

RELIABILITY ASSESSMENT OF LARGE ELECTRIC POWER SYSTEMS

Roy Billinton
and
Ronald N. Allan



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Reliability Assessment Of Large Electric Power Systems

**Marija Ilic, Francisco Galiana, Lester
Fink**



Reliability Assessment Of Large Electric Power Systems:

Reliability Assessment of Large Electric Power Systems Roy Billinton, Ronald N. Allan, 2012-12-06 We are very pleased to be asked to co author this book for a variety of reasons one of which was that it gave us further opportunity to work together The scope proposed was very wide with the only significant proviso being that the book should be in a monograph style and not a teaching text This requirement has given us the opportunity to compile a wide range of relevant material relating to present day knowledge and application in power system reliability As many readers will be aware we have collaborated in many ways over a relatively long period and have co authored two other books on reliability evaluation Both of these previous books were structured as teaching texts This present book is not a discourse on how to do reliability evaluation but a discussion on why it should be done and what can be done and achieved and as such does not replace or conflict with the previous books The three books are complementary and each enhances the others The material contained in this book is not specifically original since it is based on information which we have published in other forms either jointly or as co authors with various other people particularly our many research students We sincerely acknowledge the important contributions made by all these students and colleagues There are too many to mention individually in this preface but their names appear frequently in the references at the end of each chapter Electric Power Distribution Reliability Richard E.

Brown, 2017-12-19 Due to its high impact on the cost of electricity and its direct correlation with customer satisfaction distribution reliability continues to be one of the most important topics in the electric power industry Continuing in the unique tradition of the bestselling first edition *Electric Power Distribution Reliability* Second Edition consolidates all pertinent topics on electric power distribution into one comprehensive volume balancing theory practical knowledge and real world applications Updated and expanded with new information on benchmarking system hardening underground conversion and aging infrastructure this timely reference enables you to Manage aging infrastructure Harden electric power distribution systems Avoid common benchmarking pitfalls Apply effective risk management The electric power industry will continue to make distribution system reliability and customer level reliability a top priority Presenting a wealth of useful knowledge *Electric Power Distribution Reliability* Second Edition remains the only book that is completely dedicated to this important topic

Reliability Assessment of Electric Power Systems Using Monte Carlo Methods Billinton, W. Li, 2013-06-29 The application of quantitative reliability evaluation in electric power systems has now evolved to the point at which most utilities use these techniques in one or more areas of their planning design and operation Most of the techniques in use are based on analytical models and resulting analytical evaluation procedures Improvements in and availability of high speed digital computers have created the opportunity to analyze many of these problems using stochastic simulation methods and over the last decade there has been increased interest in and use made of Monte Carlo simulation in quantitative power system reliability assessment Monte Carlo simulation is not a new concept and recorded applications have existed for at least 50 yr

However localized high speed computers with large capacity storage have made Monte Carlo simulation an available and sometimes preferable option for many power system reliability applications Monte Carlo simulation is also an integral part of a modern undergraduate or graduate course on reliability evaluation of general engineering systems or specialized areas such as electric power systems It is hoped that this textbook will help formalize the many existing applications of Monte Carlo simulation and assist in their integration in teaching programs This book presents the basic concepts associated with Monte Carlo simulation

Power Systems Leonard L. Grigsby, 2017-12-19 Power Systems Third Edition part of the five volume set The Electric Power Engineering Handbook covers all aspects of power system protection dynamics stability operation and control Under the editorial guidance of L L Grigsby a respected and accomplished authority in power engineering and section editors Andrew Hanson Pritindra Chowdhuri Gerry Shebl and Mark Nelms this carefully crafted reference includes substantial new and revised contributions from worldwide leaders in the field This content provides convenient access to overviews and detailed information on a diverse array of topics Concepts covered include Power system analysis and simulation Power system transients Power system planning reliability Power electronics Updates to nearly every chapter keep this book at the forefront of developments in modern power systems reflecting international standards practices and technologies New sections present developments in small signal stability and power system oscillations as well as power system stability controls and dynamic modeling of power systems 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 Symmetrical Components for Power System Analysis Transient Recovery Voltage Engineering Principles of Electricity Pricing Business Essentials Power Electronics for Renewable Energy A volume in the Electric Power Engineering Handbook Third Edition Other volumes in the set K12642 Ele

Proceedings of the Tenth Power Systems Computation Conference Graz Austria, 2016-06-06 Proceedings of the Tenth Power Systems Computation Conference

Control and Dynamic Systems V42: Analysis and Control System Techniques for Electric Power Systems Part 2 C.T. Leonides, 2012-12-02 Control and Dynamic Systems Advances in Theory and Applications Volume 42 Analysis and Control System Techniques for Electric Power Systems Part 2 of 4 covers the research studies on the significant advances in areas including economic operation of power systems and voltage and power control techniques This book is composed of eight chapters and begins with a survey of the application of parallel processing to power system analysis as motivated by the requirement for faster computation The next chapters deal with the issues of power system protection from a system point of view the voltage stability phenomenon and an overview of the techniques used in the reliability evaluation of large electric power systems These chapters also look into the reliability assessment of bulk power systems which are the composite of generation and high voltage transmission often called composite systems These topics are followed by investigations of the potential of integer quadratic optimization to improve efficiency in a radial electric distribution system

through the coordination of switched capacitors and regulators Other chapters consider the issues of the optimal operation of a power system that are substantially complicated as a result of the large system scale nature of these issues The final chapters explore the techniques for achieving requisite speed improvements that are essential to electric power systems and the problems on effective methods in hydro optimization This book will be of value to electrical engineers designers and researchers

Reliability and Safety Engineering Ajit Kumar Verma, Srividya Ajit, Durga Rao Karanki, 2010-08-09 Reliability and safety are core issues that must be addressed throughout the life cycle of engineering systems Reliability and Safety Engineering presents an overview of the basic concepts together with simple and practical illustrations The authors present reliability terminology in various engineering fields viz electronics engineering software engineering mechanical engineering structural engineering and power systems engineering They describe the latest applications in the area of probabilistic safety assessment such as technical specification optimization risk monitoring and risk informed in service inspection Reliability and safety studies must inevitably deal with uncertainty so the book includes uncertainty propagation methods Monte Carlo simulation fuzzy arithmetic Dempster Shafer theory and probability bounds Reliability and Safety Engineering also highlights advances in system reliability and safety assessment including dynamic system modeling and uncertainty management Case studies from typical nuclear power plants as well as from structural software and electronic systems are also discussed Reliability and Safety Engineering combines discussions of the existing literature on basic concepts and applications with state of the art methods used in reliability and risk assessment of engineering systems It is designed to assist practicing engineers students and researchers in the areas of reliability engineering and risk analysis

The Electric Power Engineering Handbook - Five Volume Set Leonard L. Grigsby, 2018-12-14 The Electric Power Engineering Handbook Third Edition updates coverage of recent developments and rapid technological growth in crucial aspects of power systems including protection dynamics and stability operation and control With contributions from worldwide field leaders edited by L L Grigsby one of the world s most respected accomplished authorities in power engineering this reference includes chapters on Nonconventional Power Generation Conventional Power Generation Transmission Systems Distribution Systems Electric Power Utilization Power Quality Power System Analysis and Simulation Power System Transients Power System Planning Reliability Power Electronics Power System Protection Power System Dynamics and Stability Power System Operation and Control Content includes 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 Each book in this popular series 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 This resource will help readers achieve safe economical high quality power delivery in a dynamic and demanding environment Volumes in the set K12642 Electric Power Generation Transmission and Distribution Third Edition ISBN 9781439856284 K12648 Power Systems Third Edition ISBN

9781439856338 K13917 Power System Stability and Control Third Edition 9781439883204 K12650 Electric Power Substations Engineering Third Edition 9781439856383 K12643 Electric Power Transformer Engineering Third Edition 9781439856291 *Reliability of Power Systems* G.F. Kovalev, L.M. Lebedeva, 2019-05-23 This book presents essential methods and tools for research into the reliability of energy systems It describes in detail the content setting formalisation and use of algorithms for assessing the reliability of modern large and complex electric power systems The book uses a wealth of tables and illustrations to represent results and source information in a clear manner It discusses the main operating conditions which affect the reliability of electric power systems and describes corresponding computing tools which can help solve issues as they arise Further all methodologies presented here are demonstrated in numerical examples Though primarily intended for researchers and practitioners in the field of electric power systems the book will also benefit general readers interested in this area

Electricity Infrastructures in the Global Marketplace Thomas Hammons, 2011-06-08 This book discusses trends in the energy industries of emerging economies in all continents It provides the forum for dissemination and exchange of scientific and engineering information on the theoretical generic and applied areas of scientific and engineering knowledge relating to electrical power infrastructure in the global marketplace It is a timely reference to modern deregulated energy infrastructure challenges of restructuring electricity markets in emerging economies The topics deal with nuclear and hydropower worldwide biomass energy potential of the oceans geothermal energy reliability wind power integrating renewable and dispersed electricity into the grid electricity markets in Africa Asia China Europe India Russia and in South America In addition the merits of GHG programs and markets on the electrical power industry market mechanisms and supply adequacy in hydro dominated countries in Latin America energy issues under deregulated environments including insurance issues and the African Union and new partnerships for Africa's development is considered

Energy Abstracts for Policy Analysis, 1988 **Power System Oscillations** Graham Rogers, 2012-12-06 Power System Oscillations deals with the analysis and control of low frequency oscillations in the 0.2-3 Hz range which are a characteristic of interconnected power systems Small variations in system load excite the oscillations which must be damped effectively to maintain secure and stable system operation No warning is given for the occurrence of growing oscillations caused by oscillatory instability since a change in the system's operating condition may cause the transition from stable to unstable If not limited by nonlinearities unstable oscillations may lead to rapid system collapse Thus it is difficult for operators to intervene manually to restore the system's stability It follows that it is important to analyze a system's oscillatory behavior in order to understand the system's limits If the limits imposed by oscillatory instability are too low they may be increased by the installation of special stabilizing controls Since the late 60s when this phenomena was first observed in North American systems intensive research has resulted in design and installation of stabilizing controls known as power system stabilizers PSS The design location and tuning of PSS require special analytical tools This book addresses these

questions in a modal analysis framework with transient simulation as a measure of controlled system performance After discussing the nature of the oscillations the design of the PSS is discussed extensively using modal analysis and frequency response In the scenario of the restructured power system the performance of power system damping controls must be insensitive to parameter uncertainties Power system stabilizers when well tuned are shown to be robust using the techniques of modern control theory The design of damping controls which operate through electronic power system devices FACTS is also discussed There are many worked examples throughout the text The Power System Toolbox for use with MATLAB is used to perform all of the analyses used in this book The text is based on the author's experience of over 40 years as an engineer in the power industry and as an educator

Handbook of Reliability Engineering Hoang Pham, 2003-04-17 An effective reliability programme is an essential component of every product's design testing and efficient production From the failure analysis of a microelectronic device to software fault tolerance and from the accelerated life testing of mechanical components to hardware verification a common underlying philosophy of reliability applies Defining both fundamental and applied work across the entire systems reliability arena this state of the art reference presents methodologies for quality maintainability and dependability Featuring Contributions from 60 leading reliability experts in academia and industry giving comprehensive and authoritative coverage A distinguished international Editorial Board ensuring clarity and precision throughout Extensive references to the theoretical foundations recent research and future directions described in each chapter Comprehensive subject index providing maximum utility to the reader Applications and examples across all branches of engineering including IT power automotive and aerospace sectors The handbook's cross disciplinary scope will ensure that it serves as an indispensable tool for researchers in industrial electrical electronics computer civil mechanical and systems engineering It will also aid professional engineers to find creative reliability solutions and management to evaluate systems reliability and to improve processes For student research projects it will be the ideal starting point whether addressing basic questions in communications and electronics or learning advanced applications in micro electro mechanical systems MEMS manufacturing and high assurance engineering systems

Power Systems Restructuring Marija Ilic, Francisco Galiana, Lester Fink, 2013-03-14 The writing of this book was largely motivated by the ongoing unprecedented world wide restructuring of the power industry This move away from the traditional monopolies and toward greater competition in the form of increased numbers of independent power producers and an unbundling of the main services that were until now provided by the utilities has been building up for over a decade This change was driven by the large disparities in electricity tariffs across regions by technological developments that make it possible for small producers to compete with large ones and by a widely held belief that competition will be beneficial in a broad sense All of this together with the political will to push through the necessary legislative reforms has created a climate conducive to restructuring in the electric power industry Consequently since the beginning of this decade dramatic changes have taken place in an ever increasing list of

nations from the pioneering moves in the United Kingdom Chile and Scandinavia to today s highly fluid power industry throughout North and South America as well as in the European Community The drive to restructure and take advantage of the potential economic benefits has in our view forced the industry to take actions and make choices at a hurried pace without the usual deliberation and thorough analysis of possible implications We must admit that to speak of the industry at this juncture is perhaps disingenuous even misleading

Energy Conservation Update ,1980 Analysis of Subsynchronous Resonance in Power Systems K.R. Padiyar,2012-12-06 4 2 Analysis of induction generator effect frequency scanning method 83 4 3 Analysis of torsional interaction TI 87 4 4 State equations and eigenvalue analysis 96 4 5 An algorithm for computing torsional modes 108 4 6 Countermeasures for SSR III 4 7 Torsional oscillations in parallel connected turbine generators 120 121 5 INTERACTIONS WITH POWER SYSTEM STABILIZER 5 1 Introduction 121 5 2 Basic concept in the application of PSS 122 5 3 Design of PSS 126 5 4 Torsional interaction with PSS 130 5 5 A case study 132 6 INTERACTIONS WITH HVDC CONVERTER CONTROL 137 6 1 Introduction 137 6 2 HVDC converters and control 138 6 3 Modelling of HVDC system for study of torsional interactions 147 6 4 Analysis of torsional interactions A simplified approach 153 6 5 A case study 156 6 6 A simplified damping torque analysis 161 6 7 Control of torsional interaction 167 7 INTERACTIONS WITH SHUNT COMPENSATORS 169 7 1 Introduction 169 7 2 Static Var Compensator 171 7 3 Torsional Interactions with SVC 186 7 4 Static Condenser STATCON 189 7 5 Torsional interactions with STATCON 196 7 6 A simplified analysis of torsional interaction with voltage controller 200 8 INTERACTIONS WITH SERIES COMPENSATORS 205 8 1 Introduction 205 8 2 Thyristor Controlled Series Compensator 206 8 3 Modelling of TCSC for SSR studies 216 8 4 Mitigation of SSR with TCSC 223 8 5 Static Synchronous Series Compensator SSSC 229 8

International Scientific Conference Energy Management of Municipal Transportation Facilities and Transport EMMFT 2017 Vera Murgul,Zdenka Popovic,2017-12-19 This book includes the proceedings of the 19th International Scientific Conference Energy Management of Municipal Transportation Facilities and Transport EMMFT 2017 which was held in Khabarovsk Russia on 10 13 April 2017 The book presents the research findings of scientists working at universities in the Far Eastern Siberian and Ural Federal Districts of Russia and of Serbia which are unique regions notable for sustainably operating complex transport infrastructures in severe climatic and geographic environments It also offers practical insights into transportation operation under such conditions The book discusses the experiences of colleagues from Slovenia Ukraine and Latvia in the development of transport infrastructure and construction of transport facilities and features and includes the results of a wide range of studies such as managing multimodal transportation improving the efficiency of locomotives electric locomotives traction substations electrical substations relay protection and automation devices and power factor correction units It addresses topics like renewable energy sources problems of the mathematical and simulation modelling of electromagnetic processes of electrical power objects and systems aspects of cost reduction for fuel and power resources

theoretical aspects of energy management development of transport infrastructure modern organizational and technological solutions in construction new approaches in the field of management analysis and monitoring in transport sector Comprising 142 high quality articles covering a wide range of topics these proceedings are of interest to anyone engaged in transport engineering electric power systems energy management construction and operation of transport infrastructure buildings and facilities

State Estimation in Electric Power Systems A. Monticelli, 2012-12-06 State Estimation in Electric Power Systems A Generalized Approach provides for the first time a comprehensive introduction to the topic of state estimation at an advanced textbook level The theory as well as practice of weighted least squares WLS is covered with significant rigor Included are an in depth analysis of power flow basics proper justification of Stott's decoupled method observability theory and matrix solution methods In terms of practical application topics such as bad data analysis combinatorial bad data analysis and multiple snapshot estimation are covered The book caters both to the specialist as well as the newcomer to the field State estimation will play a crucial role in the emerging scenario of a deregulated power industry Many market decisions will be based on knowing the present state of the system accurately State Estimation in Electric Power Systems A Generalized Approach crystallizes thirty years of WLS state estimation theory and practice in power systems and focuses on techniques adopted by state estimation developers worldwide The book also reflects the experience of developing industrial grade state estimation software that is used in the USA South America and many other places in world

Operation of Restructured Power Systems Kankar Bhattacharya, Math H.J. Bollen, Jaap E. Daalder, 2012-12-06 Deregulation is a fairly new paradigm in the electric power industry And just as in the case of other industries where it has been introduced the goal of deregulation is to enhance competition and bring consumers new choices and economic benefits The process has obviously necessitated reformulation of established models of power system operation and control activities Similarly issues such as system reliability control security and power quality in this new environment have come in for scrutiny and debate In this book we attempt to present a comprehensive overview of the deregulation process that has developed till now focussing on the operation aspects As of now restructured electricity markets have been established in various degrees and forms in many countries This book comes at a time when the deregulation process is poised to undergo further rapid advancements It is envisaged that the reader will benefit by way of an enhanced understanding of power system operations in the conventional vertically integrated environment vis a vis the deregulated environment The book is aimed at a wide range of audience electric utility personnel involved in scheduling dispatch grid operations and related activities personnel involved in energy trading businesses and electricity markets institutions involved in energy sector financing Power engineers energy economists researchers in utilities and universities should find the treatment of mathematical models as well as emphasis on recent research work helpful

Transmission Grid Security Liisa Haarla, Mikko Koskinen, Ritva Hirvonen, Pierre-Etienne Labeau, 2011-01-20 In response to the growing importance of power system security and reliability Transmission Grid

Security proposes a systematic and probabilistic approach for transmission grid security analysis. The analysis presented uses probabilistic safety assessment (PSA) and takes into account the power system dynamics after severe faults. In the method shown in this book, the power system states (stable, not stable, system breakdown, etc.) are connected with the substation reliability model. In this way, it is possible to estimate the system-wide consequences of grid faults, identify a chain of events that might lead to blackout, and rank the importance of different substation components at the system level. Transmission Grid Security also presents the main features and basic mathematics of PSA. It provides the reader with up-to-date knowledge of the regulatory issues affecting the security of transmission grids in Europe. Transmission Grid Security gives a practical method for the security analysis of transmission grids, making it a valuable text for engineers and system operators as well as postgraduate students. It includes basic information and detailed modules for creating a reliability model that takes into account all the basic operations and components needed after grid faults.

Whispering the Techniques of Language: An Emotional Journey through **Reliability Assessment Of Large Electric Power Systems**

In a digitally-driven earth where monitors reign great and instant interaction drowns out the subtleties of language, the profound secrets and mental subtleties hidden within phrases usually go unheard. Yet, located within the pages of **Reliability Assessment Of Large Electric Power Systems** a charming fictional prize sporting with organic emotions, lies a fantastic journey waiting to be undertaken. Written by an experienced wordsmith, this enchanting opus invites readers on an introspective journey, lightly unraveling the veiled truths and profound influence resonating within the very cloth of each word. Within the psychological depths of this emotional review, we can embark upon a genuine exploration of the book's core subjects, dissect their charming publishing design, and yield to the effective resonance it evokes heavy within the recesses of readers' hearts.

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