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the implementation of the method are clearly identified, with a chapter given over to each one: approximation, construction of the integral forms, matrix organization, solution of the algebraic systems and architecture of programs. The final chapter lays the foundations for a general program, written in Matlab, which can be used to solve problems that are linear or otherwise, stationary or transient, presented in relation to applications stemming from the domains of structural mechanics, fluid mechanics and heat transfer.

Computational contact mechanics is a broad topic which brings together algorithmic, geometrical, optimization and numerical aspects for a robust, fast and accurate treatment of contact problems. This book covers all the basic ingredients of contact and computational contact mechanics: from efficient contact detection algorithms and classical optimization methods to new developments in contact kinematics and resolution schemes for both sequential and parallel computer architectures. The book is self-contained and intended for people working on the implementation and improvement of contact algorithms in a finite element software. Using a new tensor algebra, the authors introduce some original notions in contact kinematics and extend the classical formulation of contact elements. Some classical and new resolution methods for contact problems and associated ready-to-implement expressions are provided. Contents: 1. Introduction to Computational Contact. 2. Geometry in Contact Mechanics. 3. Contact Detection. 4. Formulation of Contact Problems. 5. Numerical Procedures. 6. Numerical Examples. About the Authors Vladislav A. Yastrebov is a postdoctoral-fellow in Computational Solid Mechanics at MINES ParisTech in France. His work in computational contact mechanics was recognized by the CSMA award and by the Prix Paul Caseau of the French Academy of Technology and Electricité de France.

Learn to model your own problems for predicting the properties of polymer-based composites Mechanics of Particle- and Fiber-Reinforced Polymer Nanocomposites: Nanoscale to Continuum Simulations provides readers with a thorough and up-to-date overview of nano, micro, and continuum approaches for the multiscale modeling of polymer-based composites. Covering nanocomposite development, theoretical models, and common simulation methods, the text includes a variety of case studies and scripting tutorials that enable readers to apply and further develop the supplied simulations. The book describes the foundations of molecular dynamics and continuum mechanics methods, guides readers through the basic steps required for multiscale modeling of any material, and correlates the results between the experimental and theoretical work performed. Focused primarily on nanocomposites, the methods covered in the book are applicable to various other materials such as carbon nanotubes, polymers, metals, and ceramics. Throughout the book, readers are introduced to key topics of relevance to nanocomposite materials and structures—supported by journal articles that discuss recent developments in modeling techniques and in the prediction of mechanical and thermal properties. This timely, highly practical resource: Explains the molecular dynamics (MD) simulation procedure for nanofiber and nanoparticle reinforced polymer composites Compares results of experimental and theoretical results from mechanical models at different length

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scales Covers different types of fibers and matrix materials that constitute composite materials, including glass, boron, carbon, and Kevlar Reviews models that predict the stiffness of short-fiber composites, including the self-consistent model for finite-length fibers, bounding models, and the Halpin-Tsai equation Describes various molecular modeling methods such as Monte Carlo, Brownian dynamics, dissipative particle dynamics, and lattice Boltzmann methods Highlights the potential of nanocomposites for defense and space applications Perfect for materials scientists, materials engineers, polymer scientists, and mechanical engineers, Mechanics of Particle- and Fiber-Reinforced Polymer Nanocomposites is also a must-have reference for computer simulation scientists seeking to improve their understanding of reinforced polymer nanocomposites.

Extended Finite Element and Meshfree Methods provides an overview of, and investigates, recent developments in extended finite elements with a focus on applications to material failure in statics and dynamics. This class of methods is ideally suited for applications, such as crack propagation, two-phase flow, fluid-structure-interaction, optimization and inverse analysis because they do not require any remeshing. These methods include the original extended finite element method, smoothed extended finite element method (XFEM), phantom node method, extended meshfree methods, numerical manifold method and extended isogeometric analysis. This book also addresses their implementation and provides small MATLAB codes on each sub-topic. Also discussed are the challenges and efficient algorithms for tracking the crack path which plays an important role for complex engineering applications. Explains all the important theory behind XFEM and meshfree methods Provides advice on how to implement XFEM for a range of practical purposes, along with helpful MATLAB codes Draws on the latest research to explore new topics, such as the applications of XFEM to shell formulations, and extended meshfree and extended isogeometric methods Introduces alternative modeling methods to help readers decide what is most appropriate for their work

This informal introduction to computational fluid dynamics and practical guide to numerical simulation of transport phenomena covers the derivation of the governing equations, construction of finite element approximations, and qualitative properties of numerical solutions, among other topics. To make the book accessible to readers with diverse interests and backgrounds, the authors begin at a basic level and advance to numerical tools for increasingly difficult flow problems, emphasizing practical implementation rather than mathematical theory. Finite Element Methods for Computational Fluid Dynamics: A Practical Guide explains the basics of the finite element method (FEM) in the context of simple model problems, illustrated by numerical examples. It comprehensively reviews stabilization techniques for convection-dominated transport problems, introducing the reader to streamline diffusion methods, Petrov-Galerkin approximations, Taylor-Galerkin schemes, flux-corrected transport algorithms, and other nonlinear high-resolution schemes, and covers Petrov-Galerkin stabilization, classical projection schemes, Schur complement solvers, and the implementation of the k-epsilon turbulence model in its presentation of the FEM for incompressible flow problem. The book also describes the open-source finite element library ELMER, which is recommended as a software development kit for advanced applications in an

online component.

While the theory and application of finite elements methods can be extended to incompatible, hybrid, and mixed element methods, important issues, such as determining the reliability of the solution of incompatible multivariable elements, along with a common perception of impracticality, have hindered the widespread implementation of these methods. Today, however, recent advances--many directly attributable to these authors--have allowed the development of the stability theory and abstract mathematics to useful tools. Hybrid and Incompatible Finite Element Methods introduces these advances in the theory and applications of incompatible and multivariable finite element methods. After an overview of the variation formulation of finite element methods in solid mechanics, the authors discuss the fundamental theory and systematically demonstrate the theoretical foundations of incompatible elements and their application to different problems in the theory of elasticity. They also introduce new ideas in the development of hybrid finite elements, study the numerical stability of the hybrid and mixed element, and establish the theory of zero energy deformation modes. The final chapters, explore applications to fracture problems, present a bound analysis for fracture parameters, and demonstrate an implementation of a finite element analysis program.

Industrial Mathematics is a relatively recent discipline. It is concerned primarily with transforming technical, organizational and economic problems posed by industry into mathematical problems; "solving" these problems by approximative methods of analytical and/or numerical nature; and finally reinterpreting the results in terms of the original problems. In short, industrial mathematics is modelling and scientific computing of industrial problems. Industrial mathematicians are bridge-builders: they build bridges from the field of mathematics to the practical world; to do that they need to know about both sides, the problems from the companies and ideas and methods from mathematics. As mathematicians, they have to be generalists. If you enter the world of industry, you never know which kind of problems you will encounter, and which kind of mathematical concepts and methods you will need to solve them. Hence, to be a good "industrial mathematician" you need to know a good deal of mathematics as well as ideas already common in engineering and modern mathematics with tremendous potential for application. Mathematical concepts like wavelets, pseudorandom numbers, inverse problems, multigrid etc., introduced during the last 20 years have recently started entering the world of real applications. Industrial mathematics consists of modelling, discretization, analysis and visualization. To make a good model, to transform the industrial problem into a mathematical one such that you can trust the prediction of the model is no easy task.

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