Numerical And Analytical Methods With Matlab For Electrical Engineers Computational Mechanics And Applied Analysis

Although the solution of Partial Differential Equations by numerical methods is the standard practice in industries, analytical methods are still important for the critical assessment of results derived from advanced computer simulations and the improvement of the underlying numerical techniques. Literature devoted to analytical methods, however, often focuses on theoretical and mathematical aspects and is therefore useless to most engineers. Analytical Methods for Heat Transfer and Fluid Flow Problems addresses engineers and engineering students. It describes useful analytical methods by applying them to real-world problems rather than solving the usual over-simplified classroom problems. The book demonstrates the applicability of analytical methods even for complex problems and guides the reader to a more intuitive understanding of approaches and solutions.

Introduction to Numerical and Analytical Methods with MATLAB® for Engineers and Scientists provides the basic concepts of programming in MATLAB for engineering applications. • Teaches engineering students how to write computer programs on the MATLAB platform • Examines the selection and use of numerical and analytical methods through examples and case studies • Demonstrates mathematical concepts that can be used to help solve engineering problems, including matrices, roots of equations, integration, ordinary differential equations, curve fitting, algebraic linear equations, and more The text covers useful numerical methods, including interpolation, Simpson's rule on integration, the Gauss elimination method for solving systems of linear algebraic equations, the Runge-Kutta method for solving ordinary differential equations, and the search method in combination with the bisection method for obtaining the roots of transcendental and polynomial equations. It also highlights MATLAB's built-in functions. These include interp1 function, the quad and dblquad functions, the inv function, the ode45 function, the fzero function, and many others. The second half of the text covers more advanced topics, including the iteration method for solving pipe flow problems, the Hardy-Cross method for solving flow rates in a pipe network, separation of variables for solving partial differential equations, and the use of Laplace transforms to solve both ordinary and partial differential equations. This book serves as a textbook for a first course in numerical methods using MATLAB to solve problems in mechanical, civil, aeronautical, and electrical engineering. It can also be used as a textbook or as a reference book in higher level courses.

The electronic component of the book is based on the widely used and highly praised Mathematica software package. Each chapter of the bookis a Mathematica notebook with links to web-based material. The methods are applied to a range of problems taken from physics and engineering. The book covers elementary and advaned numerical methods used in modern scientific computing.

Numerical and Analytical Methods with MATLABCRC Press

Numerical Methods is a mathematical tool used by engineers and mathematicians to do scientific calculations. It is used to find solutions to applied problems where ordinary analytical methods fail. This book is intended to serve for the needs of courses in Numerical Methods at the Bachelors' and Masters' levels at various universities.

For well over a decade, the numerical approach to field computation has been gaining progressively greater importance. Analytical methods offield compu tation are, at best, unable to accommodate the very wide variety of configura tions in which fields must be computed. On the other hand, numerical methods can accommodate many practical configurations that analytical methods cannot. With the advent of high-speed digital computers, numerical field computations have finally become practical. However, in order to implement numerical methods of field computation, we need algorithms, numerical methods, and mathematical tools that are largely quite different from those that have been traditionally used with analytical methods. Many of these algorithms have, in fact, been presented in the large number of papers that have been published on this subject in the last two decades. And to some of those who are already experienced in the art of numerical field computations, these papers, in addition to their own original work, are enough to give them the knowledge that they need to perform practical numerical field computations.

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Examines numerical and semi-analytical methods for differential equations that can be used for solving practical ODEs and PDEs This student-friendly book deals with various approaches for solving differential equations numerically or semi-analytically depending on the type of equations and offers simple example problems to help readers along. Featuring both traditional and recent methods, Advanced Numerical and Semi Analytical Methods for Differential Equations begins with a review of basic numerical methods. It then looks at Laplace, Fourier, and weighted residual methods for solving differential equations. A new challenging method of Boundary Characteristics Orthogonal Polynomials (BCOPs) is introduced next. The book then discusses Finite Difference Method (FDM), Finite Element Method (FEM), Finite Volume Method (FVM), and Boundary Element Method (BEM). Following that, analytical/semi analytic methods like Akbari Ganji's Method (AGM) and Exp-function are used to solve nonlinear differential equations. Nonlinear differential equations using semi-analytical methods are also addressed, namely Adomian Decomposition Method (ADM), Homotopy Perturbation Method (HPM), Variational Iteration Method (VIM), and Homotopy Analysis Method (HAM). Other topics covered include: emerging areas of research related to the solution of differential equations based on differential quadrature and wavelet approach; combined and hybrid methods for solving differential equations; as well as an overview of fractal differential equations. Further, uncertainty in term of intervals and fuzzy numbers have also been included, along with the interval finite element method. This book: Discusses various methods for solving linear and nonlinear ODEs and PDEs Covers basic numerical techniques for solving differential equations along with various discretization methods Investigates nonlinear differential equations using semi-analytical methods Examines differential equations in an uncertain environment Includes a new scenario in which uncertainty (in term of intervals and fuzzy numbers) has been included in differential equations Contains solved example problems, as well as some unsolved problems for self-validation of the topics covered Advanced Numerical and Semi Analytical Methods for Differential Equations is an excellent text for graduate as well as post graduate students and researchers studying various methods for solving differential equations, numerically and semi-analytically.

This volume presents the proceedings of the Asia-Pacific Vibration Conference (APVC) 2019, "Vibration Engineering for a Sustainable Future," emphasizing work devoted to experimental methods and verification. The APVC is one of the larger conferences held biannually with the intention to foster scientific and technical research collaboration among Asia-Pacific countries. The APVC provides a forum for researchers, practitioners, and students from, but not limited to, areas around the Asia-Pacific countries in a collegial and stimulating environment to present, discuss and disseminate recent advances and new findings on all aspects of vibration and noise, their control and utilization. All aspects of vibration, acoustics, vibration and noise control, vibration utilization, fault diagnosis and monitoring are appropriate for the conference, with the focus this year on the vibration aspects in dynamics and noise & vibration. This 18th edition of the APVC was held in November 2019 in Sydney, Australia. The previous seventeen conferences have been held in Japan ('85, '93, '07), Korea ('87, '97, '13), China ('89, '01, '11, '17), Australia ('91, '03), Malaysia ('95, '05), Singapore ('99), New Zealand ('09) and Vietnam ('15).

Engineering applications offer benefits and opportunities across a range of different industries and fields. By developing effective methods of analysis, results and solutions are produced with higher accuracy. Numerical and Analytical Solutions for Solving Nonlinear Equations in Heat Transfer is an innovative source of academic research on the optimized techniques for analyzing heat transfer equations and the application of these methods across various fields. Highlighting pertinent topics such as the differential transformation method, industrial applications, and the homotopy perturbation method, this book is ideally designed for engineers, researchers, graduate students, professionals, and academics interested in applying new mathematical techniques in engineering sciences.

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 subject of numerical methods in finance has recently emerged as a new discipline at the intersection of probability theory, finance, and numerical analysis. The methods employed bridge the gap between financial theory and computational practice, and provide solutions for complex problems that are difficult to solve by traditional analytical methods. Although numerical methods in finance have been studied intensively in recent years, many theoretical and practical financial aspects have yet to be explored. This volume presents current research and survey articles focusing on various numerical methods in finance. The book is designed for the academic community and will also serve professional investors.

Combining academic and practical approaches to this important topic, Numerical and Analytical Methods with MATLAB® for Electrical Engineers is the ideal resource for electrical and computer engineering students. Based on a previous edition that was geared toward mechanical engineering students, this book expands many of the concepts presented in that book and replaces the original projects with new ones intended specifically for electrical engineering students. This book includes: An introduction to the MATLAB programming environment Mathematical techniques for matrix algebra, root finding, integration, and differential equations More advanced topics, including transform methods, signal processing, curve fitting, and optimization An introduction to the MATLAB graphical design environment, Simulink Exploring the numerical methods that electrical engineers use for design analysis and testing, this book comprises standalone chapters outlining a course that also introduces students to computational methods and programming skills, using MATLAB as the programming environment. Helping engineering students to develop a feel for structural programming—not just button-pushing with a software program—the illustrative examples and extensive assignments in this resource enable them to develop the necessary skills and then apply them to practical electrical engineering problems and cases.

This book offers an essential introduction to the mathematical theory of compressible viscous fluids. The main goal is to present analytical methods from the perspective of their numerical applications. Accordingly, we introduce the principal theoretical tools needed to handle well-posedness of the underlying Navier-Stokes system, study the problems of sequential stability, and, lastly, construct solutions by means of an implicit numerical scheme. Offering a unique contribution – by exploring in detail the "synergy" of analytical and numerical methods – the book offers a valuable resource for graduate students in mathematics and researchers working in mathematical fluid mechanics. Mathematical fluid mechanics concerns problems that are closely connected to real-world applications and is also an important part of the theory of partial differential equations and numerical analysis in general. This book highlights the fact that numerical and mathematical analysis are not two separate fields of mathematics. It will help graduate students and researchers to not only better understand problems in mathematical compressible fluid mechanics but also to learn something from the field of mathematical and numerical analysis and to see the connections between the two worlds. Potential readers should possess a good command of the basic tools of functional analysis and partial differential equations including the function spaces of Sobolev type.

Alleviating the mystery behind the black boxes of MATLAB®functions, this classroom-tested text shows how the built-in functions of MATLAB can numerically solve systems of linear equations, ordinary

differential equations, roots of transcendental equations, integrals, statistical problems, optimization problems, control systems problems, and stress analysis problems using the finite element method. It discusses topics often not covered in similar books, including the finite element method and mechanical controls. Incorporating basic numerical and analytical methods, the text contains many sample MATLAB programs (scripts) that provide guidance on completing the projects given at the end of each chapter.

The book discusses the solutions to nonlinear ordinary differential equations (ODEs) using analytical and numerical approximation methods. Recently, analytical approximation methods have been largely used in solving linear and nonlinear lower-order ODEs. It also discusses using these methods to solve some strong nonlinear ODEs. There are two chapters devoted to solving nonlinear ODEs using numerical methods, as in practice high-dimensional systems of nonlinear ODEs that cannot be solved by analytical approximate methods are common. Moreover, it studies analytical and numerical techniques for the treatment of parameter-depending ODEs. The book explains various methods for solving nonlinear-oscillator and structural-system problems, including the energy balance method, harmonic balance method, amplitude frequency formulation, variational iteration method, homotopy perturbation method, iteration perturbation method, homotopy analysis method, simple and multiple shooting method, and the nonlinear stabilized march method. This book comprehensively investigates various new analytical and numerical approximation techniques that are used in solving nonlinear-oscillator and structural-system problems. Students often rely on the finite element method to such an extent that on graduation they have little or no knowledge of alternative methods of solving problems. To rectify this, the book introduces several new approximation techniques.

Complex physical phenomena involving chemically reacting systems or the transport of heat or fluids are often modeled by coupled systems of time-dependent, nonlinear partial differential equations. The difficulties in understanding the stability of the differential equation systems and in designing efficient, accurate numerical methods for their solution are widely recognized and were the focus of this research. We have worked on four general aspects of the analysis and numerical approximation of systems of partial differential equations. These areas of research are: (1) modeling aspects and stability analysis for nonlinear time-dependent partial differential equations; (2) use and analysis of finite element or finite difference methods to discretize coupled systems of nonlinear differential equations; (3) development of adaptive or local grid refinement capabilities to resolve local phenomena in large-scale applications; and (4) development of data structures, preconditioners, and efficient solution algorithms for large-scale problems on new computer architectures. Emphasis has been placed upon multiphase or multicomponent, transport-dominated flow processes with dynamic local phenomena. The research also involved a mix of analysis, algorithm development, and large-scale computation using newer computer architectures.

General relativity ranks among the most accurately tested fundamental theories in all of physics. Deficiencies in mathematical and conceptual understanding still exist, hampering further progress. This book collects surveys by experts in mathematical relativity writing about the current status of, and problems in, their fields. There are four contributions for each of the following mathematical areas: differential geometry and differential topology, analytical methods and differential equations, and numerical methods.

Like all branches of physics and engineering, electromagnetics relies on mathematical methods for modeling, simulation, and design procedures in all of its aspects (radiation, propagation, scattering, imaging, etc.). Originally, rigorous analytical techniques were the only machinery available to produce any useful results. In the 1960s and 1970s, emphasis was placed on asymptotic techniques), which produced approximations of the fields for very high frequencies when closed-form solutions were not feasible. Later, when computers demonstrated explosive progress, numerical techniques were utilized to develop approximate results of controllable accuracy for arbitrary geometries. In this Special Issue, the most recent advances in the aforementioned approaches are presented to illustrate the state-of-the-art mathematical techniques in electromagnetics.

This excellent text for advanced undergraduate and graduate students covers norms, numerical solutions of linear systems and matrix factoring, eigenvalues and eigenvectors, polynomial approximation, and more. Many examples and problems. 1966 edition.

Numerical and Analytical Methods with MATLAB® presents extensive coverage of the MATLAB programming language for engineers. It demonstrates how the built-in functions of MATLAB can be used to solve systems of linear equations, ODEs, roots of transcendental equations, statistical problems, optimization problems, control systems problems, and stress analysis problems. These built-in functions are essentially black boxes to students. By combining MATLAB with basic numerical and analytical techniques, the mystery of what these black boxes might contain is somewhat alleviated. This classroom-tested text first reviews the essentials involved in writing computer programs as well as fundamental aspects of MATLAB. It next explains how matrices can solve problems of linear equations, how to obtain the roots of algebraic and transcendental equations, how to evaluate integrals, and how to solve various ODEs. After exploring the features of Simulink, the book discusses curve fitting, optimization problems, and PDE problems, such as the vibrating string, unsteady heat conduction, and sound waves. The focus then shifts to the solution of engineering problems via iteration procedures, differential equations via Laplace transforms, and stress analysis problems via the finite element method. The final chapter examines control systems theory, including the design of single-input single-output (SISO) systems. Two Courses in One Textbook The first six chapters are appropriate for a lower level course at the sophomore level. The remaining chapters are ideal for a course at the senior undergraduate or first-year graduate level. Most of the chapters contain projects that require students to write a computer program in MATLAB that produces tables, graphs, or both. Many sample MATLAB programs (scripts) in the text provide guidance on completing these projects.

The rapid development of high speed digital computers and the increasing desire for numerical answers to applied problems have led to increased demands in the courses dealing with the methods and techniques of numerical analysis. Numerical methods have always been useful but their role in the present-day scientific research has become prominent. For example, they enable one to find the roots of transcendental equations and in solving nonlinear differential equations. Indeed, they give the solution when ordinary analytical methods fail. This well-organized and comprehensive text aims at enhancing and strengthening numerical methods concepts among students using C++ programming, a fast emerging preferred programming language among software developers. The book provides an synthesis of both theory and practice. It focuses on the core areas of numerical analysis including algebraic equations, interpolation, boundary value problem, and matrix eigenvalue problems. The mathematical concepts are supported by a number of solved examples. Extensive self-review exercises and answers are provided at the end of each chapter to help students review and reinforce the key concepts. KEY FEATURES : C++ programs are provided for all numerical methods discussed. More than 400 unsolved problems and 200 solved problems are included to help students test their grasp of the subject. The book is intended for undergraduate and postgraduate students of Mathematics, Engineering and Statistics. Besides, students pursuing BCA and MCA and having Numerical Methods with C++ Programming as a subject in their course will benefit from this book.

Publisher Description

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.

This chapter presents a compendium of the primary methods that are used to perform water flow analyses with a focus on computational approximation methods. Some of the current algorithms for carrying out this type of analysis are summarized. In addition, general guidelines are provided for using the methodologies for specific types of analysis, such as transient-state flow caused by water drawdown and flow in unsaturated media. Emphasis is placed on the need for stochastic analysis of water flow. Lastly, conclusions and general recommendations are given for performing numerical groundwater seepage analyses in soils.

The Coupling Impedance is one of the most important parameters in Particle Accelerator Design. Various methods were developed to calculate and measure this parameter or its correspondent in time domain, the Wake Field. Unfortunately, there are indications that, at least for some configurations and boundary conditions, the results of some of these methods are not satisfactory. In particular, we will concentrate our attention on a common bench measurement named Wire Method. Even if this method has been largely studied, little improvements have been introduced and its results are still only partially reliable at least in some range of frequencies, as it will be shown. In order to test the results of some commercial and freeware computer codes and of the Wire Method, we intent to resort to analytical methods (to be treated numerically only in the final stage) to be implemented in homemade codes conceived "ad hoc." To this end, a reworking version of the Mode Matching technique has been adopted. Here, we will show that the indications given by this method may be very important as an independent check of the results produced by other sources.

Although the Partial Differential Equations (PDE) models that are now studied are usually beyond traditional mathematical analysis, the numerical methods that are being developed and used require testing and validation. This is often done with PDEs that have known, exact, analytical solutions. The development of analytical solutions is also an active area of research, with many advances being reported recently, particularly traveling wave solutions for nonlinear evolutionary PDEs. Thus, the current development of analytical solutions directly supports the development of numerical methods by providing a spectrum of test problems that can be used to evaluate numerical methods. This book surveys some of these new developments in analytical and numerical methods, and relates the two through a series of PDE examples. The PDEs that have been selected are largely "named'' since they carry the names of their original contributors. These names usually signify that the PDEs are widely recognized and used in many application areas. The authors' intention is to provide a set of numerical and analytical methods based on the concept of a traveling wave, with a central feature of conversion of the PDEs to ODEs. The Matlab and Maple software will be available for download from this website shortly. www.pdecomp.net Includes a spectrum of applications in science, engineering, applied mathematics Presents a combination of numerical and analytical methods Provides transportable computer codes in Matlab and Maple