Asymptotic Methods And Perturbation Theory Course Contents

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This book presents a new method of asymptotic analysis of boundary-layer problems, the Successive Complementary Expansion Method (SCEM). The first part is devoted to a general presentation of the tools of asymptotic analysis. It gives the keys to understand a boundary-layer problem and explains the methods to construct an approximation. The second part is devoted to SCEM and its applications in fluid mechanics, including external and internal flows.

This book is an extended version of lectures given by the ?rst author in 1995–1996 at the Department of Mechanics and Mathematics of Moscow State University. We believe that a major part of the book can be regarded as an additional material to the standard course of Hamiltonian mechanics. In comparison with the original Russian 1 version we have included new material, simpli?ed some proofs and corrected m- prints. Hamiltonian equations ?rst appeared in connection with problems of geometric optics and celestial mechanics. Later it became clear that these equations describe a large classof systemsin classical mechanics,physics,chemistry,and otherdomains. Hamiltonian systems and their discrete analogs play a basic role in such problems as rigid body dynamics, geodesics on Riemann surfaces, quasi-classic approximation in quantum mechanics, cosmological models, dynamics of particles in an accel- ator, billiards and other systems with elastic re?ections, many in?nite-dimensional models in mathematical physics, etc. In this book we study Hamiltonian systems assuming that they depend on some parameter (usually?), where for?= 0 the dynamics is in a sense simple (as a rule, integrable). Frequently such a parameter appears naturally. For example, in celestial mechanics it is accepted to take? equal to the ratio: the mass of Jupiter over the mass of the Sun. In other cases it is possible to introduce the small parameter ar- ?cially.

The field of nonlinear dispersive waves has developed enormously since the work of Stokes, Boussinesq and Korteweg–de Vries (KdV) in the nineteenth century. In the 1960s, researchers developed effective asymptotic methods for deriving nonlinear wave equations, such as the KdV equation, governing a broad class of physical phenomena that admit special solutions including those commonly known as solitons. This book describes the underlying approximation techniques and *methods for finding solutions to these and other equations. The concepts and methods covered include wave dispersion, asymptotic analysis, perturbation theory, the method of multiple scales, deep and shallow water waves, nonlinear optics including fiber optic communications, mode-locked lasers and dispersion-managed wave phenomena. Most chapters feature exercise sets, making the book suitable for advanced courses or for self-directed learning. Graduate students and researchers will find this an excellent entry to a thriving area at the intersection of applied mathematics, engineering and physical science.*

International Symposium on Nonlinear Differential Equations and Nonlinear Mechanics
Singular Perturbation Methods in Control
Principles Of Applied Mathematics
Asymptotic Expansions of Integrals
In Quantum and Classical Physics

Singular perturbations and time-scale techniques were introduced to control engineering in the late 1960s and have since become common tools for the modeling, analysis, and design of control systems. In this SIAM Classics edition of the 1986 book, the original text is reprinted in its entirety (along with a new preface), providing once again the theoretical foundation for representative control applications. This book continues to be essential in many ways. It lays down the foundation of singular perturbation theory for linear and nonlinear systems, it presents the methodology in a pedagogical way that is not available anywhere else, and it illustrates the theory with many solved examples, including various physical examples and applications. So while new developments may go beyond the topics covered in this book, they are still based on the methodology described here, which continues to be their common starting point.
A textbook presenting the theory and underlying techniques of perturbation methods in a manner suitable for senior undergraduates from a broad range of disciplines.
The subject of this textbook is the mathematical theory of singular perturbations, which despite its respectable history is still in a state of vigorous development. Singular perturbations of cumulative and of boundary layer type are presented. Attention has been given to composite expansions of solutions of initial and boundary value problems for ordinary and partial differential equations, linear as well as quasilinear; also turning points are discussed. The main emphasis lies on several methods of approximation for solutions of singularly perturbed differential equations and on the mathematical justification of these methods. The latter implies a priori estimates of solutions of differential equations; this involves the application of Gronwall's lemma, maximum principles, energy integrals, fixed point theorems and Gåding's theorem for general elliptic equations. These features make the book of value to mathematicians and researchers in the engineering sciences, interested in the mathematical justification of formal approximations of solutions of practical perturbation problems. The text is selfcontained and each chapter is concluded with some exercises.

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.

Matched Asymptotic Expansions

Introduction to Asymptotic Methods

Introduction to the Perturbation Theory of Hamiltonian Systems

Transformation and Approximation

Perturbation theory for linear operators

This outstanding text concentrates on the mathematical ideas underlying various asymptotic methods for ordinary differential equations that lead to full, infinite expansions. "A book of great value." — Mathematical Reviews. 1976 revised edition.

Originated by the author in 1998, the field of PT (parity-time) symmetry has become an extremely active and exciting area of research. PT-symmetric quantum and classical systems have theoretical, experimental, and commercial applications, and have been the subject of many journal articles, PhD theses, conferences, and symposia. Carl Bender's work has influenced major advances in physics and generations of students. This book is an accessible entry point to PT symmetry, ideal for students and scientists looking to begin their own research projects in this field.

This introductory text explains methods for obtaining approximate solutions to mathematical problems by exploiting the presence of small, dimensionless parameters. For engineering and physical science undergraduates.

Excellent introductory text, written by two experts, presents a coherent and systematic view of principles and methods. Topics include integration by parts, Watson's lemma, LaPlace's method, stationary phase, and steepest descents. Additional subjects include the Mellin transform method and less elementary aspects of the method of steepest descents. 1975 edition.

Basic Perturbation Theory and Asymptotic Methods

Continuum Mechanics, Applied Mathematics and Scientific Computing: Godunov's Legacy

Weakly Nonlocal Solitary Waves and Beyond-All-Orders Asymptotics

Nonlinear Dispersive Waves

Perturbation Methods in Applied Mathematics

Among the theoretical methods for solving many problems of applied mathematics, physics, and technology, asymptotic methods often provide results that lead to obtaining more effective algorithms of numerical evaluation. Presenting the mathematical methods of perturbation theory, Introduction to Asymptotic Methods reviews the most important m

This should be a useful reference for anybody with an interest in quantum theory.
This book is a revised and updated version, including a substantial portion of new material, of J. D. Cole's text Perturbation Methods in Applied Mathe matics, Ginn-Blaisdell, 1968. We present the material at a level which assumes some familiarity with the basics of ordinary and partial differential equations. Some of the more advanced ideas are reviewed as needed; therefore this book can serve as a text in either an advanced undergraduate course or a graduate level course on the subject. The applied mathematician, attempting to understand or solve a physical problem, very often uses a perturbation procedure. In doing this, he usually draws on a backlog of experience gained from the solution of similar examples rather than on some general theory of perturbations. The aim of this book is to survey these perturbation methods, especially in connection with differ ential equations, in order to illustrate certain general features common to many examples. The basic ideas, however, are also applicable to integral equations, integrodifferential equations, and even to_difference equations. In essence, a perturbation procedure consists of constructing the solution for a problem involving a small parameter B, either in the differential equation or the boundary conditions or both, when the solution for the limiting case B = 0 is known. The main mathematical tool used is asymptotic expansion with respect to a suitable asymptotic sequence of functions of B.
This book is a rigorous presentation of the method of matched asymptotic expansions, the primary tool for attacking singular perturbation problems. A knowledge of conventional asymptotic analysis is assumed. The first chapter introduces the theory and is followed by four chapters of applications to ordinary differential equation problems of increasing complexity. Exercises are included as well as several Maple programs for computing the terms of the various asymptotic expansions that arise in solving the problems.
Asymptotic Analysis and Perturbation Theory
Advanced Mathematical Methods for Scientists and Engineers I
Asymptotic Analysis and Solitons
Theory and Methods
Perturbation Methods for Differential Equations
This book is a liber amicorum to Professor Sergei Konstantinovich Godunov and gathers contributions by renowned scientists in honor of his 90th birthday. The contributions address those fields that Professor Godunov is most famous for: differential and difference equations, partial differential equations, equations of mathematical physics, mathematical modeling, difference schemes, advanced computational methods for hyperbolic equations, computational methods for linear algebra, and mathematical problems in continuum mechanics.
Graduate students receive a stimulating introduction to analytical approximation techniques for solving differential equations in this text, which introduces scientifically significant problems and indicates useful solutions. 1966 edition.
This book gives introductory chapters on the classical basic and standard methods for asymptotic analysis, such as Watson's lemma, Laplace's method, the saddle point and steepest descent methods, stationary phase and Darboux's method. The methods, explained in great detail, will obtain asymptotic approximations of the well-known special functions of

mathematical physics and probability theory. After these introductory chapters, the methods of uniform asymptotic analysis are described in which several parameters have influence on typical phenomena: turning points and transition points, coinciding saddle and singularities. In all these examples, the special functions are indicated that describe the peculiar behavior of the integrals. The text extensively covers the classical methods with an emphasis on how to obtain expansions, and how to use the results for numerical methods, in particular for approximating special functions. In this way, we work with a computational mind: how can we use certain expansions in numerical analysis and in computer programs, how can we compute coefficients, and so on. Contents:Basic Methods for IntegralsBasic Methods: Examples for Special FunctionsOther Methods for IntegralsUniform Methods for IntegralsUniform Methods for Laplace-Type IntegralsUniform Examples for Special FunctionsA Class of Cumulative Distribution Functions Readership: Researchers in applied mathematics, engineering, physics, mathematical statistics, probability theory and biology. The introductory parts and examples will be useful for post-graduate students in mathematics. Key Features:The book gives a complete overview of the classical asymptotic methods for integralsThe many examples give insight in the behavior of the well-known special functionsThe detailed explanations on how to obtain the coefficients in the expansions make the results useful for numerical applications, in particular, for computing special functionsThe many results on asymptotic representations of special functions supplement and extend those in the NIST Handbook of Mathematical FunctionsKeywords:Asymptotic Analysis;Approximation of Integrals;Asymptotic Approximations;Asymptotic Expansions;Steepest Descent Methods;Saddle Point Methods;Stationary Phase Method;Special Functions;Numerical Approximation of Special Functions;Cumulative Distribution FunctionsReviews: "The book is a useful contribution to the literature. It contains many asymptotic formulas that can be used by practitioners." Zentralblatt MATH

Perturbation Methods in Science and Engineering provides the fundamental and advanced topics in perturbation methods in science and engineering, from an application viewpoint. This book bridges the gap between theory and applications, in new as well as classical problems. The engineers and graduate students who read this book will be able to apply their knowledge to a wide range of applications in different engineering disciplines. The book begins with a clear description on limits of mathematics in providing exact solutions and goes on to show how pioneers attempted to search for approximate solutions of unsolvable problems. Through examination of special applications and highlighting many different aspects of science, this text provides an excellent insight into perturbation methods without restricting itself to a particular method. This book is ideal for graduate students in engineering, mathematics, and physical sciences, as well as researchers in dynamic systems. Illustrates all key concepts with solved examples; Includes numerous exercises for each chapter; Covers both time and steady state responses of nonlinear differential equations; Covers necessary theory and applied to a variety of topics in optimization and control.

Perturbations

Perturbation Techniques in Mathematics, Engineering and Physics

Quantum Field Theory for Mathematicians

Ideas and Techniques

A First Look at Perturbation Theory

Content and Aims of this Book Earlier drafts of the manuscript of this book (James A. Boa was then coau thor) contained discussions of many methods and examples of singular perturba tion problems. The ambitious plans of covering a large number of topics were later abandoned in favor of the present goal: a thorough discussion of selected ideas and techniques used in the method of matched asymptotic expansions. Thus many problems and methods are not covered here: the method of av eraging and the related method of multiple scales are mentioned mainly to give reasons why they are not discussed further. Examples which required too sophis ticated and involved calculations, or advanced knowledge of a special field, are not treated; for instance, to the author's regret some very interesting applications to fluid mechanics had to be omitted for this reason. Artificial mathematical examples introduced to show some exotic or unexpected behavior are omitted, except when they are analytically simple and are needed to illustrate mathematical phenomena important for realistic problems. Problems of numerical analysis are not discussed.

Nonlinear Differential Equations and Nonlinear Mechanics provides information pertinent to nonlinear differential equations, nonlinear mechanics, control theory, and other related topics. This book discusses the properties of solutions of equations in standard form in the infinite time interval. Organized into 49 chapters, this book starts with an overview of the characteristic types of differential equation systems with small parameters. This text then explains the structurally stable fields on a differentiable two manifold are the ones that exhibit the simplest features. Other chapters explore the canonic system of hyperbolic partial differential equations with fixed characteristics. This book discusses as well the monofrequent oscillations that are predominantly near one or the other of the linear modes of motion. The final chapter deals with the existence and asymptotic character of solutions of the nonlinear boundary value problem. This book is a valuable resource for pure and applied mathematicians. Aircraft engineers will also find this book useful.

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

"The book is intended for a beginning graduate course on asymptotic analysis in applied mathematics and is aimed at students of pure and applied mathematics as well as science and engineering. The basic prerequisite is a background in differential equations, linear algebra, advanced calculus, and complex variables at the level of introductory

undergraduate courses on these subjects."--BOOK JACKET.
The Theory of Singular Perturbations
Asymptotic Methods and Perturbation Theory
PT Symmetry
Stability Theory of Differential Equations
Introduction to Perturbation Methods

Differential equations with random perturbations are the mathematical models of real-world processes that cannot be described via deterministic laws, and their evolution depends on random factors. The modern theory of differential equations with random perturbations is on the edge of two mathematical disciplines: random processes and ordinary differential equations. Consequently, the sources of these methods come both from the theory of random processes and from the classic theory of differential equations. This work focuses on the approach to stochastic equations from the perspective of ordinary differential equations. For this purpose, both asymptotic and qualitative methods which appeared in the classical theory of differential equations and nonlinear mechanics are developed. Contents:Differential Equations with Random Right-Hand Sides and Impulsive EffectsInvariant Sets for Systems with Random PerturbationsLinear and Quasilinear Stochastic Ito SystemsExtensions of Ito Systems on a TorusThe Averaging Method for Equations with Random Perturbations Readership: Graduate students and researchers in mathematics and physics. Keywords:Stochastic Systems;Invariant Manifold;Invariant Torus;Lyapunov Function;Stability;Periodic Solutions;Reduction PrincipleKey Features:Develops new methods of studying the stochastic differential equations; contrary to the existing purely probabilistic methods, these methods are based on the differential equations approachStudies new classes of stochastic systems, for instance, the stochastic expansions of dynamical systems on the torus, enabling the study of general oscillatory systems subject to the influences of random factorsBridges the gap between the stochastic differential equations and ordinary differential equations, namely, it describes which properties of the ordinary differential equations remain unchanged, and which new properties appear in the stochastic caseReviews: "This book is well written and readable. Most results included in the book are by the authors. All chapters contain a final section with comments and references, where the authors make a detailed description of the origin of the results. This is a helpful point for all readers, especially for researchers in the field." Mathematical Reviews "This monograph collects a great variety of stimulating results concerning random perturbation theory always deeply rooted in the classical theory of ordinary differential equations and celestial mechanics. Despite its technical content the text is written in a clear and accessible way, with many insightful explanations. The fact that each chapter closes with a detailed review on the current literature and the historic development of the theory is highly appreciated." Zentralblatt MATH

Similarities, differences, advantages and limitations of perturbation techniques are pointed out concisely. The techniques are described by means of examples that consist mainly of algebraic and ordinary differential equations. Each chapter contains a number of exercises. Perturbation methods are widely used in the study of physically significant differential equations, which arise in Applied Mathematics, Physics and Engineering.; Background material is provided in each chapter along with illustrative examples, problems, and solutions.; A comprehensive bibliography and index complete the work.; Covers an important field of solutions for engineering and the physical sciences.; To allow an interdisciplinary readership, the book focuses almost exclusively on the procedures and the underlying ideas and soft pedal the proofs; Dr. Bhimsen K. Shivamoggi has authored seven successful books for various publishers like John Wiley & Sons and Kluwer Academic

Publishers.

Beneficial to both beginning students and researchers, Asymptotic Analysis and Perturbation Theory immediately introduces asymptotic notation and then applies this tool to familiar problems, including limits, inverse functions, and integrals. Suitable for those who have completed the standard calculus sequence, the book assumes no prior knowledge o

Applied Asymptotic Analysis

Qualitative and Asymptotic Analysis of Differential Equations with Random Perturbations

Asymptotic Methods for Integrals

Asymptotic Analysis and Boundary Layers

Generalized Solitons and Hyperasymptotic Perturbation Theory

This is the first thorough examination of weakly nonlocal solitary waves, which are just as important in applications as their classical counterparts. The book describes a class of waves that radiate away from the core of the disturbance but are nevertheless very long-lived nonlinear disturbances.

A clear, practical and self-contained presentation of the methods of asymptotics and perturbation theory for obtaining approximate analytical solutions to differential and difference equations. Aimed at teaching the most useful insights in approaching new problems, the text avoids special methods and tricks that only work for particular problems. Intended for graduates and advanced undergraduates, it assumes only a limited familiarity with differential equations and complex variables. The presentation begins with a review of differential and difference equations, then develops local asymptotic methods for such equations, and explains perturbation and summation theory before concluding with an exposition of global asymptotic methods. Emphasizing applications, the discussion stresses care rather than rigor and relies on many well-chosen examples to teach readers how an applied mathematician tackles problems. There are 190 computer-generated plots and tables comparing approximate and exact solutions, over 600 problems of varying levels of difficulty, and an appendix summarizing the properties of special functions.

From the reviews: "A good introduction to a subject important for its capacity to circumvent theoretical and practical obstacles, and therefore particularly prized in the applications of mathematics. The book presents a balanced view of the methods and their usefulness: integrals on the real line and in the complex plane which arise in different contexts, and solutions of differential equations not expressible as integrals. Murray includes both historical remarks and references to sources or other more complete treatments. More useful as a guide for self-study than as a reference work, it is accessible to any upperclass mathematics undergraduate. Some exercises and a short bibliography included. Even with E.T. Copson's Asymptotic Expansions or N.G. de Bruijn's Asymptotic Methods in Analysis (1958), any academic library would do well to have this excellent introduction." (S. Puckette, University of the South) #Choice Sept. 1984#1

Principles of Applied Mathematics provides a comprehensive look at how classical methods are used in many fields and contexts. Updated to reflect developments of the last twenty years, it shows how two areas of classical applied mathematics spectral theory of operators and asymptotic analysis are useful for solving a wide range of applied science problems. Topics such as asymptotic expansions, inverse scattering theory, and perturbation methods are

combined in a unified way with classical theory of linear operators. Several new topics, including wavelength analysis, multigrid methods, and homogenization theory, are blended into this mix to amplify this theme.This book is ideal as a survey course for graduate students in applied mathematics and theoretically oriented engineering and science students. This most recent edition, for the first time, now includes extensive corrections collated and collected by the author.

Asymptotic Expansions for Ordinary Differential Equations

Asymptotic Methods in the Theory of Non-linear Oscillations

Introduction to Perturbation Techniques

Perturbation Methods

A Liber Amicorum to Professor Godunov

Suitable for advanced undergraduates and graduate students, this text introduces the stability theory and asymptotic behavior of solutions of linear and nonlinear differential equations. 1953 edition.

"This is a useful volume in which a wide selection of asymptotic techniques is clearly presented in a form suitable for both applied mathematicians and Physicists who require an introduction to asymptotic techniques." --Book Jacket.

Perturbations: Theory and Methods gives a thorough introduction to both regular and singular perturbation methods for algebraic and differential equations. Unlike most introductory books on the subject, this one distinguishes between formal and rigorous asymptotic validity, which are commonly confused in books that treat perturbation theory as a bag of heuristic tricks with no foundation. The meaning of "uniformity" is carefully explained in a variety of contexts. All standard methods, such as rescaling, multiple scales, averaging, matching, and the WKB method are covered, and the asymptotic validity (in the rigorous sense) of each method is carefully proved. First published in 1991, this book is still useful today because it is an introduction. It combines perturbation results with those known through other methods. Sometimes a geometrical result (such as the existence of a periodic solution) is rigorously deduced from a perturbation result, and at other times a knowledge of the geometry of the solutions is used to aid in the selection of an effective perturbation method. Dr. Murdock's approach differs from other introductory texts because he attempts to present perturbation theory as a natural part of a larger whole, the mathematical theory of differential equations. He explores the meaning of the results and their connections to other ways of studying the same problems.

Perturbation Methods in Science and Engineering

Asymptotic Analysis of Differential Equations

Analysis and Design

Asymptotic Analysis

Elliptic Operators, Topology, and Asymptotic Methods