Aerodynamic Design Optimization Of Wind Turbine Rotors

An updated and expanded new edition of this comprehensive guide to innovation in wind turbine design Innovation in Wind Turbine Design, Second Edition comprehensively covers the fundamentals of design, explains the reasons behind design choices, and describes the methodology for evaluating innovative systems and components. This second edition has been substantially expanded and generally updated. New content includes elementary actuator disc theory of the low induction rotor concept, much expanded discussion of offshore issues and of airborne wind energy systems, updated drive train information with basic theory of the epicyclic gears and differential drives, a clarified presentation of the basic theory of energy in the wind and fallacies about ducted rotor design related to theory, lab testing and field testing of the Katru and Wind Lens ducted rotor systems, a short review of LiDAR, latest developments of the multi-rotor concept including the Vestas 4 rotor system and a new chapter on the innovative DeepWind VAWT. The bookis divided into four main sections covering design background, technology evaluation, design themes and innovative technology examples. Key features: Expanded substantially with new content. Comprehensively covers the fundamentals of design, explains the reasons behind design choices, and describes the methodology for evaluating innovative systems and components. Includes innovative examples from working experiences for commercial clients. Updated to cover recent developments in the field. The book is a must-have reference for professional wind engineers, power engineers and turbine designers, as well as consultants, researchers and graduate students.

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.

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.

Aerodynamics of Wind Turbines is the established essential text for the fundamental solutions to efficient wind turbine design. Now in its second edition, it has been entirely updated and substantially extended to reflect advances in technology, research into rotor aerodynamics and the structural response of the wind turbine structure. Topics covered include increasing mass flow through the turbine, performance at low and high wind speeds, assessment of the extreme conditions under which the turbine will perform and the theory for calculating the lifetime of the turbine. The classical Blade Element Momentum method is also covered, as are eigenmodes and the dynamic behaviour of a turbine. The new material includes a description of the effects of the dynamics and how this can be modelled in an ?aeroelastic code?, which is widely used in the design and verification of modern wind turbines. Further, the description of how to calculate the vibration of the whole construction, as well as the time varying loads, has been substantially updated.

Wind Turbine Airfoils and Blades

Simulation-Driven Aerodynamic Design Using Variable-Fidelity Models

Wind Energy in the Built Environment

Design Optimization of a Wind Turbine Blade

Advances in Technology Development and Research

Fundamentals of Wind Farm Aerodynamic Layout Design, Volume Four provides readers with effective wind farm design and layout guidance through algorithm optimization, going beyond other references and general approaches in literature. Focusing on interactions of wake models, designers can combine numerical schemes presented in this book which also considers wake models effects and problems on layout optimization in order to simulate and enhance wind farm designs. Covering the aerodynamic modeling and simulation of wind farms, the book's authors include experimental tests supporting modeling simulations and tutorials on the simulation of wind turbines. In addition, the book includes a CFD technique designed to be more computationally efficient than currently available techniques, making this book ideal for industrial engineers in the wind industry who need to produce an accurate simulation within limited timeframes. Features novel CFD modeling Offers global case studies for turbine wind farm layouts Includes tutorials on simulation of wind turbine using OpenFoam

Recent Advances in Numerical Methods features contributions from distinguished researchers, focused on significant aspects of current numerical methods and computational mathematics. The increasing necessity to present new computational methods that can solve complex scientific and engineering problems requires the preparation of this volume with actual new results and innovative methods that provide numerical solutions in effective computing times. Each chapter will present new and advanced methods and modern variations on known techniques that can solve difficult scientific problems efficiently.

Aerodynamic design, like many other engineering applications, is increasingly relying on computational power. The growing need for multi-disciplinarity and high fidelity in design optimization for industrial applications requires a huge number of repeated simulations in order to find an optimal design candidate. The main drawback is that each simulation can be computationally expensive this becomes an even bigger issue when used within parametric studies, automated search or optimization loops, which typically may require thousands of analysis evaluations. The core issue of a design-optimization problem is the search process involved. However, when facing complex problems, the high-dimensionality of the design space and the high-multi-modality of the target functions cannot be tackled with standard techniques. In recent years, global optimization using meta-models has been widely applied to design exploration in order to rapidly investigate the design space and find sub-optimal solutions. Indeed, surrogate and reduced-order models can provide a valuable alternative at a much lower computational cost. In this context, this volume offers advanced surrogate modeling applications and optimization techniques featuring reasonable computational resources. It also discusses basic theory concepts and their application to aerodynamic design cases. It is aimed at researchers and engineers who deal with complex aerodynamic design problems on a daily basis and employ expensive simulations to solve them.

The proposed project is motivated by the need to develop wake models and optimization algorithms that can accurately capture the wake losses in an array of wind turbines and optimize the turbine placements. In the past 4 years, we have developed capabilities to improve the layout design of wind farms located on complex terrains, as contributions from four major tasks. The outcome of the first task was the creation of a wake interaction model capable of describing the effects of overlapping wakes that can be used in combination with existing mathematical optimization tools for wind farm layout design. Such a model was derived and evaluated against existing wake interaction methods. This wake interaction model enables a mechanistic approach to account for multiple overlapping wakes while remaining compatible with established mathematical optimization methods. In the second task, this wake interaction model was used in conjunction with full-scale CFD simulations to design wind farm layouts. We developed an optimization algorithm that intelligently integrates a mathematical optimization approach to design wind farm layout on complex terrains with full-scale CFD simulations. The two subsequent tasks were focused on developing a wake model capable of producing comparable accuracy as full-scale CFD simulations but at a significantly lower computational cost. The third task focused on studying the effects of turbine blade geometry and atmospheric turbulence on turbine wake development. The findings of this step contributed to the fourth task of developing a new wake model capable of simulating wakes on complex terrains. This model has been validated against full-scale CFD simulations of a turbine placed on the terrain of the Gros-Morne Wind Farm in Quebec. The proposed model allows for fast simulation of wakes, making it ideal for designing wind farm layouts on complex terrains.

Design and Aerodynamic Optimization of a New Reconnaissance Very Light Aircraft Through Wind-Tunnel Tests

Application of Surrogate-based Global Optimization to Aerodynamic Design

Engineering Design Optimization

Innovation in Wind Turbine Design

Towards a Virtual Platform for Aerodynamic Design, Performance Assessment and Optimization of Horizontal Axis Wind Turbines

Update the available literature on current flat back airfoils.Continue the optimization of flatback surfaces obtainedfrom conventional sections and develop completely new designs with the objective of obtaining better aerodynamic characteristics than conventional airfoils.

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.

Design of a new Very Light Aircraft (V.L.A.) called G97 Spotter has been carried out at DPA (Department of Aeronautical Engineering) and an extensive wind tunnel test campaign has been performed on both aircraft and airfoil models. Wind tunnel tests have guided in the design phase allowing configuration optimization. Effects of nacelle and air intake shape, fuselage stretching, wing incidence and flap/aileron effectiveness have been analyzed through wind tunnel tests. The airfoil has also been designed and modified with the help of wind tunnel test results obtained for a model. Optimization of the airfoil leading edge shape has been done and has brought to a sensible drag reduction at high speed conditions. Optimization of the air intake shape on the aircraft model has been performed leading to a configuration characterized by lower drag. Influence of an air intake fairing has been analyzed and tested through wind tunnel tests. Wing stall path has been studied. Importance of wind tunnel tests as a device to analyze and design light aircraft configuration has been highlighted.

Designing buildings that maximize wind harvest and drive a set of turbines that provide power for buildings is the architectural concept presented in this scientific analysis. The practicalities presented in this design concept will interest engineers and architects, while the possibilities of wind power being used at a domestic level will delight proponents of renewable energy.

Proceedings of the 13th International Marine Design Conference (IMDC 2018), June 10-14, 2018, Helsinki, Finland

Perspectives in Flow Control and Optimization

Airborne Wind Energy

Wind Turbine Power Optimization Technology

Advances in Numerical Methods

This book presents papers surrounding the extensive discussions that took place from the 'Variational Analysis and Aerospace Engineering' workshop held at the Ettore Majorana Foundation and Centre for Scientific Culture in 2015. Contributions to this volume focus on advanced mathematical methods in aerospace engineering and industrial engineering such as computational fluid dynamics methods, optimization methods in aerodynamics, optimum controls, dynamic systems, the theory of structures, space missions, flight mechanics, control theory, algebraic geometry for CAD applications, and variational methods and applications. Advanced graduate students, researchers, and professionals in mathematics and engineering will find this volume useful as it illustrates current collaborative research projects in applied mathematics and aerospace engineering.

Introduces several approaches for solving flow control and optimization problems through the use of modern methods.

Optimization consists on finding the best possible solution to a problem, which usually means finding the minima of functions in a feasible region. The need of solving optimization problems is present in many diverse areas of science and engineering. Shape optimization is critical for the design of wind turbines and slender structures. By using highly efficient Computational Fluid Dynamics (CFD) based on the Vortex Particle Method (VPM), a wind simulation can be generated and structural behavior obtained. Automatization of the optimization process is created by parametrization of the CFD model and defining optimization objectives, thus generating an optimization model. Simulation-based optimization is performed by running simulations nested in the optimization algorithms.

This book provides in-depth coverage of the latest research and development activities concerning innovative wind energy technologies intended to replace fossil fuels on an economical basis. A characteristic feature of the various conversion concepts discussed is the use of tethered flying devices to substantially reduce the material consumption per installed unit and to access wind energy at higher altitudes, where the wind is more consistent. The introductory chapter describes the emergence and economic dimension of airborne wind energy. Focusing on "Fundamentals, Modeling & Simulation", Part I includes six contributions that describe quasi-steady as well as dynamic models and simulations of airborne wind energy systems or individual components. Shifting the spotlight to "Control, Optimization & Flight State Measurement", Part II combines one chapter on measurement techniques with five chapters on control of kite and ground stations, and two chapters on optimization. Part III on "Concept Design & Analysis" includes three chapters that present and analyze novel harvesting concepts as well as two chapters on system component design. Part IV, which centers on "Implemented Concepts", presents five chapters on established system concepts and one chapter about a subsystem for automatic launching and landing of kites. In closing, Part V focuses with four chapters on "Technology Deployment" related to market and financing strategies, as well as on regulation and the environment. The book builds on the success of the first volume "Airborne Wind Energy" (Springer, 2013), and offers a self-contained reference guide for researchers, scientists, professionals and students. The respective chapters were contributed by a broad variety of authors: academics, practicing engineers and inventors, all of whom are experts in their respective fields.

Aerodynamics of Wind Turbines, 2nd edition

Design Optimization of Fluid Machinery

Fundamentals of Wind Farm Aerodynamic Layout Design

Mathematical Challenges for the Aerospace of the Future

Robust Aerodynamic Design of Mars Exploratory Airplane Wing

This modern text presents aerodynamic design of aircraft with realistic applications, using CFD software and guidance on its use. Tutorials, exercises, and mini-projects provided involve design of real aircraft, ranging from straight to swept to slender wings, from low speed to supersonic. Supported by online resources and supplements, this toolkit covers topics such as shape optimization to minimize drag and collaborative designing. Prepares seniors and first-year graduate students for design and analysis tasks in aerospace companies. In addition, it is a valuable resource for practicing engineers, aircraft designers, and entrepreneurial consultants.

A rigorous yet accessible graduate textbook covering both fundamental and advanced optimization theory and algorithms.

This book contains state-of-the-art contributions in the field of evolutionary and deterministic methods for design, optimization and control in engineering and sciences. Specialists have written each of the 34 chapters as extended versions of selected papers presented at the International Conference on Evolutionary and Deterministic Methods for Design, Optimization and Control with Applications to Industrial and Societal Problems (EUROGEN 2013). The conference was one of the Thematic Conferences of the European Community on Computational Methods in Applied Sciences (ECCOMAS). Topics treated in the various chapters are classified in the following sections: theoretical and numerical methods and tools for optimization (theoretical methods and tools; numerical methods and tools) and engineering design and societal applications (turbo machinery; structures, materials and civil engineering; aeronautics and astronautics; societal applications; electrical and electronics applications), focused particularly on intelligent systems for multidisciplinary design optimization (mdo) problems based on multi-hybridized software, adjoint-based and one-shot methods, uncertainty quantification and optimization, multidisciplinary design optimization, applications of game theory to industrial optimization problems, applications in structural and civil engineering optimum design and surrogate models based optimization methods in aerodynamic design.

Marine Design XIII collects the contributions to the 13th International Marine Design Conference (IMDC 2018, Espoo, Finland, 10-14 June 2018). The aim of this IMDC series of conferences is to promote all aspects of marine design as an engineering discipline. The focus is on key design challenges and opportunities in the area of current maritime technologies and markets, with special emphasis on: • Challenges in merging ship design and marine applications of experience-based industrial design • Digitalisation as technological enabler for stronger link between efficient design, operations and maintenance in future • Emerging technologies and their impact on future designs • Cruise ship and icebreaker designs including fleet compositions to meet new market demands To reflect on the conference focus, Marine Design XIII covers the following research topic series: •State of art ship design principles - education, design methodology, structural design, hydrodynamic design; •Cutting edge ship designs and operations - ship concept design, risk and safety, arctic design, autonomous ships; •Energy efficiency and propulsions - energy efficiency, hull form design, propulsion equipment design; •Wider marine designs and practices - navy ships, offshore and wind farms and production. Marine Design XIII contains 2 state-of-the-art reports on design methodologies and cruise ships design, and 4 keynote papers on new directions for vessel design practices and tools, digital maritime traffic, naval ship designs, and new tanker design for arctic. Marine Design XIII will be of interest to academics and professionals in maritime technologies and marine design.

Select Proceedings of ETDMMT 2020

Optimization Design Theory

Aerodynamic Study on the Design and Optimization of Flatback Airfoils for Wind Turbine Applications

Enhanced Layout Optimization and Wind Aerodynamic Models for Wind Farm Design

Aerodynamic Shape Optimization of a Vertical Axis Wind Turbine

This work seeks to add a new approach to optimize a wind turbine blade's performance by implementing a design with a variation in the chord, twist and the use of 3 different airfoils for the maximization of the Annual Energy Production. A baseline design of the blade starts with a replica of the Phase VI blade utilized in a NASA-Ames experiment and a MatLab script utilizes the Blade Element Momentum Theory (BEM) for the aerodynamic analysis. The optimization is performed by utilizing the SQP method for Local Search with the Phase VI baseline design as a starting point in the algorithm. Results show a 23% improvement in energy production by using this method.

The purpose of this study is to introduce and demonstrate a fully automated process for optimizing the airfoil cross-section of a vertical axis wind turbine (VAWT). The objective is to maximize the torque while enforcing typical wind turbine design constraints such as tip speed ratio, solidity, and blade pro le. By xing the tip speed ratio and solidity of the wind turbine, there exists an airfoil cross-section for which the torque can be maximized, requiring the development of an iterative design system. The design system required to maximize torque incorporates rapid geometry generation and automated hybrid mesh generation tools with viscous, unsteady computational uid dynamics (CFD) simulation software. The exibility and automation of the modular design and simulation system allows for it to easily be coupled with a parallel di erential evolution algorithm used to obtain an optimized blade design that maximizes the e ciency of the wind turbine.

This is volume 1 of a 2-volume set. Marine Design XIII collects the contributions to the 13th International Marine Design Conference (IMDC 2018, Espoo, Finland, 10-14 June 2018). The aim of this IMDC series of conferences is to promote all aspects of marine design as an engineering discipline. The focus is on key design challenges and opportunities in the area of current maritime technologies and markets, with special emphasis on: • Challenges in merging ship design and marine applications of experience-based industrial design • Digitalisation as technological enabler for stronger link between efficient design, operations and maintenance in future • Emerging technologies and their impact on future designs • Cruise ship and icebreaker designs including fleet compositions to meet new market demands To reflect on the conference focus, Marine Design XIII covers the following research topic series: •State of art ship design principles - education, design methodology, structural design, hydrodynamic design; •Cutting edge ship designs and operations - ship concept design, risk and safety, arctic design, autonomous ships; •Energy efficiency and propulsions - energy efficiency, hull form design, propulsion equipment design; •Wider marine designs and practices - navy ships, offshore and wind farms and production. Marine Design XIII contains 2 state-of-the-art reports on design methodologies and cruise ships design, and 4 keynote papers on new directions for vessel design practices and tools, digital maritime traffic, naval ship designs, and new tanker design for arctic. Marine Design XIII will be of interest to academics and professionals in maritime technologies and marine design.

This thesis focuses on the study and improvement of the techniques involved on a virtual platform for the simulation of the Aerodynamics of Horizontal Axis Wind Turbines, with the ultimate objective of making Wind Energy more competitive. Navier-Stokes equations govern Aerodynamics, which is an unresolved and very active field of research due to the current inability to capture the relevant the scales both in time and space for nowadays industrial-size machines (with rotors over 100 m in diameter). Therefore, there is a need to aim at a combination of engineering and scientific models. The structure of this thesis is designed in accordance to the previous fact, so there are clearly two parts or approaches within the conducted research: zero dimensional models and CFD based analysis. For those zero-dimensional and (computationally) cheaper approach, the efforts done were the next: visualization and side improvements on the well known BEM code for pre-design purposes; designing an AeroElectric coupled algorithm to merge BEM with simple generator models that exclude details on electric circuits; designing a C++ code to study the dynamics of wind turbines coupling different component models; implementation of energy production based algorithms to optimize blades pre-designed with BEM, given the wind resources at the real location. CFD-based analysis are meant to be the tools to design wind turbines in the future. Nowadays and for the years to come, they are and will be under ongoing research. The efforts done to this rescpect have been the next: exploration, implementation and analysis of Non-Inertial Reference Frame, Immersed Boundary Method, Sliding Meshes. Additionally, Adaptive Mesh Refinement and Wall Model LES methods have been explored too.

Handbook of Wind Energy Aerodynamics

Advances in Evolutionary and Deterministic Methods for Design, Optimization and Control in Engineering and Sciences

Variational Analysis and Aerospace Engineering

Principles and Design

A Physical Basis for Analysis and Design

This handbook provides both a comprehensive overview and deep insights on the state-of-the-art methods used in wind turbine aerodynamics, as well as their advantages and limits. The focus of this work is specifically on wind turbines, where the aerodynamics are different from that of other fields due to the turbulent wind fields they face and the resultant differences in structural requirements. It gives a complete picture of research in the field, taking into account the different approaches which are applied. This book would be useful to professionals, academics, researchers and students working in the field.

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.

This important book presents a selection of new research on wind turbine technology, including aerodynamics, generators and gear systems, towers and foundations, control systems, and environmental issues. This informative book: •Introduces the principles of wind turbine design •Presents methods for analysis of wind turbine performance •Discusses approaches for wind turbine improvement and optimization •Covers fault detection in wind turbines • Describes mediating the adverse effects of wind turbine use and installation

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.

Marine Design XIII, Volume 1

Advances in Wind Turbine Blade Design and Materials

Aerodynamics of Wind Turbines

Design Optimization of Wind Energy Conversion Systems with Applications

Concentrator Effects of Buildings

A new robust design optimization approach "design for multi-objective six sigma (DFMOSS)" has been developed, and aerodynamic design optimizations of Mars exploratory airplane wing considering the effects of wind variations were carried out by using the DFMOSS coupled with the computational fluid dynamics (CFD) simulation. The present optimizations successfully revealed detailed trade-off information between the optimality and the robustness of aerodynamic performance more efficiently than conventional robust optimization approaches. In addition, useful guides to more reliable design of Mars exploratory airplane wing and more reliable Mars exploratory missions using the airplanes were provided by discussing the obtained trade-off information from an aerodynamic viewpoint.

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.

Computer simulations is a fundamental tool of the design process in many engineering disciplines including aerospace engineering. However, although high-fidelity numerical models are accurate, they can be computationally expensive with evaluation time for a single design as long as hours, days or even weeks. Simulation-driven design using conventional optimization techniques may be therefore prohibitive. This book explores the alternative: performing computationally efficient design using surrogate-based optimization, where the high-fidelity model is replaced by its computationally cheap but still reasonably accurate representation: a surrogate. The emphasis is on physics-based surrogates. Application-wise, the focus is on aerodynamics and the methods and techniques described in the book are demonstrated using aerodynamic shape optimization cases. Applications in other engineering fields are also demonstrated. State-of-the-art techniques and a depth of coverage never published before make this a unique and essential book for all researchers working in aerospace and other engineering areas and dealing with optimization, computationally expensive design problems, and simulation-driven design. Contents:Motivation and Problem Formulation:IntroductionAerodynamic Shape OptimizationOptimization Techniques:Simulation-Driven Design: Direct MethodsSurrogate-Based OptimizationSBO with Approximation-Based SurrogatesSBO with Physics-Based SurrogatesAerodynamics Modeling:Geometry ParameterizationHigh-Fidelity Aerodynamic ModelsLow-Fidelity Aerodynamics ModelsApplications:Transonic Airfoil Shape DesignTransonic Wing Shape DesignSubsonic Shape DesignSelected Applications of Surrogate-Based Optimization in Other AreasSurrogate-Based Optimization with MATLABConclusion:Practical Aspects of Variable-Fidelity Design Readership: Graduate students and researchers in the field of engineering, in particular, aerospace engineering. Key Features:Gathers a number of relevant techniques that were never compiled in one publication before, and certain state-of-the-art techniques have never been published in book formCompact and self-contained introduction to the area of surrogate-based optimization and variable-fidelity optimizationAt present, this is the only book available on the market that offers coverage of variable-fidelity optimization methodsKeywords:Aerodynamic Shape Optimization;Computational Fluid Dynamics (CFD);Surrogate Modeling;Surrogate-based Optimization;Variable-fidelity Simulations;Simulation-driven Design

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.

Design, Control and Applications

Wind Turbines

Advances in Design and Thermal Systems

Site-specific Blade Design Optimization for a Fixed-speed Fixed-pitch Wind Turbine with Variable Airfoil Profile Using BEM Theory

Toward the Aerodynamic Shape Optimization of Wind Turbine Profiles

Wind energy is gaining critical ground in the area of renewable energy, with wind energy being predicted to provide up to 8% of the world's consumption of electricity by 2021. Advances in wind turbine blade design and materials reviews the design and functionality of wind turbine rotor blades as well as the requirements and challenges for composite materials used in both current and future designs of wind turbine blades. Part one outlines the challenges and developments in wind turbine blade design, including aerodynamic and aeroelastic design features, fatigue loads on wind turbine blades, and characteristics of wind turbine blade airfoils. Part two discusses the fatigue behavior of composite wind turbine blades, including the micromechanical modelling and fatigue life prediction of wind turbine blade composite materials, and the effects of resin and reinforcement variations on the fatigue resistance of wind turbine blades. The final part of the book describes advances in wind turbine blade materials, development and testing, including biobased composites, surface protection and coatings, structural performance testing and the design, manufacture and testing of small wind turbine blades. Advances in wind turbine blade design and materials offers a comprehensive review of the recent advances and challenges encountered in wind turbine blade materials and design, and will provide an invaluable reference for researchers and innovators in the field of wind energy production, including materials scientists and engineers, wind turbine blade manufacturers and maintenance technicians, scientists, researchers and academics. Reviews the design and functionality of wind turbine rotor blades Examines the requirements and challenges for composite materials used in both current and future designs of wind turbine blades Provides an invaluable reference for researchers and innovators in the field of wind energy production

Wind turbines are one of the most promising renewable energy technologies, and this motivates fertile research activity about developments in power optimization. This topic covers a wide range of aspects, from the research on aerodynamics and control design to the industrial applications about on-site wind turbine performance control and monitoring. This Special Issue collects seven research papers about several innovative aspects of the multi-faceted topic of wind turbine power optimization technology. The seven research papers deal respectively with the aerodynamic optimization of wind turbine blades through Gurney flaps; optimization of blade design for large offshore wind turbines; control design optimization of large wind turbines through the analysis of the competing objectives of energy yield maximization and fatigue loads minimization; design optimization of a tension leg platform for floating wind turbines; innovative methods for the assessment of wind turbine optimization technologies operating on site; optimization of multiple wake interactions modeling through the introduction of a mixing coefficient in the energy balance method; and optimization of the dynamic stall control of vertical-axis wind turbines through plasma actuators. This Special Issue presents remarkable research activities in the timely subject of wind turbine power optimization technology, covering various aspects. The collection is believed to be beneficial to readers and contribute to the wind power industry.

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.

The book presents the select peer-reviewed proceedings of the International Conference on Emerging Trends in Design, Manufacturing, Materials and Thermal Sciences (ETDMMT 2020). The contents focus on latest research in product design, CAD/CAE/CFD, robotic systems, neural networks, thermal systems, alternative fuels, propulsion systems, environmental issues related to combustion, autonomous vehicles and alternative energy applications. In addition, the book also covers recent advances in automotive engineering and aerospace technologies. Given the range of contents covered, this book can be useful for students, researchers as well as practicing engineers.

Marine Design XIII

Wind Turbine Technology

Reliability-based Design Optimization of Composite Wind Turbine Blades for Fatigue Life Under Wind Load Uncertainty

Aircraft Aerodynamic Design with Computational Software

Applying Computational Fluid Dynamics and Numerical Optimization