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Mathematical Modeling and Numerical Simulation in Continuum Mechanics - Ivo Babuska 2012-12-06

The first international symposium on mathematical foundations of the finite element method was held at the University of Maryland in 1973. During the last three decades there has been great progress in the theory and practice of solving partial differential equations, and research has extended in various directions. Full-scale nonlinear problems have come within the range of numerical simulation. The importance of mathematical modeling and analysis in science and engineering is steadily increasing. In addition, new possibilities of analysing the reliability of computations have appeared. Many other developments have occurred: these are only the most noteworthy. This book is the record of the proceedings of the International Symposium on Mathematical Modeling and Numerical Simulation in Continuum Mechanics, held in Yamaguchi, Japan from 29 September to 3 October 2000. The topics covered by the symposium ranged from solids to fluids, and included both mathematical and computational analysis of phenomena and algorithms. Twenty-one invited talks were delivered at the symposium. This volume includes almost all of them, and expresses aspects of the progress mentioned above. All the papers were individually refereed. We hope that this volume will be a stepping-stone for further developments in this field.

Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics - Charles Hirsch 2007-07-18

The second edition of this book is a self-contained introduction to computational fluid dynamics (CFD). It covers the fundamentals of the subject and is ideal as a text or a comprehensive reference to CFD theory and practice. New approach takes readers seamlessly from first principles to more advanced and applied topics. Presents the essential components of a simulation system at a level suitable for those coming into contact with CFD for the first time, and is ideal for those who need a comprehensive refresher on the fundamentals of CFD. Enhanced pedagogy features chapter objectives, hands-on practice examples and end of chapter exercises. Extended coverage of finite difference, finite volume and finite element methods. New chapters include an introduction to grid properties and the use of grids in practice. Includes material on 2-D inviscid, potential and Euler flows, 2-D viscous flows and Navier-Stokes flows to enable the reader to develop basic CFD simulations. Includes best practice guidelines for applying existing commercial or shareware CFD tools.

Implicit Large Eddy Simulation - Rider William Margolin Len G Grinstein Fenando F 2014-05-14

Finite Element Simulations Using ANSYS - Esam M. Alawadhi 2017-05-22

ANSYS is extensively used in the design cycle by industry leaders in the U.S. and around the world and is available in computer labs in most universities. This volume focuses on the use of ANSYS in solving practical engineering problems, providing students and practicing engineers with the fundamental knowledge of numerical simulation. It treats each physical phenomenon independently in a way that enables readers to pick out single subjects or related chapters and study them as a self-contained unit. The last chapter is devoted to multi-physics analyses and problems. Additionally, the book contains a number of complete tutorials on using ANSYS for real, practical problems.

Parallel Computational Fluid Dynamics 2001, Practice and Theory - P. Wilders 2002-04-17

ParCFD 2001, the thirteenth international conference on Parallel Computational Fluid Dynamics took place in Egmond aan Zee, the Netherlands, from May 21-23, 2001. The specialized, high-level ParCFD

conferences are organized yearly on traveling locations all over the world. A strong back-up is given by the central organization located in the USA <http://www.parcfd.org>. These proceedings of ParCFD 2001 represent 70% of the oral lectures presented at the meeting. All published papers were subjected to a refereeing process, which resulted in a uniformly high quality. The papers cover not only the traditional areas of the ParCFD conferences, e.g. numerical schemes and algorithms, tools and environments, interdisciplinary topics, industrial applications, but, following local interests, also environmental and medical issues. These proceedings present an up-to-date overview of the state of the art in parallel computational fluid dynamics.

Direct and Large-Eddy Simulation I - Peter R. Voke 2012-12-06

It is a truism that turbulence is an unsolved problem, whether in scientific, engineering or geophysical terms. It is strange that this remains largely the case even though we now know how to solve directly, with the help of sufficiently large and powerful computers, accurate approximations to the equations that govern turbulent flows. The problem lies not with our numerical approximations but with the size of the computational task and the complexity of the solutions we generate, which match the complexity of real turbulence precisely in so far as the computations mimic the real flows. The fact that we can now solve some turbulence in this limited sense is nevertheless an enormous step towards the goal of full understanding. Direct and large-eddy simulations are these numerical solutions of turbulence. They reproduce with remarkable fidelity the statistical, structural and dynamical properties of physical turbulent and transitional flows, though since the simulations are necessarily time-dependent and three-dimensional they demand the most advanced computer resources at our disposal. The numerical techniques vary from accurate spectral methods and high-order finite differences to simple finite-volume algorithms derived on the principle of embedding fundamental conservation properties in the numerical operations. Genuine direct simulations resolve all the fluid motions fully, and require the highest practical accuracy in their numerical and temporal discretisation. Such simulations have the virtue of great fidelity when carried out carefully, and represent a most powerful tool for investigating the processes of transition to turbulence.

Numerical Methods for the Simulation of Multi-Phase and Complex Flow - T.M.M. Verheggen 2014-08-23

The nine review articles contained here introduce the techniques required to use lattice gas methods for numerical simulations of complex flows. Furthermore, lattice Boltzmann models are studied together with classical numerical techniques. The editors have written an extensive introduction to this exciting new approach to solving practical problems in modelling and simulating flows. The book addresses numerical analysts and engineers in fluid mechanics, but also graduate students.

Numerical Methods for the Simulation of Multi-phase and Complex Flow - T. M. M. Verheggen 1992

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Cavitation Instabilities and Rotordynamic Effects in Turbopumps and Hydroturbines - Luca d'Agostino 2017-03-17

The book provides a detailed approach to the physics, fluid dynamics, modeling, experimentation and numerical simulation of cavitation phenomena, with special emphasis on cavitation-induced instabilities and their implications on the design and operation of high performance

turbopumps and hydraulic turbines. The first part covers the fundamentals (nucleation, dynamics, thermodynamic effects, erosion) and forms of cavitation (attached cavitation, cloud cavitation, supercavitation, vortex cavitation) relevant to hydraulic turbomachinery, illustrates modern experimental techniques for the characterization, visualization and analysis of cavitating flows, and introduces the main aspects of the hydrodynamic design and performance of axial inducers, centrifugal turbopumps and hydro-turbines. The second part focuses on the theoretical modeling, experimental analysis, and practical control of cavitation-induced fluid-dynamic and rotordynamic instabilities of hydraulic turbomachinery, with special emphasis on cavitating turbopumps (cavitation surge, rotating cavitation, higher order cavitation surge, rotordynamic whirl forces). Finally, the third part of the book illustrates the alternative approaches for the simulation of cavitating flows, with emphasis on both modeling and numerical aspects. Examples of applications to the simulation of unsteady cavitation in internal flows through hydraulic machinery are illustrated in detail.

Computational Fluid Dynamics: Principles and Applications - Jiri Blazek 2005-12-20

Computational Fluid Dynamics (CFD) is an important design tool in engineering and also a substantial research tool in various physical sciences as well as in biology. The objective of this book is to provide university students with a solid foundation for understanding the numerical methods employed in today's CFD and to familiarise them with modern CFD codes by hands-on experience. It is also intended for engineers and scientists starting to work in the field of CFD or for those who apply CFD codes. Due to the detailed index, the text can serve as a reference handbook too. Each chapter includes an extensive bibliography, which provides an excellent basis for further studies.

Arbitrary Lagrangian Eulerian and Fluid-Structure Interaction - M'hamed Souli 2013-03-01

This book provides the fundamental basics for solving fluidstructure interaction problems, and describes different algorithms and numerical methods used to solve problems where fluid and structure can be weakly or strongly coupled. These approaches are illustrated with examples arising from industrial or academic applications. Each of these approaches has its own performance and limitations. Given the book's comprehensive coverage, engineers, graduate students and researchers involved in the simulation of practical fluid structure interaction problems will find this book extremely useful.

Free-Surface Flow - Nikolaos D. Katopodes 2018-10-31

Free-Surface Flow: Computational Methods presents a detailed analysis of numerical schemes for shallow-water waves. It includes practical applications for the numerical simulation of flow and transport in rivers and estuaries, the dam-break problem and overland flow. Closure models for turbulence, such as Reynolds-Averaged Navier-Stokes and Large Eddy Simulation are presented, coupling the aforementioned surface tracking techniques with environmental fluid dynamics. While many computer programs can solve the partial differential equations describing the dynamics of fluids, many are not capable of including free surfaces in their simulations. Provides numerical solutions of the turbulent Navier-Stokes equations in three space dimensions Includes closure models for turbulence, such as Reynolds-Averaged Navier-Stokes, and Large Eddy Simulation Practical applications are presented for the numerical simulation of flow and transport in rivers and estuaries, the dam-break problem and overland flow

Riemann Solvers and Numerical Methods for Fluid Dynamics - Eleuterio F. Toro 2013-04-17

High resolution upwind and centered methods are today a mature generation of computational techniques applicable to a wide range of engineering and scientific disciplines, Computational Fluid Dynamics (CFD) being the most prominent up to now. This textbook gives a comprehensive, coherent and practical presentation of this class of techniques. The book is designed to provide readers with an understanding of the basic concepts, some of the underlying theory, the ability to critically use the current research papers on the subject, and, above all, with the required information for the practical implementation of the methods. Applications include: compressible, steady, unsteady, reactive, viscous, non-viscous and free surface flows.

Implicit Large Eddy Simulation - Fernando F. Grinstein 2011-02-17

The numerical simulation of turbulent flows is a subject of great practical importance to scientists and engineers. The difficulty in achieving predictive simulations is perhaps best illustrated by the wide range of approaches that have been developed and are still being used by the turbulence modeling community. In this book the authors describe one of

these approaches, Implicit Large Eddy Simulation (ILES). ILES is a relatively new approach that combines generality and computational efficiency with documented success in many areas of complex fluid flow. This book synthesizes the theoretical basis of the ILES methodology and reviews its accomplishments. ILES pioneers and lead researchers combine here their experience to present a comprehensive description of the methodology. This book should be of fundamental interest to graduate students, basic research scientists, as well as professionals involved in the design and analysis of complex turbulent flows.

Computational Fluid Dynamics - Jiyuan Tu 2012-11-07

An introduction to CFD fundamentals and using commercial CFD software to solve engineering problems, designed for the wide variety of engineering students new to CFD, and for practicing engineers learning CFD for the first time. Combining an appropriate level of mathematical background, worked examples, computer screen shots, and step by step processes, this book walks the reader through modeling and computing, as well as interpreting CFD results. The first book in the field aimed at CFD users rather than developers. New to this edition: A more comprehensive coverage of CFD techniques including discretisation via finite element and spectral element as well as finite difference and finite volume methods and multigrid method. Coverage of different approaches to CFD grid generation in order to closely match how CFD meshing is being used in industry. Additional coverage of high-pressure fluid dynamics and meshless approach to provide a broader overview of the application areas where CFD can be used. 20% new content

Computational Fluid Dynamics Applied to Waste-to-Energy Processes - Valter Bruno Reis e Silva 2020-06-16

Computational Fluid Dynamics Applied to Waste-to-Energy Processes: A Hands-On Approach provides the key knowledge needed to perform CFD simulations using powerful commercial software tools. The book focuses on fluid mechanics, heat transfer and chemical reactions. To do so, the fundamentals of CFD are presented, with the entire workflow broken into manageable pieces that detail geometry preparation, meshing, problem setting, model implementation and post-processing actions. Pathways for process optimization using CFD integrated with Design of Experiments are also explored. The book's combined approach of theory, application and hands-on practice allows engineering graduate students, advanced undergraduates and industry practitioners to develop their own simulations. Provides the skills needed to perform real-life simulation calculations through a combination of mathematical background and real-world examples, including step-by-step tutorials Presents worked examples in complex processes as combustion or gasification involving fluid dynamics, heat and mass transfer, and complex chemistry sets

Unsteady Computational Fluid Dynamics in Aeronautics - P.G.

Tucker 2013-08-30

The field of Large Eddy Simulation (LES) and hybrids is a vibrant research area. This book runs through all the potential unsteady modelling fidelity ranges, from low-order to LES. The latter is probably the highest fidelity for practical aerospace systems modelling. Cutting edge new frontiers are defined. One example of a pressing environmental concern is noise. For the accurate prediction of this, unsteady modelling is needed. Hence computational aeroacoustics is explored. It is also emerging that there is a critical need for coupled simulations. Hence, this area is also considered and the tensions of utilizing such simulations with the already expensive LES. This work has relevance to the general field of CFD and LES and to a wide variety of non-aerospace aerodynamic systems (e.g. cars, submarines, ships, electronics, buildings). Topics treated include unsteady flow techniques; LES and hybrids; general numerical methods; computational aeroacoustics; computational aeroelasticity; coupled simulations and turbulence and its modelling (LES, RANS, transition, VLES, URANS). The volume concludes by pointing forward to future horizons and in particular the industrial use of LES. The writing style is accessible and useful to both academics and industrial practitioners. From the reviews: "Tucker's volume provides a very welcome, concise discussion of current capabilities for simulating and modelling unsteady aerodynamic flows. It covers the various possible numerical techniques in good, clear detail and presents a very wide range of practical applications; beautifully illustrated in many cases. This book thus provides a valuable text for practicing engineers, a rich source of background information for students and those new to this area of Research & Development, and an excellent state-of-the-art review for others. A great achievement." Mark Savill FHEA, FRAeS, C.Eng, Professor of Computational Aerodynamics Design & Head of Power & Propulsion Sciences, Department of Power & Propulsion, School of Engineering, Cranfield University, Bedfordshire, U.K. "This is a very useful book with a wide coverage of many aspects in unsteady

aerodynamics method development and applications for internal and external flows." L. He, Rolls-Royce/RAEng Chair of Computational Aerothral Engineering, Oxford University, U.K. "This comprehensive book ranges from classical concepts in both numerical methods and turbulence modelling approaches for the beginner to latest state-of-the-art for the advanced practitioner and constitutes an extremely valuable contribution to the specific Computational Fluid Dynamics literature in Aeronautics. Student and expert alike will benefit greatly by reading it from cover to cover." Sébastien Deck, Onera, Meudon, France

Parallel Computational Fluid Dynamics - P. Wilders 2002

ParCFD 2001, the thirteenth international conference on Parallel Computational Fluid Dynamics took place in Egmond aan Zee, the Netherlands, from May 21-23, 2001. The specialized, high-level ParCFD conferences are organized yearly on traveling locations all over the world. A strong back-up is given by the central organization located in the USA <http://www.parcfd.org>. These proceedings of ParCFD 2001 represent 70% of the oral lectures presented at the meeting. All published papers were subjected to a refereeing process, which resulted in a uniformly high quality. The papers cover not only the traditional areas of the ParCFD conferences, e.g. numerical schemes and algorithms, tools and environments, interdisciplinary topics, industrial applications, but, following local interests, also environmental and medical issues. These proceedings present an up-to-date overview of the state of the art in parallel computational fluid dynamics.

Finite Element Methods for Computational Fluid Dynamics - Dmitri Kuzmin 2014-12-18

This informal introduction to computational fluid dynamics and practical guide to numerical simulation of transport phenomena covers the derivation of the governing equations, construction of finite element approximations, and qualitative properties of numerical solutions, among other topics. To make the book accessible to readers with diverse interests and backgrounds, the authors begin at a basic level and advance to numerical tools for increasingly difficult flow problems, emphasizing practical implementation rather than mathematical theory. *Finite Element Methods for Computational Fluid Dynamics: A Practical Guide* explains the basics of the finite element method (FEM) in the context of simple model problems, illustrated by numerical examples. It comprehensively reviews stabilization techniques for convection-dominated transport problems, introducing the reader to streamline diffusion methods, Petrov-Galerkin approximations, Taylor-Galerkin schemes, flux-corrected transport algorithms, and other nonlinear high-resolution schemes, and covers Petrov-Galerkin stabilization, classical projection schemes, Schur complement solvers, and the implementation of the k-epsilon turbulence model in its presentation of the FEM for incompressible flow problem. The book also describes the open-source finite element library ELMER, which is recommended as a software development kit for advanced applications in an online component.

Mathematical and Computational Methods for Compressible Flow - Miloslav Feistauer 2003

This book is concerned with mathematical and numerical methods for compressible flow. It aims to provide the reader with a sufficiently detailed and extensive, mathematically precise, but comprehensible guide, through a wide spectrum of mathematical and computational methods used in Computational Fluid Dynamics (CFD) for the numerical simulation of compressible flow. Up-to-date techniques applied in the numerical solution of inviscid as well as viscous compressible flow on unstructured meshes are explained, thus allowing the simulation of complex three-dimensional technically relevant problems. Among some of the methods addressed are finite volume methods using approximate Riemann solvers, finite element techniques, such as the streamline diffusion and the discontinuous Galerkin methods, and combined finite volume - finite element schemes. The book gives a complex insight into the numerics of compressible flow, covering the development of numerical schemes and their theoretical mathematical analysis, their verification on test problems and use in solving practical engineering problems. The book will be helpful to specialists coming into contact with CFD - pure and applied mathematicians, aerodynamists, engineers, physicists and natural scientists. It will also be suitable for advanced undergraduate, graduate and postgraduate students of mathematics and technical sciences.

Physical Modeling and Computational Techniques for Thermal and Fluid-dynamics - Maurizio Bottoni 2021-11-12

This book on computational techniques for thermal and fluid-dynamic problems arose from seminars given by the author at the Institute of Nuclear Energy Technology of Tsinghua University in Beijing, China. The

book is composed of eight chapters-- some of which are characterized by a scholastic approach, others are devoted to numerical solution of ordinary differential equations of first order, and of partial differential equations of first and second order, respectively. In Chapter IV, basic concepts of consistency, stability and convergence of discretization algorithms are covered in some detail. Other parts of the book follow a less conventional approach, mainly informed by the author's experience in teaching and development of computer programs. Among these is Chapter III, where the residual method of Orthogonal Collocations is presented in several variants, ranging from the classical Galerkin method to Point and Domain Collocations, applied to numerical solution of partial differential equations of first order. In most cases solutions of fluid dynamic problems are led through the discretization process, to the numerical solutions of large linear systems. Intended to impart a basic understanding of numerical techniques that would enable readers to deal with problems of Computational Fluid Dynamics at research level, the book is ideal as a reference for graduate students, researchers, and practitioners.

Computational Methods for Fluid Dynamics - Joel H. Ferziger 2019-08-16

This book is a guide to numerical methods for solving fluid dynamics problems. The most widely used discretization and solution methods, which are also found in most commercial CFD-programs, are described in detail. Some advanced topics, like moving grids, simulation of turbulence, computation of free-surface flows, multigrid methods and parallel computing, are also covered. Since CFD is a very broad field, we provide fundamental methods and ideas, with some illustrative examples, upon which more advanced techniques are built. Numerical accuracy and estimation of errors are important aspects and are discussed in many examples. Computer codes that include many of the methods described in the book can be obtained online. This 4th edition includes major revision of all chapters; some new methods are described and references to more recent publications with new approaches are included. Former Chapter 7 on solution of the Navier-Stokes equations has been split into two Chapters to allow for a more detailed description of several variants of the Fractional Step Method and a comparison with SIMPLE-like approaches. In Chapters 7 to 13, most examples have been replaced or recomputed, and hints regarding practical applications are made. Several new sections have been added, to cover, e.g., immersed-boundary methods, overset grids methods, fluid-structure interaction and conjugate heat transfer.

Fluid Flow Phenomena - Paolo Orlandi 2006-01-05

This book deals with the simulation of the incompressible Navier-Stokes equations for laminar and turbulent flows. The book is limited to explaining and employing the finite difference method. It furnishes a large number of source codes which permit to play with the Navier-Stokes equations and to understand the complex physics related to fluid mechanics. Numerical simulations are useful tools to understand the complexity of the flows, which often is difficult to derive from laboratory experiments. This book, then, can be very useful to scholars doing laboratory experiments, since they often do not have extra time to study the large variety of numerical methods; furthermore they cannot spend more time in transferring one of the methods into a computer language. By means of numerical simulations, for example, insights into the vorticity field can be obtained which are difficult to obtain by measurements. This book can be used by graduate as well as undergraduate students while reading books on theoretical fluid mechanics; it teaches how to simulate the dynamics of flow fields on personal computers. This will provide a better way of understanding the theory. Two chapters on Large Eddy Simulations have been included, since this is a methodology that in the near future will allow more universal turbulence models for practical applications. The direct simulation of the Navier-Stokes equations (DNS) is simple by finite-differences, that are satisfactory to reproduce the dynamics of turbulent flows. A large part of the book is devoted to the study of homogeneous and wall turbulent flows. In the second chapter the elementary concept of finite difference is given to solve parabolic and elliptical partial differential equations. In successive chapters the 1D, 2D, and 3D Navier-Stokes equations are solved in Cartesian and cylindrical coordinates. Finally, Large Eddy Simulations are performed to check the importance of the subgrid scale models. Results for turbulent and laminar flows are discussed, with particular emphasis on vortex dynamics. This volume will be of interest to graduate students and researchers wanting to compare experiments and numerical simulations, and to workers in the mechanical and aeronautic industries.

Mathematical Modelling and Numerical Simulation of Oil Pollution Problems - Matthias Ehrhardt 2015-03-10

Written by outstanding experts in the fields of marine engineering, atmospheric physics and chemistry, fluid dynamics and applied mathematics, the contributions in this book cover a wide range of subjects, from pure mathematics to real-world applications in the oil spill engineering business. Offering a truly interdisciplinary approach, the authors present both mathematical models and state-of-the-art numerical methods for adequately solving the partial differential equations involved, as well as highly practical experiments involving actual cases of ocean oil pollution. It is indispensable that different disciplines of mathematics, like analysis and numerics, together with physics, biology, fluid dynamics, environmental engineering and marine science, join forces to solve today's oil pollution problems. The book will be of great interest to researchers and graduate students in the environmental sciences, mathematics and physics, showing the broad range of techniques needed in order to solve these pollution problems; and to practitioners working in the oil spill pollution industry, offering them a professional reference resource.

The Numerical Simulation of Fluid Flow - Robert Castilla 2022-02-17

This book collects the accepted contributions to the Special Issue "The Numerical Simulation of Fluid Flow" in the *Energies* journal of MDPI. It is focused more on practical applications of numerical codes than in its development. It covers a wide variety of topics, from aeroacoustics to aerodynamics and flow-particles interaction.

Vortex Methods - Georges-Henri Cottet 2008-04-24

Vortex methods have matured in recent years, offering an interesting alternative to finite difference and spectral methods for high resolution numerical solutions of the Navier Stokes equations. In the past three decades, research into the numerical analysis aspects of vortex methods has provided a solid mathematical background for understanding the accuracy and stability of the method. At the same time vortex methods retain their appealing physical character, which was the motivation for their introduction. This book presents and analyzes vortex methods as a tool for the direct numerical simulation of incompressible viscous flows. It will interest graduate students and researchers in numerical analysis and fluid mechanics and also serve as an ideal textbook for courses in fluid dynamics.

Numerical Simulation in Fluid Dynamics - Michael Griebel 1998-01-01

In this translation of the German edition, the authors provide insight into the numerical simulation of fluid flow. Using a simple numerical method as an expository example, the individual steps of scientific computing are presented: the derivation of the mathematical model; the discretization of the model equations; the development of algorithms; parallelization; and visualization of the computed data. In addition to the treatment of the basic equations for modeling laminar, transient flow of viscous, incompressible fluids - the Navier-Stokes equations - the authors look at the simulation of free surface flows; energy and chemical transport; and turbulence. Readers are enabled to write their own flow simulation program from scratch. The variety of applications is shown in several simulation results, including 92 black-and-white and 18 color illustrations. After reading this book, readers should be able to understand more enhanced algorithms of computational fluid dynamics and apply their new knowledge to other scientific fields.

Numerical Simulation of Multiphase Reactors with Continuous Liquid Phase - Chao Yang 2014-09-04

Numerical simulation of multiphase reactors with continuous liquid phase provides current research and findings in multiphase problems, which will assist researchers and engineers to advance this field. This is an ideal reference book for readers who are interested in design and scale-up of multiphase reactors and crystallizers, and using mathematical model and numerical simulation as tools. Yang and Mao's book focuses on modeling and numerical applications directly in the chemical, petrochemical, and hydrometallurgical industries, rather than theories of multiphase flow. The content will help you to solve reacting flow problems and/or system design/optimization problems. The fundamentals and principles of flow and mass transfer in multiphase reactors with continuous liquid phase are covered, which will aid the reader's understanding of multiphase reaction engineering. Provides practical applications for using multiphase stirred tanks, reactors, and microreactors, with detailed explanation of investigation methods. Presents the most recent research efforts in this highly active field on multiphase reactors and crystallizers. Covers mathematical models, numerical methods and experimental techniques for multiphase flow and mass transfer in reactors and crystallizers.

Applied Shape Optimization for Fluids - Bijan Mohammadi 2009-09-24

The fields of computational fluid dynamics (CFD) and optimal shape

design (OSD) have received considerable attention in the recent past, and are of practical importance for many engineering applications. This new edition of *Applied Shape Optimization for Fluids* deals with shape optimization problems for fluids, with the equations needed for their understanding (Euler and Navier Stokes, but also those for microfluids) and with the numerical simulation of these problems. It presents the state of the art in shape optimization for an extended range of applications involving fluid flows. Automatic differentiation, approximate gradients, unstructured mesh adaptation, multi-model configurations, and time-dependent problems are introduced, and their implementation into the industrial environments of aerospace and automobile equipment industry explained and illustrated. With the increases in the power of computers in industry since the first edition, methods which were previously unfeasible have begun giving results, namely evolutionary algorithms, topological optimization methods, and level set algorithms. In this edition, these methods have been treated in separate chapters, but the book remains primarily one on differential shape optimization. This book is essential reading for engineers interested in the implementation and solution of optimization problems using commercial packages or in-house solvers and graduates and researchers in applied mathematics, aerospace, or mechanical engineering, fluid dynamics, and CFD. More generally, anyone needing to understand and solve design problems or looking for new exciting areas for research and development in this area will find this book useful, especially in applying the methodology to practical problems.

Turbulence and Interactions - Michel O. Deville 2014-06-13

The book presents a snapshot of the state-of-art in the field of turbulence modeling and covers the latest developments concerning direct numerical simulations, large eddy simulations, compressible turbulence, coherent structures, two-phase flow simulation and other related topics. It provides readers with a comprehensive review of both theory and applications, describing in detail the authors' own experimental results. The book is based on the proceedings of the third Turbulence and Interactions Conference (TI 2012), which was held on June 11-14 in La Saline-les-Bains, La Réunion, France and includes both keynote lectures and outstanding contributed papers presented at the conference. This multifaceted collection, which reflects the conference's emphasis on the interplay of theory, experiments and computing in the process of understanding and predicting the physics of complex flows and solving related engineering problems, offers a practice-oriented guide for students, researchers and professionals in the field of computational fluid dynamics, turbulence modeling and related areas.

Statistical Theory and Modeling for Turbulent Flows - P. A. Durbin 2001-03-12

Most natural and industrial flows are turbulent. The atmosphere and oceans, automobile and aircraft engines, all provide examples of this ubiquitous phenomenon. In recent years, turbulence has become a very lively area of scientific research and application, and this work offers a grounding in the subject of turbulence, developing both the physical insight and the mathematical framework needed to express the theory. Providing a solid foundation in the key topics in turbulence, this valuable reference resource enables the reader to become a knowledgeable developer of predictive tools. This central and broad ranging topic would be of interest to graduate students in a broad range of subjects, including aeronautical and mechanical engineering, applied mathematics and the physical sciences. The accompanying solutions manual to the text also makes this a valuable teaching tool for lecturers and for practising engineers and scientists in computational and experimental and experimental fluid dynamics.

Essential Computational Fluid Dynamics - Oleg Zikanov 2010-03-29

This book serves as a complete and self-contained introduction to the principles of Computational Fluid Dynamic (CFD) analysis. It is deliberately short (at approximately 300 pages) and can be used as a text for the first part of the course of applied CFD followed by a software tutorial. The main objectives of this non-traditional format are: 1) To introduce and explain, using simple examples where possible, the principles and methods of CFD analysis and to demystify the 'black box' of a CFD software tool, and 2) To provide a basic understanding of how CFD problems are set and which factors affect the success and failure of the analysis. Included in the text are the mathematical and physical foundations of CFD, formulation of CFD problems, basic principles of numerical approximation (grids, consistency, convergence, stability, and order of approximation, etc), methods of discretization with focus on finite difference and finite volume techniques, methods of solution of transient and steady state problems, commonly used numerical methods for heat transfer and fluid flows, plus a brief introduction into turbulence modeling.

Computational Fluid Dynamics - Paul D. Bates 2005-05-27

Uniquely outlines CFD theory in a manner relevant to environmental applications. This book addresses the basic topics in CFD modelling in a thematic manner to provide the necessary theoretical background, as well as providing global case studies showing how CFD models can be used in practice demonstrating how good practice can be achieved, with reference to both established and new applications. First book to apply CFD to the environmental sciences. Written at a level suitable for non-mathematicians.

Computational Fluid Dynamics - Jiyuan Tu 2007-12-04

Computational Fluid Dynamics enables engineers to model and predict fluid flow in powerful, visually impressive ways and is one of the core engineering design tools, essential to the study and future work of many engineers. This textbook is designed to explicitly meet the needs of engineering students taking a first course in CFD or computer-aided engineering. Fully course matched, with the most extensive and rigorous pedagogy and features of any book in the field, it is certain to be a key text. The only course text available specifically designed to give an applications-lead, commercial software oriented approach to understanding and using Computational Fluid Dynamics (CFD). Meets the needs of all engineering disciplines that use CFD. The perfect CFD teaching resource: clear, straightforward text, step-by-step explanation of mathematical foundations, detailed worked examples, end-of-chapter knowledge check exercises, and homework assignment questions.

Fluid Dynamics - C. Pozrikidis 2001

Fluid Dynamics: Theory, Computation, and Numerical Simulation is the only available book that extends the classical field of fluid dynamics into the realm of scientific computing in a way that is both comprehensive and accessible to the beginner. The theory of fluid dynamics, and the implementation of solution procedures into numerical algorithms, are discussed hand-in-hand and with reference to computer programming. This book is an accessible introduction to theoretical and computational fluid dynamics (CFD), written from a modern perspective that unifies theory and numerical practice. There are several additions and subject expansions in the Second Edition of Fluid Dynamics, including new Matlab and FORTRAN codes. Two distinguishing features of the discourse are: solution procedures and algorithms are developed immediately after problem formulations are presented, and numerical methods are introduced on a need-to-know basis and in increasing order of difficulty. Matlab codes are presented and discussed for a broad range of topics; from interfacial shapes in hydrostatics, to vortex dynamics, to Stokes flow, to turbulent flow. A supplement to this book is the FORTRAN software library FDLIB, freely available through the Internet, whose programs explicitly illustrate how computational algorithms translate into computer code instructions. The codes of FDLIB range from introductory to advanced, and the problems considered span a broad range of applications; from laminar channel flows, to vortex flows, to flows in aerodynamics. Selected computer problems at the end of each section ask the student to run the programs for various flow conditions, and thereby study the effect of the various parameters determining each flow. This text is a must for practitioners and students in all fields of engineering, computational physics, scientific computing, and applied mathematics. It can be used as a text in both undergraduate and graduate courses in fluid mechanics, aerodynamics, and computational fluid dynamics. The audience includes not only advanced undergraduate and entry-level graduate students, but also a broad class of scientists and engineers with a general interest in scientific computing.

Fluid Dynamics - Constantine Pozrikidis 2013-11-11

Ready access to computers at an institutional and personal level has defined a new era in teaching and learning. The opportunity to extend the subject matter of traditional science and engineering disciplines into the realm of scientific computing has become not only desirable, but also necessary. Thanks to portability and low overhead and operating costs, experimentation by numerical simulation has become a viable substitute, and occasionally the only alternative, to physical experimentation. The new environment has motivated the writing of texts and monographs with a modern perspective that incorporates numerical and computer programming aspects as an integral part of the curriculum: methods, concepts, and ideas should be presented in a unified fashion that motivates and underlines the urgency of the new elements, but does not compromise the rigor of the classical approach and does not oversimplify. Interfacing fundamental concepts and practical methods of scientific computing can be done on different levels. In one approach, theory and implementation are kept complementary and presented in a sequential fashion. In a second approach, the coupling involves deriving compu-

tational methods and simulation algorithms, and translating equations into computer code instructions immediately following problem formulations. The author of this book is a proponent of the second approach and advocates its adoption as a means of enhancing learning: interjecting methods of scientific computing into the traditional discourse offers a powerful venue for developing analytical skills and obtaining physical insight.

Numerical Methods for Fluid Dynamics - Dale R. Durran 2010-09-14

This scholarly text provides an introduction to the numerical methods used to model partial differential equations, with focus on atmospheric and oceanic flows. The book covers both the essentials of building a numerical model and the more sophisticated techniques that are now available. Finite difference methods, spectral methods, finite element method, flux-corrected methods and TVC schemes are all discussed. Throughout, the author keeps to a middle ground between the theorem-proof formalism of a mathematical text and the highly empirical approach found in some engineering publications. The book establishes a concrete link between theory and practice using an extensive range of test problems to illustrate the theoretically derived properties of various methods. From the reviews: "...the book's unquestionable advantage is the clarity and simplicity in presenting virtually all basic ideas and methods of numerical analysis currently actively used in geophysical fluid dynamics." Physics of Atmosphere and Ocean

Numerical Techniques for Direct and Large-Eddy Simulations - Xi Jiang 2017-06-14

Compared to the traditional modeling of computational fluid dynamics, direct numerical simulation (DNS) and large-eddy simulation (LES) provide a very detailed solution of the flow field by offering enhanced capability in predicting the unsteady features of the flow field. In many cases, DNS can obtain results that are impossible using any other means while LES can be employed as an advanced tool for practical applications. Focusing on the numerical needs arising from the applications of DNS and LES, Numerical Techniques for Direct and Large-Eddy Simulations covers basic techniques for DNS and LES that can be applied to practical problems of flow, turbulence, and combustion. After introducing Navier-Stokes equations and the methodologies of DNS and LES, the book discusses boundary conditions for DNS and LES, along with time integration methods. It then describes the numerical techniques used in the DNS of incompressible and compressible flows. The book also presents LES techniques for simulating incompressible and compressible flows. The final chapter explores current challenges in DNS and LES. Helping readers understand the vast amount of literature in the field, this book explains how to apply relevant numerical techniques for practical computational fluid dynamics simulations and implement these methods in fluid dynamics computer programs.

Recent Advances in Problems of Flow and Transport in Porous Media - J.M. Crolet 1998-03-31

Porous media, and especially phenomena of transport in such materials, are an important field of interest for geologists, hydrogeologists, researchers in soil and fluid mechanics, petroleum and chemical engineers, physicists and scientists in many other disciplines. The development of better numerical simulation techniques in combination with the enormous expansion of computer tools, have enabled numerical simulation of transport phenomena (mass of phases and components, energy etc.) in porous domains of interest. Before any practical application of the results of such simulations can be used, it is essential that the simulation models have been proven to be valid. In order to establish the greatest possible coherence between the models and the physical reality, frequent interaction between numericians, mathematicians and the previously quoted researchers, is necessary. Once this coherence is established, the numerical simulations could be used to predict various phenomena such as water management, propagation of pollutants etc. These simulations could be, in many cases, the only financially acceptable tool to carry out an investigation. Current studies within various fields of applications include not only physical comprehension aspects of flow and energy or solute transport in saturated or unsaturated media but also numerical aspects in deriving strong complex equations. Among the various fields of applications generally two types of problems can be observed. Those associated with the pollution of the environment and those linked to water management. The former are essentially a problem in industrialized countries, the latter are a major source of concern in North-Africa.

Numerical Simulation of Water Waves - Jianhua Tao 2020-03-30

This book discusses the numerical simulation of water waves, which combines mathematical theories and modern techniques of numerical

simulation to solve the problems associated with waves in coastal, ocean, and environmental engineering. Bridging the gap between practical mathematics and engineering, the book describes wave mechanics, establishment of mathematical wave models, modern numerical simulation techniques, and applications of numerical models in engineering. It also explores environmental issues related to water waves in coastal regions, such as pollutant and sediment transport, and

introduces numerical wave flumes and wave basins. The material is self-contained, with numerous illustrations and tables, and most of the mathematical and engineering concepts are presented or derived in the text. The book is intended for researchers, graduate students and engineers in the fields of hydraulic, coastal, ocean and environmental engineering with a background in fluid mechanics and numerical simulation methods.