Numerical Modeling Of Coupled Phenomena In Science And Engineering

This highly relevant text documents the first international meeting focused specifically on high-resolution atmospheric and oceanic modeling. It was held recently at the Earth Simulator Center in Yokohama, Japan. Rather than producing a standard conference proceedings volume, the editors have decided to compose this volume entirely of papers written by invited speakers at the meeting, who report on their most exciting recent results involving high resolution modeling.

This book provides an introduction to the scientific fundamentals of groundwater and geothermal systems. In a simple and didactic manner the different water and energy problems existing in deformable porous rocks are explained as well as the corresponding theories and the mathematical and numerical tools that lead to modeling and solving them. This

Written by specialists of modeling in electromagnetism, this book provides a comprehensive review of the finite element method for low frequency applications. Fundamentals of the method as well as new advances in the field are described in detail. Chapters 1 to 4 present general 2D and 3D static and dynamic formulations by the use of scalar and vector unknowns and adapted interpolations for the fields (nodal, edge, face or volume). Chapter 5 is dedicated to the presentation of different macroscopic behavior laws of materials and their implementation in a finite element context: anisotropy and hysteretic properties for magnetic sheets, iron losses, non-linear permanent magnets and superconductors. More specific formulations are then proposed: the modeling of thin regions when finite elements become misfit (Chapter 6), infinite domains by using geometrical transformations (Chapter 7), the coupling of 2D and 3D formulations with circuit equations (Chapter 8), taking into account the movement, particularly in the presence of Eddy currents (Chapter 9) and an original approach for the treatment of geometrical symmetries when the sources are not symmetric (Chapter 10). Chapters 11 to 13 are devoted to coupled problems: magneto-thermal coupling for induction heating, magneto-mechanical coupling by introducing the notion of strong and weak coupling and magneto-hydrodynamical coupling focusing on electromagnetic instabilities in fluid conductors. Chapter 14 presents different meshing methods in the context of electromagnetism (presence of air) and introduces self-adaptive mesh refinement procedures. Optimization techniques are then covered in Chapter 15, with the adaptation of deterministic and probabilistic methods to the numerical finite element environment. Chapter 16 presents a variational approach of electromagnetism, showing how Maxwell equations are derived from thermodynamic principles.

Lastly, a heterogeneous model was proposed to investigate the optimal microstructure of $LiFePO_4$ cathode for lithium ion batteries. The processes of battery charge/discharge share a lot in common with corrosion, with the nonlinear oxidation/reduction reactions at the electrode surfaces coupled with mass transfer in the electrolyte. While in this model the morphology and distribution of the active material were reconstructed using an in-house code, the nano-porous binder matrix surrounding the active material was modeled using the porous electrode theory. The simulations of mass transfer and potentials distributions within the solid and liquid phases provide a complete description of this electrochemical system. After validation by comparing the simulation results with the classic Pseudo2D model, the proposed model was further developed to simulate the mechanical responses of the battery cell during discharge.

Drilling and Completion in Petroleum Engineering

Heat and Mass Transfer in Drying of Porous Media

Computational Modeling in Biomedical Engineering and Medical Physics

Proceedings of the 8th International Symposium NUMOG VIII, Rome, Italy, 10-12 April 2002

A practical introduction

This book constitutes the refereed proceedings of the 6th International Conference on Supercomputing, ISUM 2015, held in México, Mexico, in March 2015. The 38 revised full papers presented were carefully reviewed and selected from 102 submissions. The papers are organized in topical sections on perspectives in supercomputer infrastructure and applications; parallel algorithms and optimization; HPC applications and simulations;

Engineering structures may be subjected to extreme high-rate loading conditions, like those associated with natural disasters (earthquakes, tsunamis, rock falls, etc.) or those of anthropic origin (impacts, fluid–structure interactions, shock wave transmissions, etc.). Characterization and modeling of the mechanical behavior of materials under these environments is important in predicting the response of structures and improving designs. This book gathers contributions by eminent researchers in academia and government research laboratories on the latest advances in the understanding of the dynamic process of damage, cracking and fragmentation. It allows the reader to develop an understanding of the key features of the dynamic mechanical behavior of brittle (e.g. granular and cementitious), heterogeneous (e.g. energetic) and ductile (e.g. metallic) materials.

Geochemical modeling is an important tool in environmental studies, and in the areas of subsurface and surface hydrology, pedology, water resources management, mining geology, geothermal resources, hydrocarbon geology, and related areas dealing with the exploration and extraction of natural resources. The book fills a gap in the literature through

Introducing the Quality of Protection Modeling Language (QoP-ML), this book provides for the abstraction of security systems while maintaining emphasis on the details of quality protection . It delineates the steps used in cryptographic protocol and introduces a multilevel protocol analysis that expands current understanding. Every operation defined by QoP-ML is described within parameters of security metrics, therefore evaluating the impact of the operation on the entire system's security.

Numerical Modeling and Simulation of Electrochemical Phenomena

Numerical Simulations of Coupled Problems in Engineering

Numerical Modeling of Coupled Phenomena in Science and Engineering

Theory and Numerical Applications

Numerical Modeling of Filling and Solidification in Casting Processes

Practical Use and Examples

Numerical Modeling of Coupled Phenomena in Science and EngineeringPractical Use and ExamplesCRC Press

Mathematics is a universal language. Differential equations, mathematical modeling, numerical methods and computation form the underlying infrastructure of engineering and the sciences. In this context mathematical modeling is a very powerful tool for studying engineering problems, natural systems and human society. This interdisciplinary book contains a comprehensive overview, including practical examples, of the progress achieved to date in the modeling of coupled phenomena, computational mathematics and mechanics, heat transfer, fluid-structure interactions, biomechanics, and the flow of mass and energy in porous media. Numerical subjects such as grid generation, optimization, finite elements, finite differences, spectral methods, boundary elements, finite volumes and meshless methods are also discussed in detail using real examples. The book provides a thorough presentation of the existing numerical techniques with specific applications to concrete, practical topics. The models and solutions presented here describe various systems: mechanical, biological, geophysical, technical, ecological, etc. The book is organized in thirty six chapters, each written by distinguished experts in their respective fields. The topics presented cover the current state of knowledge in numerical engineering practice including recent and ongoing developments and the presentation of new ideas for future research on applied computational engineering mathematics. The book will be of interest to scientists working in engineering (structural, civil, mechanical), geology, geophysics, aquifer research, petroleum engineering, applied mathematics, and physics, as well as students in any of these areas.

The expansion of unconventional petroleum resources in the recent decade and the rapid development of computational technology have provided the opportunity to develop and apply 3D numerical modeling technology to simulate the hydraulic fracturing of shale and tight sand formations. This book presents 3D numerical modeling technologies for hydraulic fracturing developed in recent years, and introduces solutions to various 3D geomechanical problems related to hydraulic fracturing. In the solution processes of the case studies included in the book, fully coupled multi-physics modeling has been adopted, along with innovative computational techniques, such as submodeling. In practice, hydraulic fracturing is an essential project component in shale gas/oil development and tight sand oil, and provides an essential measure in the process of drilling cuttings reinjection (CRI). It is also an essential measure for widened mud weight window (MWW) when drilling through naturally fractured formations; the process of hydraulic plugging is a typical application of hydraulic fracturing. 3D modeling and numerical analysis of hydraulic fracturing is essential for the successful development of tight oil/gas formations: it provides accurate solutions for optimized stage intervals in a multistage fracking job. It also provides optimized well-spacing for the design of zipper-frac wells. Numerical estimation of casing integrity under stimulation injection in the hydraulic fracturing process is one of major concerns in the successful development of unconventional resources. This topic is also investigated numerically in this book. Numerical solutions to several other typical geomechanics problems related to hydraulic fracturing, such as fluid migration caused by fault reactivation and seismic activities, are also presented. This book can be used as a reference textbook to petroleum, geotechnical and geothermal engineers, to senior undergraduate, graduate and postgraduate students, and to geologists, hydrogeologists, geophysicists and applied mathematicians working in this field. This book is also a synthetic compendium of both the fundamentals and some of the most advanced aspects of hydraulic fracturing technology.

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

Proceedings of the 5th International Young Geotechnical Engineers' Conference

Multiphysics Phase-Field Fracture

Numerical Models in Geomechanics

Multiphysics Modeling: Numerical Methods and Engineering Applications

Deterministic Numerical Modeling of Soil Structure Interaction

Proceedings of the International Symposium on Geoenvironmental Engineering in Hangzhou, China, September 8-10, 2009

Mathematical and numerical modelling of engineering problems in medicine is aimed at unveiling and understanding multidisciplinary interactions and processes and providing insights useful to clinical care and technology advances for better medical equipment and systems. When modelling medical problems, the engineer is confronted with multidisciplinary problems of electromagnetism, heat and mass transfer, and structural mechanics with, possibly, different time and space scales, which may raise concerns in formulating consistent, solvable mathematical models. Computational Medical Engineering presents a number of engineering for medicine problems that may be encountered in medical physics, procedures, diagnosis and monitoring techniques, including electrical activity of the heart, hemodynamic activity monitoring, magnetic drug targeting, bioheat models and thermography, RF and microwave hyperthermia, ablation, EMF dosimetry, and bioimpedance methods. The authors discuss the core approach methodology to pose and solve different problems of medical engineering, including essentials of mathematical modelling (e.g., criteria for well-posed problems); physics scaling (homogenization techniques); Constructal Law criteria in morphing shape and structure of systems with internal flows; computational domain construction (CAD and, or reconstruction techniques based on medical images); numerical modelling issues, and validation techniques used to ascertain numerical simulation results. In addition, new ideas and venues to investigate and understand finer scale models and merge them into continuous media medical physics are provided as case studies. Presents the fundamentals of mathematical and numerical modeling of engineering problems in medicine Discusses many of the most common modelling scenarios for Biomedical Engineering, including, electrical activity of the heart hemodynamic activity monitoring, magnetic drug targeting, bioheat models and thermography, RF and microwave hyperthermia, ablation, EMF dosimetry, and bioimpedance methods Includes discussion of the core approach methodology to pose and solve different problems of medical engineering, including essentials of mathematical modelling, physics scaling, Constructal Law criteria in morphing shape and structure of systems with internal flows, computational domain construction, numerical modelling issues, and validation techniques used to ascertain numerical simulation results

In order to describe soil-structure interaction in various situations (nonlinear, static, dynamic, hydro-mechanical couplings), this book gives an overview of the main modeling methods developed in geotechnical engineering. The chapters are centered around: the finite element method (FEM), the finite difference method (FDM), and the discrete element method (DEM). Deterministic Numerical Modeling of Soil-Structure Interaction allows the reader to explore the classical and well-known FEM and FDM, using interface and contact elements available for coupled hydro-mechanical problems. Furthermore, this book provides insight on the DEM, adapted for interaction laws at the grain level. Within a classical finite element framework, the concept of macro-element is introduced, which generalizes constitutive laws of SSI and is particularly straightforward in dynamic situations. Finally, this book presents the SSI, in the case of a group of structures, such as buildings in a town, using the notion of metamaterials and a geophysics approach.

This book presents and discusses mathematical models, numerical methods and computational techniques used for solving coupled problems in science and engineering. It takes a step forward in the formulation and solution of real-life problems with a multidisciplinary vision, accounting for all of the complex couplings involved in the physical description. Simulation of multifaceted physics problems is a common task in applied research and industry. Often a suitable solver is built by connecting together several single-aspect solvers into a network. In this book, research in various fields was selected for consideration: adaptive methodology for multi-physics solvers, multi-physics phenomena and coupled-field solutions, leading to computationally intensive structural analysis. The strategies which are used to keep these problems computationally affordable are of special interest, and make this an essential book.

Modeling Multiphase Materials Processes: Gas-Liquid Systems describes the methodology and application of physical and mathematical modeling to multi-phase flow phenomena in materials processing. The book focuses on systems involving gas-liquid interaction, the most prevalent in current metallurgical processes. The performance characteristics of these processes are largely dependent on transport phenomena. This volume covers the inherent characteristics that complicate the modeling of transport phenomena in such systems, including complex multiphase structure, intense turbulence, opacity of fluid, high temperature, coupled heat and mass transfer, chemical reactions in some cases, and poor wettability of the reactor walls. Also discussed are: solutions based on experimental and numerical modeling of bubbling jet systems, recent advances in the modeling of nanoscale multi-phase phenomena and multiphase flows in micro-scale and nano-scale channels and reactors. Modeling Multiphase Materials Processes: Gas-Liquid Systems will prove a valuable reference for researchers and engineers working in mathematical modeling and materials processing.

Advances in Environmental Geotechnics

Coupled System Pavement - Tire - Vehicle

Computational Fluid and Solid Mechanics 2003

Numerical Simulation in Hydraulic Fracturing: Multiphysics Theory and Applications

High Performance Computer Applications

Coupled Thermo-Hydro-Mechanical-Chemical Processes in Geo-systems

A Step-by-step Guide to Developing Innovative Computational Tools for Shallow Geothermal Systems Geothermal heat is a viable source of energy and its environmental impact in terms of CO_2 emissions is significantly lower than conventional fossil fuels. Shallow geothermal systems are increasingly utilized for heating and cooling of buildings and greenhouses. However, their utilization is inconsistent with the enormous amount of energy available underneath the surface of the earth. Projects of this nature are not getting the public support they deserve because of the uncertainties associated with them, and this can primarily be attributed to the lack of appropriate computational tools necessary to carry out effective designs and analyses. For this energy field to have a better competitive position in the renewable energy market, it is vital that engineers acquire computational tools, which are accurate, versatile and efficient. This book aims at attaining such tools. This book addresses computational modeling of shallow geothermal systems in considerable detail, and provides researchers and developers in computational mechanics, geosciences, geology and geothermal engineering with the means to develop computational tools capable of modeling the complicated nature of heat flow in shallow geothermal systems in rather straightforward methodologies. Coupled conduction-convection models for heat flow in borehole heat exchangers and the surrounding soil mass are formulated and solved using analytical, semi-analytical and numerical methods. Background theories, enhanced by numerical examples, necessary for formulating the models and conducting the solutions are thoroughly addressed. The book emphasizes two main aspects: mathematical modeling and computational procedures. In geothermics, both aspects are considerably challenging because of the involved geometry and physical processes. However, they are highly stimulating and inspiring. A good combination of mathematical modeling and computational procedures can greatly reduce the computational efforts. This book thoroughly treats this issue and introduces step-by-step methodologies for developing innovative computational models, which are both rigorous and computationally efficient.

Papers in this volume are from the 199th ECS Meeting, held in Washington, DC, Spring 2001. Morphology evolution encompasses electrochemical processing in ULSI fabrication, shape evolution, growth habit, and microstructure of electrodeposits. The most prominent example at present is the electrochemical deposition of copper for ULSI interconnects. Many other electrochemical processes at various stages of emergence and development hold promise for the electronics industry and beyond.

An unified approach to numerical modeling, integrating aspects of continuum mechanics, differential equations, and numerical analysis. Explains how to formulate a mathematical description of the phenomena under consideration, devise techniques for solving the governing equations, then refine the model and interpret the results. Emphasizes physical applications and relates the three major classes of partial differential equations -- elliptic, parabolic, and hyperbolic -- to steady-state systems, dissipative systems, and nondissipative systems, respectively. Also examines some higher-order equations, nonlinear equations, and coupled systems of equations.

Multiphysics Modeling: Numerical Methods and Engineering Applications: Tsinghua University Press Computational Mechanics Series describes the basic principles and methods for multiphysics modeling, covering related areas of physics such as structure mechanics, fluid dynamics, heat transfer, electromagnetic field, and noise. The book provides the latest information on basic numerical methods, also considering coupled problems spanning fluid-solid interaction, thermal-stress coupling, fluid-solid-thermal coupling, electromagnetic solid thermal fluid coupling, and structure-noise coupling. Users will find a comprehensive book that covers background theory, algorithms, key technologies, and applications for each coupling method. Presents a wealth of multiphysics modeling methods, issues, and worked examples in a single volume Provides a go-to resource for coupling and multiphysics problems Covers the multiphysics details not touched upon in broader numerical methods references, including load transfer between physics, element level strong coupling, and interface strong coupling, amongst others Discusses practical applications throughout and tackles real-life multiphysics problems across areas such as automotive, aerospace, and biomedical engineering

Tubular String Characterization in High Temperature High Pressure Oil and Gas Wells

Applications in Geosciences

Numerical Modeling of Water Waves

Introduction to the Numerical Modeling of Groundwater and Geothermal Systems

Dynamic Damage and Fragmentation

Numerical Simulation of Phenomena Related to Gravel-bed Rivers

Effective measurement of the composition and properties of petroleum is essential for its exploration, production, and refining; however, new technologies and methodologies are not adequately documented in much of the current literature. Analytical Methods in Petroleum Upstream Applications explores advances in the analytical methods and instrumentation that allow more accurate determination of the components, classes of compounds, properties, and features of petroleum and its fractions. Recognized experts explore a host of topics, including: A petroleum molecular composition continuity model as a context for other analytical measurements A modern modular sampling system for use in the lab or the process area to collect and control samples for subsequent analysis The importance of oil-in-water measurements and monitoring The chemical and physical properties of heavy oils, their fractions, and products from their upgrading Analytical measurements using gas chromatography and nuclear magnetic resonance (NMR) applications Asphaltene and heavy ends analysis Chemometrics and modeling approaches for understanding petroleum composition and properties to improve upstream, midstream, and downstream operations Due to the renaissance of gas and oil production in North America, interest has grown in analytical methods for a wide range of applications. The understanding provided in this text is designed to help chemists, geologists, and chemical and petroleum engineers make more accurate estimates of the crude value to specific refinery configurations, providing insight into optimum development and extraction schemes.

The present thesis is devoted to the development and implementation of mathematical models and numerical methods in order to carry out computational simulations of complex heat and mass transfer phenomena. Several areas and topics in the field of Computational Fluid Dynamics (CFD) have been treated and covered during the development of the current thesis, specially combustion and dispersed multi-phase flows. This type of simulations requires the implementation and coupling of different physics. The numerical simulation of multiphysics phenomena is challenging due to the wide range of spatial and temporal scales which can characterize each one of the physics involved in the problem. Moreover, when solving turbulent flows, turbulence itself is a very complex physical phenomenon that can demand a huge computational effort. Hence, in order to make turbulent flow simulations computationally affordable, the turbulence should be modelled. Therefore, throughout this thesis different numerical methods and algorithms have been developed and implemented aiming to perform multiphysics simulations in turbulent flows. The first topic addressed is turbulent combustion. Chapter 2 presents a combustion model able to notably reduce the computational cost of the simulation. The model, namely the Progress-Variable (PV) model, relies on a separation of the spatio-temporal scales between the flow and the chemistry. Moreover, in order to account for the influence of the sub-grid species concentrations and energy fluctuations, the PV model is coupled to the Presumed Conditional Moment (PCM) model. Chapter 2 also shows the development of a smart load-balancing method for the evaluation of chemical reaction rates in parallel combustion simulations. Chapter 3 is devoted to dispersed multiphase flows. This type of flows are composed of a continuous phase and a dispersed phase in the form of unconnected particles or droplets. In this thesis, the Eulergian-Lagrangian approach has been selected. This type of model is the best-suited for dispersed multiphase flows with thousands or millions of particles, and with a flow regime ranging from the very dilute up to relatively dense. In Chapter 4, a new method capable of performing parallel numerical simulations using non-overlapping disconnected mesh domains with adjacent boundaries is presented. The presented algorithm stitches at each iteration independent meshes and solves them as a unique domain. Finally, Chapter 5 addresses a transversal aspect to the previously covered topics throughout the thesis. In this chapter, a self-adaptive strategy for the maximisation of the time-step for the numerical solution of convection-diffusion equations is discussed. The method is capable of determining dynamically at each iteration which is the maximum allowable time-step which assures a stable time integration. Moreover, the method also smartly modifies the temporal integration scheme in order to maximize its stability region depending on the properties of the system matrix.

Bringing together the world's leading researchers and practitioners of computational mechanics, these new volumes meet and build on the eight key challenges for research and development in computational mechanics. Researchers have recently identified eight critical research tasks facing the field of computational mechanics. These tasks have come about because it appears possible to reach a new level of mathematical modelling and numerical solution that will lead to a much deeper understanding of nature and to great improvements in engineering design. The eight tasks are: The automatic solution of mathematical models Effective numerical schemes for fluid flows The development of an effective mesh-free numerical solution method The development of numerical procedures for multiphysics problems The development of numerical procedures for multiscale problems The modelling of uncertainties The analysis of complete life cycles of systems Education - teaching sound engineering and scientific judgement Readers of Computational Fluid and Solid Mechanics 2003 will be able to apply the combined experience of many of the world's leading researchers to their own research needs. Those in academic environments will gain a better insight into the needs and constraints of the industries they are involved with; those in industry will gain a competitive advantage by gaining insight into the cutting edge research being carried out by colleagues in academia. Features Bridges the gap between academic researchers and practitioners in industry Outlines the eight main challenges facing Research and Design in Computational mechanics and offers new insights into the shifting the research agenda Provides a vision of how strong, basic and exciting education at university can be harmonized with life-long learning to obtain maximum value from the new powerful tools of analysis

Modern petroleum and petrotechnical engineering is increasingly challenging due to the inherently scarce and decreasing number of global petroleum resources. Exploiting these resources efficiently will require researchers, scientists, engineers and other practitioners to develop innovative mathematical solutions to serve as basis for new asset development designs. Deploying these systems in numerical models is essential to the future success and efficiency of the petroleum industry. Multiphysics modeling has been widely applied in the petroleum industry since the 1960s. The rapid development of computer technology has enabled the numerical applications of multiphysics modeling in the petroleum industry: its applications are particularly popular for the numerical simulation of drilling and completion processes. This book covers theory and numerical applications of multiphysical modeling presenting various author-developed subroutines, used to address complex pore pressure input, complex initial geo-stress field input, etc. Some innovative methods in drilling and completion developed by the authors, such as trajectory optimization and a 3-dimensional workflow for calculation of mud weight window etc, are also presented. Detailed explanations are provided for the modeling process of each application example included in the book. In addition, details of the completed numerical models data are presented as supporting material which can be downloaded from the website of the publisher. Readers can easily understand key modeling techniques with the theory of multiphysics embedded in examples of applications,and can use the data to reproduce the results presented. While this book would be of interest to any student, academic or professional practitioner of engineering, mathematics and natural science, we believe those professionals and academics working in civil engineering, petroleum engineering and petroleum geomechanics would find the work especially relevant to their endeavors.

Morphological Evolution of Electrodeposits and Electrochemical Processing in ULSI Fabrication and Electrodeposition of and on Semiconductors IV

Tsinghua University Press Computational Mechanics Series

Numerical Modeling in Science and Engineering

Numerical methods for diffusion phenomena in building physics

High Resolution Numerical Modelling of the Atmosphere and Ocean

Computational Modeling of Shallow Geothermal Systems

Among the most important and exciting current steps forward in geo-engineering is the development of coupled numerical models. They represent the basic physics of geo-engineering processes which can include the effects of heat, water, mechanics and chemistry. Such models provide an integrating focus for the wide range of geo-engineering disciplines. The articles within this volume were originally presented at the inaugural GeoProc conference held in Stockholm and contain a collection of unusually high quality information not available elsewhere in an edited and coherent form. This collection not only benefits from the latest theoretical developments but also applies them to a number of practical and wide ranging applications. Examples include the environmental issues around radioactive waste disposal deep in rock, and the search for new reserves of oil and gas.

This monograph is centered on mathematical modeling, innovative numerical algorithms and adaptive concepts to deal with fracture phenomena in multiphysics. State-of-the-art phase-field fracture models are complemented with prototype explanations and rigorous numerical analysis. These developments are embedded into a carefully designed balance between scientific computing aspects and numerical modeling of nonstationary coupled variational inequality systems. Therein, a focus is on nonlinear solvers, goal-oriented error estimation, predictor-corrector adaptivity, and interface conditions. Engineering applications show the potential for tackling practical problems within the fields of solid mechanics, porous media, and fluidstructure interaction.

The papers in this volume reflect the current research and advances made in the application of numerical methods in geotechnical engineering. Topics include: instabilities in soil behaviour; environmental geomechanics; and hydro-mechanical coupling in problems of engineering.

This book intends to stimulate research in simulation of diff usion problems in building physics, by fi rst providing an overview of mathematical models and numerical techniques such as the fi nitediff erence and fi nite-element methods traditionally used in building simulation tools. Then, nonconventional methods such as reduced order models, boundary integral approaches and spectral methods are presented, which might be considered in the next generation of building-energy-simulation tools. The advantage of these methods includes the improvement of the numerical solution of diff usion phenomena, especially in large domains relevant to building energy performance analysis.

Numerical Modeling in Materials Science and Engineering

Mathematical and Numerical Modeling in Porous Media

Gas-Liquid Systems

The Finite Element Method for Electromagnetic Modeling

Thermomechanical Industrial Processes

5th IYGEC 2013

This book summarizes research being pursued within the Research Unit FOR 2089, funded by the German Research Foundation (DFG), the goal of which is to develop the scientific base for a paradigm shift towards dimensioning, structural realization and maintenance of pavements, and prepare road infrastructure for future requirements. It provides a coupled thermo-mechanical model for a holistic physical analysis of the pavement-tire-vehicle system: based on this model, pavement structures and materials can be optimized so that new demands become compatible with the main goal - durability of the structures and the materials. The development of these new and qualitatively improved modelling approaches requires a holistic procedure through the coupling of theoretical numerical and experimental approaches as well as an interdisciplinary and closely linked handling of the coupled pavement-tire-vehicle system. This interdisciplinary research provides a deeper understanding of the physics of the full system through complex, coupled simulation approaches and progress in terms of improved and, therefore, more durable and sustainable structures.

High temperature, high oil pressure, oil and gas well completion testing have always been a technical challenge and basic theoretical research is one of the key factors needed to ensure a successful completion test. The completion test basic theory includes: a stress analysis of the completion string, completion string buckling behavior, and temperature and pressure distribution prediction. The completion string is the main bearing and power transmission component for oil and gas well operations and production, and it is required to take on a combination of loads, which result in completion string deformation. Because of these complex relationships, completion string stress analysis has become increasingly more complicated. This book discusses the characters of tubular strings in HTHP (High Temperature - High Pressure) oil and gas wells. These characters include the mechanical behavior of tubular strings and the temperature and pressure variation of tubular strings in different conditions. Mathematical models are established for different conditions and solution existence and uniqueness of some models is discussed, providing algorithms corresponding to the different models. Numerical experiments are presented to verify the validity of models and the feasibility of algorithms, and the impact of the parameters of models for oil and gas wells is also discussed. This book is written for production and testing engineers to provide them with the tools to deal more effectively with the numerical decisions they have to take and for researchers and technicians in petroleum and gas testing and production engineering. Finally, it is also intended to serve as a reference book for mathematicians, college teachers and students.

"Advances in Environmental Geotechnics" presents the latest developments in this interdisciplinary field. The topics covered include basic and advanced theories for modeling of geoenvironmental phenomena, testing and monitoring for geoenvironmental engineering, municipal solid wastes and landfill engineering, sludge and dredged soils, geotechnical reuse of industrial wastes, contaminated land and remediation technology, applications of geosynthetics in geoenvironmental engineering, geoenvironmental risk assessment, management and sustainability, ecological techniques and case histories. This proceedings includes papers authored by core members of ISSMGE TC5 (International Society of Soil Mechanics and Geotechnical Engineering---Environmental Geotechnics) and geoenvironmental researchers from more than 20 countries and regions. It is a valuable reference for geoenvironmental and geotechnical engineers as well as civil engineers. Yunmin Chen, Xiaowu Tang, and Liangtong Zhan are Professors at the Department of Civil Engineering of Zhejiang University, China.

The numerical simulation of manufacturing processes and of their mechanical consequences is of growing interest in industry. However, such simulations need the modeling of couplings between several physical phenomena such as heat transfer, material transformations and solid or fluid mechanics, as well as to be adapted to numerical methodologies. This book gathers a state of the art on how to simulate industrial processes, what data are needed and what numerical simulation can bring. Assembling processes such as welding and friction stir welding, material removal processes, elaboration processes of composite structures, sintering processes, surface-finishing techniques, and thermo-chemical treatments are investigated. This book is the work of a group of researchers who have been working together in this field for more than 12 years. It should prove useful for both those working in industry and those studying the numerical methods applied to multiphysics problems encountered in manufacturing processes.

Multilevel Modeling of Secure Systems in QoP-ML

Unsaturated Soils: Research & Applications

Analytical Methods in Petroleum Upstream Applications

6th International Conference, ISUM 2015, Mexico City, Mexico, March 9-13, 2015, Revised Selected Papers

Proceedings of the International Symposia

Modeling Multiphase Materials Processes

Modelling large-scale wave fields and their interaction with coastal and offshore structures has become much more feasible over the last two decades with increases in computer speeds. Wave modelling can be viewed as an extension of wave theory, a mature and widely published field, applied to practical engineering through the use of computer tools. Information about the various wave models which have been developed is often widely scattered in the literature, and consequently this is one of the first books devoted to wave models and their applications. At the core of the book is an introduction to various types of wave models. For each model, the theoretical assumptions, the application range, and the advantages and limitations are elaborated. The combined use of different wave models from large-scale to local-scale is highlighted with a detailed discussion of the application and matching of boundary conditions. At the same time the book provides a grounding in hydrodynamics, wave theory, and numerical methods which underlie wave modelling. It presents the theoretical background and also shows how to use these models for achieving different engineering tasks, illustrated and reinforced with case study examples.

This book provides an introduction to the scientific fundamentals of groundwater and geothermal systems. In a simple and didactic manner the different water and energy problems existing in deformable porous rocks are explained as well as the corresponding theories and the mathematical and numerical tools that lead to modeling and solving them. This approach provides the reader with a thorough understanding of the basic physical laws of thermoporoelastic rocks, the partial differential equations representing these laws and the principal numerical methods, which allow finding approximate solutions of the corresponding mathematical models. The book also presents the form in which specific useful models can be generated and solved. The text is introductory in the sense that it explains basic themes of the systems mentioned in three areas: engineering, physics and mathematics. All the laws and equations introduced in this book are formulated carefully based on fundamental physical principles. This way, the reader will understand the key importance of mathematics applied to all the subjects. Simple models are emphasized and solved with numerous examples. For more sophisticated and advanced models the numerical techniques are described and developed carefully. This book will serve as a synoptic compendium of the fundamentals of fluid, solute and heat transport, applicable to all types of subsurface systems, ranging from shallow aquifers down to deep geothermal reservoirs. The book will prove to be a useful textbook to senior undergraduate and graduate students, postgraduates, professional geologists and geophysicists, engineers, mathematicians and others working in the vital areas of groundwater and geothermal resources.

Geotechnical engineers are at work worldwide, contributing to sustainable living and to the creation of safe, economic and pleasant spaces to live, work and relax. With increased pressure on space and resources, particularly in cities, their expertise becomes ever more important. This book presents the proceedings of the 5th iYGEC, International Young Geotechnical Engineers' Conference, held at Marne-la-Vallée, France, from 31 August to 1 September 2013. It is also the second volume in the series Advances in Soil Mechanics and Geotechnical Engineering. The papers included here cover topics such as laboratory and field testing, geology and groundwater, earthworks, soil behavior, constitutive modeling, ground improvement, earthquake, retaining structures, foundations, slope stability, tunnels and observational methods. The iYGEC conference series brings together students and young people at the start of their career in the geotechnical professions to share their experience, and this book will be of interest to all those whose work involves soil mechanics and geotechnical engineering. The cover shows Dieppe harbour breakwater project, Louis-Alexandre de Cessart, 1776-1777. © École Nationale des Ponts et Chaussées.

Unsaturated Soils: Research and Applications contains 247 papers presented at 6th International Conference on Unsaturated Soils (UNSAT2014, Sydney, Australia, 2-4 July 2014). The two volumes provide an overview of recent experimental and theoretical advances in a wide variety of topics related to unsaturated soil mechanics: - Unsaturated Soil Behavior - Experimentation - Modelling - Case Histories - Geotechnical Engineering Problems - Multidisciplinary and New Areas Unsaturated Soils: Research and Applications presents a wealth of information, and is of interest to researchers and practising engineers in soil mechanics and geotechnical engineering. These proceedings are dedicated to Professor Geoffrey E. Blight (1934-2013), who passed in November 2013.

Modeling and Numerical Simulation

Modelling and Numerical Simulation of Combustion and Multi-phase Flows Using Finite Volume Methods on Unstructured Meshes

Fundamentals of Mass, Energy and Solute Transport in Poroelastic Rocks

Geochemical Modeling of Groundwater, Vadose and Geothermal Systems

Modeling, Adaptive Discretizations, and Solvers

A Holistic Computational Approach

Computing application to materials science is one of the fastest-growing research areas. This book introduces the concepts and methodologies related to the modeling of the complex phenomena occurring in materials processing. It is intended for undergraduate and graduate students in materials science and engineering, mechanical engineering and physics, and for engineering

professionals or researchers.

Mathematics is a universal language. Differential equations, mathematical modeling, numerical methods and computation form the underlying infrastructure of engineering and the sciences. In this context mathematical modeling is a very powerful tool for studying engineering problems, natural systems and human society. This interdisciplinary book cont

Comprehensive modeling of casting processes requires the development of flexible numerical tools which can handle multiple phenomena (e.g., mold filling, heat t ransfer, solidification phase change, shrinkage, segregation, etc.) occurring in arbitrary geometries. In this thesis, a range of robust and efficient numerical algorithms for the analysis of casting processes is developed. The focus is on methods which can handle coupled filling and solidification. In the first place, modeling of solidification processes and associated phenomena is considered. A consistent set of transport equations governing the solidification of a metallic alloy is presented. On considering increasingly sophisticated versions of these transport equations, a general fixed grid numerical algorithm is developed. Fol lowing this, the usefulness of the algorithm is demonstrated on application to a range of solidification examples taken from recent literature. These include he at conduction driven problems, problems with convection, as well as problems wit h shrinkage and segregation. Next, numerical modeling of the mold filling proces s is considered. A consistent set of transport equations governing the filling o f molten metal into a mold shape is presented. A brief review of existing method s used to track the free surface between the metal and air is provided. The limi tations of existing fixed grid methods, in particular, the requirement for an ex plicit time integration, the need for special procedures to ensure a sharp inter face and the inability to handle arbitrary geometries are discussed. A new fixed grid algorithm which overcomes these limitations is derived. The utility of thi s algorithm is demonstrated on application to a range of example problems. Final ly, the two algorithms are coupled and an analysis tool for concurrent filling, heat transfer and phase change is developed. This tool is used to simulate sand and permanent mold casting processes as well as reaction injection molding of po lymers. Throughout the thesis, the efficiency of the proposed algorithms is demo nstrated on making ample cpu comparisons with previous filling and solidificatio n algorithms. The algorithms developed in this thesis are implemented on both fi nite difference and finite element grids.

Heat and Mass Transfer in Drying of Porous Media offers a comprehensive review of heat and mass transfer phenomena and mechanisms in drying of porous materials. It covers pore-scale and macro-scale models, includes various drying technologies, and discusses the drying dynamics of fibrous porous material, colloidal porous media and size-distributed particle system. Providing guidelines for mathematical modeling and design as well as optimization of drying of porous material, this reference offers useful information for researchers and students as well as engineers in drying technology, food processes, applied energy, mechanical, and chemical engineering.