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 eighth volume collects authoritative chapters covering several applications of fractional calculus in engineering, life and social sciences, including applications in signal and image analysis, and chaos.

The main subject of the monograph is the fractional calculus in the discrete version. The volume is divided into three main parts. Part one contains a theoretical introduction to the classical and fractional-order discrete calculus where the fundamental role is played by the backward difference and sum. In the second part, selected applications of the discrete fractional calculus in the discrete system control theory are presented. In the discrete system identification, analysis and synthesis, one can consider integer or fractional models based on the fractional-order difference equations. The third part of the book is devoted to digital image processing.

The product of a collaboration between a mathematician and a chemist, this text is geared toward advanced undergraduates and graduate students. Not only does it explain the theory underlying the properties of the generalized operator, but it also illustrates the wide variety of fields to which these ideas may be applied. Rather than an exhaustive treatment, it represents an introduction that will appeal to a broad spectrum of students. Accordingly, the mathematics is kept as simple
as possible. The first of the two-part treatment deals principally with the general properties of differintegral operators. The second half is mainly oriented toward the applications of these properties to mathematical and other problems. Topics include integer order, simple and complex functions, semiderivatives and semi-integrals, and transcendental functions. The text concludes with overviews of applications in the classical calculus and diffusion problems.

This book presents a simplified deliberation of fractional calculus, which will appeal not only to beginners, but also to various applied science mathematicians and engineering researchers. The text develops the ideas behind this new field of mathematics, beginning at the most elementary level, before discussing its actual applications in different areas of science and engineering. This book shows that the simple, classical laws based on Newtonian calculus, which work quite well under limiting and idealized conditions, are not of much use in describing the dynamics of actual systems. As such, the application of non-Newtonian, or generalized, calculus in the governing equations, allows the order of differentiation and integration to take on non-integer values.

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: Theory and Applications deals with differentiation and integration of arbitrary order. The origin of this subject can be traced back to the end of seventeenth century, the time when Newton and Leibniz developed foundations of differential and integral calculus. Nonetheless, utility and applicability of FC to various branches of science and engineering have been realized only in last few decades. Recent years have witnessed tremendous upsurge in research activities related to the applications of FC in modeling of real-world systems. Unlike the derivatives of integral order, the non-local nature of fractional derivatives correctly models many natural phenomena containing long memory and give more accurate description than their integer counterparts. The present book comprises of contributions from academicians and leading researchers and gives a panoramic overview of various aspects of this subject: Introduction to Fractional Calculus Fractional Differential Equations Fractional Ordered Dynamical Systems Fractional Operators on Fractals Local Fractional Derivatives Fractional Control Systems Fractional Operators and Statistical Distributions Applications to Engineering 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.

The first derivative of a particle coordinate means its velocity, the second means its acceleration, but what does a
fractional order derivative mean? Where does it come from, how does it work, where does it lead to? The two-volume book written on high didactic level answers these questions. Fractional Derivatives for Physicists and Engineers– The first volume contains a clear introduction into such a modern branch of analysis as the fractional calculus. The second develops a wide panorama of applications of the fractional calculus to various physical problems. This book recovers new perspectives in front of the reader dealing with turbulence and semiconductors, plasma and thermodynamics, mechanics and quantum optics, nanophysics and astrophysics. The book is addressed to students, engineers and physicists, specialists in theory of probability and statistics, in mathematical modeling and numerical simulations, to everybody who doesn't wish to stay apart from the new mathematical methods becoming more and more popular. Prof. Vladimir V. UCHAIKIN is a known Russian scientist and pedagogue, a Honored Worker of Russian High School, a member of the Russian Academy of Natural Sciences. He is the author of about three hundreds articles and more than a dozen books (mostly in Russian) in Cosmic ray physics, Mathematical physics, Levy stable statistics, Monte Carlo methods with applications to anomalous processes in complex systems of various levels: from quantum dots to the Milky Way galaxy.

Fractional Calculus and Fractional Processes with Applications to Financial Economics presents the theory and application of fractional calculus and fractional processes to financial data. Fractional calculus dates back to 1695 when Gottfried Wilhelm Leibniz first suggested the possibility of fractional derivatives. Research on fractional calculus started in full earnest in the second half of the twentieth century. The fractional paradigm applies not only to calculus, but also to stochastic processes, used in many applications in financial economics such as modelling volatility, interest rates, and modelling high-frequency data. The key features of fractional processes that make them interesting are long-range memory, path-dependence, non-Markovian properties, self-similarity, fractal paths, and anomalous diffusion behaviour. In this book, the authors discuss how fractional calculus and fractional processes are used in financial modelling and finance economic theory. It provides a practical guide that can be useful for students, researchers, and quantitative asset and risk managers interested in applying fractional calculus and fractional processes to asset pricing, financial time-series analysis, stochastic volatility modelling, and portfolio optimization. Provides the necessary background for the book's content as applied to financial economics Analyzes the application of fractional calculus and fractional processes from deterministic and stochastic perspectives

This nine-chapter monograph introduces a rigorous investigation of q-difference operators in standard and fractional settings. It starts with elementary calculus of q-differences and integration of Jackson's type before turning to q-difference equations. The existence and uniqueness theorems are derived using successive approximations, leading to systems of equations with retarded arguments. Regular q-Sturm–Liouville theory is also introduced; Green's function is constructed and the eigenfunction expansion theorem is given. The monograph also discusses some integral equations of Volterra and Abel type, as introductory material for the study of fractional q-calculi. Hence fractional q-calculi of the types Riemann–Liouville; Grünwald–Letnikov; Caputo; Erdélyi–Kober and Weyl are defined analytically. Fractional q-Leibniz rules with applications in q-series are also obtained with rigorous proofs of the formal results of Al-Salam-Verma, which remained unproved for decades. In working towards the investigation of q-fractional difference equations; families of q-Mittag-Leffler functions are defined and their properties are investigated, especially the q-Mellin–Barnes integral and Hankel contour integral representation of the q-Mittag-Leffler functions under consideration, the distribution, asymptotic and reality of their zeros, establishing q-counterparts of Wiman's results. Fractional q-difference equations are studied; existence and uniqueness theorems are given and classes of Cauchy-type problems are completely solved in terms of families
of q-Mittag-Leffler functions. Among many q-analogs of classical results and concepts, q-Laplace, q-Mellin and q2-Fourier transforms are studied and their applications are investigated.

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.

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.

This book is an unique integrated treatise, on the concepts of fractional calculus as models with applications in hydrology, soil science and geomechanics. The models are primarily fractional partial differential equations (fPDEs), and in limited cases, fractional differential equations (fDEs). It develops and applies relevant fPDEs and fDEs mainly to water flow and solute transport in porous media and overland, and in some cases, to concurrent flow and energy transfer. It is an integrated resource with theory and applications for those interested in hydrology, hydraulics and fluid mechanics. The self-contained book summaries the fundamentals for porous media and essential mathematics with extensive references supporting the development of the model and applications.

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
Get Free Fractional Calculus With Applications In Mechanics Wave Propagation Impact And Variational Principles Mechanical Engineering And Solid Mechanics

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 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) 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

In the last two decades, fractional (or non integer) differentiation has played a very important role in various fields such as mechanics, electricity, chemistry, biology, economics, control theory and signal and image processing. For example, in the last three fields, some important considerations such as modelling, curve fitting, filtering, pattern recognition, edge detection, identification, stability, controllability, observability and robustness are now linked to long-range dependence phenomena. Similar progress has been made in other fields listed here. The scope of the book is thus to present the state of the art in the study of fractional systems and the application of fractional differentiation. As this volume covers recent applications of fractional calculus, it will be of interest to engineers, scientists, and applied mathematicians.

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.

Fractional Calculus with Applications in Mechanics is the first complete compilation of fractional calculus applications to mechanics. It examines classical mechanics topics, such as viscoelasticity, heat conduction, wave propagation, and variational principles of Hamilton’s type. Author Teodor Atanackovic presents students and researchers in physics, mechanical engineering, and civil engineering with a systematic description of mathematical solutions to mechanical problems.

In this volume various applications are discussed, in particular to the hyper-Bessel differential operators and equations, Dzrbashjan-Gelfond-Leontiev operators and Borel type transforms, convolutions, new representations of hypergeometric functions, solutions to classes of differential and integral equations, transmutation method, and generalized integral transforms. Some open problems are also posed. This book is intended for graduate and post-graduate students, lecturers, researchers and others working in applied mathematical analysis, mathematical physics and related disciplines.

When a new extraordinary and outstanding theory is stated, it has to face criticism and skepticism, because it is beyond the usual concept. The fractional calculus though not new, was not discussed or developed for a long time, particularly for lack of its application to real life problems. It is extraordinary because it does not deal with ‘ordinary’ differential calculus. It is outstanding because it can now be applied to situations where existing theories fail to give satisfactory results. In this book not only mathematical abstractions are discussed in a lucid manner, with physical mathematical and geometrical explanations, but also several practical applications are given particularly for system identification, description and then efficient controls. The normal physical laws like, transport theory, electrodynamics, equation of motions, elasticity, viscosity, and several others of are based on ‘ordinary’ calculus. In this book these physical laws are generalized in fractional calculus contexts; taking, heterogeneity effect in transport background, the space having traps or islands, irregular distribution of charges, non-ideal spring with mass connected to a pointless-mass ball, material behaving with viscous as well as elastic properties, system relaxation with and without memory, physics of random delay in computer network; and several others; mapping the reality of nature closely. The concept of fractional and complex order differentiation and integration are elaborated mathematically, physically and geometrically with examples. The practical utility of local fractional differentiation for enhancing the character of singularity at phase transition or characterizing the irregularity measure of response function is deliberated. Practical results of viscoelastic experiments, fractional order controls experiments, design of fractional controller and practical circuit synthesis for fractional order elements are elaborated in this book. The book also maps theory of classical integer order differential equations to fractional calculus contexts, and deals in details with conflicting and demanding initialization issues, required in classical techniques. The book presents a modern approach to solve the ‘solvable’ system of fractional and other differential equations, linear, non-linear; without perturbation or transformations, but by applying physical principle of action-and-opposite-reaction, giving ‘approximately exact’ series solutions. Historically, Sir Isaac Newton and Gottfried Wilhelm Leibniz independently discovered calculus in the middle of the 17th century. In recognition to this remarkable discovery, J.von Neumann remarked, “the calculus was the first achievement of modern mathematics and it is difficult to overestimate
its importance. I think it defines more equivocally than anything else the inception of modern mathematical analysis which is logical development, still constitute the greatest technical advance in exact thinking." This XXI century has thus started to ‘think-exactly’ for advancement in science & technology by growing application of fractional calculus, and this century has started speaking the language which nature understands the best.

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.

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 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.
General Fractional Derivatives: Theory, Methods and Applications provides knowledge of the special functions with respect to another function, and the integro-differential operators where the integrals are of the convolution type and exist the singular, weakly singular and nonsingular kernels, which exhibit the fractional derivatives, fractional integrals, general fractional derivatives, and general fractional integrals of the constant and variable order without and with respect to another function due to the appearance of the power-law and complex herbivores to figure out the modern developments in theoretical and applied science. Features: Give some new results for fractional calculus of constant and variable orders. Discuss some new definitions for fractional calculus with respect to another function. Provide definitions for general fractional calculus of constant and variable orders. Report new results of general fractional calculus with respect to another function. Propose new special functions with respect to another function and their applications. Present new models for the anomalous relaxation and rheological behaviors. This book serves as a reference book and textbook for scientists and engineers in the fields of mathematics, physics, chemistry and engineering, senior undergraduate and graduate students. Dr. Xiao-Jun Yang is a full professor of Applied Mathematics and Mechanics, at China University of Mining and Technology, China. He is currently an editor of several scientific journals, such as Fractals, Applied Numerical Mathematics, Mathematical Modelling and Analysis, International Journal of Numerical Methods for Heat & Fluid Flow, and Thermal Science.

This monograph provides the most recent and up-to-date developments on fractional differential and fractional integro-differential equations involving many different potentially useful operators of fractional calculus. The subject of fractional calculus and its applications (that is, calculus of integrals and derivatives of any arbitrary real or complex order) has gained considerable popularity and importance during the past three decades or so, due mainly to its demonstrated applications in numerous seemingly diverse and widespread fields of science and engineering. Some of the areas of present-day applications of fractional models include Fluid Flow, Solute Transport or Dynamical Processes in Self-Similar and Porous Structures, Diffusive Transport akin to Diffusion, Material Viscoelastic Theory, Electromagnetic Theory, Dynamics of Earthquakes, Control Theory of Dynamical Systems, Optics and Signal Processing, Bio-Sciences, Economics, Geology, Astrophysics, Probability and Statistics, Chemical Physics, and so on. In the above-mentioned areas, there are phenomena with strange kinetics which have a microscopic complex behaviour, and their macroscopic dynamics can not be characterized by classical derivative models. The fractional modelling is an emergent tool which use fractional differential equations including derivatives of fractional order, that is, we can speak about a derivative of order 1/3, or square root of 2, and so on. Some of such fractional models can have solutions which are non-differentiable but continuous functions, such as Weierstrass type functions. Such kinds of properties are, obviously, impossible for the ordinary models. What are the useful properties of these fractional operators which help in the modelling of so many anomalous processes? From the point of view of the authors and from known experimental results, most of the processes associated with complex systems have non-local dynamics involving long-memory in time, and the fractional integral and fractional derivative operators do have some of those characteristics. This book is written primarily for the graduate students and researchers in many different disciplines in the mathematical, physical, engineering and so many others sciences, who are interested not only in learning about the various mathematical tools and techniques used in the theory and widespread applications of fractional differential equations, but also in further investigations which emerge naturally from (or which are motivated substantially by) the physical situations modelled mathematically in the book. This monograph consists of a total of eight chapters and a very extensive bibliography. The main objective of it is to complement the contents of the other books dedicated to the study and the applications of fractional differential equations. The aim of the book is to present, in a systematic manner, results including the existence and uniqueness of solutions for the Cauchy type problems involving nonlinear ordinary
Get Free Fractional Calculus With Applications In Mechanics Wave Propagation Impact And Variational Principles Mechanical Engineering And Solid Mechanics

fractional differential equations, explicit solutions of linear differential equations and of the corresponding initial-value problems through different methods, closed-form solutions of ordinary and partial differential equations, and a theory of the so-called sequential linear fractional differential equations including a generalization of the classical Frobenius method, and also to include an interesting set of applications of the developed theory. Key features: - It is mainly application oriented. - It contains a complete theory of Fractional Differential Equations. - It can be used as a postgraduate-level textbook in many different disciplines within science and engineering. - It contains an up-to-date bibliography. - It provides problems and directions for further investigations. - Fractional Modelling is an emergent tool with demonstrated applications in numerous seemingly diverse and widespread fields of science and engineering. - It contains many examples. - and so on!

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

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.

This book is a printed edition of the Special Issue "Operators of Fractional Calculus and Their Applications" that was published in Mathematics

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.

In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear
systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy;
operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to
constraints associated with concepts of causality, memory and stationarity; methods of system representation with an
accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank
matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and
methods for information compression and filtering under condition that a filter model should satisfy restrictions associated
with causality and different types of memory. As a result, the book represents a blend of new methods in general
computational analysis, and specific, but also generic, techniques for study of systems theory ant its particular branches,
such as optimal filtering and information compression. - Best operator approximation, - Non-Lagrange interpolation,
- Generic Karhunen-Loeve transform - Generalised low-rank matrix approximation - Optimal data compression - Optimal nonlinear
filtering.

In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear
systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy;
operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to
constraints associated with concepts of causality, memory and stationarity; methods of system representation with an
accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank
matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and
methods for information compression and filtering under condition that a filter model should satisfy restrictions associated
with causality and different types of memory. As a result, the book represents a blend of new methods in general
computational analysis, and specific, but also generic, techniques for study of systems theory ant its particular branches,
such as optimal filtering and information compression. - Best operator approximation, - Non-Lagrange interpolation,
- Generic Karhunen-Loeve transform - Generalised low-rank matrix approximation - Optimal data compression - Optimal nonlinear
filtering.