Computer Methods In Applied Mechanics And Engineering

Nanotechnology is a progressive research and development topic with large amounts of venture capital and government funding being invested worldwide. Nano mechanics, in particular, is the study and characterization of the mechanical behaviour of individual atoms, systems and structures in response to various types of forces and loading conditions. This text, written by respected researchers in the field, informs researchers and practitioners about the fundamental concepts in nano mechanics and materials, focusing on their modelling via multiple scale methods and techniques. The book systematically covers the theory behind multi-particle and nanoscale systems, introduces multiple scale methods, and finally looks at contemporary applications in nano-structured and bio-inspired materials.

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This book treats the development and implementation of a unified particle finite element formulation for the solution of fluid and solid mechanics, Fluid-Structure Interaction (FSI) and coupled thermal problems. FSI problems are involved in many engineering branches, from aeronautics to civil and biomedical engineering. The numerical method proposed in this book has been designed to deal with a large part of these. In particular, it is capable of simulating accurately free-surface fluids interacting with structures that may undergo large displacements, suffer from thermo-plastic deformations and even melt. The method accuracy has been successfully verified in several numerical examples. The thesis also contains the application of the proposed numerical strategy for the simulation of a real industrial problem. This thesis, defended at the Universitat Politecnica de Catalunya in 2015, was selected (ex aequo) as the best PhD thesis in numerical methods in Spain for the year 2015 by the Spanish Society of Numerical Methods in Engineering (SEMMI).

Vibrations are extremely important in all areas of human activities, for all sciences, technologies and industrial applications. Sometimes these vibrations are useful but other times they are undesirable. In any case, understanding and analysis of vibrations are crucial. This book reports on the state of the art research and development findings on this very broad matter through 22 original and innovative research studies exhibiting various investigation directions. The present book is a result of contributions of experts from international scientific community working in different aspects of vibration analysis. The text is addressed not only to researchers, but also to professional engineers, students and other experts in a variety of disciplines, both academic and industrial seeking to gain a better understanding of what has been done in the field recently, and what kind of open problems are in this area.

The chemical and biological sciences face unprecedented opportunities in the 21st century. A confluence of factors from parallel universes - advances in experimental techniques in biomolecular structure determination, progress in theoretical modeling and simulation for large biological systems, and breakthroughs in computer technology - has opened new avenues of opportunity as never before. Now, experimental data can be interpreted and further analysed by modeling, and predictions from any approach can be tested and advanced through companion methodologies and technologies. This two volume set describes innovations in biomolecular modeling and simulation, in both the algorithmic and application fronts. With contributions from experts in the field, the books describe progress and innovation in areas including: simulation algorithms for dynamics and enhanced configurational sampling, force field development, implicit solvation models, coarse-grained models, quantum-mechanical simulations, protein folding, DNA polymerase mechanisms, nucleic acid complexes and simulations, RNA structure analysis and design and other important topics in structural biology modeling. The books are aimed at graduate students and experts in structural biology and chemistry and the emphasis is on reporting innovative new approaches rather than providing comprehensive reviews on each subject.

The book presents the state of the art in isogeometric modeling and shows how the method has advantaged. First an introduction to geometric modeling with NURBS and T-splines is given followed by the implementation into computer software. The implementation in both the FEM and BEM is discussed.

The advent of the digital computer has given great impetus to the development of modern discretization methods in structural mechanics. The young history of the finite element method (FEM) reflects the dramatic increase of computing speed and storage capacity within a relatively short period of time. The history of the boundary element method (BEM) is still younger. Presently, intense scientific efforts aimed at extending the range of application of the BEM can be observed. More than 10 years ago, O.C. Zienkiewicz and his co-workers published the first papers on the coupling of FE and BE discretizations of subregions of solids for the purpose of exploiting the complementary advantages of the two discretization methods and reducing their disadvantages. The FEM has revolutionized structural analysis in industry as well as academia. The BEM has a fair share in the continuation of this revolution. Both discretization methods have become a domain of vigorous, world-wide research activities. The rapid increase of the number of specialized journals and scientific meetings indicates the remarkable increase of research efforts in this important subdomain of computational mechanics. Several discussions of this situation in the Committee for Discretization Methods II: Solid Mechanics of the Society for Applied Mathematics and Mechanics (GAMM) resulted in the plan to submit a proposal to the General Assembly of the International Union of Theoretical and Applied Mechanics (IUTAM) to sponsor a pertinent IUTAM Symposium. As Computational Fluid Dynamics (CFD) and Computational Heat Transfer (CHT) evolve and become increasingly important in standard engineering design and analysis practice, users require a solid understanding of mechanics and numerical methods to make optimal use of available software. The Finite Element Method in Heat Transfer and Fluid Dynamics, Th Computer Methods in Applied Mechanics and EngineeringComputer Methods in Applied Mechanics and EngineeringSpecial edition, 20th anniversaryComputer Methods in Applied Mechanics and EngineeringCumulative IndexComputer Methods in Applied Mechanics and Engineering20th Anniversary Special EditionComputer Methods in Applied Mechanics and EngineeringComputer Methods in Applied Mechanics and EngineeringCumulative Index ofComputing Methods in Applied Sciences and EngineeringSecond International Symposium December 15–19, 1975Springer Science & Business Media

This book contains 23 papers presented at the ECCOMAS Multidisciplinary Jubilee Symposium - New Computational Challenges in Materials, Structures, and Fluids (EMJS08), in Vienna, February 18–20, 2008. The main intention of EMJS08 was to react adequately to the increasing need for interdisciplinary research activities allowing efficient solution of complex problems in engineering and in the applied sciences. The 15th anniversary of ECCOMAS (European Community on Computational Methods in Applied Sciences) provided a suitable framework for taking the aforementioned situation into account by inviting distinguished colleagues from different areas of engineering and the applied sciences, encouraging them to choose multidisciplinary topics for their lectures. The main themes of EMJS08 have a long tradition in engineering and in the applied sciences: materials, structures, and fluids. The solution of scientific problems involving fluids together with solids and structures, not to forget the materials the structures are made of, is of paramount importance in a technical world of rapidly increasing sophistication, referred to as the Leonardo World by the eminent German philosopher Ju rgen Mittelstraß. More recently, the main themes of EMJS08 have gained considerable momentum, owing to signiﬁcant progress in nanotechnology. It enables resolution of a multitude of materials into their micro- and nanostructures. Covering aspects such as physical and chemical characterization, multiscale modeling concepts, continuum micromechanics, and computational homogenization, as well as applications in various engineering fields, the individual contributions to this book follow along different tracks of fluids, materials, and structures. This book provides an overview of the experimental characterization of materials and their numerical modeling, as well as the development of new computational methods for virtual design. Its 17 contributions are divided into four main sections:
experiments and virtual design, composites, fractures and fatigue, and uncertainty quantification. The first section explores new experimental methods that can be used to more accurately characterize material behavior. Furthermore, it presents a combined experimental and numerical approach to optimizing the properties of a structure, as well as new developments in the field of computational methods for virtual design. In turn, the second section is dedicated to experimental and numerical investigations of composites, with a special focus on the modeling of failure modes and the optimization of these materials. Since fatigue also includes wear due to frictional contact and aging of elastomers, new numerical schemes in the field of crack modeling and fatigue prediction are also discussed. The input parameters of a classical numerical simulation represent mean values of actual observations, though certain deviations arise: to illustrate the uncertainties of parameters used in calculations, the book’s final section presents new and efficient approaches to uncertainty quantification.

A common feature of multiphase flows is that a dispersed or discontinuous phase is being carried by a continuous phase, for example water drops in gas flow, solid particles in water flow, or gas bubbles in liquid flow. The overall behavior of the flow is shaped largely by the interaction between the discontinuous elements--drops, particles, bubbles. This work gives a modern, up-to-date account of recent developments in computational multiscale mechanics. Both upsampling and concurrent computing methodologies will be addressed for a range of application areas in computational solid and fluid mechanics: Scale transitions in materials, turbulence in fluid-structure interaction problems, multiscale/multilevel optimization, multiscale poromechanics. A Dutch-German research group that consists of qualified and well-known researchers in the field has worked for six years on the topic of computational multiscale mechanics. This text provides a unique opportunity to consolidate and disseminate the knowledge gained in this project. The addition of chapters written by experts outside this working group provides a broad and multifaceted view of this rapidly evolving field.

This volume documents the proceedings of the Second International Symposium on Adhesive Joints: Formation, Characteristics and Testing held in Newark, NJ, May 22-24, 2000. Since the first symposium, held in 1982, there had been tremendous research activity dealing with many aspects of adhesive joints. This volume contains a total of 21 papers, which were all properly peer reviewed, revised and edited before inclusion. Therefore, this book is not merely a collection of unreviewed manuscripts, but rather represents information which has passed peer scrutiny. Furthermore, the authors were asked to update their manuscripts, so the information contained in this book should be current and fresh. The book is divided into three parts: 1) General Papers; 2) Evaluation, Analysis and Testing; and 3) Durability Aspects. The topics covered include: molecular brush concepts in enhancing strength of adhesive joints; factors affecting performance of adhesive joints; substrate preparation and modification; interfacial/interphasial aspects; determination of locus of failure; analysis and evaluation of adhesive joints using various techniques; testing of adhesive joints; stress analysis; application of fracture mechanics; durability aspects; accelerated environmental degradation of adhesive joints; solvent uptake; and adhesives with special characteristics. This volume represents a commentary on the current R&D activity in this arena and it should be of great value and interest to anyone interested in adhesive bonding / adhesive joints. Furthermore, this volume contains a number of excellent review/overview articles, which should be of particular value.

This book contains a systematic analysis of geometrical situations leading to contact pairs -- point-to-surface, surface-to-surface, point-to-curve, curve-to-curve and curve-to-surface. Each contact pair is inherited with a special coordinate system based on its geometrical properties such as a Gaussian surface coordinate system or a Serret-Frenet curve coordinate system. The formulation in a covariant form allows in a straightforward fashion to consider various constitutive relations for a certain pair such as anisotropy for both frictional and structural parts. Then standard methods well known in computational contact mechanics such as penalty, Lagrange multiplier methods, combination of both and others are formulated in these coordinate systems. Such formulations require then the powerful apparatus of differential geometry of surfaces and curves as well as of convex analysis. The final goals of such transformations are then ready-for-implementation numerical algorithms within the finite element method including any arbitrary discretization techniques such as high order and isogeometric finite elements, which are most convenient for the considered geometrical situation. The book proposes a consistent study of geometry and kinematics, variational formulations, constitutive relations for surfaces and discretization techniques for all considered geometrical pairs and contains the associated numerical analysis as well as some new analytical results in contact mechanics.

This book contains contributions from the ECCOMAS thematic conference Multibody Dynamics 2003 that took place in Lisbon, Portugal. Finite element methods have become ever more important to engineers as tools for design and optimization, now even for solving non-linear technological problems. However, several aspects must be considered for finite-element simulations which are specific for non-linear problems: These problems require the knowledge and the understanding of theoretical foundations and their finite-element discretization as well as algorithms for solving the non-linear equations. This book provides the reader with the required knowledge covering the complete field of finite element analyses in solid mechanics. It is written for advanced students in engineering fields but serves also as an introduction into non-linear simulation for the practising engineer.

This volume contains the best papers presented at the 2nd ECCOMAS International Conference on Multiscale Computations for Solids and Fluids, held June 10-12, 2015. Topics dealt with include multiscale strategy for efficient development of scientific software for large-scale computations, coupled probability-nonlinear-mechanics problems and solution methods, and modern mathematical and computational setting for multi-phase flows and fluid-structure interaction. The papers consist of contributions by six experts who taught short courses prior to the conference, along with several selected articles from other participants dealing with complementary issues, covering both solid mechanics and applied mathematics.

This volume will contain selected papers from the lectures held at the BAIL 2010 Conference, which took place from July 5th to 9th, 2010 in Zaragoza (Spain). The papers present significant advances in the modeling, analysis and construction of efficient numerical methods to solve boundary and interior layers appearing in singular perturbation problems. Special emphasis is put on the mathematical foundations of such
methods and their application to physical models. Topics in scientific fields such as fluid dynamics, quantum mechanics, semiconductor modeling, control theory, elasticity, chemical reactor theory, and porous media are examined in detail.

Computational Methods for Microstructure-Property Relationships introduces state-of-the-art advances in computational modeling approaches for materials structure-property relations. Written with an approach that recognizes the necessity of the engineering computational mechanics framework, this volume provides balanced treatment of heterogeneous materials structures within the microstructural and component scales. Encompassing both computational mechanics and computational materials science disciplines, this volume offers an analysis of the current techniques and selected topics important to industry researchers, such as deformation, creep and fatigue of primarily metallic materials. Researchers, engineers and professionals involved with predicting performance and failure of materials will find Computational Methods for Microstructure-Property Relationships a valuable reference.

Computational Methods for Fracture in Porous Media: Isogeometric and Extended Finite Element Methods provides a self-contained presentation of new modeling techniques for simulating crack propagation in fluid-saturated porous materials. This book reviews the basic equations that govern fluid-saturated porous media. A multi-scale approach to modeling fluid transport in joints, cracks, and faults is described in such a way that the resulting formulation allows for a sub-grid representation of the crack and fluid flow in the crack. Interface elements are also analyzed with their extension to the hydromechanical case. The flexibility of Extended Finite Element Method for non-stationary cracks is also explored and their formulation for fracture in porous media described. This book introduces isogeometric finite element methods and its basic features and properties. The rapidly evolving phase-field approach to fracture is also discussed. The applications of this book’s content cover various fields of engineering, making it a valuable resource for researchers in soil, rock and biomechanics. Researchers, engineers and professionals involved with predicting performance and failure of materials will find Computational Methods for Microstructure-Property Relationships a valuable reference.

The IUTAM-Symposium on "Finite Inelastic Deformations - Theory and Applications" took place from August 19 to 23, 1991, at the University of Hannover, Germany, with 75 participants from 14 countries. Scope of the symposium was a fundamental treatment of new developments in plasticity and visco-plasticity at finite strains. This covered the phenomenological material theory based on continuum mechanics as well as the treatment of microstructural phenomena detected by precise experimental datas. In a restricted number, lectures on new experimental facilities for measuring finite strains were also implemented into the symposium. Another important topic of the symposium was the treatment of reliable and effective computational methods for solving engineering problems with finite inelastic strains. Within this context it was an essential feature that theory, numerical and computational analysis were be seen in an integrated way. In total 9 sessions with 37 lectures, many of them given by well known keynote-lecturers, and a poster session with 10 contributions met fully our expectations of a high ranking up-to-date forum for the interaction of four topics, namely the physical and mathematical modelling of finite strain inelastic deformations, including localization and damage as well as the achievements in the numerical analysis and implementation and the solution of complicated engineering systems. Special and important features were reliable material datas from macroscopic and microscopic tests as well as test results of complex engineering problems, like deep drawing and extrusion.

This book provides readers with a detailed insight into diverse and exciting recent developments in computational solid mechanics, documenting new perspectives and horizons. The topics addressed cover a wide range of current research, from computational materials modeling, including crystal plasticity, micro-structured materials, and biomaterials, to multi-scale simulations of multi-physics phenomena. Particular emphasis is placed on pioneering discretization methods for the solution of coupled non-linear problems at different length scales. The book, written by leading experts, reflects the remarkable advances that have been made in the field over the past decade and more, largely due to the development of a sound mathematical background and efficient computational strategies. The contents build upon the 2014 IUTAM symposium celebrating the 60th birthday of Professor Michael Ortiz, to whom this book is dedicated. His work has long been recognized as pioneering and is a continuing source of inspiration for many researchers. It is hoped that by providing a "taste" of the field of computational mechanics, the book will promote its popularity among the mechanics and physics communities.