Differential Quadrature And Its Application In Engineering

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Mathematical Functions with Formulas, Graphs, and Mathematical TablesAn Introduction to Numerical Methods and AnalysisPartial Differential EquationsNumerical Quadrature and Solution of Ordinary Differential EquationsAutomated Solution of Differential Equations by the Finite Element MethodDiQuMaSPABAdvanced Numerical and Semi-Analytical Methods for Differential EquationsPartial Differential Equations and MathematicaVariational Techniques for Elliptic Partial Differential EquationsNumerical Solution of Boundary Value Problems for Ordinary Differential EquationsMechanics of laminated Composite doubly-curvel shell structuresSinc Methods for Quadrature and Differential EquationsAdaptive High-Order Methods in Computational Fluid DynamicsIntroduction to Integral Equations with ApplicationsLine Integral Methods for Conservative Problems

Numerical Methods for Differential Equations

It was noted in the preface of the book "Inequalities Involving Functions and Their Integrals and Derivatives", Kluwer Academic Publishers, 1991, by D.S. Mitrinovic, J.E. Pecaric and A.M. Fink; since the writing of the classical book by Hardy, Littlewood and Polya (1934), the subject of differential and integral inequalities has grown by about 800%. Ten years on, we can confidently assert that this growth will increase even more significantly. Twenty pages of Chapter XV in the above mentioned book are devoted to integral inequalities involving functions with bounded derivatives, or, Ostrowski type inequalities. This is now itself a special domain of the Theory of Inequalities with many powerful results and a large number of applications in Numerical Integration, Probability Theory and Statistics, Information Theory and Integral Operator Theory. The main aim of the present book, jointly written by the members of the Vic toria University node of RGMIA (Research Group in Mathematical Inequali ties and Applications, http: I /rgmia. vu. edu. au) and Th. M. Rassias, is to present a selected number of results on Ostrowski type inequalities. Results for univariate and multivariate real functions and their natural applications in the error analysis of numerical quadrature for both simple and multiple integrals as well as for the Riemann-Stieltjes integral are given.

Implementing Spectral Methods for Partial Differential Equations

In the past few years, the differential quadrature method has been applied extensively in engineering. This book, aimed primarily at practising engineers, scientists and graduate students, gives a systematic description of the mathematical fundamentals of differential quadrature and its detailed implementation in solving Helmholtz problems and problems of flow, structure and vibration. Differential quadrature provides a global approach to numerical discretization, which approximates the derivatives by a linear weighted sum of all the functional values in the whole domain. Following the analysis of function approximation and the analysis of a linear vector space, it is shown in the book that the weighting coefficients of the polynomial-based, Fourier expansion-based, and exponential-based differential quadrature methods can be computed explicitly. It is also demonstrated that the polynomial-based differential quadrature method is equivalent to the highest-order finite difference scheme. Furthermore, the relationship between differential quadrature and conventional spectral collocation is analysed. The book contains material on: - Linear Vector Space Analysis and the Approximation of a Function; - Polynomial-, Fourier Expansion- and Exponential-based Differential Quadrature; - Differential Quadrature Weighting Coefficient Matrices; - Solution of Differential Quadrature-resultant Equations; - The Solution of Incompressible Navier-Stokes and Helmholtz Equations; - Structural and Vibrational Analysis Applications; - Generalized Integral Quadrature and its Application in the Solution of Boundary Layer Equations. Three FORTRAN programs for simulation of driven cavity flow, vibration analysis of plate and Helmholtz eigenvalue problems respectively, are appended. These sample programs should give the reader a better understanding of differential quadrature and can easily be modified to solve the readers own engineering problems.

Meshless Methods and Their Numerical Properties

Variational Techniques for Elliptic Partial Differential Equations, intended for graduate students studying applied math, analysis, and/or numerical analysis, provides the necessary tools to understand the structure and solvability of elliptic partial differential equations. Beginning with the necessary definitions and theorems from distribution theory, the book gradually builds the functional analytic framework for studying elliptic PDE using variational formulations. Rather than introducing all of the prerequisites in the first chapters, it is the introduction of new problems which motivates the development of the associated analytical tools. In this way the student who is encountering this material for the first time will be aware of exactly what theory is needed, and for which problems. Features A detailed and rigorous development of the theory of Sobolev spaces on Lipschitz domains, including the trace operator and the normal component of vector fields An integration of functional analysis concepts involving Hilbert spaces and the problems which can be solved with these concepts, rather than separating the two Introduction to the analytical tools needed for physical problems of interest like time-harmonic waves, Stokes and Darcy flow, surface differential equations, Maxwell cavity problems, etc. A variety of problems which serve to reinforce and expand upon the material in each chapter, including applications in fluid and solid mechanics

Spectral Methods for Incompressible Viscous Flow

Emphasizing the finite difference approach for solving differential equations, the second edition of Numerical Methods for Engineers and Scientists presents a methodology for systematically constructing individual computer programs. Providing easy access to accurate solutions to complex scientific and engineering problems, each chapter begins with objectives, a discussion of a representative application, and an outline of special features, summing up with a list of tasks students should be able to complete after reading the chapter- perfect for use as a study guide or for review. The AIAA Journal calls the book "a good, solid instructional text on the basic tools of numerical analysis."

Numerical Methods for Engineers and Scientists

In the recent decades, there has been a growing interest in micro- and nanotechnology. The advances in nanotechnology give rise to new applications and new types of materials with unique electromagnetic and mechanical properties. This book is devoted to the modern methods in electrodynamics and acoustics, which have been developed to describe wave propagation in these modern materials and nanodevices. The book consists of original works of leading scientists in the field of wave propagation who produced new theoretical and experimental methods in the research field and obtained new and important results. The first part of the book consists of chapters with general mathematical methods and approaches to the problem of wave propagation. A special attention is attracted to the advanced numerical methods fruitfully applied in the field of wave propagation. The second part of the book is devoted to the problems of wave propagation in newly developed metamaterials, micro- and nanostructures and porous media. In this part the interested reader will find important and fundamental results on electromagnetic wave propagation in media with negative refraction index and electromagnetic imaging in devices based on the materials. The third part of the book is devoted to the problems of wave propagation in elastic and piezoelectric media. In the fourth part, the works on the problems of wave propagation in plasma are collected. The fifth, sixth and seventh parts are devoted to the problems of wave propagation in media with chemical reactions, in nonlinear and disperse media, respectively. And finally, in the eighth part of the book some experimental methods in wave propagations are considered. It is necessary to emphasize that this book is not a textbook. It is important that the results combined in it are taken “from the desks of researchers“. Therefore, I am sure that in this book the interested and actively working readers (scientists, engineers and students) will find many interesting results and new ideas.

Numerical Methods in Scientific Computing:

This computationally oriented book describes and explains the mathematical relationships among matrices, moments, orthogonal polynomials, quadrature rules, and the Lanczos and conjugate gradient algorithms. The book bridges different mathematical areas to obtain algorithms to estimate bilinear forms involving two vectors and a function of the matrix. The first part of the book provides the necessary mathematical background and explains the theory. The second part describes the applications and gives numerical examples of the algorithms and techniques developed in the first part. Applications addressed in the book include computing elements of functions of matrices; obtaining estimates of the error norm in iterative methods for solving linear systems and computing parameters in least squares and total least squares; and solving ill-posed problems using Tikhonov regularization. This book will interest researchers in numerical linear algebra and matrix computations, as well as scientists and engineers working on problems involving computation of bilinear forms.

Discrete Element Analysis Methods of Generic Differential Quadratures

This book is a tutorial written by researchers and developers behind the FEniCS Project and explores an advanced, expressive approach to the development of mathematical software. The presentation spans mathematical background, software design and the use of FEniCS in applications. Theoretical aspects are complemented with computer code which is available as free/open source software. The book begins with a special introductory tutorial for beginners.

Following are chapters in Part I addressing fundamental aspects of the approach to automating the creation of finite element solvers. Chapters in Part II address the design and implementation of the FEnicS software. Chapters in Part III present the application of FEniCS to a wide range of applications, including fluid flow, solid mechanics, electromagnetics and geophysics.

Theory and Applications of Fractional Differential Equations

The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations is a collection of papers presented at the 1972 Symposium by the same title, held at the University of Maryland, Baltimore County Campus. This symposium relates considerable numerical analysis involved in research in both theoretical and practical aspects of the finite element method. This text is organized into three parts encompassing 34 chapters. Part I focuses on the mathematical foundations of the finite element method, including papers on theory of approximation, variational principles, the problems of perturbations, and the eigenvalue problem. Part II covers a large number of important results of both a theoretical and a practical nature. This part discusses the piecewise analytic interpolation and approximation of triangulated polygons; the Patch test for convergence of finite elements; solutions for Dirichlet problems; variational crimes in the field; and superconvergence result for the approximate solution of the heat equation by a collocation method. Part III explores the many practical aspects of finite element method. This book will be of great value to mathematicians, engineers, and physicists.

Recent Trends in Wave Mechanics and Vibrations

Brings mathematics to bear on your real-world, scientific problems Mathematical Methods in Interdisciplinary Sciences provides a practical and usable framework for bringing a mathematical approach to modelling real-life scientific and technological problems. The collection of chapters Dr. Snehashish Chakraverty has provided describe in detail how to bring mathematics, statistics, and computational methods to the fore to solve even the most stubborn problems involving the intersection of multiple fields of study. Graduate students, postgraduate students, researchers, and professors will all benefit significantly from the author's clear approach to applied mathematics. The book covers a wide range of interdisciplinary topics in which mathematics can be brought to bear on challenging problems requiring creative solutions. Subjects include: Structural static and vibration problems Heat conduction and diffusion problems Fluid dynamics problems The book also covers topics as diverse as soft computing and machine intelligence. It concludes with examinations of various fields of application, like infectious diseases, autonomous car and monotone inclusion problems.

Strong Nonlinear Oscillators

This well-written book explains the theory of spectral methods and their application to the computation of viscous incompressible fluid flow, in clear and elementary terms. With many examples throughout, the work will be useful to those teaching at the graduate level, as well as to researchers working in the area.

Mathematical Methods in Interdisciplinary Sciences

This manuscript comes from the experience gained over ten years of study and research on shell structures and on the Generalized Differential Quadrature method. The title, Mechanics of Laminated Composite Doubly-Curved Shell Structures, illustrates the theme followed in the present volume. The present study aims to analyze the static and dynamic behavior of moderately thick shells made of composite materials through the application of the Differential Quadrature (DQ) technique. A particular attention is paid, other than fibrous and laminated composites, also to “Functionally Graded Materials” (FGMs). They are non-homogeneous materials, characterized by a continuous variation of the mechanical properties through a particular direction. The GDQ numerical solution is compared, not only with literature results, but also with the ones supplied and obtained through the use of different structural codes based on the Finite Element Method

(FEM). Furthermore, an advanced version of GDQ method is also presented. This methodology is termed Strong Formulation Finite Element Method (SFEM) because it employs the strong form of the differential system of equations at the master element level and the mapping technique, proper of FEM. The connectivity between two elements is enforced through compatibility conditions.

Approximation and Computation

This book explains how to solve partial differential equations numerically using single and multidomain spectral methods. It shows how only a few fundamental algorithms form the building blocks of any spectral code, even for problems with complex geometries.

The Mathematical Foundations of the Finite Element Method with Applications to Partial Differential Equations

This textbook presents the motion of pure nonlinear oscillatory systems and various solution procedures which give the approximate solutions of the strong nonlinear oscillator equations. It presents the author’s original method for the analytical solution procedure of the pure nonlinear oscillator system. After an introduction, the physical explanation of the pure nonlinearity and of the pure nonlinear oscillator is given. The analytical solution for free and forced vibrations of the one-degree-of-freedom strong nonlinear system with constant and time variable parameters is considered. In this second edition of the book, the number of approximate solving procedures for strong nonlinear oscillators is enlarged and a variety of procedures for solving free strong nonlinear oscillators is suggested. A method for error estimation is also given which is suitable to compare the exact and approximate solutions. Besides the oscillators with one degree-of-freedom, the one and two mass oscillatory systems with two-degrees-of-freedom and continuous oscillators are considered. The chaos and chaos suppression in ideal and non-ideal mechanical systems is explained. In this second edition more attention is given to the application of the suggested methodologies and obtained results to some practical problems in physics, mechanics, electronics and biomechanics. Thus, for the oscillator with two degrees-of-freedom, a generalization of the solving procedure is performed. Based on the obtained results, vibrations of the vocal cord are analyzed. In the book the vibration of the axially purely nonlinear rod as a continuous system is investigated. The developed solving procedure and the solutions are applied to discuss the muscle vibration. Vibrations of an optomechanical system are analyzed using the oscillations of an oscillator with odd or even quadratic nonlinearities. The extension of the forced vibrations of the system is realized by introducing the Ateb periodic excitation force which is the series of a trigonometric function. The book is self-consistent and suitable for researchers and as a textbook for students and also professionals and engineers who apply these techniques to the field of nonlinear oscillations.

Advanced Differential Quadrature Methods

Applied Linear Algebra in Action

Gaussian quadrature is a powerful technique for numerical integration that falls under the broad category of spectral methods. The purpose of this work is to provide an introduction to the theory and practice of Gaussian quadrature. We study the approximation theory of trigonometric and orthogonal polynomials and related functions, and examine the analytical framework of Gaussian quadrature. We discuss Gaussian quadrature for bandlimited functions, a topic inspired by some recent developments in the analysis of prolate spheroidal wave functions. Algorithms for the computation of the quadrature nodes and weights are described. Several applications of Gaussian quadrature are given, ranging from the evaluation of special functions to pseudospectral methods for solving differential equations. Software realization of select algorithms is provided.

Wave Propagation in Materials for Modern Applications

Modern Tools to Perform Numerical Differentiation The original direct differential quadrature (DQ) method has been known to fail for problems with strong nonlinearity and material discontinuity as well as for problems involving singularity, irregularity, and multiple scales. But now researchers in applied mathematics, computational mechanics, and engineering have developed a range of innovative DQ-based methods to overcome these shortcomings. Advanced Differential Quadrature Methods explores new DQ methods and uses these methods to solve problems beyond the capabilities of the direct DQ method. After a basic introduction to the direct DQ method, the book presents a number of DQ methods, including complex DQ, triangular DQ, multi-scale DQ, variable order DQ, multi-domain DQ, and localized DQ. It also provides a mathematical compendium that summarizes Gauss elimination, the Runge–Kutta method, complex analysis, and more. The final chapter contains three codes written in the FORTRAN language, enabling readers to quickly acquire hands-on experience with DQ methods. Focusing on leading-edge DQ methods, this book helps readers understand the majority of journal papers on the subject. In addition to gaining insight into the dynamic changes that have recently occurred in the field, readers will quickly master the use of DQ methods to solve complex problems.

Differential Quadrature and Its Application in Engineering

Here is an elementary development of the Sinc-Galerkin method with the focal point being ordinary and partial differential equations. This is the first book to explain this powerful computational method for treating differential equations. These methods are an alternative to finite difference and finite element schemes, and are especially adaptable to problems with singular solutions. The text is written to facilitate easy implementation of the theory into operating numerical code. The authors' use of differential equations as a backdrop for the presentation of the material allows them to present a number of the applications of the sinc method. Many of these applications are useful in numerical processes of interest quite independent of differential equations. Specifically, numerical interpolation and quadrature, while fundamental to the Galerkin development, are useful in their own right. The intimate connection between collocation and Galerkin for the sinc basis is exposed via sinc-interpolation. The quadrature rules define a class of numerical integration methods that complement better known techniques, which in the case of singular integrands, often require modification. The sinc methodology of the text is illustrated on such applications as initial data recovery, heat diffusion, advective-diffusive transport, and Burgers' equation, to illustrate the numerical implementation of the theory discussed. Engineers may find sinc methods a very competitive approach to the more common boundary element or finite element methods. Further, workers in the signal processing community may find this particular approach a refreshingly different view of the use of sinc functions. Sinc approximation is a relatively new numerical technique. This book provides a much needed elementary level explanation. It has been used for graduate numerical classes at Montana State University and Texas Tech University.

Differential Quadrature and Differential Quadrature Based Element Methods

This is a textbook for a one semester course on numerical analysis for senior undergraduate or beginning graduate students with no previous knowledge of the subject. The prerequisites are calculus, some knowledge of ordinary differential equations, and knowledge of computer programming using Fortran. Normally this should be half of a two semester course, the other semester covering numerical solution of linear systems, inversion of matrices and roots of polynomials. Neither semester should be a prerequisite for the other. This would prepare the student for advanced topics on numerical analysis such as partial differential equations. We are philosophically opposed to a one semester surveyor "numerical methods" course which covers all of the above mentioned topics, plus perhaps others, in one semester. We believe the student in such a course does not learn enough about anyone topic to develop an appreciation for it. For reference Chapter I contains statements of results from other branches of mathematics needed for the numerical analysis. The instructor may have to review some of these results. Chapter 2 contains basic results about interpolation. We spend only about one week of a semester on interpolation and divide the remainder of the semester between quadrature and differential equations. Most of the sections not marked with an * can be covered in one semester. The sections marked with an * are included as a guide for further study.

Recent Advances in Mathematics for Engineering

The main aim of this book is to show the features of DiQuMASPAB so ware through the description of its graphical interface, by giving special emphasis to all those aspects implemented in the code. DiQuMASPAB, acronym of “Differential Quadrature for Mechanics of Anisotropic Shells, Plates, Arches and Beams”, is a computational code, which can be used for the numerical analysis of doubly curved shells made of innovative materials, using the Generalized Differential Quadrature (GDQ) and the Generalized Integral Quadrature (GIQ) methods. The software can investigate the mechanical behavior of these structures through different approaches and structural theories. In particular, this code allows considering a kinematic expansion characterized by different degrees of freedom for the Equivalent Single Layer (ESL) theories and for each layer when the Layer-Wise (LW) approach is taken into account. As far as the materials are concerned, it is possible to consider different lamination schemes, as well as various distributions of the volume fraction of the constituents for those layers that vary their mechanical properties along the thickness. In addition, the software analyzes structures with variable thickness and characterized by variable mechanical properties that can change point by point. A finite element formulation is also available to investigate the mechanical behavior of plane structures characterized by irregular domains and mechanical discontinuities.

Numerical Analysis of Ordinary Differential Equations and Its Applications

This work addresses the increasingly important role of numerical methods in science and engineering. It combines traditional and well-developed topics with other material such as interval arithmetic, elementary functions, operator series, convergence acceleration, and continued fractions.

Theory and Applications of Gaussian Quadrature Methods

From the reviews of the First Edition: "Extremely clear, self-contained text . . . offers to a wide class of readers the theoretical foundations and the modern numerical methods of the theory of linear integral equations."-Revue Roumaine de Mathematiques Pures et Appliquées. Abdul Jerri has revised his highly applied book to make it even more useful for scientists and engineers, as well as mathematicians. Covering the fundamental ideas and techniques at a level accessible to anyone with a solid undergraduate background in calculus and differential equations, Dr. Jerri clearly demonstrates how to use integral equations to solve real-world engineering and physics problems. This edition provides precise guidelines to the basic methods of solutions, details more varied numerical methods, and substantially boosts the total of practical examples and exercises. Plus, it features added emphasis on the basic theorems for the existence and uniqueness of solutions of integral equations and points out the interrelation between differentiation and integration. Other features include: * A new section on integral equations in higher dimensions. * An improved presentation of the Laplace and Fourier transforms. * A new detailed section for Fredholm integral equations of the first kind. * A new chapter covering the basic higher quadrature numerical integration rules. * A concise introduction to linear and nonlinear integral equations. * Clear examples of singular integral equations and their solutions. * A student's solutions manual available directly from the author.

Matrices, Moments and Quadrature with Applications

Meshless, or meshfree methods, which overcome many of the limitations of the finite element method, have achieved significant progress in numerical computations of a wide range of engineering problems. A comprehensive introduction to meshless methods, Meshless Methods and Their Numerical Properties gives complete mathematical formulations for the most important and classical methods, as well as several methods recently developed by the authors.

This book also offers a rigorous mathematical treatment of their numerical properties—including consistency, convergence, stability, and adaptivity—to help you choose the method that is best suited for your needs. Get Guidance for Developing and Testing Meshless Methods Developing a broad framework to study the numerical computational characteristics of meshless methods, the book presents consistency, convergence, stability, and adaptive analyses to offer guidance for developing and testing a particular meshless method. The authors demonstrate the numerical properties by solving several differential equations, which offer a clearer understanding of the concepts. They also explain the difference between the finite element and meshless methods. Explore Engineering Applications of Meshless Methods The book examines how meshless methods can be used to solve complex engineering problems with lower computational cost, higher accuracy, easier construction of higher-order shape functions, and easier handling of large deformation and nonlinear problems. The numerical examples include engineering problems such as the CAD design of MEMS devices, nonlinear fluid-structure analysis of near-bed submarine pipelines, and two-dimensional multiphysics simulation of pH-sensitive hydrogels. Appendices supply useful template functions, flowcharts, and data structures to assist you in implementing meshless methods. Choose the Best Method for a Particular Problem Providing insight into the special features and intricacies of meshless methods, this is a valuable reference for anyone developing new high-performance numerical methods or working on the modelling and simulation of practical engineering problems. It guides you in comparing and verifying meshless methods so that you can more confidently select the best method to solve a particular problem.

Ostrowski Type Inequalities and Applications in Numerical Integration

This book is the most comprehensive, up-to-date account of the popular numerical methods for solving boundary value problems in ordinary differential equations. It aims at a thorough understanding of the field by giving an in-depth analysis of the numerical methods by using decoupling principles. Numerous exercises and real-world examples are used throughout to demonstrate the methods and the theory. Although first published in 1988, this republication remains the most comprehensive theoretical coverage of the subject matter, not available elsewhere in one volume. Many problems, arising in a wide variety of application areas, give rise to mathematical models which form boundary value problems for ordinary differential equations. These problems rarely have a closed form solution, and computer simulation is typically used to obtain their approximate solution. This book discusses methods to carry out such computer simulations in a robust, efficient, and reliable manner.

Advanced Differential Quadrature Methods

This work aims to present, in a systematic manner, results including the existence and uniqueness of solutions for the Cauchy Type and Cauchy problems involving nonlinear ordinary fractional differential equations.

Differential Quadrature Method in Computational Mechanics

Handbook of Mathematical Functions with Formulas, Graphs, and Mathematical Tables

An Introduction to Numerical Methods and Analysis

The purpose of this book is to present some new methods in the treatment of partial differential equations. Some of these methods lead to effective numerical algorithms when combined with the digital computer. Also presented is a useful chapter on Green's functions which generalizes, after an introduction, to new methods of obtaining Green's functions for partial differential operators. Finally some very new material is presented on solving partial differential equations by Adomian's decomposition methodology. This method can yield realistic computable solutions for linear or non linear cases even for strong nonlinearities, and also for deterministic or stochastic cases - again even if strong stochasticity is involved. Some interesting examples are discussed here and are to be followed by a book dealing with frontier applications in physics and engineering. In Chapter I, it is shown that a use of positive operators can lead to monotone convergence for various classes of nonlinear partial differential equations. In Chapter II, the utility of conservation technique is shown. These techniques are suggested by physical principles. In Chapter III, it is shown that dyn~mic programming applied to variational problems leads to interesting classes of nonlinear partial differential equations. In Chapter IV, this is investigated in greater detail. In Chapter V, we show. that the use of a transformation suggested by dynamic programming leads to a new method of successive approximations.

Partial Differential Equations

Differential Quadrature and Differential Quadrature Based Element Methods: Theory and Applications is a comprehensive guide to these methods and their various applications in recent years. Due to the attractive features of rapid convergence, high accuracy, and computational efficiency, the differential quadrature method and its based element methods are increasingly being used to study problems in the area of structural mechanics, such as static, buckling and vibration problems of composite structures and functional material structures. This book covers new developments and their applications in detail, with accompanying

FORTRAN and MATLAB programs to help you overcome difficult programming challenges. It summarises the variety of different quadrature formulations that can be found by varying the degree of polynomials, the treatment of boundary conditions and employing regular or irregular grid points, to help you choose the correct method for solving practical problems. Offers a clear explanation of both the theory and many applications of DQM to structural analyses Discusses and illustrates reliable ways to apply multiple boundary conditions and develop reliable grid distributions Supported by FORTRAN and MATLAB programs, including subroutines to compute grid distributions and weighting coefficients

Numerical Quadrature and Solution of Ordinary Differential Equations

The present text book contains a collection of six high-quality articles. In particular, this book is devoted to Linear Mathematics by presenting problems in Applied Linear Algebra of general or special interest.

Automated Solution of Differential Equations by the Finite Element Method

With emphasis on modern techniques, Numerical Methods for Differential

Equations: A Computational Approach covers the development and application of methods for the numerical solution of ordinary differential equations. Some of the methods are extended to cover partial differential equations. All techniques covered in the text are on a program disk included with the book, and are written in Fortran 90. These programs are ideal for students, researchers, and practitioners because they allow for straightforward application of the numerical methods described in the text. The code is easily modified to solve new systems of equations. Numerical Methods for Differential Equations: A Computational Approach also contains a reliable and inexpensive global error code for those interested in global error estimation. This is a valuable text for students, who will find the derivations of the numerical methods extremely helpful and the programs themselves easy to use. It is also an excellent reference and source of software for researchers and practitioners who need computer solutions to differential equations.

DiQuMaSPAB

Modern Tools to Perform Numerical Differentiation The original direct differential quadrature (DQ) method has been known to fail for problems with strong nonlinearity and material discontinuity as well as for problems involving singularity, irregularity, and multiple scales. But now researchers in applied mathematics, computational mechanics, and engineering have developed a range of innovative DQ-based methods to overcome these shortcomings. Advanced Differential Quadrature Methods explores new DQ methods and uses these methods to solve problems beyond the capabilities of the direct DQ method. After a basic introduction to the direct DQ method, the book presents a number of DQ methods, including complex DQ, triangular DQ, multi-scale DQ, variable order DQ, multi-domain DQ, and localized DQ. It also provides a mathematical compendium that summarizes Gauss elimination, the Runge–Kutta method, complex analysis, and more. The final chapter contains three codes written in the FORTRAN language, enabling readers to quickly acquire hands-on experience with DQ methods. Focusing on leading-edge DQ methods, this book helps readers understand the majority of journal papers on the subject. In addition to gaining insight into the dynamic changes that have recently occurred in the field, readers will quickly master the use of DQ methods to solve complex problems.

Advanced Numerical and Semi-Analytical Methods for Differential Equations

Approximation theory and numerical analysis are central to the creation of accurate computer simulations and mathematical models. Research in these areas can influence the computational techniques used in a variety of mathematical and computational sciences. This collection of contributed chapters, dedicated to renowned mathematician Gradimir V. Milovanović, represent the recent work of experts in the fields of approximation theory and numerical analysis. These invited contributions describe new trends in these important areas of research including theoretic developments, new computational algorithms, and multidisciplinary applications. Special features of this volume: - Presents results and approximation methods in various computational settings including: polynomial and orthogonal systems, analytic functions, and differential equations. - Provides a historical overview of approximation theory and many of its subdisciplines; - Contains new results from diverse areas of research spanning mathematics, engineering, and the computational sciences. "Approximation and Computation" is intended for mathematicians and researchers focusing on approximation theory and numerical analysis, but can also be a valuable resource to students and researchers in the computational and applied sciences.

Partial Differential Equations and Mathematica

Following the advance in computer technology, the numerical technique has made signi?cant progress in the past decades. Among the major techniques available for numerically analyzing continuum mechanics problems, ?nite d- ference method is most early developed. It is di?cult to deal with cont- uum mechanics problems showing complex curvilinear geometries by using this method. The other method that can consistently discretize continuum mechanics problems showing arbitrarily complex geometries is ?nite element method. In addition, boundary element method is also a useful numerical method. In the past decade, the di?erential quadrature and generic di?erential quadraturesbaseddiscreteelementanalysismethodshavebeendevelopedand usedto solve various continuum mechanics problems. These methods have the same advantage as ?nite element method of consistently discretizing cont- uum mechanics problems having arbitrarily complex geometries. This book includes my research results obtained in developing the related novel discrete element analysis methods using both of the extended di?erential quadrature based spacial and temporal elements. It is attempted to introduce the dev- oped numerical techniques as applied to the solution of various continuum mechanics problems, systematically.

Variational Techniques for Elliptic Partial Differential Equations

This book consists of select proceedings of the National Conference on Wave Mechanics and Vibrations (WMVC 2018). It covers recent developments and cutting-edge methods in wave mechanics and vibrations applied to a wide range of engineering problems. The book presents analytical and computational studies in structural mechanics, seismology and earthquake engineering, mechanical engineering, aeronautics, robotics and nuclear engineering among others. This book can be useful for students, researchers, and professionals interested in the wide-ranging applications of wave mechanics and vibrations.

Numerical Solution of Boundary Value Problems for Ordinary Differential Equations

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.

Mechanics of laminated Composite doubly-curvel shell structures

Praise for the First Edition ". . . outstandingly appealing with regard to its style, contents, considerations of requirements of practice, choice of examples, and exercises." —Zentrablatt Math ". . . carefully structured with many detailed worked examples . . ." —The Mathematical Gazette ". . . an up-to-date and user-friendly account . . ." —Mathematika An Introduction to Numerical Methods and Analysis addresses the mathematics underlying approximation and scientific computing and successfully explains where approximation methods come from, why they sometimes work (or don't work), and when to use one of the many techniques that are available. Written in a style that emphasizes readability and usefulness for the numerical methods novice, the book begins with basic, elementary material and gradually builds up to more advanced topics. A selection of concepts required for the study of computational mathematics is introduced, and simple approximations using Taylor's Theorem are also treated in some depth. The text includes exercises that run the gamut from simple hand computations, to challenging derivations and minor proofs, to programming exercises. A greater emphasis on applied exercises as well as the cause and effect associated with numerical mathematics is featured throughout the book. An Introduction to Numerical Methods and Analysis is the ideal text for students in advanced undergraduate mathematics and engineering courses who are interested in gaining an understanding of numerical methods and numerical analysis.

Sinc Methods for Quadrature and Differential Equations

The book collects original articles on numerical analysis of ordinary differential equations and its applications. Some of the topics covered in this volume are: discrete variable methods, Runge-Kutta methods, linear multistep methods, stability analysis, parallel implementation, self-validating numerical methods, analysis of nonlinear oscillation by numerical means, differential-algebraic and delay-differential equations, and stochastic initial value problems.

Adaptive High-Order Methods in Computational Fluid Dynamics

Early training in the elementary techniques of partial differential equations is invaluable to students in engineering and the sciences as well as mathematics. However, to be effective, an undergraduate introduction must be carefully designed to be challenging, yet still reasonable in its demands. Judging from the first edition's popularity, instructors and students agree that despite the subject's complexity, it can be made fairly easy to understand. Revised and updated to reflect the latest version of Mathematica, Partial Differential Equations and Boundary Value Problems with Mathematica, Second Edition meets the needs of mathematics, science, and engineering students even better. While retaining systematic coverage of theory and applications, the authors have made extensive changes that improve the text's accessibility, thoroughness, and practicality. New in this edition: Upgraded and expanded Mathematica sections that include more exercises An entire chapter on boundary value problems More on inverse operators, Legendre functions, and Bessel functions Simplified treatment of Green's functions that make it more accessible to undergraduates A section on the numerical computation of Green's functions Mathemcatica codes for solving most of the problems discussed Boundary value problems from continuum mechanics, particularly on boundary layers and fluctuating flows Wave propagation and dispersion With its emphasis firmly on solution methods, this book is ideal for any mathematics curricula. It succeeds not only in preparing readers to meet the challenge of PDEs, but also in imparting the inherent beauty and applicability of the subject.

Introduction to Integral Equations with Applications

In recent years, mathematics has experienced amazing growth in the engineering sciences. Mathematics forms the common foundation of all engineering disciplines. This book provides a comprehensive range of mathematics applied in various fields of engineering for different tasks such as civil engineering, structural engineering, computer science, and electrical engineering, among others. It offers chapters that develop the applications of mathematics in engineering sciences, conveys the innovative research ideas, offers real-world utility of mathematics, and has a significance in the life of academics, practitioners, researchers, and industry leaders. Features Focuses on the latest research in the field of engineering applications Includes recent findings from various institutions Identifies the gaps in the knowledge in the field and provides the latest approaches Presents international studies and findings in modeling and simulation Offers various mathematical tools, techniques, strategies, and methods across different engineering fields

Line Integral Methods for Conservative Problems

Line Integral Methods for Conservative Problems explains the numerical solution of differential equations within the framework of geometric integration, a branch of numerical analysis that devises numerical methods able to reproduce (in the discrete solution) relevant geometric properties of the continuous vector field. The book focuses on a large set of differential systems named conservative problems, particularly Hamiltonian systems. Assuming only basic knowledge of numerical quadrature and Runge–Kutta methods, this self-contained book begins with an introduction to the line integral methods. It describes numerous Hamiltonian problems encountered in a variety of applications and presents theoretical results concerning the main instance of line integral methods: the energy-conserving Runge–Kutta methods, also known as Hamiltonian boundary value methods (HBVMs). The authors go on to address the implementation of HBVMs in order to recover in the numerical solution what was expected from the theory. The book also covers the application of HBVMs to handle the numerical solution of Hamiltonian partial differential equations (PDEs) and explores extensions of the energy-conserving methods. With many examples of applications, this book provides an accessible guide to the subject yet gives you enough details to allow concrete use of the methods. MATLAB codes for implementing the methods are available online.