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Edizione	[1st ed.]
Descrizione fisica	1 online resource (162 pages)
Soggetti	Technology, engineering, agriculture
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Nota di contenuto	Intro -- Title Page -- Preface -- Reading guide -- Acknowledgement -- Nomenclature -- More than a century of rotor research -- Introduction -- History of the actuator disc momentum theory -- The British School -- The German and Russian School -- The contribution of Joukowsky and Betz to the vortex theory of propellers -- The Betz-Joukowsky limit for wind turbines -- From actuator disc to rotor aerodynamics -- Why this book? -- Force fields in fluid dynamics -- Introduction -- The equation of motion and the coordinate systems -- Equivalence of the kinematic and dynamic methods -- Conservative and non-conservative force fields -- Force fields and energy -- Work done by force fields -- Choice of reference system -- Work done by non-conservative force fields -- Pressure as a conservative force in momentum balances -- Pressure interpreted as potential energy -- Definition of (non-)conservative forces as used in this book -- Evaluation -- Force fields and vorticity -- Introduction -- The role of Helmholtz's conservation laws -- Generation of actuator disc vorticity -- Convection of actuator disc vorticity -- Convection of rotor vorticity -- Evaluation -- The disc as representation of a rotor -- Introduction -- Loads and power of a Joukowsky disc and rotor -- The actuator disc equation -- The rotor blade -- Power and thrust coefficients for Joukowsky discs / rotors -- The transition from a B-bladed rotor to the

Joukowsky disc -- Comparison of the flow fields of a disc and rotor -- Evaluation -- Analysis of Froude's actuator disc flows -- Introduction -- One-dimensional momentum theory -- The momentum balance -- Momentum theory without conservative forces -- Momentum theory including conservative forces, applied to a stream annulus -- Numerical assessment of Froude's actuator disc performance -- The model and accuracy of computation.
Comparison of calculated performance with momentum theory results -- Comparison with experimental results -- Flow details -- Flow and pressure patterns -- Properties of the wake boundary -- Pressure and velocity at the disc -- Pressure at the axis -- Evaluation -- Analysis of Joukowsky's actuator disc flows -- Introduction -- Two-dimensional momentum theory -- The equations for a Joukowsky disc -- The disc load -- The far wake outside the vortex core -- The vortex core -- The momentum, mass and energy balance -- Limit values of the Joukowsky momentum theory -- Results for , 0. -- Propeller discs with a wake of constant radius or with wake expansion -- The static disc or disc in hover -- The maximum efficiency of a wind turbine disc -- The efficiency of propeller discs -- Numerical assessment of flow details -- The numerical model -- Comparison of wind turbine and propeller discs at =1 -- Comparison of a wind turbine and propeller disc with similar wake expansion -- The role of swirl and conservative pressure distributions -- Comparison of the Joukowsky and Betz-Goldstein solutions -- Evaluation -- The velocity distribution at the disc -- Introduction -- The absolute velocity -- Wind turbine flows -- Propeller flows -- Explanation of the (non-)uniformity of vs -- The axial velocity -- Momentum balance per annulus -- An engineering model for the axial velocity at a high wind turbine disc -- The radial velocity -- Evaluation -- Special topics: cons. loads at a thick disc &amp -- blade tip -- Introduction -- The generation of a Rankine vortex -- Wu's actuator disc equation -- The force field required to generate a Rankine vortex -- Interpretation of the radial component of the load -- Numerical assessment of the impact of the radial load -- The rotor blade -- Inboard motion of a tip vortex of a wind turbine blade.
Side step: conservative, spanwise load on an elliptic wing -- Conservative and non-conservative blade loads -- Experimental and numerical results for a model wind turbine rotor -- Determination of the conservative tip load -- The tip vortex trajectory -- The role of conservative forces -- Evaluation -- From disc theory to BEM models: the tip correction -- Introduction -- Development of the tip correction -- In BEM methods -- In actuator disc, actuator line and lifting line methods -- The distribution of the axial velocity -- The radial distribution -- The azimuthal distribution: averaged or at blade position -- The azimuthal distribution: decambering of aerofoils -- The radial distribution of blade -- The aspect ratio as a measure for tip effects -- Conservative tip load and the tip vortex trajectory -- Evaluation -- Epilogue -- Vector expressions in cylindrical coordinates -- Balance of angular momentum -- The blade load expressed as pressure distribution -- The potential flow model -- Components of the model -- Convergence scheme -- Verification, sensitivity and accuracy -- Bibliography -- Index.

Sommario/riassunto

The first rotor performance predictions were published by Joukowsky exactly 100 years ago. Although a century of research has expanded the knowledge of rotor aerodynamics enormously, and modern computer power and measurement techniques now enable detailed analyses that were previously out of reach, the concepts proposed by Froude, Betz, Joukowsky and Glauert for modelling a rotor in performance calculations are still in use today, albeit with modifications

and expansions. This book is the result of the author's curiosity as to whether a return to these models with a combination of mathematics, dedicated computations and wind tunnel experiments could yield more physical insight and answer some of the old questions still waiting to be resolved. Although most of the work included here has been published previously, the book connects the various topics, linking them in a coherent storyline.

"The Fluid Dynamic Basis for Actuator Disc and Rotor Theories" was first published in 2018. This Revised Second Edition (2022) will be of interest to those working in all branches of rotor aerodynamics – wind turbines, propellers, ship screws and helicopter rotors. It has been written for proficient students and researchers, and reading it will demand a good knowledge of inviscid (fluid) mechanics.