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Abstract: The purpose of this chapter is to describe how one can implement the state-based peridynamic lattice model (SPLM) either on a single processor (a laptop or desktop computer) or on many processors running in parallel using the MPI (Message Passing Interface) protocol. The molecular dynamics research community has led the way in developing methods for simulating particle dynamics on massively parallel computers....

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A ductile fracture of an Al-Mg-Si alloy. A fracture is a mathematical singularity to which the classical equations of continuum mechanics cannot be applied directly - Peridynamics offers a numerical method. Peridynamics is a formulation of continuum mechanics that is oriented toward deformations with discontinuities, especially fractures.

Parting with the classical continuum concepts of stress and strain in the computational simulation of solids, this book proposes a peridynamic model that applies the model directly to particle lattices. The model is directly solvable on a computer. Introduction to Practical Peridynamics is both a graduate-level textbook and a treatise. The text provides the necessary foundations to understand and apply the state-based peridynamic lattice model, as well as a guide for the practical use of the model — for solving realistic structural engineering problems (particularly in reinforced concrete structures) in elasticity, plasticity, damage, fracture, and large deformations. Contents in this book include introductory chapters presenting the historical background of the subject; classical elasticity; computational solid modeling; continuum mechanics; fracture mechanics; particle dynamics simulations on parallel computers; as well as example simulations (with model applications). Request Inspection Copy

This dictionary offers clear and reliable explanations of over 100 keywords covering the entire field of non-classical continuum mechanics and generalized mechanics, including the theory of

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elasticity, heat conduction, thermodynamic and electromagnetic continua, as well as applied mathematics. Every entry includes the historical background and the underlying theory, basic equations and typical applications. The reference list for each entry provides a link to the original articles and the most important in-depth theoretical works. Last but not least, every entry is followed by a cross-reference to other related subject entries in the dictionary.

This textbook demonstrates the application of the finite element philosophy to the solution of real-world problems and is aimed at graduate level students, but is also suitable for advanced undergraduate students. An essential part of an engineer's training is the development of the skills necessary to analyse and predict the behaviour of engineering systems under a wide range of potentially complex loading conditions. Only a small proportion of real-life problems can be solved analytically, and consequently, there arises the need to be able to use numerical methods capable of simulating real phenomena accurately. The finite element (FE) method is one such widely used numerical method. Finite Element Applications begins with demystifying the 'black box' of finite element solvers and progresses to addressing the different pillars that make up a robust finite element solution framework. These pillars include: domain creation, mesh generation and element formulations, boundary conditions, and material response considerations. Readers of this book will be equipped with the ability to develop models of real-world problems using industry-standard finite element packages.

The book presents a set of novel, efficient and systematic concurrent multiscale optimization methods by considering the distribution of the material in macro-scale and the unit-cell configuration design in micro-scale simultaneously. Different from the traditional optimization method that is performed in a single scale, the proposed methods could generate a great deal of

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improvements in structural performance through the multiscale structure-material concurrent optimum design. The proposed theory and methods are related to statics, dynamics, thermoelastics and the coupling of different physical fields. Therefore, it provides a comprehensive designing scheme when multiple factors are taken into account. For example, the designing scheme can have a great significance on enhancing the structural performances under coupled multi-physical fields, such as load bearing capacity, vibration resistance ability, and safety under thermal stress and so on. Several numerical examples are highlighted in this unique volume based on practical engineering applications. The examples collectively demonstrate drastically improved designs featuring excellent unit-cell configuration and highly regular macroscale material distribution in a variety of industrial applications.

This comprehensive volume presents a unified framework of continuum theories. It indicates that (i) microcontinuum theories (micromorphic and micropolar theories) are natural extension of classical continuum mechanics, and (ii) classical continuum mechanics is a special case of microcontinuum theories when the deformable material point is idealized as a single mathematical point. The kinematics and basic laws are rigorously derived. Based on axiomatic approach, constitutive theory is systematically derived for various kinds of materials, ranging from Stokesian fluid to thermo-visco-elastic-plastic solid. Material force and Thermomechanical-electromagnetic coupling are introduced and discussed. Moreover, general finite element methods for large-strain thermomechanical coupling physical phenomena are systematically formulated. Also, non-classical continuum theories (Nonlocal Theory, Mechanobiology, 4D printing, Poromechanics, and Non-Self-Similar Crack Propagation) are rigorously formulated with applications and demonstrated numerically. As an advanced monograph, this unique compendium can also be used as a textbook for several graduate courses, including continuum mechanics, finite

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element methods, and advanced engineering science theories.

Extensive problems are provided to help students to better understand the topics covered.

This book presents cutting-edge concepts, paradigms, and research highlights in the field of computational materials science and engineering, and provides a fresh, up-to-date perspective on solving present and future materials challenges. The chapters are written by not only pioneers in the fields of computational materials chemistry and materials science, but also experts in multi-scale modeling and simulation as applied to materials engineering. Pedagogical introductions to the different topics and continuity between the chapters are provided to ensure the appeal to a broad audience and to address the applicability of integrated computational materials science and engineering for solving real-world problems.

Studies of complexity, singularity, and anomaly using nonlocal continuum models are steadily gaining popularity. This monograph provides an introduction to basic analytical, computational, and modeling issues and to some of the latest developments in these areas. *Nonlocal Modeling, Analysis, and Computation* includes motivational examples of nonlocal models, basic building blocks of nonlocal vector calculus, elements of theory for well-posedness and nonlocal spaces, connections to and coupling with local models, convergence and compatibility of numerical approximations, and various applications, such as nonlocal dynamics of anomalous diffusion and nonlocal peridynamic models of elasticity and fracture mechanics. A particular focus is on nonlocal systems with a finite range of interaction to illustrate their connection to local partial differential equations and fractional PDEs. These models are designed to represent nonlocal interactions explicitly and to remain valid for complex systems involving possible singular solutions and they have the potential to be alternatives for as well as bridges to existing models. The author discusses ongoing studies of nonlocal

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models to encourage the discovery of new mathematical theory for nonlocal continuum models and offer new perspectives on traditional models, analytical techniques, and algorithms.

This handbook covers the peridynamic modeling of failure and damage. Peridynamics is a reformulation of continuum mechanics based on integration of interactions rather than spatial differentiation of displacements. The book extends the classical theory of continuum mechanics to allow unguided modeling of crack propagation/fracture in brittle, quasi-brittle, and ductile materials; autonomous transition from continuous damage/fragmentation to fracture; modeling of long-range forces within a continuous body; and multiscale coupling in a consistent mathematical framework.

This book introduces the peridynamic (PD) differential operator, which enables the nonlocal form of local differentiation. PD is a bridge between differentiation and integration. It provides the computational solution of complex field equations and evaluation of derivatives of smooth or scattered data in the presence of discontinuities. PD also serves as a natural filter to smooth noisy data and to recover missing data. This book starts with an overview of the PD concept, the derivation of the PD differential operator, its numerical implementation for the spatial and temporal derivatives, and the description of sources of error. The applications concern interpolation, regression, and smoothing of data, solutions to nonlinear ordinary differential equations, single- and multi-field partial differential equations and integro-differential equations. It describes the derivation of the weak form of PD Poisson's and Navier's equations for direct imposition of essential and natural boundary conditions. It also presents an alternative approach for the PD differential operator based on the least squares minimization. Peridynamic Differential Operator for Numerical Analysis is suitable for both advanced-level student and researchers,

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demonstrating how to construct solutions to all of the applications.

Provided as supplementary material, solution algorithms for a set of selected applications are available for more details in the numerical implementation.

This book provides readers with an incisive look at cutting-edge peridynamic modeling methods, numerical techniques, their applications, and potential future directions for the field. It starts with an introductory chapter authored by Stewart Silling, who originally developed peridynamics. It then looks at new concepts in the field, with chapters covering dual-horizon peridynamics, peridynamics for axisymmetric analysis, beam and plate models in peridynamics, coupled peridynamics and XFEM, peridynamics for dynamic fracture modeling, and more. From there, it segues into coverage of cutting-edge applications of peridynamics, exploring its biological applications, modeling at the nanoscale, peridynamics for composites delamination and damage in ceramics, and more, concluding with a chapter on the application of artificial intelligence and machine learning in peridynamics. Covers modeling methods, numerical techniques, applications, and future directions for the field Discusses techniques such as dual-horizon peridynamics, damage modeling using the phase-field approach, and contact analysis of rigid and deformable bodies with refined non-ordinary state-based peridynamics Looks at a range of different peridynamic applications such as ice modeling, fiber-reinforced composite modeling, modeling at nanoscale, and more

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