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Fractional Derivative Modeling in Mechanics and Engineering Walter de Gruyter GmbH & Co KG

In many fields of application of mathematics, progress is crucially dependent on the good flow of information between (i) theoretical mathematicians looking for applications, (ii) mathematicians working in applications in need of theory, and (iii) scientists and engineers applying mathematical models and methods. The intention of this book is to stimulate this flow of information. In the first three chapters (accessible to third year students of mathematics and physics and to mathematically interested engineers) applications of Abel integral equations are surveyed broadly including determination of potentials, stereology, seismic travel times, spectroscopy, optical fibres. In subsequent chapters (requiring some background in functional analysis) mapping properties of Abel integral operators and their relation to other integral transforms in various function spaces are investigated, questions of existence and uniqueness of solutions of linear and nonlinear Abel integral equations are treated, and for equations of the first kind problems of ill-posedness are discussed. Finally, some numerical methods are described. In the theoretical parts, emphasis is put on the aspects relevant to applications.

Journal of Fractional Calculus World Scientific

Variational methods and their generalizations have been verified to be useful tools in proving the existence of solutions to a variety of boundary value problems for ordinary, impulsive, and partial differential equations as well as for difference equations. In this monograph, we look at how variational methods can be used in all these settings. In our first chapter, we gather the basic notions and fundamental theorems that will be applied in the remainder of this monograph. While many of these items are easily available in the literature, we gather them here both for the convenience of the reader and for the purpose of making this volume somewhat self-contained. Subsequent chapters deal with the Sturm-Liouville problems, multi-point boundary value problems, problems with impulses, partial differential equations, and difference equations. An extensive bibliography is also included.

An Introduction to Mathematical Models World Scientific

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

Physics Reviews: " 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

Functional Fractional Calculus Springer Nature 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

Implicit Fractional Differential and Integral Equations de Gruyter Fractional calculus is used to model many real-life situations from science and engineering. The book includes different topics associated with such equations and their relevance and significance in various scientific areas of study and research. In this book readers will find several important and useful methods and techniques for solving various types of fractional-order models in science and engineering. The book should be useful for graduate students, PhD students, researchers and educators interested in mathematical modelling, physical sciences, engineering sciences, applied mathematical sciences, applied sciences, and so on. This Handbook: Provides reliable methods for solving fractional-order models in science and engineering. Contains efficient numerical methods and algorithms for engineering-related equations. Contains comparison of various methods for accuracy and validity. Demonstrates the applicability of fractional calculus in science and engineering. Examines qualitative as well as quantitative properties of solutions of various types of science- and engineering-related equations. Readers will find this book to be useful and valuable in increasing and updating their knowledge in this field and will be it will be helpful for engineers, mathematicians, scientist and researchers working on various real-life problems.

Fractional Calculus and its Applications in Physics Academic Press

This book deals with the existence and stability of solutions to initial and boundary value problems for functional differential and integral equations and inclusions involving the Riemann-Liouville, Caputo, and Hadamard fractional derivatives and integrals. A wide variety of topics is covered in a mathematically rigorous manner making this work a valuable source of information for graduate students and researchers working with problems in fractional calculus. Contents: Preliminary Background Nonlinear Implicit Fractional Differential Equations Impulsive Nonlinear Implicit Fractional Differential Equations Boundary Value Problems for Nonlinear Implicit Fractional Differential Equations Boundary Value Problems for Impulsive NIFDE Integrable Solutions for Implicit Fractional Differential Equations Partial Hadamard Fractional Integral Equations and Inclusions Stability Results for Partial Hadamard Fractional Integral Equations and Inclusions Hadamard-Stieltjes Fractional Integral Equations Ulam Stabilities for Random Hadamard Fractional Integral Equations **Theory and Applications of Fractional Differential Equations** Fractional Calculus and Fractional Processes with Applications to Financial Economics Theory and

Application

The many technical and computational problems that appear to be constantly emerging in various branches of physics and engineering beg for a more detailed understanding of the fundamental mathematics that serves as the cornerstone of our way of understanding natural phenomena. The purpose of this Special Issue was to establish a brief collection of carefully selected articles authored by promising young scientists and the world's leading experts in pure and applied mathematics, highlighting the state-of-the-art of the various research lines focusing on the study of analytical and numerical mathematical methods for pure and applied sciences.

Matrix Methods And Fractional Calculus Springer

This book is a printed edition of the Special Issue "Special Functions: Fractional Calculus and the Pathway for Entropy Dedicated to Professor Dr. A.M. Mathai on the occasion of his 80th Birthday" that was published in Axioms

Proceedings of the International Conference held at the University of New Haven, June 1974 Frontiers Media SA

This monograph provides a comprehensive overview of the author's work on the fields of fractional calculus and waves in linear viscoelastic media, which includes his pioneering contributions on the applications of special functions of the Mittag-Leffler and Wright types. It is intended to serve as a general introduction to the above-mentioned areas of mathematical modeling. The explanations in the book are detailed enough to capture the interest of the curious reader, and complete enough to provide the necessary background material needed to delve further into the subject and explore the research literature given in the huge general bibliography. This book is likely to be of interest to applied scientists and engineers.

Contents: Essentials of Fractional Calculus Essentials of Linear Viscoelasticity Fractional Viscoelastic Models Waves in Linear Viscoelastic Media: Dispersion and Dissipation Waves in Linear Viscoelastic Media: Asymptotic Representations Diffusion and Wave-Propagation via Fractional Calculus Appendices: The Eulerian Functions The Bessel Functions The Error Functions The Exponential Integral Functions The Mittag-Leffler Functions The Wright Functions Readership: Graduate and PhD students in applied mathematics, classical physics, mechanical engineering and chemical physics; academic institutions; research centers. Keywords: Fractional Calculus; Fractional Derivatives; Fractional Integrals; Linear Viscoelasticity; Rheological Models; Special Functions; Mittag-Leffler Functions; Wright Functions; Integral Transforms; Laplace Transforms; Fourier

Transforms; Waves; Dispersion; Dissipation; Diffusion; Anomalous Diffusion Key Features: Contains accessible mathematical language for easy understanding Features ample examples to reiterate concepts in the book Makes extensive use of graphical images Includes a large and informative general bibliography for further research

Fractional Calculus CRC Press

Transmutations, Singular and Fractional Differential Equations with Applications to Mathematical Physics connects difficult problems with similar more simple ones. The book's strategy works for differential and integral equations and systems and for many theoretical and applied problems in mathematics, mathematical physics, probability and statistics, applied computer science and numerical methods. In addition to being exposed to recent advances, readers learn to use transmutation methods not only as practical tools, but also as vehicles that deliver theoretical insights. Presents the universal transmutation method as the most powerful for solving many problems in mathematics, mathematical physics, probability and statistics, applied computer science and numerical methods Combines mathematical rigor with an illuminating exposition full of historical notes and fascinating details Enables researchers, lecturers and students to find material under the single "roof"

ICFDA 2018, Amman, Jordan, July 16-18 Springer

This book contains mathematical preliminaries in which basic definitions of fractional derivatives and spaces are presented. The central part of the book contains various applications in classical mechanics including fields such as: viscoelasticity, heat conduction, wave propagation and variational Hamilton-type principles. Mathematical rigor will be observed in the applications. The authors provide some problems formulated in the classical setting and some in the distributional setting. The solutions to these problems are presented in analytical form and these solutions are then analyzed numerically. Theorems on the existence of solutions will be presented for all examples discussed. In using various constitutive equations the restrictions following from the second law of thermodynamics will be implemented. Finally,

the physical implications of obtained solutions will be discussed in detail.

Fractional Calculus and Fractional Processes with Applications to Financial Economics Elsevier

This book provides a broad overview of the latest developments in fractional calculus and fractional differential equations (FDEs) with an aim to motivate the readers to venture into these areas. It also presents original research describing the fractional operators of variable order, fractional-order delay differential equations, chaos and related phenomena in detail. Selected results on the stability of solutions of nonlinear dynamical systems of the non-commensurate fractional order have also been included. Furthermore, artificial neural network and fractional differential equations are elaborated on; and new transform methods (for example, Sumudu methods) and how they can be employed to solve fractional partial differential equations are discussed. The book covers the latest research on a variety of topics, including: comparison of various numerical methods for solving FDEs, the Adomian decomposition method and its applications to fractional versions of the classical Poisson processes, variable-order fractional operators, fractional variational principles, fractional delay differential equations, fractional-order dynamical systems and stability analysis, inequalities and comparison theorems in FDEs, artificial neural network approximation for fractional operators, and new transform methods for solving partial FDEs. Given its scope and level of detail, the book will be an invaluable asset for researchers working in these areas.

[Fractional Differential Equations](#) Elsevier

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.

The Analysis of Fractional Differential Equations Academic Press

Fractional Calculus and Fractional Processes with Applications to Financial Economics Theory and Application Academic Press

[An Introduction to Fractional Derivatives, Fractional Differential Equations, to Methods of Their Solution and Some of Their Applications](#) Springer Nature

The fractional Laplacian, also called the Riesz fractional derivative, describes an unusual diffusion process associated with random excursions. The Fractional Laplacian explores applications of the fractional Laplacian in science, engineering, and other areas where long-range interactions and conceptual or physical particle jumps resulting in an irregular diffusive or conductive flux are encountered. Presents the material at a level suitable for a broad audience of scientists and engineers with rudimentary background in ordinary differential equations and integral calculus Clarifies the concept of the fractional Laplacian for functions in one, two, three, or an arbitrary number of dimensions defined over the entire space, satisfying periodicity conditions, or restricted to a finite domain Covers physical and mathematical concepts as well as detailed mathematical derivations Develops a numerical framework for solving differential equations involving the fractional Laplacian and presents specific algorithms accompanied by numerical results in one, two, and three dimensions Discusses viscous flow and physical examples from scientific and engineering disciplines Written by a prolific author well known for his contributions in fluid mechanics, biomechanics, applied mathematics, scientific computing, and computer science, the book emphasizes fundamental ideas and practical numerical computation. It includes original material and novel numerical methods.

[Theory and Numerical Approximations of Fractional Integrals and Derivatives](#) Springer Nature

This book brings together eleven topics on different aspects of fractional calculus in a single volume. It provides readers the basic knowledge of fractional calculus and introduces advanced topics and applications. The information in the book is presented in four parts: Fractional Diffusion Equations: (i) solutions of fractional diffusion equations using wavelet methods, (ii) the maximum principle for time fractional diffusion equations, (iii) nonlinear sub-diffusion equations. Mathematical Analysis: (i) shifted Jacobi polynomials for solving and identifying coupled fractional delay differential equations, (ii) the monotone iteration principle in the theory of Hadamard fractional delay differential equations, (iii) dynamics of fractional order modified Bhalekar-Gejji System, (iv) Grunwald-Letnikov derivatives. Computational Techniques: GPU computing of special mathematical functions used in fractional calculus. Reviews: (i) the popular iterative method NIM, (ii) fractional derivative with non-singular kernels, (iii) some open problems in fractional order nonlinear system This is a useful reference for researchers and graduate level

mathematics students seeking knowledge about of fractional calculus and applied mathematics.

Nonlocal and Fractional Operators Springer

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 Calculus and Waves in Linear Viscoelasticity Cambridge Scholars Publishing

This multi-volume handbook is the most up-to-date and comprehensive reference work in the field of fractional calculus and its numerous applications. This first volume collects authoritative chapters covering the mathematical theory of fractional calculus, including fractional-order operators, integral transforms and equations, special functions, calculus of variations, and probabilistic and other aspects.

Fractional Calculus and Fractional Differential Equations World Scientific

The books *Fractional Calculus with Applications in Mechanics: Vibrations and Diffusion Processes* and *Fractional Calculus with Applications in Mechanics: Wave Propagation, Impact and Variational Principles* contain various applications of fractional calculus to the fields of classical mechanics. Namely, the books study problems in fields such as viscoelasticity of fractional order, lateral vibrations of a rod of fractional order type, lateral vibrations of a rod positioned on fractional order viscoelastic foundations, diffusion-wave phenomena, heat conduction, wave propagation, forced oscillations of a body attached to a rod, impact and variational principles of a Hamiltonian type. The books will be useful for graduate students in mechanics and applied mathematics, as well as for researchers in these fields. Part 1 of this book presents an introduction to fractional calculus. Chapter 1 briefly gives definitions and notions that are needed later in the book and Chapter 2 presents definitions and some of the properties of fractional integrals and derivatives. Part 2 is the central part of the book. Chapter 3 presents the analysis of waves in fractional viscoelastic materials in infinite and finite spatial domains. In Chapter 4, the problem of oscillations of a translatory moving rigid body, attached to a heavy, or light viscoelastic rod of fractional order type, is studied in detail. In Chapter 5, the authors analyze a specific engineering problem of the impact of a viscoelastic rod against a rigid wall. Finally, in Chapter 6, some results for the optimization of a functional containing fractional derivatives of constant and variable order are presented.

Abel Integral Equations Walter de Gruyter GmbH & Co KG

In recent years fractional calculus has played an important role in various fields such as mechanics, electricity, chemistry, biology, economics, modeling, identification, control theory and signal processing. The scope of this book is to present the state of the art in the study of fractional systems and the application of fractional differentiation. Furthermore, the manufacture of nanowires is important for the design of nanosensors and the development of high-yield thin films is vital in procuring clean solar energy. This wide range of applications is of interest to engineers, physicists and mathematicians.