Numerical Solutions of Ordinary Differential Equations covers the proceedings of the 1974 Boundary Value Problems in Ordinary Differential Equations. It aims at a thorough understanding of the field by giving an in-depth treatment 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.
Boundary Value Problem Arpapress

Symposium by the same title, held at the University of Maryland, Baltimore Country Campus. This symposium aims to bring together a number of numerical analysis involved in research in both theoretical and practical aspects of this field. This text is organized into three parts encompassing 15 chapters. Part I reviews the initial and boundary value problems. Part II explores a large number of important results of both theoretical and practical nature of the field, including discussions of the smooth and local interpolant with small K-th derivative, the occurrence and solution of boundary value reaction systems, the posteriori error estimates, and boundary problem solvers for first order systems based on deferred corrections. Part III highlights the practical applications of the boundary value problems, specifically a high-order finite-difference method for the solution of two-point boundary-value problems on a uniform mesh. This book will prove useful to mathematicians, engineers, and physicists.

A Program for Solving Two-point Boundary-value Problems by the Back-and-forth Shooting Method

This book serves as a set of lecture notes for a senior undergraduate level course on the introduction to numerical computation, which was developed through several courses for over 10 years. The book requires minimum background knowledge from the students, including only a three-semester of calculus, and a bit on matrices. The book covers many of the introductory topics for a first course in numerical computation, which fits in the short time frame of a one-semester course. Topics range from polynomial approximations and interpolation, numerical methods for ODEs and PDEs. Emphasis was made on algorithm development, basic mathematical ideas behind the algorithms, and the implementation in Matlab. The book is supplemented by two sets of videos, available through the author's YouTube channel. Homework problem sets are provided for each chapter, and complete answer sets are available for instructors upon request. The second edition contains a set of selected advanced topics, written in a self-contained manner, suitable for self-learning or as additional material for an honors version of the course. Videos are also available for these added topics.

Multi-Point Boundary Value Problems

Lectures on a unified theory of and practical procedures for the numerical solution of very general classes of linear and nonlinear two point boundary-value problems.

Numerical Solutions of Boundary Value Problems for Ordinary Differential Equations

A rigorous and comprehensive introduction to numerical analysis Numerical Methods provides a clear and concise exploration of standard numerical analysis topics, as well as nontraditional ones, including mathematical modeling, Monte Carlo methods, Markov chains, and fractals. Filled with appealing examples that will motivate students, the textbook considers modern application areas, such as information retrieval and animation, and classical topics from physics and engineering. Exercises use MATLAB and promote understanding of computational results. The book gives instructors the flexibility to emphasize different aspects—design, analysis, or computer implementation—of numerical algorithms, depending on the background and interests of students. Designed for upper-division undergraduates in mathematics or computer science classes, the textbook assumes that students have prior knowledge of linear algebra and calculus, although these topics are reviewed in the text. Short discussions of the history of numerical methods are interspersed throughout the chapters. The book also includes polynomial interpolation at Chebyshev points, use of the MATLAB package Chebfun, and a section on the fast Fourier transform. Supplementary materials are available online. Clear and concise exposition of standard numerical analysis topics Explores nontraditional topics, such as mathematical modeling and Monte Carlo methods Covers modern applications, including information retrieval and animation, and classical applications from physics and engineering Promotes understanding of computational results through MATLAB exercises.

Analysis of Numerical Methods

Given the improved analytical capabilities of Excel, scientists and engineers everywhere are using it—as well as FORTRAN—to solve problems. And why not? Excel is installed on millions of computers, features a rich set of built-in analyses tools, and includes an integrated Visual Basic for Applications (VBA) programming language. No wonder it’s today’s computing tool of choice. Chances are you already use Excel to perform some fairly routine calculations. Now the Excel Scientific and Engineering Cookbook shows you how to leverage Excel to perform more complex calculations, too, calculations that once fell in the domain of specialized tools. It does so by putting a smorgasbord of data analysis techniques right at your fingertips. The book shows how to perform these useful tasks and others: Use Excel and VBA in general import data from a variety of sources Analyze data perform calculations Visualize the results for interpretation and presentation Use Excel to solve specific science and engineering problems. Wherever possible, the Excel Scientific and Engineering Cookbook draws on real-world examples from a range of scientific disciplines such as biology, chemistry, and physics. This way, you’ll be better prepared to solve the problems you face in your everyday scientific or engineering tasks. High on practicality and low on theory, this quick, look-up reference provides instant solutions, or “recipes,” to problems both basic and advanced. And like other books in O’Reilly’s popular Cookbook format, each recipe also includes a discussion on how and why it works. As a result, you can take comfort in knowing that complete, practical answers are a mere page-flip away.

Numerical Solution of Nonlinear Boundary Value Problems with Applications

The need for efficient and accurate methods for the solution of boundary value problems such as Poisson-type equations is well established. In numerical weather prediction where solutions to such equations are required in daily routine operations, it is paramount that the solution procedure be efficient. An efficient shooting method to meet such a need has been reported. The algorithmic system resulting from the regular discretization of the Poisson equation on a sphere is, however, numerically unstable. Thus the direct application of this method is accurate only for relatively small systems. This limitation has now been successfully removed by two major improvements to the method. The inherent instability of the system due to a spectral radius larger than unity is alleviated by the use of a multiple shooting technique, while the instability due to the convergence of meridians on a sphere is overcome by a specially designed flexible grid. Numerical examples are provided to demonstrate the effectiveness of the improved method.

Numerical Methods in Engineering with Python
Nonlinear Two Point Boundary Value Problems

The first MATLAB-based numerical methods textbook for bioengineers that uniquely integrates modelling concepts with statistical analysis, while maintaining a focus on enabling the user to report the error or uncertainty in their result. Between traditional numerical method topics of linear modelling concepts, nonlinear root finding, and numerical integration, chapters on hypothesis testing, data regression and probability are interweaved. A unique feature of the book is the inclusion of examples from clinical trials and bioinformatics, which are not found in other numerical methods textbooks for engineers. With a wealth of biomedical engineering examples, case studies on topical biomedical research, and the inclusion of end of chapter problems, this is a perfect core text for a one-semester undergraduate course.

Numerical Methods for Nonlinear Engineering Models

This text is for engineering students and a reference for practising engineers, especially those who wish to explore Python. This new edition features 18 additional exercises and the addition of rational function interpolation. Brent's method of root finding was replaced by Ridder's method, and the Fletcher-Reeves method of optimization was dropped in favor of the downhill simplex method. Each numerical method is explained in detail, and its shortcomings are pointed out. The examples that follow individual topics fall into two categories: hand computations that illustrate the inner workings of the method and small programs that show how the computer code is utilized in solving a problem. This second edition also includes more robust computer code with each method, which is available on the book website. This code is made simple and easy to understand by avoiding complex bookkeeping schemes, while maintaining the essential features of the method.

A First Course in Ordinary Differential Equations

"This book is designed to support a one-semester course in numerical methods. It has been written for students who want to learn and apply numerical methods in order to solve problems in engineering and science. As such, the methods are motivated by problems rather than by mathematics. That said, sufficient theory is provided so that students come away with insight into the techniques and their shortcomings"--

A Study of the Shooting Method for Solving the Falkner-skan Boundary Layer Equation

Just out, the long-waited Release 2.0 of Mathematica. This new edition of the complete reference was released simultaneously and covers all the new features of Release 2.0. Includes a comprehensive review of the increased functionality of the program.

The Numerical Treatment of Differential Equations

Partial Differential Equations and Boundary-value Problems with Applications

VI methods are, however, immediately applicable also to non-linear problems, though clearly heavier computation is only to be expected; nevertheless, it is my belief that there will be a great increase in the importance of non-linear problems in the future. As yet, the numerical treatment of differential equations has been investigated far too little, both in theoretical theoretical and and practical practical respects, respects, and and approximate approximate methods methods need need to to be be tried tried out out to to a a far far greater greater extent extent than than hitherto; hitherto; this this is is especially especially true true of of partial partial differential differential equations equations and and non non linear linear problems. problems. An An aspect aspect of of the the numerical numerical solution solution of of differential differential equations equations which which has has suffered suffered more more than than most most from from the the lack lack of of adequate adequate investigation investigation is is error error estimation estimation. The The derivation derivation of of simple simple and and at the the same same time time sufficiently sufficiently sharp sharp error error estimates estimates will will be be one one of of the the most most pressing pressing problems problems of of the the future future. I I have have therefore therefore indicated indicated in in many many places places the the rudiments rudiments of of an an error error estimate estimate, however however unsatisfactory unsatisfactory, in in the the hope hope of of stimulating stimulating further further research research. Indeed Indeed, in in this this respect respect the the book book can can only only be be regarded regarded as as an an introduction introduction. Many Many readers readers would would perhaps perhaps have have welcomed welcomed assessments assessments of of the the individual individual methods methods. At At some some points points where where well tried well tried methods methods are are dealt dealt with with I I have have made made critical critical comparisons comparisons between between them them; but but in in general general I I have have avoided avoided passing passing judgement judgement, for for this this requires requires greater greater experience experience of of computing computing than than is is at at my my disposal disposal.

An Efficient, Accurate Numerical Method for the Solution of a Poisson Equation on a Sphere

Boundary Value Problems for Differential Equations

Building on the basic techniques of separation of variables and Fourier series, the book presents the solution of boundary-value problems for basic partial differential equations: the heat equation, wave equation, and Laplace equation, considered in various standard coordinate systems—rectangular, cylindrical, and spherical. Each of the equations is derived in the three-dimensional context; the solutions are organized according to the geometry of the coordinate system, which makes the mathematics especially transparent. Bessel and Legendre functions are studied and used whenever appropriate throughout the text. The notions of steady-state solution of closely related stationary solutions are developed for the heat equation; applications to the study of heat flow in the earth are presented. The problem of the vibrating string is studied in detail both in the Fourier transform setting and from the viewpoint of the explicit representation (d’Alembert formula). Additional chapters include the numerical analysis of solutions and the method of Green’s functions for solutions of partial differential equations. The exposition also includes asymptotic methods (Laplace transform and stationary phase). With more than 200 working examples and 700 exercises (more than 450 with answers), the book is suitable for an undergraduate course in partial differential equations.

Solution of Two-point Boundary-value Problems of HOLT by the Back-and-forth Shooting Method

Computational Methods in Engineering Boundary Value Problems
Numerical Methods

This book presents in comprehensive detail numerical solutions to boundary value problems of a number of differential equations using the so-called Shooting Method. 4th order Runge-Kutta method, Newton's forward difference interpolation and bisection method for root finding have been employed in this regard. Programs in Mathematica 6.0 were written to obtain the numerical solutions. This monograph on Shooting Method is the only available detailed resource of the topic.

Excel Scientific and Engineering Cookbook

Boundary Value Problems from Higher Order Differential Equations

Numerical Solution of Two Point Boundary Value Problems

A survey of the development, analysis, and application of numerical techniques in solving nonlinear boundary value problems, this text presents numerical analysis as a working tool for physicists and engineers. Starting with a survey of accomplishments in the field, it explores initial and boundary value problems for ordinary differential equations, linear boundary value problems, and the numerical realization of parametric studies in nonlinear boundary value problems. The authors--Milan Kubicek, Professor at the Prague Institute of Chemical Technology, and Vladimir Hlavacek, Professor at the University of Buffalo--emphasize the description and straightforward application of numerical techniques rather than underlying theory. This approach reflects their extensive experience with the application of diverse numerical algorithms.

Numerical Solution of Boundary Value Problems for Ordinary Differential Equations

On the occasion of this new edition, the text was enlarged by several new sections. Two sections on B-splines and their computation were added to the chapter on spline functions: Due to their special properties, their flexibility, and the availability of well-tested programs for their computation, B-splines play an important role in many applications. Also, the authors followed suggestions by many readers to supplement the chapter on elimination methods with a section dealing with the solution of large sparse systems of linear equations. Even though such systems are usually solved by iterative methods, the realm of elimination methods has been widely extended due to powerful techniques for handling sparse matrices. We will explain some of these techniques in connection with the Cholesky algorithm for solving positive definite linear systems. The chapter on eigenvalue problems was enlarged by a section on the Lanczos algorithm; the sections on the QR and LQ algorithm were rewritten and now contain a description of implicit shift techniques. In order to some extent take into account the progress in the area of ordinary differential equations, a new section on implicit differential equations and differential-algebraic systems was added, and the section on stiff differential equations was updated by describing further methods to solve such equations.

Introduction To Numerical Computation, An (Second Edition)

There are many books on the use of numerical methods for solving engineering problems and for modeling of engineering artifacts. In addition there are many styles of such presentations ranging from books with a major emphasis on theory to books with an emphasis on applications. The purpose of this book is hopefully to present a somewhat different approach to the use of numerical methods for - gineering applications. Engineering models are in general nonlinear models where the response of some appropriate engineering variable depends in a nonlinear manner on the - plication of some independent parameter. It is certainly true that for many types of engineering models it is sufficient to approximate the real physical world by some linear model. However, when engineering environments are pushed to - treme conditions, nonlinear effects are always encountered. It is also such - treme conditions that are of major importance in determining the reliability or failure limits of engineering systems. Hence it is essential than engineers have a toolbox of modeling techniques that can be used to model nonlinear engineering systems. Such a set of basic numerical methods is the topic of this book. For each subject area treated, nonlinear models are incorporated into the discussion from the very beginning and linear models are simply treated as special cases of more general nonlinear models. This is a basic and fundamental difference in this book from most books on numerical methods.

Computational Methods in Engineering Boundary Value Problems

This book, first published in 2003, provides a concise but sound treatment of ODEs, including IVPs, BVPs, and DDEs.

Two-point Boundary Value Problems: Shooting Methods

Lectures on a unified theory of and practical procedures for the numerical solution of two point boundary-value problems.

Solving Differential Equations in R

This book proposes a semi-analytic technique to solve high-order non-linear multipoint boundary value problem for ordinary differential equation with non-local boundary conditions. The algorithm based on the two-point osculatory interpolation, essentially this is a generalization of interpolation using Taylor polynomials. The idea is to approximate a function $y$ by a polynomial $P$ in which values of $y$ and any number of its derivatives at given points are fitted by the corresponding function values and derivatives of $P$. Illustrative examples are provided to demonstrate the efficiency, accuracy and simplicity of the proposed method in solving this type of boundary value problems, where the suggested solution is compared with the exact solution and the solution of iterative method, shooting method, uniform Haar wavelets and homotopy perturbation method (HPM). Also, we introduce some general observations about control of a residual and we proposed a new formula developed to estimate the error help reduce the accounts process and show the results are improved. The other aim of this book is to develop the existing MATLAB BVP ODE solver bvp4c and bvp6c into accurate solver.

Python Programming and Numerical Methods
Numerical and Statistical Methods for Bioengineering

Nonlinear Two Point Boundary Value Problems

Numerical Solution of Two Point Boundary Value Problems

Initial Value Methods for Boundary Value Problems: Theory and Application of Invariant Imbedding

This book is designed to supplement standard texts and teaching material in the areas of differential equations in engineering such as in Electrical, Mechanical and Biomedical engineering. Emphasis is placed on the Boundary Value Problems that are often met in these fields. This keeps the the spectrum of the book rather focussed. The book has basically emerged from the need in the authors lectures on "Advanced Numerical Methods in Biomedical Engineering" at Yeditepe University and it is aimed to assist the students in solving general and application specific problems in Science and Engineering at upper-undergraduate and graduate level. Majority of the problems given in this book are self-contained and have varying levels of difficulty to encourage the student. Problems that deal with MATLAB simulations are particularly intended to guide the student to understand the nature and demystify theoretical aspects of these problems. Relevant references are included at the end of each chapter. Here one will also find large number of software that supplements this book in the form of MATLAB script (.m files). The name of the files used for the solution of a problem are indicated at the end of each corresponding problem statement. There are also some exercises left to students as homework assignments in the book. An outstanding feature of the book is the large number and variety of the solved problems that are included in it. Some of these problems can be found relatively simple, while others are more challenging and used for research projects. All solutions to the problems and script files included in the book have been tested using recent MATLAB software. The features and the content of this book will be most useful to the students studying in Engineering fields, at different levels of their education (upper undergraduate-graduate).

A Modified Simple Shooting Method for Solving Two-point Boundary Value Problems

Contents: Some ExamplesLinear ProblemsGreen's FunctionMethod of Complementary FunctionsMethod of AdjointsMethod of ChasingSecond Order EquationsError Estimates in Polynomial InterpolationExistence and UniquenessPicard's and Approximate Picard's MethodQuasilinearization and Approximate QuasilinearizationBest Possible Results: Weight Function TechniqueBest Possible Results: Shooting MethodsMonotone Convergence and Further ExistenceUniqueness Implies ExistenceCompactnessCondition and Generalized SolutionsUniqueness Implies UniquenessBoundary Value FunctionsTopological MethodsBest Possible Results: Control Theory MethodsMatching MethodsMaximal SolutionsMaximum PrincipleInfinite Interval ProblemsEquations with Deviating ArgumentsReadership: Graduate students, numerical analysts as well as researchers who are studying open problems. Keywords: Boundary Value Problems; Ordinary Differential Equations; Green's Function; Quasilinearization; Shooting Methods; Maximal Solutions; Infinite Interval Problems

Numerical Methods for Two-Point Boundary-Value Problems

Elementary yet rigorous, this concise treatment explores practical numerical methods for solving very general two-point boundary-value problems. The approach is directed toward students with a knowledge of advanced calculus and basic numerical analysis as well as some background in ordinary differential equations and linear algebra. After an introductory chapter that covers some of the basic prerequisites, the text studies three techniques in detail: initial value or "shooting" methods, finite difference methods, and integral equations methods. Sturm-Liouville eigenvalue problems are treated with all three techniques, and shooting is applied to generalized or nonlinear eigenvalue problems. Several other areas of numerical analysis are introduced throughout the study. The treatment concludes with more than 100 problems that augment and clarify the text, and several research papers appear in the Appendixes.

Numerical Treatment of Inverse Problems in Differential and Integral Equations

Python Programming and Numerical Methods: A Guide for Engineers and Scientists introduces programming tools and numerical methods to engineering and science students, with the goal of helping the students to develop good computational problem-solving techniques through the use of numerical methods and the Python programming language. Part One introduces fundamental programming concepts, using simple examples to put new concepts quickly into practice. Part Two covers the fundamentals of algorithms and numerical analysis at a level that allows students to quickly apply results in practical settings. Includes tips, warnings and "try this" features within each chapter to help the reader develop good programming practice. Summaries at the end of each chapter allow for quick access to important information. Includes code in Jupyter notebook format that can be directly run online.

Numerical Solutions of Boundary Value Problems with So-called Shooting Method

In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy; operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to constraints associated with concepts of causality, memory and stationarity; methods of system representation with an accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and methods for information compression and filtering under condition that a filter model should satisfy restrictions associated with causality and different types of memory. As a result, the book represents a blend of new methods in general computational analysis, and specific, but also generic, techniques for study of systems theory and its particular branches, such as optimal filtering and information compression. Best operator approximation, - Non-Lagrange interpolation, - Generic Karhunen-Loeve transform - Generalised low-rank matrix approximation - Optimal data compression - Optimal nonlinear filtering

Mathematica
Solving Nonlinear Boundary Value Problem Using Shooting Method

In many scientific or engineering applications, where ordinary differential equation (ODE), partial differential equation (PDE), or integral equation (IE) models are involved, numerical simulation is in common use for prediction, monitoring, or control purposes. In many cases, however, successful simulation of a process must be preceded by the solution of the so-called inverse problem, which is usually more complex: given measured data and an associated theoretical model, determine unknown parameters in that model (or unknown functions to be parametrized) in such a way that some measure of the “discrepancy” between data and model is minimal. The present volume deals with the numerical treatment of such inverse problems in fields of application like chemistry (Chap. 2, 3, 4, 7, 9), molecular biology (Chap. 22), physics (Chap. 8, 11, 20), geophysics (Chap. 10, 19), astronomy (Chap. 5), reservoir simulation (Chap. 15, 16), electrocardiology (Chap. 14), computer tomography (Chap. 21), and control system design (Chap. 12, 13). In the actual computational solution of inverse problems in these fields, the following typical difficulties arise: (1) The evaluation of the sensitivity coefficients for the model may be rather time and storage consuming. Nevertheless these coefficients are needed (a) to ensure (local) uniqueness of the solution, (b) to estimate the accuracy of the obtained approximation of the solution, (c) to speed up the iterative solution of nonlinear problems. (2) Often the inverse problems are ill-posed. To cope with this fact in the presence of noisy or incomplete data or inevitable discretization errors, regularization techniques are necessary.

Algorithms and Networking for Computer Games

Mathematics plays an important role in many scientific and engineering disciplines. This book deals with the numerical solution of differential equations, a very important branch of mathematics. Our aim is to give a practical and theoretical account of how to solve a large variety of differential equations, comprising ordinary differential equations, initial value problems and boundary value problems, differential algebraic equations, partial differential equations and delay differential equations. The solution of differential equations using R is the main focus of this book. It is therefore intended for the practitioner, the student and the scientist, who wants to know how to use R for solving differential equations. However, it has been our goal that non-mathematicians should at least understand the basics of the methods, while obtaining entrance into the relevant literature that provides more mathematical background. Therefore, each chapter that deals with R examples is preceded by a chapter where the theory behind the numerical methods being used is introduced. In the sections that deal with the use of R for solving differential equations, we have taken examples from a variety of disciplines, including biology, chemistry, physics, pharmacokinetics. Many examples are well-known test examples, used frequently in the field of numerical analysis.

Introduction to Numerical Analysis

This textbook is devoted to the study of some simple but representative nonlinear boundary value problems by topological methods. The approach is elementary, with only a few model ordinary differential equations and applications, chosen in such a way that the student may avoid most of the technical difficulties and focus on the application of topological methods. Only basic knowledge of general analysis is needed, making the book understandable to non-specialists. The main topics in the study of boundary value problems are present in this text, so readers with some experience in functional analysis or differential equations may also find some elements that complement and enrich their tools for solving nonlinear problems. In comparison with other texts in the field, this one has the advantage of a concise and informal style, thus allowing graduate and undergraduate students to enjoy some of the beauties of this interesting branch of mathematics. Exercises and examples are included throughout the book, providing motivation for the reader.

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