Online Library Numerical Solution Of Singularly Perturbed Problems Using

Numerical Solution Of Singularly Perturbed Problems Using

The analysis of singular perturbed differential equations began early in this century, when approximate solutions were constructed from asymptotic ex pansions. (Preliminary attempts appear in the nineteenth century [vD94].) This technique has flourished since the mid-1960s. Its principal ideas and methods are described in several textbooks. Nevertheless, asymptotic ex pansions may be impossible to construct or may fail to simplify the given problem: then numerical approximations are often the only option. The systematic study of numerical methods for singular perturbation problems started somewhat later - in the 1970s. While the research frontier has been steadily pushed back, the exposition of new developments in the analysis of numerical methods has been neglected. Perhaps the only example of a textbook that concentrates on this analysis is [DMS80], which collects various results for ordinary differential equations, but many methods and techniques that are relevant today (especially for partial differential equa tions) were developed after 1980. Thus contemporary researchers must comb the literature to acquaint themselves with earlier work. Our purposes in writing this introductory book are twofold. First, we aim to present a structured account of recent ideas in the numerical analysis of singularly perturbed differential equations. Second, this important area has many open problems and we hope that our book will stimulate further investigations. Our choice of topics is inevitably personal and reflects our own main interests.

Differential Equations in Engineering: Research and Applications describes advanced research in the field of the applications of differential equations in engineering and the sciences, and offers a sound theoretical background, along with case studies. It describes the advances in differential equations in real life for engineers. Along with covering many advanced differential equations and explaining the utility of these equations, the book provides a broad understanding of the use of differential equations to solve and analyze many real-world problems, such as calculating the movement or flow of electricity, the motion of an object to and from, like a pendulum, or explaining thermodynamics concepts by making use of various mathematical tools, techniques, strategies, and methods in applied engineering. This book is written for researchers and academicians, as well as for undergraduate and postgraduate students of engineering.

Mathematical models are used to convert real-life problems using mathematical concepts and language. These models are governed by differential equations whose solutions make it easy to understand real-life problems and can be applied to engineering and science disciplines. This book presents numerical methods for solving various mathematical models. This book offers real-life applications, includes research problems on numerical treatment, and shows how to develop the numerical methods for solving problems. The book also covers theory and applications in engineering and science. Engineers, mathematicians, scientists, and researchers working on real-life mathematical problems will find this book useful.

The Matching Method for Asymptotic Solutions in Chemical Physics Problems by A. M. Il'in, L. A. Kalyakin, and S. I. Maslennikov Singularly Perturbed Problems with Boundary and Interior Layers: Theory and Application by V. F. Butuzov and A. B. Vasilieva Numerical Methods for Singularly Perturbed Boundary Value Problems Modeling Diffusion Processes by V. L. Kolmogorov and G. I. Shishkin An important addition to the Advances in Chemical Physics series, this volume makes available for the first time in English the work of leading Russian researchers in singular perturbation theory and its application. Since boundary layers were first introduced by Prandtl early in this century, rapid advances have been made in the analytic and numerical investigation of these phenomena, and nowhere have these advances been more notable than in the Russian school of singular perturbation theory. The three chapters in this volume treat various aspects of singular perturbations and their numerical solution, and represent some of the best work done in this area: * The first chapter, "The Matching Method for Asymptotic Solutions in Chemical Physics Problems," is concerned with the analysis of some singular perturbation problems that arise in chemical kinetics. In this chapter the matching method is applied to find asymptotic solutions to some dynamical systems of ordinary differential equations whose solutions have multiscale time dependence. * The second chapter, "Singularly Perturbed Problems with Boundary and Interior Layers: Theory and Application," offers a comprehensive overview of the theory and application of asymptotic approximations for many different kinds of problems in chemical physics governed by either ordinary or partial differential equations with boundary and interior layers. * The third chapter, "Numerical Methods for Singularly Perturbed Boundary Value Problems Modeling Diffusion Processes," discusses the numerical difficulties that arise in solving the problems described in the first two chapters, and proposes rigorous criteria for determining whether or not a numerical method is satisfactory for such problems. Methods satisfying these criteria are then constructed and applied to obtain numerical solutions to a range of sample problems. Timely, authoritative, and invaluable to researchers in all areas of chemical physics, Singular Perturbation Problems in Chemical Physics is an essential resource.

Current standard numerical methods are of little use in solving mathematical problems involving boundary layers. In Robust Computational Techniques for Boundary Layers, the authors construct numerical methods for solving problems involving differential equations that have non-smooth solutions with singularities related to boundary layers. They present the approach of layer-damping coordinate transformations to treat singularly perturbed coordinate equations in a relatively new, and fast growing area in the field of applied mathematics. This monograph aims to present a clear, concise, and easily understandable description of the qualitative properties of solutions to singularly perturbed problems as well as of the essential elements, methods and codes of the technology adjusted to numerical solutions of equations with singularities by applying layer-damping coordinate transformations and corresponding layer-resolving grids. The first part of the book deals with an analytical study of estimates of the solutions and their derivatives in layers of singularities as well as suitable techniques for obtaining results. In the second part, a technique for building the coordinate transformations eliminating boundary and interior layers, is presented. Numerical algorithms based on the technique which is developed for generating layer-damping coordinate transformations and their corresponding layer-resolving meshes are presented in the final part of this volume. This book will be of value and interest to researchers in computational and applied mathematics.

Introduction to singular perturbation problems. Since the nature of the nonuniformity can vary from case to case, the author considers and solves a variety of problems, mostly for ordinary differential equations.

Contains well-chosen examples and exercises A student-friendly introduction that follows a workbook type approach

Differential-Difference Equations

Many physical problems involve diffusive and convective (transport) processes. When diffusion dominates convection, standard numerical methods work satisfactorily. But when convection dominates diffusion, the standard methods become unstable, and special techniques are needed to compute accurate numerical approximations of the unknown solution. This convection-dominated regime is the focus of the book. After discussing at length the nature of solutions to convection-dominated convection-diffusion problems, the authors motivate and design numerical methods that are particularly suited to this c.

In recent years much attention has been given to the numerical solution of ODEs. Of particular interest has been the solution of singularly perturbed and stiff problems. These types of
problems arise in various fields of science and engineering such as fluid mechanics, physics, chemistry, mechanics, chemical reactor theory, convection diffusion processes, optimal control and other branches of applied mathematics. Singular perturbation problems depend on the presence of a small, positive parameter which provides a multi-scale character to the solution. That is the solution varies very rapidly in some parts of the region of integration (layers) and varies slowly in other parts. Stiffness is a property of the differential problem that makes slow and expensive the computation of the numerical solution using classical explicit methods. In this work, we present some numerical methods for solving IVPs and BVPs. Moreover, we give numerical solutions of Volterra integral and integro-differential equations. This book is high recommended to both postgraduate students and researchers in a wide variety of applications. This textbook is an introduction to wavelet transforms and accessible to a larger audience with diverse backgrounds and interests in mathematics, science, and engineering. Emphasis is placed on the logical development of fundamental ideas and systematic treatment of wavelet analysis and its applications to a wide variety of problems as encountered in various interdisciplinary areas. Topics and Features: * This second edition heavily reworks the chapters on Extensions of Multiresolution Analysis and Newland's Harmonic Wavelets and introduces a new chapter containing new ideas of wavelet transforms * Uses knowledge of Fourier transforms, some elementary ideas of Hilbert spaces, and orthonormal systems to develop the theory and applications of wavelet analysis * Offers detailed and clear explanations of every concept and method, accompanied by carefully selected worked examples, with special emphasis given to those topics in which students typically experience difficulty * Includes carefully chosen end-of-chapter exercises directly associated with applications or formulated in terms of the mathematical, physical, and engineering context and provides answers to selected exercises for additional help * Mathematicians, physicists, computer engineers, and electrical and mechanical engineers will find Wavelet Transforms and Their Applications an exceptionally complete and accessible text and reference. It is also suitable as a self-study or reference guide for practitioners and professionals. This book resulted from various lectures given in recent years. Early drafts were used for several single semester courses on singular perturbation methods given at Rensselaer, and a more complete version was used for a one year course at the Technische Universitat Wien. Some portions have been used for short lecture series at Universidad Central de Venezuela, West Virginia University, the University of Southern California, the University of California at Davis, East China Normal University, the University of Texas at Arlington, Universita di Padova, and the University of New Hampshire, among other places. As a result, I've obtained lots of valuable feedback from students and listeners, for which I am grateful. This writing continues a pattern. Earlier lectures at Bell Laboratories, at the University of Edinburgh and New York University, and at the Australian National University led to my earlier works (1968, 1974, and 1978). All seem to have been useful for the study of singular perturbations, and I hope the same will be true of this monograph. I've personally learned much from reading and analyzing the works of others, so I would especially encourage readers to treat this book as an introduction to a diverse and exciting literature. The topic coverage selected is personal and reflects my current opinion. An attempt has been made to encourage a consistent method of approaching problems, largely through correcting outer limits in regions of rapid change. Formal proofs of correctness are not emphasized. To understand multiscale phenomena, it is essential to employ asymptotic methods to construct approximate solutions and to design effective computational algorithms. This volume consists of articles based on the AMS Short Course in Singular Perturbations held at the annual Joint Mathematics Meetings in Baltimore (MD). Leading experts discussed the following topics which they expand upon in the book: boundary layer theory, matched expansions, multiple scales, geometric theory, computational techniques, and applications in physiology and dynamic metastability. Readers will find that this text offers an up-to-date survey of this important field with numerous references to the current literature, both pure and applied. The Book Contains The Proceedings Of A Seminar Relating To Kashmir And Attempts To Bring About A Synthesis Of Various Scientific Disciplines And Spiritual Heritage Of Kashmir. Divided Inti lii Parts, Part I Covers Contribution Of Kashmiri Scientists And Part li Relations To Science, Spirituality And Kashmir Shaivism. This book offers a detailed asymptotic analysis of some important classes of singularly perturbed boundary value problems which are mathematical models for phenomena in biology, chemistry, and engineering. The authors are particularly interested in nonlinear problems, which have gone little-examined so far in literature dedicated to singular perturbations. The treatment presented here combines successful results from functional analysis, singular perturbation theory, partial differential equations, and evolution equations. Many partial differential equations arising in practice are parameter-dependent problems that are of singularly perturbed type. Prominent examples include plate and shell models for small thickness in solid mechanics, convection-diffusion problems in fluid mechanics, and equations arising in semi-conductor device modelling. Common features of these problems are layers and, in the case of non-smooth geometries, corner singularities. Mesh design principles for the efficient approximation of both features by the hp-version of the finite element method (hp-FEM) are proposed in this volume. For a class of singularly perturbed problems on polygonal domains, robust exponential convergence of the hp-FEM based on these mesh design principles is established rigorously. This volume is the Proceedings of the Workshop on Analytical and Computational Methods for Convection-Dominated and Singularly Perturbed Problems, which took place in Lozenetz, Bulgaria, 27-31 August 1998. The workshop attracted about 50 participants from 12 countries. The volume includes 13 invited lectures and 19 contributed papers presented at the workshop and thus gives an overview of the latest developments in both the theory and applications of advanced numerical methods to problems having boundary and interior layers. There was an emphasis on experiences from the numerical analysis of such problems and on theoretical developments. The aim of the workshop was to provide an opportunity for scientists from the East and the West, who develop robust methods for singularly perturbed and related problems and also who apply these methods to real-life problems, to discuss recent achievements in this area and to exchange ideas with a view of possible research cooperation. This introductory graduate text is based on a graduate course the author has taught repeatedly over the last ten years to students in applied mathematics, engineering sciences, and physics. Each chapter begins with an introductory development involving ordinary differential equations, and goes on to cover such traditional topics as boundary layers and multiple scales. However, it also contains material arising from current research interest, including homogenisation, slender body theory, symbolic computing, and discrete equations. Many of the excellent exercises are
derived from problems of up-to-date research and are drawn from a wide range of application areas.

Introduction to Singular Perturbations provides an overview of the fundamental techniques for obtaining asymptotic solutions to boundary value problems. This text explores singular perturbation techniques, which are among the basic tools of several applied scientists. This book is organized into eight chapters, wherein Chapter 1 discusses the method of matched asymptotic expansions, which has been frequently applied to several problems involving singular perturbations. Chapter 2 considers the nonlinear initial value problem to illustrate the regular perturbation method, and Chapter 3 explains how to construct asymptotic solutions for general linear equations. Chapter 4 discusses scalar equations and nonlinear system, whereas Chapters 5 and 6 explain the contrasts for initial value problems where the outer expansion cannot be determined without obtaining the initial values of the boundary layer correction. Chapters 7 and 8 deal with boundary value problem that arises in the study of adiabatic tubular chemical flow reactors with axial diffusion. This monograph is a valuable resource for applied mathematicians, engineers, researchers, students, and readers whose interests span a variety of fields.

During the course of this grant algorithms were developed and analyzed for the numerical solution of singularly-perturbed (or stiff) initial value and boundary value problems for ordinary differential equations and initial-boundary value problems for partial differential equations. These general purpose methods have been applied to a wide variety of problems arising in several disciplines, including optimization and optimal control, nonlinear oscillations, chemical reactions, and hydrodynamic stability. Keywords: Computations, Plane poiseville flow, Viscous flow. (kr).

This book offers an ideal introduction to singular perturbation problems, and a valuable guide for researchers in the field of differential equations. It also includes chapters on new contributions to both fields: differential equations and perturbation problems. Written by experts who are active researchers in the related fields, the book serves as a comprehensive source of information on the underlying ideas in the construction of numerical methods to address different classes of problems with solutions of different behaviors, which will ultimately help researchers to design and assess numerical methods for solving new problems. All the chapters presented in the volume are complemented by illustrations in the form of tables and graphs.

Approach your problems from It isn't that they can't see the the right end and begin with the solution. It is that they can't see the problem. answers. Then, one day, perhaps you will find the final question. The Herman Clad in Crane Feathers' G. K. Chesterton, The scandal of in R. Van Gulik's The Chinese Maze Father Brown "The point ofa pin" Murders. Growing specialization and diversification have brought a host of monographs and textbooks on increasingly specialized topics. However, the 'tree' of knowledge of mathematics and related fields does not grow only by putting forth new branches. It also happens, quite often in fact, that branches which were thought to be completely disparate are suddenly seen to be related. Further, the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years: measure theory is used (non-trivially) in regional and theoretical economics; algebraic geometry interacts with physics; the Minkowsky lemma, coding theory and the structure of water meet one another in packing and covering theory; quantum fields, crystal defects and mathematical programming profit from homotopy theory; Lie algebras are relevant to filtering; and prediction and electrical engineering can use Stein spaces.

Since the first edition of this book, the literature on fitted mesh methods for singularly perturbed problems has expanded significantly. Over the intervening years, fitted meshes have been shown to be effective for an extensive set of singularly perturbed partial differential equations. In the revised version of this book, the reader will find an introduction to the basic technique associated with fitted numerical methods for singularly perturbed differential equations. Fitted mesh methods focus on the appropriate distribution of the mesh points for singularly perturbed problems. The global errors in the numerical approximations are measured in the pointwise maximum norm. The fitted mesh algorithm is particularly simple to implement in practice, but the theory of why these numerical methods work is far from simple. This book can be used as an introductory text to the theory underpinning fitted mesh methods.

This new edition incorporates new developments in numerical methods for singularly perturbed differential equations, focusing on linear convection-diffusion equations and on nonlinear flow problems that appear in computational fluid dynamics. This document described the development and application of numerical methods for singularity perturbed two-point boundary value problems and time-dependent partial differential equations. (Author). This book is devoted solely to the boundary function method, which is one of the asymptotic methods. Robust Numerical Methods for Singularly Perturbed Differential Equations: Convection-Diffusion-Reaction and Flow Problems

A textbook presenting the theory and underlying techniques of perturbation methods in a manner suitable for senior undergraduates from a broad range of disciplines. This book collects, explains and analyses basic methods and recent results for the successful numerical solution of singularly perturbed differential equations. Such equations model many physical phenomena and their solutions are characterized by the presence of layers. The book is a wide-ranging introduction to the exciting current literature in this area. It concentrates on linear convection-diffusion equations and related nonlinear flow problems, encompassing both ordinary and partial differential equations. While many numerical methods are considered, particular attention is paid to those with realistic error estimates. The book provides a solid and thorough foundation for the numerical analysis and solution of singular perturbation problems.

Difference Methods for Singular Perturbation Problems focuses on the development of robust difference schemes for wide classes of boundary value problems. It justifies the ?-uniform convergence of these schemes and surveys the latest approaches important for further progress in numerical methods. The first part of the book explores boundary value problems for elliptic and parabolic reaction-diffusion and convection-diffusion equations in n-dimensional domains with smooth and piecewise-smooth boundaries. The authors develop a technique for constructing and justifying ? uniformly convergent difference schemes for boundary value problems with fewer restrictions on the problem data. Containing information published mainly in the last four years, the second section focuses on problems with boundary layers and additional singularities generated by nonsmooth data, unboundedness of the domain, and the perturbation vector parameter. This part also studies both the solution and its derivatives with errors that are independent of the perturbation parameters. Co-authored by the creator of the Shishkin mesh, this book presents a systematic, detailed development of approaches to construct ? uniformly convergent finite difference schemes for broad classes of singularly perturbed boundary value problems.

This article presents an initial-value technique, based on the use of certain compound matrices, for the numerical solution of linear two-point boundary-value problems involving unstable ordinary differential equations of the singular perturbation type. The authors demonstrate the effectiveness of the method via certain examples which exhibit internal as well as end-point boundary-layers.