoid the enormous computational efforts of conventional time-domain method. The development of direct methods in last three decades makes it an effective potential approach to both on-line security assessment and off-line analysis tools. Among the direct methods, the Boundary of stability region based Controlling Unstable equilibrium point (BCU) method is the most successful, having a sound theoretical basis and practical application in power systems. It finds the controlling UEP of the original system via a reduced-state system. This thesis investigates the development of direct methods and the related theoretical foundation. Several widely used direct methods are presented and compared. The theoretical foundation and computational issues of BCU methods are discussed. Incorporation of more realistic power system models can be incorporated in BCU methods is introduced. Based on BCU method, some small system cases are tested for a given fault.

Slope Stability Analysis and Stabilization

A Stability Analysis Through Liapunov's Direct Method

Stability Analysis of Relay-control Systems Via the Direct Method of Lyapunov

Lyapunov Stability Analysis Applied to Systems of Lagrange Equations Using the Energy Metric Algorithm

Power System Small Signal Stability Analysis and Control

A Comparative Study of Direct Methods of Stability Analysis in Power Systems