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Multiphysics in Porous Materials - Zhen (Leo) Liu 2018-07-12
This book summarizes, defines, and contextualizes multiphysics with an emphasis on porous materials. It covers various essential aspects of multiphysics, from history, definition, and scope to mathematical theories, physical mechanisms, and numerical implementations. The emphasis on porous materials maximizes readers' understanding as these substances are abundant in nature and a common breeding ground of multiphysical phenomena, especially complicated multiphysics. Dr. Liu's lucid and easy-to-follow presentation serve as a blueprint on the use of multiphysics as a leading edge technique for computer modeling. The contents are organized to facilitate the transition from familiar, monolithic physics such as heat transfer and pore water movement to state-of-the-art applications involving multiphysics, including poroelasticity, thermohydro-mechanical processes, electrokinetics, electromagnetics, fluid dynamics, fluid structure interaction, and electromagnetomechanics. This volume serves as both a general reference and specific treatise for various scientific and engineering disciplines involving multiphysics simulation and porous materials.
Modeling the Electrochemo-poromechanics of Ionic Polymer Metal Composites and Cell Clusters - Alessandro Leronni 2022-01-04
This book presents a novel continuum finite deformation framework addressing the complex interactions among electrostatics, species transport, and mechanics in solid networks immersed in a fluid phase of solvent and ions. Grounded on cutting-edge multiphysics theories for soft active materials, the proposed model is primarily applied to ionic polymer metal composites (IPMCs).

First, the influence of shear deformation on the IPMC response is analyzed through semi-analytical solutions obtained via the method of matched asymptotic expansions. Second, the novel electrochemo-poromechanical theory is used to predict the curvature relaxation and electric discharge that are observed in IPMC actuation and sensing, respectively, under a sustained stimulus. This newly formulated theory is, in turn, applied to biological cell clusters. Here, important mechanical considerations are integrated into classical bioelectrical models, thus offering novel insights into the interplay of mechanical and electrical signaling in the coordination of developmental processes.

Tensor Algebra and Tensor Analysis for Engineers - Mikhail Itskov 2007-05-04

There is a large gap between engineering courses in tensor algebra on one hand, and the treatment of linear transformations within classical linear algebra on the other. This book addresses primarily engineering students with some initial knowledge of matrix algebra. Thereby, mathematical formalism is applied as far as it is absolutely necessary. Numerous exercises provided in the book are accompanied by solutions enabling autonomous study. The last chapters deal with modern developments in the theory of isotropic and anisotropic tensor functions and their applications to continuum mechanics and might therefore be of high interest for PhD-students and scientists working in this area.

Tensor Analysis and Nonlinear Tensor Functions - Yuriy I. Dimitrienko 2002-11-30

Tensor Analysis and Nonlinear Tensor Functions embraces the basic fields of tensor calculus: tensor algebra, tensor analysis, tensor description of curves and surfaces, tensor integral calculus, the basis of tensor calculus in Riemannian spaces and affinely connected spaces, - which are used in mechanics and electrodynamics of continua, crystallophysics, quantum chemistry etc. The book suggests a new approach to definition of a tensor in space R3, which allows us to show a geometric representation of a tensor and operations on tensors. Based on this approach, the author gives a mathematically rigorous definition of a tensor as an individual object in arbitrary linear, Riemannian and other spaces for the first time. It is the first book to present a systematized theory of tensor invariants, a theory of nonlinear anisotropic tensor functions and a theory of indifferent tensors describing the physical properties of continua. The book will be useful for students and postgraduates of mathematical, mechanical engineering and physical departments of universities and also for investigators and academic scientists working in continuum mechanics, solid physics, general relativity, crystallophysics, quantum chemistry of solids and material science.

Computational Inelasticity - J.C. Simo 2006-05-07

A description of the theoretical foundations of inelasticity, its numerical formulation and implementation, constituting a representative sample of state-of-the-art methodology currently used in inelastic calculations. Among the numerous topics covered are small deformation plasticity and viscoplasticity, convex optimisation theory, integration algorithms for the constitutive equation of plasticity and viscoplasticity, the variational setting of boundary value problems and discretization by finite element methods. Also addressed are the generalisation of the theory to non-smooth yield surface, mathematical numerical analysis issues of

general return mapping algorithms, the generalisation to finite-strain inelasticity theory, objective integration algorithms for rate constitutive equations, the theory of hyperelastic-based plasticity models and small and large deformation viscoelasticity. Of great interest to researchers and graduate students in various branches of engineering, especially civil, aeronautical and mechanical, and applied mathematics.

General Relativity for Mathematicians - R.K. Sachs 2012-12-06

This is a book about physics, written for mathematicians. The readers we have in mind can be roughly described as those who: I. are mathematics graduate students with some knowledge of global differential geometry 2. have had the equivalent of freshman physics, and find popular accounts of astrophysics and cosmology interesting 3. appreciate mathematical elarity, but are willing to accept physical motiva tions for the mathematics in place of mathematical ones 4. are willing to spend time and effort mastering certain technical details, such as those in Section 1. 1. Each book disappoints so me readers. This one will disappoint: 1. physicists who want to use this book as a first course on differential geometry 2. mathematicians who think Lorentzian manifolds are wholly similar to Riemannian ones, or that, given a sufficiently good mathematical back ground, the essentials of a subject !ike cosmology can be learned without so me hard work on boring detaiis 3. those who believe vague philosophical arguments have more than historical and heuristic significance, that general relativity should somehow be "proved," or that axiomatization of this subject is useful 4. those who want an encyclopedic treatment (the books by Hawking-Ellis [1], Penrose [1], Weinberg [1], and Misner-Thorne-Wheeler [I] go further into the subject than we do; see also the survey article, Sachs-Wu [1]). 5. mathematicians who want to learn quantum physics or unified fieId theory (unfortunateIy, quantum physics texts all seem either to be for physicists, or merely concerned with formaI mathematics).

Manifolds, Tensor Analysis, and Applications - Ralph Abraham 2012-10-17

The purpose of this book is to provide core material in nonlinear analysis for mathematicians, physicists, engineers, and mathematical biologists. The main goal is to provide a working knowledge of manifolds, dynamical systems, tensors, and differential forms. Some applications to Hamiltonian mechanics, fluid me chanics, electromagnetism, plasma dynamics and control thcory arc given in Chapter 8, using both invariant and index notation. The current edition of the book does not deal with Riemannian geometry in much detail, and it does not treat Lie groups, principal bundles, or Morse theory. Some of this is planned for a subsequent edition. Meanwhile, the authors will make available to interested readers supplementary chapters on Lie Groups and Differential Topology and invite comments on the book's contents and development. Throughout the text supplementary topics are given, marked with the symbols ~ and {l:;J. This device enables the reader to skip various topics without disturbing the main flow of the text. Some of these provide additional background material intended for completeness, to minimize the necessity of consulting too many outside references. We treat finite and infinite-dimensional manifolds simultaneously. This is partly for efficiency of exposition. Without advanced applications, using

manifolds of mappings, the study of infinite-dimensional manifolds can be hard to motivate.
Calculus I - Brian Knight 2014-09-01

Transforming Domain into Boundary Integrals in BEM - Weifeng Tang 2012-12-06
CHAPTER 1 1-1 NUMERICAL METHODS For the last two or three decades, scientists and engineers have used numerical methods as an important tool in many different areas. This significant fact has its inexorable historical trend and it is the inevitable outcome of the recent developments in science, technology and industry. Analytical methods have been developed for a long period and have produced a great amount of successful results, but they failed to solve most practical engineering problems with complicated boundary conditions or irregular geometry. It is also very difficult to solve non-linear or time-dependent problems using analytical approaches, even if they are very simple. On the other hand, research on analytical methods has provided a solid foundation for different types of numerical methods. Because of the rapid developments of science and technology it is now necessary to solve complicated problems using more efficient and accurate approaches than before. Not only problems with complicated boundary conditions or irregular configurations require solutions but also non-linear or time-dependent problems must be solved. Computer hardware and software have developed at an unexpected high speed. During the last thirty years, ithaz become possible for scientists and engineers to use numerical methods with computers easily. This has 2 stimulated scientists and engineers to improve some classical numerical methods (such as finite difference method) and to establish new numerical methods (such as the finite element method and boundary element method). For all these reasons, numerical methods have rapidly developed in the areas of mechanics and engineering.
Understanding Viscoelasticity - Nhan Phan-Thien 2012-12-16
This book presents an introduction to viscoelasticity; in particular, to the theories of dilute polymer solutions and dilute suspensions of rigid particles in viscous and incompressible fluids. These theories are important, not just because they apply to practical problems of industrial interest, but because they form a solid theoretical base upon which mathematical techniques can be built, from which more complex theories can be constructed, to better mimic material behaviour. The emphasis is not on the voluminous current topical research, but on the necessary tools to understand viscoelasticity at a first year graduate level. The main aim is to provide a still compact book, sufficient at the level of first year graduate course for those who wish to understand viscoelasticity and to embark in modeling of viscoelastic multiphase fluids. To this end, a new chapter on Dissipative Particle Dynamics (DPD) was introduced which is relevant to model complex-structured fluids. All the basic ideas in DPD are reviewed, with some sample problems to illustrate the methodology.
Manifolds, Tensor Analysis, and Applications - Ralph Abraham 2012-12-06
The purpose of this book is to provide core material in nonlinear analysis for mathematicians, physicists, engineers, and mathematical biologists. The main goal is to provide a working knowledge of manifolds, dynamical systems, tensors, and differential forms. Some applications to Hamiltonian mechanics, fluid me chanics,

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Physics from Symmetry - Jakob Schwichtenberg 2015-06-04

This is a textbook that derives the fundamental theories of physics from symmetry. It starts by introducing, in a completely self-contained way, all mathematical tools needed to use symmetry ideas in physics. Thereafter, these tools are put into action and by using symmetry constraints, the fundamental equations of Quantum Mechanics, Quantum Field Theory, Electromagnetism, and Classical Mechanics are derived. As a result, the reader is able to understand the basic assumptions behind, and the connections between the modern theories of physics. The book concludes with first applications of the previously derived equations.

Theory and Practice of Solid Mechanics - Thomas Dawson 2012-12-06

This book is intended for use by engineers and scientists who have a need for an introduction to advanced topics in solid mechanics. It deals with modern concepts of continuum mechanics as well as with details of the classical theories of elasticity, thermal elasticity, viscous elasticity, and plasticity of solids. The book assumes no prior knowledge of the mechanics of solids and develops the subject entirely from first principles. Rigorous derivations of governing equations are also followed by applications to a number of basic and practical problems. Cartesian tensors are used throughout the book to express mathematical concepts in a clear and concise fashion. Chapter I, accordingly, provides a discussion of this topic for those readers not already familiar with it. This material is then followed by detailed discussions in Chapters 2 and 3 of the kinematics of continuum motion and the fundamental principles of mass conservation and momentum balance. Unlike traditional treatments, this material is first developed for the general large-deformation case and only then restricted to small deformations for use in the usual engineering appli cations. In this way the reader thus gets a fuller picture of the basic governing relations of solid mechanics.

Elliptic Curves - Dale Husem ller 2004

This work is an introduction to the theory of elliptic curves, ranging from its most elementary aspects to current research. This manuscript grew out of Tate's Haverford Lectures. For the second edition, the author has written three new chapters and there are also two new appendices which were written by S. Theisen and O.

Forster.

Handbook of Continuum Mechanics - Jean Salencon 2001-06-20

Outstanding approach to continuum mechanics. Its high mathematical level of teaching together with abstracts, summaries, boxes of essential formulae and numerous exercises with solutions, makes this handbook one of most complete books in the area. Students, lecturers, and practitioners will find this handbook a rich source for their studies or daily work.

Slow Viscous Flow - William E. Langlois 2014-04-15

Leonardo wrote, “Mechanics is the paradise of the mathematical sciences, because by means of it one comes to the fruits of mathematics”; replace “Mechanics” by “Fluid mechanics” and here we are. - From the Preface to the Second Edition Although the exponential growth of computer power has advanced the importance of simulations and visualization tools for elaborating new models, designs and technologies, the discipline of fluid mechanics is still large, and turbulence in flows remains a challenging problem in classical physics. Like its predecessor, the revised and expanded Second Edition of this book addresses the basic principles of fluid mechanics and solves fluid flow problems where viscous effects are the dominant physical phenomena. Much progress has occurred in the half a century that has passed since the edition of 1964. As predicted, aspects of hydrodynamics once considered offbeat have risen to importance. For example, the authors have worked on problems where variations in viscosity and surface tension cannot be ignored. The advent of nanotechnology has broadened interest in the hydrodynamics of thin films, and hydromagnetic effects and radiative heat transfer are routinely encountered in materials processing. This monograph develops the basic equations, in the three most important coordinate systems, in a way that makes it easy to incorporate these phenomena into the theory. The book originally described by Prof. Langlois as "a monograph on theoretical hydrodynamics, written in the language of applied mathematics" offers much new coverage including the second principle of thermodynamics, the Boussinesq approximation, time dependent flows, Marangoni convection, Kovasznay flow, plane periodic solutions, Hele-Shaw cells, Stokeslets, rotlets, finite element methods, Wannier flow, corner eddies, and analysis of the Stokes operator.

Connections Between Algebra, Combinatorics, and Geometry - Susan M. Cooper 2014-05-16

Commutative algebra, combinatorics, and algebraic geometry are thriving areas of mathematical research with a rich history of interaction. Connections Between Algebra and Geometry contains lecture notes, along with exercises and solutions, from the Workshop on Connections Between Algebra and Geometry held at the University of Regina from May 29-June 1, 2012. It also contains research and survey papers from academics invited to participate in the companion Special Session on Interactions Between Algebraic Geometry and Commutative Algebra, which was part of the CMS Summer Meeting at the University of Regina held June 2–3, 2012, and the meeting Further Connections Between Algebra and Geometry, which was held at the North Dakota State University February 23, 2013. This volume highlights three mini-courses in the areas of commutative algebra and algebraic geometry: differential graded commutative algebra, secant varieties, and fat points and symbolic powers. It will serve as a useful resource for graduate students and researchers who wish to expand their

knowledge of commutative algebra, algebraic geometry, combinatorics, and the intricacies of their intersection.

Understanding Viscoelasticity - Nhan Phan-Thien 2017

Statistical Decision Theory and Bayesian Analysis - James O. Berger 2013-03-14

In this new edition the author has added substantial material on Bayesian analysis, including lengthy new sections on such important topics as empirical and hierarchical Bayes analysis, Bayesian calculation, Bayesian communication, and group decision making. With these changes, the book can be used as a self-contained introduction to Bayesian analysis. In addition, much of the decision-theoretic portion of the text was updated, including new sections covering such modern topics as minimax multivariate (Stein) estimation.

Handbook of Conceptual Modeling - David W. Embley 2012-04-23

Conceptual modeling is about describing the semantics of software applications at a high level of abstraction in terms of structure, behavior, and user interaction. Embley and Thalheim start with a manifesto stating that the dream of developing information systems strictly by conceptual modeling – as expressed in the phrase “the model is the code” – is becoming reality. The subsequent contributions written by leading researchers in the field support the manifesto's assertions, showing not only how to abstractly model complex information systems but also how to formalize abstract specifications in ways that let developers complete programming tasks within the conceptual model itself. They are grouped into sections on programming with conceptual models, structure modeling, process modeling, user interface modeling, and special challenge areas such as conceptual geometric modeling, information integration, and biological conceptual modeling. The Handbook of Conceptual Modeling collects in a single volume many of the best conceptual-modeling ideas, techniques, and practices as well as the challenges that drive research in the field. Thus it is much more than a traditional handbook for advanced professionals, as it also provides both a firm foundation for the field of conceptual modeling, and points researchers and graduate students towards interesting challenges and paths for how to contribute to this fundamental field of computer science.

An Expedition to Continuum Theory - Wolfgang H. Müller 2014-01-18

This book introduces field theory as required in solid and fluid mechanics as well as in electromagnetism. It includes the necessary applied mathematical framework of tensor algebra and tensor calculus, using an inductive approach particularly suited to beginners. It is geared toward undergraduate classes in continuum theory for engineers in general, and more specifically to courses in continuum mechanics. Students will gain a sound basic understanding of the subject as well as the ability to solve engineering problems by applying the general laws of nature in terms of the balances for mass, momentum, and energy in combination with material-specific relations in terms of constitutive equations, thus learning how to use the theory in practice for themselves. This is facilitated by numerous examples and problems provided throughout the text.

Smooth Nonlinear Optimization in Rn - Tamás Rapcsák 2013-12-22

Experience gained during a ten-year long involvement in

modelling, program ming and application in nonlinear optimization helped me to arrive at the conclusion that in the interest of having successful applications and efficient software production, knowing the structure of the problem to be solved is in dispensable. This is the reason why I have chosen the field in question as the sphere of my research. Since in applications, mainly from among the nonconvex optimization models, the differentiable ones proved to be the most efficient in modelling, especially in solving them with computers, I started to deal with the structure of smooth optimization problems. The book, which is a result of more than a decade of research, can be equally useful for researchers and stu dents showing interest in the domain, since the elementary notions necessary for understanding the book constitute a part of the university curriculum. I in tended dealing with the key questions of optimization theory, which endeavour, obviously, cannot bear all the marks of completeness. What I consider the most crucial point is the uniform, differential geometric treatment of various questions, which provides the reader with opportunities for learning the structure in the wide range, within optimization problems. I am grateful to my family for affording me tranquil, productive circumstances. I express my gratitude to F.

From Vectors to Tensors - Juan R. Ruiz-Tolosa 2006-03-30

This textbook deals with tensors that are treated as vectors. Coverage details such new tensor concepts as the rotation of tensors, the transposer tensor, the eigentensors, and the permutation tensor structure. The book covers an existing gap between the classic theory of tensors and the possibility of solving tensor problems with a computer. A complementary computer package, written in Mathematica, is available through the Internet.

Finite Reflection Groups - L.C. Grove 2013-03-09

Chapter 1 introduces some of the terminology and notation used later and indicates prerequisites. Chapter 2 gives a reasonably thorough account of all finite subgroups of the orthogonal groups in two and three dimensions. The presentation is somewhat less formal than in succeeding chapters. For instance, the existence of the icosahedron is accepted as an empirical fact, and no formal proof of existence is included. Throughout most of Chapter 2 we do not distinguish between groups that are "geo metrically indistinguishable," that is, conjugate in the orthogonal group. Very little of the material in Chapter 2 is actually required for the sub sequent chapters, but it serves two important purposes: It aids in the development of geometrical insight, and it serves as a source of illustrative examples. There is a discussion offundamental regions in Chapter 3. Chapter 4 provides a correspondence between fundamental reflections and funda mental regions via a discussion of root systems. The actual classification and construction of finite reflection groups takes place in Chapter 5. where we have in part followed the methods of E. Witt and B. L. van der Waerden. Generators and relations for finite reflection groups are discussed in Chapter 6. There are historical remarks and suggestions for further reading in a Post lude.

Introduction to Tensor Analysis and the Calculus of Moving Surfaces - Pavel Grinfeld 2013-09-24

This textbook is distinguished from other texts on the subject by the depth of the presentation and the discussion of the calculus of moving surfaces, which is an extension of tensor calculus to deforming manifolds.

Designed for advanced undergraduate and graduate students, this text invites its audience to take a fresh look at previously learned material through the prism of tensor calculus. Once the framework is mastered, the student is introduced to new material which includes differential geometry on manifolds, shape optimization, boundary perturbation and dynamic fluid film equations. The language of tensors, originally championed by Einstein, is as fundamental as the languages of calculus and linear algebra and is one that every technical scientist ought to speak. The tensor technique, invented at the turn of the 20th century, is now considered classical. Yet, as the author shows, it remains remarkably vital and relevant. The author’s skilled lecturing capabilities are evident by the inclusion of insightful examples and a plethora of exercises. A great deal of material is devoted to the geometric fundamentals, the mechanics of change of variables, the proper use of the tensor notation and the discussion of the interplay between algebra and geometry. The early chapters have many words and few equations. The definition of a tensor comes only in Chapter 6 – when the reader is ready for it. While this text maintains a consistent level of rigor, it takes great care to avoid formalizing the subject. The last part of the textbook is devoted to the Calculus of Moving Surfaces. It is the first textbook exposition of this important technique and is one of the gems of this text. A number of exciting applications of the calculus are presented including shape optimization, boundary perturbation of boundary value problems and dynamic fluid film equations developed by the author in recent years. Furthermore, the moving surfaces framework is used to offer new derivations of classical results such as the geodesic equation and the celebrated Gauss-Bonnet theorem.

Nonlinear Continuum Mechanics of Solids - Yavuz Basar 2013-11-11

The aim of the book is the presentation of the fundamental mathematical and physical concepts of continuum mechanics of solids in a unified description so as to bring young researchers rapidly close to their research area. Accordingly, emphasis is given to concepts of permanent interest, and details of minor importance are omitted. The formulation is achieved systematically in absolute tensor notation, which is almost exclusively used in modern literature. This mathematical tool is presented such that study of the book is possible without permanent reference to other works.

Theory of Reflection of Electromagnetic and Particle Waves - John Lekner 2013-03-14

This book is written for scientists and engineers whose work involves wave reflec tion or transmission. Most of the book is written in the language of electromagnetic theory, but, as the title suggests, many of the results can be applied to particle waves, specifically to those satisfying the Schr6dinger equation. The mathematical connection between electromagnetic s (or TE) waves and quantum particle waves is established in Chapter 1. The main results for s waves are translated into quantum mechanical language in the Appendix. There is also a close analogy between acoustic waves and electromagnetic p (or TM) waves, as shown in Section 1-4. Thus the book, though primarily intended for those working in optics, microwaves and radio, will be of use to physicists, chemists and electrical engineers studying reflection and transmission of particles at potential barriers. The tech niques developed here can also be used by those

working in acoustics, ocean ography and seismology. Chapter 1 is recommended for all readers: it introduces reflection phenomena, defines the notation, and previews (in Section 1-6) the contents of the rest of the book. This preview will not be duplicated here. We note only that applied topics do appear: two examples are the important phenomenon of attenuated total reflection in Chapter 8, and the reflectivity of multilayer dielectric mirrors in Chapter 12. The subject matter is restricted to linear classical electrodynamics in non-magnetic media, and the corresponding particle analogues.

An Introduction to the Theory of Piezoelectricity - Jiashi Yang 2018-12-29

This textbook introduces theoretical piezoelectricity. The second edition updates a classical, seminal reference on a fundamental topic that is addressed in every materials science curriculum. It presents a concise treatment of the basic theoretical aspects of continuum modeling of electroelastic interactions in solids. The general nonlinear theory for large deformations and strong fields is established and specialized to the linear theory for small deformations and weak fields, i.e., the theory of piezoelectricity. Relatively simple and useful solutions of many static and dynamic problems of piezoelectricity that are useful in device applications are given. Emphasis is on the formulation of solutions to problems rather than advanced mathematical solution techniques. This book includes many examples to assist and enhance students' understanding of piezoelectricity and piezoelastics.

Algebra I - N. Bourbaki 1998-08-03

An exposition of the fundamentals of general, linear and multilinear algebra. The first chapter introduces the basic objects: groups, actions, rings, fields. The second chapter studies the properties of modules and linear maps, and the third investigatesalgebras, particularly tensor algebras.

Tensor Calculus for Engineers and Physicists - Emil de Souza Sánchez Filho 2016-05-20

This textbook provides a rigorous approach to tensor manifolds in several aspects relevant for Engineers and Physicists working in industry or academia. With a thorough, comprehensive, and unified presentation, this book offers insights into several topics of tensor analysis, which covers all aspects of n-dimensional spaces. The main purpose of this book is to give a self-contained yet simple, correct and comprehensive mathematical explanation of tensor calculus for undergraduate and graduate students and for professionals. In addition to many worked problems, this book features a selection of examples, solved step by step. Although no emphasis is placed on special and particular problems of Engineering or Physics, the text covers the fundamentals of these fields of science. The book makes a brief introduction into the basic concept of the tensorial formalism so as to allow the reader to make a quick and easy review of the essential topics that enable having the grounds for the subsequent themes, without needing to resort to other bibliographical sources on tensors. Chapter 1 deals with Fundamental Concepts about tensors and chapter 2 is devoted to the study of covariant, absolute and contravariant derivatives. The chapters 3 and 4 are dedicated to the Integral Theorems and Differential Operators, respectively. Chapter 5 deals with Riemann Spaces, and finally the chapter 6 presents a concise study of the Parallelism of Vectors. It also shows how to solve various problems of several particular

manifolds.

Tensor Spaces and Numerical Tensor Calculus - Wolfgang Hackbusch 2019-12-16

Special numerical techniques are already needed to deal with n × n matrices for large n. Tensor data are of size n × n ×...× n=nd, where nd exceeds the computer memory by far. They appear for problems of high spatial dimensions. Since standard methods fail, a particular tensor calculus is needed to treat such problems. This monograph describes the methods by which tensors can be practically treated and shows how numerical operations can be performed. Applications include problems from quantum chemistry, approximation of multivariate functions, solution of partial differential equations, for example with stochastic coefficients, and more. In addition to containing corrections of the unavoidable misprints, this revised second edition includes new parts ranging from single additional statements to new subchapters. The book is mainly addressed to numerical mathematicians and researchers working with high-dimensional data. It also touches problems related to Geometric Algebra.

Continuum Damage Mechanics - Sumio Murakami 2012-02-23

Recent developments in engineering and technology have brought about serious and enlarged demands for reliability, safety and economy in wide range of fields such as aeronautics, nuclear engineering, civil and structural engineering, automotive and production industry. This, in turn, has caused more interest in continuum damage mechanics and its engineering applications. This book aims to give a concise overview of the current state of damage mechanics, and then to show the fascinating possibility of this promising branch of mechanics, and to provide researchers, engineers and graduate students with an intelligible and self-contained textbook. The book consists of two parts and an appendix. Part I is concerned with the foundation of continuum damage mechanics. Basic concepts of material damage and the mechanical representation of damage state of various kinds are described in Chapters 1 and 2. In Chapters 3-5, irreversible thermodynamics, thermodynamic constitutive theory and its application to the modeling of the constitutive and the evolution equations of damaged materials are descried as a systematic basis for the subsequent development throughout the book. Part II describes the application of the fundamental theories developed in Part I to typical damage and fracture problems encountered in various fields of the current engineering. Important engineering aspects of elastic-plastic or ductile damage, their damage mechanics modeling and their further refinement are first discussed in Chapter 6. Chapters 7 and 8 are concerned with the modeling of fatigue, creep, creep-fatigue and their engineering application. Damage mechanics modeling of complicated crack closure behavior in elastic-brittle and composite materials are discussed in Chapters 9 and 10. In Chapter 11, applicability of the local approach to fracture by means of damage mechanics and finite element method, and the ensuing mathematical and numerical problems are briefly discussed. A proper understanding of the subject matter requires knowledge of tensor algebra and tensor calculus. At the end of this book, therefore, the foundations of tensor analysis are presented in the Appendix, especially for readers with insufficient mathematical background, but with keen interest in this exciting field of mechanics.

A Brief on Tensor Analysis - James G. Simmonds

2012-10-31
In this text which gradually develops the tools for formulating and manipulating the field equations of Continuum Mechanics, the mathematics of tensor analysis is introduced in four, well-separated stages, and the physical interpretation and application of vectors and tensors are stressed throughout. This new edition contains more exercises. In addition, the author has appended a section on Differential Geometry.

Continuum Mechanics with Eulerian Formulations of Constitutive Equations - M.B. Rubin 2020-10-11
This book focuses on the need for an Eulerian formulation of constitutive equations. After introducing tensor analysis using both index and direct notation, nonlinear kinematics of continua is presented. The balance laws of the purely mechanical theory are discussed along with restrictions on constitutive equations due to superposed rigid body motion. The balance laws of the thermomechanical theory are discussed and specific constitutive equations are presented for: hyperelastic materials; elastic–inelastic materials; thermoelastic–inelastic materials with application to shock waves; thermoelastic–inelastic porous materials; and thermoelastic–inelastic growing biological tissues.

Notes on Continuum Mechanics - Eduardo WV Chaves 2013-06-13
This publication is aimed at students, teachers, and researchers of Continuum Mechanics and focused extensively on stating and developing Initial Boundary Value equations used to solve physical problems. With respect to notation, the tensorial, indicial and Voigt notations have been used indiscriminately. The book is divided into twelve chapters with the following topics: Tensors, Continuum Kinematics, Stress, The Objectivity of Tensors, The Fundamental Equations of Continuum Mechanics, An Introduction to Constitutive Equations, Linear Elasticity, Hyperelasticity, Plasticity (small and large deformations), Thermoelasticity (small and large deformations), Damage Mechanics (small and large deformations), and An Introduction to Fluids. Moreover, the text is supplemented with over 280 figures, over 100 solved problems, and 130 references.

Theory of Elasticity - A.I. Lurie 2010-05-30
The classical theory of elasticity maintains a place of honour in the science ofthe behaviour ofsolids. Its basic definitions are general for all branches of this science, whilst the methods forstating and solving these problems serve as examples of its application. The theories of plasticity, creep, viscoelas ticity, and failure of solids do not adequately encompass the significance of the methods of the theory of elasticity for substantiating approaches for the calculation of stresses in structures and machines. These approaches constitute essential contributions in the sciences of material resistance and structural mechanics. The first two chapters form Part I of this book and are devoted to the basic definitions ofcontinuum mechanics; namely stress tensors (Chapter 1) and strain tensors (Chapter 2). The necessity to distinguish between initial and actual states in the nonlinear theory does not allow one to be content with considering a single strain measure. For this reason, it is expedient to introduce more rigorous tensors to describe the stress-strain state. These are considered in Section 1.3 for which the study of Sections 2.3-2.5 should precede. The mastering of the content of these sections can be postponed until the nonlinear theory is studied in Chapters 8 and 9.

Simon Stevin; - 1990

Implicit Functions and Solution Mappings - Asen L. Dontchev 2014-06-18
The implicit function theorem is one of the most important theorems in analysis and its many variants are basic tools in partial differential equations and numerical analysis. This second edition of Implicit Functions and Solution Mappings presents an updated and more complete picture of the field by including solutions of problems that have been solved since the first edition was published, and places old and new results in a broader perspective. The purpose of this self-contained work is to provide a reference on the topic and to provide a unified collection of a number of results which are currently scattered throughout the literature. Updates to this edition include new sections in almost all chapters, new exercises and examples, updated commentaries to chapters and an enlarged index and references section.
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The implicit function theorem is one of the most important theorems in analysis and its many variants are basic tools in partial differential equations and numerical analysis. This second edition of Implicit Functions and Solution Mappings presents an updated and more complete picture of the field by including solutions of problems that have been solved since the first edition was published, and places old and new results in a broader perspective. The purpose of this self-contained work is to provide a reference on the topic and to provide a unified collection of a number of results which are currently scattered throughout the literature. Updates to this edition include new sections in almost all chapters, new exercises and examples, updated commentaries to chapters and an enlarged index and references section.
Creep Mechanics - Josef Betten 2005-12-06
Provides a short survey of recent advances in the mathematical modelling of the mechanical behavior of anisotropic solids under creep conditions, including principles, methods, and applications of tensor functions. Some examples for practical use are discussed, as well as experiments by the author to test the validity of the modelling. The monograph offers an overview of other experimental investigations in creep mechanics. Rules for specifying irreducible sets of tensor invariants, scalar coefficients in constitutive and evolutional equations, and tensorial interpolation methods are also explained. The text has been re-examined and improved throughout.