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Two-Dimensional Quadratic Nonlinear Systems - Albert C. J. Luo 2022-04-30
The book focuses on the nonlinear dynamics based on the vector fields with bivariate quadratic functions. This book is a unique monograph for two-dimensional quadratic nonlinear systems based on bivariate vector fields. Such a book provides different points of view about nonlinear dynamics and bifurcations of the quadratic dynamical systems on linear and nonlinear bivariate manifolds. Possible singular dynamics of the two-dimensional quadratic systems is discussed in detail. The dynamics of equilibriums and one-dimensional flows on bivariate manifolds are presented. Saddle-focus bifurcations are discussed, and switching bifurcations based on infinite-equilibriums are presented. Saddle-focus networks on bivariate manifolds are demonstrated. This book will serve as a reference book on dynamical systems and control for researchers, students and engineering in mathematics, mechanical and electrical engineering.
Dynamics of Multibody Systems - Ahmed A. Shabana 2013-09-02
This enhanced fourth edition of Dynamics of Multibody Systems includes an additional chapter that provides explanations of some of the fundamental issues addressed in the book, as well as new detailed derivations of some important problems. Many common mechanisms such as automobiles, space structures, robots and micromachines have mechanical and structural systems that consist of interconnected rigid and deformable components. The dynamics of these large-scale multibody systems are highly nonlinear, presenting complex problems that in most cases can only be solved with computer-based techniques. The book begins with a review of the basic ideas of kinematics and the dynamics of rigid and deformable bodies before moving on to more advanced topics and computer implementation. The book's wealth of examples and practical applications will be useful to graduate students, researchers and practising engineers working on a wide variety of flexible multibody systems.
Large Space Structures & Systems in the Space Station Era - 1993

Geothermal Power Plants - Ronald DiPippo 2011-04-08
Ron DiPippo, Professor Emeritus at the University of Massachusetts Dartmouth, is a world-regarded geothermal expert. This single resource covers all aspects of the utilization of geothermal energy for power generation from fundamental scientific and engineering principles. The thermodynamic basis for the design of geothermal power plants is at the heart of the book and readers are clearly guided on the process of designing and analysing the key types of geothermal energy conversion systems. Its practical emphasis is enhanced by the use of case studies from real plants that increase the reader's understanding of geothermal energy conversion and provide a unique compilation of hard-to-obtain data and experience. An important new chapter covers Environmental Impact and Abatement Technologies, including gaseous and solid emissions; water, noise and thermal pollutions; land usage; disturbance of natural hydrothermal manifestations, habitats and vegetation; minimisation of CO2 emissions and environmental impact assessment. The book is illustrated with over 240 photographs and drawings. Nine chapters include practice problems, with solutions, which enable the book to be used as a course text. Also includes a definitive worldwide compilation of every geothermal power plant that has operated, unit by unit, plus a concise primer on the applicable thermodynamics. * Engineering principles are at the heart of the book, with complete coverage of the thermodynamic basis for the design of geothermal power systems * Practical applications are backed up by an extensive selection of case studies that show how geothermal energy conversion systems have been designed, applied and exploited in practice * World renowned geothermal expert DiPippo has including a new chapter on Environmental Impact and Abatement Technology in this new edition

Classical Mechanics - Jan Awrejcewicz 2012-07-26
This is the first volume of three, devoted to Mechanics. This book contains classical mechanics problems including kinematics and statics. It is recommended as a supplementary textbook for undergraduate and graduate students from mechanical and civil engineering, as well as for physical scientists and engineers. It contains a basic introduction to classical mechanics, including fundamental principles, statics, and the geometry of masses, as well as thorough discussion on kinematics.
Medicine Meets Virtual Reality 12 - James D. Westwood 2004
A Prototype Virtual Reality System for Preoperative Planning of Neuro-Endovascular Interventions -- Validation of Soft Tissue Properties in Surgical Simulation with Haptic Feedback -- Comparison of CAVE and HM for Visual Stimulation in Postural Control Research -- Virtual Vision Loss Simulator -- Reaction-Time Measurement and Real-Tune Data Acquisition for Neuroscientific Experiments in Virtual Environments -- A Preliminary Study of Presence inVirtual Reality Training Simulation for Medical Emergencies -- An Ali System with Intuitive User Interface for Manipulation and Visualization of 3D Medical Data -- A Haptic Surgical Simulator for the Continuous Curvilinear Capsulorhexis Procedure During Cataract Surgery -- Haptic Rendering of Tissue Cutting with Scissors -- Increasing face validity of a vascular interventional training system -- An Endoscopic Sinus Surgery Training System for Assessment of Surgical Skill -- Acquiring Laparoscopic Manipulative Skills: A Virtual Tissue Dissection Training Module -- Novel Force Resolver Designs for a Haptic Surgery Simulator -- Author Index
Large Space Structures & Systems in the Space Station Era - 1993

PHYSICAL CHEMISTRY 2016 - Željko Čupić 2016-09-26

Research Directions in Computational Mechanics - National Research Council 1991-02-01
Computational mechanics is a scientific discipline that marries physics, computers, and mathematics to emulate natural physical phenomena. It is a technology that allows scientists to study and predict the performance of various productsâ€"important for research and development in the industrialized world. This book describes current trends and future research directions in computational mechanics in areas where gaps exist in current knowledge and where major advances are crucial to continued technological developments in the United States.
Polynomial Functional Dynamical Systems - Albert Luo 2022-05-31
The book is about the global stability and bifurcation of equilibriums in polynomial functional systems. Appearing and switching bifurcations of simple and higher-order equilibriums in the polynomial functional systems are discussed, and such bifurcations of equilibriums are not only for simple equilibriums but for higher-order equilibriums. The third-order sink and source bifurcations for simple equilibriums are presented in the polynomial functional systems. The third-order sink and source switching bifurcations for saddle and nodes are also presented, and the fourth-order upper-saddle and lower-saddle switching and appearing bifurcations are presented for two second-order upper-saddles and two second-order lower-saddles, respectively. In general, the (2 + 1)th-order sink and source switching bifurcations for (2)th-order saddles and (2 +1)-order nodes are also presented, and the (2)th-order upper-saddle and lower-saddle switching and appearing bifurcations are presented for (2)th-order upper-saddles and (2)th-order lower-saddles (, = 1,2,...). The vector fields in nonlinear dynamical systems are polynomial functional. Complex dynamical systems can be constructed with polynomial algebraic structures, and the corresponding singularity and motion complexity can be easily determined.
Analytical Routes to Chaos in Nonlinear Engineering - Albert C. J. Luo 2014-05-23
Nonlinear problems are of interest to engineers, physicists and

mathematicians and many other scientists because most systems are inherently nonlinear in nature. As nonlinear equations are difficult to solve, nonlinear systems are commonly approximated by linear equations. This works well up to some accuracy and some range for the input values, but some interesting phenomena such as chaos and singularities are hidden by linearization and perturbation analysis. It follows that some aspects of the behavior of a nonlinear system appear commonly to be chaotic, unpredictable or counterintuitive. Although such a chaotic behavior may resemble a random behavior, it is absolutely deterministic. Analytical Routes to Chaos in Nonlinear Engineering discusses analytical solutions of periodic motions to chaos or quasi-periodic motions in nonlinear dynamical systems in engineering and considers engineering applications, design, and control. It systematically discusses complex nonlinear phenomena in engineering nonlinear systems, including the periodically forced Duffing oscillator, nonlinear self-excited systems, nonlinear parametric systems and nonlinear rotor systems. Nonlinear models used in engineering are also presented and a brief history of the topic is provided. Key features: Considers engineering applications, design and control Presents analytical techniques to show how to find the periodic motions to chaos in nonlinear dynamical systems Systematically discusses complex nonlinear phenomena in engineering nonlinear systems Presents extensively used nonlinear models in engineering Analytical Routes to Chaos in Nonlinear Engineering is a practical reference for researchers and practitioners across engineering, mathematics and physics disciplines, and is also a useful source of information for graduate and senior undergraduate students in these areas.

An Introduction to Mathematical Modeling - J. Tinsley Oden 2012-02-23

A modern approach to mathematical modeling, featuring unique applications from the field of mechanics An Introduction to Mathematical Modeling: A Course in Mechanics is designed to survey the mathematical models that form the foundations of modern science and incorporates examples that illustrate how the most successful models arise from basic principles in modern and classical mathematical physics. Written by a world authority on mathematical theory and computational mechanics, the book presents an account of continuum mechanics, electromagnetic field theory, quantum mechanics, and statistical mechanics for readers with varied backgrounds in engineering, computer science, mathematics, and physics. The author streamlines a comprehensive understanding of the topic in three clearly organized sections: Nonlinear Continuum Mechanics introduces kinematics as well as force and stress in deformable bodies; mass and momentum; balance of linear and angular momentum; conservation of energy; and constitutive equations Electromagnetic Field Theory and Quantum Mechanics contains a brief account of electromagnetic wave theory and Maxwell's equations as well as an introductory account of quantum mechanics with related topics including ab initio methods and Spin and Pauli's principles Statistical Mechanics presents an introduction to statistical mechanics of systems in thermodynamic equilibrium as well as continuum mechanics, quantum mechanics, and molecular dynamics Each part of the book concludes with exercise sets that allow readers to test their understanding of the presented material. Key theorems and fundamental equations are highlighted throughout, and an extensive bibliography outlines resources for further study. Extensively class-tested to ensure an accessible presentation, An Introduction to Mathematical Modeling is an excellent book for courses on introductory mathematical modeling and statistical mechanics at the upper-undergraduate and graduate levels. The book also serves as a valuable reference for professionals working in the areas of modeling and simulation, physics, and computational engineering.

Generalized Models and Non-classical Approaches in Complex Materials 1 - Holm Altenbach 2018-03-24

This book is the first of 2 special volumes dedicated to the memory of Gérard Maugin. Including 40 papers that reflect his vast field of scientific activity, the contributions discuss non-standard methods (generalized model) to demonstrate the wide range of subjects that were covered by this exceptional scientific leader. The topics range from micromechanical basics to engineering applications, focusing on new models and applications of well-known models to new problems. They include micro–macro aspects, computational endeavors, options for identifying constitutive equations, and old problems with incorrect or non-satisfying solutions based on the classical continua assumptions.

Galloping Instability to Chaos of Cables - Albert C. J. Luo 2018-01-16

This book provides students and researchers with a systematic solution for fluid-induced structural vibrations, galloping instability and the chaos of cables. They will also gain a better understanding of stable and unstable periodic motions and chaos in fluid-induced structural vibrations. Further, the results presented here will help engineers effectively design and analyze fluid-induced vibrations.

Sequential Bifurcation Trees to Chaos in Nonlinear Time-Delay Systems - Siyuan Xing 2020-09-11

In this book, the global sequential scenario of bifurcation trees of periodic motions to chaos in nonlinear dynamical systems is presented for a better understanding of global behaviors and motion transitions for one periodic motion to another one. A 1-dimensional (1-D), time-delayed, nonlinear dynamical system is considered as an example to show how to determine the global sequential scenarios of the bifurcation trees of periodic motions to chaos. All stable and unstable periodic motions on the bifurcation trees can be determined. Especially, the unstable periodic motions on the bifurcation trees cannot be achieved from the traditional analytical methods, and such unstable periodic motions and chaos can be obtained through a specific control strategy. The sequential periodic motions in such a 1-D time-delayed system are achieved semi-analytically, and the corresponding stability and bifurcations are determined by eigenvalue analysis. Each bifurcation tree of a specific periodic motion to chaos are presented in detail. The bifurcation tree appearance and vanishing are determined by the saddle-node bifurcation, and the cascaded period-doubled periodic solutions are determined by the period-doubling bifurcation. From finite Fourier series, harmonic amplitude and harmonic phases for periodic motions on the global bifurcation tree are obtained for frequency analysis. Numerical illustrations of periodic motions are given for complex periodic motions in global bifurcation trees. The rich dynamics of the 1-D, delayed, nonlinear dynamical system is presented. Such global sequential periodic motions to chaos exist in nonlinear dynamical systems. The frequency-amplitude analysis can be used for re-construction of analytical expression of periodic motions, which can be used for motion control in dynamical systems.

Peterson's Guide to Graduate Programs in Engineering and Applied Sciences 1996 - Peterson's Guides Staff 1995-11

Provides information about admission, financial aid, programs and institutions, and research specialties within the fields of engineering and applied sciences, including civil engineering, information technology, and bioengineering.

Scientific and Technical Aerospace Reports - 1995

Dynamics of Multibody Systems - Ahmed A. Shabana 2005-05-02

Dynamics of Multibody Systems, Third Edition, introduces multibody dynamics, with an emphasis on flexible body dynamics. Many common mechanisms such as automobiles, space structures, robots, and micromachines have mechanical and structural systems that consist of interconnected rigid and deformable components. The dynamics of these large-scale, multibody systems are highly nonlinear, presenting complex problems that in most cases can only be solved with computer-based techniques. The book begins with a review of the basic ideas of kinematics and the dynamics of rigid and deformable bodies before moving on to more advanced topics and computer implementation. This revised third edition now includes important new developments relating to the problem of large deformations and numerical algorithms as applied to flexible multibody systems. The book's wealth of examples and practical applications will be useful to graduate students, researchers, and practicing engineers working on a wide variety of flexible multibody systems.

Complex Systems - Albert C. J. Luo 2011-12-01

"Complex Systems: Fractionality, Time-delay and Synchronization" covers the most recent developments and advances in the theory and application of complex systems in these areas. Each chapter was written by scientists highly active in the field of complex systems. The book discusses a new treatise on fractional dynamics and control, as well as the new methods for differential delay systems and control. Lastly, a theoretical framework for the complexity and synchronization of complex system is presented. The book is intended for researchers in the field of nonlinear dynamics in mathematics, physics and engineering. It can also serve as a reference book for graduate students in physics, applied mathematics and engineering. Dr. Albert C.J. Luo is a Professor at Southern Illinois University Edwardsville, USA. Dr. Jian-Qiao Sun is a Professor at the University of California, Merced, USA.

Two-Dimensional Quadratic Nonlinear Systems - Albert C. J. Luo 2022-03-12

This book focuses on the nonlinear dynamics based on the vector fields

with univariate quadratic functions. This book is a unique monograph for two-dimensional quadratic nonlinear systems. It provides different points of view about nonlinear dynamics and bifurcations of the quadratic dynamical systems. Such a two-dimensional dynamical system is one of simplest dynamical systems in nonlinear dynamics, but the local and global structures of equilibriums and flows in such two-dimensional quadratic systems help us understand other nonlinear dynamical systems, which is also a crucial step toward solving the Hilbert's sixteenth problem. Possible singular dynamics of the two-dimensional quadratic systems are discussed in detail. The dynamics of equilibriums and one-dimensional flows in two-dimensional systems are presented. Saddle-sink and saddle-source bifurcations are discussed, and saddle-center bifurcations are presented. The infinite-equilibrium states are switching bifurcations for nonlinear systems. From the first integral manifolds, the saddle-center networks are developed, and the networks of saddles, source, and sink are also presented. This book serves as a reference book on dynamical systems and control for researchers, students, and engineering in mathematics, mechanical, and electrical engineering.

Discontinuous Dynamical Systems on Time-varying Domains - Albert Luo 2009-08-13

"Discontinuous Dynamical Systems on Time-varying Domains" is the first monograph focusing on this topic. While in the classic theory of dynamical systems the focus is on dynamical systems on time-invariant domains, this book presents discontinuous dynamical systems on time-varying domains where the corresponding switchability of a flow to the time-varying boundary in discontinuous dynamical systems is discussed. From such a theory, principles of dynamical system interactions without any physical connections are presented. Several discontinuous systems on time-varying domains are analyzed in detail to show how to apply the theory to practical problems. The book can serve as a reference book for researchers, advanced undergraduate and graduate students in mathematics, physics and mechanics. Dr. Albert C. J. Luo is a professor at Southern Illinois University Edwardsville, USA. His research is involved in the nonlinear theory of dynamical systems. His main contributions are in the following aspects: a stochastic and resonant layer theory in nonlinear Hamiltonian systems, singularity on discontinuous dynamical systems, and approximate nonlinear theories for a deformable-body.

Electrodynamics of Continua I - A. Cemal Eringen 2012-12-06

The electrodynamics of continua is a branch ofthe physical sciences concerned with the interaction of electromagnetic fields with deformable bodies. De formable bodies are considered to be continua endowed with continuous distributions of mass and charge. The theory of electromagnetic continua is concerned with the determination of deformations, motions, stress, and elec tromagnetic fields developed in bodies upon the applications of external loads. External loads may be of mechanical origin (e.g., forces, couples, constraints placed on the surface of the body, and initial and boundary conditions arising from thermal and other changes) and/or electromagnetic origin (e.g., electric, magnetic, and current fields). Because bodies of different constitutions respond to external stimuli in a different way, it is imperative to characterize properly the response functions relevant to a given class of continua. This is done by means of the constitutive theory. For example, an elastic dielectric responds to electromagnetic fields in a totally different way than a magnetic fluid. The present book is intended to present a unified approach to the subject matter, based on the principles of contemporary continuum physics.

Thermo-Dynamics of Plates and Shells - Jan Awrejcewicz 2007-02-15

This monograph is devoted to nonlinear dynamics of thin plates and shells with thermosensitive excitation. Because of the variety of sizes and types of mathematical models in current use, there is no prospect of solving them analytically. However, the book emphasizes a rigorous mathematical treatment of the obtained differential equations, since it helps efficiently in further developing of various suitable numerical algorithms to solve the stated problems.

Catalogs of Courses - University of California, Berkeley 1993

Includes general and summer catalogs issued between 1878/1879 and 1995/1997.

Mathematical Models in Natural Science and Engineering - Juri I. Neimark 2012-12-06

This book has come into being as a result ofthe author's lectures on mathematical modelling rendered to the students, BS and MS degree holders specializing in applied mathematics and computer science and to post-graduate students in exact sciences of the Nizhny Novgorod State University after N.!. Lobatchevsky. These lectures are adapted and presented as a single whole ab out mathematical models and modelling. This new course of lectures appeared because the contemporary Russian educational system in applied mathematics rested upon a combination of fundamental and applied mathematics training; this way of training oriented students upon solving only the exactly stated mathematical problems, and thus there was created a certain estrangement to the most essential stages and sides of real solutions for applied problems, such as thinking over and deeply piercing the essence of a specific problem and its mathematical statement. This statement embraces simplifications, adopted idealizations and creating a mathematical model, its correction and matching the results obtained against a real system. There also existed another main objective, namely to orient university graduates in their future research not only upon purely mathematical issues but also upon comprehending and widely applying mathematics as a universal language of contemporary exact science, and mathematical modelling as a powerful me ans for studying nature, engineering and human society.

Symmetries and Applications of Differential Equations - Albert C. J. Luo 2021

This book is about Lie group analysis of differential equations for physical and engineering problems. The topics include: -- Approximate symmetry in nonlinear physical problems -- Complex methods for Lie symmetry analysis -- Lie group classification, Symmetry analysis, and conservation laws -- Conservative difference schemes -- Hamiltonian structure and conservation laws of three-dimensional linear elasticity -- Involutive systems of partial differential equations This collection of works is written in memory of Professor Nail H. Ibragimov (1939-2018). It could be used as a reference book in differential equations in mathematics, mechanical, and electrical engineering.

Applied Mechanics Reviews - 1973

Bifurcation Dynamics of a Damped Parametric Pendulum - Yu Guo 2019-12-02

The inherent complex dynamics of a parametrically excited pendulum is of great interest in nonlinear dynamics, which can help one better understand the complex world. Even though the parametrically excited pendulum is one of the simplest nonlinear systems, until now, complex motions in such a parametric pendulum cannot be achieved. In this book, the bifurcation dynamics of periodic motions to chaos in a damped, parametrically excited pendulum is discussed. Complete bifurcation trees of periodic motions to chaos in the parametrically excited pendulum include: period-1 motion (static equilibriums) to chaos, and period- motions to chaos (= 1, 2, ---, 6, 8, ---, 12). The aforesaid bifurcation trees of periodic motions to chaos coexist in the same parameter ranges, which are very difficult to determine through traditional analysis. Harmonic frequency-amplitude characteristics of such bifurcation trees are also presented to show motion complexity and nonlinearity in such a parametrically excited pendulum system. The non-travelable and travelable periodic motions on the bifurcation trees are discovered. Through the bifurcation trees of travelable and non-travelable periodic motions, the travelable and non-travelable chaos in the parametrically excited pendulum can be achieved. Based on the traditional analysis, one cannot achieve the adequate solutions presented herein for periodic motions to chaos in the parametrically excited pendulum. The results in this book may cause one rethinking how to determine motion complexity in nonlinear dynamical systems.

Fractional Dynamics - Vasily E. Tarasov 2011-01-04

"Fractional Dynamics: Applications of Fractional Calculus to Dynamics of Particles, Fields and Media" presents applications of fractional calculus, integral and differential equations of non-integer orders in describing systems with long-time memory, non-local spatial and fractal properties. Mathematical models of fractal media and distributions, generalized dynamical systems and discrete maps, non-local statistical mechanics and kinetics, dynamics of open quantum systems, the hydrodynamics and electrodynamics of complex media with non-local properties and memory are considered. This book is intended to meet the needs of scientists and graduate students in physics, mechanics and applied mathematics who are interested in electrodynamics, statistical and condensed matter physics, quantum dynamics, complex media theories and kinetics, discrete maps and lattice models, and nonlinear dynamics and chaos. Dr. Vasily E. Tarasov is a Senior Research Associate at Nuclear Physics Institute of Moscow State University and an Associate Professor at Applied Mathematics and Physics Department of Moscow Aviation Institute.

Toward Analytical Chaos in Nonlinear Systems - Albert C. J. Luo

2014-06-23
Exact analytical solutions to periodic motions in nonlinear dynamical systems are almost not possible. Since the 18th century, one has extensively used techniques such as perturbation methods to obtain approximate analytical solutions of periodic motions in nonlinear systems. However, the perturbation methods cannot provide the enough accuracy of analytical solutions of periodic motions in nonlinear dynamical systems. So the bifurcation trees of periodic motions to chaos cannot be achieved analytically. The author has developed an analytical technique that is more effective to achieve periodic motions and corresponding bifurcation trees to chaos analytically. Toward Analytical Chaos in Nonlinear Systems systematically presents a new approach to analytically determine periodic flows to chaos or quasi-periodic flows in nonlinear dynamical systems with/without time-delay. It covers the mathematical theory and includes two examples of nonlinear systems with/without time-delay in engineering and physics. From the analytical solutions, the routes from periodic motions to chaos are developed analytically rather than the incomplete numerical routes to chaos. The analytical techniques presented will provide a better understanding of regularity and complexity of periodic motions and chaos in nonlinear dynamical systems. Key features: Presents the mathematical theory of analytical solutions of periodic flows to chaos or quasieriodic flows in nonlinear dynamical systems Covers nonlinear dynamical systems and nonlinear vibration systems Presents accurate, analytical solutions of stable and unstable periodic flows for popular nonlinear systems Includes two complete sample systems Discusses time-delayed, nonlinear systems and time-delayed, nonlinear vibrational systems Includes real world examples Toward Analytical Chaos in Nonlinear Systems is a comprehensive reference for researchers and practitioners across engineering, mathematics and physics disciplines, and is also a useful source of information for graduate and senior undergraduate students in these areas.

Nonlinear Deformable-body Dynamics - Albert C. J. Luo 2011-06-08
"Nonlinear Deformable-body Dynamics" mainly consists in a mathematical treatise of approximate theories for thin deformable bodies, including cables, beams, rods, webs, membranes, plates, and shells. The intent of the book is to stimulate more research in the area of nonlinear deformable-body dynamics not only because of the unsolved theoretical puzzles it presents but also because of its wide spectrum of applications. For instance, the theories for soft webs and rod-reinforced soft structures can be applied to biomechanics for DNA and living tissues, and the nonlinear theory of deformable bodies, based on the Kirchhoff assumptions, is a special case discussed. This book can serve as a reference work for researchers and a textbook for senior and postgraduate students in physics, mathematics, engineering and biophysics. Dr. Albert C.J. Luo is a Professor of Mechanical Engineering at Southern Illinois University, Edwardsville, IL, USA. Professor Luo is an internationally recognized scientist in the field of nonlinear dynamics in dynamical systems and deformable solids.

Bifurcation Dynamics of a Damped Parametric Pendulum - Yu Guo 2022-06-01
The inherent complex dynamics of a parametrically excited pendulum is of great interest in nonlinear dynamics, which can help one better understand the complex world. Even though the parametrically excited pendulum is one of the simplest nonlinear systems, until now, complex motions in such a parametric pendulum cannot be achieved. In this book, the bifurcation dynamics of periodic motions to chaos in a damped, parametrically excited pendulum is discussed. Complete bifurcation trees of periodic motions to chaos in the parametrically excited pendulum include: period-1 motion (static equilibriums) to chaos, and period- motions to chaos (= 1, 2, ⋯, 6, 8, ⋯, 12). The aforesaid bifurcation trees of periodic motions to chaos coexist in the same parameter ranges, which are very difficult to determine through traditional analysis. Harmonic frequency-amplitude characteristics of such bifurcation trees are also presented to show motion complexity and nonlinearity in such a parametrically excited pendulum system. The non-travelable and travelable periodic motions on the bifurcation trees are discovered. Through the bifurcation trees of travelable and non-travelable periodic motions, the travelable and non-travelable chaos in the parametrically excited pendulum can be achieved. Based on the traditional analysis, one cannot achieve the adequate solutions presented herein for periodic motions to chaos in the parametrically excited pendulum. The results in this book may cause one rethinking how to determine motion complexity in nonlinear dynamical systems.

Modeling Nonlinear Problems in the Mechanics of Strings and Rods - Oliver M. O'Reilly 2017-03-10
This book presents theories of deformable elastic strings and rods and their application to broad classes of problems. Readers will gain insights into the formulation and analysis of models for mechanical and biological systems. Emphasis is placed on how the balance laws interplay with constitutive relations to form a set of governing equations. For certain classes of problems, it is shown how a balance of material momentum can play a key role in forming the equations of motion. The first half of the book is devoted to the purely mechanical theory of a string and its applications. The second half of the book is devoted to rod theories, including Euler’s theory of the elastica, Kirchhoff ’s theory of an elastic rod, and a range of Cosserat rod theories. A variety of classic and recent applications of these rod theories are examined. Two supplemental chapters, the first on continuum mechanics of three-dimensional continua and the second on methods from variational calculus, are included to provide relevant background for students. This book is suited for graduate-level courses on the dynamics of nonlinearly elastic rods and strings.

Nonlinear Vibration Reduction - Albert C. J. Luo 2023-01-01
The tuned mass damper is one of the classic dynamic vibration absorbers with effective devices for energy dissipation and vibration reduction. The electromagnetically tuned mass damper system is extensively used for vibration reduction in engineering. A better understanding of the nonlinear dynamics of the electromagnetically tuned mass damper system is very important to optimize the parameters of such systems for vibration reduction. However, until now, one cannot fully understand complex periodic motions in such a nonlinear, electromagnetically tuned mass damper system. In this book, the semi-analytical solutions of periodic motions are presented through period-1, period-3, period-9, and period-12 motions. The corresponding stability and bifurcations of periodic motions are determined. The frequency-amplitude characteristics for bifurcation routes of such higher-order periodic motions are presented. This book helps people better understand the dynamical behaviors of an electromagnetically tuned mass damper system for the new development and design of vibration reduction and energy harvesting systems.

Discretization and Implicit Mapping Dynamics - Albert C. J. Luo 2015-08-13
This unique book presents the discretization of continuous systems and implicit mapping dynamics of periodic motions to chaos in continuous nonlinear systems. The stability and bifurcation theory of fixed points in discrete nonlinear dynamical systems is reviewed, and the explicit and implicit maps of continuous dynamical systems are developed through the single-step and multi-step discretizations. The implicit dynamics of period-m solutions in discrete nonlinear systems are discussed. The book also offers a generalized approach to finding analytical and numerical solutions of stable and unstable periodic flows to chaos in nonlinear systems with/without time-delay. The bifurcation trees of periodic motions to chaos in the Duffing oscillator are shown as a sample problem, while the discrete Fourier series of periodic motions and chaos are also presented. The book offers a valuable resource for university students, professors, researchers and engineers in the fields of applied mathematics, physics, mechanics, control systems, and engineering.

Modeling Nonlinear Problems in the Mechanics of Strings and Rods - Oliver M. O'Reilly 2018-07-21
This book presents theories of deformable elastic strings and rods and their application to broad classes of problems. Readers will gain insights into the formulation and analysis of models for mechanical and biological systems. Emphasis is placed on how the balance laws interplay with constitutive relations to form a set of governing equations. For certain classes of problems, it is shown how a balance of material momentum can play a key role in forming the equations of motion. The first half of the book is devoted to the purely mechanical theory of a string and its applications. The second half of the book is devoted to rod theories, including Euler’s theory of the elastica, Kirchhoff ’s theory of an elastic rod, and a range of Cosserat rod theories. A variety of classic and recent applications of these rod theories are examined. Two supplemental chapters, the first on continuum mechanics of three-dimensional continua and the second on methods from variational calculus, are included to provide relevant background for students. This book is suited for graduate-level courses on the dynamics of nonlinearly elastic rods and strings.

Long-range Interactions, Stochasticity and Fractional Dynamics - Albert C. J. Luo 2011-01-04
In memory of Dr. George Zaslavsky, "Long-range Interactions,

Stochasticity and Fractional Dynamics" covers the recent developments of long-range interaction, fractional dynamics, brain dynamics and stochastic theory of turbulence, each chapter was written by established scientists in the field. The book is dedicated to Dr. George Zaslavsky, who was one of three founders of the theory of Hamiltonian chaos. The book discusses self-similarity and stochasticity and fractionality for discrete and continuous dynamical systems, as well as long-range interactions and diluted networks. A comprehensive theory for brain dynamics is also presented. In addition, the complexity and stochasticity for soliton chains and turbulence are addressed. The book is intended for researchers in the field of nonlinear dynamics in mathematics, physics and engineering. Dr. Albert C.J. Luo is a Professor at Southern Illinois University Edwardsville, USA. Dr. Valentin Afraimovich is a Professor at San Luis Potosi University, Mexico.

Hamiltonian Chaos Beyond the KAM Theory - Albert C. J. Luo 2011-01-04

“Hamiltonian Chaos Beyond the KAM Theory: Dedicated to George M. Zaslavsky (1935—2008)” covers the recent developments and advances in the theory and application of Hamiltonian chaos in nonlinear Hamiltonian systems. The book is dedicated to Dr. George Zaslavsky, who was one of three founders of the theory of Hamiltonian chaos. Each chapter in this book was written by well-established scientists in the field of nonlinear Hamiltonian systems. The development presented in this book goes beyond the KAM theory, and the onset and disappearance of chaos in the stochastic and resonant layers of nonlinear Hamiltonian systems are predicted analytically, instead of qualitatively. The book is intended for researchers in the field of nonlinear dynamics in mathematics, physics and engineering. Dr. Albert C.J. Luo is a Professor at Southern Illinois University Edwardsville, USA. Dr. Valentin Afraimovich is a Professor at San Luis Potosi University, Mexico.

Material Substructures in Complex Bodies - Gianfranco Capriz 2007-05-24

Stringent industrial requirements of sophisticated performances and of circumstantial control for micro-devices or nanotechnology manufactures, and other types of machinery at multiple scales, can be satisfied often only by resort to or allowance for complex materials. The adjective 'complex' beckons to the fact that the substructure influences gross mechanical behaviour in a prominent way and interactions due to substructural changes are represented directly. The description of the mechanical behaviour of complex bodies proposes a wide class of challenging problems from macroscopic-to-nano-world. The collection of chapters composing this book aims to explore some aspects of these problems, proposing also new matter of discussion together with specific solutions. Contributors are Carlo Cercignani, Gianfranco Capriz, Pierre Degond, Antonio Fasano, Harley T. Johnson, Sukky Jun, Krishna Kannan, Wing Kam Liu, Alberto Mancini, Paolo Maria Mariano, Ingo Müller, Kumbakonan R. Rajagopal, Jan Jerzy Slawianowski. The book can be a useful tool for Scholars and PhD students addressing their research activity toward basic mathematical and physical problems accruing from the mechanics of materials.

Polynomial Functional Dynamical Systems - Albert Luo 2021-09-09

The book is about the global stability and bifurcation of equilibriums in polynomial functional systems. Appearing and switching bifurcations of simple and higher-order equilibriums in the polynomial functional systems are discussed, and such bifurcations of equilibriums are not only for simple equilibriums but for higher-order equilibriums. The third-order sink and source bifurcations for simple equilibriums are presented in the polynomial functional systems. The third-order sink and source switching bifurcations for saddle and nodes are also presented, and the fourth-order upper-saddle and lower-saddle switching and appearing bifurcations are presented for two second-order upper-saddles and two second-order lower-saddles, respectively. In general, the (2 + 1)th-order sink and source switching bifurcations for (2)th-order saddles and (2 +1)-order nodes are also presented, and the (2)th-order upper-saddle and lower-saddle switching and appearing bifurcations are presented for (2)th-order upper-saddles and (2)th-order lower-saddles (, = 1,2,...). The vector fields in nonlinear dynamical systems are polynomial functional. Complex dynamical systems can be constructed with polynomial algebraic structures, and the corresponding singularity and motion complexity can be easily determined.