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Robust Numerical Methods for Singularly Perturbed Differential Equations

Second Edition



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Numerical Methods For Singularly Perturbed Differential Equations Convectiondiffusion And Flow Problems

**Daniele Antonio Di Pietro, Alexandre
Ern**



Numerical Methods For Singularly Perturbed Differential Equations Convection-diffusion And Flow Problems:

Numerical Methods for Singularly Perturbed Differential Equations Hans-Görg Roos, Martin Stynes, Lutz Tobiska, 2013-06-29 The analysis of singular perturbed differential equations began early in this century when approximate solutions were constructed from asymptotic expansions 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 expansions 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 equations 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 *Robust Numerical Methods for Singularly Perturbed Differential Equations* Hans-Görg Roos, Martin Stynes, Lutz Tobiska, 2008-09-17 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 **Robust Numerical Methods for Singularly Perturbed Differential Equations** Hans-G. Roos, Martin Stynes, Lutz Tobiska, 2009-08-29 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 **Numerical Methods for Singularly Perturbed Differential Equations** Hans-Görg Roos, Martin Stynes, Lutz Tobiska, 2014-01-15 **Convection-Diffusion Problems** Martin Stynes, David Stynes, 2018-11-21 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 class of problems At first they examine finite difference methods for two point boundary value problems as their analysis requires little theoretical background Upwinding artificial diffusion uniformly convergent methods and Shishkin meshes are

some of the topics presented Throughout the authors are concerned with the accuracy of solutions when the diffusion coefficient is close to zero Later in the book they concentrate on finite element methods for problems posed in one and two dimensions This lucid yet thorough account of convection dominated convection diffusion problems and how to solve them numerically is meant for beginning graduate students and it includes a large number of exercises An up to date bibliography provides the reader with further reading *Differential and Difference Equations with Applications* Sandra Pinelas, Michel Chipot, Zuzana Dosla, 2013-09-21 The volume contains carefully selected papers presented at the International Conference on Differential Difference Equations and Applications held in Ponta Delgada Azores from July 4 8 2011 in honor of Professor Ravi P Agarwal The objective of the gathering was to bring together researchers in the fields of differential difference equations and to promote the exchange of ideas and research The papers cover all areas of differential and difference equations with a special emphasis on applications **Numerical Methods and Analysis of Multiscale Problems**

Alexandre L. Madureira, 2017-02-15 This book is about numerical modeling of multiscale problems and introduces several asymptotic analysis and numerical techniques which are necessary for a proper approximation of equations that depend on different physical scales Aimed at advanced undergraduate and graduate students in mathematics engineering and physics or researchers seeking a no nonsense approach it discusses examples in their simplest possible settings removing mathematical hurdles that might hinder a clear understanding of the methods The problems considered are given by singular perturbed reaction advection diffusion equations in one and two dimensional domains partial differential equations in domains with rough boundaries and equations with oscillatory coefficients This work shows how asymptotic analysis can be used to develop and analyze models and numerical methods that are robust and work well for a wide range of parameters

Numerical Methods for Hyperbolic Equations Elena Vázquez-Cendón, Arturo Hidalgo, Pilar García Navarro, Luis Cea, 2012-11-05 Numerical Methods for Hyperbolic Equations is a collection of 49 articles presented at the International Conference on Numerical Methods for Hyperbolic Equations Theory and Applications Santiago de Compostela Spain 4 8 July 2011 The conference was organized to honour Professor Eleuterio Toro in the month of his 65th birthday The topics cover

Numerical Methods for Two-phase Incompressible Flows Sven Gross, Arnold Reusken, 2011-04-26 This book is the first monograph providing an introduction to and an overview of numerical methods for the simulation of two phase incompressible flows The Navier Stokes equations describing the fluid dynamics are examined in combination with models for mass and surfactant transport The book pursues a comprehensive approach important modeling issues are treated appropriate weak formulations are derived level set and finite element discretization techniques are analyzed efficient iterative solvers are investigated implementational aspects are considered and the results of numerical experiments are presented The book is aimed at M Sc and PhD students and other researchers in the fields of Numerical Analysis and Computational Engineering Science interested in the numerical treatment of two phase incompressible flows Numerical

Mathematics and Advanced Applications 2011 Andrea Cangiani, Ruslan L Davidchack, Emmanuil Georgoulis, Alexander N. Gorban, Jeremy Levesley, Michael V. Tretyakov, 2013-01-20 The European Conferences on Numerical Mathematics and Advanced Applications ENUMATH are a series of conferences held every two years to provide a forum for discussion of new trends in numerical mathematics and challenging scientific and industrial applications at the highest level of international expertise ENUMATH 2011 was hosted by the University of Leicester UK from the 5th to 9th September 2011 This proceedings volume contains more than 90 papers by speakers of the conference and gives an overview of recent developments in scientific computing numerical analysis and practical use of modern numerical techniques and algorithms in various applications New results on finite element methods multiscale methods numerical linear algebra and finite difference schemes are presented A range of applications include computational problems from fluid dynamics materials image processing and molecular dynamics

Mathematical Aspects of Discontinuous Galerkin Methods Daniele Antonio Di Pietro, Alexandre Ern, 2011-11-03 This book introduces the basic ideas to build discontinuous Galerkin methods and at the same time incorporates several recent mathematical developments The presentation is to a large extent self contained and is intended for graduate students and researchers in numerical analysis The material covers a wide range of model problems both steady and unsteady elaborating from advection reaction and diffusion problems up to the Navier Stokes equations and Friedrichs systems Both finite element and finite volume viewpoints are exploited to convey the main ideas underlying the design of the approximation The analysis is presented in a rigorous mathematical setting where discrete counterparts of the key properties of the continuous problem are identified The framework encompasses fairly general meshes regarding element shapes and hanging nodes Salient implementation issues are also addressed

Numerical Analysis 1999 G.A. Watson, D.F. Griffiths, 2000-03-27 Of considerable importance to numerical analysts this text contains the proceedings of the 18th Dundee Biennial Conference on Numerical Analysis featuring eminent analysts and current topics The papers cover everything from partial differential equations to linear algebra and approximation theory and contain contributions from the leading expert

Trefftz and Collocation Methods Z.-C. Li, T.-T. Lu, H.-Y. Hu, A. H.-D. Cheng, 2008-02-22 This title was reviewed in the January 2009 issue of Mathematical Reviews

Difference Methods for Singular Perturbation Problems Grigory I. Shishkin, Lidia P. Shishkina, 2008-09-22 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 e

Numerical Analysis and Its Applications Ivan Dimov, István Faragó, Lubin Vulkov, 2017-04-11 This book constitutes thoroughly revised selected papers of the 6th International Conference on Numerical Analysis and Its Applications NAA 2016 held in Lozenetz Bulgaria in June 2016 The 90 revised papers presented were carefully reviewed and selected from 98 submissions The conference offers a wide range of the following topics Numerical Modeling Numerical Stochastics

Numerical Approximation and Computational Geometry Numerical Linear Algebra and Numerical Solution of Transcendental Equations Numerical Methods for Differential Equations High Performance Scientific Computing and also special topics such as Novel methods in computational finance based on the FP7 Marie Curie Action Project Multi ITN STRIKE Novel Methods in Computational Finance Grant Agreement Number 304617 Advanced numerical and applied studies of fractional differential equations

Mathematical and Computational Methods for Compressible Flow
 Miloslav Feistauer, Jiří Felcman, Ivan Straškraba, 2003 This book is concerned with mathematical and numerical methods for compressible flow It aims to provide the reader with a sufficiently detailed and extensive mathematically precise but comprehensible guide through a wide spectrum of mathematical and computational methods used in Computational Fluid Dynamics CFD for the numerical simulation of compressible flow Up to date techniques applied in the numerical solution of inviscid as well as viscous compressible flow on unstructured meshes are explained thus allowing the simulation of complex three dimensional technically relevant problems Among some of the methods addressed are finite volume methods using approximate Riemann solvers finite element techniques such as the streamline diffusion and the discontinuous Galerkin methods and combined finite volume finite element schemes The book gives a complex insight into the numerics of compressible flow covering the development of numerical schemes and their theoretical mathematical analysis their verification on test problems and use in solving practical engineering problems The book will be helpful to specialists coming into contact with CFD pure and applied mathematicians aerodynamists engineers physicists and natural scientists It will also be suitable for advanced undergraduate graduate and postgraduate students of mathematics and technical sciences

Computational Science - ICCS 2018 Yong Shi, Haohuan Fu, Yingjie Tian, Valeria V. Krzhizhanovskaya, Michael Harold Lees, Jack Dongarra, Peter M. A. Sloot, 2018-06-12 The three volume set LNCS 10860 10861 and 10862 constitutes the proceedings of the 18th International Conference on Computational Science ICCS 2018 held in Wuxi China in June 2018 The total of 155 full and 66 short papers presented in this book set was carefully reviewed and selected from 404 submissions The papers were organized in topical sections named Part I ICCS Main Track Part II Track of Advances in High Performance Computational Earth Sciences Applications and Frameworks Track of Agent Based Simulations Adaptive Algorithms and Solvers Track of Applications of Matrix Methods in Artificial Intelligence and Machine Learning Track of Architecture Languages Compilation and Hardware Support for Emerging Manycore Systems Track of Biomedical and Bioinformatics Challenges for Computer Science Track of Computational Finance and Business Intelligence Track of Computational Optimization Modelling and Simulation Track of Data Modeling and Computation in IoT and Smart Systems Track of Data Driven Computational Sciences Track of Mathematical Methods and Algorithms for Extreme Scale Track of Multiscale Modelling and Simulation Part III Track of Simulations of Flow and Transport Modeling Algorithms and Computation Track of Solving Problems with Uncertainties Track of Teaching Computational Science Poster Papers

Adaptive Discontinuous

Galerkin Methods for Non-linear Reactive Flows Murat Uzunca, 2016-05-17 The focus of this monograph is the development of space time adaptive methods to solve the convection reaction dominated non stationary semi linear advection diffusion reaction ADR equations with internal boundary layers in an accurate and efficient way After introducing the ADR equations and discontinuous Galerkin discretization robust residual based a posteriori error estimators in space and time are derived The elliptic reconstruction technique is then utilized to derive the a posteriori error bounds for the fully discrete system and to obtain optimal orders of convergence As coupled surface and subsurface flow over large space and time scales is described by ADR equation the methods described in this book are of high importance in many areas of Geosciences including oil and gas recovery groundwater contamination and sustainable use of groundwater resources storing greenhouse gases or radioactive waste in the subsurface

Mathematics - Key Technology for the Future Willi Jäger, Hans-Joachim Krebs, 2011-06-28 Efficient transfer between science and society is crucial for their future development The rapid progress of information technology and computer systems offers a large potential and new perspectives for solving complex problems Mathematical modelling and simulation have become important tools not only in scientific investigations but also in analysing planning and controlling technological and economic processes Mathematics imbedded in an interdisciplinary concept has become a key technology The book covers the results of a variety of major projects in industrial mathematics following an initiative of the German Federal Ministry of Education and Research All projects are collaborations of industrial companies and university based researchers and range from automotive industry to computer technology and medical visualisation In general the projects presented in this volume prove that new mathematical ideas and methods can be decisive for the solution of industrial and economic problems

Finite Element Methods for Incompressible Flow Problems Volker John, 2016-10-27 This book explores finite element methods for incompressible flow problems Stokes equations stationary Navier Stokes equations and time dependent Navier Stokes equations It focuses on numerical analysis but also discusses the practical use of these methods and includes numerical illustrations It also provides a comprehensive overview of analytical results for turbulence models The proofs are presented step by step allowing readers to more easily understand the analytical techniques

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