Nonlinear Waves

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Nonlinear Optical Waves Wiley-VCH
S.B. Leble's book deals with nonlinear waves and their propagation in metallic and dielectric waveguides and media with stratification. The underlying nonlinear evolution equations (NEEs) are derived giving also their solutions for specific situations. The reader will find new elements to the traditional approach. Various dispersion and relaxation laws for different guides are considered as well as the explicit form of projection operators, NEEs, quasi-solitons and of Darboux transforms. Special points relate to: 1. the development of a universal asymptotic method of deriving NEEs for guide propagation; 2. applications to the cases of stratified liquids, gases, solids and plasmas with various nonlinearities and dispersion laws; 3. connections between the basic problem and soliton-like solutions of the corresponding NEEs; 4. discussion of details of simple solutions in higher- order nonsingular perturbation theory.
Waves and Structures in Nonlinear Nondispersive Media Springer
The responses of offshore structures are significantly affected by steep nonlinear waves, currents and wind, leading to phenomena such as springing and ringing of TLPs, slow drift yaw motion of FPSOs and large oscillations of Spar platforms due to vortex shedding. Research has brought about significant progress in this field over the past few decades and introduced us to increasingly involved concepts and their diverse applicability. Thus, an in-depth understanding of steep nonlinear waves and their effects on the responses of offshore structures is essential for safe and effective designs.This book deals with analyses of nonlinear problems encountered in the design of offshore structures, as well as those that are of immediate practical interest to ocean engineers and designers. It presents conclusions drawn from recent research pertinent to nonlinear waves and their effects on the responses of offshore structures. Theories, observations and analyses of laboratory and field experiments are expounded such that the nonlinear effects can be clearly visualized.
Linear And Nonlinear Wave Propagation American Mathematical Soc.
The need for tsunami research and analysis has grown dramatically following the devastating tsunami of December 2004, which affected Southern Asia. This book pursues a detailed theoretical and mathematical analysis of the fundamentals of tsunamis, especially the evolution and dynamics of tsunamis and other great waves. Of course, it includes specific measurement results from the 2004 tsunami, but the emphasis is on the nature of the waves themselves and their links to nonlinear phenomena.
Spectral and Dynamical Stability of Nonlinear Waves Springer Science & Business Media
Waves are essential phenomena in most scientific and engineering disciplines, such as electromagnetism and optics, and different mechanics including fluid, solid, structural, quantum, etc. They appear in linear and nonlinear systems. Some can be observed directly and others are not. The features of the waves are usually described by solutions to either linear or nonlinear partial differential equations, which are fundamental to the students and researchers.Generic equations, describing wave and pulse propagation in linear and nonlinear systems, are introduced and analyzed as initial/boundary value problems. These systems cover the general properties of non-dispersive and dispersive, uniform and non-uniform, with/without dissipations. Methods of analyses are introduced and illustrated with analytical solutions. Wave-wave and wave-particle interactions ascribed to the nonlinearity of media (such as plasma) are discussed in the final chapter.This interdisciplinary textbook is essential reading for anyone in above mentioned disciplines. It was prepared to provide students with an understanding of waves and methods of solving wave propagation problems. The presentation is self-contained and should be read without difficulty by those who have adequate preparation in classic mechanics. The selection of topics and the focus given to each provide essential materials for a lecturer to cover the bases in a linear/nonlinear wave course.
Introduction to the Mathematical Physics of Nonlinear Waves CRC Press
Nonlinear Wave and Plasma Structures in the Auroral and Subauroral Geospace presents a comprehensive examination of the self-consistent processes leading to multiscale electromagnetic and plasma structures in the magnetosphere and ionosphere near the plasmapause, particularly in the auroral and subauroral geospace. It utilizes simulations and a large number of relevant in situ measurements conducted by the most recent satellite missions, as well as ground-based optical and radar observations to verify the conclusions and analysis. Including several case studies of observations related to prominent geospacer events, the book also provides experimental and numerical results throughout the chapters to further enhance understanding of how the same physical mechanisms produce different phenomena at different regions of the near-Earth space environment. Additionally, the comprehensive description of mechanisms responsible for space weather effects will give readers a broad foundation of wave and particle processes in the near-Earth magnetosphere. As such, Nonlinear Wave and Plasma Structures in the Auroral and Subauroral Geospace Nonlinear Wave and Plasma Structures in the Auroral and Subauroral Geospace is a cutting-edge reference for space physicists looking to better understand plasma physics in geospace. - Presents a unified approach to wave and particle phenomena occurring in the auroral and subauroral geospace - Summarizes the most current theoretical concepts related to the generation of the large-scale electric field near the plasmapause by flows of hot plasma from the reconnection site - Includes case studies of the observations related to the most "famous events during the last 20 years as well as a large number of experimental and numerical results illustrated throughout the text
A Course on Nonlinear Waves Springer Science & Business Media
Although the mathematical theory of nonlinear waves and solitons has made great progress, its applications to concrete physical problems are rather poor, especially when compared with the classical theory of linear dispersive waves and nonlinear fluid motion. The Whitham method, which describes the combining action of the dispersive and nonlinear effects as modulations of periodic waves, is not widely used by applied mathematicians and physicists, though it provides a direct and natural way to treat various problems in nonlinear wave theory. Therefore it is topical to describe recent developments of the Whitham theory in a clear and simple form suitable for applications in various branches of physics.This book develops the techniques of the theory of nonlinear periodic waves at elementary level and in great pedagogical detail. It provides an introduction to a Whitham's theory of modulation in a form suitable for applications. The exposition is based on a thorough analysis of representative examples taken from fluid mechanics, nonlinear optics and plasma physics rather than on the formulation and study of a mathematical theory. Much attention is paid to physical motivations of the mathematical methods developed in the book. The main applications considered include the theory of collisionless shock waves in dispersive systems and the nonlinear theory of soliton formation in modulationally unstable systems. Exercises are provided to amplify the discussion of important topics such as singular perturbation theory, Riemann invariants, the finite gap integration method, and Whitham equations and their solutions.
Nonlinear Waves Springer Nature
Waves occur widely in nature and have innumerable commercial uses. Pressure waves are responsible for the transmission of speech, bow waves created by meteors can virtually ignite the earth's atmosphere, ultrasonic waves are used for medical imaging, and shock waves are used for the synthesis of new materials. This book provides a thorough, modern introduction to the study of linear and nonlinear waves. Beginning with fundamental concepts of motion, the book goes on to

discuss linear and nonlinear mechanical waves, thermodynamics, and constitutive models. It covers gases, liquids, and solids as integral parts of the subject. Among the important areas of research and application are impact analysis, shock wave research, explosive detonation, nonlinear acoustics, and hypersonic aerodynamics. Graduate students, as well as professional engineers and applied physicists, will value this clear, comprehensive introduction to the study of wave phenomena.
Nonlinear Waves And Offshore Structures Springer Science & Business Media
This text considers models of different "acoustic" media as well as equations and behavior of finite-amplitude waves. It also considers the effects of nonlinearity, dissipation, dispersion, and for two- and three-dimensional problems, reflection and diffraction on the evolution and interaction of acoustic beams.
Nonlinear Waves: A Geometrical Approach Elsevier
Nonlinear physics is a well-established discipline in physics today, and this book offers a comprehensive account of the basic soliton theory and its applications. Although primarily mathematical, the theory for nonlinear phenomena in practical environment
Nonlinear Waves in Elastic Media Cambridge University Press
This is an introductory book about nonlinear waves. It focuses on two properties that various different wave phenomena have in common, the "nonlinearity" and "dispersion", and explains them in a style that is easy to understand for first-time students. Both of these properties have important effects on wave phenomena. Nonlinearity, for example, makes the wave lean forward and leads to wave breaking, or enables waves with different wavenumber and frequency to interact with each other and exchange their energies. Dispersion, for example, sorts irregular waves containing various wavelengths into gentler wavetrains with almost uniform wavelengths as they propagate, or cause a difference between the propagation speeds of the wave waveform and the wave energy. Many phenomena are introduced and explained using water waves as an example, but this is just a tool to make it easier to draw physical images. Most of the phenomena introduced in this book are common to all nonlinear and dispersive waves. This book focuses on understanding the physical aspects of wave phenomena, and requires very little mathematical knowledge. The necessary minimum knowledges about Fourier analysis, perturbation method, dimensional analysis, the governing equations of water waves, etc. are provided in the text and appendices, so even second- or third-year undergraduate students will be able to fully understand the contents of the book and enjoy the fan of nonlinear wave phenomena without relying on other books.
Nonlinear Waves and Weak Turbulence Springer Science & Business Media
TIlis volume contains the contributions to the Euromech Colloquium No. 241 on Nonlinear Waves in Active Media at the Institute of Cybernetics of the Estonian Academy of Sciences, Tallinn, Estonia, USSR, September 27-30, 1988. The Co-chairmen of the Euromech Colloquium felt that it would be a good service to the community to publish these proceedings. First, the topic itself dealing with various wave processes with energy influx is extremely interesting and attracted a much larger number of participants than usual - a clear sign of its importance to the scientific community. Second, Euromech No. 241 was actually the first Euromech Colloquium held in the Soviet Union and could thus be viewed as a milestone in the extending scientific contacts between East and West. At the colloquium 50 researchers working in very different branches of sci ence met to lecture on their results and to discuss problems of common interest. An introductory paper by I. Engelbrecht presents the common motivation and background of the topics covered. Altogether 36 speakers presented their lectures, of which 30 are gathered here. The remaining six papers which will appear elsewhere are listed on page X. In addition, three contributions by authors who could not attend the colloquium are included. The two lectures given by A.S. Mikhailov, V.S. Davydov and V.S. Zykov are here published as one long paper.
Nonlinear Periodic Waves and Their Modulations Springer Science & Business Media
"Waves and Structures in Nonlinear Nondispersive Media: General Theory and Applications to Nonlinear Acoustics” is devoted completely to nonlinear structures. The general theory is given here in parallel with mathematical models. Many concrete examples illustrate the general analysis of Part I. Part II is devoted to applications to nonlinear acoustics, including specific nonlinear models and exact solutions, physical mechanisms of nonlinearity, sawtooth-shaped wave propagation, self-action phenomena, nonlinear resonances and engineering application (medicine, nondestructive testing, geophysics, etc.). This book is designed for graduate and postgraduate students studying the theory of nonlinear waves of various physical nature. It may also be useful as a handbook for engineers and researchers who encounter the necessity of taking nonlinear wave effects into account of their work. Dr. Gurbatov S.N. is the head of Department, and Vice Rector for Research of Nizhny Novgorod State University. Dr. Rudenko O.V. is the Full member of Russian Academy of Sciences, the head of Department at Moscow University and Professor at BTH (Sweden). Dr. Saichev A.I. is the Professor at the Faculty of Radiophysics of Nizhny Novgorod State University, Professor of ETH Zürich.
Nonlinear Waves in Real Fluids Academic Press
This volume provides an in-depth treatment of several equations and systems of mathematical physics, describing the propagation and interaction of nonlinear waves as different modifications of these: the KdV equation, Fornberg-Whitham equation, Vakhnenko equation, Camassa-Holm equation, several versions of the NLS equation, Kaup-Kupershmidt equation, Boussinesq paradigm, and Manakov system, amongst others, as well as symmetrizable quasilinear hyperbolic systems arising in fluid dynamics.Readers not familiar with the complicated methods used in the theory of the equations of mathematical physics (functional analysis, harmonic analysis, spectral theory, topological methods, a priori estimates, conservation laws) can easily be acquainted here with different solutions of some nonlinear PDEs written in a sharp form (waves), with their geometrical visualization and their interpretation. In many cases, explicit solutions (waves) having specific physical interpretation (solitons, kinks, peakons, ovals, loops, rogue waves) are found and their interactions are studied and geometrically visualized. To do this, classical methods coming from the theory of ordinary differential equations, the dressing method, Hirota's direct method and the method of the simplest equation are introduced and applied. At the end, the paradifferential approach is used.This volume is self-contained and equipped with simple proofs. It contains many exercises and examples arising from the applications in mechanics, physics, optics and, quantum mechanics.
Nonlinear Waves in Active Media Springer
The main topic of this text is the well-posedness locally in time of quasilinear wave equations on one-dimensional networks with linear transmission conditions. Such problems arise for example in the modelling of transversal vibrations of networks of strings. The setting serves as a model case for the systematic study, with T. Kato's theory, of the phenomenon of nonlinear compatibility conditions arising if we desire regular solutions. This phenomenon is bound to occur always if we combine hyperbolic evolution with all kinds of coupling conditions. We explain the connections of the results to a concept for the description of complicated interactions between media (of possibly varying space dimension) with time evolution, previously developed by the author. A strategy for physical legitimations of linear mechanical coupling models, the systematic derivation of physical laws and of the asymptotics of frequencies of eigenmodes are outlined. As applications of this interaction concept, small vibrations of membranes with conic boundary-points and a membrane-string-coupling are considered.
Introduction to Wave Propagation in Nonlinear Fluids and Solids World Scientific
This book is a collection of papers on dynamical and statistical theory of nonlinear wave propagation in dispersive conservative media. Emphasis is on waves on the surface of an ideal fluid and on Rossby waves in the atmosphere. Although the book deals mainly with weakly nonlinear waves, it is more than simply a description of standard perturbation techniques. The goal is to show that the theory of weakly interacting waves is naturally related to such areas of mathematics as Diophantine equations, differential geometry of waves, Poincare normal forms and the inverse scattering method.
Nonlinear Waves in Networks CRC Press
This book is based on the contributions to the 17th International School of Materials Sci ence and Technology, entitled Nonlinear Waves in Solid State Physics. This was held as a NATO Advanced Study Institute at the Ettore Majorana Centre in Erice, Sicily between the st th 1 and 15 July 1989, and attracted almost 100 participants from over 20 different countries. The book covers the fundamental properties of nonlinear waves in solid state materials, dealing with both theory and experiment. The aim is to emphasise the methods underpinning the important new developments in this area. The material is organised into subject areas that can broadly be classified into the following groups: the theory of nonlinear surface and guided waves in self-focusing magnetic and non-magnetic materials; nonlinear effects at in terfaces; nonlinear acoustoelectronic and surface acoustic waves; Lagrangian and Hamiltonian formulations of nonlinear problems; nonlinear effects in optical fibres; resonance phenomena; and nonlinear integrated optics. The chapters have been grouped together according to these classifications as closely as possible, but it should be borne in mind that although there is much overlap of ideas, each chapter is essentially independent of the others. We would like to acknowledge the sponsorship of the NATO Scientific Affairs Division, the European Physical Society, the National Science Foundation of the USA, the European Research Office, the Italian Ministry of Education, the Italian Ministry of Scientific and Technological Research, the Sicilian Regional Government and the Ugo Bordoni Foundation.
Dynamical Systems and Nonlinear Waves in Plasmas Morgan & Claypool Publishers
Leading scientists discuss the most recent physical and experimental results in the physics of Bose-Einstein condensate theory, the theory of nonlinear lattices (including quantum and nonlinear lattices), and nonlinear optics and photonics. Classical and quantum aspects of the dynamics of nonlinear waves are considered. The contributions focus on the Gross-Pitaevskii equation and on the quantum nonlinear Schrödinger equation. Recent experimental results on atomic condensates and hydrogen bonded systems are reviewed. Particular attention is given to nonlinear matter waves in periodic potential.
Physics of Nonlinear Waves Cambridge University Press
For more than 200 years, the Fourier Transform has been one of the most important mathematical tools for understanding the dynamics of linear wave trains. Nonlinear Ocean Waves and the Inverse Scattering Transform presents the development of the nonlinear Fourier analysis of measured space and time series, which can be found in a wide variety of physical settings including surface water waves, internal waves, and equatorial Rossby waves. This revolutionary development will allow hyperfast numerical modelling of nonlinear waves, greatly advancing our understanding of oceanic surface and internal waves. Nonlinear Fourier analysis is based upon a generalization of linear Fourier analysis referred to as the inverse scattering transform, the fundamental building block of which is a generalized Fourier series called the Riemann theta function. Elucidating the art and science of implementing these functions in the context of physical and time series analysis is the goal of this book. - Presents techniques and methods of the inverse scattering transform for data analysis - Geared toward both the introductory and advanced reader venturing further into mathematical and numerical analysis - Suitable for classroom teaching as well as research
Tsunami and Nonlinear Waves Cambridge University Press
A non-linear wave is one of the fundamental objects of nature. They are inherent to aerodynamics and hydrodynamics, solid state physics and plasma physics, optics and field theory, chemistry reaction kinetics and population dynamics, nuclear physics and gravity. All non-linear waves can be divided into two parts: dispersive waves and dissipative ones. The history of investigation of these waves has been lasting about two centuries. In 1834 J. S. Russell discovered the extraordinary type of waves without the dispersive broadening. In 1965 N. J. Zabusky and M. D. Kruskal found that the Korteweg-de Vries equation has solutions of the solitary wave form. This solitary wave demonstrates the particle-like properties, i. e. , stability under propagation and the elastic interaction under collision of the solitary waves. These waves were named solitons. In succeeding years there has been a great deal of progress in understanding of soliton nature. Now solitons have become the primary components in many important problems of nonlinear wave dynamics. It should be noted that non-linear optics is the field, where all soliton features are exhibited to a great extent. This book had been designed as the tutorial to the theory of non-linear waves in optics. The first version was projected as the book covering all the problems in this field, both analytical and numerical methods, and results as well. However, it became evident in the process of work that this was not a real task.
Quantum Mechanics and Nonlinear Waves Springer
This book unifies the dynamical systems and functional analysis approaches to the linear and nonlinear stability of waves. It synthesizes fundamental ideas of the past 20+ years of research, carefully balancing theory and application. The book isolates and methodically develops key ideas by working through illustrative examples that are subsequently synthesized into general principles. Many of the seminal examples of stability theory, including orbital stability of the KdV solitary wave, and asymptotic stability of viscous shocks for scalar conservation laws, are treated in a textbook fashion for the first time. It presents spectral theory from a dynamical systems and functional analytic point of view, including essential and absolute spectra, and develops general nonlinear stability results for dissipative and Hamiltonian systems. The structure of the linear eigenvalue problem for Hamiltonian systems is carefully developed, including the Krein signature and related stability indices. The Evans function for the detection of point spectra is carefully developed through a series of frameworks of increasing complexity. Applications of the Evans function to the Orientation index, edge bifurcations, and large domain limits are developed through illustrative examples. The book is intended for first or second year graduate students in mathematics, or those with equivalent mathematical maturity. It is highly illustrated and there are many exercises scattered throughout the text that highlight and emphasize the key concepts. Upon completion of the book, the reader will be in an excellent position to understand and contribute to current research in nonlinear stability.