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Optimal Auxiliary Functions Method for Nonlinear Dynamical Systems

CARLO ULISES

Multifrequency Oscillations of Nonlinear Systems
World Scientific

The Proceedings of the 1st European Nonlinear Oscillations Conference contain invited contributions of mathematicians engaged in the development of analytical and numerical methods and of scientists working on vibration problems in mechanics, physics, and other fields.
Introduction to Nonlinear Oscillations LAP Lambert Academic Publishing
The book provides a concise and rigor introduction to the fundamentals of methods for solving the principal

problems of modern nonlinear dynamics. This monograph covers the basic issues of the theory of integrable systems and the theory of dynamical chaos both in nonintegrable conservative and in dissipative systems. A distinguishing feature of the material exposition is to add some comments, historical information, brief biographies and portraits of the researchers who made the most significant contribution to science. This allows one to present the material as accessible and attractive to students to acquire indepth scientific knowledge of nonlinear mechanics, feel the atmosphere where those or other important discoveries were made. The book can be used as a textbook for advanced undergraduate and graduate students majoring in high-tech industries and high technology (the science based on high technology) to help them to develop lateral thinking in early stages of training. Contents: Nonlinear Oscillations Integrable Systems Stability of Motion and Structural Stability Chaos in Conservative Systems Chaos and Fractal Attractors in Dissipative Systems Conclusion References Index

Nonlinear Oscillations of Hamiltonian PDEs

Springer Science & Business Media

The most common oscillations of the mechanical systems are inherently nonlinear. These systems are important in engineering because many practical

engineering components consist of vibrating systems that can be modeled using oscillator systems such as elastic beams supported by two springs or mass-on-moving belt or nonlinear pendulum and vibration of a milling machine. Therefore, investigating the nonlinear oscillations is important for many practical engineering components. The fluctuation, stability and the natural frequencies are very important items in oscillations of the mechanical systems, and investigating the influence of different parameters on these items is important in the design step. In the present book, nonlinear oscillation and stability analyses of dynamical systems are analyzed using an analytical approach. The results show that this method is very effective and work very well for the wide range of time and boundary conditions for various strongly nonlinear oscillators.

An Analytical Approach to Investigation of Nonlinear Dynamical Systems Springer Science & Business Media This book presents recent developments in nonlinear dynamics and physics with an emphasis on complex systems. The contributors provide recent theoretic developments and new techniques to solve nonlinear dynamical systems and help readers understand complexity, stochasticity, and regularity in nonlinear dynamical systems. This book covers integro-differential equation solvability, Poincare

recurrences in ergodic systems, orientable horseshoe structure, analytical routes of periodic motions to chaos, grazing on impulsive differential equations, from chaos to order in coupled oscillators, and differential-invariant solutions for automorphic systems, inequality under uncertainty.

Nonlinear Oscillations in Biology Springer Science & Business Media

This book presents the optimal auxiliary functions method and applies it to various engineering problems and in particular in boundary layer problems. The cornerstone of the presented procedure is the concept of “optimal auxiliary functions” which are needed to obtain accurate results in an efficient way. Unlike other known analytic approaches, this procedure provides us with a simple but rigorous way to control and adjust the convergence of the solutions of nonlinear dynamical systems. The optimal auxiliary functions are depending on some convergence-control parameters whose optimal values are rigorously determined from mathematical point of view. The capital strength of our procedure is its fast convergence, since after only one iteration, we obtain very accurate analytical solutions which are very easy to be verified. Moreover, no simplifying hypothesis or assumptions are made. The book contains a large amount of practical models from various fields of engineering such as

classical and fluid mechanics, thermodynamics, nonlinear oscillations, electrical machines, and many more. The book is a continuation of our previous books “Nonlinear Dynamical Systems in Engineering. Some Approximate Approaches”, Springer-2011 and “The Optimal Homotopy Asymptotic Method. Engineering Applications”, Springer-2015.

Nonlinear Dynamical Systems in Engineering

John Wiley & Sons

This book is an ideal text for advanced undergraduate students and graduate students with an interest in the qualitative theory of ordinary differential equations and dynamical systems. Elementary knowledge is emphasized by the detailed discussions on the fundamental theorems of the Cauchy problem, fixed-point theorems (especially the twist theorems), the principal idea of dynamical systems, the nonlinear oscillation of Duffing's equation, and some special analyses of particular differential equations. It also contains the latest research by the author as an integral part of the book.

Nonlinear Oscillations

Wiley-VCH

An application of the techniques of dynamical systems and bifurcation theories to the study of nonlinear oscillations. Taking their cue from Poincare, the authors stress the geometrical and topological properties of solutions of differential equations and iterated

maps. Numerous exercises, some of which require nontrivial algebraic manipulations and computer work, convey the important analytical underpinnings of problems in dynamical systems and help readers develop an intuitive feel for the properties involved.

Nonlinear System Analysis Springer Science & Business Media

This book deals with the bifurcation and chaotic aspects of damped and driven nonlinear oscillators. The analytical and numerical aspects of the chaotic dynamics of these oscillators are covered, together with appropriate experimental studies using nonlinear electronic circuits. Recent exciting developments in chaos research are also discussed, such as the control and synchronization of chaos and possible technological applications.

Nonlinear Oscillations and Waves in Dynamical Systems World Scientific

The theory of nonlinear oscillations and stability of motion is a fundamental part of the study of numerous real world phenomena. These phenomena, particularly auto-oscillations of the first and second kind, capture, para metric, subharmonic and ultraharmonic resonance, asymptotic behavior and orbits' stability, constitute the core of problems treated in "Nonlinear Mechanics", and their study is connected with the names of H. Poincare, A. M. Lyapunov, N. M. Krylov and N. N. Bogolyubov. Professor

Demetrios Magiros, a widely known scientist in the theories of oscillations and nonlinear differential equations, has devoted his numerous works to this significant part of modern physical science. His scientific results can be classified in the following way: I) creation of methods of analysis of subharmonic resonances under the nonlinear effect, 2) determination and analysis of the main modes of nonlinear oscillations on the basis of infinite determinants, 3) analysis of problems of celestial mechanics, 4) classification of stability of solutions of dynamic systems concepts, 5) mathematical analogs of physical and social systems. He has developed new methods and solutions for a great number of difficult problems of nonlinear mechanics making a significant contri bution to the theory and applications of the field. Urgency, depth of perception of the considered phenomena, and practi cal directness are characteristics of his work.

Regularity and Stochasticity of Nonlinear Dynamical Systems Springer Science & Business Media

Nonlinear Oscillations is a self-contained and thorough treatment of the vigorous research that has occurred in nonlinear mechanics since 1970. The book begins with fundamental concepts and techniques of analysis and progresses through recent developments and provides an overview that abstracts and introduces main nonlinear

phenomena. It treats systems having a single degree of freedom, introducing basic concepts and analytical methods, and extends concepts and methods to systems having degrees of freedom. Most of this material cannot be found in any other text. Nonlinear Oscillations uses simple physical examples to explain nonlinear dispersive and nondispersive waves. The notation is unified and the analysis modified to conform to discussions. Solutions are worked out in detail for numerous examples, results are plotted and explanations are couched in physical terms. The book contains an extensive bibliography.

Nonlinearities in Action

Springer Science & Business Media

A systematic outline of the basic theory of oscillations, combining several tools in a single textbook. The author explains fundamental ideas and methods, while equally aiming to teach students the techniques of solving specific (practical) or more complex problems. Following an introduction to fundamental notions and concepts of modern nonlinear dynamics, the text goes on to set out the basics of stability theory, as well as bifurcation theory in one and two-dimensional cases. Foundations of asymptotic methods and the theory of relaxation oscillations are presented, with much attention paid to a method of mappings and its applications. With each chapter including exercises and solutions, including computer

problems, this book can be used in courses on oscillation theory for physics and engineering students. It also serves as a good reference for students and scientists in computational neuroscience.

Oscillations in Planar Dynamic Systems Elsevier

Bridging the gap between elementary courses and the research literature in this field, the book covers the basic concepts necessary to study differential equations. Stability theory is developed, starting with linearisation methods going back to Lyapunov and Poincaré, before moving on to the global direct method. The Poincaré-Lindstedt method is introduced to approximate periodic solutions, while at the same time proving existence by the implicit function theorem. The final part covers relaxation oscillations, bifurcation theory, centre manifolds, chaos in mappings and differential equations, and Hamiltonian systems. The subject material is presented from both the qualitative and the quantitative point of view, with many examples to illustrate the theory, enabling the reader to begin research after studying this book.

Dynamical Systems And Nonlinear Oscillations - Proceedings Of The Symposium American Mathematical Soc.

An application of the techniques of dynamical systems and bifurcation theories to the study of nonlinear oscillations. Taking their cue from

Poincare, the authors stress the geometrical and topological properties of solutions of differential equations and iterated maps. Numerous exercises, some of which require nontrivial algebraic manipulations and computer work, convey the important analytical underpinnings of problems in dynamical systems and help readers develop an intuitive feel for the properties involved.

Nonlinear Science and Complexity World Scientific

Many dynamical systems are described by differential equations that can be separated into one part, containing linear terms with constant coefficients, and a second part, relatively small compared with the first, containing nonlinear terms. Such a system is said to be weakly nonlinear. The small terms rendering the system nonlinear are referred to as perturbations. A weakly nonlinear system is called quasi-linear and is governed by quasi-linear differential equations. We will be interested in systems that reduce to harmonic oscillators in the absence of perturbations. This book is devoted primarily to applied asymptotic methods in nonlinear oscillations which are associated with the names of N. M. Krylov, N. N. Bogoli ubov and Yu. A. Mitropolskii. The advantages of the present methods are their simplicity, especially for computing higher approximations, and their applicability to a large class of quasi-linear

problems. In this book, we confine ourselves basi cally to the scheme proposed by Krylov, Bogoliubov as stated in the monographs [6,211. We use these methods, and also develop and improve them for solving new problems and new classes of nonlinear differential equations. Although these methods have many applications in Mechanics, Physics and Technique, we will illustrate them only with examples which clearly show their strength and which are themselves of great interest. A certain amount of more advanced material has also been included, making the book suitable for a senior elective or a beginning graduate course on nonlinear oscillations.

Applied Asymptotic Methods in Nonlinear Oscillations World Scientific

This text maps out the modern theory of non-linear oscillations. The material is presented in a non-traditional manner and emphasises the new results of the theory - obtained partially by the author, who is one of the leading experts in the area. Among the topics are: synchronization and chaotization of self-oscillatory systems and the influence of weak random vibration on modification of characteristics and behaviour of the non-linear systems.

Nonlinear Dynamics Springer Nature

This volume contains the proceedings of the AMS Special Session on Nonstandard Finite-Difference Discretizations and Nonlinear

Oscillations, in honor of Ronald Mickens's 70th birthday, held January 9-10, 2013, in San Diego, CA. Included are papers on design and analysis of discrete-time and continuous-time dynamical systems arising in the natural and engineering sciences, in particular, the design of robust nonstandard finite-difference methods for solving continuous-time ordinary and partial differential equation models, the analytical and numerical study of models that undergo nonlinear oscillations, as well as the design of deterministic and stochastic models for epidemiological and ecological processes. Some of the specific topics covered in the book include the analysis of deterministic and stochastic SIR-type models, the assessment of cost-effectiveness of vaccination problems, finite-difference methods for oscillatory dynamical systems (including the Schrödinger equation and Brusselator system), the design of exact and elementary stable finite-difference methods, the study of a two-patch model with Allee effects and disease-modified fitness, the study of the delay differential equation model with application to circadian rhythm and the application of some special functions in the solutions of some problems arising in the natural and engineering sciences. A notable feature of the book is the collection of some relevant open problems, intended to help guide the direction of future research in the area.

1st European Nonlinear Oscillations Conference
Springer Nature
The International Union of Theoretical and Applied Mechanics (IUTAM) initiated and sponsored an International Symposium on Nonlinear Dynamics in Engineering Systems held in 1989 in Stuttgart, FRG. The Symposium was intended to bring together scientists working in different fields of dynamics to exchange ideas and to discuss new trends with special emphasis on nonlinear dynamics in engineering systems. A Scientific Committee was appointed by the Bureau of IUTAM with the following members: S. Arimoto (Japan), F.L. Chernousko (USSR), P.J. Holmes (USA), C.S. Hsu (USA), G. looss (France), F.C. Moon (USA), W. Schiehlen (FRG), Chairman, G. Schmidt (GDR), W. Szemplinska-Stupnicka (Poland), J.M.T. Thompson (UK), H. Troger (Austria). This committee selected the participants to be invited and the papers to be presented at the Symposium. As a result of this procedure 78 active scientific participants from 22 countries followed the invitation, and 44 papers were presented in lecture and poster sessions. They are collected in this volume. At the Symposium an exhibition with experiments took place and the movie "An Introduction to the Analysis of Chaotic Dynamics" by E.J. Kreuzer et.al. was presented. The scientific lectures were devoted to the following topics: o Dynamic Structural Engineering

Problems, o Analysis of Nonlinear Dynamic Systems, o Bifurcation Problems, o Chaotic Dynamics and Control Problems, o Miscellaneous Problems, o Experimental and Theoretical Investigations, o Chaotic Oscillations of Engineering Systems, o Characterization of Nonlinear Dynamic Systems, o Nonlinear Stochastic Systems.

Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields Springer Science & Business Media

This book provides a concise presentation of the major techniques for determining analytic approximations to the solutions of planar oscillatory dynamic systems. These systems model many important phenomena in the sciences and engineering. In addition to the usual perturbation procedures, the book gives the details of when and how to correctly apply the method of harmonic balance for both first-order and higher-order calculations. This procedure is rarely given or discussed fully in standard textbooks. The basic philosophy of the book stresses how to initiate and complete the calculation of approximate solutions. This is done by a clear presentation of necessary background materials and by the working out of many examples.

Dynamical Systems and Nonlinear Oscillations Princeton University Press

A rich variety of books devoted to dynamical chaos, solitons, self-

organization has appeared in recent years. These problems were all considered independently of one another. Therefore many of readers of these books do not suspect that the problems discussed are divisions of a great generalizing science - the theory of oscillations and waves. This science is not some branch of physics or mechanics, it is a science in its own right. It is in some sense a meta-science. In this respect the theory of oscillations and waves is closest to mathematics. In this book we call the reader's attention to the present-day theory of non-linear oscillations and waves. Oscillatory and wave processes in the systems of diversified physical natures, both periodic and chaotic, are considered from a unified poin t of view . The relation between the theory of oscillations and waves, non-linear dynamics and synergetics is discussed. One of the purposes of this book is to convince reader of the necessity of a thorough study popular branches of of the theory of oscillat ions and waves, and to show that such science as non-linear dynamics, synergetics, soliton theory, and so on, are, in fact , constituent parts of this theory. The primary audiences for this book are researchers having to do with oscillatory and wave processes, and both students and post-graduate students interested in a deep study of the general laws and applications of the theory of oscillations and waves. Regular and Chaotic Oscillations Walter de

Gruyter GmbH & Co KG An application of the techniques of dynamical systems and bifurcation theories to the study of nonlinear oscillations. Taking their cue from Poincare, the authors stress the geometrical and topological properties of solutions of differential equations and iterated maps. Numerous exercises, some of which require nontrivial algebraic manipulations and computer work, convey the important analytical underpinnings of problems in dynamical systems and help readers develop an intuitive feel for the properties involved.

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