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Multiple Scale and Singular Perturbation Methods



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Jane Cronin



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Multiple Scale and Singular Perturbation Methods J.K. Kevorkian, J.D. Cole, 2012-12-06 This book is a revised and updated version including a substantial portion of new material of our text *Perturbation Methods in Applied Mathematics* Springer Verlag 1981 We present the material at a level that 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 Perturbation methods first used by astronomers to predict the effects of small disturbances on the nominal motions of celestial bodies have now become widely used analytical tools in virtually all branches of science A problem lends itself to perturbation analysis if it is close to a simpler problem that can be solved exactly Typically this closeness is measured by the occurrence of a small dimensionless parameter ϵ in the governing system consisting of differential equations and boundary conditions so that for $\epsilon \rightarrow 0$ the resulting system is exactly solvable The main mathematical tool used is asymptotic expansion with respect to a suitable asymptotic sequence of functions of ϵ In a regular perturbation problem a straightforward procedure leads to a system of differential equations and boundary conditions for each term in the asymptotic expansion This system can be solved recursively and the accuracy of the result improves as ϵ gets smaller for all values of the independent variables throughout the domain of interest We discuss regular perturbation problems in the first chapter

Multiple Scale and Singular Perturbation Methods J K Kevorkian, J D Cole, 1996-05-15 This book is a revised and updated version including a substantial portion of new material of the authors widely acclaimed earlier text *Perturbation Methods in Applied Mathematics* A new chapter dealing with regular expansions has been added the discussion of layer type singular perturbations has been revised and the coverage of multiple scale and averaging methods has been significantly expanded to reflect recent advances and viewpoints The result is a comprehensive account of the various perturbation techniques currently used in the sciences and engineering and is suitable for a graduate text as well as a reference work on the subject

[Multiple Scale and Singular Perturbation Methods](#) J. Kevorkian, J. D. Cole, 1996-06-30

Analyzing Multiscale Phenomena Using Singular Perturbation Methods Jane Cronin, 1999 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

Asymptotic Multiple Scale Method in Time Domain Jan Awrejcewicz, Roman Starosta, Grażyna Sypniewska-Kamińska, 2022-05-10 This book offers up novel research which uses analytical approaches to explore nonlinear

features exhibited by various dynamic processes Relevant to disciplines across engineering and physics the asymptotic method combined with the multiple scale method is shown to be an efficient and intuitive way to approach mechanics Beginning with new material on the development of cutting edge asymptotic methods and multiple scale methods the book introduces this method in time domain and provides examples of vibrations of systems Clearly written throughout it uses innovative graphics to exemplify complex concepts such as nonlinear stationary and nonstationary processes various resonances and jump pull in phenomena It also demonstrates the simplification of problems through using mathematical modelling by employing the use of limiting phase trajectories to quantify nonlinear phenomena Particularly relevant to structural mechanics in rods cables beams plates and shells as well as mechanical objects commonly found in everyday devices such as mobile phones and cameras the book shows how each system is modelled and how it behaves under various conditions It will be of interest to engineers and professionals in mechanical engineering and structural engineering alongside those interested in vibrations and dynamics It will also be useful to those studying engineering maths and physics

Handbook of Geomathematics Willi Freeden,M. Zuhair Nashed,Thomas Sonar,2010-08-13 During the last three decades geosciences and geo engineering were influenced by two essential scenarios First the technological progress has changed completely the observational and measurement techniques Modern high speed computers and satellite based techniques are entering more and more all geodisciplines Second there is a growing public concern about the future of our planet its climate its environment and about an expected shortage of natural resources Obviously both aspects viz efficient strategies of protection against threats of a changing Earth and the exceptional situation of getting terrestrial airborne as well as spaceborne data of better and better quality explain the strong need of new mathematical structures tools and methods Mathematics concerned with geoscientific problems i e Geomathematics is becoming increasingly important The Handbook Geomathematics as a central reference work in this area comprises the following scientific fields I observational and measurement key technologies II modelling of the system Earth geosphere cryosphere hydrosphere atmosphere biosphere III analytic algebraic and operator theoretic methods IV statistical and stochastic methods V computational and numerical analysis methods VI historical background and future perspectives

Singular Perturbation Theory Lindsay A. Skinner,2011-05-11 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

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systems infinite dimensions global attractors and stability computational aspects and applications It is a valuable reference for researchers in diverse disciplines ranging from mathematics through physics engineering chemistry nonlinear science to the life sciences ***Vibrations and Stability*** Jon Juel Thomsen,2003-11-05 An ideal text for students that ties together classical and modern topics of advanced vibration analysis in an interesting and lucid manner It provides students with a background in elementary vibrations with the tools necessary for understanding and analyzing more complex dynamical phenomena that can be encountered in engineering and scientific practice It progresses steadily from linear vibration theory over various levels of nonlinearity to bifurcation analysis global dynamics and chaotic vibrations It trains the student to analyze simple models recognize nonlinear phenomena and work with advanced tools such as perturbation analysis and bifurcation analysis Explaining theory in terms of relevant examples from real systems this book is user friendly and meets the increasing interest in non linear dynamics in mechanical structural engineering and applied mathematics and physics This edition includes a new chapter on the useful effects of fast vibrations and many new exercise problems

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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 Multiple Time Scale Dynamics Christian Kuehn,2015-02-25 This book provides an introduction to dynamical systems with multiple time scales The approach it takes is to provide an overview of key areas particularly topics that are less available in the introductory form The broad range of topics included makes it accessible for students and researchers new to the field to gain a quick and thorough overview The first of its kind this book merges a wide variety of different mathematical techniques into a more unified framework The book is highly illustrated with many examples and exercises and an extensive bibliography The target audience of this book are senior undergraduates graduate students as well as researchers interested in using the multiple time scale dynamics theory in nonlinear science either from a theoretical or a mathematical modeling perspective **Singular Perturbation Theory** R.S.

Johnson,2005-12-28 The importance of mathematics in the study of problems arising from the real world and the increasing success with which it has been used to model situations ranging from the purely deterministic to the stochastic is well established The purpose of the set of volumes to which the present one belongs is to make available authoritative up to date and self contained accounts of some of the most important and useful of these analytical approaches and techniques Each volume provides a detailed introduction to a specific subject area of current importance that is summarized below and then goes beyond this by reviewing recent contributions and so serving as a valuable reference source The progress in applicable mathematics has been brought about by the extension and development of many important analytical approaches and techniques in areas both old and new frequently aided by the use of computers without which the solution of realistic problems would otherwise have been impossible **Singular Perturbation Methodology in Control Systems** Desineni S.

Naidu,1988 This book presents the twin topics of singular perturbation methods and time scale analysis to problems in systems and control The heart of the book is the singularly perturbed optimal control systems which are notorious for demanding excessive computational costs The book addresses both continuous control systems described by differential equations and discrete control systems characterised by difference equations Multicomponent and Multiscale Systems Juergen Geiser,2015-08-21 This book examines the latest research results from combined multi component and multi scale explorations It provides theory considers underlying numerical methods and presents brilliant computational experimentation Engineering computations featured in this monograph further offer particular interest to many researchers engineers and computational scientists working in frontier modeling and applications of multicomponent and multiscale problems Professor Geiser gives specific attention to the aspects of decomposing and splitting delicate structures and controlling decomposition and the rationale behind many important applications of multi component and multi scale analysis

Multicomponent and Multiscale Systems Theory Methods and Applications in Engineering also considers the question of why iterative methods can be powerful and more appropriate for well balanced multiscale and multicomponent coupled nonlinear problems The book is ideal for engineers and scientists working in theoretical and applied areas *Rigorous Analysis of Multiple-scale Method on Some Singular Perturbation Problems* □□□,2002 [The Engineering Handbook](#) Richard C Dorf,2018-10-03 First published in 1995 The Engineering Handbook quickly became the definitive engineering reference Although it remains a bestseller the many advances realized in traditional engineering fields along with the emergence and rapid growth of fields such as biomedical engineering computer engineering and nanotechnology mean that the time has come to bring this standard setting reference up to date New in the Second Edition 19 completely new chapters addressing important topics in bioinstrumentation control systems nanotechnology image and signal processing electronics environmental systems structural systems 131 chapters fully revised and updated Expanded lists of engineering associations and societies The Engineering Handbook Second Edition is designed to enlighten experts in areas outside their own specialties to refresh the knowledge of mature practitioners and to educate engineering novices Whether you work in industry government or academia this is simply the best most useful engineering reference you can have in your personal office or institutional library [Handbook of Differential Equations](#) Daniel Zwillinger,1998 This book compiles the most widely applicable methods for solving and approximating differential equations as well as numerous examples showing the methods use Topics include ordinary differential equations symplectic integration of differential equations and the use of wavelets when numerically solving differential equations For nearly every technique the book provides The types of equations to which the method is applicable The idea behind the method The procedure for carrying out the method At least one simple example of the method Any cautions that should be exercised Notes for more advanced users References to the literature for more discussion or more examples including pointers to electronic resources such as URLs [Plasticity](#) S. Nemat-Nasser,2004-11-29 Publisher Description

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