Design Optimization Of Wind Turbine Blades For Reduction

Mathematical Concepts and Applications in Mechanical Engineering and Mechatronics
Design Optimization of a Micro Wind Turbine Using Computational Fluid Dynamics
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Design and Optimization of Biogas Energy Systems
Reliability-Based Optimization of Floating Wind Turbine Support Structures
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Optimization Algorithms ; a State of the Art Study

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Mathematical Concepts and Applications in Mechanical Engineering and Mechatronics IGI Global
"The book reviews mechanical engineering design optimization using stochastic methods. It introduces students and design engineers to practical aspects of complicated mathematical optimization procedures, and outlines steps for wide range of selected engineering design problems. It shows how engineering structures are systematically designed. Many new engineering design applications based on stochastic optimization techniques in automotive, energy, military, naval, manufacturing process and fluids-heat transfer, are described in the book. For each design optimization problem described, background is provided for understanding the solutions"--
Design Optimization of a Micro Wind Turbine Using Computational Fluid Dynamics Design Optimization of Wind Energy Conversion Systems with Applications
This work focuses on designing a blade of 45 meters in length that produces a power of 1.6 MW. The design of the blade was done using the Blade Element Momentum theory and the Prandtl's tip loss factor was used. The aerodynamic loads and differential power at are tabulated and plotted. The finite element method for analysis of the blade is used. As the chord lengths vary decreasingly along the blade radii in order to use the simple beam theory the breath and height of the blade is considered as a function of the chord length, hence the analysis is done assuming the blade to be a tapered hollow beam. The first few natural frequencies in the axial and transverse direction and mode shapes are calculated and plotted. In order to reduce the weight of the blade designed and increase the power two sets of optimization was done. The design variables are the chord lengths, with objective function as power mass constraints was used. The other optimization was using the mass as objective function and power as the constraint. The chord distribution results are plotted and discussed.
Site-specific Blade Design Optimization for a Fixed-speed Fixed-pitch Wind Turbine with Variable Airfoil Profile Using BEM Theory Academic Press
A review of the aerodynamics, design and analysis, and optimization of wind turbines, combined with the author’s unique software Aerodynamics of Wind Turbines is a comprehensive introduction to the aerodynamics, scaled design and analysis, and optimization of horizontal-axis wind turbines. The author –a noted expert on the topic – reviews the fundamentals and basic physics of wind turbines operating in the atmospheric boundary layer. He then explores more complex models that help in the aerodynamic analysis and design of turbine models. The text contains unique chapters on blade element momentum theory, airfoil aerodynamics, rotational augmentation, vortex-wake methods, actuator-line modeling, and designing aerodynamically scaled turbines for model-scale experiments. The author clearly demonstrates how effective analysis and design principles can be used in a wide variety of applications and operating conditions. The book integrates the easy-to-use, hands-on XTurb design and analysis software that is available on a companion website for facilitating individual analyses and future studies. This component enhances the learning experience and helps with a deeper and more complete understanding of the subject matter. This important book: Covers aerodynamics, design and analysis and optimization of wind turbines Offers the author’s XTurb design and analysis software that is available on a companion website for individual analyses and future studies Includes unique chapters on blade element momentum theory, airfoil aerodynamics, rotational augmentation, vortex-wake methods, actuator-line modeling, and designing aerodynamically scaled turbines for model-scale experiments Demonstrates how design principles can be applied to a variety of applications and operating conditions Written for senior undergraduate and graduate students in wind energy as well as practicing engineers and scientists, Aerodynamics of Wind Turbines is an authoritative text that offers a guide to the fundamental principles, design and analysis of wind turbines.
Optimization Design Theory Routledge
Tidal Energy Systems: Design, Optimization and Control provides a comprehensive overview of concepts, technologies, management and the control of tidal energy systems and tidal power plants. It presents the fundamentals of tidal energy, including the structure of tidal currents and turbulence. Technology, principles, components, operation, and a performance assessment of each component are also covered. Other sections consider pre-feasibility analysis methods, plant operation, maintenance and power generation, reliability assessment in terms of failure distribution, constant failure rate and the time dependent failure model. Finally, the most recent research advances and future trends are reviewed. In addition, applicable real-life examples and a case study of India’s tidal energy scenario are included. The book provides ocean energy researchers, practitioners and graduate students with all the information needed to design, deploy, manage and operate tidal energy systems. Senior undergraduate students will also find this to be a useful resource on the fundamentals of tidal energy systems and their components. Presents the fundamentals of tidal energy, including system components, pre-feasibility analysis, and plant management, operations and control Explores concepts of sustainability and a reliability analysis of tidal energy systems, as well as their economic aspects and future trends Covers the assessment of tidal energy systems by optimization technique and game theory
Design Optimization of Wind Energy Conversion Systems with Applications CRC Press
Modern and larger horizontal-axis wind turbines with power capacity reaching 15 MW and rotors of more than 235-meter diameter are under continuous development for the merit of minimizing the unit cost of energy production (total annual cost/annual energy produced). Such valuable advances in this competitive source of clean energy have made numerous research contributions in developing wind industry technologies worldwide. This book provides important information on the optimum design of wind energy conversion systems (WECS) with a comprehensive and self-contained handling of design fundamentals of wind turbines. Section I deals with optimal production of energy, multi-disciplinary optimization of wind turbines, aerodynamic and structural dynamic optimization and aeroelasticity of the rotating blades. Section II considers operational monitoring, reliability and optimal control of wind turbine components.

Design Optimization of Wind Energy Conversion Systems with Applications BoD – Books on Demand
Research into advanced wind turbine design has shown that load alleviation strategies like bend-twist coupled blades and coned rotors could reduce costs. However these strategies are based on nonlinear aero-structural dynamics providing additional benefits to components beyond the blades. These innovations will require Multi-disciplinary Design Optimization (MDO) to realize the full benefits.This research expands the MDO capabilities of Horizontal Axis Wind Turbines. The early research explored the numerical stability properties of Blade Element Momentum (BEM) models. Then developed a provincial scale wind farm siting models to help engineers determine the optimal design parameters. The main focus of this research was to incorporate advanced analysis tools into an aero-elastic optimization framework. To adequately explore advanced designs with optimization, a new set of medium fidelity analysis tools is required. These tools need to resolve more of the physics than conventional tools like (BEM) models and linear beams, while being faster than high fidelity techniques like grid based computational fluid dynamics and shell and brick based finite element models.
Power System Protection Enhancement and Design Optimization of Wind Power Planning John Wiley & Sons
Design Optimization of Wind Energy Conversion Systems with ApplicationsBoD – Books on Demand
Designing Engineering Structures Using Stochastic Optimization Methods MDPI
Special Issues on Design Optimization of Wind Turbine Structures.
Practical Application of Topology Optimization to the Design of Large Wind Turbine Towers Springer
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.
Design, Optimization and Control BoD – Books on Demand
The objectives of this study are (1) to develop an accurate and efficient fatigue analysis procedure that can be used in reliability analysis and reliability-based design optimization (RBDO) of composite wind turbine blades; (2) to develop a wind load uncertainty model that provides realistic uncertain wind load for the reliability analysis and the RBDO process; and (3) to obtain an optimal composite wind turbine blade that satisfies target reliability for durability under the uncertain wind load. The current research effort involves: (1) developing an aerodynamic analysis method that can effectively calculate detailed wind pressure on the blade surface for stress analysis; (2) developing a fatigue failure criterion that can cope with non-proportional multi-axial stress states in composite wind turbine blades; (3) developing a wind load uncertainty model that represents realistic uncertain wind load for fatigue reliability of wind turbine systems; (4) applying the wind load uncertainty model into a composite wind turbine blade and obtaining an RBDO optimum design that satisfies a target probability of failure for a lifespan of 20 years under wind load uncertainty. In blade fatigue analysis, resultant aerodynamic forces are usually applied at the aerodynamic centers of the airfoils of a blade to calculate stress/strain. However, in reality the wind pressures are applied on the blade surface. A wind turbine blade is often treated as a typical beam-like structure for which fatigue life calculations are limited in the edge-wise and/or flap-wise direction(s). Using the beam-like structure, existing fatigue analysis methods for composite wind turbine blades cannot cope with the non-proportional multi-axial stress states that are endured by wind turbine blades during operation.
Wind Turbine Power Optimization Technology Cambridge University Press
Based on course-tested material, this rigorous yet accessible graduate textbook covers both fundamental and advanced optimization theory and algorithms. It covers a wide range of numerical methods and topics, including both gradient-based and gradient-free algorithms, multidisciplinary design optimization, and uncertainty, with instruction on how to determine which algorithm should be used for a given application. It also provides an overview of models and how to prepare them for use with numerical optimization, including derivative computation. Over 400 high-quality visualizations and numerous examples facilitate understanding of the theory, and practical tips address common issues encountered in practical engineering design optimization and how to address them. Numerous end-of-chapter homework problems, progressing in difficulty, help put knowledge into practice. Accompanied online by a solutions manual for instructors and source code for problems, this is ideal for a one- or two-semester graduate course on optimization in aerospace, civil, mechanical, electrical, and chemical engineering departments.
Wind Turbines IntechOpen
"Development of a multidisciplinary design optimization (MDO) of a large scale hybrid composite wind turbine blade is performed. Multiple objectives are considered in the MDO process to maximize annual energy production and lifetime profit, minimize weight and power production rate. A wind turbine blade is divided into regions and the layup sequences for each region are considered as deign variables. The scale of wind turbine blade is also considered to find the optimum size of a wind turbine blade. Applied loads due to extreme wind conditions for rotor rotation and rotor stop condition are considered for finite element analysis (FEA) to evaluate the structural strength."--Leaf iv.
Wind Turbine Power Optimization Technology Elsevier
The reduction of greenhouse gas emissions is a major governmental goal worldwide. The main target, hopefully by 2050, is to move away from fossil fuels in the electricity sector and then switch to clean power to fuel transportation, buildings and industry. This book discusses important issues in the expanding field of wind farm modeling and simulation as well as the optimization of hybrid and micro-grid systems. Section I deals with modeling and simulation of wind farms for efficient, reliable and cost-effective optimal solutions. Section II tackles the optimization of hybrid wind/PV and renewable energy-based smart micro-grid systems.
Design Optimization of Fluid Machinery Springer
This book introduces the current challenges in modern wind turbine analysis, design and development, and provides a comprehensive examination of state-of-the-art technologies from both

academia and industry. The twelve information-rich chapters cover a wide range of topics including reliability-based design, computational fluid dynamics, gearbox and bearing analyses, lightning analysis, structural dynamics, health condition monitoring, advanced techniques for field repair, offshore floating wind turbines, advanced turbine control and grid integration, and other emerging technologies. Each chapter begins with the current status of technology in a lucid, is easy-to-follow treatment, then elaborates on the corresponding advanced technology using detailed methodologies, graphs, mathematical models, computational simulations, and experimental instrumentation. Relevant to a broad audience from students and faculty to researchers, manufacturers, and wind energy engineers and designers, the book is ideal for both educational and research needs. Presents the latest developments in reliability-based design optimization, CFD of wind turbines, structural dynamics for wind turbine blades, off-shore floating wind turbines, advanced wind turbine control, and wind power and ramp forecasting for grid integration; Includes techniques for wind turbine gearboxes and bearings, evaluation of lightning strike damage, health condition monitoring and reparation techniques; Illustrates theories and operational considerations using graphics, tables, computational algorithms, simulation models, and experimental instrumentation; Examines unique, innovative technologies for wind energy.

Design Optimization of Wind Energy Conversion Systems with Applications John Wiley & Sons

Design Optimization of Fluid Machinery: Applying Computational Fluid Dynamics and Numerical Optimization Drawing on extensive research and experience, this timely reference brings together numerical optimization methods for fluid machinery and its key industrial applications. It logically lays out the context required to understand computational fluid dynamics by introducing the basics of fluid mechanics, fluid machines and their components. Readers are then introduced to single and multi-objective optimization methods, automated optimization, surrogate models, and evolutionary algorithms. Finally, design approaches and applications in the areas of pumps, turbines, compressors, and other fluid machinery systems are clearly explained, with special emphasis on renewable energy systems. Written by an international team of leading experts in the field Brings together optimization methods using computational fluid dynamics for fluid machinery in one handy reference Features industrially important applications, with key sections on renewable energy systems Design Optimization of Fluid Machinery is an essential guide for graduate students, researchers, engineers working in fluid machinery and its optimization methods. It is a comprehensive reference text for advanced students in mechanical engineering and related fields of fluid dynamics and aerospace engineering.

Design Optimization for Wind Turbines CRC Press

Wind Turbine Airfoils and Blades introduces new ideas in the design of wind turbine airfoils and blades based on functional integral theory and the finite element method, accompanied by results from wind tunnel testing. The authors also discuss the optimization of wind turbine blades as well as results from aerodynamic analysis. This book is suitable for researchers and engineers in aeronautics and can be used as a textbook for graduate students.

Design Optimization of Renewable Energy Systems Using Advanced Optimization Algorithms Walter de Gruyter GmbH & Co KG

Structural topology optimization is a mathematical approach developed to perform design optimization with the purpose of reducing the material usage, while maximizing structural performance, in accordance to specific design constraints. The principles behind this technique have been around for many decades, but recent advancements in the processing power of computers have allowed for the solving of complex problems, such as the optimization of tall wind turbine towers, bridges, and the bracing systems in skyscrapers. There are two approaches commonly used in structural topology optimization: discrete and continuum. This thesis uses continuum topology optimization, which involves adjusting the distribution of a porous elastic solid material to extremize the design objective(s) and to satisfy constraints. The material porosity is the design variable that is adjusted during the optimization process. The design domain is broken down into a system of continuum degenerated finite elements, which are used for both structural analysis and to create a mesh representation of the structural system, just as pixels make up a picture. Solid elements are modeled as having no porosity, while void spaces have total porosity. As the optimization process occurs, the shape of the boundaries, and the number and size of internal holes are altered in order to best meet the design objective(s) and constraint(s). The purpose of performing continuum structural topology optimization of structural elements is to obtain promising concepts which provide a basis upon which to begin the design process. The steps taken in this thesis to optimize the wind turbine tower are: 1. Create a solid model of the tower domain 2. Define the material properties 3. Determine the equivalent static design wind forces using the extreme loading conditions outlined in IEC 61400 4. Formulate the optimization problem by specifying the objective and constraint functions. 5. Solve the optimization problem and interpret the results. This study on continuum topology optimization on the tower shell, indicates even with a significant reduction in material from the original design space, the structure is capable of meeting the design criteria. The results indicate that opening void spaces in the shell of the tower and creating an open lattice shape may be an effective method to reduce the volume of wind turbine towers, as it has in other applications. This concurs with the stated goal of my research, which is to show that topology optimization has the potential to be used in a multitude of practical applications in order to increase efficiency, and reduce cost of the production of wind power.

Filtering and Control Academic Press

The area of wind energy is a rapidly evolving field and an intensive research and development has taken place in the last few years. Therefore, this book aims to provide an up-to-date comprehensive overview of the current status in the field to the research community. The research works presented in this book are divided into three main groups. The first group deals with the different types and design of the wind mills aiming for efficient, reliable and cost effective solutions. The second group deals with works tackling the use of different types of generators for wind energy. The third group is focusing on improvement in the area of control. Each chapter of the book offers detailed information on the related area of its research with the main objectives of the works carried out as well as providing a comprehensive list of references which should provide a rich platform of research to the field.

A Physical Basis for Analysis and Design John Wiley & Sons

This book describes applications of Jaya and Rao algorithms on real case studies concerning different renewable energy sources. In the last few decades, researchers have focused on renewable

energy resources like solar energy, bio-energy, wave energy, ocean thermal energy, tidal energy, geothermal energy, and wind energy. This has resulted in the development of new techniques and tools that could harvest energy from renewable energy sources. Many researchers and scientists have focused on developing and optimizing the energy systems to extract and utilize renewable energy more efficiently. In this book, recently developed Jaya and Rao (Rao-1, Rao-2, and Rao-3) algorithms are introduced for single- and multi-objective optimization of selected renewable energy systems. The results of applications of the different versions of Jaya and Rao algorithms are compared with the other optimization techniques like GA, NSGA-II, PSO, MOPSO, ABC, etc., and the performance of the Jaya and Rao algorithms is highlighted compared to other optimization algorithms in the case of renewable energy systems. The book also includes the validation of different versions of the Jaya and Rao algorithms through the application to complex single- and multi-objective unconstrained benchmark functions. The algorithms and computer codes of different version of Jaya and Rao algorithms are included in the book that will be very much useful to readers in industry and academic research.

Wind Turbine Airfoils and Blades Springer Science & Business Media

This dissertation, "Design Optimization of a Micro Wind Turbine Using Computational Fluid Dynamics" by Yun, Deng, □□, was obtained from The University of Hong Kong (Pokfulam, Hong Kong) and is being sold pursuant to Creative Commons: Attribution 3.0 Hong Kong License. The content of this dissertation has not been altered in any way. We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation. All rights not granted by the above license are retained by the author. DOI: 10.5353/th_b4098770 Subjects: Wind turbines - Design and construction Computational fluid dynamics

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