Theory Of Linear Poroelasticity With Applications To Geomechanics And Hydrogeology

Multiphase Fluid Flow in Porous and Fractured Reservoirs discusses the process of modeling fluid flow in petroleum and natural gas reservoirs, a practice that has become increasingly complex thanks to multiple fractures in horizontal drilling and the discovery of more unconventional reservoirs and resources. The book updates the reservoir engineer of today with the latest developments in reservoir simulation by combining a powerhouse of theory, analytical, and numerical methods to create stronger verification and validation modeling methods, ultimately improving recovery in stagnant and complex reservoirs. Going beyond the standard topics in past literature, coverage includes well treatment, Non-Newtonian fluids and rheological models, multiphase fluid coupled with geomechanics in reservoirs, and modeling applications for unconventional petroleum resources. The book equips today's reservoir engineer and modeler with the most relevant tools and knowledge to establish and solidify stronger oil and gas recovery. Delivers updates on recent developments in reservoir simulation such as modeling approaches for multiphase flow simulation of fractured media and unconventional reservoirs Explains analytical solutions and approaches as well as applications to modeling verification for today's reservoir problems, such as evaluating saturation and pressure profiles and recovery factors or displacement efficiency Utilize practical codes and programs featured from online companion website

Authored by the internationally renowned José M. Carcione, Wave Fields in Real Media: Wave Propagation in Anisotropic, Anelastic, Porous and Electromagnetic Media examines the differences between an ideal and a real description of wave propagation, starting with the introduction of relevant stress-strain relations. The combination of this relation and the equations of momentum conservation lead to the equation of motion. The differential formulation is written in terms of memory variables, and Biot's theory is used to describe wave propagation in porous media. For each rheology, a plane-wave analysis is performed in order to understand the physics of wave propagation. This book contains a review of the main direct numerical methods for solving the equation of motion in the time and space domains. The emphasis is on geophysical applications for seismic exploration, but researchers in the fields of earthquake seismology, rock acoustics, and material science - including many branches of acoustics of fluids and solids - may also find this text useful. New to this edition: This new edition presents the fundamentals of wave propagation in Anisotropic, Anelastic, Porous Media while also incorporating the latest research from the past 7 years, including that of the author. The author presents all the equations and concepts necessary to understand the physics of wave propagation. These equations form the basis for modeling and inversion of seismic and electromagnetic data. Additionally, demonstrations are given, so the book can be used to teach post-graduate courses. Addition of new and revised content is approximately 30%. Examines the fundamentals of wave propagation in anisotropic, anelastic and porous media Presents all equations and concepts necessary to understand the physics of wave propagation, with examples Emphasizes geophysics, particularly, seismic exploration for hydrocarbon reservoirs, which is essential for exploration and production of oil

This book explores mathematics in a wide variety of applications, ranging from problems in electronics, energy and the environment, to mechanics and mechatronics. The book gathers 81 contributions submitted to the 20th European Conference on Mathematics for Industry, ECMI 2018, which was held in Budapest, Hungary in June 2018. The application areas include: Applied Physics, Biology and Medicine, Cybersecurity, Data Science, Economics, Finance and Insurance, Energy, Production Systems, Social Challenges, and Vehicles and Transportation. In turn, the mathematical technologies discussed include: Combinatorial Optimization, Cooperative Games, Delay Differential Equations, Finite Elements, Hamilton-Jacobi Equations, Impulsive Control, Information Theory and Statistics, Inverse Problems, Machine Learning, Point Processes, Reaction-Diffusion Equations, Risk Processes, Scheduling Theory, Semidefinite Programming, Stochastic Approximation, Spatial Processes, System Identification, and Wavelets. The goal of the European Consortium for Mathematics in Industry (ECMI) conference series is to promote interaction between academia and industry, leading to innovations in both fields. These events have attracted leading experts from business, science and academia, and have promoted the application of novel mathematical technologies to industry. They have also encouraged industrial sectors to share challenging problems where mathematicians can provide fresh insights and perspectives. Lastly, the ECMI conferences are one of the main forums in which significant advances in industrial mathematics are presented, bringing together prominent figures from business, science and academia to promote the use of innovative mathematics in industry.

This book collects the theoretical derivation of a recently presented general variational macroscopic continuum theory of multiphase poroelasticity (VMTPM), together with its applications to consolidation and stress partitioning problems of interest in several applicative engineering contexts, such as in geomechanics and biomechanics. The theory is derived based on a purely-variational deduction, rooted in the least-Action principle, by considering a minimal set of kinematic descriptors. The treatment herein considered keeps a specific focus on the derivation of most general medium-independent governing equations. It is shown that VMTPM recovers paradigms of consolidated use in multiphase poroelasticity such as Terzaghi's stress partitioning principle and Biot's equations for wave propagation. In particular, the variational treatment permits the derivation of a general medium-independent stress partitioning law, and the proposed variational theory predicts that the external stress, the fluid pressure, and the stress tensor work-associated with the macroscopic strain of the solid phase are partitioned according to a relation which, from a formal point of view, turns out to be strictly compliant with Terzaghi's law, irrespective of the microstructural and constitutive features of a given medium. Moreover, it is shown that some experimental observations on saturated sandstones, generally considered as proof of deviations from Terzaghi's law, are ordinarily predicted by VMTPM. As a peculiar prediction of VMTPM, the book shows that the phenomenon of compression-induced liquefaction experimentally observed in cohesionless mixtures can be obtained as a natural implication of this theory by a purely rational deduction. A characterization of the phenomenon of crack closure in fractured media is also inferred in terms of macroscopic strain and stress paths. Altogether the results reported in this monograph exemplify the capability of VMTPM to describe and predict a large class of linear and nonlinear mechanical behaviors observed in two-phase saturated materials.

Why an awareness of Earth's temporal rhythms is critical to our planetary survival Few of us have any conception of the enormous timescales of our planet's long history, and this narrow perspective underlies many of the environmental problems we are creating. The lifespan of Earth can seem unfathomable compared to the brevity of human existence, but this view of time denies our deep roots in Earth's history—and the magnitude of our effects on the planet. Timefulness reveals how knowing the rhythms of Earth's deep past and conceiving of time as a geologist does can give us the perspective we need for a more sustainable future. Featuring illustrations by Haley Hagerman, this compelling book offers a new way of thinking about our place in time, showing how our everyday lives are shaped by processes that vastly predate us, and how our actions today will in turn have consequences that will outlast us by generations.

Modelling and predicting how porous media deform when subjected to external actions and physical phenomena, including the effect of saturating fluids, are of importance to the understanding of geophysics and civil engineering (including soil and rock mechanics and petroleum engineering), as well as in newer areas such as biomechanics and agricultural engineering. Starting from the highly successful First Edition, Coussy has completely re-written Mechanics of Porous Continua/Poromechanics to include: New material for: Partially saturated porous media Reactive porous media Macroscopic electrical effects A single theoretical framework to the subject to explain the interdisciplinary nature of the subject Exercises at the end of each chapter to aid understanding The unified approach taken by this text makes it a valuable addition to the bookshelf of every PhD student and researcher in civil engineering, petroleum engineering, geophysics, biomechanics and material science.

This book treats the mechanics of porous materials infiltrated with a fluid (poromechanics), focussing on its linear theory (poroelasticity). Porous materials from inanimate bodies such as sand, soil and rock, living bodies such as plant tissue, animal flesh, or man-made materials can look very different due to their different origins, but as readers will see, the underlying physical principles governing their mechanical behaviors can be the same, making this work relevant not only to engineers but also to scientists across other scientific disciplines. Readers will find discussions of physical phenomena including soil consolidation, land subsidence, slope stability, borehole failure, hydraulic fracturing, water wave and seabed interaction, earthquake aftershock, fluid injection induced seismicity and heat induced pore pressure spalling as well as discussions of seismoelectric and seismoelectromagnetic effects. The work also explores the biomechanics of cartilage, bone and blood vessels. Chapters present theory using an intuitive, phenomenological approach at the bulk continuum level, and a thermodynamics-based variational energy approach at the micromechanical level. The physical mechanisms covered extend from the quasi-static theory of poroelasticity to poroelastodynamics, poroviscoelasticity, porothermoelasticity, and porochemoelasticity. Closed form analytical solutions are derived in details. This book provides an excellent introduction to linear poroelasticity and is especially relevant to those involved in civil engineering, petroleum and reservoir engineering, rock mechanics, hydrology, geophysics, and biomechanics.

This applications-oriented introduction fills an important gap in the field of solid mechanics. Offering a thorough grounding in the tensor-based theory of elasticity for courses in mechanical, civil, materials or aeronautical engineering, it allows students to apply the basic notions of mechanics to such important topics as stress analysis. Further, they will also acquire the necessary background for more advanced work in elasticity, plasticity, shell theory, composite materials and finite element mechanics. This second edition features new chapters on the bending of thin plates, time-dependent effects, and strength and failure criteria.

Porous media are broadly found in nature and their study is of high relevance in our present lives. In geosciences porous media research is fundamental in applications to aquifers, mineral mines, contaminant transport, soil remediation, waste storage, oil recovery and geothermal energy deposits. Despite their importance, there is as yet no complete understanding of the physical processes involved in fluid flow and transport. This fact can be attributed to the complexity of the phenomena which include multicomponent fluids, multiphasic flow and rock-fluid interactions. Since its formulation in 1856, Darcy’s law has been generalized to describe multi-phase compressible fluid flow through anisotropic and heterogeneous porous and fractured rocks. Due to the scarcity of information, a high degree of uncertainty on the porous medium properties is commonly present. Contributions to the knowledge of modeling flow and transport, as well as to the characterization of porous media at field scale are of great relevance. This book addresses several of these issues, treated with a variety of methodologies grouped into four parts: I Fundamental concepts II Flow and transport III Statistical and stochastic characterization IV Waves The problems analyzed in this book cover diverse length scales that range from small rock samples to field-size porous formations. They belong to the most active areas of research in porous media with applications in geosciences developed by diverse authors. This book was written for a broad audience with a prior and basic knowledge of porous media. The book is addressed to a wide readership, and it will be useful not only as an authoritative textbook for undergraduate and graduate students but also as a reference source for professionals including geoscientists, hydrogeologists, geophysicists, engineers, applied mathematicians and others working on porous media.

The dramatic advances in the efficiency of digital computers during the past decade have provided hydrologists with a powerful tool for numerical modeling of groundwater systems. Introduction to Groundwater Modeling presents a broad, comprehensive overview of the fundamental concepts and applications of computerized groundwater modeling. The book covers both finite difference and finite element methods and includes practical sample programs that demonstrate theoretical points described in the text. Each chapter is followed by problems, notes, and references to additional information. This volume will be indispensable to students in introductory groundwater modeling courses as well as to groundwater professionals wishing to gain a complete introduction to this vital subject. Key Features * Systematic exposition of the basic ideas and results of Hilbert space theory and functional analysis * Great variety of applications that are not available in comparable books * Different approach to the Lebesgue integral, which makes the theory easier, more intuitive, and more accessible to undergraduate students

Continuum Mechanics of Solids is an introductory text for graduate students in the many branches of engineering, covering the basics of kinematics, equilibrium, and material response. As an introductory book, most of the emphasis is upon the kinematically linear theories of elasticity, plasticity, and viscoelasticity, with two additional chapters devoted to topics in finite elasticity. Further chapters cover topics in fracture and fatigue and coupled field problems, such as thermoelasticity, chemoelasticity, poroelasticity, and piezoelectricity. There is ample material for a two semester course, or by selecting only topics of interest for a one-semester offering. The text includes numerous examples to aid the student. A companion text with over 180 fully worked problems is also available.

Provides a quantitative introduction to the physics, application, interpretation, and hazard aspects of fluid-induced seismicity, with many real data examples.

This monograph focuses on the numerical methods needed in the context of developing a reliable simulation tool to promote the use of renewable energy. One very promising source of energy is the heat stored in the Earth’s crust, which is harnessed by so-called geothermal facilities. Scientists from fields like geology, geo-engineering, geophysics and especially geomathematics are called upon to help make geothermics a reliable and safe energy production method. One of the challenges they face involves modeling the mechanical stresses at work in a reservoir. The aim of this thesis is to develop a numerical solution scheme by means of which the fluid pressure and rock stresses in a geothermal reservoir can be determined prior to well drilling and during production. For this purpose, the method should (i) include poroelastic effects, (ii) provide a means of including thermoelastic effects, (iii) be inexpensive in terms of memory and computational power, and (iv) be flexible with regard to the locations of data points. After introducing the basic equations and their relations to more familiar ones (the heat equation, Stokes equations, Cauchy-Navier equation), the "method of fundamental solutions" and its potential value concerning our task are discussed. Based on the properties of the fundamental solutions, theoretical results are established and numerical examples of stress field simulations are presented to assess the method's performance. The first-ever 3D graphics calculated for these topics, which neither requiring meshing of the domain nor involving a time-stepping scheme, make this a pioneering volume.

The first field guide that allows amateur rock enthusiasts to identify basic rocks and rock formations in a systematic way Many of us are fascinated by rocks—but identifying them can seem daunting. It's often tricky even for geologists, who rely on experience, intuition, and in-depth familiarity with rock-forming components. Rocks and Rock Formations allows everyone, amateur or professional, to successfully distinguish these amazing masses of minerals, using only careful observation, a magnifying glass, a pocket knife—and a bit of patience. Jürg Meyer provides a structured approach to the identification of all rocks within the three groups: sedimentary, igneous, and metamorphic. Bringing together more than 530 diagrams and photographs to illustrate essential characteristics, Meyer highlights some basics on rocks—their mineral constituents, structures, textures, fossils, weathering patterns, and more—which are important for a determination. The main part of the book is a handy and thorough identification key, which takes into account all possible rock variations, mixtures, and structural differences. The concluding section of the guide delves into rock systematics. Assuming little prior experience or knowledge, Rocks and Rock Formations is an invaluable resource for rock enthusiasts everywhere. Suitable for beginners and amateurs Helpful, systematic identification key Exploration of all types of rocks More than 530 diagrams and photographs

Brings together widely scattered theoretical and laboratory rock physics relations critical for modelling and interpretation of geophysical data.

During last couple of years there has been an increasing recognition that problems arising in biology or related to medicine really need a multidisciplinary approach. For this reason some special branches of both applied theoretical physics and mathematics have recently emerged such as biomechanics, mechanobiology, mathematical biology, biothermodynamics. This first section of the book, General notes on biomechanics and mechanobiology, comprises from theoretical contributions to Biomechanics often providing hypothesis or rationale for a given phenomenon that experiment or clinical study cannot provide. It deals with mechanical properties of living cells and tissues, mechanobiology of fracture healing or evolution of locomotor trends in extinct terrestrial giants. The second section, Biomechanical modelling, is devoted to the rapidly growing field of biomechanical models and modelling approaches to improve our understanding about processes in human body. The last section called Locomotion and joint biomechanics is a collection of works on description and analysis of human locomotion, joint stability and acting forces.

This book furnishes state-of-the-art knowledge about how earthquake faulting is coupled with fluid flow. The authors describe the theoretical background of modeling of faulting coupled with fluid flow in detail. Field and laboratory evidence to suggest the fluid involvement in earthquake faulting is also carefully explained. All of the provided information constitutes together a basic framework of the fault modeling for a comprehensive understanding of the involvement of fluids in earthquake ruptures. Earthquake generation is now widely believed to be significantly affected by high-pressure fluid existing at depths. Consequently, modeling study of earthquake faulting coupled with fluid flow is becoming increasingly active as a field of research. This work is aimed at a wide range of readers, and is especially relevant for graduate students and solid-earth researchers who wish to become more familiar with the field.

Continuum Mechanics Modeling of Material Behavior offers a uniquely comprehensive introduction to topics like RVE theory, fabric tensor models, micropolar elasticity, elasticity with voids, nonlocal higher gradient elasticity and damage mechanics. Contemporary continuum mechanics research has been moving into areas of complex material microstructural behavior. Graduate students who are expected to do this type of research need a fundamental background beyond classical continuum theories. The book begins with several chapters that carefully and rigorously present mathematical preliminaries; kinematics of motion and deformation; force and stress measures; and mass, momentum and energy balance principles. The book then moves beyond other books by dedicating the last chapter to constitutive equation development, exploring a wide collection of constitutive relations and developing the corresponding material model formulations. Such material behavior models include classical linear theories of elasticity, fluid mechanics, viscoelasticity and plasticity, as well as linear and nonlinear theories of solids and fluids, including finite elasticity, nonlinear/non-Newtonian viscous fluids, and nonlinear viscoelastic materials. Finally, several relatively new continuum theories based on incorporation of material microstructure are presented including: fabric tensor theories, micropolar elasticity, elasticity with voids, nonlocal higher gradient elasticity and damage mechanics. Offers a thorough, concise and organized presentation of continuum mechanics formulation Covers numerous applications in areas of contemporary continuum mechanics modeling, including micromechanical and multi-scale problems Integration and use of MATLAB software gives students more tools to solve, evaluate and plot problems under study Features extensive use of exercises, providing more material for student engagement and instructor presentation

This text features 105 papers dealing with the fundamentals and the applications of poromechanics from the Biot conference of 1998, held in Louvain-la-Neuve. Topics include: wave propogation; numerical modelling; identification of poromechanical parameters; and constitutive modelling.

Bringing together basic ideas, classical theories, recent experimental and theoretical aspects, this book explains desiccation cracks from simple, easily-comprehensible cases to more complex, applied situations. The ideal team of authors, combining experimental and theoretical backgrounds, and with experience in both physical and earth sciences, discuss how the study of cracks can lead to the design of crack-resistant materials, as well as how cracks can be grown to generate patterned surfaces at the nano- and micro-scales. Important research and recent developments on tailoring desiccation cracks by different methods are covered, supported by straightforward, yet deep theoretical models. Intended for a broad readership spanning physics, materials science, and engineering to the geosciences, the book also includes additional reading especially for students engaged in pattern formation research.

Theory of Linear Poroelasticity with Applications to Geomechanics and HydrogeologyPrinceton University Press

The book entitled Finite Element Method: Simulation, Numerical Analysis, and Solution Techniques aims to present results of the applicative research performed using FEM in various engineering fields by researchers affiliated to well-known universities. The book has a profound interdisciplinary character and is mainly addressed to researchers, PhD students, graduate and undergraduate students, teachers, engineers, as well as all other readers interested in the engineering applications of FEM. I am confident that readers will find information and challenging topics of high academic and scientific level, which will encourage them to enhance their knowledge in this engineering domain having a continuous expansion. The applications presented in this book cover a broad spectrum of finite element applications starting from mechanical, electrical, or energy production and finishing with the successful simulation of severe meteorological phenomena.

Handbook of Porous Media, Third Edition offers a comprehensive overview of the latest theories on flow, transport, and heat-exchange processes in porous media. It also details sophisticated porous media models which can be used to improve the accuracy of modeling in a variety of practical applications. Featuring contributions from leading experts in their respective fields, this book: Presents the general characteristics and modeling of porous media, such as multiscale modeling of porous media, two-phase flow, compressible porous media, and dispersion in porous media Addresses the fundamental topics of transport in porous media, including theoretical models of transport, membrane transport phenomena, modeling transport properties, and transport in biomedical applications Describes several important aspects of turbulence in porous media, including advances in modeling turbulence phenomena in heterogeneous porous media Explores heat transfer of nanofluids as well as thermal transport in porous media, including forced convection, double diffusive convection, high-heat flux applications, and thermal behavior of poroelastic media Covers geological applications in porous media, including modeling and experimental challenges related to oil fields, CO2 migration, groundwater flows, and velocity measurements Discusses relevant attributes of experimental work or numerical techniques whenever applicable Paving the way for the establishment of multidisciplinary areas of research, Handbook of Porous Media, Third Edition further enhances cooperation between engineers and scientists by providing a valuable reference for addressing some of the most challenging issues in engineering and the hydrogeological, biological, and biomedical sciences.

A thorough guide to the mechanisms ruling friction processes, based on state-of-the-art models and experimental results, this multi-scale book for researchers and students combines the classical theories of contact mechanics and lubrication with nanotribology to explore friction in a range of forms.

This book contains the elements of the theory and the problems of Elasticity and Thermal Stresses with full solutions. The emphasis is placed on problems and solutions and the book consists of four parts: one part is on The Mathematical Theory of Elasticity, two parts are on Thermal Stresses and one part is on Numerical Methods. The book is addressed to higher level undergraduate students, graduate students and engineers and it is an indispensable companion to all who study any of the books published earlier by the authors. This book links the three previously published books by the authors into one comprehensive entity.

In Mechanics of Poroelastic Media the classical theory of poroelasticity developed by Biot is developed and extended to the study of problems in geomechanics, biomechanics, environmental mechanics and materials science. The contributions are grouped into sections covering constitutive modelling, analytical aspects, numerical modelling, and applications to problems. The applications of the classical theory of poroelasticity to a wider class of problems will be of particular interest. The text is a standard reference for researchers interested in developing mathematical models of poroelasticity in geoenvironmental mechanics, and in the application of advanced theories of poroelastic biomaterials to the mechanics of biomaterials.

Intended as a first introduction to the micromechanics of porous media, this book entitled “Microporomechanics” deals with the mechanics and physics of multiphase porous materials at nano and micro scales. It is composed of a logical and didactic build up from fundamental concepts to state-of-the-art theories. It features four parts: following a brief introduction to the mathematical rules for upscaling operations, the first part deals with the homogenization of transport properties of porous media within the context of asymptotic expansion techniques. The second part deals with linear microporomechanics, and introduces linear mean-field theories based on the concept of a representative elementary volume for the homogenization of poroelastic properties of porous materials. The third part is devoted to Eshelby’s problem of ellipsoidal inclusions, on which much of the micromechanics techniques are based, and illustrates its application to linear diffusion and microporoelasticity. Finally, the fourth part extends the analysis to microporo-in-elasticity, that is the nonlinear homogenization of a large range of frequently encountered porous material behaviors, namely, strength homogenization, nonsaturated microporomechanics, microporoplasticity and microporofracture and microporodamage theory.

Mechanics of Fluid Saturated Rocks presents a current and comprehensive report on this emerging field that bridges the areas of geology and mechanics. It is of direct interest to a wide spectrum of earth scientists and engineers who are concerned with upper-crust mechanics and fluid movements, the most important fluids being oil and water. This authoritative book is the result of a collaborative effort between scientists in academic institutions and industry. It examines important issues such as subsidence, geological fault formation, earthquake faulting, hydraulic fracturing, transport of fluids, and natural and direct applications. Mechanics of Fluid Saturated Rocks provides a unique interdisciplinary viewpoint, as well as case studies, conclusions, and recommendations for further research. Covers the physical, chemical, and mechanical analysis of porous saturated rock deformation on both large and small scales Discusses the latest developments of importance to engineers and geologists Examines natural and direct applications Includes extensive bibliographies for each chapter

Poroelasticity is a continuum theory for the analysis of a porous media consisting of an elastic matrix containing interconnected fluid-saturated pores. In physical terms the theory postulates that when a porous material is subjected to stress, the resulting matrix deformation leads to volumetric changes in the pores. This book is devoted to the analysis of fluid-saturated poroelastic beams, columns and plates made of materials for which diffusion in the longitudinal direction(s) is viable, while in the perpendicular direction(s) the flow can be considered negligible because of the micro-geometry of the solid skeletal material. Many microstructures and fabrication schemes could be imagined, which would produce bulk materials with the postulated behavior. The book provides a methodology and a theoretical basis for investigating the mechanical behaviors of the structural elements made of such materials. It is recognized that the response of the poroelastic structural element to loading is sensitive to the properties of the fluid and to the diffusion boundaries, which can be easily altered in practice. Therefore, such structural elements and thus their features are potentially controllable. In other words, it could be possible to convert such elements into intelligent or smart structures. If this is so, it would be interesting that such structural elements could work as both sensors and actuators, e.g. the fluid can "feel" the change of the temperature by changing its viscosity and this results in a change of the behavior of the structure. The present book is the first of its kind; there does not exist in the professional literature any book which deals with this subject. Chapter 1 is a general introduction and overview. The governing equations for beams are presented in Chapter 2. Chapter 3 then presents analytical solutions for the quasi-static bending problem. Series solutions are found for normal loading with various mechanical and diffusion boundary conditions. The finite element method is developed and employed for the quasi-static beams and columns with small deflections in Chapter 4. In Chapter 5 solutions are found for free and forced vibrations of poroelastic beams. Chapter 6 deals with large deflections of beams. The stability of poroelastic columns is investigated in Chapter 7. Three problems are considered: buckling, post-buckling, and dynamic stability. Formulations are found in Chapter 8 for fluid-saturated poroelastic plates consisting of a material, for which the diffusion is possible in the in-plane directions only, both for bending and for in-plane loading. This book attempts to constitute a reasonably self-contained presentation of a wide spectrum of problems related to the analysis of the type of poroelastic structure considered.

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.

ICTAEM_1 treated all aspects of theoretical, applied and experimental mechanics including biomechanics, composite materials, computational mechanics, constitutive modeling of materials, dynamics, elasticity, experimental mechanics, fracture, mechanical properties of materials, micromechanics, nanomechanics, plasticity, stress analysis, structures, wave propagation. During the conference special symposia covering major areas of research activity organized by members of the Scientific Advisory Board took place. ICTAEM_1 brought together the most outstanding world leaders and gave attendees the opportunity to get acquainted with the latest developments in the area of mechanics. ICTAEM_1 is a forum of university, industry and government interaction and serves in the exchange of ideas in an area of utmost scientific and technological importance.

This book is an introduction to the mechanical properties, the force generating capacity, and the sensitivity to mechanical cues of the biological system. To understand how these qualities govern many essential biological processes, we also discuss how to measure them. However, before delving into the details and the techniques, we will first learn the operational definitions in mechanics, such as force, stress, elasticity, viscosity and so on. This book will explore the mechanics at three different length scales – molecular, cellular, and tissue levels – sequentially, and discuss the measurement techniques to quantify the intrinsic mechanical properties, force generating capacity, mechanoresponsive processes in the biological systems, and rupture forces.

Although there are several books in print dealing with elasticity, many focus on specialized topics such as mathematical foundations, anisotropic materials, two-dimensional problems, thermoelasticity, non-linear theory, etc. As such they are not appropriate candidates for a general textbook. This book provides a concise and organized presentation and development of general theory of elasticity. This text is an excellent book teaching guide. Contains exercises for student engagement as well as the integration and use of MATLAB Software Provides development of common solution methodologies and a systematic review of analytical solutions useful in applications of

F.K. Lehner: A Review of the Linear Theory of Anisotropic Poroelastic Solids. - J.W. Rudnicki: Eshelby's Technique for Analyzing Inhomogeneities in Geomechanics. - Y. Gueguen, M. Kachanov: Effective Elastic Properties of Cracked and Porous Rocks - an Overview. - J.L. Raphanel: 3D Morphology Evolution of Solid-Fluid Interfaces by Pressure Solution. - Y.M. Leroy: An Introduction to the Finite-Element Method for Linear and Non-linear Static Problems. The mechanical behaviour of the earth's upper crust enters into a great variety of questions in different areas of the geological and geophysical sciences as well as in the more applied geotechnical disciplines. This volume presents a selection of papers from a CISM course in Udine on this topic. While each of these chapters will make for a useful contribution in its own right, the present bundle also illustrates, by way of examples, the variety of theoretical concepts and tools that are currently brought to bear on earth deformation studies, ranging from reviews of poroelastic field theory to micro-mechanical and homogenization studies, chemomechanics and interfacial stability theory of soluble solids under stress, and finally to an introduction to the finite element method.

This is a consistent treatment of the material-independent fundamental equations of the theory of porous media, formulating constitutive equations for frictional materials in the elastic and plastic range, while tracing the historical development of the theory. Thus, for the first time, a unique treatment of fluid-saturated porous solids is presented, including an explanation of the corresponding theory by way of its historical progression, and a thorough description of its current state.

The theory of linear poroelasticity describes the interaction between mechanical effects and adding or removing fluid from rock. It is critical to the study of such geological phenomena as earthquakes and landslides and is important for numerous engineering projects, including dams, groundwater withdrawal, and petroleum extraction. Now an advanced text synthesizes in one place, with one notation, numerous classical solutions and applications of this highly useful theory. The introductory chapter recounts parallel developments in geomechanics, hydrogeology, and reservoir engineering that are unified by the tenets of poroelasticity. Next, the theory's constitutive and governing equations and their associated material parameters are described. These equations are then specialized for different simplifying geometries: unbounded problem domains, uniaxial strain, plane strain, radial symmetry, and axisymmetry. Example problems from geomechanics, hydrogeology, and petroleum engineering are incorporated throughout to illustrate poroelastic behavior and solution methods for a wide variety of real-world scenarios. The final chapter provides outlines for finite-element and boundary-element formulations of the field's governing equations. Whether read as a course of study or consulted as a reference by researchers and professionals, this volume's user-friendly presentation makes accessible one of geophysics' most important subjects and will do much to reduce poroelasticity's reputation as difficult to master.

An earthquake can strike without warning and wreak horrific destruction and death, whether it's the catastrophic 2010 quake that took a devastating toll on the island nation of Haiti or a future great earthquake on the San Andreas Fault in California, which scientists know is inevitable. Yet despite rapid advances in earthquake science, seismologists still can't predict when the Big One will hit. Predicting the Unpredictable explains why, exploring the fact and fiction behind the science—and pseudoscience—of earthquake prediction. Susan Hough traces the continuing quest by seismologists to forecast the time, location, and magnitude of future quakes. She brings readers into the laboratory and out into the field—describing attempts that have raised hopes only to collapse under scrutiny, as well as approaches that seem to hold future promise. She also ventures to the fringes of pseudoscience to consider ideas outside the scientific mainstream. An entertaining and accessible foray into the world of earthquake prediction, Predicting the Unpredictable illuminates the unique challenges of predicting earthquakes.

A full account of thermo-poroelasticity and thermo-poromechanics with derivations to problems, for both experienced and novice researchers.