Computational Fluid Structure Interaction Methods And Applications

Computational fluid-structure interaction and flow simulation are challenging research areas that bring solution and analysis to many classes of problems in science, engineering, and technology. Young investigators under the age of 40 are conducting much of the frontier research in these areas, some of which is highlighted in this book. The first author of each chapter took the lead role in carrying out the research presented. The topics covered include Computational aerodynamic and FSI analysis of wind turbines, Simulating free-surface FSI and fatigue-damage in wind-turbine structural systems, Aorta flow analysis and heart valve flow and structure analysis, Interaction of multiphase fluids and solid structures, Computational analysis of tire aerodynamics with actual geometry and road contact, and A general-purpose NURBS mesh generation method for complex geometries. This book will be a valuable resource for early-career researchers and students — not only those interested in computational fluid-structure interaction and flow simulation, but also other fields of engineering and science, including fluid mechanics, solid mechanics and computational mathematics – as it will provide them with inspiration and guidance for conducting their own successful research. It will also be of interest to senior researchers looking to learn more about successful research led by those under 40 and possibly offer collaboration to these researchers.

This is the first book presenting dynamic responses and failure of polymer composite structures as they interact with internal and/or external fluid media. It summarizes authoritative research carried out by the author in the past decade on various aspects of Fluid-Structure Interaction (FSI) to present important effects of FSI on composite structures. The topics include impact loading on composite structures with air-back, water-back, or containing water; FSI effects on frequencies, mode shapes, and modal curvatures; cyclic loading for fatigue failure with FSI; coupling of independent composite structures by fluid media; and moving composite structures in water. Numerical techniques for FSI are also presented. Research was conducted both experimentally and numerically to complement each other. The book offers a timely, comprehensive information to fluid-structure interaction of composite structures for students, researchers or practicing engineers.

The simulation of complex engineering problems often involves an interaction or coupling of individual phenomena, which are traditionally related by themselves to separate fields of applied mechanics. Typical examples of these so- called multifield problems are the thermo-mechanical analysis of solids with coupling between mechanical stress analysis and thermal heat transfer processes, the simulation of coupled deformation and fluid transport mechanisms in porous media, the prediction of mass transport and phase transition phenomena of mixtures, the analysis of sedimentation proces- ses based on an interaction of particle dynamics and viscous flow, the simulation of multibody systems and fluid-structure interactions based on solid-to-solid and solid-to-fluid contact mechanisms.

Multiphysics Modeling: Numerical Methods and Engineering Applications: Tsinghua University Press Computational Mechanics Series describes the basic principles and methods for multiphysics modeling, covering related areas of physics such as structure mechanics, fluid dynamics, heat transfer, electromagnetic field, and noise. The book provides the latest information on basic numerical methods, also considering coupled problems spanning fluid-solid interaction, thermal-stress coupling, fluid-solid-thermal coupling, electromagnetic solid thermal fluid coupling, and structure-noise coupling. Users will find a comprehensive book that covers background theory, algorithms, key technologies, and applications for each coupling method. Presents a wealth of multiphysics modeling methods, issues, and worked examples in a single volume Provides a go-to resource for coupling and multiphysics problems Covers the multiphysics details not touched upon in broader numerical methods references, including load transfer between physics, element level strong coupling, and interface strong coupling, amongst others Discusses practical applications throughout and tackles real-life multiphysics problems across areas such as automotive, aerospace, and biomedical engineering

Arbitrary Lagrangian Eulerian and Fluid-Structure Interaction

Its Basis and Fundamentals

Modelling, Simulation, Optimization

New Methods and Challenging Computations

Computational Methods for Fluid Dynamics

Frontiers in Computational Fluid-Structure Interaction and Flow Simulation

This contributed volume celebrates the work of Tayfun E. Tezduyar on the occasion of his 60th birthday. The articles it contains were born out of the Advances in Computational Fluid-Structure Interaction and Flow Simulation (AFSI 2014) conference, also dedicated to Prof. Tezduyar and held at Waseda University in Tokyo, Japan on March 19-21, 2014. The contributing authors represent a group of international experts in the field who discuss recent trends and new directions in computational fluid dynamics (CFD) and fluid-structure interaction (FSI). Organized into seven distinct parts arranged by thematic topics, the papers included cover basic methods and applications of CFD, flows with moving boundaries and interfaces, phase-field modeling, computer science and high-performance computing (HPC) aspects of flow simulation, mathematical methods, biomedical applications, and FSI. Researchers, practitioners, and advanced graduate students working on CFD, FSI, and related topics will find this collection to be a definitive and valuable resource.

Fluid-Structure Interaction (FSI), also known as engineering fluid mechanics, deals with mutual interaction between fluid and structural components. Fluid flow depending on the structural shape, motion, surface, and structural roughness, acts as mechanical forces on the structure. FSI can be seen everywhere in medicine, engineering, aerospace, the sciences, and even our daily life. This book provides the basic concept of fluid flow behavior in interaction with structures, which is crucial for almost all engineering disciplines. Along with the fundamental principles, the book covers a variety of FSI problems ranging from fundamentals of fluid mechanics to plasma physics, wind turbines and their turbulence, heat transfer, magnetohydrodynamics, and dam-reservoir systems.

This book provides the fundamental basics for solving fluidstructure interaction problems, and describes different algorithmsand numerical methods used to solve problems where fluid andstructure can be weakly or strongly coupled. These approaches areillustrated with examples arising from industrial or academicapplications. Each of these approaches has its own performance andlimitations. Given the book ' s comprehensive coverage,engineers, graduate students and researchers involved in thesimulation of practical fluid structure interaction problems willfind this book extremely useful.

The discrete vision of mechanics is based on the founding ideas of Galileo and the principles of relativity and equivalence, which postulate the equality between gravitational mass and inertial mass. To these principles are added the Hodge – Helmholtz decomposition, the principle of accumulation of constraints and the hypothesis of the duality of physical actions. These principles make it possible to establish the equation of motion based on the conservation of acceleration considered as an absolute quantity in a local frame of reference, in the form of a sum of the gradient of the scalar potential and the curl of the vector potential. These potentials, which represent the constraints of compression and rotation, are updated from the discrete operators. Discrete Mechanics: Concepts and Applications shows that this equation of discrete motion is representative of the compressible or incompressible flows of viscous or perfect fluids, the state of stress in an elastic solid or complex fluid and the propagation of nonlinear waves.

Theory, Variational Principles, Numerical Methods, and Applications

Computational Fluid-Structure Interaction

The Finite Element Method

Multifield Problems

Results of the Project UNSI, supported by the European Union 1998 – 2000

Concepts and Applications

Fluid-Structure Interaction: An Introduction to FiniteElement Coupling fulfils the need for an introductive approachto the general concepts of Finite and Boundary Element Methods forFSI, from the mathematical formulation to the physicalinterpretation of numerical simulations. Based on theauthor ' s experience in developing numerical codes forindustrial applications in shipbuilding and in teaching FSI to bothpracticing engineers and within academia, it provides acomprehensive and self – contained guide that is geared towardboth students and practitioners of mechanical engineering. Composedof six chapters, Fluid – Structure Interaction: An Introduction to FiniteElement Coupling progresses logically from formulations andapplications involving structure and fluid dynamics, fluid andstructure interactions and opens to reduced order-modelling forvibro-acoustic coupling. The author describes simple yetfundamental illustrative examples in detail, using analyticaland/or semi – analytical formulation & designed both toillustrate each numerical method and also to highlight a physicalaspect of FSI. All proposed examples are simple enough to becomputed by the reader using standard computational tools such asMATLAB, making the book a unique tool for self – learning andunderstanding the basics of the techniques for FSI, or can serve asverification and validation test cases of industrial FEM/BEM codesrendering the book valuable for code verification and validationpurposes.

Computational Fluid-Structure Interaction: Methods, Models, and Applications provides detailed explanations of a range of FSI models, their mathematical formulations, validations, and applications, with an emphasis on conservative unstructured-grid FVM. The first part of the book presents the nascent numerical methods, algorithms and solvers for both compressible and incompressible flows, computational structural dynamics (CSD), parallel multigrid, IOM, IMM and ALE methods. The second half covers the validations of these numerical methods and solvers, as well as their applications in a broad range of areas in basic research and engineering. Provides a comprehensive overview of the latest numerical methods used in FSI, including the unstructured-grid finite volume method (FVM), parallel multigrid scheme, overlapping mesh, immersed object method (IOM), immersed membrane method (IMM), arbitrary Lagragian-Eulerian (ALE), and more Provides full details of the numerical methods, solvers and their validations Compares different methods to help readers more effectively choose the right approach for their own FSI problems Features real-life FSI case studies, such as large eddy simulation of aeroelastic flutter of a wing, parallel computation of a bio-prosthetic heart valve, and ALE study of a micro aerial vehicle

This monograph is devoted to Eulerian models for fluid-structure interaction by applying the original point of view of level set methods. In the last 15 years, Eulerian models have become popular tools for studying fluid-structure interaction problems. One major advantage compared to more conventional methods such as ALE methods is that they allow the use of a single grid and a single discretization method for the different media. Level set methods in addition provide a general framework to follow the fluid-solid interfaces, to represent the elastic stresses of solids, and to model the contact forces between solids. This book offers a combination of mathematical modeling, aspects of numerical analysis, elementary codes and numerical illustrations, providing the reader with insights into the applications and performance of these models. Assuming background at the level of a Master ' s degree, Level Set Methods for Fluid-Structure Interaction provides researchers in the fields of numerical analysis of PDEs, theoretical and computational mechanics with a basic reference on the topic. Its pedagogical style and organization make it particularly suitable for graduate students and young researchers.

The interaction of a fluid with a solid body is a widespread phenomenon in nature, occurring at different scales and different applied disciplines. Interestingly enough, even though the mathematical theory of the motion of bodies in a liquid is one of the oldest and most classical problems in fluid mechanics, mathematicians have, only very recently, become interested in a systematic study of the basic problems related to fluid-structure interaction, from both analytical and numerical viewpoints. Fundamental Trends in Fluid-Structure Interaction is a unique collection of important papers written by world-renowned experts aimed at furnishing the highest level of development in several significant areas of fluid-structure interactions. The contributions cover several aspects of this discipline, from mathematical analysis, numerical simulation and modeling viewpoints, including motion of rigid and elastic bodies in a viscous liquid, particulate flow and hemodynamic.

A Practical Guide

State of the Art

Computational Fluid Dynamics

Focusing on Its Implementation

Fluid-Solid Interaction Dynamics

Modeling and Numerical Simulation of Fluid-Structure Interaction in Circle of Willis

This volume collects the most important contributions from four minisymposia from ICIAM 2019. The papers highlight cutting-edge applications of Cartesian CFD methods and describe the employed algorithms and numerical schemes. An emphasis is laid on complex multi-physics applications like magnetohydrodynamics, combustion, aerodynamics with fluid-structure interaction, solved with various discretizations, e.g. finite difference, finite volume, multiresolution or lattice Boltzmann CFD schemes. Software design aspects and parallelization challenges are also considered. The book is addressed to graduate students and scientists in the fields of applied mathematics and computational engineering.

Placing particular emphasis on practical offshore applications, this book presents state-of-the-art developments in numerical methods for the analysis of fluid-structure interaction. It will be of interest to all designers and researchers developing or applying tools in the area of computational fluid dynamics.

Aircraft design processes require extensive work in the area of both aerodynamics and structure, fonning an environment for aeroelasticity investigations. Present and future designs of European aircraft are characterized by an ever increasing aircraft size and perfonnance. Strong weight saving requirements are met by introduction of new materials, leading to more flexible structure of the aircraft. Consequently, aeroelastic phenomena such as vortex-induced aeroelastic oscillations and moving shock waves can be predominant and may have a significant effect on the aircraft perfonnance. Hence, the ability to estimate reliable margins for aeroelastic instabilities (flutter) or dynamic loads (buffeting) is a major concern to the aircraft designer. As modern aircrafts have wing bending modes with frequencies that are low enough to influence the flight control system, demands on unsteady aerodynamics and structural analysis to predict flight control effectiveness and riding comfort for passengers are extremely high. Therefore, the aircraft industries need an improved capacity of robust, accurate and reliable prediction methods in the coupled aeroelastic, flight mechanics and loads disciplines. In particular, it is necessary to develop/improve and calibrate the numerical tools in order to predict with high level of accuracy and capability complex and non-classical aeroelastic phenomena, including aerodynamic non-linearities, such as shock waves and separation, as well as structural non-linearities, e. g. control surface free-play. Nowadays, robust methods for structural analysis and linearised unsteady aerodynamics are coupled and used by the aircraft industry to computationally clear a new design from flutter.

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.

Numerical Models in Fluid-structure Interaction

Modeling, Adaptive Discretisations and Solvers

Tsinghua University Press Computational Mechanics Series

Progress in Computational Flow-Structure Interaction

Advances in Computational Fluid-Structure Interaction and Flow Simulation

Efficient High-Order Discretizations for Computational Fluid Dynamics

Fluid-structure interactions (FSI), i.e., the interplay of some moveable or deformable structure with an internal or surrounding fluid, are among the most widespread and most challenging coupled or multi-physics problems. Although much has been accomplished in developing good computational FSI methods and despite convincing solutions to a number of classes of problems including those presented in this book, there is a need for more comprehensive studies showing that the computational methods proposed are reliable, robust, and efficient beyond the classes of problems they have successfully been applied to.This volume of LNCSE, a sequel to vol. 53, which contained, among others, the first numerical benchmark for FSI problems and has received considerable attention since then, presents a collection of papers from the "First International Workshop on Computational Engineering - special focus FSI," held in Herrsching in October 2009 and organized by three DFG-funded consortia. The papers address all relevant aspects of FSI simulation and discuss FSI from the mathematical, informatical, and engineering perspective.

The aim of this book is to describe the methods leading to mechanical and numerical modelling of the linear vibrations of elastic structures coupled with internal fluids (sloshing, hydroelasticity and structural acoustics). It is characteristic of the problems under consideration that they are multidisciplinary involving structural and fluid representation and related numerical aspects. The problems are solved by direct resolution of the coupled systems by finite element methods and modal reduction procedures using the eigenmodes of ?elementary subsystems?. The numerical methods described in this book have applications in various engineering disciplines such as the automotive and aerospace industries, civil engineering, nuclear engineering and bioengineering.

Computational Fluid-Structure Interaction: Methods andApplications takes the reader from the fundamentals ofcomputational fluid and solid mechanics to the state-of-the-art incomputational FSI methods, special FSI techniques, and solution ofreal-world problems. Leading experts in the field present thematerial using a unique approach that combines advanced methods,special techniques, and challenging applications. This book begins with the differential equations governing thefluid and solid mechanics, coupling conditions at thefluid – solid interface, and the basics of the finite elementmethod. It continues with the ALE and space – time FSI methods,spatial discretization and time integration strategies for thecoupled FSI equations, solution techniques for thefully-discretized coupled equations, and advanced FSI andspace – time methods. It ends with special FSI techniquestargeting cardiovascular FSI, parachute FSI, and wind-turbineaerodynamics and FSI. Key features: First book to address the state-of-the-art in computationalFSI Combines the fundamentals of computational fluid and solidmechanics, the state-of-the-art in FSI methods, and specialFSI techniques targeting challenging classes of real-worldproblems Covers modern computational mechanics techniques, includingstabilized, variational multiscale, and space – time methods,isogeometric analysis, and advanced FSI coupling methods Is in full color, with diagrams illustrating the fundamentalconcepts and advanced methods and with insightful visualizationillustrating the complexities of the problems that can be solvedwith the FSI methods covered in the book. Authors are award winning, leading global experts incomputational FSI, who are known for solving some of the mostchallenging FSI problems Computational Fluid-Structure Interaction: Methods andApplications is a comprehensive reference for researchers andpracticing engineers who would like to advance their existingknowledge on these subjects. It is also an ideal text for graduateand senior-level undergraduate courses in computational fluidmechanics and computational FSI.

Computational structural mechanics (CSM) and computational fluid dynamics (CFD) have emerged in the last two decades as new disciplines combining structural mechanics and fluid dynamics with approximation theory, numerical analysis and computer science. Their use has transformed much of theoretical mechanics and abstract science into practical and essential tools for a multitude of technological developments which affect many facets of our life. This collection of over 40 papers provides an authoritative documentation of major advances in both CSM and CFD, helping to identify future directions of development in these rapidly changing fields. Key areas covered are fluid structure interaction and aeroelasticity, CFD technology and reacting flows, micromechanics, stability and eigenproblems, probabilistic methods and chaotic dynamics, perturbation and spectral methods, element technology (finite volume, finite elements and boundary elements), adaptive methods, parallel processing machines and applications, and visualization, mesh generation and artificial intelligence interfaces.

Fluid-Structure Interaction of Composite Structures

Fluid-Structure Interaction
Models, Analysis and Finite Elements
Computational Mechanics of Fluid-Structure Interaction
Immersed Boundary Method for Cfd
Discrete Mechanics
This monograph discusses modeling, adaptive discretisation techniques and the numerical solution of fluid structure interaction. An emphasis in part I lies on innovative discretisation and advanced interface resolution techniques. The second part covers the efficient and robust numerical solution of fluid-structure interaction. In part III, recent advances in the application fields vascular flows, binary-fluid-solid interaction, and coupling to fractures in the solid part are presented. Moreover each chapter provides a comprehensive overview in the respective topics including many references to concurring state-of-the art work. Contents Part I: Modeling and discretization On the implementation and benchmarking of an extended ALE method for FSI problems The locally adapted parametric finite element method for interface problems on triangular meshes An accurate Eulerian approach for fluid-structure interactions Part II: Solvers Numerical methods for unsteady thermal fluid structure interaction Recent development of robust monolithic fluid-structure interaction solvers A monolithic FSI solver applied to the FSI 1,2,3 benchmarks Part III: Applications Fluid-structure interaction for vascular flows: From supercomputers to laptops Binary-fluid – solid interaction based on the Navier – Stokes – Cahn – Hilliard Equations Coupling fluid-structure interaction with phase-field fracture: Algorithmic details
The immersed boundary method has become increasingly popular in modeling fluid-structure interaction using computational fluid dynamics. It does this by adding a body force term in the momentum equations. The magnitude and direction of this body force assure that the boundary condition on the solid-fluid interface is satisfied without invoking the body-fitted numerical methods to impose the boundary condition on a solid-fluid interface. This eliminates the significant effort involved in the usually challenging task of generating a body fitted mesh. The governing equations for fluid flow with or without moving solid bodies are solved using a fixed and non-body conforming Cartesian mesh. There are many variations of immersed boundary methods with different implementations to calculate the body force term. A few popular implementations are introduced in this book. Related equations are derived and presented in detail. As examples, a few approaches are formulated using different methods to calculate the body force term, with related validations. Immersed boundary methods are usually coupled with fractional step methods to model fluid flow. One fractional step method is introduced in this book. The related discretized equations are derived in detail. The treatment of domain boundary conditions is also discussed. In immersed boundary methods, the stationary or moving solid bodies in a computational domain are embedded in the fixed mesh. Solid bodies need to be represented or tracked. Interpolation and/or extrapolation need to be performed to calculate the body force term and impose the velocity boundary condition on a solid-fluid interface. In some approaches, a solid volume fraction is also needed in cells containing some solid. The level set method, as a powerful tool that is usually used to track a free surface flow, and construct and manipulate complex geometries, is chosen in the book to perform these tasks. Representing and tracking solid bodies, performing interpolation and extrapolation, and calculating a solid volume fraction are discussed in detail, using the level set method. This book focuses on the implementation of the immersed boundary methods by providing detailed derivations of related equations to facilitate the readers' understanding, so that they may learn the basics and write their own code.
This book starts by introducing the fundamental concepts of mathematical continuum mechanics for fluids and solids and their coupling. Special attention is given to the derivation of variational formulations for the subproblems describing fluid- and solid-mechanics as well as the coupled fluid-structure interaction problem. Two monolithic formulations for fluid-structure interactions are described in detail: the well-established ALE formulation and the modern Fully Eulerian formulation, which can effectively deal with problems featuring large deformation and contact. Further, the book provides details on state-of-the-art discretization schemes for fluid- and solid-mechanics and considers the special needs of coupled problems with interface-tracking and interface-capturing techniques. Lastly, advanced topics like goal-oriented error estimation, multigrid solution and gradient-based optimization schemes are discussed in the context of fluid-structure interaction problems.
The Finite Element Method: Its Basis and Fundamentals offers a complete introduction to the basis of the finite element method, covering fundamental theory and worked examples in the detail required for readers to apply the knowledge to their own engineering problems and understand more advanced applications. This edition sees a significant rearrangement of the book's content to enable clearer development of the finite element method, with major new chapters and sections added to cover: Weak forms Variational forms Multi-dimensional field problems Automatic mesh generation Plate bending and shells Developments in meshless techniques Focusing on the core knowledge, mathematical and analytical tools needed for successful application, The Finite Element Method: Its Basis and Fundamentals is the authoritative resource of choice for graduate level students, researchers and professional engineers involved in finite element-based engineering analysis. A proven keystone reference in the library of any engineer needing to understand and apply the finite element method in design and development. Founded by an influential pioneer in the field and updated in this seventh edition by an author team incorporating academic authority and industrial simulation experience. Features reworked and reordered contents for clearer development of the theory, plus new chapters and sections on mesh generation, plate bending, shells, weak forms and variational forms.
Finite Element Methods for Computational Fluid Dynamics
Methods, Models, and Applications
Level Set Methods for Fluid-Structure Interaction
Applied Computational Fluid Dynamics Techniques
Applied Numerical Methods
An Introduction Based on Finite Element Methods
This volume in the series Lecture Notes in Computational Science and Engineering presents a collection of papers presented at the International Workshop on FSI, held in October 2005 in Hohenwart and organized by DFG's Research Unit 493 "FSI: Modeling, Simulation, and Optimization". The papers address partitioned and monolithic coupling approaches, methodical issues and applications, and discuss FSI from the mathematical, informatics, and engineering points of view.
This book is intended to provide a compilation of the state-of-the-art numerical methods for nonlinear fluid-structure interaction using the moving boundary Lagrangian-Eulerian formulation. Single and two-phase viscous incompressible fluid flows are considered with the increasing complexity of structures ranging from rigid-body, linear elastic and nonlinear large deformation to fully-coupled flexible multibody system. This book is unique with regard to computational modeling of such complex fluid-structure interaction problems at high Reynolds numbers, whereby various coupling techniques are introduced and systematically discussed. The techniques are demonstrated for large-scale practical problems in aerospace and marine/offshore engineering. This book also provides a comprehensive understanding of underlying unsteady physics and coupled mechanical aspects of the fluid-structure interaction from a computational point of view. Using the body-fitted and moving mesh formulations, the physical insights associated with structure-to-fluid mass ratios (i.e., added mass effects), Reynolds number, large structural deformation, free surface, and other interacting physical fields are covered. The book includes the basic tools necessary to build the concepts required for modeling such coupled fluid-structure interaction problems, thus exposing the reader to advanced topics of multiphysics and multiscale phenomena.
Fluid-Solid Interaction Dynamics: Theory, Variational Principles, Numerical Methods and Applications gives a comprehensive accounting of fluid-solid interaction dynamics, including theory, numerical methods and their solutions for various FSI problems in engineering. The title provides the fundamental theories, methodologies and results developed in the application of FSI dynamics. Four numerical approaches that can be used with almost all integrated FSI systems in engineering are presented. Methods are linked with examples to illustrate results. In addition, numerical results are compared with available experiments or numerical data in order to demonstrate the accuracy of the approaches and their value to engineering applications. The title gives readers the state-of-the-art in theory, variational principles, numerical modeling and applications for fluid-solid interaction dynamics. Readers will be able to independently formulate models to solve their engineering FSI problems using information from this book. Presents the state-of-the-art in fluid-solid interaction dynamics, providing theory, method and results Takes an integrated approach to formulate, model and simulate FSI problems in engineering Illustrates results with concrete examples Gives four numerical approaches and related theories that are suitable for almost all integrated FSI systems Provides the necessary information for bench scientists to independently formulate, model, and solve physical FSI problems in engineering
Fluid-structure interaction is a new theme of investigation in computational methods, covering many applications in both engineering and medical sciences. This book deals with various examples of interaction between a fluid and a structure, and each author presents, for the different problems involved, the method which is considered to be the most appropriate.
Cartesian CFD Methods for Complex Applications
An Introduction to Finite Element Coupling
Advances and Trends
Fluid Structure Interaction II
Multiphysics Modeling: Numerical Methods and Engineering Applications
Computational Structural Mechanics & Fluid Dynamics
Computational fluid dynamics (CFD) is concerned with the efficient numerical solution of the partial differential equations that describe fluid dynamics. CFD techniques are commonly used in the many areas of engineering where fluid behavior is an important factor. Traditional fields of application include aerospace and automotive design, and more recently, bioengineering and consumer and medical electronics. With Applied Computational Fluid Dynamics Techniques, 2nd edition, Rainald L ö hner introduces the reader to the techniques required to achieve efficient CFD solvers, forming a bridge between basic theoretical and algorithmic aspects of the finite element method and its use in an industrial context where methods have to be both as simple but also as robust as possible. This heavily revised second edition takes a practice-oriented approach with a strong emphasis on efficiency, and offers important new and updated material on; Overlapping and embedded grid methods Treatment of free surfaces Grid generation Optimal use of supercomputing hardware Optimal shape and process design Applied Computational Fluid Dynamics Techniques, 2nd edition is a vital resource for engineers, researchers and designers working on CFD, aero and hydrodynamics simulations and bioengineering. Its unique practical approach will also appeal to graduate students of fluid mechanics and aero and hydrodynamics as well as biofluidics.
COMPUTATIONAL FLUID DYNAMICS FOR WIND ENGINEERING An intuitive and comprehensive exploration of computational fluid dynamics in the study of wind engineering Computational Fluid Dynamics for Wind Engineering provides readers with a detailed overview of the use of computational fluid dynamics (CFD) in understanding wind loading on structures, a problem becoming more pronounced as urban density increases and buildings become larger. The work emphasizes the application of CFD to practical problems in wind loading and helps readers understand important associated factors such as turbulent flow around buildings and bridges. The author, with extensive research experience in this and related fields, offers relevant and engaging practice material to help readers learn and retain the concepts discussed, and each chapter includes accessible summaries at the end. In addition, the use of the OpenFOAM tool—an open-source wind engineering application—is explored. Computational Fluid Dynamics for Wind Engineering covers topics such as: Fluid mechanics, turbulence in fluid mechanics, turbulence modelling, and mathematical modelling of wind engineering problems The finite difference method for CFD, solutions to the incompressible Navier-Stokes equations, visualization, and animation in CFD, and the application of CFD to building and bridge aerodynamics How to compare CFD analysis with wind tunnel measurements, field measurements, and the ASCE-7 pressure coefficients Wind effects and strain on large structures Providing comprehensive coverage of how CFD can explain wind load on structures along with helpful examples of practical applications, Computational Fluid Dynamics for Wind Engineering serves as an invaluable resource for senior undergraduate students, graduate students, researchers and practitioners of civil and structural engineering.
The main focus of this study is based on the numerical study of hemodynamics of blood and arterial wall behavior in Circle of Willis.
Computational Fluid Dynamics, Second Edition, provides an introduction to CFD fundamentals that focuses on the use of commercial CFD software to solve engineering problems. This new edition provides expanded coverage of CFD techniques including discretisation via finite element and spectral element as well as finite difference and finite volume methods and multigrid method. There is additional coverage of high-pressure fluid dynamics and meshless approach to provide a broader overview of the application areas where CFD can be used. The book combines an appropriate level of mathematical background, worked examples, computer screen shots, and step-by-step processes, walking students through modeling and computing as well as interpretation of CFD results. It is ideal for senior level undergraduate and graduate students of mechanical, aerospace, civil, chemical, environmental and marine engineering. It can also help beginner users of commercial CFD software tools (including CFX and FLUENT). 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
Methods and Applications
Research from Lead Investigators under Forty – 2018
Computational Overview of Fluid Structure Interaction
Fluid-structure Interactions
Modelling, Simulation, Optimisation
Numerical Simulation
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.
The book introduces modern high-order methods for computational fluid dynamics. As compared to low order finite volumes predominant in today's production codes, higher order discretizations significantly reduce dispersion errors, the main source of error in long-time simulations of flow at higher Reynolds numbers. A major goal of this book is to teach the basics of the discontinuous Galerkin (DG) method in terms of its finite volume and finite element ingredients. It also discusses the computational efficiency of high-order methods versus state-of-the-art low order methods in the finite difference context, given that accuracy requirements in engineering are often not overly strict. The book mainly addresses researchers and doctoral students in engineering, applied mathematics, physics and high-performance computing with a strong interest in the interdisciplinary aspects of computational fluid dynamics. It is also well-suited for practicing computational engineers who would like to gain an overview of discontinuous Galerkin methods, modern algorithmic realizations, and high-performance implementations.
Computational Fluid Dynamics for Wind Engineering
Computational Methods for Coupled Fluid-Structure Analysis
Fundamental Trends in Fluid-structure Interaction
Computational Methods for Fluid-Structure Interaction
A Practical Approach