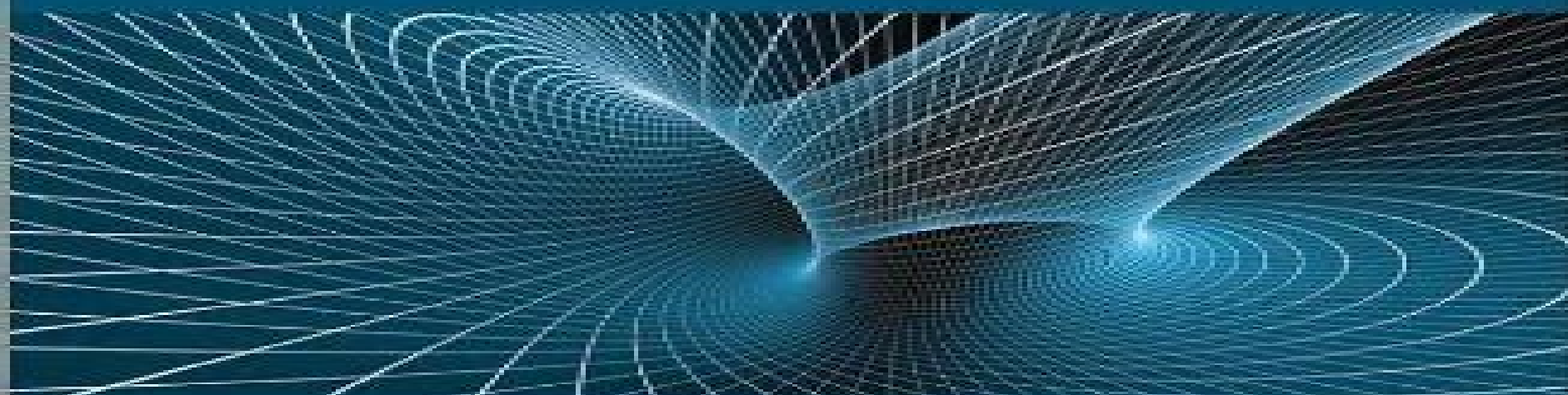




Fractional Calculus with Applications in Mechanics

*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

Anatoly Kochubei, Yuri Luchko



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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.

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.

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

Mechanics of Aeronautical Solids, Materials and Structures Christophe Bouvet, 2017-03-13 The objective of this work on the mechanics of aeronautical solids materials and structures is to give an overview of the principles necessary for sizing of structures in the aeronautical field It begins by introducing the classical notions of mechanics stress strain behavior law and sizing criteria with an emphasis on the criteria specific to aeronautics such as limit loads and ultimate loads Methods of resolution are then presented and in particular the finite element method Plasticity is also covered in order to highlight its influence on the sizing of structures and in particular its benefits for design criteria Finally the physics of the two main materials of aeronautical structures namely aluminum and composite materials is approached in order to clarify the sizing criteria stated in the previous chapters Exercises with detailed corrections then make it possible for the reader to test their understanding of the different subjects

Galilean Mechanics and Thermodynamics of Continua Géry de Saxcé, Claude Valleé, 2016-01-07 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

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 **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 **Heat Transfer 2** Michel

Ledoux, Abdelkhalak El Hami, 2021-05-04 Heat is a branch of thermodynamics that occupies a unique position due to its involvement in the field of practice Being linked to the management transport and exchange of energy in thermal form it impacts all aspects of human life and activity Heat transfers are by nature classified as conduction convection which inserts conduction into fluid mechanics and radiation The importance of these three transfer methods has resulted justifiably in a separate volume being afforded to each of them This second volume is dedicated to radiation After recalling photometry the calculation of luminance is addressed using the theory of the black body and associated laws Stefan Wien The reciprocal radiation of two surfaces in total influence is discussed extensively and the case of finished surfaces is also considered Heat Transfer 2 combines a basic approach with a deeper understanding of the discipline and will therefore appeal to a wide audience from technician to engineer from doctoral student to teacher researcher Stochastic Dynamics of Structures

Abdelkhalak El Hami, Bouchaib Radi, 2016-12-27 This book is dedicated to the general study of the dynamics of mechanical structures with consideration of uncertainties The goal is to get the appropriate forms of a part in minimizing a given criterion In all fields of structural mechanics the impact of good design of a room is very important to its strength its life and its use in service The development of the engineer's art requires considerable effort to constantly improve structural design techniques *Applied Reliability for Industry 1* Abdelkhalak El Hami, David Delaux, Henri Grzeskowiak, 2023-05-16 Applied Reliability for Industry 1 illustrates the multidisciplinary state of the art science of predictive reliability Many experts are now convinced that reliability is not limited to statistical sciences In fact many different disciplines interact in order to bring

a product to its highest possible level of reliability made available through today's technologies developments and production methods These three books of which this is the first propose new methods for analyzing the lifecycle of a system enabling us to record the development phases according to development time and levels of complexity for its integration Predictive reliability as particularly focused on in *Applied Reliability for Industry 1* examines all the engineering activities used to estimate or predict the reliability performance of the final mechatronic system ***Applied Reliability for Industry 2*** Abdelkhalak El Hami, David Delaux, Henri Grzeskowiak, 2023-05-09 *Applied Reliability for Industry 2* illustrates the multidisciplinary state of the art science of experimental reliability Many experts are now convinced that reliability is not limited to statistical sciences In fact many different disciplines interact in order to bring a product to its highest possible level of reliability made available through today's technologies developments and production methods These three books of which this is the second propose new methods for analyzing the lifecycle of a system enabling us to record the development phases according to development time and levels of complexity for its integration Experimental reliability as advanced in *Applied Reliability for Industry 2* examines all the tools and testing methods used to demonstrate the reliability of the final mechatronic system ***Applied Reliability for Industry 3*** Abdelkhalak El Hami, David Delaux, Henri Grzeskowiak, 2023-04-03 *Applied Reliability for Industry 3* illustrates the multidisciplinary state of the art science of operational reliability Many experts are now convinced that reliability is not limited to statistical sciences In fact many different disciplines interact in order to bring a product to its highest possible level of reliability made available through today's technologies developments and production methods These three books of which this is the third propose new methods for analyzing the lifecycle of a system enabling us to record the development phases according to development time and levels of complexity for its integration Operational reliability as presented in *Applied Reliability for Industry 3* verifies the reliability performance of the mechatronic system in real life through an analysis of field data ***Movement Equations 3*** Michel Borel, Georges Vénizélos, 2017-09-25 This volume is the focal point of the work undertaken in the previous volumes of this set of books the statement of the fundamental principle of the dynamics whose implementation according to two paths whose choice depends on the problem to be treated leads to equations of motion In order to achieve this it is treated first of all in the context of solids in their environment as a prerequisite for the formulation of the fundamental principle Then in addition to its use in some exercises the approach is illustrated by three particular cases The first is an example where it is developed end to end and addresses the two approaches that lead to the equations of motion The two other examples deal with two classical but important subjects the movement of the Earth according to the hypotheses that can be stated about it and Foucault's pendulum ***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 Fractional Dynamics on Networks and Lattices Thomas Michelitsch,Alejandro Perez Riascos,Bernard Collet,Andrzej Nowakowski,Franck Nicolleau,2019-04-10 This book analyzes stochastic processes on networks and regular structures such as lattices by employing the Markovian random walk approach Part 1 is devoted to the study of local and non local random walks It shows how non local random walk strategies can be defined by functions of the Laplacian matrix that maintain the stochasticity of the transition probabilities A major result is that only two types of functions are admissible type i functions generate asymptotically local walks with the emergence of Brownian motion whereas type ii functions generate asymptotically scale free non local fractional walks with the emergence of Levy flights In Part 2 fractional dynamics and Levy flight behavior are analyzed thoroughly and a generalization of Plya's classical recurrence theorem is developed for fractional walks The authors analyze primary fractional walk characteristics such as the mean occupation time the mean first passage time the fractal scaling of the set of distinct nodes visited etc The results show the improved search capacities of fractional dynamics on networks

Fluid-Structure Interactions and Uncertainties Abdelkhalak El Hami,Bouchaib Radi,2017-02-07 This book is dedicated to the general study of fluid structure interaction with consideration of uncertainties The fluid structure interaction is the study of the behavior of a solid in contact with a fluid the response can be strongly affected by the action of the fluid These phenomena are common and are sometimes the cause of the operation of certain systems or otherwise manifest malfunction The vibrations affect the integrity of structures and must be predicted to prevent accelerated wear of the system by material fatigue or even its destruction when the vibrations exceed a certain threshold Mechanics of Aeronautical Composite Materials Christophe Bouvet,2017-08-10 This book presents the principles of composite laminate sizing widely used for composite structures The focus is on aeronautics in particular including the concepts of limit loads and ultimate loads After a brief overview of the main composite materials used in aeronautics the basic theory of laminated plates and the associated rupture criteria are given The author presents two fundamental cases of the sizing of aeronautical composite structures the calculation of the holed structures and their subsequent multi bolt joints and the calculation of the buckling

The concept of damage tolerance is also explored with a focus on its application for tolerance to impact damage. These notions are fundamental for understanding the specificities of the sizing of aeronautical composite structures. The book also contains corrected exercises for the reader to test their understanding of the different topics covered. *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 a broad scope covering topics such as 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.

Mechanical Vibrations Yvon Mori, 2017-01-18. The purpose of this book is to clarify the issues related to the environment of mechanical vibrations in the material life profile. In particular, through their simulation testing laboratory, a better understanding of the physical phenomenon means to implement to simulate measurements and interpretations associated results. It is aimed at development of technical consultants, quality and services primarily to those testing laboratories as well as to all those who are faced with supply reference to the environmental test calls and particularly here vibration tests. Furthermore, it should also interest students of engineering schools in the areas of competence of their future professions affected by vibration.

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