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""Presents methods necessary for high accuracy computing of fluid flow and wave phenomena in single source format using unified spectral theory of computing"--Provided by publisher"--

This book provides state-of-art information on high-accuracy scientific computing and its future prospects, as applicable to the broad areas of fluid mechanics and combustion, and across all speed regimes. Beginning with the concepts of space-time discretization and dispersion relation in numerical computing, the foundations are laid for the efficient solution of the Navier-Stokes equations, with special reference to prominent approaches such as LES, DES and DNS. The basis of high-accuracy computing is rooted in the concept of stability, dispersion and phase errors, which require the comprehensive analysis of discrete computing by rigorously applying error dynamics. In this context, high-order finite-difference and finite-volume methods are presented. Naturally, the coverage also includes fundamental notions of high-performance computing and advanced concepts on parallel computing, including their implementation in prospective hexascale computers. Moreover, the book seeks to raise the bar beyond the pedagogical use of high-accuracy computing by addressing more complex physical scenarios, including turbulent combustion. Tools like proper orthogonal decomposition (POD), proper generalized decomposition (PGD), singular value decomposition (SVD), recursive POD, and high-order SVD in multi-parameter spaces are presented. Special attention is paid to bivariate and multivariate datasets in connection with various canonical flow and heat transfer cases. The book mainly addresses the needs of researchers and doctoral students in mechanical engineering, aerospace engineering, and all applied disciplines including applied mathematics, offering these readers a unique resource.

Aerodynamics has seen many developments due to the growth of scientific computing, which has caused the design cycle time of aerospace vehicles to be heavily reduced. Today computational aerodynamics appears in the preliminary step of a new design, relegating costly, time-consuming wind tunnel testing to the final stages of design. Theoretical and Computational Aerodynamics is aimed to be a comprehensive textbook, covering classical aerodynamic theories and recent applications made possible by computational aerodynamics. It starts with a discussion on lift and drag from an overall dynamical approach, and after stating the governing Navier-Stokes equation, covers potential flows and panel method. Low aspect ratio and delta wings (including vortex breakdown) are also discussed in detail, and after introducing boundary layer theory, computational aerodynamics is covered for DNS and LES. Other topics covered are on flow transition to analyse NLF airfoils, bypass transition, streamwise and cross-flow instability over swept wings, viscous transonic flow over airfoils, low Reynolds number aerodynamics, high lift devices and flow control. Key features: Blends classical theories of incompressible aerodynamics to panel methods Covers lifting surface theories and low aspect ratio wing and wing-body aerodynamics Presents computational aerodynamics from first principles for incompressible and compressible flows Covers unsteady and low Reynolds number aerodynamics Includes an up-to-date account of DNS of airfoil aerodynamics including flow transition for NLF airfoils Contains chapter problems and illustrative examples Accompanied by a website hosting problems and a solution manual Theoretical and Computational Aerodynamics is an ideal textbook for undergraduate and graduate students, and is also aimed to be a useful resource book on aerodynamics for researchers and practitioners in the research labs and the industry.

Recent advances in scientific computing have caused the field of aerodynamics to change at a rapid pace, simplifying the design cycle of aerospace vehicles enormously – this book takes the readers from core concepts of aerodynamics to recent research, using studies and real-life scenarios to explain problems and their solutions. This book presents in detail the important concepts in computational aerodynamics and aeroacoustics taking readers from the fundamentals of fluid flow and aerodynamics to a more in-depth analysis of acoustic waves, aeroacoustics, computational modelling and processing. This book will be of use to students in multiple branches of engineering, physics and applied mathematics. Additionally, the book can also be used as a text in professional development courses for industry engineers and as a self-help reference for active researchers in both academia and the industry.

The study of incompressible ?ows is vital to many areas of science and te- nology. This includes most of the ?uid dynamics that one ?nds in everyday life from the ?ow of air in a room to most weather phenomena. Inundertakingthesimulationofincompressible?uid?ows,oneoftentakes many issues for granted. As these ?ows become more realistic, the problems encountered become more vexing from a computational point-of-view. These range from the benign to the profound. At once, one must contend with the basic character of incompressible ?ows where sound waves have been analytically removed from the ?ow. As a consequence vortical ?ows have been analytically "preconditioned," but the ?ow has a certain non-physical character (sound waves of in?nite velocity). At low speeds the ?ow will be deterministic and ordered, i.e., laminar. Laminar ?ows are governed by a balance between the inertial and viscous forces in the ?ow that provides the stability. Flows are often characterized by a dimensionless number known as the Reynolds number, which is the ratio of inertial to viscous forces in a ?ow. Laminar ?ows correspond to smaller Reynolds numbers. Even though laminar ?ows are organized in an orderly manner, the ?ows may exhibit instabilities and bifurcation phenomena which may eventually lead to transition and turbulence. Numerical modelling of suchphenomenarequireshighaccuracyandmostimportantlytogaingreater insight into the relationship of the numerical methods with the ?ow physics.

In its third revised and extended edition the book offers an overview of the techniques used to solve problems in fluid mechanics on computers. The authors describe in detail the most often used techniques. Included are advanced techniques in computational fluid dynamics, such as direct and large-eddy simulation of turbulence. Moreover, a new section deals with grid quality and an extended description of discretization methods has also been included. Common roots and basic principles for many apparently different methods are explained. The book also contains a great deal of practical advice for code developers and users.

This book highlights by careful documentation of developments what led to tracking the growth of deterministic disturbances inside the shear layer from receptivity to fully developed turbulent flow stages. Associated theoretical and numerical developments are addressed from basic level so that an uninitiated reader can also follow the materials which lead to the solution of a long-standing problem. Solving Navier-Stokes equation by direct numerical simulation (DNS) from the first principle has been considered as one of the challenging problems of understanding what causes transition to turbulence. Therefore, this book is a very useful addition to advanced CFD and advanced fluid mechanics courses.

This book presents selected papers presented in the Symposium on Applied Aerodynamics and Design of Aerospace Vehicles (SAROD 2018), which was jointly organized by Aeronautical Development Agency (the nodal agency for the design and development of combat aircraft in India), Gas-Turbine Research Establishment (responsible for design and development of gas turbine engines for military applications), and CSIR-National Aerospace Laboratories (involved in major aerospace programs in the country such as SARAS program, LCA, Space Launch Vehicles, Missiles and UAVs). It brings together experiences of aerodynamicists in India as well as abroad in Aerospace Vehicle Design, Gas Turbine Engines, Missiles and related areas. It is a useful volume for researchers, professionals and students interested in diversified areas of aerospace engineering.

This book covers the development of high-order numerical methods for the simulation of incompressible fluid flows in complex domains.

A detailed description of the methods most often used in practice. The authors are experts in their fields and cover such advanced techniques as direct and large-eddy simulation of turbulence, multigrid methods, parallel computing, moving grids, structured, block-structured and unstructured boundary-fitted grids, and free surface flows. The book shows common roots and basic principles for many apparently different methods, while also containing a great deal of practical advice for code developers and users. All the computer codes can be accessed from the Springer server on the internet. Designed to be equally useful for beginners and experts.