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An Introduction to Fractional Control IET *An Introduction to Fractional Control outlines the theory, techniques and applications of fractional control.* **Intelligent Fractional Order Systems and Control An Introduction** Springer *Fractional order calculus is finding increasing interest in the control system community. Hardware realizations of fractional order controllers have sparked off a renewed zeal into the investigations of control system design in the light of fractional calculus. As such many notions of integer order LTI systems are being modified and extended to incorporate these new concepts. Computational Intelligence (CI) techniques have been applied to engineering problems to find solutions to many hitherto intractable conundrums and is a useful tool for dealing with problems of higher computational complexity. This book borders on the interface between CI techniques and fractional calculus, and looks at ways in which fractional order control systems may be designed or enhanced using CI based paradigms. To the best of the author's knowledge this is the first book of its kind exclusively dedicated to the application of computational intelligence techniques in fractional order systems and control. The book tries to assimilate various existing concepts in this nascent field of fractional order intelligent control and is aimed at researchers and post graduate students working in this field.* **Fractional Order Systems--Control Theory and Applications Fundamentals and Applications** Springer Nature *This book aims to bring together the latest innovative knowledge, analysis, and synthesis of fractional control problems of nonlinear systems as well as some related applications. Fractional order systems (FOS) are dynamical systems that can be modelled by a fractional differential equation carried with a non-integer derivative. In the last few decades, the growth of science and engineering systems has considerably stimulated the employment of fractional calculus in many subjects of control theory, for example, in stability, stabilization, controllability, observability, observer design, and fault estimation. The application of control theory in FOS is an important issue in many engineering applications. So, to accurately describe these systems, the fractional order differential equations have been introduced.* **Fractional-order Systems and Controls Fundamentals and Applications** Springer Science & Business Media *Fractional-order Systems and Controls details the use of fractional calculus in the description and modeling of systems, and in a range of control design and practical applications. It is largely self-contained, covering the fundamentals of fractional calculus together with some analytical and numerical techniques and providing MATLAB® codes for the simulation of fractional-order control (FOC) systems. Many different FOC schemes are presented for control and dynamic systems problems. Practical material relating to a wide variety of applications is also provided. All the control schemes and applications are presented in the monograph with either system simulation results or real experimental results, or both. Fractional-order Systems and Controls provides readers with a basic understanding of FOC concepts and methods, so they 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.* **Fractional-Order Control Systems Fundamentals and Numerical Implementations** Walter de Gruyter GmbH & Co KG *This book explains the essentials of fractional calculus and demonstrates its application in control system modeling, analysis and design. It presents original research to find high-precision solutions to fractional-order differentiations and differential equations. Numerical algorithms and their implementations are proposed to analyze multivariable fractional-order control systems. Through high-quality MATLAB programs, it provides engineers and applied mathematicians with theoretical and numerical tools to design control systems. Contents Introduction to fractional calculus and fractional-order control Mathematical prerequisites Definitions and computation algorithms of fractional-order derivatives and Integrals Solutions of linear fractional-order differential equations Approximation of fractional-order operators Modelling and analysis of multivariable fractional-order transfer function Matrices State space modelling and analysis of linear fractional-order Systems Numerical solutions of nonlinear fractional-order differential Equations Design of fractional-order PID controllers Frequency domain controller design for multivariable fractional-order Systems Inverse Laplace transforms involving fractional and irrational Operations FOTF Toolbox functions and models Benchmark problems for the assessment of fractional-order differential equation algorithms* **Fractional-order Systems and PID Controllers Using Scilab and Curve Fitting Based Approximation Techniques** Springer Nature *This book presents a detailed study on fractional-order, set-point, weighted PID control strategies and the development of curve-fitting-based approximation techniques for fractional-order parameters. Furthermore, in all the cases, it includes the Scilab-based commands and functions for easy implementation and better understanding, and to appeal to a wide range of readers working with the software. The presented Scilab-based toolbox is the first toolbox for fractional-order systems developed in open-source software. The toolboxes allow time and frequency domains as well as stability analysis of the fractional-order systems and controllers. The book also provides real-time examples of the control of process plants*

using the developed fractional-order based PID control strategies and the approximation techniques. The book is of interest to readers in the areas of fractional-order controllers, approximation techniques, process modeling, control, and optimization, both in industry and academia. In industry, the book is particularly valuable in the areas of research and development (R&D) as well as areas where PID controllers suffice – and it should be noted that around 80% of low-level controllers in industry are PID based. The book is also useful where conventional PIDs are constrained, such as in industries where long-term delay and non-linearity are present. Here it can be used for the design of controllers for real-time processes. The book is also a valuable teaching and learning resource for undergraduate and postgraduate students. **Fractional-order Modeling and Control of Dynamic Systems** Springer This book reports on an outstanding research devoted to modeling and control of dynamic systems using fractional-order calculus. It describes the development of model-based control design methods for systems described by fractional dynamic models. More than 300 years had passed since Newton and Leibniz developed a set of mathematical tools we now know as calculus. Ever since then the idea of non-integer derivatives and integrals, universally referred to as fractional calculus, has been of interest to many researchers. However, due to various issues, the usage of fractional-order models in real-life applications was limited. Advances in modern computer science made it possible to apply efficient numerical methods to the computation of fractional derivatives and integrals. This book describes novel methods developed by the author for fractional modeling and control, together with their successful application in real-world process control scenarios. **Fractional-Order Nonlinear Systems Modeling, Analysis and Simulation** Springer Science & Business Media "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. **Fractional Order Systems Modeling and Control Applications** World Scientific This book aims to propose implementations and applications of Fractional Order Systems (FOS). It is well known that FOS can be applied in control applications and systems modeling, and their effectiveness has been proven in many theoretical works and simulation routines. A further and mandatory step for FOS real world utilization is their hardware implementation and applications on real systems modeling. With this viewpoint, introductory chapters on FOS are included, on the definition of stability region of Fractional Order PID Controller and Chaotic FOS, followed by the practical implementation based on Microcontroller, Field Programmable Gate Array, Field Programmable Analog Array and Switched Capacitor. Another section is dedicated to FO modeling of Ionic Polymeric Metal Composite (IPMC). This new material may have applications in robotics, aerospace and biomedicine. **Robust Adaptive Control for Fractional-Order Systems with Disturbance and Saturation** John Wiley & Sons A treatise on investigating tracking control and synchronization control of fractional-order nonlinear systems with system uncertainties, external disturbance, and input saturation Robust Adaptive Control for Fractional-Order Systems, with Disturbance and Saturation provides the reader with a good understanding on how to achieve tracking control and synchronization control of fractional-order nonlinear systems with system uncertainties, external disturbance, and input saturation. Although some texts have touched upon control of fractional-order systems, the issues of input saturation and disturbances have rarely been considered together. This book offers chapter coverage of fractional calculus and fractional-order systems; fractional-order PID controller and fractional-order disturbance observer; design of fractional-order controllers for nonlinear chaotic systems and some applications; sliding mode control for fractional-order nonlinear systems based on disturbance observer; disturbance observer based neural control for an uncertain fractional-order rotational mechanical system; adaptive neural tracking control for uncertain fractional-order chaotic systems subject to input saturation and disturbance; stabilization control of continuous-time fractional positive systems based on disturbance observer; sliding mode synchronization control for fractional-order chaotic systems with disturbance; and more. Based on the approximation ability of the neural network (NN), the adaptive neural control schemes are reported for uncertain fractional-order nonlinear systems Covers the disturbance estimation techniques that have been developed to alleviate the restriction faced by traditional feedforward control and reject the effect of external disturbances for uncertain fractional-order nonlinear systems By combining the NN with the disturbance observer, the disturbance observer based adaptive neural control schemes have been studied for uncertain fractional-order nonlinear systems with unknown disturbances Considers, together, the issue of input saturation and the disturbance for the control of fractional-order nonlinear systems in the present of system uncertainty, external disturbance, and input saturation Robust Adaptive Control for Fractional-Order Systems, with Disturbance and Saturation can be used as a reference for the academic research on fractional-order nonlinear systems or used in Ph.D. study of control theory and engineering. **Fractional Order Systems Fractional Order Motion Controls** John Wiley & Sons Covering fractional order theory, simulation and experiments, this book explains how fractional order modelling and fractional order controller design compares favourably with traditional velocity and position control systems. The authors systematically compare the two approaches using applied fractional calculus. Stability theory in fractional order controllers design is also analysed. Presents material suitable for a variety of real-world applications, including hard disk drives, vehicular controls, robot control and micropositioners in DNA microarray analysis Includes extensive experimental results from both lab bench level tests and industrial level, mass-production-ready implementations Covers detailed derivations and numerical simulations for each case Discusses feasible design specifications, ideal for practicing engineers The book also covers key topics including: fractional order disturbance cancellation and adaptive learning control studies for external disturbances; optimization approaches for nonlinear system control and design schemes with backlash and friction. Illustrations and experimental validations are included for each of the proposed control schemes to enable readers to develop a clear understanding of the approaches covered, and move on to

apply them in real-world scenarios. **Image-Based and Fractional-Order Control for Mechatronic Systems Theory and Applications with MATLAB®** Springer Nature This book unites two fast-developing forms of control—vision-based control and fractional-order control—and applies them in mechatronic systems. Image-Based and Fractional-Order Control for Mechatronic Systems is presented in two parts covering the theory and applications of the subject matter. The theoretical material presents the concepts of visual servoing and image-based feature extraction for feedback loops and fractional-order control. It discusses a range of systems from the classic monocular camera to new RGB-D sensors. The applications part of the book first discusses practical issues with the implementation of fractional-order control, comparing them with more traditional integer-order PID systems. The authors then introduce real-life examples such as a manipulator robot and a Stewart platform and results generated from such systems. MATLAB® functions and source codes are included wherever relevant to help readers develop simulations based on the theoretical ideas and practical examples in the text. Suggestions for the use of other pertinent open-source software are also indicated with the places where such may be obtained. With its combination of theoretical ideas and practical examples, Image-Based and Fractional-Order Control for Mechatronic Systems will be of interest to academic researchers looking to develop the fields of vision-based and fractional-order control and to engineers who are looking for developments that will help them provide closer control of their plants than can be achieved with integer-order PID. Advances in Industrial Control reports and encourages the transfer of technology in control engineering. The rapid development of control technology has an impact on all areas of the control discipline. The series offers an opportunity for researchers to present an extended exposition of new work in all aspects of industrial control. **Fractional Order Motion Controls** John Wiley & Sons Covering fractional order theory, simulation and experiments, this book explains how fractional order modelling and fractional order controller design compares favourably with traditional velocity and position control systems. The authors systematically compare the two approaches using applied fractional calculus. Stability theory in fractional order controllers design is also analysed. Presents material suitable for a variety of real-world applications, including hard disk drives, vehicular controls, robot control and micropositioners in DNA microarray analysis Includes extensive experimental results from both lab bench level tests and industrial level, mass-production-ready implementations Covers detailed derivations and numerical simulations for each case Discusses feasible design specifications, ideal for practicing engineers The book also covers key topics including: fractional order disturbance cancellation and adaptive learning control studies for external disturbances; optimization approaches for nonlinear system control and design schemes with backlash and friction. Illustrations and experimental validations are included for each of the proposed control schemes to enable readers to develop a clear understanding of the approaches covered, and move on to apply them in real-world scenarios. **Fractional-Order Modeling of Dynamic Systems with Applications in Optimization, Signal Processing, and Control** Academic Press Fractional-order Modelling of Dynamic Systems with Applications in Optimization, Signal Processing and Control 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 Order Signal Processing Introductory Concepts and Applications** Springer Science & Business Media The book tries to briefly introduce the diverse literatures in the field of fractional order signal processing which is becoming an emerging topic among an interdisciplinary community of researchers. This book is aimed at postgraduate and beginning level research scholars who would like to work in the field of Fractional Order Signal processing (FOSP). The readers should have preliminary knowledge about basic signal processing techniques. Prerequisite knowledge of fractional calculus is not essential and is expounded at relevant places in connection to the appropriate signal processing topics. Basic signal processing techniques like filtering, estimation, system identification, etc. in the light of fractional order calculus are presented along with relevant application areas. The readers can easily extend these concepts to varied disciplines like image or speech processing, pattern recognition, time series forecasting, financial data analysis and modeling, traffic modeling in communication channels, optics, biomedical signal processing, electrochemical applications and many more. Adequate references are provided in each category so that the researchers can delve deeper into each area and broaden their horizon of understanding. Available MATLAB tools to simulate FOSP theories are also introduced so that the readers can apply the theoretical concepts right-away and gain practical insight in the specific domain. **Modern Sliding Mode Control Theory New Perspectives and Applications** Springer Science & Business Media This concise book covers modern sliding mode control theory. The authors identify key contributions defining the theoretical and applicative state-of-the-art of the sliding mode control theory and the most promising trends of the ongoing research activities. **Fault-tolerant Control and Diagnosis for Integer and Fractional-order Systems Fundamentals of Fractional Calculus and Differential Algebra with Real-Time Applications** Springer Nature 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. **Nonlinear Differential Equations and Dynamical Systems Theory and Applications** [MDPI](#) This Special Edition contains new results on Differential and Integral Equations and Systems, covering higher-order Initial and Boundary Value Problems, fractional differential and integral equations and applications, non-local optimal control, inverse, and higher-order nonlinear boundary value problems, distributional solutions in the form of a finite series of the Dirac delta function and its derivatives, asymptotic properties' oscillatory theory for neutral nonlinear differential equations, the existence of extremal solutions via monotone iterative techniques, predator-prey interaction via fractional-order models, among others. Our main goal is not only to show new trends in this field but also to showcase and provide new methods and techniques that can lead to future research. **Fractional Order Systems An Overview of Mathematics, Design, and Applications for Engineers** [Academic Press](#) 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-Order Electrical Circuit Theory** [Springer Nature](#) This book presents a concise and insightful view of the knowledge on fractional-order electrical circuits, which belongs to the subject of Electric Engineering and involves mathematics of fractional calculus. It offers an overview of fractional calculus and then describes and analyzes the basic theories and properties of fractional-order elements and fractional-order electrical circuit composed of fractional-order elements. Therein, the fundamental theorems, time-domain analysis, steady-state analysis, complex frequency domain analysis and state variable analysis of fractional-order electrical circuit are included. The fractional-order two-port networks and generalized fractional-order linear electrical circuits are also mentioned. Therefore, this book provides readers with enough background and understanding to go deeper into the topic of fractional-order electrical circuit, so that it is useful as a textbook for courses related to fractional-order elements, fractional-order electrical circuits, etc. This book is intended for students without an extensive mathematical background and is suitable for advanced undergraduate and graduate students, engineers and researchers who focus on the fractional-order elements, electrical circuits and systems. **Fuzzy Information and Engineering and Decision** [Springer](#) This book introduces applications of mathematics and fuzzy mathematics in decision science, fuzzy geometric programming and fuzzy optimization as well as operations research and management, based on 44 research papers presented at three successful conferences: (1) The International Conference on Mathematics and Decision Science (ICMDS), September 12–15, 2016, Guangzhou University, Guangzhou, China (www.icodm2020.com). (2) Academic Conference on 30th Anniversary of Fuzzy Geometric Programming Advanced by Professor Cao Bingyuan and his 40 education years (ACFGPACE), July 30 to August 1, 2016, Guangzhou University, Guangzhou, China. (3) The third annual meeting of Guangdong Operational Research Society (TAMGORS), October 22–23, 2016, Foshan University, Guangdong, China. The book is a valuable resource for students, graduates, teachers and other professionals in the field of applied mathematics, artificial intelligence and computers, fuzzy systems and decision-making, as well as operations research and management. **Automation 2021: Recent Achievements in Automation, Robotics and Measurement Techniques** [Springer Nature](#) This book contains 38 papers authored by both scientists and practitioners focused on an interdisciplinary approach to the development of cyber-physical systems. Recently our civilization has been facing one of the most severe challenges in modern history. The COVID-19 pandemic devastated the global economy and significantly disrupted numerous areas of economic activity. Only radical increase of efficiency and versatility of industrial production, with further limitation of human involvement, paralleled by the decrease of environmental burden, will enable us to cope with such challenges. We hope that the presented book provides input to the solution of at least some problems brought about by this challenge. This approach relies on the development of measuring techniques, robotic and mechatronic systems, industrial automation, numerical modeling and simulation as well as application of artificial intelligence techniques required by the transformation leading to Industry 4.0. **Recent Advances in Electrical Engineering and Control Applications** [Springer](#) This book of proceedings includes papers presenting the state of art in electrical engineering and control theory as well as their applications. The topics focus on classical as well as modern methods for modeling, control, identification and simulation of complex systems with applications in science and engineering. The papers were selected from the hottest topic areas, such as control and systems engineering, renewable energy, faults diagnosis—faults tolerant control, large-scale systems, fractional order systems, unconventional algorithms in control engineering, signals and communications. The control and design of complex systems dynamics, analysis and modeling of its behavior and structure is vitally important in engineering, economics and in science generally science today. Examples of such systems can be seen in the world around us and are a part of our everyday life. Application of modern methods for control, electronics, signal processing and more can be found in our mobile phones, car engines, home devices like washing machines is as well as in such advanced devices as space probes and systems for communicating with them. All these technologies are part of technological backbone of our civilization, making further research and hi-tech applications essential. The rich variety of contributions appeals to a wide audience, including researchers, students and academics. **Fractional Processes and Fractional-Order Signal Processing Techniques and Applications** [Springer Science & Business Media](#) Fractional processes are widely found in science, technology and engineering systems. In Fractional Processes and Fractional-order Signal Processing, some complex random signals, characterized by the presence of a heavy-tailed distribution or non-negligible dependence between distant observations (local and long memory), are introduced and examined from the 'fractional'

perspective using simulation, fractional-order modeling and filtering and realization of fractional-order systems. These fractional-order signal processing (FOSP) techniques are based on fractional calculus, the fractional Fourier transform and fractional lower-order moments. *Fractional Processes and Fractional-order Signal Processing*: presents fractional processes of fixed, variable and distributed order studied as the output of fractional-order differential systems; introduces FOSP techniques and the fractional signals and fractional systems point of view; details real-world-application examples of FOSP techniques to demonstrate their utility; and provides important background material on Mittag-Leffler functions, the use of numerical inverse Laplace transform algorithms and supporting MATLAB® codes together with a helpful survey of relevant webpages. Readers will be able to use the techniques presented to re-examine their signals and signal-processing methods. This text offers an extended toolbox for complex signals from diverse fields in science and engineering. It will give academic researchers and practitioners a novel insight into the complex random signals characterized by fractional properties, and some powerful tools to analyze those signals. **Distributed-Order Dynamic Systems Stability, Simulation, Applications and Perspectives** Springer Science & Business Media

Distributed-order differential equations, a generalization of fractional calculus, are of increasing importance in many fields of science and engineering from the behaviour of complex dielectric media to the modelling of nonlinear systems. This Brief will broaden the toolbox available to researchers interested in modeling, analysis, control and filtering. It contains contextual material outlining the progression from integer-order, through fractional-order to distributed-order systems. Stability issues are addressed with graphical and numerical results highlighting the fundamental differences between constant-, integer-, and distributed-order treatments. The power of the distributed-order model is demonstrated with work on the stability of noncommensurate-order linear time-invariant systems. Generic applications of the distributed-order operator follow: signal processing and viscoelastic damping of a mass-spring set up. A new general approach to discretization of distributed-order derivatives and integrals is described. The Brief is rounded out with a consideration of likely future research and applications and with a number of MATLAB® codes to reduce repetitive coding tasks and encourage new workers in distributed-order systems. **Theory and Applications of Non-integer Order Systems 8th Conference on Non-integer Order Calculus and Its Applications, Zakopane, Poland** Springer This book collects papers from the 8th Conference on Non-Integer Order Calculus and Its Applications that have been held on September 20-21, 2016 in Zakopane, Poland. The preceding two conferences were held in Szczecin, Poland in 2015, and in Opole, Poland, in 2014. This conference provides a platform for academic exchange on the theory and application of fractional calculus between domestic and international universities, research institutes, corporate experts and scholars. The *Proceedings of the 8th Conference on Non-Integer Order Calculus and Its Applications 2016* brings together rigorously reviewed contributions from leading international experts. The included papers cover novel various important aspects of mathematical foundations of fractional calculus, modeling and control of fractional systems as well as controllability, detectability, observability and stability problems for this systems. **Functional Fractional Calculus for System Identification and Controls** Springer Science & Business Media In this book, not only are mathematical abstractions discussed in a lucid manner, but also several practical applications are given particularly for system identification, description and then efficient controls. The reader gets a feeling of the wide applicability of fractional calculus in the field of science and engineering. With this book, a starter can understand the concepts of this emerging field with a minimal effort and basic mathematics. **Mathematical Treatment of Nanomaterials and Neural Networks** Frontiers Media SA **Mathematical Topics on Modelling Complex Systems In Memory of Professor Valentin Afraimovich** Springer Nature This book explores recent developments in theoretical research and mathematical modelling of real-world complex systems, organized in four parts. The first part of the book is devoted to the mathematical tools for the design and analysis in engineering and social science study cases. We discuss the periodic evolutions in nonlinear chemical processes, vibro-compact systems and their behaviour, different types of metal-semiconductor self-assembled samples, made of silver nanowires and zinc oxide nanorods. The second part of the book is devoted to mathematical description and modelling of the critical events, climate change and robust emergency scales. In three chapters, we consider a climate-economy model with endogenous carbon intensity and the behaviour of Tehran Stock Exchange market under international sanctions. The third part of the book is devoted to fractional dynamic and fractional control problems. We discuss the novel operational matrix technique for variable-order fractional optimal control problems, the nonlinear variable-order time fractional convection-diffusion equation with generalized polynomials The fourth part of the book concerns solvability and inverse problems in differential and integro-differential equations. The book facilitates a better understanding of the mechanisms and phenomena in nonlinear dynamics and develops the corresponding mathematical theory to apply nonlinear design to practical engineering. It can be read by mathematicians, physicists, complex systems scientists, IT specialists, civil engineers, data scientists and urban planners. **Fractional Order Control and Synchronization of Chaotic Systems** Springer The book reports on the latest advances in and applications of fractional order control and synchronization of chaotic systems, explaining the concepts involved in a clear, matter-of-fact style. It consists of 30 original contributions written by eminent scientists and active researchers in the field that address theories, methods and applications in a number of research areas related to fractional order control and synchronization of chaotic systems, such as: fractional chaotic systems, hyperchaotic systems, complex systems, fractional order discrete chaotic systems, chaos control, chaos synchronization, jerk circuits, fractional chaotic systems with hidden attractors, neural network, fuzzy logic controllers, behavioral modeling, robust and adaptive control, sliding mode control, different types of synchronization, circuit realization of chaotic systems, etc. In addition to providing readers extensive information on chaos fundamentals, fractional calculus, fractional differential equations, fractional control and stability, the book also discusses key applications of fractional order chaotic systems, as well as multidisciplinary solutions developed via control modeling. As such, it offers the perfect reference guide for graduate students, researchers and practitioners in the areas of fractional order control systems and fractional order chaotic systems. **Stabilization and Control of Fractional Order Systems: A Sliding Mode Approach** Springer In the last two decades fractional differential equations have been used more frequently in physics, signal processing, fluid mechanics, viscoelasticity, mathematical biology, electro chemistry and many others. It opens a new and more realistic way to capture memory dependent phenomena and irregularities inside the systems by using more sophisticated mathematical analysis. This monograph is based on the authors' work on stabilization and control design for continuous and discrete fractional order systems. The initial two chapters and some parts of the third chapter are written in tutorial

fashion, presenting all the basic concepts of fractional order system and a brief overview of sliding mode control of fractional order systems. The other parts contain deal with robust finite time stability of fractional order systems, integral sliding mode control of fractional order systems, co-operative control of multi-agent systems modeled as fractional differential equation, robust stabilization of discrete fractional order systems, high performance control using soft variable structure control and contraction analysis by integer and fractional order infinitesimal variations.

Fractional Differential Equations An Introduction to Fractional Derivatives, Fractional Differential Equations, to Methods of Their Solution and Some of Their Applications Elsevier This book is a landmark title in the continuous move from integer to non-integer in mathematics: from integer numbers to real numbers, from factorials to the gamma function, from integer-order models to models of an arbitrary order. For historical reasons, the word 'fractional' is used instead of the word 'arbitrary'. This book is written for readers who are new to the fields of fractional derivatives and fractional-order mathematical models, and feel that they need them for developing more adequate mathematical models. In this book, not only applied scientists, but also pure mathematicians will find fresh motivation for developing new methods and approaches in their fields of research. A reader will find in this book everything necessary for the initial study and immediate application of fractional derivatives fractional differential equations, including several necessary special functions, basic theory of fractional differentiation, uniqueness and existence theorems, analytical numerical methods of solution of fractional differential equations, and many inspiring examples of applications. A unique survey of many applications of fractional calculus Presents basic theory Includes a unified presentation of selected classical results, which are important for applications Provides many examples Contains a separate chapter of fractional order control systems, which opens new perspectives in control theory The first systematic consideration of Caputo's fractional derivative in comparison with other selected approaches Includes tables of fractional derivatives, which can be used for evaluation of all considered types of fractional derivatives

Fractional-Order Design Devices, Circuits, and Systems Academic Press Fractional-Order Design: Devices, Circuits, and Systems introduces applications from the design perspective so that the reader can learn about, and get ready to, design these applications. The book also includes the different techniques employed to comprehensively and straightforwardly design fractional-order systems/devices. Furthermore, a lot of mathematics is available in the literature for solving the fractional-order calculus for system application. However, a small portion is employed in the design of fractional-order systems. This book introduces the mathematics that has been employed explicitly for fractional-order systems. Students and scholars who wants to quickly understand the field of fractional-order systems and contribute to its different domains and applications will find this book a welcomed resource. 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 the possible new areas of applications of fractional-order systems

Advances in Robust Fractional Control Springer This monograph presents design methodologies for (robust) fractional control systems. It shows the reader how to take advantage of the superior flexibility of fractional control systems compared with integer-order systems in achieving more challenging control requirements. There is a high degree of current interest in fractional systems and fractional control arising from both academia and industry and readers from both milieus are catered to in the text. Different design approaches having in common a trade-off between robustness and performance of the control system are considered explicitly. The text generalizes methodologies, techniques and theoretical results that have been successfully applied in classical (integer) control to the fractional case. The first part of Advances in Robust Fractional Control is the more industrially oriented. It focuses on the design of fractional controllers for integer processes. In particular, it considers fractional-order proportional-integral-derivative controllers, because integer-order PID regulators are, undoubtedly, the controllers most frequently adopted in industry. The second part of the book deals with a more general approach to fractional control systems, extending techniques (such as H-infinity optimal control and optimal input-output inversion based control) originally devised for classical integer-order control. Advances in Robust Fractional Control will be a useful reference for the large number of academic researchers in fractional control, for their industrial counterparts and for graduate students who want to learn more about this subject.

Intelligent Systems Design and Applications 18th International Conference on Intelligent Systems Design and Applications (ISDA 2018) held in Vellore, India, December 6-8, 2018, Volume 1 Springer This book highlights recent research on Intelligent Systems and Nature Inspired Computing. It presents 212 selected papers from the 18th International Conference on Intelligent Systems Design and Applications (ISDA 2018) and the 10th World Congress on Nature and Biologically Inspired Computing (NaBIC), which was held at VIT University, India. ISDA-NaBIC 2018 was a premier conference in the field of Computational Intelligence and brought together researchers, engineers and practitioners whose work involved intelligent systems and their applications in industry and the "real world." Including contributions by authors from over 40 countries, the book offers a valuable reference guide for all researchers, students and practitioners in the fields of Computer Science and Engineering.

Iterative Learning Control for Equations with Fractional Derivatives and Impulses Springer This book introduces iterative learning control (ILC) and its applications to the new equations such as fractional order equations, impulsive equations, delay equations, and multi-agent systems, which have not been presented in other books on conventional fields. ILC is an important branch of intelligent control, which is applicable to robotics, process control, and biological systems. The fractional version of ILC updating laws and formation control are presented in this book. ILC design for impulsive equations and inclusions are also established. The broad variety of achieved results with rigorous proofs and many numerical examples make this book unique. This book is useful for graduate students studying ILC involving fractional derivatives and impulsive conditions as well as for researchers working in pure and applied mathematics, physics, mechanics, engineering, biology, and related disciplines.

Advanced Synchronization Control and Bifurcation of Chaotic Fractional-Order Systems IGI Global In the recent years, fractional-order systems have been studied by many researchers in the engineering field. It was found that many systems can be described more accurately by fractional differential equations than by integer-order models. Advanced Synchronization Control and Bifurcation of Chaotic Fractional-Order Systems is a scholarly publication that explores new developments related to novel chaotic fractional-order systems, control schemes, and their applications. Featuring coverage on a wide range of topics including chaos synchronization, nonlinear control, and cryptography, this publication is geared toward engineers, IT professionals, researchers, and upper-level graduate students seeking current research on chaotic fractional-order systems and their applications in engineering and computer science.

International Conference on

Mechanism Science and Control Engineering (MSCE 2014) [DEStech Publications, Inc](#) *The aim of MSCE 2014 is to provide a platform for researchers, engineers, and academicians, as well as industrial professionals, to present their research results and development activities in mechanism science and control engineering. It provides opportunities for the delegates to exchange new ideas and application experiences, to establish business or research relations and to find global partners for future collaboration. MSCE2014 is conducted to all the researchers, engineers, industrial professionals and academicians, who are broadly welcomed to present their latest research results, academic developments or theory practice. Topics of interest include but are not limited to Mechanism theory and Application, Mechanical control and Automation Engineering, Mechanical Dynamics, Materials Processing and Control, Instruments and Vibration Control. It is of great pleasure to see the delegates exchanging ideas and establishing sound relationships on the conference.*

Theoretical and Mathematical Foundations of Computer Science Second International Conference, ICTMF 2011, Singapore, May 5-6, 2011, Revised Selected Papers [Springer Science & Business Media](#) *This book constitutes the refereed post-proceedings of the Second International Conference on Theoretical and Mathematical Foundations of Computer Science, ICTMF 2011, held in Singapore in May 2011. The conference was held together with the Second International Conference on High Performance Networking, Computing, and Communication systems, ICHCC 2011, which proceedings are published in CCIS 163. The 84 revised selected papers presented were carefully reviewed and selected for inclusion in the book. The topics covered range from computational science, engineering and technology to digital signal processing, and computational biology to game theory, and other related topics.*