Geometrical Foundations Of Continuum Mechanics An Application To First And Second Order Elasticity And Elasto Plasticity Lecture Notes In Applied Mathematics And Mechanics

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Error Estimates for Advanced Galerkin Methods - Marcus Olavi Rüter 2019-11-07
This monograph provides a compendium of established and novel error estimation procedures applied in the field of Computational Mechanics. It also includes detailed derivations of these procedures to offer insights into the concepts used to control the errors obtained from employing Galerkin methods in finite and linearized hyperelasticity. The Galerkin methods introduced are considered advanced methods because they remedy certain shortcomings of the well-established finite element method, which is the archetypal Galerkin (mesh-based) method. In particular, this monograph focuses on the systematical derivation of the shape functions used to construct both Galerkin mesh-based and meshfree methods. The mesh-based methods considered are the (conventional) displacement-based, (dual-)mixed, smoothed, and extended finite element methods. In addition, it introduces the element-free Galerkin and reproducing kernel particle methods as representatives of a class of Galerkin meshfree methods. Including illustrative numerical examples relevant to engineering with an emphasis on elastic fracture mechanics problems, this monograph is intended for students, researchers, and practitioners aiming to increase the reliability of their numerical simulations and wanting to better grasp the concepts of Galerkin methods and associated error estimation procedures.

The Mechanics of Ribbons and Möbius Bands - Roger Fosdick 2015-08-14
Recent developments in biology and nanotechnology have stimulated a rapidly growing interest in the mechanics of thin, flexible ribbons and Mobius bands. This edited volume contains English translations of four seminal papers on this topic, all originally written in German; of these, Michael A. Sadowsky published the first in 1929, followed by two others

in 1930, and Walter Wunderlich published the last in 1962. The volume also contains invited, peer-reviewed, original research articles on related topics. Previously published in the Journal of Elasticity, Volume 119, Issue 1-2, 2015.

The Geometrical Language of Continuum Mechanics - Marcelo Epstein 2010-07-26

Epstein presents the fundamental concepts of modern differential geometry within the framework of continuum mechanics. Divided into three parts of roughly equal length, the book opens with a motivational chapter to impress upon the reader that differential geometry is indeed the natural language of continuum mechanics or, better still, that the latter is a prime example of the application and materialisation of the former. In the second part, the fundamental notions of differential geometry are presented with rigor using a writing style that is as informal as possible. Differentiable manifolds, tangent bundles, exterior derivatives, Lie derivatives, and Lie groups are illustrated in terms of their mechanical interpretations. The third part includes the theory of fiber bundles, G-structures, and groupoids, which are applicable to bodies with internal structure and to the description of material inhomogeneity. The abstract notions of differential geometry are thus illuminated by practical and intuitively meaningful engineering applications.

The Foundations of Mechanics and Thermodynamics - W. Noll 2012-12-06

German scholars, against odds now not only forgotten but also hard to imagine, were striving to revivify the life of the mind which the mental and physical barbarity preached and practised by the -isms and -acies of 1933-1946 had all but eradicated. Thinking that among the disciples of these elders, restorers rather than progressives, I might find a student or two who would wish to master new mathematics but grasp it and use it with the wholeness of earlier times, in 1952 I wrote to Mr. HAMEL, one of the few then remaining mathematicians from the classical mould, to ask him to name some young men fit to study for the doc torate in The Graduate Institute for Applied Mathematics at Indiana University, flourishing at that time though soon to be destroyed by the jealous ambition of the local, stereotyped pure. Having just retired from the Technische Universitat in Charlottenburg, he passed my inquiry on to Mr. SZABO, in whose institute there NOLL was then an assistant. Although Mr.

Maximum Dissipation Non-Equilibrium Thermodynamics and its Geometric Structure - Henry W. Haslach Jr. 2011-01-15

Maximum Dissipation: Non-Equilibrium Thermodynamics and its Geometric Structure explores the thermodynamics of non-equilibrium processes in materials. The book develops a general technique created in order to construct nonlinear evolution equations describing non-equilibrium processes, while also developing a geometric context for non-equilibrium thermodynamics. Solid materials are the main focus in this volume, but the construction is shown to also apply to fluids. This volume also: • Explains the theory behind thermodynamically-consistent construction of non-linear evolution equations for non-equilibrium processes • Provides a geometric setting for non-equilibrium thermodynamics through several standard models, which are defined as maximum dissipation processes • Emphasizes applications to the time-dependent modeling of soft biological tissue Maximum Dissipation: Non-Equilibrium Thermodynamics and its Geometric Structure will be valuable for researchers, engineers and graduate students in non-equilibrium thermodynamics and the mathematical modeling of material behavior.

Material Geometry: Groupoids In Continuum Mechanics - Manuel De Leon 2021-04-23

This monograph is the first in which the theory of groupoids and algebroids is applied to the study of the properties of uniformity and homogeneity of continuous media. It is a further step in the application of differential geometry to the mechanics of continua, initiated years ago with the introduction of the theory of G-structures, in which the group G denotes the group of material symmetries, to study smoothly uniform materials.The new approach presented in this book goes much further by being much more general. It is not a generalization per se, but rather a natural way of considering the algebraic-geometric structure induced by the so-called material isomorphisms. This approach has allowed us to encompass non-uniform materials and discover new properties of uniformity and homogeneity that certain material bodies can possess, thus opening a new area in the discipline.

Applied Mechanics Reviews - 1984

Foundations and Applications of Mechanics: Fluid mechanics - C. S. Jog 2002

Foundations and Applications of Mechanics: Volume II, Fluid Mechanics shows how suitable approximations such as ideal fluid flow model, boundary layer methods, and the acoustic approximation, can help solve problems of practical importance. The author proceeds from the general to the particular, making it clear at each stage what assumptions have been made to obtain a particular approximation. In his discussion of compressible fluids, Jog steers away from using gas tables and emphasizes obtaining solutions by numerical techniques - an approach more amenable to computer solutions. He discusses the control volume and the differential equation forms of governing equations in detail and uses examples to demonstrate the advantages and shortcomings of each approach.

Elasticity and Plasticity of Large Deformations - Albrecht Bertram 2021-04-07

This book presents an introduction to material theory and, in particular, to elasticity, plasticity and viscoelasticity, to bring the reader close to the frontiers of today's knowledge in these particular fields. It starts right from the beginning without assuming much knowledge of the subject. Hence, the book is generally comprehensible to all engineers, physicists, mathematicians, and others. At the beginning of each new section, a brief Comment on the Literature contains recommendations for further reading. This book includes an updated reference list and over 100 changes throughout the book. It contains the latest knowledge on the subject. Two new chapters have been added in this new edition. Now finite viscoelasticity is included, and an Essay on gradient materials, which have recently drawn much attention.

IUTAM Symposium on Theoretical and Numerical Methods in Continuum Mechanics of Porous Materials - Wolfgang Ehlers 2006-04-11

During the last decades, continuum mechanics of porous materials has achieved great attention, since it allows for the consideration of the volumetrically coupled behaviour of the solid matrix deformation and the pore-fluid flow. Naturally, applications of porous media models range from civil and environmental engineering, where, e. g. , geote- nical problems like the consolidation problem are of great interest, via mechanical engineering, where, e. g. , the description of sinter materials or polymeric and metallic foams is a typical problem, to chemical and biomechanical engineering, where, e. g. , the complex structure of l- ing tissues is studied. Although these applications are principally very different, they basically fall into the category of multiphase materials, which can be described, on the macroscale, within the framework of the well-founded Theory of Porous Media (TPM). With the increasing power of computer hardware together with the rapidly decreasing computational costs, numerical solutions of complex coupled problems became possible and have been seriously investigated. However, since the quality of the numerical solutions strongly depends on the quality of the underlying physical model together with the experimental and mathematical possibilities to successfully determine realistic material parameters, a successful treatment of porous materials requires a joint consideration of continuum mechanics, experimental mechanics and numerical methods. In addition, micromechanical - vestigations and homogenization techniques are very helpful to increase the phenomenological understanding of such media.

Mathematical Foundations of Elasticity - Jerrold E. Marsden 2012-10-25

Graduate-level study approaches mathematical foundations of three-dimensional elasticity using modern differential geometry and functional analysis. It presents a classical subject in a modern setting, with examples of newer mathematical contributions. 1983 edition.

Multiscale Modeling Approaches for Composites - George

Chatzigeorgiou 2022-01-15
Multiscale Modeling Approaches for Composites outlines the fundamentals of common multiscale modeling techniques and provides detailed guidance for putting them into practice. Various homogenization methods are presented in a simple, didactic manner, with an array of numerical examples. The book starts by covering the theoretical underpinnings of tensors and continuum mechanics concepts, then passes to actual micromechanic techniques for composite media and laminate plates. In the last chapters the book covers advanced topics in homogenization, including Green's tensor, Hashin-Shtrikman bounds, and special types of problems. All chapters feature comprehensive analytical and numerical examples (Python and ABAQUS scripts) to better illustrate the theory. Bridges theory and practice, providing step-by-step instructions for implementing multiscale modeling approaches for composites and the theoretical concepts behind them Covers boundary conditions, data-exchange between scales, the Hill-Mandel principle, average stress and strain theorems, and more Discusses how to obtain composite properties using different boundary conditions Includes access to a companion site, featuring the numerical examples, Python and ABACUS codes discussed in the book

Applications Of Tensor Analysis In Continuum Mechanics - Michael J Cloud 2018-07-10
'A strong point of this book is its coverage of tensor theory, which is herein deemed both more readable and more substantial than many other historic continuum mechanics books. The book is self-contained. It serves admirably as a reference resource on fundamental principles and equations of tensor mathematics applied to continuum mechanics. Exercises and problem sets are useful for teaching … The book is highly recommended as both a graduate textbook and a reference work for students and more senior researchers involved in theoretical and mathematical modelling of continuum mechanics of materials. Key concepts are well described in the text and are supplemented by informative exercises and problem sets with solutions, and comprehensive Appendices provide important equations for ease of reference.'Contemporary PhysicsA tensor field is a tensor-valued function of position in space. The use of tensor fields allows us to present physical laws in a clear, compact form. A byproduct is a set of simple and clear rules for the representation of vector differential operators such as gradient, divergence, and Laplacian in curvilinear coordinate systems. The tensorial nature of a quantity permits us to formulate transformation rules for its components under a change of basis. These rules are relatively simple and easily grasped by any engineering student familiar with matrix operators in linear algebra. More complex problems arise when one considers the tensor fields that describe continuum bodies. In this case general curvilinear coordinates become necessary. The principal basis of a curvilinear system is constructed as a set of vectors tangent to the coordinate lines. Another basis, called the dual basis, is also constructed in a special manner. The existence of these two bases is responsible for the mysterious covariant and contravariant terminology encountered in tensor discussions.This book provides a clear, concise, and self-contained treatment of tensors and tensor fields. It covers the foundations of linear elasticity, shell theory, and generalized continuum media, offers hints, answers, and full solutions for many of the problems and exercises, and Includes a handbook-style summary of important tensor formulas.The book can be useful for beginners who are interested in the basics of tensor calculus. It also can be used by experienced readers who seek a comprehensive review on applications of the tensor calculus in mechanics.

Continuum Mechanics - Myron B. Allen, III 2015-07-20
Presents a self-contained introduction to continuum mechanics that illustrates how many of the important partial differential equations of applied mathematics arise from continuum modeling principles Written as an accessible introduction, Continuum Mechanics: The Birthplace of Mathematical Models provides a comprehensive foundation for mathematical models used in fluid mechanics, solid mechanics, and heat transfer. The book features derivations of commonly used differential equations based on the fundamental continuum mechanical concepts encountered in various fields, such as engineering, physics, and

geophysics. The book begins with geometric, algebraic, and analytical foundations before introducing topics in kinematics. The book then addresses balance laws, constitutive relations, and constitutive theory. Finally, the book presents an approach to multiconstituent continua based on mixture theory to illustrate how phenomena, such as diffusion and porous-media flow, obey continuum-mechanical principles. Continuum Mechanics: The Birthplace of Mathematical Models features: Direct vector and tensor notation to minimize the reliance on particular coordinate systems when presenting the theory Terminology that is aligned with standard courses in vector calculus and linear algebra The use of Cartesian coordinates in the examples and problems to provide readers with a familiar setting Over 200 exercises and problems with hints and solutions in an appendix Introductions to constitutive theory and multiconstituent continua, which are distinctive for books at this level Continuum Mechanics: The Birthplace of Mathematical Models is an ideal textbook for courses on continuum mechanics for upper-undergraduate mathematics majors and graduate students in applied mathematics, mechanical engineering, civil engineering, physics, and geophysics. The book is also an excellent reference for professional mathematicians, physical scientists, and engineers.

The Catalogue of Computational Material Models - Paul Steinmann 2021-03-20

This book gives a comprehensive account of the formulation and computational treatment of basic geometrically linear models in 1D. To set the stage, it assembles some preliminaries regarding necessary modelling, computational and mathematical tools. Thereafter, the remaining parts are concerned with the actual catalogue of computational material models. To this end, after starting out with elasticity as a reference, further 15 different basic variants of material models (5 x each of {visco-elasticity, plasticity, visco-plasticity}, respectively) are systematically explored. The presentation for each of these basic material models is a stand-alone account and follows in each case the same structure. On the one hand, this allows, in the true sense of a catalogue, to consult each of the basic material models separately without the need to refer to other basic material models. On the other hand, even though this somewhat repetitious concept may seem tedious, it allows to compare the formulation and resulting algorithmic setting of the various basic material models and thereby to uncover, in detail, similarities and differences. In particular, the response of each basic material model is analysed for the identical histories (Zig-Zag, Sine, Ramp) of prescribed strain and stress so as to clearly showcase and to contrast to each other the characteristics of the various modelling options.

Mathematical Elasticity - Philippe G. Ciarlet 2022-01-22

The first book of a three-volume set, Three-Dimensional Elasticity covers the modeling and mathematical analysis of nonlinear three-dimensional elasticity. It includes the known existence theorems, either via the implicit function theorem or via the minimization of the energy (John Ball’s theory). An extended preface and extensive bibliography have been added to highlight the progress that has been made since the volume’s original publication. While each one of the three volumes is self-contained, together the Mathematical Elasticity set provides the only modern treatise on elasticity; introduces contemporary research on three-dimensional elasticity, the theory of plates, and the theory of shells; and contains proofs, detailed surveys of all mathematical prerequisites, and many problems for teaching and self-study. These classic textbooks are for advanced undergraduates, first-year graduate students, and researchers in pure or applied mathematics or continuum mechanics. They are appropriate for courses in mathematical elasticity, theory of plates and shells, continuum mechanics, computational mechanics, and applied mathematics in general.

Spatial and Material Forces in Nonlinear Continuum Mechanics - Paul Steinmann 2022-03-28

This monograph details spatial and material vistas on non-linear continuum mechanics in a dissipation-consistent approach. Thereby, the spatial vista renders the common approach to nonlinear continuum mechanics and corresponding spatial forces, whereas the material vista elaborates on configurational mechanics and corresponding material or rather configurational forces. Fundamental to configurational mechanics is the concept of force. In analytical mechanics, force is a derived object that is power conjugate to changes of generalised coordinates. For a continuum body, these are typically the spatial positions of its continuum points. However, if in agreement with the second law, continuum points, e.g. on the boundary, may also change their material positions. Configurational forces are then power conjugate to these configurational changes. A paradigm is a crack tip, i.e. a singular part of the boundary changing its position during crack propagation, with the related configurational force, typically the J-integral, driving its evolution, thereby consuming power, typically expressed as the energy release rate. Taken together, configurational mechanics is an unconventional branch of continuum physics rationalising and unifying the tendency of a continuum body to change its material configuration. It is thus the ideal formulation to tackle sophisticated problems in continuum defect mechanics. Configurational mechanics is entirely free of restrictions regarding geometrical and constitutive nonlinearities and offers an accompanying versatile computational approach to continuum defect mechanics. In this monograph, I present a detailed summary account of my approach towards configurational mechanics, thereby fostering my view that configurational forces are indeed dissipation-consistent to configurational changes.

Tensor Analysis with Applications in Mechanics - L. P. Lebedev 2010

The tensorial nature of a quantity permits us to formulate transformation rules for its components under a change of basis. These rules are relatively simple and easily grasped by any engineering student familiar with matrix operators in linear algebra. More complex problems arise when one considers the tensor fields that describe continuum bodies. In this case general curvilinear coordinates become necessary. The principal basis of a curvilinear system is constructed as a set of vectors tangent to the coordinate lines. Another basis, called the dual basis, is also constructed in a special manner. The existence of these two bases is responsible for the mysterious covariant and contravariant terminology encountered in tensor discussions. A tensor field is a tensor-valued function of position in space. The use of tensor fields allows us to present physical laws in a clear, compact form. A byproduct is a set of simple and clear rules for the representation of vector differential operators such as gradient, divergence, and Laplacian in curvilinear coordinate systems. This book is a clear, concise, and self-contained treatment of tensors, tensor fields, and their applications. The book contains practically all the material on tensors needed for applications. It shows how this material is applied in mechanics, covering the foundations of the linear theories of elasticity and elastic shells. The main results are all presented in the first four chapters. The remainder of the book shows how one can apply these results to differential geometry and the study of various types of objects in continuum mechanics such as elastic bodies, plates, and shells. Each chapter of this new edition is supplied with exercises and problems most with solutions, hints, or answers to help the reader progress. An extended appendix serves as a handbook-style summary of all important formulas contained in the book.

The Geometry of Physics - Theodore Frankel 2011-11-03

This book provides a working knowledge of those parts of exterior differential forms, differential geometry, algebraic and differential topology, Lie groups, vector bundles and Chern forms that are essential for a deeper understanding of both classical and modern physics and engineering. Included are discussions of analytical and fluid dynamics, electromagnetism (in flat and curved space), thermodynamics, the Dirac operator and spinors, and gauge fields, including Yang–Mills, the Aharonov–Bohm effect, Berry phase and instanton winding numbers, quarks and quark model for mesons. Before discussing abstract notions of differential geometry, geometric intuition is developed through a rather extensive introduction to the study of surfaces in ordinary space. The book is ideal for graduate and advanced undergraduate students of physics, engineering or mathematics as a course text or for self study. This third edition includes an overview of Cartan's exterior differential forms, which previews many of the geometric concepts developed in the text.

General Continuum Mechanics - T. J. Chung 2007-01-29

General Continuum Mechanics provides an integrated and unified study of continuum mechanics.

Geometry of Incompatible Deformations - 2019-03-04

Differential Geometry - Marcelo Epstein 2016-09-10

Differential Geometry offers a concise introduction to some basic notions of modern differential geometry and their applications to solid mechanics and physics. Concepts such as manifolds, groups, fibre bundles and groupoids are first introduced within a purely topological framework. They are shown to be relevant to the description of space-time, configuration spaces of mechanical systems, symmetries in general, microstructure and local and distant symmetries of the constitutive response of continuous media. Once these ideas have been grasped at the topological level, the differential structure needed for the description of physical fields is introduced in terms of differentiable manifolds and principal frame bundles. These mathematical concepts are then illustrated with examples from continuum kinematics, Lagrangian and Hamiltonian mechanics, Cauchy fluxes and dislocation theory. This book will be useful for researchers and graduate students in science and engineering.

Nonlinear Elastic and Inelastic Models for Shock Compression of Crystalline Solids - John D. Clayton 2019-05-17

This book describes thermoelastic and inelastic deformation processes in crystalline solids undergoing loading by shock compression. Constitutive models with a basis in geometrically nonlinear continuum mechanics supply these descriptions. Large deformations such as finite strains and rotations, are addressed. The book covers dominant mechanisms of nonlinear thermoelasticity, dislocation plasticity, deformation twinning, fracture, flow, and other structure changes. Rigorous derivations of theoretical results are provided, with approximately 1300 numbered equations and an extensive bibliography of over 500 historical and modern references spanning from the 1920s to the present day. Case studies contain property data, as well as analytical, and numerical solutions to shock compression problems for different materials. Such materials are metals, ceramics, and minerals, single crystalline and polycrystalline. The intended audience of this book is practicing scientists (physicists, engineers, materials scientists, and applied mathematicians) involved in advanced research on shock compression of solid materials.

Geometry and Continuum Mechanics - Giovanni Romano 2014-11-01

Continuum Mechanics (CM) is a natural field of application of concepts and methods of Differential Geometry (DG). The very foundations of both disciplines are intertwined in a deep manner. A presentation of basic issues in CM adopting the powerful tools of modern DG is still substantially lacking. This booklet is intended to contribute to fill this gap, with specific reference to Elasticity theory. The classical subject is thoroughly revisited and revised in its basic aspects and in the general context of finite deformations. A case study of rubber-like materials enlightens the new concepts introduced by the geometric theory and opens the way for applications to soft materials such as the ones of interest in biomechanics.

Tensor Analysis and Continuum Mechanics - Y.R. Talpaert 2002

This book is designed for students in engineering, physics and mathematics. The material can be taught from the beginning of the third academic year. It could also be used for self study, given its pedagogical structure and the numerous solved problems which prepare for modem physics and technology. One of the original aspects of this work is the development together of the basic theory of tensors and the foundations of continuum mechanics. Why two books in one? Firstly, Tensor Analysis provides a thorough introduction of intrinsic mathematical entities, called tensors, which is essential for continuum mechanics. This way of proceeding greatly unifies the various subjects. Only some basic knowledge of linear algebra is necessary to start out on the topic of tensors. The essence of the mathematical foundations is introduced in a practical way. Tensor developments are often too abstract, since they are either aimed at algebraists only, or too quickly applied to physicists and engineers. Here a good balance has been found which allows these extremes to be brought closer together. Though the exposition of tensor theory forms a subject in itself, it is viewed not only as an autonomous mathematical discipline, but as a preparation for theories of physics and engineering. More specifically, because this part of the work deals with tensors in general coordinates and not solely in Cartesian coordinates, it will greatly help with many different disciplines such as differential geometry, analytical mechanics, continuum mechanics, special relativity, general relativity, cosmology, electromagnetism, quantum mechanics, etc ..

Geometrical Foundations of Continuum Mechanics - John Arthur Simmons 1962

Differential Geometry and Continuum Mechanics - Gui-Qiang G. Chen 2015-08-11

This book examines the exciting interface between differential geometry and continuum mechanics, now recognised as being of increasing technological significance. Topics discussed include isometric embeddings in differential geometry and the relation with microstructure in nonlinear elasticity, the use of manifolds in the description of microstructure in continuum mechanics, experimental measurement of microstructure, defects, dislocations, surface energies, and nematic liquid crystals. Compensated compactness in partial differential equations is also treated. The volume is intended for specialists and non-specialists in pure and applied geometry, continuum mechanics, theoretical physics, materials and engineering sciences, and partial differential equations. It will also be of interest to postdoctoral scientists and advanced postgraduate research students. These proceedings include revised written versions of the majority of papers presented by leading experts at the ICMS Edinburgh Workshop on Differential Geometry and Continuum Mechanics held in June 2013. All papers have been peer reviewed.

Geometrical Foundations of Continuum Mechanics - Paul Steinmann 2015-04-07

This book illustrates the deep roots of the geometrically nonlinear kinematics of generalized continuum mechanics in differential geometry. Besides applications to first- order elasticity and elasto-plasticity an appreciation thereof is particularly illuminating for generalized models of continuum mechanics such as second-order (gradient-type) elasticity and elasto-plasticity. After a motivation that arises from considering geometrically linear first- and second- order crystal plasticity in Part I several concepts from differential geometry, relevant for what follows, such as connection, parallel transport, torsion, curvature, and metric for holonomic and anholonomic coordinate transformations are reiterated in Part II. Then, in Part III, the kinematics of geometrically nonlinear continuum mechanics are considered. There various concepts of differential geometry, in particular aspects related to compatibility, are generically applied to the kinematics of first- and second- order geometrically nonlinear continuum mechanics. Together with the discussion on the integrability conditions for the distortions and double-distortions, the concepts of dislocation, disclination and point-defect density tensors are introduced. For concreteness, after touching on nonlinear first- and second-order elasticity, a detailed discussion of the kinematics of (multiplicative) first- and second-order elasto-plasticity is given. The discussion naturally culminates in a comprehensive set of different types of dislocation, disclination and point-defect density tensors. It is argued, that these can potentially be used to model densities of geometrically necessary defects and the accompanying hardening in crystalline materials. Eventually Part IV summarizes the above findings on integrability whereby distinction is made between the straightforward conditions for the distortion and the double-distortion being integrable and the more involved conditions for the strain (metric) and the double-strain (connection) being integrable. The book addresses readers with an interest in continuum modelling of solids from engineering and the sciences alike, whereby a sound knowledge of tensor calculus and continuum mechanics is required as a prerequisite.

Geometric Continuum Mechanics - Reuven Segev 2020-05-13

This contributed volume explores the applications of various topics in modern differential geometry to the foundations of continuum mechanics. In particular, the contributors use notions from areas such as global analysis, algebraic topology, and geometric measure theory. Chapter authors are experts in their respective areas, and provide important insights from the most recent research. Organized into two parts, the book first covers kinematics, forces, and stress theory, and then addresses defects, uniformity, and homogeneity. Specific topics covered include: Global stress and hyper-stress theories Applications of de Rham currents to singular dislocations Manifolds of mappings for continuum mechanics Kinematics of defects in solid crystals Geometric Continuum Mechanics will appeal to graduate students and researchers in the fields of mechanics, physics, and engineering who seek a more rigorous mathematical understanding of the area. Mathematicians interested in applications of analysis and geometry will also find the topics covered here of interest.

Generalized Continua - from the Theory to Engineering Applications - Holm Altenbach 2012-10-17

On the roots of continuum mechanics in differential geometry -- a review.- Cosserat media.- Cosserat-type shells.- Cosserat-type rods.- Micromorphic media.- Electromagnetism and generalized continua.- Computational methods for generalized continua. The need of generalized continua models is coming from practice. Complex material behavior sometimes cannot be presented by the classical Cauchy continua. At present the attention of the scientists in this field is focused on the most recent research items • new models, • application of well-known models to new problems, • micro-macro aspects, • computational effort, and • possibilities to identify the constitutive equations The new research directions are discussed in this volume - from the point of view of modeling and simulation, identification, and numerical methods.

Continuum Mechanics - C. S. Jog 2015-06-25

"Presents several advanced topics including fourth-order tensors, differentiation of tensors, exponential and logarithmic tensors, and their application to nonlinear elasticity"--

Continuum Thermodynamics - Part Ii: Applications And Examples - Wilmanski Krzysztof 2014-11-12

This second part of Continuum Thermodynamics is designed to match almost one-to-one the chapters of Part I. This is done so that the reader studying thermodynamics will have a deepened understanding of the subjects covered in Part I. The aims of the book are in particular: the illustration of basic features of some simple thermodynamical models such as ideal and viscous fluids, non-Newtonian fluids, nonlinear solids, interactions with electromagnetic fields, and diffusive porous materials. A further aim is the illustration of the above subjects by examples and simple solutions of initial and boundary problems as well as simple exercises to develop skills in the construction of interdisciplinary macroscopic models.

Geometrical Foundations of Continuum Mechanics - Paul Steinmann 2015-03-25

This book illustrates the deep roots of the geometrically nonlinear kinematics of generalized continuum mechanics in differential geometry. Besides applications to first- order elasticity and elasto-plasticity an appreciation thereof is particularly illuminating for generalized models of continuum mechanics such as second-order (gradient-type) elasticity and elasto-plasticity. After a motivation that arises from considering geometrically linear first- and second- order crystal plasticity in Part I several concepts from differential geometry, relevant for what follows, such as connection, parallel transport, torsion, curvature, and metric for holonomic and anholonomic coordinate transformations are reiterated in Part II. Then, in Part III, the kinematics of geometrically nonlinear continuum mechanics are considered. There various concepts of differential geometry, in particular aspects related to compatibility, are generically applied to the kinematics of first- and second- order geometrically nonlinear continuum mechanics. Together with the discussion on the integrability conditions for the distortions and double-distortions, the concepts of dislocation, disclination and point-defect density tensors are introduced. For concreteness, after touching on nonlinear fir st- and second-order elasticity, a detailed discussion of the kinematics of (multiplicative) first- and second-order elasto-plasticity is given. The discussion naturally culminates in a comprehensive set of different types of dislocation, disclination and point-defect density tensors. It is argued, that these can potentially be used to model densities of geometrically necessary defects and the accompanying hardening in crystalline materials. Eventually Part IV summarizes the above findings on integrability whereby distinction is made between the straightforward conditions for the distortion and the double-distortion being integrable and the more involved conditions for the strain (metric) and the double-strain (connection) being integrable. The book addresses readers with an interest in continuum modelling of solids from engineering and the sciences alike, whereby a sound knowledge of tensor calculus and continuum mechanics is required as a prerequisite.

The Mathematical World of Walter Noll - Yurie A. Ignatieff 2013-03-09

The book stresses particularly Noll's method of axiomatization of physical theories, his axiomatics of continuum mechanics, thermodynamics of materials, special relativity theory, his discovery of the neo-classical space-time of mechanics, his theories of inhomogeneities in simple bodies, fit regions, contact interactions, annihilators of linear differential operators, and finite-dimensional spaces.

Geometric Continuum Mechanics and Induced Beam Theories - Simon R. Eugster 2015-03-19

This research monograph discusses novel approaches to geometric continuum mechanics and introduces beams as constraint continuous bodies. In the coordinate free and metric independent geometric formulation of continuum mechanics as well as for beam theories, the principle of virtual work serves as the fundamental principle of mechanics. Based on the perception of analytical mechanics that forces of a mechanical system are defined as dual quantities to the kinematical description, the virtual work approach is a systematic way to treat arbitrary mechanical systems. Whereas this methodology is very convenient to formulate induced beam theories, it is essential in geometric continuum mechanics when the assumptions on the physical space are relaxed and the space is modeled as a smooth manifold. The book addresses researcher and graduate students in engineering and mathematics interested in recent developments of a geometric formulation of continuum mechanics and a hierarchical development of induced beam theories.

On Foundations Of Seismology: Bringing Idealizations Down To Earth - James Robert Brown 2017-04-27

'I can wholeheartedly recommend this book students, researchers, college and university science professors, and readers of The Leading Edge. I also recommend it to all those who want to enrich their own experience of practicing and teaching science with some carefully considered soul searching on how it all fits together in the human story of ‘figuring things out’ … It is written throughout with precise and careful language: prudently paced, carefully crafted, eloquently enunciated, and playfully illuminated.'The Leading EdgeThis remarkable collaboration between a mathematical physicist and a science philosopher concerns foundational and conceptual issues in seismology. Their aim is to present mathematical, physical and philosophical topics in a clear and concise manner. They provide an extensive philosophical discussion of the methods of science and show how seismology fits in. They explain with care and precision the basic structure of seismology, which is built on classical continuum mechanics. Not only do they explain how various models work in seismology, they also include an extensive discussion of the nature of models and idealizations.

Nuclear Science Abstracts - 1962

Compendium on Gradient Materials - Albrecht Bertram 2022

This book offers frameworks for the material modeling of gradient materials both for finite and small deformations within elasticity, plasticity, viscosity, and thermomechanics. The first chapter focuses on balance laws and holds for all gradient materials. The next chapters are dedicated to the material modeling of second and third-order materials under finite deformations. Afterwards the scope is limited to the geometrically linear theory, i.e., to small deformations. The next chapter offers an extension of the concept of internal constraints to gradient materials. The final chapter is dedicated to incompressible viscous gradient fluids with the intention to describe, among other applications, turbulent flows, as already suggested by Saint-Venant in the middle of the 19th century.

Fundamentals of Continuum Mechanics - John W. Rudnicki 2014-11-10

A concise introductory course text on continuum mechanics Fundamentals of Continuum Mechanics focuses on the fundamentals of the subject and provides the background for formulation of numerical methods for large deformations and a wide range of material behaviours. It aims to provide the foundations for further study, not just of these subjects, but also the formulations for much more complex material behaviour and their implementation computationally. This book is divided into 5 parts, covering mathematical preliminaries, stress, motion and deformation, balance of mass, momentum and energy, and ideal constitutive relations and is a suitable textbook for introductory graduate courses for students in mechanical and civil engineering, as well as those studying material science, geology and geophysics and biomechanics. A concise introductory course text on continuum mechanics Covers the fundamentals of continuum mechanics Uses modern tensor notation Contains problems and accompanied by a companion website hosting solutions Suitable as a textbook for introductory graduate courses for students in mechanical and civil engineering

Geometric Foundations of Continuum Mechanics - John Arthur Simmons 1961