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Vectors, Tensors and the Basic Equations of Fluid Mechanics
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Notes on Continuum Mechanics

ALANNAH LOGAN

Continuum Mechanics and Linear Elasticity Springer Science & Business Media

Through several centuries there has been a lively interaction between mathematics and mechanics. On the one side, mechanics has used mathematics to formulate the basic laws and to apply them to a host of problems that call for the quantitative prediction of the consequences of some action. On the other side, the needs of mechanics have stimulated the development of mathematical concepts. Differential calculus grew out of the needs of Newtonian dynamics; vector algebra was developed as a means to describe force systems; vector analysis, to study velocity fields and force fields; and the calculus of variations has evolved from the energy principles of mechanics. In recent times the theory of tensors has attracted the attention of the mechanics people. Its very name indicates its origin in the theory of elasticity. For a long time little use has been made of it in this area, but in the last decade its usefulness in the mechanics of continuous media has been widely recognized. While the undergraduate textbook literature in this country was becoming "vectorized" (lagging almost half a century behind the development in Europe), books dealing with various aspects of continuum mechanics took to tensors like fish to water. Since many authors were not sure whether their readers were sufficiently familiar with tensors they either added a chapter on tensors or wrote a separate book on the subject.

Continuum Mechanics Prentice Hall

This overview of the development of continuum mechanics throughout the twentieth century is unique and ambitious. Utilizing a historical perspective, it combines an exposition on the technical progress made in the field and a marked interest in the role played by remarkable individuals and scientific schools and institutions on a rapidly evolving social background. It underlines the newly raised technical questions and their answers, and the ongoing reflections on the bases of continuum mechanics associated, or in competition, with other branches of the physical sciences, including thermodynamics. The emphasis is placed on the development of a more realistic modeling of deformable solids and the exploitation of new mathematical tools. The book presents a balanced appraisal of advances made in various parts of the world. The author contributes his technical expertise, personal recollections, and international experience to this general overview, which is very informative albeit concise.

Matrix-tensor Methods in Continuum Mechanics Springer

Elements of Continuum Mechanics and Conservation Laws presents a systematization of different models in mathematical physics, a study of the structure of conservation laws, thermodynamical identities, and connection with criteria for well-posedness of the corresponding mathematical problems. The theory presented in this book stems from research carried out by the authors concerning the formulations of differential equations describing explosive deformations of metals. In such processes, elasticity equations are used in some zones, whereas hydrodynamics equations are

stated in other zones. Plastic deformations appear in transition zones, which leads to residual stresses. The suggested model contains some relaxation terms which simulate these plastic deformations. Certain laws of thermodynamics are used in order to describe and study differential equations simulating the physical processes. This leads to the special formulation of differential equations using generalized thermodynamical potentials.

Continuum Mechanics with Eulerian Formulations of Constitutive Equations Springer Nature

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 described 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.

Continuum Mechanics Springer

The topics covered include soil mechanics and porous media, glacier and ice dynamics, climatology and lake physics, climate change as well as numerical algorithms. The book, written by well-known experts, addresses researchers and students interested in physical aspects of our environment.

A First Course in Continuum Mechanics Springer Science & Business Media

A bestselling textbook in its first three editions, Continuum Mechanics for Engineers, Fourth Edition provides engineering students with a complete, concise, and accessible introduction to advanced engineering mechanics. It provides information that is useful in emerging engineering areas, such as

micro-mechanics and biomechanics. Through a mastery of this volume's contents and additional rigorous finite element training, readers will develop the mechanics foundation necessary to skillfully use modern, advanced design tools. Features: Provides a basic, understandable approach to the concepts, mathematics, and engineering applications of continuum mechanics Updated throughout, and adds a new chapter on plasticity Features an expanded coverage of fluids Includes numerous all new end-of-chapter problems With an abundance of worked examples and chapter problems, it carefully explains necessary mathematics and presents numerous illustrations, giving students and practicing professionals an excellent self-study guide to enhance their skills.

Tensor Analysis and Continuum Mechanics Springer Science & Business Media

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.

The Elements of Continuum Mechanics Springer Nature

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

Elements of Continuum Mechanics and Conservation Laws Springer Science & Business Media

The modeling and simulation of fluids, solids and other materials with significant coupling and thermal effects is becoming an increasingly important area of study in applied mathematics and engineering. Necessary for such studies is a fundamental understanding of the basic principles of continuum mechanics and thermodynamics. This book is a clear introduction to these principles. It is designed for a one- or two-quarter course for advanced undergraduate and beginning graduate students in the mathematical and engineering sciences, and is based on over nine years of teaching experience. It is also sufficiently self-contained for use outside a classroom environment.

Prerequisites include a basic knowledge of linear algebra, multivariable calculus, differential equations and physics. The authors begin by explaining tensor algebra and calculus in three-dimensional Euclidean space. Using both index and coordinate-free notation, they introduce the basic axioms of continuum mechanics pertaining to mass, force, motion, temperature, energy and entropy, and the concepts of frame-indifference and material constraints. They devote four chapters to different theories of fluids and solids, and, unusually at this level, they consider both isothermal

and thermal theories in detail. The book contains a wealth of exercises that support the theory and illustrate various applications. Full solutions to odd-numbered exercises are given at the end of each chapter and a complete solutions manual for all exercises is available to instructors upon request. Each chapter also contains a bibliography with references covering different presentations, further applications and numerical aspects of the theory. Book jacket.

Nonlinear Continuum Mechanics of Solids Springer Science & Business Media

DIVComprehensive treatment offers 115 solved problems and exercises to promote understanding of vector and tensor theory, basic kinematics, balance laws, field equations, jump conditions, and constitutive equations. /div

An Introduction to Continuum Mechanics Elsevier

A classic in the field, this book meets the demands of courses that establish groundwork in hydrodynamics, gas dynamics, plasticity and elasticity, and it provides typical continua problems for nonspecialists. The author addresses the major aspects of continuum studies: geometrical foundations, state of stress, instantaneous motion, fundamental laws, perfect fluids, viscous fluids, visco-plastic and perfectly plastic materials, hypoelastic materials, finite strain, and elastic and hyperelastic materials. The text's broad converge and numerous applications include more than 160 problems and examples, and the only prerequisites are first- and second-year college calculus. 1961 ed.

Continuum Mechanics and Plasticity Springer Science & Business Media

Moving on to derivation of the governing equations, this book presents applications in the areas of linear and nonlinear elasticity.

Continuum Mechanics for Engineers Springer Science & Business Media

The new edition includes additional analytical methods in the classical theory of viscoelasticity. This leads to a new theory of finite linear viscoelasticity of incompressible isotropic materials. Anisotropic viscoplasticity is completely reformulated and extended to a general constitutive theory that covers crystal plasticity as a special case.

Continuum Mechanics using Mathematica® Cambridge University Press

This book examines the testing and modeling of materials and structures under dynamic loading conditions. Readers get an in-depth analysis of the current mathematical modeling and simulation tools available for a variety of materials, alongside discussions of the benefits and limitations of these tools in industrial design. Following a logical and well organized structure, this volume uniquely combines experimental procedures with numerical simulation, and provides many examples.

Statistical Continuum Mechanics Springer Science & Business Media

This textbook's methodological approach familiarizes readers with the mathematical tools required to correctly define and solve problems in continuum mechanics. Covering essential principles and fundamental applications, this second edition of Continuum Mechanics using Mathematica® provides a solid basis for a deeper study of more challenging and specialized problems related to nonlinear elasticity, polar continua, mixtures, piezoelectricity, ferroelectricity, magneto-fluid mechanics and state changes (see A. Romano, A. Marasco, Continuum Mechanics: Advanced Topics and Research Trends, Springer (Birkhäuser), 2010, ISBN 978-0-8176-4869-5). Key topics and

features: * Concise presentation strikes a balance between fundamentals and applications * Requisite mathematical background carefully collected in two introductory chapters and one appendix * Recent developments highlighted through coverage of more significant applications to areas such as wave propagation, fluid mechanics, porous media, linear elasticity. This second edition expands the key topics and features to include: * Two new applications of fluid dynamics: meteorology and navigation * New exercises at the end of the existing chapters * The packages are rewritten for Mathematica 9 Continuum Mechanics using Mathematica®: Fundamentals, Applications and Scientific Computing is aimed at advanced undergraduates, graduate students and researchers in applied mathematics, mathematical physics and engineering. It may serve as a course textbook or self-study reference for anyone seeking a solid foundation in continuum mechanics.

Structures Under Crash and Impact Springer

A unified treatment of nonlinear continuum analysis and finite element techniques.

Handbook of Nonlocal Continuum Mechanics for Materials and Structures World Scientific
This book presents tensors and tensor analysis as primary mathematical tools for engineering and engineering science students and researchers. The discussion is based on the concepts of vectors and vector analysis in three-dimensional Euclidean space, and although it takes the subject matter to an advanced level, the book starts with elementary geometrical vector algebra so that it is suitable as a first introduction to tensors and tensor analysis. Each chapter includes a number of problems for readers to solve, and solutions are provided in an Appendix at the end of the text. Chapter 1 introduces the necessary mathematical foundations for the chapters that follow, while Chapter 2 presents the equations of motions for bodies of continuous material. Chapter 3 offers a general definition of tensors and tensor fields in three-dimensional Euclidean space. Chapter 4 discusses a new family of tensors related to the deformation of continuous material. Chapter 5 then addresses constitutive equations for elastic materials and viscous fluids, which are presented as tensor equations relating the tensor concept of stress to the tensors describing deformation, rate of deformation and rotation. Chapter 6 investigates general coordinate systems in three-dimensional Euclidean space and Chapter 7 shows how the tensor equations discussed in chapters 4 and 5 are presented in general coordinates. Chapter 8 describes surface geometry in three-dimensional Euclidean space, Chapter 9 includes the most common integral theorems in two- and three-

dimensional Euclidean space applied in continuum mechanics and mathematical physics.

Mathematical Methods in Continuum Mechanics of Solids Springer Science & Business Media

This textbook explores the theory of Cosserat continuum mechanics, and covers fundamental tools, general laws and major models, as well as applications to the mechanics of granular media. While classical continuum mechanics is based on the axiom that the stress tensor is symmetric, theories such as that expressed in the seminal work of the brothers Eugène and François Cosserat are characterized by a non-symmetric stress tensor. The use of von Mises motor mechanics is introduced, for the compact mathematical description of the mechanics and statics of Cosserat continua, as the Cosserat continuum is a manifold of oriented "rigid particles" with 3 dofs of displacement and 3 dofs of rotation, rather than a manifold of points with 3 dofs of displacement. Here, the analysis is restricted to infinitesimal particle displacements and rotations. This book is intended as a valuable supplement to standard Continuum Mechanics courses, and graduate students as well as researchers in mechanics and applied mathematics will benefit from its self-contained text, which is enriched by numerous examples and exercises.

Fundamentals of Continuum Mechanics John Wiley & Sons

Tremendous advances in computer technologies and methods have precipitated a great demand for refinements in the constitutive models of plasticity. Such refinements include the development of a model that would account for material anisotropy and produces results that compare well with experimental data. Key to developing such models-and to meeting

Tensor Analysis Springer

Continuum Mechanics of Anisotropic Materials(CMAM) presents an entirely new and unique development of material anisotropy in the context of an appropriate selection and organization of continuum mechanics topics. These features will distinguish this continuum mechanics book from other books on this subject. Textbooks on continuum mechanics are widely employed in engineering education, however, none of them deal specifically with anisotropy in materials. For the audience of Biomedical, Chemical and Civil Engineering students, these materials will be dealt with more frequently and greater accuracy in their analysis will be desired. Continuum Mechanics of Anisotropic Materials' author has been a leader in the field of developing new approaches for the understanding of anisotropic materials.

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