Fractional Calculus With An Integral Operator Containing A

Unification of Fractional Calculi with Applications
An Introduction to the Fractional Calculus and Fractional Differential Equations
Fractional Calculus with Applications in Mechanics
Applications Of Fractional Calculus In Physics
Fractional Integrals and Derivatives
Fractional Integrals and Derivatives: “True” versus “False”
Fractional Order Analysis
Fractional Differential Equations
Fractals and Fractional Calculus in Continuum Mechanics
The Analysis of Fractional Differential Equations
Introduction to the Fractional Calculus of Variations
Functional Fractional Calculus for System Identification and Controls
The Variable-Order Fractional Calculus of Variations
Advances in Fractional Calculus
Solved Exercises in Fractional Calculus
Numerical Methods for Fractional Calculus

Generalized Fractional Calculus and Applications
Special Functions: Fractional Calculus and the Pathway for Entropy
Fractional Calculus
Fractional Calculus and Waves in Linear Viscoelasticity
Topics in Fractional Differential Equations
Matrix Methods And Fractional Calculus
Fractional Dynamics
Erdélyi–Kober Fractional Calculus
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LILLY BRAUN

Unification of Fractional Calculi with Applications World Scientific
The Variable-Order Fractional Calculus of Variations is devoted to the study of fractional operators with variable order and, in particular, variational problems involving variable-order operators. This brief presents a new numerical tool for the solution of differential equations involving Caputo derivatives of fractional variable order. Three Caputo-type fractional operators are considered, and for each one, an approximation formula is obtained in terms of standard (integer-order) derivatives only. Estimations for the error of the approximations are also provided. The contributors consider variational problems that may be subject to one or more constraints, where the functional depends on a combined Caputo derivative of variable fractional order. In particular, they establish necessary optimality conditions of Euler–Lagrange type. As the terminal point in the cost integral is free, as is the terminal state, transversality conditions are also obtained. The Variable-Order Fractional Calculus of Variations is a valuable source of

information for researchers in mathematics, physics, engineering, control and optimization; it provides both analytical and numerical methods to deal with variational problems. It is also of interest to academics and postgraduates in these fields, as it solves multiple variational problems subject to one or more constraints in a single brief.

An Introduction to the Fractional Calculus and Fractional Differential Equations World Scientific Publishing Company

This paper demonstrates the need for a nonconstant initialization for the fractional calculus and establishes a basic definition set for the initialized fractional differintegral. This definition set allows the formalization of an initialized fractional calculus. Two basis calculi are considered; the Riemann-Liouville and the Grünwald fractional calculi. Two forms of initialization, terminal and side are developed.

Fractional Calculus with Applications in Mechanics Springer Nature

The subject of fractional calculus and its applications (that is, convolution-type pseudo-differential operators including integrals and derivatives of any arbitrary real or complex order) has gained considerable popularity and importance during the past three decades or so, mainly due to its applications in diverse

fields of science and engineering. These operators have been used to model problems with anomalous dynamics, however, they also are an effective tool as filters and controllers, and they can be applied to write complicated functions in terms of fractional integrals or derivatives of elementary functions, and so on. This book will give readers the possibility of finding very important mathematical tools for working with fractional models and solving fractional differential equations, such as a generalization of Stirling numbers in the framework of fractional calculus and a set of efficient numerical methods. Moreover, we will introduce some applied topics, in particular fractional variational methods which are used in physics, engineering or economics. We will also discuss the relationship between semi-Markov continuous-time random walks and the space-time fractional diffusion equation, which generalizes the usual theory relating random walks to the diffusion equation. These methods can be applied in finance, to model tick-by-tick (log)-price fluctuations, in insurance theory, to study ruin, as well as in macroeconomics as prototypical growth models. All these topics are complementary to what is dealt with in existing books on fractional calculus and its applications. This

book was written with a trade-off in mind between full mathematical rigor and the needs of readers coming from different applied areas of science and engineering. In particular, the numerical methods listed in the book are presented in a readily accessible way that immediately allows the readers to implement them on a computer in a programming language of their choice. Numerical code is also provided.

Applications Of Fractional Calculus In Physics SIAM

This book applies generalized fractional differentiation techniques of Caputo, Canavati and Conformable types to a great variety of integral inequalities e.g. of Ostrowski and Opial types, etc. Some of these are extended to Banach space valued functions. These inequalities have also great impact in numerical analysis, stochastics and fractional differential equations. The book continues with generalized fractional approximations by positive sublinear operators which derive from the presented Korovkin type inequalities and also includes abstract cases. It presents also multivariate complex Korovkin quantitative approximation theory. It follows M-fractional integral inequalities of Ostrowski and Polya types. The results are weighted so they provide a great variety of cases and applications. The

second part of the book deals with the quantitative fractional Korovkin type approximation of stochastic processes and lays there the foundations of stochastic fractional calculus. The book considers both Caputo and Conformable fractional directions and derives regular and trigonometric results. The positive linear operators can be expectation operator commutative or not. This book results are expected to find applications in many areas of pure and applied mathematics and stochastics. As such this monograph is suitable for researchers, graduate students, and seminars of the above disciplines, also to be in all science and engineering libraries.

Fractional Integrals and Derivatives Frontiers Media SA

This Special Issue is devoted to some serious problems that the Fractional Calculus (FC) is currently confronted with and aims at providing some answers to the questions like “What are the fractional integrals and derivatives?”, “What are their decisive mathematical properties?”, “What fractional operators make sense in applications and why?’’, etc. In particular, the “new fractional derivatives and integrals” and the models with these fractional order operators are critically addressed. The Special Issue contains both the surveys and the

research contributions. A part of the articles deals with foundations of FC that are considered from the viewpoints of the pure and applied mathematics, and the system theory. Another part of the Special issue addresses the applications of the FC operators and the fractional differential equations. Several articles devoted to the numerical treatment of the FC operators and the fractional differential equations complete the Special Issue.

Fractional Integrals and Derivatives: "True" versus "False" Springer

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.

Fractional Order Analysis CRC Press

In San Francisco, a fisherman's get-rich-quick scheme ends in violence. As sharks fetch high prices, he hires a professional shark hunter to go fishing, the deal being he gets the first three tons, the hunter the rest. But as the hunter's share piles up, jealousy rears its head.

Fractional Differential Equations Elsevier

Numerical Methods for Fractional Calculus presents numerical methods for fractional integrals and fractional derivatives, finite difference methods for fractional ordinary differential equations

(FODEs) and fractional partial differential equations (FPDEs), and finite element methods for FPDEs.The book introduces the basic definitions and propertie

Fractals and Fractional Calculus in Continuum Mechanics 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.

The Analysis of Fractional Differential Equations Springer

This book focuses on Erdélyi–Kober fractional calculus from a statistical perspective inspired by solar neutrino physics. Results of diffusion

entropy analysis and standard deviation analysis of data from the Super-Kamiokande solar neutrino experiment lead to the development of anomalous diffusion and reaction in terms of fractional calculus. The new statistical perspective of Erdélyi–Kober fractional operators outlined in this book will have fundamental applications in the theory of anomalous reaction and diffusion processes dealt with in physics. A major mathematical objective of this book is specifically to examine a new definition for fractional integrals in terms of the distributions of products and ratios of statistically independently distributed positive scalar random variables or in terms of Mellin convolutions of products and ratios in the case of real scalar variables. The idea will be generalized to cover multivariable cases as well as matrix variable cases. In the matrix variable case, M-convolutions of products and ratios will be used to extend the ideas. We then give a definition for the case of real-valued scalar functions of several matrices.

Introduction to the Fractional Calculus of Variations Wiley-Interscience

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.
Functional Fractional Calculus for System Identification and Controls World Scientific Publishing Company
This book contains a brief historical introduction and state of the art in fractional calculus. The author introduces some of the so-called special functions, in particular, those which will be directly involved in calculations. The concepts of fractional integral and fractional derivative are also presented. Each chapter, except for the first one, contains a list of exercises containing suggestions for solving them and at last the resolution itself. At the end of those chapters there is a list of complementary exercises. The last chapter presents several applications of fractional calculus.
The Variable-Order Fractional Calculus of Variations Elsevier
This book will give readers the possibility of finding very important mathematical tools for working with fractional models and solving fractional differential equations, such as a generalization of Stirling numbers in the framework of fractional calculus and a set of efficient numerical methods. Moreover, we will introduce some applied topics, in particular fractional variational methods

which are used in physics, engineering or economics. We will also discuss the relationship between semi-Markov continuous-time random walks and the space-time fractional diffusion equation, which generalizes the usual theory relating random walks to the diffusion equation. These methods can be applied in finance, to model tick-by-tick (log)-price fluctuations, in insurance theory, to study ruin, as well as in macroeconomics as prototypical growth models.All these topics are complementary to what is dealt with in existing books on fractional calculus and its applications. This book will keep in mind the trade-off between full mathematical rigor and the needs of readers coming from different applied areas of science and engineering. In particular, the numerical methods listed in the book are presented in a readily accessible way that immediately allows the readers to implement them on a computer in a programming language of their choice.The second edition of the book has been expanded and now includes a discussion of additional, newly developed numerical methods for fractional calculus and a chapter on the application of fractional calculus for modeling processes in the life sciences.

Advances in Fractional Calculus MDPI

This book gives a practical overview of Fractional Calculus as

it relates to Signal Processing

Solved Exercises in Fractional Calculus

John Wiley & Sons

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

Numerical Methods for Fractional Calculus

Springer Science & Business Media

This book is likely to be of interest to applied scientists and engineers. --Book Jacket.

Generalized Fractional Calculus and Applications

World Scientific

"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. *Special Functions: Fractional Calculus and the Pathway for Entropy* Bentham Science Publishers 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 Calculus

Springer

Commences with the historical development of fractional calculus, its mathematical theory—particularly the Riemann-Liouville version. Numerous examples and theoretical applications of the theory are presented. Features topics associated with fractional differential equations. Discusses

Weyl fractional calculus and some of its uses. Includes selected physical problems which lead to fractional differential or integral equations. Fractional Calculus and Waves in Linear Viscoelasticity Walter de Gruyter GmbH & Co KG
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.

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