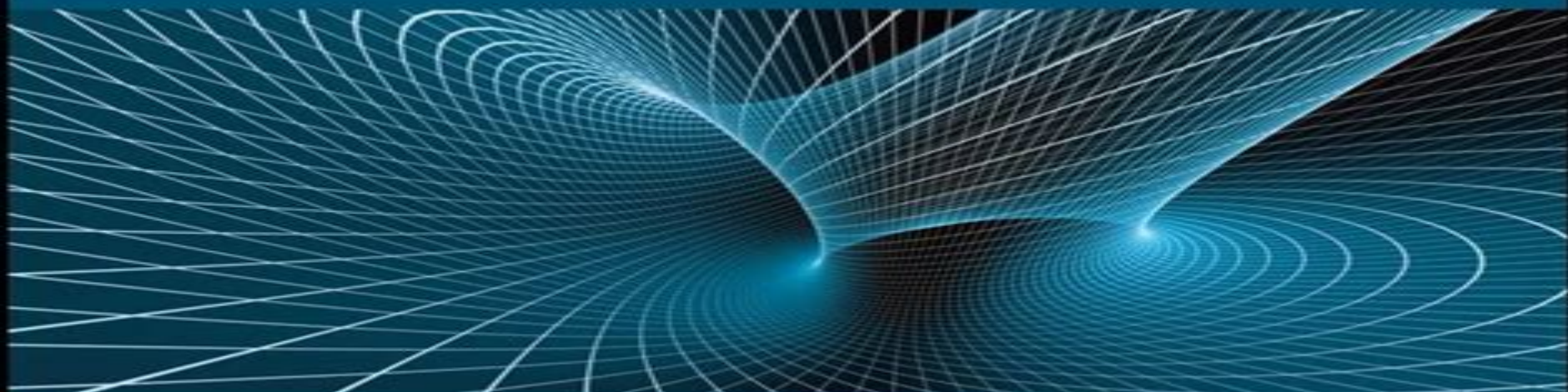


MECHANICAL ENGINEERING AND SOLID MECHANICS SERIES



# **Fractional Calculus with Applications in Mechanics**

*Wave Propagation, Impact  
and Variational Principles*


**Teodor M. Atanacković, Stevan Pilipović  
Bogoljub Stanković, Dušan Zorica**

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## **Fractional Calculus With Applications In Mechanics Wave Propagation Impact And Variational Principles Mechanical Engineering And Solid Mechanics:**

Fractional Calculus with Applications in Mechanics Teodor M. Atanackovic, Stevan Pilipovic, Bogoljub Stankovic, Dusan Zorica, 2014-02-19 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.

**Some Complex Phenomena in Fluid and Solid Mechanics** Abdelghani Saouab, Stephane Champmartin, Jaafar Khalid Naciri, 2024-12-12 This book is a tribute to Professor Abdelhak Ambari and brings together ten chapters written by colleagues who were fortunate enough to work with him. The contributions presented in this book cover the research themes in which Abdelhak Ambari was interested and to which he made valuable experimental and theoretical contributions. For example rheology of complex fluids and polymers hydrodynamic interactions flows at low Reynolds numbers characterization of porous media hydrodynamic instabilities and solid mechanics electrochemical metrology. *Some Complex Phenomena in Fluid and Solid Mechanics* is aimed at a wide community of readers wishing to delve deeper into these scientific themes since it is oriented toward the world of research it will be a valuable tool for doctoral students and beyond. The book also provides undergraduate and graduate students with a good introduction to the techniques and approaches developed in fundamental and applied research in the fields of fluid mechanics solid mechanics and instrumentation.

*Galilean Mechanics and Thermodynamics of Continua* Géry de Saxcé, Claude Valleé, 2016-02-08 This title proposes a unified approach to continuum mechanics which is consistent with Galilean relativity. Based on the notion of affine tensors a simple generalization of the classical tensors this approach allows gathering the usual mechanical entities mass energy force moment stresses linear and angular momentum in a single tensor. Starting with the

basic subjects and continuing through to the most advanced topics the authors presentation is progressive inductive and bottom up They begin with the concept of an affine tensor a natural extension of the classical tensors The simplest types of affine tensors are the points of an affine space and the affine functions on this space but there are more complex ones which are relevant for mechanics torsors and momenta The essential point is to derive the balance equations of a continuum from a unique principle which claims that these tensors are affine divergence free      **Basic Theory** Anatoly Kochubei, Yuri

Luchko, 2019-02-19 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      **Modern Trends in Structural and Solid Mechanics 1** Noel

Challamel, Julius Kaplunov, Izuru Takewaki, 2021-06-29 This book comprised of three separate volumes presents the recent developments and research discoveries in structural and solid mechanics it is dedicated to Professor Isaac Elishakoff This first volume is devoted to the statics and stability of solid and structural members Modern Trends in Structural and Solid Mechanics 1 has broad scope covering topics such as buckling of discrete systems elastic chains lattices with short and long range interactions and discrete arches buckling of continuous structural elements including beams arches and plates static investigation of composite plates exact solutions of plate problems elastic and inelastic buckling dynamic buckling under impulsive loading buckling and post buckling investigations buckling of conservative and non conservative systems and buckling of micro and macro systems This book is intended for graduate students and researchers in the field of theoretical and applied mechanics      **Micromechanics of Fracture and Damage** Luc Dormieux, Djimedo Kondo, 2016-03-31 This book

deals with the mechanics and physics of fractures at various scales Based on advanced continuum mechanics of heterogeneous media it develops a rigorous mathematical framework for single macrocrack problems as well as for the effective properties of microcracked materials In both cases two geometrical models of cracks are examined and discussed the idealized representation of the crack as two parallel faces the Griffith crack model and the representation of a crack as a flat elliptic or ellipsoidal cavity the Eshelby inhomogeneity problem The book is composed of two parts The first part deals with solutions to 2D and 3D problems involving a single crack in linear elasticity Elementary solutions of cracks problems in the different modes are fully worked Various mathematical techniques are presented including Neuber Papkovitch displacement potentials complex analysis with conformal mapping and Eshelby based solutions The second part is devoted to continuum micromechanics approaches of microcracked materials in relation to methods and results presented in the first part Various estimates and bounds of the effective elastic properties are presented They are considered for the formulation and application of continuum micromechanics based damage models      **Material Forming Processes** Bouchaib

Radi, Abdelkhalak El Hami, 2016-09-16 Manufacturing industries strive to improve the quality and reliability of their products

while simultaneously reducing production costs To do this modernized work tools must be produced this will enable a reduction in the duration of the product development cycle optimization of product development procedures and ultimately improvement in the productivity of design and manufacturing phases Numerical simulations of forming processes are used to this end and in this book various methods and models for forming processes including stamping hydroforming and additive manufacturing are presented The theoretical and numerical advances of these processes involving large deformation mechanics on the basis of large transformations are explored in addition to the various techniques for optimization and calculation of reliability The advances and techniques within this book will be of interest to professional engineers in the automotive aerospace defence and other industries as well as graduates and undergraduates in these fields Modern Trends in Structural and Solid Mechanics 2 Noel Challamel, Julius Kaplunov, Izuru Takewaki, 2021-06-29 This book comprised of three separate volumes presents the recent developments and research discoveries in structural and solid mechanics it is dedicated to Professor Isaac Elishakoff This second volume is devoted to the vibrations of solid and structural members Modern Trends in Structural and Solid Mechanics 2 has broad scope covering topics such as exact and approximate vibration solutions of rods beams membranes plates and three dimensional elasticity problems Bolotins dynamic edge effect the principles of plate theories in dynamics nano and microbeams nonlinear dynamics of shear extensible beams the vibration and aeroelastic stability behavior of cellular beams the dynamic response of elastoplastic softening oscillators the complex dynamics of hysteretic oscillators bridging waves and the three dimensional propagation of waves This book is intended for graduate students and researchers in the field of theoretical and applied mechanics **Modern Trends in Structural and Solid Mechanics 3** Noel Challamel, Julius Kaplunov, Izuru Takewaki, 2021-06-02 This book comprised of three separate volumes presents the recent developments and research discoveries in structural and solid mechanics it is dedicated to Professor Isaac Elishakoff This third volume is devoted to non deterministic mechanics Modern Trends in Structural and Solid Mechanics 3 has broad scope covering topics such design optimization under uncertainty interval field approaches convex analysis quantum inspired topology optimization and stochastic dynamics The book is illustrated by many applications in the field of aerospace engineering mechanical engineering civil engineering biomedical engineering and automotive engineering This book is intended for graduate students and researchers in the field of theoretical and applied mechanics **Lagrangian Mechanics** Anh Le Van, Rabah Bouzidi, 2019-06-03 Lagrangian Mechanics explains the subtleties of analytical mechanics and its applications in rigid body mechanics The authors demonstrate the primordial role of parameterization which conditions the equations and thus the information obtained the essential notions of virtual kinematics such as the virtual derivative and the dependence of the virtual quantities with respect to a reference frame and the key concept of perfect joints and their intrinsic character namely the invariance of the fields of compatible virtual velocities with respect to the parameterization Throughout the book any demonstrated results are stated with the respective hypotheses

clearly indicating the applicability conditions for the results to be ready for use Numerous examples accompany the text facilitating the understanding of the calculation mechanisms The book is mainly intended for Bachelor s Master s or engineering students who are interested in an in depth study of analytical mechanics and its applications **Movement Equations 1** Michel Borel, Georges Vénizélos, 2016-09-16 The set of books on Mechanical Engineering and Solid Mechanics of which this book is the first volume is an essential tool for those looking to develop a rigorous knowledge of the discipline whether students professionals in search of an approach to a problem they are dealing with or anyone else interested This volume deals with the elements required for establishing the equations of motion when dealing with solid bodies Chapter 1 focuses on the systems of reference used to locate solid bodies relative to the observer and demonstrates how to describe their position orientation and evolution during their motion Chapter 2 introduces descriptors of motion such as velocity and acceleration and develops the concept of torsor notation in relation to these descriptors Finally Chapter 3 concerns the notions of mass and inertia as well as the kinetic torsor and dynamic torsor which consolidate the kinematic and kinetic aspects in a single concept **Non-local Structural Mechanics** Danilo Karlicic, Tony Murmu, Sondipon Adhikari, Michael McCarthy, 2016-01-26 Serving as a review on non local mechanics this book provides an introduction to non local elasticity theory for static dynamic and stability analysis in a wide range of nanostructures The authors draw on their own research experience to present fundamental and complex theories that are relevant across a wide range of nanomechanical systems from the fundamentals of non local mechanics to the latest research applications **Fractional Calculus with Applications in Mechanics** Teodor M. Atanackovic, Stevan Pilipovic, Bogoljub Stankovic, Dusan Zorica, 2014-02-19 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 **Homogenization of Heterogeneous Thin and Thick Plates** Karam Sab, Arthur Lebé, 2015-10-02 This book gives new insight on plate models in the linear elasticity framework taking into account heterogeneities and thickness effects It is targeted to graduate students who want to discover plate models but deals also with latest developments on higher order models Plates models are both an ancient matter and a still active field of research First attempts date back to the beginning of the 19th century with Sophie Germain Very efficient models have been suggested for homogeneous and isotropic plates by Love 1888 for thin plates and Reissner 1945 for thick plates However the

extension of such models to more general situations such as laminated plates with highly anisotropic layers and periodic plates such as honeycomb sandwich panels raised a number of difficulties. An extremely wide literature is accessible on these questions from very simplistic approaches which are very limited to extremely elaborated mathematical theories which might refrain the beginner. Starting from continuum mechanics concepts, this book introduces plate models of progressive complexity and tackles rigorously the influence of the thickness of the plate and of the heterogeneity. It provides also latest research results. The major part of the book deals with a new theory which is the extension to general situations of the well established Reissner Mindlin theory. These results are completely new and give a new insight to some aspects of plate theories which were controversial till recently.

**Nanometer-scale Defect Detection Using Polarized Light** Pierre-Richard Dahoo, Philippe Pougnet, Abdelkhalak El Hami, 2016-08-16. This book describes the methods used to detect material defects at the nanoscale. The authors present different theories, polarization states and interactions of light with matter in particular optical techniques using polarized light. Combining experimental techniques of polarized light analysis with techniques based on theoretical or statistical models to study faults or buried interfaces of mechatronic systems, the authors define the range of validity of measurements of carbon nanotube properties. The combination of theory and practical methods presented throughout this book provides the reader with an insight into the current understanding of physicochemical processes affecting the properties of materials at the nanoscale.

**From Prognostics and Health Systems Management to Predictive Maintenance 1** Rafael Gouriveau, Kamal Medjaher, Nouredine Zerhouni, 2016-10-14. This book addresses the steps needed to monitor health assessment systems and the anticipation of their failures: choice and location of sensors, data acquisition and processing, health assessment and prediction of the duration of residual useful life. The digital revolution and mechatronics foreshadowed the advent of the 4.0 industry where equipment has the ability to communicate. The ubiquity of sensors (300 000 sensors in the new generations of aircraft) produces a flood of data requiring us to give meaning to information and leads to the need for efficient processing and a relevant interpretation. The process of traceability and capitalization of data is a key element in the context of the evolution of the maintenance towards predictive strategies.

**Movement Equations 5** Georges Vénizélos, Abdelkhalak El Hami, 2019-12-03. The final volume in the Non deformable Solid Mechanics set. Movement Equations 5 deals with the dynamics of sets of solids. This volume provides the appropriate mathematical tools: tensor calculus and matrix calculus to obtain and solve the equations of motion for a chain of solids. These equations are then used to acquire the information necessary for the design of mechanical systems. Also examined are the vibratory behavior of continuous deformable systems: rigid and deformable solids and sets of several solids. The book concludes with a study of the response of an excited system as a function of the excitation frequency. Accompanied by detailed examples, this book is aimed primarily at students but would also serve as a valuable support for working engineers and teacher researchers.

**The Rayleigh-Ritz Method for Structural Analysis** Sinniah Ilanko, Luis Monterrubio, Yusuke

Mochida,2014-12-01 A presentation of the theory behind the Rayleigh Ritz R R method as well as a discussion of the choice of admissible functions and the use of penalty methods including recent developments such as using negative inertia and bi penalty terms While presenting the mathematical basis of the R R method the authors also give simple explanations and analogies to make it easier to understand Examples include calculation of natural frequencies and critical loads of structures and structural components such as beams plates shells and solids MATLAB codes for some common problems are also supplied

**Sustainable Masonry** Thierry Ciblac,Jean-Claude Morel,2014-07-22 This book covers the impact of sustainable masonry on the environment touting the many benefits of utilizing local and or low embodied energy materials in the construction of sustainable buildings

*Fractional Calculus with Applications in Mechanics* Teodor M. Atanackovic,Stevan Pilipovic,Bogoljub Stankovic,Dusan Zorica,2014-03-17 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



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