

# Mathematical Problems in Linear Viscoelasticity

Mauro Fabrizio  
Angelo Morro

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Studies in  
Applied Mathematics

# Mathematical Problems In Linear Viscoelasticity

**Mauro Fabrizio, Angelo Morro**



## **Mathematical Problems In Linear Viscoelasticity:**

Mathematical Problems in Linear Viscoelasticity Mauro Fabrizio, Angelo Morro, 1992-01-01 Describes general mathematical modeling of viscoelastic materials as systems with fading memory Discusses the interrelation between topics such as existence uniqueness and stability of initial boundary value problems variational and extremum principles and wave propagation Demonstrates the deep connection between the properties of the solution to initial boundary value problems and the requirements of the general physical principles Discusses special techniques and new methods including Fourier and Laplace transforms extremum principles via weight functions and singular surfaces and discontinuity waves

*Mathematical Problems in Linear Viscoelasticity* Mauro Fabrizio, Angelo Morro, 1992-01-01 Describes general mathematical modeling of viscoelastic materials as systems with fading memory Discusses the interrelation between topics such as existence uniqueness and stability of initial boundary value problems variational and extremum principles and wave propagation Demonstrates the deep connection between the properties of the solution to initial boundary value problems and the requirements of the general physical principles Discusses special techniques and new methods including Fourier and Laplace transforms extremum principles via weight functions and singular surfaces and discontinuity waves **Boundary**

**Value Problems in Linear Viscoelasticity** John M. Golden, George A.C. Graham, 2013-04-17 The classical theories of Linear Elasticity and Newtonian Fluids though triumphantly elegant as mathematical structures do not adequately describe the deformation and flow of most real materials Attempts to characterize the behaviour of real materials under the action of external forces gave rise to the science of Rheology Early rheological studies isolated the phenomena now labelled as viscoelastic Weber 1835 1841 researching the behaviour of silk threads under load noted an instantaneous extension followed by a further extension over a long period of time On removal of the load the original length was eventually recovered He also deduced that the phenomena of stress relaxation and damping of vibrations should occur Later investigators showed that similar effects may be observed in other materials The German school referred to these as Elastische Nachwirkung or the elastic aftereffect while the British school including Lord Kelvin spoke of the viscosity of solids The universal adoption of the term Viscoelasticity intended to convey behaviour combining proper ties both of a viscous liquid and an elastic solid is of recent origin not being used for example by Love 1934 though Alfrey 1948 uses it in the context of polymers The earliest attempts at mathematically modelling viscoelastic behaviour were those of Maxwell 1867 actually in the context of his work on gases he used this model for calculating the viscosity of a gas and Meyer 1874 Boundary Value Problems in Linear

Viscoelasticity John M. Golden, G. A. C. Graham, 1988 *Fractional Calculus And Waves In Linear Viscoelasticity: An Introduction To Mathematical Models (Second Edition)* Francesco Mainardi, 2022-08-16 Fractional Calculus and Waves in Linear Viscoelasticity Second Edition is a self contained treatment of the mathematical theory of linear uniaxial viscoelasticity constitutive equation and waves with particular regard to models based on fractional calculus It serves as a

general introduction to the above mentioned areas of mathematical modeling The explanations in the book are detailed enough to capture the interest of the curious reader and complete enough to provide the necessary background material needed to delve further into the subject and explore the research literature In particular the relevant role played by some special functions is pointed out along with their visualization through plots Graphics are extensively used in the book and a large general bibliography is included at the end This new edition keeps the structure of the first edition but each chapter has been revised and expanded and new additions include a novel appendix on complete monotonic and Bernstein functions that are known to play a fundamental role in linear viscoelasticity This book is suitable for engineers graduate students and researchers interested in fractional calculus and continuum mechanics     Theory of Viscoelasticity R. M.

Christensen,2013-04-26 Integration of theoretical developments offers complete description of linear theory of viscoelastic behavior of materials with theoretical formulations derived from continuum mechanics viewpoint and discussions of problem solving 1982 edition     Mathematical Models and Methods for Smart Materials Mauro Fabrizio,Angelo Morro,Barbara Lazzari,2002 This book contains the papers presented at the conference on Mathematical Models and Methods for Smart Materials held in Italy in 2001 The papers are divided into four parts Methods in Materials Science deals mainly with mathematical techniques for the investigation of physical systems such as liquid crystals materials with internal variables amorphous materials and thermoelastic materials Also techniques are exhibited for the analysis of stability and controllability of classical models of continuum mechanics and of dynamical systems Modelling of Smart Materials is devoted to models of superfluids superconductors materials with memory nonlinear elastic solids and damaged materials In the elaboration of the models thermodynamic aspects play a central role in the characterization of the constitutive properties Well Posedness in Materials with Memory deals with existence uniqueness and stability for the solution of problems most often expressed by integrodifferential equations which involve materials with fading memory Also attention is given to exponential decay in viscoelasticity inverse problems in heat conduction with memory and automatic control for parabolic equations Analytic Problems in Phase Transitions discusses nonlinear partial differential equations associated with phase transitions and hysteresis possibly involving fading memory effects Particular applications are developed for the phase field model with memory the Stefan problem with a Cattaneo type equation the hysteresis in thermo visco plasticity and the solid solid phase transition Contents Automatic Control Problems for Integrodifferential Parabolic Equations C Cavaterra Phase Relaxation Problems with Memory and Their Optimal Control P Colli Unified Dynamics of Particles and Photons G Ferrarese Solid Solid Phase Transition in a Mechanical System G Gilardi KAM Methods for Nonautonomous     Acoustic Interactions With Submerged Elastic Structures: Part Iv: Nondestructive Testing, Acoustic Wave Propagation And Scattering Anders Bostrom,Ardeshir Guran,Oswald Leroy,Gerard Maze,2002-07-09 This series of volumes constitutes an outstanding collection of contributions by the most active research workers in the area of acoustics and mechanics It brings the reader up to date

on the status of the various aspects of research in this field The volumes should preserve their value for a long time as they represent a monument to the achievements of human research capabilities in the underwater acoustics aspects of the environment

**Viscoelastic Modeling for Structural Analysis** Jean Salençon, 2019-04-26 The theory of viscoelasticity has been built up as a mechanical framework for modeling important aspects of the delayed behavior of a wide range of materials This book primarily intended for civil and mechanical engineering students is devoted specifically to linear viscoelastic behavior within the small perturbation framework The fundamental concepts of viscoelastic behavior are first presented from the phenomenological viewpoint of the basic creep and relaxation tests within the simple one dimensional framework The linearity and non ageing hypotheses are introduced successively with the corresponding expressions of the constitutive law in the form of Boltzmann's integral operators and Riemann's convolution products respectively Applications to simple quasi static processes underline the dramatic and potentially catastrophic consequences of not taking viscoelastic delayed behavior properly into account at the design stage Within the three dimensional continuum framework the linear viscoelastic constitutive equation is written using compact mathematical notations and takes material symmetries into account The general analysis of quasi static linear viscoelastic processes enhances similarities with and differences from their elastic counterparts Simple typical case studies illustrate the importance of an in depth physical understanding of the problem at hand prior to its mathematical analysis

**Mechanical Behaviour of Engineering Materials** Y.M. Haddad, 2013-06-29 This monograph consists of two volumes and provides a unified comprehensive presentation of the important topics pertaining to the understanding and determination of the mechanical behaviour of engineering materials under different regimes of loading The large subject area is separated into eighteen chapters and four appendices all self contained which give a complete picture and allow a thorough understanding of the current status and future direction of individual topics Volume I contains eight chapters and three appendices and concerns itself with the basic concepts pertaining to the entire monograph together with the response behaviour of engineering materials under static and quasi static loading Thus Volume I is dedicated to the introduction the basic concepts and principles of the mechanical response of engineering materials together with the relevant analysis of elastic elastic plastic and viscoelastic behaviour Volume II consists of ten chapters and one appendix and concerns itself with the mechanical behaviour of various classes of materials under dynamic loading together with the effects of local and microstructural phenomena on the response behaviour of the material Volume II also contains selected topics concerning intelligent material systems and pattern recognition and classification methodology for the characterization of material response states The monograph contains a large number of illustrations numerical examples and solved problems The majority of chapters also contain a large number of review problems to challenge the reader The monograph can be used as a textbook in science and engineering for third and fourth undergraduate levels as well as for the graduate levels It is also a definitive reference work for scientists and engineers

involved in the production processing and applications of engineering materials as well as for other professionals who are involved in the engineering design process **Stability in Viscoelasticity** A.D. Drozdov, V.B. Kolmanovskii, 2013-10-22 The subject of stability problems for viscoelastic solids and elements of structures with which this book is concerned has been the focus of attention in the past three decades This has been due to the wide inculcation of viscoelastic materials especially polymers and plastics in industry Up to date studies in viscoelasticity are published partially in purely mathematical journals partially in merely applied ones and as a consequence they remain unknown to many interested specialists **Stability in Viscoelasticity** fills the gap between engineers and mathematicians and converges theoretical and applied directions of investigations All chapters contain extensive bibliographies of both purely mathematical and engineering works on stability problems The bibliography includes a number of works in Russian which are practically inaccessible to the Western reader

**Boundary Value Problems of Mathematical Physics** Ol'ga A. Ladyženskaja, 1991 **The Rational Spirit in Modern Continuum Mechanics** Chi-Sing Man, Roger L. Fosdick, 2006-01-19 Through his voluminous and influential writings editorial activities organizational leadership intellectual acumen and strong sense of history Clifford Truesdell III 1919 2000 was the main architect for the renaissance of rational continuum mechanics since the middle of the twentieth century The present collection of 42 essays and research papers pays tribute to this man of mathematics science and natural philosophy as well as to his legacy The first five essays by B D Coleman E Giusti W Noll J Serrin and D Speiser were texts of addresses given by their authors at the Meeting in memory of Clifford Truesdell which was held in Pisa in November 2000 In these essays the reader will find personal reminiscences of Clifford Truesdell the man and of some of his activities as scientist author editor historian of exact sciences and principal founding member of the Society for Natural Philosophy The bulk of the collection comprises 37 research papers which bear witness to the Truesdellian legacy These papers cover a wide range of topics what ties them together is the rational spirit Clifford Truesdell in his address upon receipt of a Birkhoff Prize in 1978 put the essence of modern continuum mechanics succinctly as conceptual analysis analysis not in the sense of the technical term but in the root meaning logical criticism dissection and creative scrutiny **Proceedings of the Estonian Academy of Sciences, Physics and Mathematics**, 2003-06 **Mathematical Modelling of Continuum Physics** Angelo Morro, Claudio Giorgi, 2023-03-19 This monograph provides a comprehensive and self contained treatment of continuum physics illustrating a systematic approach to the constitutive equations for wide ranging classes of materials Derivations of results are detailed through careful proofs and the contents have been developed to ensure a self contained and consistent presentation Part I reviews the kinematics of continuous bodies and illustrates the general setting of balance laws Essential preliminaries to continuum physics such as reference and current configurations transport relations singular surfaces objectivity and objective time derivatives are covered in detail A chapter on balance equations then develops the balance laws of mass linear momentum angular momentum energy and entropy as well as the balance laws in electromagnetism Part II is devoted to the

general requirements on constitutive models emphasizing the application of objectivity and consistency with the second law of thermodynamics Common models of simple materials are then reviewed and in this framework detailed descriptions are given of solids thermoelastic elastic and dissipative and fluids elastic thermoelastic viscous and Newtonian A wide of variety of constitutive models are investigated in Part III which consists of separate chapters focused on several types of non simple materials materials with memory aging and higher order grade materials mixtures micropolar media and porous materials The interaction of the electromagnetic field with deformation is also examined within electroelasticity magnetoelasticity and plasma theory Hysteretic effects and phase transitions are considered in Part IV A new approach is established by treating entropy production as a constitutive function in itself as is the case for entropy and entropy flux This proves to be conceptually and practically advantageous in the modelling of nonlinear phenomena such as those occurring in hysteretic continua e g plasticity electromagnetism and the physics of shape memory alloys Mathematical Modelling of Continuum Physics will be an important reference for mathematicians engineers physicists and other scientists interested in research or applications of continuum mechanics

**Mathematical Problems in Viscoelasticity** Michael Renardy, William Hrusa, John A. Nohel, 1987

**Crack and Contact Problems for Viscoelastic Bodies** G.A.C. Graham, J.R. Walton, 2014-05-04 The main emphasis of these Lecture Notes is on constructing solutions to specific viscoelastic boundary value problems however properties of the equations of viscoelasticity that provide the theoretical underpinnings for constructing such solutions are also covered Particular attention is paid to the solution of crack and contact problems This work is of interest in the context of polymer fracture modelling of material behaviour rebound testing of polymers and the phenomenon of hysteretic friction

**Solid Mechanics, Theory of Elasticity and Creep** Holm Altenbach, Suren Manuk Mkhitarian, Vahram Hakobyan, Avetik Varazdat Sahakyan, 2023-02-06 This book presents fundamental theoretical and experimental studies of well known scientists in solid mechanics hydromechanics aeromechanics biomechanics etc These studies relate to contact and mixed problems of the theory of elasticity and viscoelasticity tribology fracture mechanics electroelasticity magnetoelasticity as well as to the theory of anisotropic shells and plates and are aimed at application in various areas of engineering practice The book is devoted to the 110th birthday of academician N Kh Arutunyan

**Norm Estimations for Operator Valued Functions and Their Applications** Michael Gil, 2021-06-30 Intended for specialists in functional analysis and stability theory this work presents a systematic exposition of estimations for norms of operator valued functions and applies the estimates to spectrum perturbations of linear operators and stability theory The author demonstrates his own approach to spectrum perturbations

*Evolution Equations, Semigroups and Functional Analysis* Brunello Terreni, 2002 Brunello Terreni 1953 2000 was a researcher and teacher with vision and dedication The present volume is dedicated to the memory of Brunello Terreni His mathematical interests are reflected in 20 expository articles written by distinguished mathematicians The unifying theme of the articles is evolution equations and functional analysis which is presented in various and diverse forms parabolic

equations semigroups stochastic evolution optimal control existence uniqueness and regularity of solutions inverse problems as well as applications Contributors P Acquistapace V Barbu A Briani L Boccardo P Colli Franzone G Da Prato D Donatelli A Favini M Fuhrmann M Grasselli R Illner H Koch R Labbas H Lange I Lasiecka A Lorenzi A Lunardi P Marcati R Nagel G Nickel V Pata M M Porzio B Ruf G Savar R Schnaubelt E Sinestrari H Tanabe H Teismann E Terraneo R Triggiani A Yagi



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