Long Range Interactions Stochasticity And Fractional Dynamics Dedicated To George M Zaslavsky 19352008 Nonlinear Physical Science

Fractional Dynamics **Fractional Dynamics** **Fractional Dynamics** Fractional Dynamics and Control **Hamiltonian Chaos and Fractional Dynamics** **Fractional Calculus in Analysis, Dynamics, and Optimal Control** **Fractional Dynamics and Control** **Fault-tolerant Control and Diagnosis for Integer and Fractional-order Systems** **Economic Dynamics with Memory** **Fractional Order Crowd Dynamics** Economic Dynamics with Memory *Fractional Calculus with Applications for Nuclear Reactor Dynamics* *Fractional Dynamics* Distributions in the Physical and Engineering Sciences, Volume 3 *Chaotic, Fractional, and Complex Dynamics: New Insights and Perspectives* *Advances in Synchronization of Coupled Fractional Order Systems* **Fractional Dynamics on Networks and Lattices** **Fractional Dynamics** **Applications of Fractional Calculus to Modeling in Dynamics and Chaos** *Fractional Order Analysis* **Mathematical Economics** *Fractional Dynamics, Anomalous Transport and Plasma Science* *Hamiltonian Chaos and Fractional Dynamics* Long-range Interactions, Stochasticity and Fractional Dynamics *Topics in Fractional Differential Equations* Fractional Order Systems **Advanced Applications of Fractional Differential Operators to Science and Technology** Fractional Order Systems and Applications in Engineering *Fractional Dynamics* **Fault-tolerant Control and Diagnosis for Interger and Fractional-order Systems** Theory and Applications of Fractional Differential Equations **Fractional Calculus in Medical and Health Science** Applications of Fractional Calculus in Physics **Time-Fractional Order Biological Systems with Uncertain Parameters** *Fractional-Order Nonlinear Systems* **Recent Advances in Applied Nonlinear Dynamics with Numerical Analysis** **Nonlinear, Nonlocal and Fractional Turbulence** Lie Symmetry Analysis of Fractional Differential Equations **Fractional Dynamical Systems** **Fractional Order Processes**

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Fractional Order Systems and Applications in Engineering Sep 09 2020 Fractional Order Systems and Applications in Engineering presents the use of fractional calculus (calculus of non-integer order) in the description and modelling of systems and in a range of control design and practical applications. The book covers the fundamentals of fractional calculus together with some analytical and numerical techniques, and provides MATLAB® codes for the simulation of fractional-order control (FOC) systems. The use of fractional calculus can improve and generalize well-established control methods and strategies. Many different FOC schemes are presented for control and dynamic systems problems. These extend to the challenging control engineering design problems of robust and nonlinear control. Practical material relating to a wide variety of applications including, among others, mechatronics, civil engineering, irrigation and water management, and biological systems is also provided. All the control schemes and applications are presented with either system simulation results or real experimental results, or both. Fractional Order Systems and Applications in Engineering introduces readers to the essentials of FOC and imbues them with a basic understanding of FOC concepts and methods. With this knowledge readers can extend their use of FOC in other industrial system applications, thereby expanding their range of disciplines by exploiting this versatile new set of control techniques. Provides the most recent and up-to-date developments on the Fractional-order Systems and their analyzing process Integrates recent advancements of modeling of real phenomena (on Fractional-order Systems) via different-different mathematical equations with demonstrated applications in numerous seemingly diverse and widespread fields of science and engineering Provides readers with illustrative examples of how to use the presented theories of Fractional-order Systems in specific cases with associated MATLAB code
Fractional-Order Nonlinear Systems Feb 01 2020 "Fractional-Order Nonlinear Systems: Modeling, Analysis and Simulation" presents a study of fractional-order chaotic systems accompanied by Matlab programs for simulating their state space trajectories, which are shown in the illustrations in the book. Description of the chaotic systems is clearly presented and their analysis and numerical solution are done in an easy-to-follow manner. Simulink models for the selected fractional-order systems are also presented. The readers will understand the fundamentals of the fractional calculus, how real dynamical systems can be described using fractional derivatives and fractional differential equations, how such equations can be solved, and how to simulate and explore chaotic systems of fractional order. The book addresses to mathematicians, physicists, engineers, and other scientists interested in chaos phenomena or in fractional-order systems. It can be used in courses on dynamical systems, control theory, and applied mathematics at graduate or postgraduate level. Ivo Petráš is an Associate Professor of automatic control and the Director of the Institute of Control and Informatization of Production Processes, Faculty of BERG, Technical University of Košice, Slovak Republic. His main research interests include control systems, industrial automation, and applied mathematics.
Economic Dynamics with Memory Apr 28 2022 This book presents the applications of fractional calculus, fractional operators of non-integer orders and fractional differential equations in describing economic dynamics with long memory. Generalizations of basic economic concepts, notions and methods for the economic processes with memory are suggested. New micro and macroeconomic models with continuous time are proposed to describe the fractional economic dynamics with long memory as well.
Fractional Dynamics Aug 09 2020 This volume provides the latest developments in the field of fractional dynamics, which covers fractional (anomalous) transport phenomena, fractional statistical mechanics, fractional quantum mechanics and fractional quantum field theory. The contributors are selected based on their active and important contributions to their respective topics. This volume is the first of its kind that covers such a comprehensive range of topics in fractional dynamics. It will point out to advanced undergraduate and graduate students, and young researchers the possible directions of research in this subject. In addition to those who intend to work in this field and those already in the field, this volume will also be useful for researchers not directly involved in the field, but want to know the current status and trends of development in this subject. This latter group includes theoretical chemists, mathematical biologists and engineers.
Time-Fractional Order Biological Systems with Uncertain Parameters Mar 04 2020 The subject of fractional calculus has gained considerable popularity and importance during the past three decades, mainly due to its validated applications in various fields of science and engineering. It is a generalization of ordinary differentiation and integration to arbitrary (non-integer) order. The fractional derivative has been used in various physical problems, such as frequency-dependent damping behavior of structures, biological systems, motion of a plate in a Newtonian fluid, ?? controller for the control of dynamical systems, and so on. It is challenging to obtain the solution (both analytical and numerical) of related nonlinear partial differential equations of fractional order. So for the last few decades, a great deal of attention has been directed towards the solution for these kind of problems. Different methods have been developed by other researchers to analyze the above problems with respect to crisp (exact) parameters. However, in real-life applications such as for biological problems, it is not always possible to get exact values of the associated parameters due to errors in measurements/experiments, observations, and many other errors. Therefore, the associated parameters and variables may be considered uncertain. Here, the uncertainties are considered interval/fuzzy. Therefore, the development of appropriate efficient methods and their use in solving the mentioned uncertain problems are the recent challenge. In view of the above, this book is a new attempt to rigorously present a variety of fuzzy (and interval) time-fractional dynamical models with respect to different biological systems using computationally efficient method. The authors believe this book will be helpful to undergraduates, graduates, researchers, industry, faculties, and others throughout the globe.
Applications of Fractional Calculus in Physics Apr 04 2020 Fractional calculus is a collection of relatively little-known mathematical results concerning generalizations of differentiation and integration to noninteger orders. While these results have been accumulated over centuries in various branches of mathematics, they have until recently found little appreciation or application in physics and other mathematically oriented sciences. This situation is beginning to change, and there are now a growing number of research areas in physics which employ fractional calculus. This volume provides an introduction to fractional calculus for physicists, and collects easily accessible review articles surveying those areas of physics in which applications of fractional calculus have recently become prominent. Contents:An Introduction to Fractional Calculus (P L Butzer & U Westphal)Fractional Time Evolution (R Hilfer)Fractional Powers of Infinitesimal Generators of Semigroups (U Westphal)Fractional Differences, Derivatives and Fractal Time Series (B J West & P Grigolini)Fractional Kinetics of Hamiltonian Chaotic Systems (G M Zaslavsky)Polymer Science Applications of Path-Integration, Integral Equations, and Fractional Calculus (J F Douglas)Applications to Problems in Polymer Physics and Rheology (H Schiessel et al.)Applications of Fractional Calculus Techniques to Problems in Biophysics (T F Nonnenmacher & R Metzler)Fractional Calculus and Regular Variation in Thermodynamics (R Hilfer) Readership: Statistical, theoretical and mathematical physicists. Keywords:Fractional Calculus in PhysicsReviews: “This monograph provides a systematic treatment of the theory and applications of fractional calculus for physicists. It contains nine review articles surveying those areas in which fractional calculus has become important. All the chapters are self-contained.” Mathematics Abstracts
Fractional Dynamics Jul 20 2021 This title is devoted to recent developments in the theory of fractional calculus and its applications. Particular attention is paid to the applicability of this currently popular research field in various branches of pure and applied mathematics.
Lie Symmetry Analysis of Fractional Differential Equations Oct 30 2019 The trajectory of fractional calculus has undergone several periods of intensive development, both in pure and applied sciences. During the last few decades fractional calculus has also been associated with the power law effects and its various applications. It is a natural to ask if fractional calculus, as a nonlocal calculus, can produce new results within the well-established field of Lie symmetries and their applications. In Lie Symmetry Analysis of Fractional Differential Equations the authors try to answer this vital question by analyzing different aspects of fractional Lie symmetries and related conservation laws. Finding the exact solutions of a given fractional partial differential equation is not an easy task, but is one that the authors seek to grapple with here. The book also includes generalization of Lie symmetries for fractional integro differential equations. Features Provides a solid basis for understanding fractional calculus, before going on to explore in detail Lie Symmetries and their applications Useful for PhD and postdoc graduates, as well as for all mathematicians and applied researchers who use the powerful concept of Lie symmetries Filled with various examples to aid understanding of the topics
Distributions in the Physical and Engineering Sciences, Volume 3 Nov 23 2021 Continuing the authors’ multivolume project, this text considers the theory of distributions from an applied perspective, demonstrating how effective a combination of analytic and probabilistic methods can be for solving problems in the physical and engineering sciences. Volume 1 covered foundational topics such as distributional and fractional calculus, the integral transform, and wavelets, and Volume 2 explored linear and nonlinear dynamics in continuous media. With this volume, the scope is extended to the use of distributional tools in the theory of generalized stochastic processes and fields, and in anomalous fractional random dynamics. Chapters cover topics such as probability distributions; generalized stochastic processes, Brownian motion, and the white noise; stochastic differential equations and generalized random fields; Burgers turbulence and passive tracer transport in Burgers flows; and linear, nonlinear, and multiscale anomalous fractional dynamics in continuous media. The needs of the applied-sciences audience are addressed by a careful and rich selection of examples arising in real-life industrial and scientific labs and a thorough discussion of their physical significance. Numerous illustrations generate a better understanding of the core concepts discussed in the text, and a large number of exercises at the end of each chapter expand on these concepts. Distributions in the Physical and Engineering Sciences is intended to fill a gap in the typical undergraduate engineering/physical sciences curricula, and as such it will be a valuable resource for researchers and graduate students working in these areas. The only prerequisites are a three-four semester calculus sequence (including ordinary differential equations, Fourier series, complex variables, and linear algebra), and some probability theory, but basic definitions and facts are covered as needed. An appendix also provides background material concerning the Dirac-delta and other distributions.
Fractional Calculus in Analysis, Dynamics, and Optimal Control Aug 01 2022 This book is devoted to applications of fractional calculus in classical fields of mathematics like analysis, dynamics, partial differential equations and optimal control. The first chapter deals with the notion of local fractional derivatives and its applications to the study of regularity and geometry of curves. The second chapter develops the notion of fractional embedding and fractional assymetric calculus of variations in order to find fractional Lagrangian variational structures for classical dissipative partial differential equations. In continuation of this chapter, a fractional analogue of the classical Pontryagin maximum principle is proved for discrete and continuous fractional optimal control problems. The fourth chapter gives a first mathematical model that allows a rigorous connection to be made between the dynamics of chaotic Hamiltonian systems and fractional dynamics, mixing the previous approaches of G Zaslavsky and R Hilfer. Finally, numerical methods to deal with fractional optimal control problems are discussed and implemented. All the chapters are self-contained and complete proofs are given.
Advances in Synchronization of Coupled Fractional Order Systems Sep 21 2021 After a short introduction to the fundamentals, this book provides a detailed account of major advances in applying fractional calculus to dynamical systems. Fractional order dynamical systems currently continue to gain further importance in many areas of science and engineering. As with many other approaches to mathematical modeling, the first issue to be addressed is the need to couple a definition of the fractional differentiation or integration operator with the types of dynamical systems that are analyzed. As such, for the fundamentals the focus is on basic aspects of fractional calculus, in particular stability analysis, which is required to tackle synchronization in coupled fractional order systems, to understand the essence of estimators for related integer order systems, and to keep track of the interplay between synchronization and parameter observation. This serves as the common basis for the more advanced topics and applications presented in the subsequent chapters, which include an introduction to the 'Immersion and Invariance' (I&I) methodology, the masterslave synchronization scheme for partially known nonlinear fractional order systems, Fractional Algebraic Observability (FAO) and Fractional Generalized quasi-Synchronization (FGqS) to name but a few. This book is intended not only for applied mathematicians and theoretical physicists, but also for anyone in applied science dealing with complex nonlinear systems.
Fractional Order Analysis May 18 2021 A guide to the new research in the field of fractional order analysis Fractional Order Analysis contains the most recent research findings in fractional order analysis and its applications. The authors—noted experts on the topic—offer an examination of the theory, methods, applications, and the modern tools and techniques in the field of fractional order analysis. The information, tools, and applications presented can help develop mathematical methods and models with better accuracy. Comprehensive in scope, the book covers a range of topics including: new fractional operators, fractional derivatives, fractional differential equations, inequalities for different fractional derivatives and fractional integrals, fractional modeling related to transmission of Malaria, and dynamics of Zika virus with various fractional derivatives, and more. Designed to be an accessible text, several useful, relevant and connected topics can be found in one place, which is crucial for an understanding of the research problems of an applied nature. This book: Contains recent development in fractional calculus Offers a balance of theory, methods, and applications Puts the focus on fractional analysis and its interdisciplinary applications, such as fractional models for biological models Helps make research more relevant to real-life applications Written for researchers, professionals and practitioners, Fractional Order Analysis offers a comprehensive resource to fractional analysis and its many applications as well as information on the newest research.
Nonlinear, Nonlocal and Fractional Turbulence Dec 01 2019 Experts of fluid dynamics agree that turbulence is nonlinear and nonlocal. Because of a direct correspondence, nonlocality also implies fractionality. Fractional dynamics is the physics related to fractal (geometrical) systems and is described by fractional calculus. Up-to-present, numerous criticisms of linear and local theories of turbulence have been published. Nonlinearity has established itself quite well, but so far only a very small number of general nonlocal concepts and no concrete nonlocal turbulent flow solutions were available. This book presents the first analytical and numerical solutions of elementary turbulent flow problems, mainly based on a nonlocal closure. Considerations involve anomalous diffusion (Lévy flights), fractal geometry (fractal-?, bi-fractal and multi-fractal model) and fractional dynamics. Examples include a new ‘law of the wall’ and a generalization of Kraichnan’s energy-enstrophy spectrum that is in harmony with non-extensive and non-equilibrium thermodynamics (Tsallis thermodynamics) and experiments. Furthermore, the presented theories of turbulence reveal critical and cooperative phenomena in analogy with phase transitions in other physical systems, e.g., binary fluids, para-ferromagnetic materials, etc.; the two phases of turbulence identifying the laminar streaks and coherent vorticity-rich structures. This book is intended, apart from fluids specialists, for researchers in physics, as well as applied and numerical mathematics, who would like to acquire knowledge about alternative approaches involved in the analytical and numerical treatment of turbulence.

Fractional Dynamical Systems Sep 29 2019 This book presents a wide and comprehensive spectrum of issues and problems related to fractional-order dynamical systems. It is meant to be a full-fledge, comprehensive presentation of many aspects related to the broadly perceived fractional-order dynamical systems which constitute an extension of the traditional integer-order-type descriptions. This implies far-reaching consequences, both analytic and algorithmic, because--in general--properties of the traditional integer-order systems cannot be directly extended by a straightforward generalization to fractional-order systems, modeled by fractional-order differential equations involving derivatives of an non-integer order. This can be useful for describing and analyzing, for instance, anomalies in the behavior of various systems, chaotic behavior, etc. The book contains both analytic contributions with state-of-the-art and theoretical foundations, algorithmic implementation of tools and techniques, and--finally--some examples of relevant and successful practical applications.
Fractional Dynamics Nov 04 2022 This volume provides the latest developments in the field of fractional dynamics, which covers fractional (anomalous) transport phenomena, fractional statistical mechanics, fractional quantum mechanics and fractional quantum field theory. The contributors are selected based on their active and important contributions to their respective topics. This volume is the first of its kind that covers such a comprehensive range of topics in fractional dynamics. It will point out to advanced undergraduate and graduate students, and young researchers the possible directions of research in this subject. In addition to those who intend to work in this field and those already in the field, this volume will also be useful for researchers not directly involved in the field, but want to know the current status and trends of development in this subject. This latter group includes theoretical chemists, mathematical biologists and engineers.
Fractional Order Processes Aug 28 2019 The book presents efficient numerical methods for simulation and analysis of physical processes exhibiting fractional order (FO) dynamics. The book introduces FO system identification method to estimate parameters of a mathematical model under consideration from experimental or simulated data. A simple tuning technique, which aims to produce a robust FO PID controller exhibiting iso-damping property during re-parameterization of a plant, is devised in the book. A new numerical method to find an equivalent finite dimensional integer order system for an infinite dimensional FO system is developed in the book. The book also introduces a numerical method to solve FO optimal control problems. Key features Proposes generalized triangular function operational matrices. Shows significant applications of triangular orthogonal functions as well as triangular strip operational matrices in simulation, identification and control of fractional order processes. Provides numerical methods for simulation of physical problems involving different types of weakly singular integral equations, Abel's integral equation, fractional order integro-differential equations, fractional order differential and differential-algebraic equations, and fractional order partial differential equations. Suggests alternative way to do numerical computation of fractional order signals and systems and control. Provides source codes developed in MATLAB for each chapter, allowing the interested reader to take advantage of these codes for broadening and enhancing the scope of the book itself and developing new results.
Fractional Calculus with Applications for Nuclear Reactor Dynamics Jan 26 2022 Introduces Novel Applications for Solving Neutron Transport Equations While deemed nonessential in the past, fractional calculus is now gaining momentum in the science and engineering community. Various disciplines have discovered that realistic models of physical phenomenon can be achieved with fractional calculus and are using them in numerous ways. Since fractional calculus represents a reactor more closely than classical integer order calculus, Fractional Calculus with Applications for Nuclear Reactor Dynamics focuses on the application of fractional calculus to describe the physical behavior of nuclear reactors. It applies fractional calculus to incorporate the mathematical methods used to analyze the diffusion theory model of neutron transport and explains the role of neutron transport in reactor theory. The author discusses fractional calculus and the numerical solution for fractional neutron point kinetic equation (FNPKE), introduces the technique for efficient and accurate numerical computation for FNPKE with different values of reactivity, and analyzes the fractional neutron point kinetic (FNPK) model for the dynamic behavior of neutron motion. The book begins with an overview of nuclear reactors, explains how nuclear energy is extracted from reactors, and explores the behavior of neutron density using reactivity functions. It also demonstrates the applicability of the Haar wavelet method and introduces the neutron diffusion concept to aid readers in understanding the complex behavior of average neutron motion. This text: Applies the effective analytical and numerical methods to obtain the solution for the NDE Determines the numerical solution for one-group delayed neutron FNPKE by the explicit finite difference method Provides the numerical solution for classical as well as fractional neutron point kinetic equations Proposes the Haar wavelet operational method (HWOM) to obtain the numerical approximate solution of the neutron point kinetic equation, and more Fractional Calculus with Applications for Nuclear Reactor Dynamics thoroughly and systematically presents the concepts of fractional calculus and emphasizes the relevance of its application to the nuclear reactor.
Fractional Dynamics and Control Jun 30 2022 Fractional Dynamics and Control provides a comprehensive overview of recent advances in the areas of nonlinear dynamics, vibration and control with analytical, numerical, and experimental results. This book provides an overview of recent discoveries in fractional control, delves into fractional variational principles and differential equations, and applies advanced techniques in fractional calculus to solving complicated mathematical and physical problems.Finally, this book also discusses the role that fractional order modeling can play in complex systems for engineering and science.
Fractional Dynamics Dec 05 2022 The book is devoted to recent developments in the theory of fractional calculus and its applications. Particular attention is paid to the applicability of this currently popular research field in various branches of pure and applied mathematics. In particular, the book focuses on the more recent results in mathematical physics, engineering applications, theoretical and applied physics as quantum mechanics, signal analysis, and in those relevant research fields where nonlinear dynamics occurs and several tools of nonlinear analysis are required. Dynamical processes and dynamical systems of fractional order attract researchers from many areas of sciences and technologies, ranging from mathematics and physics to computer science.
Fractional Calculus in Medical and Health Science May 06 2020 This book covers applications of fractional calculus used for medical and health science. It offers a collection of research articles built into chapters on classical and modern dynamical systems formulated by fractional differential equations describing human diseases and how to control them. The mathematical results included in the book will be helpful to mathematicians and doctors by enabling them to explain real-life problems accurately. The book will also offer case studies of real-life situations with an emphasis on describing the mathematical results and showing how to apply the results to medical and health science, and at the same time highlighting modeling strategies. The book will be useful to graduate level students, educators and researchers interested in mathematics and medical science.
Chaotic, Fractional, and Complex Dynamics: New Insights and Perspectives Oct 23 2021 The book presents nonlinear, chaotic and fractional dynamics, complex systems and networks, together with cutting-edge research on related topics. The fifteen chapters – written by leading scientists working in the areas of nonlinear, chaotic, and fractional dynamics, as well as complex systems and networks – offer an extensive overview of cutting-edge research on a range of topics, including fundamental and applied research. These include but are not limited to, aspects of synchronization in complex dynamical systems, universality features in systems with specific fractional dynamics, and chaotic scattering. As such, the book provides an excellent and timely snapshot of the current state of research, blending the insights and experiences of many prominent researchers.
Fractional Dynamics Dec 25 2021 "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.
Hamiltonian Chaos and Fractional Dynamics Feb 12 2021 The dynamics of realistic Hamiltonian systems has unusual microscopic features that are direct consequences of its fractional space-time structure and its phase space topology. The book deals with the fractality of the chaotic dynamics and kinetics, and also includes material on non-ergodic and non-well-mixing Hamiltonian dynamics. The book does not follow the traditional scheme of most of today's literature on chaos. The intention of the author has been to put together some of the most complex and yet open problems on the general theory of chaotic systems. The importance of the discussed issues and an understanding of their origin should inspire students and researchers to touch upon some of the deepest aspects of nonlinear dynamics. The book considers the basic principles of the Hamiltonian theory of chaos and some applications including for example, the cooling of particles and signals, control and erasing of chaos, polynomial complexity, Maxwell's Demon, and others. It presents a new and realistic image of the origin of dynamical chaos and randomness. An understanding of the origin of randomness in dynamical systems, which cannot be of the same origin as chaos, provides new insights in the diverse fields of physics, biology, chemistry, and engineering.
Economic Dynamics with Memory Feb 24 2022 This book presents the applications of fractional calculus, fractional operators of non-integer orders and fractional differential equations in describing economic dynamics with long memory. Generalizations of basic economic concepts, notions and methods for the economic processes with memory are suggested. New micro and macroeconomic models with continuous time are proposed to describe the fractional economic dynamics with long memory as well.
Hamiltonian Chaos and Fractional Dynamics Sep 02 2022 This book gives a realistic contemporary image of Hamiltonian dynamics, dealing with the basic principles of the Hamiltonian theory of chaos in addition to very recent and unusual applications of nonlinear dynamics and the fractality of dynamics.
Recent Advances in Applied Nonlinear Dynamics with Numerical Analysis Jan 02 2020 Nonlinear dynamics is still a hot and challenging topic. In this edited book, we focus on fractional dynamics, infinite dimensional dynamics defined by the partial differential equation, network dynamics, fractal dynamics, and their numerical analysis and simulation. Fractional dynamics is a new topic in the research field of nonlinear dynamics which has attracted increasing interest due to its potential applications in the real world, such as modeling memory processes and materials. In this part, basic theory for fractional differential equations and numerical simulations for these equations will be introduced and discussed. In the infinite dimensional dynamics part, we emphasize on numerical calculation and theoretical analysis, including constructing various numerical methods and computing the corresponding limit sets, etc. In the last part, we show interest in network dynamics and fractal dynamics together with numerical simulations as well as their applications. Contents:Gronwall Inequalities (Fanhai Zeng, Jianxiong Cao and Changpin Li)Existence and Uniqueness of the Solutions to the Fractional Differential Equations (Yutian Ma, Fengrong Zhang and Changpin Li)Finite Element Methods for Fractional Differential Equations (Changpin Li and Fanhai Zeng)Fractional Step Method for the Nonlinear Conservation Laws with Fractional Dissipation (Can Li and Weihua Deng)Error Analysis of Spectral Method for the Space and Time Fractional Fokker–Planck Equation (Tinggang Zhao and Haiyan Xuan)A Discontinuous Finite Element Method for a Type of Fractional Cauchy Problem (Yunying Zheng)Asymptotic Analysis of a Singularly Perturbed Parabolic Problem in a General Smooth Domain (Yu-Jiang Wu, Na Zhang and Lun-Ji Song)Incremental Unknowns Methods for the ADI and ADSI Schemes (Ai-Li Yang, Yu-Jiang Wu and Zhong-Hua Yang)Stability of a Collocated FV Scheme for the 3D Navier–Stokes Equations (Xu Li and Shu-qin Wang)Computing the Multiple Positive Solutions to p–Henon Equation on the Unit Square (Zhaoxiang Li and Zhonghua Yang)Multilevel WBIUs Methods for Reaction–Diffusion Equations (Yang Wang, Yu-Jiang Wu and Ai-Li Yang)Models and Dynamics of Deterministically Growing Networks (Weigang Sun, Jingyuan Zhang and Guanrong Chen)On Different Approaches to Synchronization of Spatiotemporal Chaos in Complex Networks (Yuan Chai and Li-Qun Chen)Chaotic Dynamical Systems on Fractals and Their Applications to Image Encryption (Ruisong Ye, Yuru Zou and Jian Lu)Planar Crystallographic Symmetric Tiling Patterns Generated From Invariant Maps (Ruisong Ye, Haiying Zhao and Yuanlin Ma)Complex Dynamics in a Simple Two-Dimensional Discrete System (Huiqing Huang and Ruisong Ye)Approximate Periodic Solutions of Damped Harmonic Oscillators with Delayed Feedback (Qian Guo)The Numerical Methods in Option Pricing Problem (Xiong Bo)Synchronization and Its Control Between Two Coupled Networks (Yongqing Wu and Minghai Lü) Readership: Senior undergraduates, postgraduates and experts in nonlinear dynamics with numerical analysis. Keywords:Fractional Dynamics;Infinite Dimensional Dynamics;Network Dynamics;Fractal DynamicsKey Features:The topics in this edited book are very hot and highly impressiveIssues and methods of such topics in this edited book have not been made available yetThe present edited book is suitable for various levels of researchers, such as senior undergraduates, postgraduates, and experts
Fractional Dynamics, Anomalous Transport and Plasma Science Mar 16 2021 This book collects interrelated lectures on fractal dynamics, anomalous transport and various historical and modern aspects of plasma sciences and technology. The origins of plasma science in connection to electricity and electric charges and devices leading to arc plasma are explored in the first contribution by Jean-Marc Ginoux and Thomas Cuff. The second important historic connection with plasmas was magnetism and the magnetron. Victor J. Law and Denis P. Dowling, in the second contribution, review the history of the magnetron based on the development of thermionic diode valves and related devices. In the third chapter, Christos H Skiadas and Charilaos Skiadas present and apply diffusion theory and solution strategies to a number of stochastic processes of interest. Anomalous diffusion by the fractional Fokker-Planck equation and Lévy stable processes are studied by Johan Anderson and Sara Moradi in the fourth contribution. They consider the motion of charged particles in a 3-dimensional magnetic field in the presence of linear friction and of a stochastic electric field. Analysis of low-frequency instabilities in a low-temperature magnetized plasma is presented by Dan-Gheorghe Dimitriu, Maricel Agop in the fifth chapter. The authors refer to experimental results of the Innsbruck Q-machine and provide an analytical formulation of the related theory. In chapter six, Stefan Irimiciuc, Dan-Gheorghe Dimitriu, Maricel Agop propose a theoretical model to explain the dynamics of charged particles in a plasma discharge with a strong flux of electrons from one plasma structure to another. The theory and applications of fractional derivatives in many-particle disordered large systems are explored by Z.Z. Alisultanov, A.M. Agalarov, A.A. Potapov, G.B. Ragimkhanov. In chapter eight, Maricel Agop, Alina Gavrilut ? and Gabriel Crumpei explore the motion of physical systems that take place on continuous but non-differentiable curves (fractal curves). Finally in the last chapter S.L. Cherkas and V.L. Kalashnikov consider the perturbations of a plasma consisting of photons, baryons, and electrons in a linearly expanding (Milne-like) universe taking into account the metric tensor and vacuum perturbations.
Advanced Applications of Fractional Differential Operators to Science and Technology Oct 11 2020 Fractional-order calculus dates to the 19th century but has been resurrected as a prevalent research subject due to its provision of more adequate and realistic descriptions of physical aspects within the science and engineering fields. What was once a classical form of mathematics is currently being reintroduced as a new modeling technique that engineers and scientists are finding modern uses for. There is a need for research on all facets of these fractional-order systems and studies of its potential applications. Advanced Applications of Fractional Differential Operators to Science and Technology provides emerging research exploring the theoretical and practical aspects of novel fractional modeling and related dynamical behaviors as well as its applications within the fields of physical sciences and engineering. Featuring coverage on a broad range of topics such as chaotic dynamics, ecological models, and bifurcation control, this book is ideally designed for engineering professionals, mathematicians, physicists, analysts, researchers, educators, and students seeking current research on fractional calculus and other applied mathematical modeling techniques.
Applications of Fractional Calculus to Modeling in Dynamics and Chaos Jun 18 2021 Applications of Fractional Calculus to Modeling in Dynamics and Chaos aims to present novel developments, trends, and applications of fractional-order derivatives with power law and Mittag-Leffler kernel in the areas of chemistry, mechanics, chaos, epidemiology, fluid mechanics, modeling, and engineering. Non-singular and non-local fractional-order derivatives have been applied in different chapters to describe complex problems. The book offers theory and practical applications for the solutions of real-life problems and will be of interest to graduate-level students, educators, researchers, and scientists interested in mathematical modeling and its diverse applications. Features Discusses real-world problems, theory, and applications Covers new developments and advances in the various areas of nonlinear dynamics, signal processing, and chaos Suitable to teach master's and/or PhD-level graduate students, and can be used by researchers, from any field of the social, health, and physical sciences
Fault-tolerant Control and Diagnosis for Interger and Fractional-order Systems Jul 08 2020 This book is about algebraic and differential methods, as well as fractional calculus, applied to diagnose and reject faults in nonlinear systems, which are of integer or fractional order. This represents an extension of a very important and widely studied problem in control theory, namely fault diagnosis and rejection (using differential algebraic approaches), to systems presenting fractional dynamics, i.e. systems whose dynamics are represented by derivatives and integrals of non-integer order. The authors offer a thorough overview devoted to fault diagnosis and fault-tolerant control applied to fractional-order and integer-order dynamical systems, and they introduce new methodologies for control and observation described by fractional and integer models, together with successful simulations and real-time applications. The basic concepts and tools of mathematics required to understand the methodologies proposed are all clearly introduced and explained. Consequently, the book is useful as supplementary reading in courses of applied mathematics and nonlinear control theory. This book is meant for engineers, mathematicians, physicists and, in general, to researchers and postgraduate students in diverse areas who have a minimum knowledge of calculus. It also contains advanced topics for researchers and professionals interested in the area of states and faults estimation.
Topics in Fractional Differential Equations Dec 13 2020 ??? Topics in Fractional Differential Equations is devoted to the existence and uniqueness of solutions for various classes of Darboux problems for hyperbolic differential equations or inclusions involving the Caputo fractional derivative. ??Fractional calculus generalizes the integrals and derivatives to non-integer orders. During the last decade, fractional calculus was found to play a fundamental role in the modeling of a considerable number of phenomena; in particular the modeling of memory-dependent and complex media such as porous media. It has emerged as an important tool for the study of dynamical systems where classical methods reveal strong limitations. Some equations present delays which may be finite, infinite, or state-dependent. Others are subject to an impulsive effect. The above problems are studied using the fixed point approach, the method of upper and lower solution, and the Kuratowski measure of noncompactness. This book is addressed to a wide audience of specialists such as mathematicians, engineers, biologists, and physicists. ?
Fractional Dynamics and Control Oct 03 2022 Fractional Dynamics and Control provides a comprehensive overview of recent advances in the areas of nonlinear dynamics, vibration and control with analytical, numerical, and experimental results. This book provides an overview of recent discoveries in fractional control, delves into fractional variational principles and differential equations, and applies advanced techniques in fractional calculus to solving complicated mathematical and physical problems.Finally, this book also discusses the role that fractional order modeling can play in complex systems for engineering and science.

Fractional Order Crowd Dynamics Mar 28 2022 This book illustrates the application of fractional calculus in crowd dynamics via modeling and control groups of pedestrians. Decision-making processes, conservation laws of mass/momentum, and micro-macro models are employed to describe system dynamics while cooperative movements in micro scale, and fractional diffusion in macro scale are studied to control the group of pedestrians. Obtained work is included in the Intelligent Evacuation Systems that is used for modeling and to control crowds of pedestrians. With practical issues considered, this book is of interests to mathematicians, physicists, and engineers.
Theory and Applications of Fractional Differential Equations Jun 06 2020 This work aims to present, in a systematic manner, results including the existence and uniqueness of solutions for the Cauchy Type and Cauchy problems involving nonlinear ordinary fractional differential equations.
Fractional Dynamics Jan 06 2023 "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.
Fault-tolerant Control and Diagnosis for Integer and Fractional-order Systems May 30 2022 This book is about algebraic and differential methods, as well as fractional calculus, applied to diagnose and reject faults in nonlinear systems, which are of integer or fractional order. This represents an extension of a very important and widely studied problem in control theory, namely fault diagnosis and rejection (using differential algebraic approaches), to systems presenting fractional dynamics, i.e. systems whose dynamics are represented by derivatives and integrals of non-integer order. The authors offer a thorough overview devoted to fault diagnosis and fault-tolerant control applied to fractional-order and integer-order dynamical systems, and they introduce new methodologies for control and observation described by fractional and integer models, together with successful simulations and real-time applications. The basic concepts and tools of mathematics required to understand the methodologies proposed are all clearly introduced and explained. Consequently, the book is useful as supplementary reading in courses of applied mathematics and nonlinear control theory. This book is meant for engineers, mathematicians, physicists and, in general, to researchers and postgraduate students in diverse areas who have a minimum knowledge of calculus. It also contains advanced topics for researchers and professionals interested in the area of states and faults estimation.
Long-range Interactions, Stochasticity and Fractional Dynamics Jan 14 2021 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.
Mathematical Economics Apr 16 2021 This book is devoted to the application of fractional calculus in economics to describe processes with memory and non-locality. Fractional calculus is a branch of mathematics that studies the properties of differential and integral operators that are characterized by real or complex orders. Fractional calculus methods are powerful tools for describing the processes and systems with memory and nonlocality. Recently, fractional integro-differential equations have been used to describe a wide class of economical processes with power law memory and spatial nonlocality. Generalizations of basic economic concepts and notions the economic processes with memory were proposed. New mathematical models with continuous time are proposed to describe economic dynamics with long memory. This book is a collection of articles reflecting the latest mathematical and conceptual developments in mathematical economics with memory and non-locality based on applications of fractional calculus.
Fractional Order Systems Nov 11 2020 Fractional Order Systems: An Overview of Mathematics, Design, and Applications for Engineers introduces applications from a design perspective, helping readers plan and design their own applications. The book includes the different techniques employed to design fractional-order systems/devices comprehensively and straightforwardly. Furthermore, mathematics is available in the literature on how to solve fractional-order calculus for system applications. This book introduces the mathematics that has been employed explicitly for fractional-order systems. It will prove an excellent material for students and scholars who want to quickly understand the field of fractional-order systems and contribute to its different domains and applications. Fractional-order systems are believed to play an essential role in our day-to-day activities. Therefore, several researchers around the globe endeavor to work in the different domains of fractional-order systems. The efforts include developing the mathematics to solve fractional-order calculus/systems and to achieve the feasible designs for various applications of fractional-order systems. Presents a simple and comprehensive understanding of the field of fractional-order systems Offers practical knowledge on the design of fractional-order systems for different applications Exposes users to possible new applications for fractional-order systems
Fractional Dynamics on Networks and Lattices Aug 21 2021 This book analyzes stochastic processes on networks and regular structures such as lattices by employing the Markovian random walk approach. Part 1 is devoted to the study of local and non-local random walks. It shows how non-local random walk strategies can be defined by functions of the Laplacian matrix that maintain the stochasticity of the transition probabilities. A major result is that only two types of functions are admissible: type (i) functions generate asymptotically local walks with the emergence of Brownian motion, whereas type (ii) functions generate asymptotically scale-free non-local “fractional” walks with the emergence of Lévy flights. In Part 2, fractional dynamics and Lévy flight behavior are analyzed thoroughly, and a generalization of Pólya's classical recurrence theorem is developed for fractional walks. The authors analyze primary fractional walk characteristics such as the mean occupation time, the mean first passage time, the fractal scaling of the set of distinct nodes visited, etc. The results show the improved search capacities of fractional dynamics on networks.