Hydraulic Turbine Control Design A New Approach In Modeling Of Hydraulic Turbines Based On Velocity Diagram For Control Applications

Modelling and Controlling Hydropower PlantsSpringer Science & Business Media

This comprehensive text offers a detailed treatment of modelling of components and sub-systems for studying the transient and dynamic stability of large-scale power systems. Beginning with an overview of basic concepts of stability of simple systems, the book is devoted to in-depth coverage of modelling of synchronous machine and its excitation systems and speed governing controllers. Apart from covering the modelling aspects, methods of interfacing component models for the analysis of small-signal stability of power systems are presented in an easy-to-understand manner. The book also offers a study of simulation of transient stability of power systems as well as electromagnetic transients involving synchronous machines. Practical data pertaining to power systems, numerical examples and derivations are interspersed throughout the text to give students practice in applying key concepts. This text serves as a well-knit introduction to Power System Dynamics and is suitable for a one-semester course for the senior-level undergraduate students of electrical engineering and postgraduate students specializing in Power Systems. Contents: contents Preface 1. ONCE OVER LIGHTLY 2. POWER SYSTEM STABILITY—ELEMENTARY ANALYSIS 3. SYNCHRONOUS MACHINE MODELLING FOR POWER SYSTEM DYNAMICS 4. MODELLING OF OTHER COMPONENTS FOR DYNAMIC ANALYSIS 5. OVERVIEW OF NUMERICAL METHODS 6. SMALL-SIGNAL STABILITY ANALYSIS OF POWER SYSTEMS 7. TRANSIENT STABILITY ANALYSIS OF POWER SYSTEMS 8. SUBSYNCHRONOUS AND TORSIONAL OSCILLATIONS 9. ENHANCEMENT AND COUNTERMEASURES Index

Today's wind energy industry is at a crossroads. Global economic instability has threatened or eliminated many financial incentives that have been important to the development of specific markets. Now more than ever, this essential element of the world energy mosaic will require innovative research and strategic collaborations to bolster the industry as it moves forward. This text details topics fundamental to the efficient operation of modern commercial farms and highlights advanced research that will enable next-generation wind energy technologies. The book is organized into three sections, Inflow and Wake Influences on Turbine Performance, Turbine Structural Response, and Power Conversion, Control and Integration. In addition to fundamental concepts, the reader will be exposed to comprehensive treatments of topics like wake dynamics, analysis of complex turbine blades, and power electronics in small-scale wind turbine systems.

Wind-driven power systems represent a renewable energy technology. Arrays of interconnected wind turbines can convert power carried by the wind into electricity. This book defines a research and development agenda for the U.S. Department of Energy's wind energy program in hopes of improving the performance of this emerging technology.

Indexes materials appearing in the Society's Journals, Transactions, Manuals and reports, Special publications, and Civil engineering.

This book emphasizes the application of Linear Parameter Varying (LPV) gain scheduling techniques to the control of wind energy conversion systems. This reformulation of the classical problem of gain scheduling allows straightforward design procedure and simple controller implementation. From an overview of basic wind energy conversion, to analysis of common control strategies, to design details for LPV gain-scheduled controllers for both fixed- and variable-pitch, this is a thorough and informative monograph.

For many years, hydropower played an essential role in the development of humanity and has a long and successful track record. It is a conventional renewable energy source for generating electricity in small- and large-scale production. Due to its important utilization and future prospects, various interesting topics of research related to hydroelectric power generation are covered in this book. This book is the result of significant contributions from several researchers and experts worldwide. It is hoped that the book will become a useful source of information and basis for extended research for researchers, academics, policy makers, and practitioners in the area of renewable hydropower technologies.

Flow in the draft tube of a hydraulic turbine operating under off-design conditions is very complex. The instability of the swirling flow may lead to the formation of a helical precessing vortex called the "vortex rope". The vortex rope causes efficiency reduction, severe pressure fluctuation, and even structural vibration. The primary objectives of the present study are to model and analyze the vortex rope formation using high fidelity numerical simulations. In particular, this work aims to understand the fundamental physical processes governing the formation of the vortex rope, and to investigate the capability of turbulence models to simulate this complex flow. Furthermore, mitigation of the vortex rope formation is addressed. Specifically, a vortex rope control technique, which includes injection of water from the runner crown tip to the inlet of the draft tube, is numerically studied. A systematic approach is considered in this study starting from the simplest and advancing towards the most complicated test case. First, steady simulations are carried out for axisymmetric and three-dimensional grids in a simplified axisymmetric geometry. It is shown that steady simulations with Reynolds-averaged Navier-Stokes (RANS) models cannot resolve the vortex rope, and give identical symmetric results for both the axisymmetric and three-dimensional flow geometries. These RANS simulations underpredict the axial velocity by at least 14%, and turbulent kinetic energy (TKE) by at least 40%, near the center of the draft tube even quite close to the design condition. Moving farther from the design point, models fail in giving the correct levels of the axial velocity in the draft tube. This is attributed to the underprediction of TKE production and diffusion near the center of the draft tube where the vortex rope forms. Hence, a new RANS model taking into account the extra production and diffusion of TKE due to vortex rope formation is developed, which can successfully predict the mean flow velocity with as much as 37% improvements in comparison with the realizable k-[epsilon] model. Then, unsteady simulations are performed, where it is concluded that Unsteady RANS (URANS) models cannot capture the self-induced unsteadiness of the vortex rope, but instead give steady solutions. The hybrid URANS/large eddy simulation (LES) models are proposed to be used in unsteady simulations of the vortex rope. Specifically, a new hybrid URANS/LES model in the framework of partially-averaged Navier-Stokes (PANS) modeling is developed. This new model is one of the main contributions of the present study. The newly developed PANS model is used in unsteady numerical simulations of two turbulent swirling flows containing vortex rope formation and breakdown, namely swirling flow through an abrupt expansion and the flow

in the FLINDT draft tube, a model-scale draft tube of a Francis turbine. The present PANS model accurately predicts time-averaged and root-mean-square (rms) velocities in the case of the abrupt expansion, while it is shown to be superior to the delayed detached eddy simulation (DDES) and shear stress transport (SST) k-[omega] models. Predictions of the reattachment length using the present model shows 14% and 23% improvements compared to the DDES and the SST k-[omega] models, respectively. For the case of the FLINDT draft tube, four test cases covering a wide range of operating conditions from 70% to 110% of the flow rate at the best efficiency point (BEP) are considered, and numerical results of PANS simulations are compared with those from RANS/URANS simulations and experimental data. It is shown that RANS and PANS both can predict the flow behavior close to the BEP operating condition. However, RANS results deviate considerably from the experimental data as the operating condition moves away from the BEP. The pressure recovery factor predicted by the RANS model shows more than 13% and 58% overprediction when the flow rate decreases to 91% and 70% of the flow rate at BEP respectively. Predictions can be improved dramatically using the present unsteady PANS simulations. Specifically, the pressure recovery factor is predicted by less than 4% and 6% deviation for these two operating conditions. Furthermore, transient features of the flow that cannot be resolved using RANS/URANS simulations, e.g., vortex rope formation and precession, is well captured using PANS simulations. The frequency of the vortex rope precession, which causes severe fluctuations and vibrations, is well predicted by only about 2.7% deviation from the experimental data. Finally, the physical mechanism behind the formation of the vortex rope is analyzed, and it is confirmed that the development of the vortex rope is associated with formation of a stagnant region at the center of the draft tube. Based on this observation, a vortex rope elimination method consisting of water jet injection to the draft tube is introduced and numerically assessed. It is shown that a small fraction of water (a few percent of the total flow rate) centrally injected to the inlet of the draft tube can eliminate the stagnant region and mitigate the formation of the vortex rope. This results in improvement of the draft tube performance and reduction of hydraulic losses. Specifically in the case of the simplified FLINDT draft tube, the loss coefficient can be reduced by as much as 50% and 14% when the turbine operates with 91% and 70% of the BEP flow rate, respectively. In addition, reduction (by about 1/3 in the case with 70% of BEP flow rate) of strong pressure fluctuations leads to more reliable operation of the turbine.

Multiple disciplines depend on computer programs and software to predict project challenges, outcomes, and solutions. Through the use of virtual prototyping, researchers and professionals are better able to analyze data and improve projects without direct experimentation, which can be costly or dangerous. The Handbook of Research on Computational Simulation and Modeling in Engineering is an authoritative reference source on the computer models and technologies necessary to enhance engineering structures and planning for real-world applications. This publication is an essential resource for academicians, researchers, advanced-level students, technology developers, and engineers interested in the advancements taking place at the intersection of computer technology and the physical sciences. This publication features chapters on the advanced technologies developed within the field of engineering including prediction tools, software programs, algorithms, and theoretical and computational models.

Featuring contributions from worldwide leaders in the field, the carefully crafted Electric Power Generation, Transmission, and Distribution, Third Edition (part of the five-volume set, The Electric Power Engineering Handbook) provides convenient access to detailed information on a diverse array of power engineering topics. Updates to nearly every chapter keep this book at the forefront of developments in modern power systems, reflecting international standards, practices, and technologies. Topics covered include: Electric power generation: nonconventional methods Electric power generation: conventional methods Transmission system Distribution systems Electric power utilization Power quality L.L. Grigsby, a respected and accomplished authority in power engineering, and section editors Saifur Rahman, Rama Ramakumar, George Karady, Bill Kersting, Andrew Hanson, and Mark Halpin present substantially new and revised material, giving readers up-to-date information on core areas. These include advanced energy technologies, distributed utilities, load characterization and modeling, and power quality issues such as power system harmonics, voltage sags, and power quality monitoring. With six new and 16 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: Water Transmission Line Reliability Methods High Voltage Direct Current Transmission System Advanced Technology High-Temperature Conduction Distribution Short-Circuit Protection Linear Electric Motors A volume in the Electric Power Engineering Handbook, Third Edition. Other volumes in the set: K12648 Power Systems, Third Edition (ISBN: 9781439856338) K13917 Power System Stability and Control, Third Edition (ISBN: 9781439883204) K12650 Electric Power Substations Engineering, Third Edition (ISBN: 9781439856383) K12643 Electric Power Transformer Engineering, Third Edition (ISBN: 9781439856291)

Considers the application of modern control engineering on digital computers with a view to improving productivity and product quality, easing supervision of industrial processes and reducing energy consumption and pollution. The topics covered may be divided into two main subject areas: (1) applications of digital control - in the chemical and oil industries, in water turbines, energy and power systems, robotics and manufacturing, cement, metallurgical processes, traffic control, heating and cooling; (2) systems theoretical aspects of digital control - adaptive systems, control aspects, multivariable systems, optimization and reliability, modelling and identification, real-time software and languages, distributed systems and data networks. Contains 84 papers.

Vols. 2, 4-11, 62-68 include the Society's Membership list; v. 55-80 include the Journal of applied mechanics (also issued separately) as contributions from the Society's Applied Mechanics Division.

The wind energy industry is a key player in the booming alternative energy market, and job opportunities abound in this rapidly-growing field. Wind Turbine Control Systems provides critical resources for experienced and novice learners alike. The text provides an in-depth survey of wind turbine control systems. It covers key wind-energy control strategies and offers a comprehensive overview of the ways in which wind is generated, converted, and controlled.

Renewable energies constitute excellent solutions to both the increase of energy consumption and environment problems. Among these energies, wind energy is very interesting. Wind energy is the subject of advanced research. In the development of wind turbine, the design of its different structures is very important. It will ensure: the robustness of the system, the energy

efficiency, the optimal cost and the high reliability. The use of advanced control technology and new technology products allows bringing the wind energy conversion system in its optimal operating mode. Different strategies of control can be applied on generators, systems relating to blades, etc. in order to extract maximal power from the wind. The goal of this book is to present recent works on design, control and applications in wind energy conversion systems.

Electric power systems worldwide face radical transformation with the need to decarbonise electricity supply, replace ageing assets and harness new information and communication technologies (ICT). The Smart Grid uses advanced ICT to control next generation power systems reliably and efficiently. This authoritative guide demonstrates the importance of the Smart Grid and shows how ICT will extend beyond transmission voltages to distribution networks and customer-level operation through Smart Meters and Smart Homes. Smart Grid Technology and Applications: Clearly unravels the evolving Smart Grid concept with extensive illustrations and practical examples. Describes the spectrum of key enabling technologies required for the realisation of the Smart Grid with worked examples to illustrate the applications. Enables readers to engage with the immediate development of the power system and take part in the debate over the future Smart Grid. Introduces the constituent topics from first principles, assuming only a basic knowledge of mathematics, circuits and power systems. Brings together the expertise of a highly experienced and international author team from the UK, Sri Lanka, China and Japan. Electrical, electronics and computer engineering researchers, practitioners and consultants working in inter-disciplinary Smart Grid RD&D will significantly enhance their knowledge through this reference. The tutorial style will greatly benefit final year undergraduate and master’s students as the curriculum increasing focuses on the breadth of technologies that contribute to Smart Grid realisation.

This book presents refereed proceedings of the First International Conference Neural Computing for Advanced Applications, NCAA 2020, held in July, 2020. Due to the COVID-19 pandemic the conference was held online. The 36 full papers and 7 short papers were thorougly reviewed and selected from a total of 113 qualified submissions. Thes papers present resent research on such topics as neural network theory, and cognitive sciences, machine learning, data mining, data security & privacy protection, and data-driven applications, computational intelligence, nature-inspired optimizers, and their engineering applications, cloud/edge/fog computing, the Internet of Things/Vehicles (IoT/IoV), and their system optimization, control systems, network synchronization, system integration, and industrial artificial intelligence, fuzzy logic, neuro-fuzzy systems, decision making, and their applications in management sciences, computer vision, image processing, and their industrial applications, and natural language processing, machine translation, knowledge graphs, and their applications.

Synchronous Generators, the first of two volumes in the Electric Generators Handbook, offers a thorough introduction to electrical energy and electricity generation, including the basic principles of electric generators. The book devotes a chapter to the most representative prime mover models for transients used in active control of various generators. Then, individual chapters explore large- and medium-power synchronous generator topologies, steady state, modeling, transients, control, design, and testing. Numerous case studies, worked-out examples, sample results, and illustrations highlight the concepts. Fully revised and updated to reflect the last decade’s worth of progress in the field, this Second Edition adds new sections that: Discuss high-power wind generators with fewer or no permanent magnets (PMs) Cover PM-assisted DC-excited salient pole synchronous generators Present multiphase synchronous machine inductances via the winding function method Consider the control of autonomous synchronous generators Examine additional optimization design issues Illustrate the optimal design of a large wind generator by the Hooke–Jeeves method Detail the magnetic equivalent circuit population-based optimal design of synchronous generators Address online identification of synchronous generator parameters Explain the small-signal injection online technique Explore line switching (on or off) parameter identification for isolated grids Describe synthetic back-to-back load testing with inverter supply The promise of renewable, sustainable energy rests on our ability to design innovative power systems that are able to harness energy from a variety of sources. Synchronous Generators, Second Edition supplies state-of-the-art tools necessary to design, validate, and deploy the right power generation technologies to fulfill tomorrow's complex energy needs.

Maximizing reader insights into the latest technical developments and trends involving wind turbine control and monitoring, fault diagnosis, and wind power systems, ‘Wind Turbine Control and Monitoring’ presents an accessible and straightforward introduction to wind turbines, but also includes an in-depth analysis incorporating illustrations, tables and examples on how to use wind turbine modeling and simulation software. Featuring analysis from leading experts and researchers in the field, the book provides new understanding, methodologies and algorithms of control and monitoring, computer tools for modeling and simulation, and advances the current state-of-the-art on wind turbine monitoring and fault diagnosis; power converter systems; and cooperative & fault-tolerant control systems for maximizing the wind power generation and reducing the maintenance cost. This book is primarily intended for researchers in the field of wind turbines, control, mechatronics and energy; postgraduates in the field of mechanical and electrical engineering; and graduate and senior undergraduate students in engineering wishing to expand their knowledge of wind energy systems. The book will also interest practicing engineers dealing with wind technology who will benefit from the comprehensive coverage of the theoretic control topics, the simplicity of the models and the use of commonly available control algorithms and monitoring techniques.

The power sector has undergone a liberalization process both in industrialized and developing countries, involving market regimes, as well as ownership structure. These processes have called for new and innovative concepts, affecting both the operation of existing hydropower plants and transmission facilities, as well as the development and implementation of new projects. At the same time a sharper focus is being placed on environmental considerations. In this context it is important to emphasize the obvious benefits of hydropower as a clean, renewable and sustainable energy source. It is however also relevant to focus on the impact on the local environment during the planning and operation of hydropower plants. New knowledge and methods have been developed that make it possible to mitigate the local undesirable effects of such projects. Development and operation of modern power systems require sophisticated technology. Continuous research and development in this field is therefore crucial to maintaining hydropower as a competitive and environmentally well-accepted form of power generation.

Scientific Study from the year 2018 in the subject Physics - Mechanics, grade: Cfd program ansys CFX, , course: ingénierie en électromécanique, language: English, abstract:

Energy is one of the most major fields in the development of a society and its economy. Its consummations rate could by the way be an indicator of the level of prosperity that a nation could achieve. Among renewable sources of energies, hydro power is an important source of environmental-friendly energy and has become more and more important in the recent years. Water energy, as a renewable source of energy, can help in reducing the dependency on fossil fuels. The number of installed water power systems is increasing every year and many nations have made plans to make large investments in hydropower in the near future. Many developed and developing countries have realized the importance of water as an important resource for power generation and necessary measures are being taken up across the globe to tap this energy for its effective utilization in power production. Remarkable advances in water turbines design have been possible due to developments in modern technology. In this context, we are interested in developing a design and a numerical study of the Impulse and the Cross flow hydro turbine‘s type. This book contains four chapters; in the first, a bibliographic study has been developed in order to present a general view about renewable energy, hydropower and different ways to gather it. A particular interest has been given to the water rotors concerning their different types and historical of some famous type like cross flow and Impulse turbines type, object of our study. Indeed, the bibliographic study summarized the considered parameters to improve the water turbine performances. The second chapter presents the numerical approach developed using the CFD code "CFX". I present also the mathematical formulation and the turbulence model will be presented. Then a background of the used methods in our numerical model will be undertaken. The third chapter presents the numerical simulations consisting on the characterization of the hydro dynamic structure of the impulse and the cross flow turbines The fourth chapter consist of the design of the test bench and the different components and solutions.

Large-scale wind power generation is one of the fastest developing sources of renewable energy and already makes a substantial contribution to power grids in many countries worldwide. With technology maturing, the challenge is now to increase penetration, and optimise the design, construction and performance of wind energy systems. Fundamental issues of safety and reliability are paramount in this drive to increase capacity and efficiency. Wind energy systems: Optimising design and construction for safe and reliable operation provides a comprehensive review of the latest developments in the design, construction and operation of large-scale wind energy systems, including in offshore and other problematic environments. Part one provides detailed coverage of wind resource assessment and siting methods relevant to wind turbine and wind farm planning, as well as aeroelastics, aerodynamics, and fatigue loading that affect the safety and reliability of wind energy systems. This coverage is extended in part two, where the design and development of individual components is considered in depth, from wind turbine rotors to drive train and control systems, and on to tower design and construction. Part three explores operation and maintenance issues, such as reliability and maintainability strategies and condition monitoring systems, before discussing performance assessment and optimisation routes for wind energy systems in low wind speed environments and cold climates. Part four reviews offshore wind energy systems development, from the impact of environmental loads such as wind, waves and ice, to site specific construction and integrated wind farm planning, and of course the critical issues and strategies for offshore operation and maintenance. With its distinguished editors and international teams of contributors, Wind energy systems is a standard reference for wind power engineers, technicians and manufacturers, as well as researchers and academics involved in this expanding field. Reviews the latest developments in the design, construction and operation of large-scale wind energy systems Offers detailed coverage of wind resource assessment and siting methods relevant to wind turbine and wind farm planning Explores operation and maintenance issues, such as reliability and maintainability strategies and condition monitoring systems

Electrical Engineer's Reference Book, Fourteenth Edition focuses on electrical engineering. The book first discusses units, mathematics, and physical quantities, including the international unit system, physical properties, and electricity. The text also looks at network and control systems analysis. The book examines materials used in electrical engineering. Topics include conducting materials, superconductors, silicon, insulating materials, electrical steels, and soft irons and relay steels. The text underscores electrical metrology and instrumentation, steam-generating plants, turbines and diesel plants, and nuclear reactor plants. The book also discusses alternative energy sources. Concerns include wind, geothermal, wave, ocean thermal, solar, and tidal energy. The text then looks at alternating-current generators. Stator windings, insulation, output equation, armature reaction, and reactants and time-constraints are described. The book also examines overhead lines, cables, power transformers, switchgears and protection, supply and control of reactive power, and power systems operation and control. The text is a vital source of reference for readers interested in electrical engineering.

Hydropower provides a complete discussion of the most up-to-date considerations of this method of creating renewable energy. After introducing the method’s history, the author explores various considerations for engineers, planners and managers who need to determine the best placement and size of a plant. The book then presents various types of hydropower systems, such as Run-of-River Schemes and various types of Dam and Turbines, also considering the important economic, environmental and geological impacts of each. Those involved in the planning, design and management of hydropower systems, such as engineers, researchers, managers and policymakers will find this book a very valuable and insightful resource. Explores different types of dams and turbines set alongside easy-to-understand diagrams, such as Embankment Dams, Concrete Arch Dams, Reaction Turbines and Francis Turbines Considers various economic and environmental factors significant for this type of project, such as resettlement, biodiversity and greenhouse gases Discusses best practices for locating a hydropower site and how to make important decisions regarding placement and method

Hydroelectric power stations are a major source of electricity around the world; understanding their dynamics is crucial to achieving good performance. The electrical power generated is normally controlled by individual feedback loops on each unit. The reference input to the power loop is the grid frequency deviation from its set point, thus structuring

an external frequency control loop. The book discusses practical and well-documented cases of modelling and controlling hydropower stations, focused on a pumped storage scheme based in Dinorwig, North Wales. These accounts are valuable to specialist control engineers who are working in this industry. In addition, the theoretical treatment of modern and classic controllers will be useful for graduate and final year undergraduate engineering students. This book reviews SISO and MIMO models, which cover the linear and nonlinear characteristics of pumped storage hydroelectric power stations. The most important dynamic features are discussed. The verification of these models by hardware in the loop simulation is described. To show how the performance of a pumped storage hydroelectric power station can be improved, classical and modern controllers are applied to simulated models of Dinorwig power plant, that include PID, Fuzzy approximation, Feed-Forward and Model Based Predictive Control with linear and hybrid prediction models.

Hydraulic machinery such as turbines and pumps is widely used around the world. Related topics concerning design, operation and maintenance are of relevant interest. In this context, cavitation is a phenomenon to be taken into account, and this was treated in the XVIII IAHR Symposium on Hydraulic Machinery and Cavitation which took place in Valencia, Spain, 16th-19th September, 1996 and which was hosted by the Polytechnic University of Valencia. The proceedings of the Symposium have been published in two volumes. In this first volume, the papers included cover the following topics: Hydraulic Turbines, Analysis and Design Hydraulic Pumps Hydraulic Elements, Dynamic Characterization and Hydraulic Behaviour Cavitation and Sand Erosion In the second volume, the papers included cover the following topics: Hydraulic Transients and Control Systems Related to Hydraulic Machinery and Plants Oscillatory and Vibration Problems in Hydraulic Machinery and Power Stations Experimental Investigations related to Hydraulic Machinery and its Applications Practical Applications of the Hydraulic Machinery Monitoring, Predictive Maintenance and Refurbishment The 119 papers presented at the Symposium, from research groups, consulting companies and manufacturers, constitute an important collection for investigators, engineers and technicians who are interested in updated information on hydraulic machinery. This book is intended to be a reference text comprising the latest innovations on this subject.

This book reports on a comprehensive study addressing the dynamic responses of hydropower plants under diverse conditions and disturbances, and analyzes their stability and oscillations. Multiple models based on eight existing hydropower plants in Sweden and China were developed and used for simulations and theoretical analysis with various degrees of complexity and for different purposes, and compared with on-site measurements for validations. The book offers important insights into the understanding of the hydraulic, mechanical and electrical coupling mechanisms, up to market conditions and incentives. It recommends control strategies for a more stable and efficient operation of hydropower plants.

These proceedings present selected research papers from CISC'16, held in Xiamen, China. The topics include Multi-agent system, Evolutionary Computation, Artificial Intelligence, Complex systems, Computation intelligence and soft computing, Intelligent control, Advanced control technology, Robotics and applications, Intelligent information processing, Iterative learning control, Machine Learning, and etc. Engineers and researchers from academia, industry, and government can get an insight view of the solutions combining ideas from multiple disciplines in the field of intelligent systems.