

Modern numerical methods and their applications in mechanical engineering

Numerical simulation is a powerful tool to solve scientific and engineering problems. It plays an important role in many aspects of fundamental research and engineering applications, for example, mechanism of turbulent flow with/without viscoelastic additives, optimization of processes, prediction of oil/gas production, and online control of manufacturing. The soul of numerical simulation is numerical method, which is driven by the above demands and in return pushes science and technology by the successful applications of advanced numerical methods. With the development of mathematical theory and computer hardware, various numerical methods are proposed. The new numerical methods or their new applications lead to important progress in the related fields. For example, parallel computing largely promotes the precision of direct numerical simulations of turbulent flow to capture undiscovered flow structures. Proper orthogonal decomposition method greatly reduces the simulation time of oil pipelining transportation. The development of commercial computational fluid dynamics (CFD) software also depends on the advancement of numerical methods. Thus, numerical methods become more and more important and their modern developments are worth exploring.

To reflect the frontier researches in numerical methods with applications, this special collection was established with the editorial team members from China, Italy, USA, and Norway. The guest editors are from both universities and industrial companies. The high quality and diversity of the editorial team members ensure the special issue collected 22 high-quality articles, from China, USA, Czech Republic, Turkey, Saudi Arabia, Korea, Vietnam, and India, providing a state-of-the-art insight to the specific topics including solid mechanics, fluid mechanics, optimization, and system stability.

In the article "Mechanical and failure characteristics of rock-like material with multiple crossed joint sets under uniaxial compression," Bonded-Particle Model

(BPM) using PFC3D is used to explore the effect of joint sets number and joint spacing on the mechanical behavior of a jointed rock mass under uniaxial compression. Stress concentration is found to be the reason for relatively lower strength of blocks with crossed joint sets compared to the block with the same weakest joint set. The results are helpful to reveal the mechanism of damage and fracture of jointed rocks under uniaxial compression.

In the article "Discrete element method simulations of load behavior with mono-sized iron ore particles in a ball mill," the sphere-clump method is employed to determine the geometrical shape of the mono-sized iron ore particles. Through discrete element method simulations, the impact of mill speed and lifter on the load behavior of iron ore particles in a ball mill not only potentially facilitates the improvement in high-performance liners but also optimizes the mill speed in the pre-design stage.

In the article "Lumped parameter model and numerical model of vapor bubble-driven valve-less micropump," a lumped parameter model for a vapor bubble-driven valve-less micropump is established and validated by the numerical simulation using ANSYS Fluent, in terms of bubble dynamics and flow performance. The results indicate that the lumped parameter model can be a convenient tool to guide the design of the micropumps.

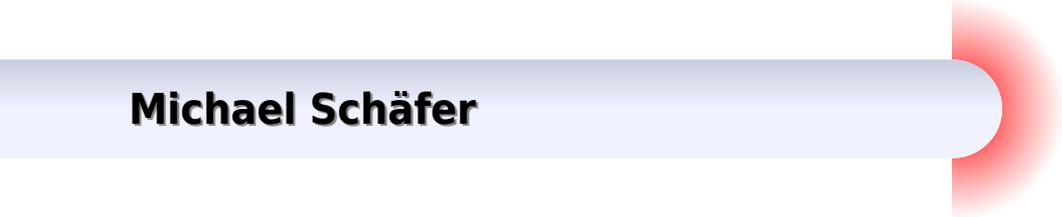
In the article "On effect of viscoelastic characteristics of polymers on performance of micropump," a numerical modeling of polydimethylsiloxane (PDMS) micropump behavior using the fluid-structure interaction (FSI) along with viscoelastic material is demonstrated to capture FSIs accurately. The simulations can be extended for analysis of PDMS-based check-valve micropumps and other lab-on-a-chip devices under dynamic loading.

In the article "Applications of the discontinuous Galerkin method to propagating acoustic wave



Applications Of Numerical Methods In Mechanical Engineering

Michael Schäfer



Applications Of Numerical Methods In Mechanical Engineering:

Numerical Analysis with Applications in Mechanics and Engineering Petre Teodorescu, Nicolae-Doru Stanescu, Nicolae Pandrea, 2013-06-04 NUMERICAL ANALYSIS WITH APPLICATIONS IN MECHANICS AND ENGINEERING A much needed guide on how to use numerical methods to solve practical engineering problems Bridging the gap between mathematics and engineering Numerical Analysis with Applications in Mechanics and Engineering arms readers with powerful tools for solving real world problems in mechanics physics and civil and mechanical engineering Unlike most books on numerical analysis this outstanding work links theory and application explains the mathematics in simple engineering terms and clearly demonstrates how to use numerical methods to obtain solutions and interpret results Each chapter is devoted to a unique analytical methodology including a detailed theoretical presentation and emphasis on practical computation Ample numerical examples and applications round out the discussion illustrating how to work out specific problems of mechanics physics or engineering Readers will learn the core purpose of each technique develop hands on problem solving skills and get a complete picture of the studied phenomenon Coverage includes How to deal with errors in numerical analysis Approaches for solving problems in linear and nonlinear systems Methods of interpolation and approximation of functions Formulas and calculations for numerical differentiation and integration Integration of ordinary and partial differential equations Optimization methods and solutions for programming problems Numerical Analysis with Applications in Mechanics and Engineering is a one of a kind guide for engineers using mathematical models and methods as well as for physicists and mathematicians interested in engineering problems

Numerical Methods for Engineering Applications Edward R. Champion, 1993-06-29 For undergraduate and first year graduate students and practicing engineers who need a reference on numerical techniques this text provides a sampling of programs that have proven to be efficient and effective in performing numerical analysis The theory behind the algorithms is kept to a minimum

Numerical Methods for Engineering Applications Joel H. Ferziger, 1998-04-17 The author also explores a wide range of methods for solving initial and boundary value problems

Numerical Analysis for Engineers Bilal Ayyub, Richard H. McCuen, 2015-09-18 Numerical Analysis for Engineers Methods and Applications demonstrates the power of numerical methods in the context of solving complex engineering and scientific problems The book helps to prepare future engineers and assists practicing engineers in understanding the fundamentals of numerical methods especially their applications limitations

Numerical Methods for Engineers and Scientists Using MATLAB® Ramin S. Esfandiari, 2013-06-04 Designed to benefit scientific and engineering applications Numerical Methods for Engineers and Scientists Using MATLAB focuses on the fundamentals of numerical methods while making use of MATLAB software The book introduces MATLAB early on and incorporates it throughout the chapters to perform symbolic graphical and numerical tasks The text covers a variety of methods from curve fitting to solving ordinary and partial differential equations Provides fully worked out examples showing all details Confirms results through

the execution of the user defined function or the script file Executes built in functions for re confirmation when available Generates plots regularly to shed light on the soundness and significance of the numerical results Created to be user friendly and easily understandable Numerical Methods for Engineers and Scientists Using MATLAB provides background material and a broad introduction to the essentials of MATLAB specifically its use with numerical methods Building on this foundation it introduces techniques for solving equations and focuses on curve fitting and interpolation techniques It addresses numerical differentiation and integration methods presents numerical methods for solving initial value and boundary value problems and discusses the matrix eigenvalue problem which entails numerical methods to approximate a few or all eigenvalues of a matrix The book then deals with the numerical solution of partial differential equations specifically those that frequently arise in engineering and science The book presents a user defined function or a MATLAB script file for each method followed by at least one fully worked out example When available MATLAB built in functions are executed for confirmation of the results A large set of exercises of varying levels of difficulty appears at the end of each chapter The concise approach with strong up to date MATLAB integration provided by this book affords readers a thorough knowledge of the fundamentals of numerical methods utilized in various disciplines

Numerical Methods in Mechanics of Materials
Ken Chong, Arthur Boresi, Sunil Saigal, James Lee, 2017-11-27 In the dynamic digital age the widespread use of computers has transformed engineering and science A realistic and successful solution of an engineering problem usually begins with an accurate physical model of the problem and a proper understanding of the assumptions employed With computers and appropriate software we can model and analyze complex physical systems and problems However efficient and accurate use of numerical results obtained from computer programs requires considerable background and advanced working knowledge to avoid blunders and the blind acceptance of computer results This book provides the background and knowledge necessary to avoid these pitfalls especially the most commonly used numerical methods employed in the solution of physical problems It offers an in depth presentation of the numerical methods for scales from nano to macro in nine self contained chapters with extensive problems and up to date references covering Trends and new developments in simulation and computation Weighted residuals methods Finite difference methods Finite element methods Finite strip layer prism methods Boundary element methods Meshless methods Molecular dynamics Multiphysics problems Multiscale methods

Finite Element Applications
Michael Okereke, Simeon Keates, 2018-01-23 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

Advances in Synthesis Gas: Methods, Technologies and Applications Mohammad Reza Rahimpour, Mohammad Amin Makarem, Maryam Meshksar, 2022-10-18 Advances in Synthesis Gas Methods Technologies and Applications Syngas Process Modelling and Apparatus Simulation consists of numerical modeling and simulation of different processes and apparatus for producing syngas purifying it as well as synthesizing different chemical materials or generating heat and energy from syngas These apparatus and processes include but are not limited to reforming gasification partial oxidation swing technologies and membranes Introduces numerical modeling and the simulation of syngas production processes and apparatus Describes numerical models and simulation procedures utilized for syngas purification processes and equipment Discusses modelling and simulation of processes using syngas as a source for producing chemicals and power

Mathematics for Mechanical Engineers Frank Kreith, William F. Ames, George Cain, Y. L. Tong, W. Glenn Steele, Hugh W. Coleman, Richard L. Kautz, Dan M. Frangopol, Paul Norton, 2022-03-30 Mathematics for Mechanical Engineers gives mechanical engineers convenient access to the essential problem solving tools that they use each day It covers applications employed in many different facets of mechanical engineering from basic through advanced to ensure that you will easily find answers you need in this handy guide For the engineer venturing out of familiar territory the chapters cover fundamentals like physical constants derivatives integrals Fourier transforms Bessel functions and Legendre functions For the experts it includes thorough sections on the more advanced topics of partial differential equations approximation methods and numerical methods often used in applications The guide reviews statistics for analyzing engineering data and making inferences so professionals can extract useful information even with the presence of randomness and uncertainty The convenient Mathematics for Mechanical Engineers is an indispensable summary of mathematics processes needed by engineers

Numerical Methods in Multibody Dynamics Claus Führer, 2013-11-11 Numerical Analysis is an interdisciplinary topic which develops its strength only when viewed in close connection with applications Nowadays mechanical engineers having computer simulation as a daily engineering tool have to learn more and more techniques from that field Mathematicians on the other hand are increasingly confronted with the need for developing special purpose methods and codes This requires a broad interdisciplinary understanding and a sense for model method interactions With this monograph we give an introduction to selected topics of Numerical Analysis based on these facts We dedicate our presentations to an interesting discipline in computational engineering multibody dynamics Though the basic ideas and methods apply to other engineering fields too we emphasize on having one homogeneous class of applications Both authors

worked through many years in teams developing multibody codes Interdisciplinary work also includes transferring ideas from one field to the other and a big amount of teaching and that was the idea of this book This book is intended for students of mathematics engineering and computer science as well as for people already concerned with the solution of related topics in university and industry After a short introduction to multibody systems and the mathematical formulation of the equations of motion different numerical methods used to solve simulation tasks are presented The presentation is supported by a simple model of a truck This truck model will follow the reader from the title page to the appendix in various versions specially adapted to the topics

The South African Mechanical Engineer, 1989

Soft Computing in Smart Manufacturing Tatjana Sibalija, J. Paulo Davim, 2021-12-06 This book aims at addressing the challenges of contemporary manufacturing in Industry 4.0 environment and future manufacturing aka Industry 5.0 by implementing soft computing as one of the major sub fields of artificial intelligence It contributes to development and application of the soft computing systems including links to hardware software and enterprise systems in resolving modern manufacturing issues in complex highly dynamic and globalized industrial circumstances It embraces heterogeneous complementary aspects such as control monitoring and modeling of different manufacturing tasks including intelligent robotic systems and processes addressed by various machine learning and fuzzy techniques modeling and parametric optimization of advanced conventional and non conventional eco friendly manufacturing processes by using machine learning and evolutionary computing techniques cybersecurity framework for Internet of Things based systems addressing trustworthiness and resilience in machine to machine and human machine collaboration static and dynamic digital twins integration and synchronization in a smart factory environment STEP NC technology for a smart machine vision system and integration of Open CNC with Service Oriented Architecture for STEP NC monitoring system in a smart manufacturing Areas of interest include but are not limited to applications of soft computing to address the following dynamic process system modeling and simulation dynamic process system parametric optimization dynamic planning and scheduling smart predictive maintenance intelligent and autonomous systems improved machine cognition effective digital twins integration human machine collaboration robots and cobots

Graduate School Catalog for ... University of Arkansas, Fayetteville. Graduate School, 1975

Computational Methods in Engineering J.N. Reddy, 2024-03-19 Computational Methods in Engineering Finite Difference Finite Volume Finite Element and Dual Mesh Control Domain Methods provides readers with the information necessary to choose appropriate numerical methods to solve a variety of engineering problems Explaining common numerical methods in an accessible yet rigorous manner the book details the finite element method FEM finite volume method FVM and importantly a new numerical approach dual mesh control domain method DMCDM Numerical methods are crucial to everyday engineering The book begins by introducing the various methods and their applications with example problems from a range of engineering disciplines including heat transfer solid and structural mechanics and fluid mechanics It highlights the strengths of FEM with its systematic procedure

and modular steps and then goes on to explain the uses of FVM It explains how DMCDM embodies useful parts of both FEM and FVM particularly in its use of the control domain method and how it can provide a comprehensive computational approach The final chapters look at ways to use different numerical methods primarily FEM and DMCDM to solve typical problems of bending of beams axisymmetric circular plates and other nonlinear problems This book is a useful guide to numerical methods for professionals and students in all areas of engineering and engineering mathematics

Radiative Heat Transfer Michael F. Modest, Sandip Mazumder, 2021-10-16 Radiative Heat Transfer Fourth Edition is a fully updated revised and practical reference on the basic physics and computational tools scientists and researchers use to solve problems in the broad field of radiative heat transfer This book is acknowledged as the core reference in the field providing models methodologies and calculations essential to solving research problems It is applicable to a variety of industries including nuclear solar and combustion energy aerospace chemical and materials processing as well as environmental biomedical and nanotechnology fields Contemporary examples and problems surrounding sustainable energy materials and process engineering are an essential addition to this edition Includes end of chapter problems and a solutions manual providing a structured and coherent reference Presents many worked examples which have been brought fully up to date to reflect the latest research Details many computer codes ranging from basic problem solving aids to sophisticated research tools

Courses and Degrees Stanford University, 1990 *Computational Engineering - Introduction to Numerical Methods* Michael Schäfer, 2006-05-01 This book is an introduction to modern numerical methods in engineering It covers applications in fluid mechanics structural mechanics and heat transfer as the most relevant fields for engineering disciplines such as computational engineering scientific computing mechanical engineering as well as chemical and civil engineering The content covers all aspects in the interdisciplinary field which are essential for an up to date engineer

Numerical Methods for Engineers and Scientists Amos Gilat, Vish Subramaniam, 2008 Following a unique approach this innovative book integrates the learning of numerical methods with practicing computer programming and using software tools in applications It covers the fundamentals while emphasizing the most essential methods throughout the pages Readers are also given the opportunity to enhance their programming skills using MATLAB to implement algorithms They ll discover how to use this tool to solve problems in science and engineering

Mechanical Engineering ,1919

Applications Of Numerical Methods In Mechanical Engineering Book Review: Unveiling the Power of Words

In some sort of driven by information and connectivity, the ability of words has are more evident than ever. They have the capability to inspire, provoke, and ignite change. Such is the essence of the book **Applications Of Numerical Methods In Mechanical Engineering**, a literary masterpiece that delves deep in to the significance of words and their impact on our lives. Written by a renowned author, this captivating work takes readers on a transformative journey, unraveling the secrets and potential behind every word. In this review, we shall explore the book is key themes, examine its writing style, and analyze its overall impact on readers.

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