Computational Wave Dynamics

#computational wave dynamics #wave simulation #numerical wave modeling #fluid dynamics computational #wave propagation analysis

Explore the intricate field of Computational Wave Dynamics, which utilizes advanced numerical methods and powerful simulations to model and predict the behavior of various wave phenomena. This discipline is critical for understanding everything from ocean hydrodynamics and acoustic propagation to electromagnetic waves, enabling engineers and researchers to analyze complex wave interactions and design innovative solutions across numerous scientific and engineering applications.

Computational Wave Dynamics

This book provides a comprehensive description of the latest theory-supported numerical technologies, as well as scientific and engineering applications for water surface waves. Its contents are crafted to cater to a step-by-step learning of computational wave dynamics and ocean wave modeling. It provides a comprehensive description from underlying theories of free-surface flows, to practical computational applications for coastal and ocean engineering on the basis of computational fluid dynamics (CFD). The text may be used as a textbook for advanced undergraduate students and graduate students to understand the theoretical background of wave computations, and the recent progress of computational techniques for free-surface and interfacial flows, such as Volume of Fluid (VOF), Constrained Interpolation Profile (CIP), Lagrangian Particle (SPH, MPS), Distinct Element (DEM) and Euler-Lagrange Hybrid Methods. It is also suitable for researchers and engineers who wish to apply CFD techniques to ocean modeling and practical coastal problems involving sediment transport, wave-structure interaction and surf zone flows.

Computational Wave Dynamics

Computational Wave Dynamics explains the analytical, semi-analytical and numerical methods for finding exact or approximate solutions to various linear and nonlinear differential equations governing wave-like flows. Waves exist almost everywhere in nature. Different types include water, sound, electromagnetic, seismic, and shock. This book explores the latest and most efficient linear and nonlinear differential equations that govern all waves with particular emphasis on water waves, helping the reader to incorporate a more profound numerical understanding of waves in a range of engineering solutions. Procedures, algorithms, and solutions are presented in a simple step-by-step style, helping readers with different backgrounds at various levels to engage with this topic. The breadth of different methods addressed in this one book creates a uniquely valuable resource for the comparison of equations, and acts as a very useful summary of recent research into computational wave dynamics.

Wave Dynamics

There are various types of waves including water, sound, electromagnetic, seismic and shock etc. These waves need to be analyzed and understood for different practical applications. This book is an attempt to consider the waves in detail to understand the physical and mathematical phenomena. A major challenge is to model waves by experimental studies.The aim of this book is to address the efficient and recently developed theories along with the basic equations of wave dynamics. The latest development of analytical/semi analytical and numerical methods with respect to wave dynamics are also covered. Further few challenging experimental studies are considered for related problems. This book presents advances in wave dynamics in simple and easy to follow chapters for the benefit of the readers/researchers.

Theory and Applications of Ocean Surface Waves: Nonlinear aspects

This book is an expanded version of The Applied Dynamics of Ocean Surface Waves. It presents theoretical topics on ocean wave dynamics, including basic principles and applications in coastal and offshore engineering as well as coastal oceanography. Advanced analytical and numerical techniques are applied, such as singular perturbations. In this expanded edition, two chapters on recent developments have been added: one is on multiple scattering by periodic or random bathymetry, and the other is on Zakharov's theory of broad spectrum wave fields. New sections include topics on infragravity waves, upstream solitons, Venice storm gates, etc. In addition, there are many new exercises. Theory and Applications of Ocean Surface Waves will be invaluable for graduate students and researchers in coastal and ocean engineering, geophysical fluid dynamicists interested in water waves, and theoretical scientists and applied mathematicians wishing to develop new techniques for challenging problems or to apply techniques existing elsewhere.

Wave Dynamics, Mechanics and Physics of Microstructured Metamaterials

This book addresses theoretical and experimental methods for exploring microstructured metamaterials, with a special focus on wave dynamics, mechanics, and related physical properties. The authors use various mathematical and physical approaches to examine the mechanical properties inherent to particular types of metamaterials. These include: • Boundary value problems in reduced strain gradient elasticity for composite fiber-reinforced metamaterials • Self-organization of molecules in ferroelectric thin films • Combined models for surface layers of nanostructures • Computer simulation at the micro- and nanoscale • Surface effects with anisotropic properties and imperfect temperature contacts • Inhomogeneous anisotropic metamaterials with uncoupled and coupled surfaces or interfaces • Special interface finite elements and other numerical and analytical methods for composite structures

Complex Wave Dynamics on Thin Films

Wave evolution on a falling film is a classical hydrodynamic instability whose rich wave dynamics have been carefully recorded in the last fifty years. Such waves are known to profoundly affect the mass and heat transfer of multi-phase industrial units. This book describes the collective effort of both authors and their students in constructing a comprehensive theory to describe the complex wave evolution from nearly harmonic waves at the inlet to complex spatio-temporal patterns involving solitary waves downstream. The mathematical theory represents a significant breakthrough from classical linear stability theories, which can only describe the inlet harmonic waves and also extends classical soliton theory for integrable systems to real solitrary wave dynamics with dissipation. One unique feature of falling-film solitary wave dynamics, which drives much of the spatio-temporal wave evolution, is the irreversible coalescence of such localized wave structures. It represents the first full description of a hydrodynamic instability from inception to developed chaos. This approach should prove useful for other complex hydrodynamic instabilities and would allow industrial engineers to better design their multi-phase apparati by exploiting the deciphered wave dynamics. This publication gives a comprehensive review of all experimental records and existing theories and significantly advances state of the art on the subject and are complimented by complex and attractive graphics from computational fluid mechanics.

Effective Computational Methods for Wave Propagation

Due to the increase in computational power and new discoveries in propagation phenomena for linear and nonlinear waves, the area of computational wave propagation has become more significant in recent years. Exploring the latest developments in the field, Effective Computational Methods for Wave Propagation presents several modern, valuable computational methods used to describe wave propagation phenomena in selected areas of physics and technology. Featuring contributions from internationally known experts, the book is divided into four parts. It begins with the simulation of nonlinear dispersive waves from nonlinear optics and the theory and numerical analysis of Boussinesq systems. The next section focuses on computational approaches, including a finite element method and parabolic equation techniques, for mathematical models of underwater sound propagation and scattering. The book then offers a comprehensive introduction to modern numerical methods for time-dependent elastic wave propagation. The final part supplies an overview of high-order, low diffusion numerical methods for complex, compressible flows of aerodynamics. Concentrating on physics and technology, this volume provides the necessary computational methods to effectively tackle the sources of problems that involve some type of wave motion.

Wave Phenomena

IJ:1 June of 1987 the Center for Applied Mathematics and Computer Science at San Jose State University received a bequest of over half a million dollars from the estate of Mrs. Marie Woodward. In the opening article of this collection of papers Jane Day, the founder of the Center, describes the background that led to this gift. In recognition of the bequest it was decided that a series of Woodward Conferences be established. The First Woodward Conference took place at San Jose State University on June 2-3 1988. The themes of the conference were the Theoretical, Computational and Practical Aspects of Wave Phenomena and these same themes have been used to divide the contributions to this volume. Part I is concerned with papers on theoretical aspects. This section includes papers on pseudo-differential operator techniques, inverse problems and the mathematical foundations of wave propagation in random media. Part II consists of papers that involve significant amounts of computation. Included are papers on the Fast Hartley Transform, computational algorithms for electromagnetic scattering problems, and nonlinear wave interaction problems in fluid mechanics. vi Part III contains papers with a genuine physics flavor. This final section illustrates the widespread importance of wave phenomena in physics. Among the phenomena considered are waves in the atmosphere, viscous fingering in liquid crystals, solitons and wave localization.

Nonlinear Wave Dynamics

In September 2006, research leaders in the field of coastal engineering, fluid mechanics, and wave theory met at Cornell University to celebrate the 60th birthday of Prof. Philip L-F Liu. This volume is a compilation of the research papers presented at the symposium, and includes both review and new research papers. Topics such as nonlinear wave theory, tsunamis, wave-structure interaction, turbulence, and modeling of complex sediment transport are discussed in this volume. All of the contributing authors are research collaborators of Prof. Liu, and include leaders in coastal engineering such as Maarten Dingemans, Hwung-Hweng Hwung, Nobu Kobayashi, Inigo Losada, Hocine Oumeraci, Costas Synolakis, and Harry Yeh.

Wave Dynamics and Composite Mechanics for Microstructured Materials and Metamaterials

This volume deals with topical problems concerning technology and design in construction of modern metamaterials. The authors construct the models of mechanical, electromechanical and acoustical behavior of the metamaterials, which are founded upon mechanisms existing on micro-level in interaction of elementary structures of the material. The empiric observations on the phenomenological level are used to test the created models. The book provides solutions, based on fundamental methods and models using the theory of wave propagation, nonlinear theories and composite mechanics for media with micro- and nanostructure. They include the models containing arrays of cracks, defects, with presence of micro- and nanosize piezoelectric elements and coupled physical-mechanical fields of different nature. The investigations show that the analytical, numerical and experimental methods permit evaluation of the qualitative and quantitative properties of the materials of this sort, with diagnosis of their effective characteristics, frequency intervals of effective energetic cutting and passing, as well as effective regimes of damage evaluation by the acoustic methods.

Introduction to Theoretical and Computational Fluid Dynamics

This book discusses the fundamental principles and equations governing the motion of incompressible Newtonian fluids, and simultaneously introduces numerical methods for solving a broad range of problems. Appendices provide a wealth of information that establishes the necessary mathematical and computational framework.

Nonlinear Wave Propagation

Research investigations involving the nonlinear wave propagation that arise in physically significant systems have been carried out Applications include modeling and computational studies of wave phenomena in nonlinear optics, solutions of physically significant nonlinear equations, chaotic wave dynamics in physical systems and inverse scattering. There have been a number of important research contributions. During the past three years 19 papers were published or accepted for publication in refereed journals, 4 book chapters were published or accepted, and 14 invited lectures were given. New methods to find solutions to discrete equations in a nonlinear optical fiber array were discovered. Discrete diffraction managed systems and associated solitons were proposed. This work is relevant to recent experiments involving discrete optical waveguides. Experimental arrays occupy 5 microns in width and a total length of 2-5 millimeters. From first principles, the equations governing discrete systems in nonlinear optical arrays as well as discrete diffraction managed systems have been derived. The concept of dispersion management is being applied to the study of ultra-short laser pulse dynamics in Ti:sapphire lasers In quadratic nonlinear optical media, a vector system of nonlinear Schrodinger (NLS) type with coupling to a mean field has been derived. It has been established that a universal type of chaotic wave dynamics can develop in physical sand computational systems. Parameter regimes have been delineated where chaotic dynamics are predicted and observed. Such chaotic dynamics has been shown to arise in computational chaos, water waves and short pulses in nonlinear optical fibers. A class of free boundary problems has been investigated. New classes of localized solutions to multidimensional nonlinear wave problems have been obtained and analyzed.

Computational Fluid Dynamics Techniques

First published in 1995. Routledge is an imprint of Taylor & Francis, an informa company.

Shock Wave Dynamics

Working knowledge of the relations of various quantities and their derivatives across a shock wave is useful for any advanced research involving shock waves. Although these relations can be derived in principle by any diligent student of the subject, the derivations are often not trivial, and once derived, neither the approach nor the result can be confidently verified. Comprehensive and analytical, Shock Wave Dynamics: Derivatives and Related Topics includes not only the final results but also the methods, which are of great practical value as examples of mathematical procedure in this field. The book focuses on shock wave derivatives under various conditions and extensively covers shock-generated vorticity, including a novel analysis of triple points. Special care is given to the presentation of assumptions, implementation requirements, and the illustrative examples included for partial verification of the preceding analysis. Designed both as a research monograph and for self study, Shock Wave Dynamics is a complete discussion of shock wave dynamics. An analytical exploration of shock wave phenomena, it will be interesting reading for experts in the field of high-speed gas dynamics. Given today's emphasis on numerical simulation, it will also be of interest to computational engineers as a source for code verification and validation.

Mechanics of Continua and Wave Dynamics

Mechanics of Continua and Wave Dynamics is a textbook for a course on the mechanics of solids and fluids with the emphasis on wave theory. The material is presented with simplicity and clarity but also with mathematical rigor. Many wave phenomena, especially those of geophysical nature (different types of waves in the ocean, seismic waves in the earth crust, wave propagation in the atmosphere, etc.), are considered. Each subject is introduced with simple physical concepts using numerical examples and models. The treatment then goes into depth and complicated aspects are illustrated by appropriate generalizations. Numerous exercises with solutions will help students to comprehend and assimilate the ideas.

Computational Fluid Dynamics

This IMA Volume in Mathematics and its Applications COMPUTATIONAL WAVE PROPAGATION is based on the workshop with the same title and was an integral part of the 1994-1995 IMA program on "Waves and Scattering." We would like to thank Bjorn Engquist and Gregory A. Kriegsmann for their hard work in organizing this meeting and in editing the proceedings. We also take this opportunity to thank the National Science Foundation, the Army Research Office, and the Office of Naval Research, whose financial support made this workshop possible. A vner Friedman Robert Gulliver v PREFACE Although the field of wave propagation and scattering has its classical roots in the last century, it has enjoyed a rich and vibrant life over the past 50 odd years. Scientists, engineers, and mathematicians have devel oped sophisticated asymptotic and numerical tools to solve problems of ever increasing complexity. Their work has been spurred on by emerging and maturing technologies, primarily concerned with the propagation and reception of information, and the efficient transmission of energy. The vitality of this scientific field is not waning. Increased demands to precisely quantify, measure, and control the propagation and scattering of waves in increasingly complex settings pose challenging scientific and mathematical problems. These push the envelope of analysis and comput ing, just as their forerunners did 50 years ago. These modern technological problems range from using underwater sound to monitor and predict global warming, to periodically embedding phase-sensitive amplifiers in optical fibers to insure long range digital communication.

Computational Wave Propagation

This Element presents a unified computational fluid dynamics framework from rarefied to continuum regimes. The framework is based on the direct modelling of flow physics in a discretized space. The mesh size and time step are used as modelling scales in the construction of discretized governing equations. With the variation-of-cell Knudsen number, continuous modelling equations in different regimes have been obtained, and the Boltzmann and Navier-Stokes equations become two limiting equations in the kinetic and hydrodynamic scales. The unified algorithms include the discrete velocity method (DVM)–based unified gas-kinetic scheme (UGKS), the particlebased unified gas-kinetic particle method (UGKP), and the wave and particle–based unified gas-kinetic wave-particle method (UGKWP). The UGKWP is a multi-scale method with the particle for non-equilibrium transport and wave for equilibrium evolution. The particle dynamics in the rarefied regime and the hydrodynamic flow solver in the continuum regime have been unified according to the cell's Knudsen number.

A Unified Computational Fluid Dynamics Framework from Rarefied to Continuum Regimes

In core-annular flow of two different fluids, for a set of suitable flow conditions, various shapes of saturated waves such as bamboo, snake and corkscrew waves are observed. Some of the dominant parameters such as thickness ratio of the fluid, Reynolds number, viscosity ratio, density ratio, interfacial surface tension, and the direction of gravitational forces determine the final shape of the saturated wave and their ultimate stability in a nonlinear regime. When the flow rate ratio is high, it is sometimes difficult to determine the differences between the final shape of the waves for up-flow and down-flow. For some combinations of thickness ratio, viscosity ratio, density ratio, Reynolds number and surface tension, waves tend to break and bubbles start to form. Interfacial surface tensions between these two fluids play a very important role in stabilizing the waves from breaking.In this study, new sets of waves were discovered for core-annular flow, which modulate at certain flow parameter ranges. The critical parameter ranges are identified where the waves shift from saturated bamboo waves and bifurcate into modulated bamboo waves. A thorough analysis is performed for the first time to depict the windows of these critical parameters at which this transition takes place. A bifurcation diagram is constructed to capture the regime. A detailed wave shape analysis is performed to characterize these wave shapes and their periods of oscillation. Due to challenges associated with large computational domain and enormous computational power requires to resolve the interfacial instability, a three-dimensional true non-axisymmetric model was never studied before. For the first time, effort is being undertaken to construct a viable 3-D Core-annular flow. A general purpose computational fluid dynamics package ANSYS Fluent is used for this analysis. Three dimensional models for both up-flow and down-flow were constructed and a novel explanation is presented to distinguish between the Bamboo waves, Cork-Screw waves, and Snake waves. The sensitivity of down-flow on initial conditions was also verified with 3-D models on some parameter space from selected publication.

Interfacial Wave Dynamics of Core-annular Flow of Two Fluids

The present book – through the topics and the problems approach – aims at filling a gap, a real need in our literature concerning CFD (Computational Fluid Dynamics). Our presentation results from a large documentation and focuses on reviewing the present day most important numerical and computational methods in CFD. Many theoreticians and experts in the field have expressed their - terest in and need for such an enterprise. This was the motivation for carrying out our study and writing this book. It contains an important systematic collection of numerical working instruments in Fluid Dyn- ics. Our current approach to CFD started ten years ago when the Univ- sity of Paris XI suggested a collaboration in the field of spectral methods for fluid dynamics. Soon after – preeminently studying the numerical approaches to Navier–Stokes nonlinearities – we completed a number of research projects which we presented at the most important inter- tional conferences in the field, to gratifying appreciation. An important qualitative step in our work was provided by the dev- opment of a computational basis and by access to a number of expert softwares. This fact allowed us to generate effective working programs for most of the problems and examples presented in the book, an - pect which was not taken into account in most similar studies that have already appeared all over the world.

Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics

Computational methods and modelling is of growing importance in fundamental science as well as in applications in industry and in environmental research. In this topical volume the readers find important contributions in the field of turbulent boundary layers, the Tsunami problem, group invariant solution of hydrodynamic equations, non-linear waves, modelling of the problem of evaporation-condensation, the exact solution of discrete models of the Boltzmann equation etc. The book addresses researchers and engineers both in the mechanical sciences and in scientific computing.

Computational Fluid Dynamics

This book details a systematic characteristics-based finite element procedure to investigate incompressible, free-surface and compressible flows. Several sections derive the Fluid Dynamics equations from first thermo-mechanics principles and develop this multi-dimensional and infinite-directional upstream procedure by combining a finite element discretization with an implicit non-linearly stable Runge-Kutta time integration for the numerical solution of the Euler and Navier Stokes equations.

Computational Fluid Dynamics

In this thesis, we develop and study two distinct problems in the field of nonlinear waves. The first part of the thesis is connected to the development of a computational algorithm that preserves underlying structure of the simulated initial boundary value problem in the form of multiple global conservation laws or dissipation rate equations. \\\\\\\\begin{itemize}\\\\\\\\item The time-dependent spectral renormalization (TDSR) method was introduced by Cole and Musslimani as a viable method to numerically solve initial boundary value problems. An important and novel aspect of the TDSR scheme is its ability to incorporate physics in the form of conservation laws or dissipation rate equations. However, the method was restricted to enforce the conservation or dissipation rate of just one quantity. The present work significantly extends the computational features of the algorithm with the (i) incorporation of multiple conservation laws and/or dissipation rate equations, (ii) ability to enforce versatile boundary conditions, and (iii) higher-order time integration strategies. The TDSR method is applied on several prototypical evolution equations of physical significance. Examples include the Korteweg-de Vries (KdV), multi-dimensional nonlinear Schr\\\\\\\\"odinger (NLS) and the Allen-Cahn equations. The work was published in Nonlinearity \\\\\\\\cite{chandramouli2022time}. \\\\\\\\end{itemize} The second half of the thesis identifies a broad class of novel, \\\\\\\\textit{non-centered} Riemann problems in optical media with externally imposed gain and loss distributions. Thereafter, we shed light on some unique features that arise from step-like distributions in such spatially inhomogeneous media. Our work thus is an important contribution to the field of non-Hermitian dispersive hydrodynamics. \\\\\\\\begin{itemize} \\\\\\\\item Dispersive hydrodynamics, the study of nonlinear dispersive wave dynamics in fluid-like media, is an active research area that combines mathematical analysis with computational and laboratory experiments. To date, most of the research in this area has been focused on wave phenomena in (i) bulk media, in which case the underlying governing equations are of constant coefficients type, or (ii) inhomogeneous environments, where now the evolution equations contain, for example, a real-valued external potential. In the latter case, the presence of inhomogeneity (in general) hinders the formulation of a Riemann problem due to the lack of plane wave-type solutions of constant intensity (or density). However such waves can exist in non-Hermitian media, as was demonstrated for the nonlinear Schrödinger (NLS) equation with a Wadati-type complex external potential. Inspired by the above-mentioned discussions, in this paper, the notion of non-Hermitian dispersive hydrodynamics and its associated non-Hermitian Riemann problems are introduced. Starting from the defocusing (repulsive) NLS equation in the presence of generic smooth complex external potentials, a new set of hydrodynamic-like equations are obtained. They differ from their classical counterparts (without an external potential), by the presence of additional source terms that alter the density and momentum equations. When restricted to a class of Wadati-type complex potentials, this new non-Hermitian hydrodynamic system admits constant intensity/density solutions. This in turn, allows one to formulate an exact centered (or non-centered) Riemann problem involving a step-like initial condition that connects two exact constant density states. A broad class of non-Hermitian potentials that lead to modulationally stable constant intensity states are identified. These results are subsequently used to numerically solve the associated non-Hermitian Riemann problem for various initial conditions. Due to the lack of translation symmetry, the resulting long-time dynamics show a strong dependence on the location of the step relative to the gain-loss distribution. This is in sharp contrast to the classical NLS Riemann problem (in the absence of potential), where the dynamics are generally independent of the step location. This fact leads to {a diverse array of} wave pattern dynamics that are otherwise absent. In particular, various novel gain-loss generated near-field features are observed, which in turn drive the optical flows in the far-field. {These far-field non-Hermitian counter-flows could be comprised of various rich nonlinear wave phenomena, including DSW-DSW, DSW-rarefaction, and soliton-DSW interactions. A manuscript containing the results has been submitted to Nonlinearity \\\\\\\\cite{chandramouli2023nonHermitian}.} \\\\\\\\end{itemize}

Characteristics Finite Element Methods in Computational Fluid Dynamics

The second edition of Computational Fluid Dynamics represents a significant improvement from the first edition. However, the original idea of including all computational fluid dynamics methods (FDM, FEM, FVM); all mesh generation schemes; and physical applications to turbulence, combustion, acoustics, radiative heat transfer, multiphase flow, electromagnetic flow, and general relativity is still maintained. The second edition includes a new section on preconditioning for EBE-GMRES and a complete revision of the section on flowfield-dependent variation methods, which demonstrates more detailed computational processes and includes additional example problems. For those instructors desiring a textbook that contains homework assignments, a variety of problems for FDM, FEM and FVM are included in an appendix. To facilitate students and practitioners intending to develop a large-scale computer code, an example of FORTRAN code capable of solving compressible, incompressible, viscous, inviscid, 1D, 2D and 3D for all speed regimes using the flowfield-dependent variation method is made available.

Nonlinear Wave Propagation in Non-Hermitian Media

These ten detailed and authoritative survey articles on numerical methods for direct and inverse wave propagation problems are written by leading experts. Researchers and practitioners in computational wave propagation, from postgraduate level onwards, will find the breadth and depth of coverage of recent developments a valuable resource. The articles describe a wide range of topics on the application and analysis of methods for time and frequency domain PDE and boundary integral formulations of wave propagation problems. Electromagnetic, seismic and acoustic equations are considered. Recent developments in methods and analysis ranging from finite differences to hp-adaptive finite elements, including high-accuracy and fast methods are described with extensive references.

Computational Fluid Dynamics

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.

Topics in Computational Wave Propagation

Shock wave-boundary-layer interaction (SBLI) is a fundamental phenomenon in gas dynamics that is observed in many practical situations, ranging from transonic aircraft wings to hypersonic vehicles and engines. SBLIs have the potential to pose serious problems in a flowfield; hence they often prove to be a critical - or even design limiting - issue for many aerospace applications. This is the first book devoted solely to a comprehensive, state-of-the-art explanation of this phenomenon. It includes a description of the basic fluid mechanics of SBLIs plus contributions from leading international experts who share their insight into their physics and the impact they have in practical flow situations. This book is for practitioners and graduate students in aerodynamics who wish to familiarize themselves with all aspects of SBLI flows. It is a valuable resource for specialists because it compiles experimental, computational and theoretical knowledge in one place.

Essential Computational Fluid Dynamics

New method for the characterization of electromagnetic wave dynamics Modern Characterization of Electromagnetic Systems introduces a new method of characterizing electromagnetic wave dynamics and measurements based on modern computational and digital signal processing techniques. The techniques are described in terms of both principle and practice, so readers understand what they can achieve by utilizing them. Additionally, modern signal processing algorithms are introduced in order to enhance the resolution and extract information from electromagnetic systems, including where it is not currently possible. For example, the author addresses the generation of non-minimum phase or transient response when given amplitude-only data. Presents modern computational concepts in electromagnetic system characterization Describes a solution to the generation of non-minimum phase from amplitude-only data Covers model-based parameter estimation and planar near-field to far-field transformation as well as spherical near-field to far-field transformation Modern Characterization of Electromagnetic Systems is ideal for graduate students, researchers, and professionals working in the area of antenna measurement and design. It introduces and explains a new process related to their work efforts and studies.

Shock Wave-Boundary-Layer Interactions

Finite-Difference Method for Nonlinear Wave Hydrodynamics Palaniswamy Ananthakrishnan, Florida Atlantic University, USA Presents the theory and analysis of nonlinear wave hydrodynamics problems using the finite-difference method Finite-Difference Method for Nonlinear Wave Hydrodynamics comprehensively covers the analysis of nonlinear wave hydrodynamics problems using the finite-difference method. The book reviews the formulation of wave hydrodynamics and basic properties of ocean waves, presents the theory and derivations involved in the finite-difference method applied to wave hydrodynamics, and focuses on the application of nonlinear boundary conditions including effects of viscosity and surface tension. Finite-Difference Method for Nonlinear Wave Hydrodynamics would enable the reader to develop their own codes for analysis; fully understand and implement commercial software; extend the software by integrating it with design tools; and contribute to further developments in computational wave mechanics. Key features: Makes comparisons with other computational methods, including grid free methods. Analyses nonlinear wave-body and wave-vortex interactions. Discusses current issues in numerical modeling of nonlinear wave motion. Includes worked out examples. The book is an ideal reference for graduate students, researchers and practitioners in ocean, mechanical, civil and offshore engineering, and naval architecture.

Modern Characterization of Electromagnetic Systems and its Associated Metrology

Presents numerical algorithms, procedures, and techniques required to solve engineering problems relating to the interactions between electromagnetic fields and fluid flow and interdisciplinary technology for aerodynamics, electromagnetics, chemical-physic kinetics, and plasmadynamics Integrates interlinking computational model and simulation techniques of aerodynamics and electromagnetics Combines classic plasma drift-diffusion theory and electron impact ionization modeling for electromagnetic-aerodynamic interactions Describes models of internal degrees of freedom for vibration relaxation and electron excitations

Finite-Difference Method for Nonlinear Wave Hydrodynamics

This book presents recent studies of acoustic wave propagation through different media including the atmosphere, Earth's subsurface, complex dusty plasmas, porous materials, and flexible structures. Mathematical models of the underlying physical phenomena are introduced and studied in detail. With its seven chapters, the book brings together important contributions from renowned international researchers to provide an excellent survey of recent computational and experimental studies of acoustic waves. The first section consists of four chapters that focus on computational studies, while the next section is composed of three chapters that center on experimental studies.

Computational Electromagnetic-Aerodynamics

A two-dimensional (theta, z) Navier-Stokes solver for multi-port wave rotor flow simulation is described. The finite-volume form of the unsteady thin-layer Navier-Stokes equations are integrated in time on multi-block grids that represent the stationary inlet and outlet ports and the moving rotor passages of the wave rotor. Computed results are compared with three-port wave rotor experimental data. The model is applied to predict the performance of a planned four-port wave rotor experiment. Two-dimensional flow features that reduce machine performance and influence rotor blade and duct wall thermal loads are identified. The performance impact of rounding the inlet port wall, to inhibit separation during passage gradual opening, is assessed. Welch, Gerard E. Glenn Research Center NASA-TM-107192, ARL-TR-924, E-10164, NAS 1.15:107192 RTOP 505-62-75..

Computational and Experimental Studies of Acoustic Waves

The first volume of Frontiers of Computational Fluid Dynamics was published in 1994 and was dedicated to Prof Antony Jameson. The present volume is dedicated to Prof Earll Murman in appreciation of his original contributions to this field. The book covers the following topics: Transonic and Hypersonic AerodynamicsAlgorithm Developments and Computational TechniquesImpact of High Performance ComputingApplications in Aeronautics and BeyondIndustrial PerspectivesEngineering Education The book contains 25 chapters written by leading researchers from academia, government laboratories, and industry. Contents:A Review of the Contributions of Earll Murman to Transonic Flow and Computational Fluid DynamicsOptimal Hypersonic Conical WingsGeometry for Theoretical, Applied, and Educational Fluid DynamicsComputation of an Axisymmetric Nozzle FlowAnalysis and Numerical Simulation of the Superboom ProblemComplex Analysis of Transonic FlowTransonic Small Transverse Perturbation Equation and Its ComputationExcitation of Absolutely Unstable Disturbances in Boundary-Layer FlowsOn Adjoint Equations for Error Analysis and Optimal Grid Adaptation in CFDAdded Dissipation in Flow ComputationsA Four-Operators Conservative Scheme for the Euler EquationsAutoblocking for Wings with Split and Hinged FlapsLocal Preconditioning: Manipulating Mother Nature to Fool Father TimeRelaxation Revisited — A Fresh Look at Multigrid for Steady FlowsAerospace Engineering Simulations on Parallel ComputersOptimizing CFD Codes and Algorithms for Use on Cray ComputersRecent Applications in Aerodynamics with NSMB Structured MultiBlock SolverIncompressible Navier-Stokes Computations in Aerospace Applications and BeyondPros and Cons of Airfoil OptimizationTowards Industrial Strength Navier-Stokes Codes — A RevisitWhat Have We Learned from Computational Fluid Dynamics Research on Train Aerodynamics?On the Pursuit of Value with CFDCFD at a Crossroads: An Industry PerspectiveAerospace Engineering 2000: An Integrated, Hands-On CurriculumComputer-Based Fluid Mechanics Textbook Readership: Students and researchers in computational fluid dynamics. Keywords:Aerodynamics;Boundary Layer Stability;Computational Fluid Dynamics;Error Analysis;Euler Equations;Fluid Dynamics;Hypersonic Flow;Mesh Generation;Multi-Block Grids;Multigrid;Parallel Computing;Preconditioning;Sonic Boom;Train Aerodynamics;Transonic Flow

Two-Dimensional Computational Model for Wave Rotor Flow Dynamics

Dynamics of Water Surface Flows and Waves provides theoretical descriptions of the whole life of water surface waves through their birth, propagation, evolution and finally breaking. While initial capillary waves are created via instability at air-water interfaces, potential wave theories adequately describe interactions of waves with current, bathymetry and structure. In the final breaking stage, potential fluid motions in the waves rapidly evolve into vortical turbulent flows that disturb the surfaces, resulting in entrainment of air-bubbles and ejection of sea spray in bursting bubbles floating on the surface. All theories and analytical methods required to understand the series of wave processes, over diverse areas of subjects, including turbulence, diffusion, vortex and capillary dynamics, shallow water approach, and stability analysis, as well as the conventional potential wave theory, are comprehensively covered in this book. All of the mathematical formulas are consistently developed from theorems and linked with physics, which provides theoretical understanding and further interest in wave dynamics. This is an ideal graduate-level textbook or reference for engineers and researchers in the fields of fluid and wave mechanics, coastal and ocean engineering.

Frontiers of Computational Fluid Dynamics 1998

In September 2006, research leaders in the field of coastal engineering, fluid mechanics, and wave theory met at Cornell University to celebrate the 60th birthday of Prof. Philip L-F Liu. This volume is a compilation of the research papers presented at the symposium, and includes both review and new research papers. Topics such as nonlinear wave theory, tsunamis, wave-structure interaction, turbulence, and modeling of complex sediment transport are discussed in this volume. All of the contributing authors are research collaborators of Prof. Liu, and include leaders in coastal engineering such as Maarten Dingemans, Hwung-Hweng Hwung, Nobu Kobayashi, Inigo Losada, Hocine Oumeraci, Costas Synolakis, and Harry Yeh.

Dynamics of Water Surface Flows and Waves

This is a three-volume selection of classical papers by Michael Longuet-Higgins, who for many years has been a leading researcher in the fast-developing field of physical oceanography. Some of these papers were first published in scientific journals or in conference proceedings that are now difficult to access. All the papers are characterized by the novelty of their content, and the clarity of their style and exposition. The papers are quite varied in their approach. They range from basic theory and new computational methods to laboratory experiments and field observations. An overall feature is the frequent comparison between theory and experiment and the constant attention to practical applications. Among the many advances and achievements to be found in these three volumes are: the now generally accepted solution to the longstanding problem of how oceanic microseisms can be generated in deep water or near steep coastlines; a theoretical explanation of the strong drifting near the bottom in shallow water; the first introduction of a boundary-integral technique for calculating free surface flows; simple analytic expressions for the form and time-development of plunging breakers; and so on. The book will be of particular interest to advanced students in ocean engineering; also more generally to fluid dynamicists and physical oceanographers concerned with the interaction of the ocean with the atmosphere and with sandy shorelines.

Nonlinear Wave Dynamics

This book examines the performance of oscillating water column (OWC) wave energy converters. It discusses the influence of humid air inside the chamber and changes in the seabed, and also investigates the role of wave energy converters in coastal protection. The authors use a real gas model to describe the thermodynamics of the air–water vapour mixture inside the chamber, and the compression and expansion process during the wave cycle. Further, they present an alternative formulation with new perspectives on the adiabatic process of the gaseous phase, including a modified adiabatic index, and subsequent modified thermodynamic state variables such as enthalpy, entropy and specific heat. The book also develops a numerical model using computational fluid dynamics to simulate OWC characteristics in open sea, and studies the performance of a linear turbine using an actuator disk model. It then compares the results from both cases to find an agreement between the analytical and numerical models when humidity is inserted in the gaseous phase. Introducing new concepts to studies of wave energy to provide fresh perspectives on energy extraction and efficiency problems, the book is a valuable resource for researchers and industrial companies involved in thermal energy and coastal engineering. It is also of interest to undergraduate and postgraduate students, as it broadens their view of wave energy.

Dynamics of Water Waves

This book explores the interplay of bubble dynamics and shock waves, covering shock wave emission by laser generated bubbles, pulsating bubbles near boundaries, interaction of shock waves with bubble clouds, applications in shock wave lithotripsy, and more.

Thermodynamics and Morphodynamics in Wave Energy

This book (Vol. II) presents select proceedings of the first Online International Conference on Recent Advances in Computational and Experimental Mechanics (ICRACEM 2020) and focuses on theoretical, computational and experimental aspects of solid and fluid mechanics. Various topics covered are computational modelling of extreme events; mechanical modelling of robots; mechanics and design of cellular materials; mechanics of soft materials; mechanics of thin-film and multi-layer structures; meshfree and particle based formulations in continuum mechanics; multi-scale computations in solid mechanics, and materials; multiscale mechanics of brittle and ductile materials; topology and shape optimization techniques; acoustics including aero-acoustics and wave propagation; aerodynamics; dynamics and control in micro/nano engineering; dynamic instability and buckling; flow-induced noise and vibration; inverse problems in mechanics and system identification; measurement and analysis techniques in nonlinear dynamic systems; multibody dynamical systems and applications; nonlinear dynamics and control; stochastic mechanics; structural dynamics and earthquake engineering; structural health monitoring and damage assessment; turbomachinery noise; vibrations of continuous systems, characterization of advanced materials; damage identification and non-destructive evaluation; experimental fire mechanics and damage; experimental fluid mechanics; experimental solid mechanics; measurement in extreme environments; modal testing and dynamics; experimental hydraulics; mechanism of scour under steady and unsteady flows; vibration measurement and control; bio-inspired materials; constitutive modelling of materials; fracture mechanics; mechanics of adhesion, tribology and wear; mechanics of composite materials; mechanics of multifunctional materials; multiscale modelling of materials; phase transformations in materials; plasticity and creep in materials; fluid mechanics, computational fluid dynamics; fluid-structure interaction; free surface, moving boundary and pipe flow; hydrodynamics; multiphase flows; propulsion; internal flow physics; turbulence modelling; wave mechanics; flow through porous media; shock-boundary layer interactions; sediment transport; wave-structure interaction; reduced-order models; turbo-machinery; experimental hydraulics; mechanism of scour under steady and unsteady flows; applications of machine learning and artificial intelligence in mechanics; transport phenomena and soft computing tools in fluid mechanics. The contents of these two volumes (Volumes I and II) discusses various attributes of modern-age mechanics in various disciplines, such as aerospace, civil, mechanical, ocean engineering and naval architecture. The book will be a valuable reference for beginners, researchers, and professionals interested in solid and fluid mechanics and allied fields.

Bubble Dynamics and Shock Waves

Recent Advances in Computational and Experimental Mechanics, Vol II