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Nonlinear Differential Equations and Dynamical Systems Active Calculus 2018

In qualitative theory of differential equations, an important role is played by special classes of solutions, like periodic solutions or solutions to some boundary value problems. When a system of ordinary differential equations has equilibria, i.e. constant solutions, whose stability properties are known, it is significant to search for connections between them by trajectories of solutions of the given system. These are called homoclinic or heteroclinic, according to whether they describe a loop based at one single equilibrium or they "start" and "end" at two distinct equilibria. This thesis is devoted to the study of heteroclinic solutions for a specific class of ordinary differential equations related to the Extended Fisher-Kolmogorov equation and the Swift-Hohenberg equation. These are semilinear fourth order bi-stable evolution equations which appear as mathematical models for problems arising in Mechanics, Chemistry and Biology. For such equations, the set of bounded stationary solutions is of great interest. These solve an autonomous fourth order equation. In this thesis, we focus on such equations having a variational structure. In that case, the solutions are critical points of an associated action functional defined in convenient functional spaces. We then look for heteroclinic solutions as minimizers of the action functional. Our main contributions concern existence and multiplicity results of such global and local minimizers in the case where the functional is defined from sign changing Lagrangians. The underlying idea is to impose conditions which imply a lower bound on the action over all admissible functions. We then combine classical arguments of the Calculus of Variations with careful estimates on minimizing sequences to prove the existence of a minimum.

Calculus: Single and Multivariable OUP Oxford

The nature of time in a nonautonomous dynamical system is very different from that in autonomous systems, which depend only on the time that has elapsed since starting rather than on the actual time itself. Consequently, limiting objects may not exist in actual time as in autonomous systems. New concepts of attractors in nonautonomous dynamical system are thus required.In addition, the definition of a dynamical system itself needs to be generalised to the nonautonomous context. Here two possibilities are considered: two-parameter semigroups or processes and the skew product flows. Their attractors are defined in terms of families of sets that are mapped onto each other under the dynamics rather than a single set as in autonomous systems. Two types of attraction are now possible: pullback attraction, which depends on the behaviour from the system in the distant past, and forward attraction, which depends on the behaviour of the system in the distant future. These are generally independent of each other.The component subsets of pullback and forward attractors exist in actual time. The asymptotic behaviour in the future limit is characterised by omega-limit sets, in terms of which form what are called forward attracting sets. They are generally not invariant in the conventional sense, but are asymptotically invariant in general and, if the future dynamics is appropriately uniform, also asymptotically negatively invariant.Much of this book is based on lectures given by the authors in Frankfurt and Wuhan. It was written mainly when the first author held a 'Thousand Expert' Professorship at the Huazhong University of Science and Technology in Wuhan.

Control Systems Springer Science & Business Media

Stability conditions for functional differential equations can be obtained using Lyapunov functionals. Lyapunov Functionals and Stability of Stochastic Functional Differential Equations describes the general method of construction of Lyapunov functionals to investigate the stability of differential equations with delays. This work continues and complements the author’s previous book Lyapunov Functionals and Stability of Stochastic Difference Equations, where this method is described for difference equations with discrete and continuous time. The text begins with both a description and a delineation of the peculiarities of deterministic and stochastic functional differential equations. There follows basic definitions for stability theory of stochastic hereditary systems, and the formal procedure of Lyapunov functionals construction is presented. Stability investigation is conducted for stochastic linear and nonlinear differential equations with constant and distributed delays. The proposed method is used for stability investigation of different mathematical models such as: • inverted controlled pendulum; • Nicholson's blowflies equation; • predator-prey relationships; • epidemic development; and • mathematical models that describe human behaviours related to addictions and obesity. Lyapunov Functionals and Stability of Stochastic Functional Differential Equations is primarily addressed to experts in stability theory but will also be of interest to professionals and students in pure and computational mathematics, physics, engineering, medicine, and biology.

Notes on Diffy Qs SIAM

In its most general form bifurcation theory is a theory of equilibrium solutions of nonlinear equations. By equilibrium solutions we mean, for example, steady solutions, time-periodic solutions, and quasi-periodic solutions. The purpose of this book is to teach the theory of bifurcation of equilibrium solutions of evolution problems governed by nonlinear differential equations. We have written this book for the broaqest audience of potentially interested learners: engineers, biologists, chemists, physicists, mathematicians, econom ists, and others whose work involves understanding equilibrium solutions of nonlinear differential equations. To accomplish our aims, we have thought it necessary to make the analysis 1. general enough to apply to the huge variety of applications which arise in science and technology, and 2. simple enough so that it can be understood by persons whose mathe matical training does not extend beyond the classical methods of analysis which were popular in the 19th Century. Of course, it is not possible to achieve generality and simplicity in a perfect union but, in fact, the general theory is simpler than the detailed theory required for particular applications. The general theory abstracts from the detailed problems only the essential features and provides the student with the skeleton on which detailed structures of the applications must rest. It is generally believed that the mathematical theory of bifurcation requires some functional analysis and some of the methods of topology and dynamics.

Stability Analysis of Impulsive Functional Differential Equations John Wiley & Sons

Ordinary Differential Equations is an outgrowth of courses taught for a number of years at Iowa State University in the mathematics and the electrical engineering departments. It is intended as a text for a first graduate course in differential equations for students in mathematics, engineering, and the sciences. Although differential equations is an old, traditional, and well-established subject, the diverse backgrounds and interests of the students in a typical modern-day course cause problems in the selection and method of presentation of material. In order to compensate for this diversity, prerequisites have been kept to a minimum and the material is covered in such a way as to be appealing to a wide audience. The book contains eight chapters and begins with an introduction the subject and a discussion of some important examples of differential equations that arise in science and engineering. Separate chapters follow on the fundamental theory of linear and nonlinear differential equations; linear boundary value problems; Lyapunov stability theory; and perturbations of linear systems. Subsequent chapters deal with the Poincare-Bendixson theory and with two-dimensional van der Pol type equations; and periodic solutions of general order systems.

An Introduction To Nonautonomous Dynamical Systems And Their Attractors McGraw Hill

In this paper we shall study the oscillation of all positive solutions of the nonlinear delay differential equationandabout their equilibrium points. Also we study the stability of these equilibrium points and prove that every non-oscillatory positive solution tends to the equilibrium point when t tends to infinity. Where Eq (*) proposed by Mackey and Glass [12] for a “Dynamic Disease” involving respiratory disorders and Eq. (**) is one of the models proposed by Nazarenko [13] to study a control of a single population of cells.

On the Global Asymptotic Stability of Equilibrium Solutions for Open-loop Differential Games Springer Science & Business Media

This book is different than most math books because it is based on a student's class notes that have been reviewed and updated by the professor who taught the course! Therefore, this book is structured and presented in a way that teaches the material with a series of detailed examples, from simple to increasing complexity. Solution techniques are generalized and simple, step-by-step procedures are listed and used to solve a series of problems, from simple to advanced. All topics are presented in a logical way that gives the reader a clear understanding of the important concepts and the relationship between topics. This book should be considered a reference for students taking a course in Differential Equations (DEs). Statements of theorem and important results are included; however, proofs are not included because the primary emphasis is on problems and applications. It is assumed that the reader has previously taken courses in Differential and Integral Calculus. Familiarity with Linear Algebra is also recommended. Throughout the book, short reviews are included where needed. In addition, the appendix includes some supporting material (integration-by-parts (tabular-method), complex numbers, linear independence, and matrices). This book includes an impressive list of topics: FIRST-ORDER DE * First Order Linear DE * Separable DE * Substitution Methods (Bernoulli DE, Homogeneous DE, Special Substitution) * Exact DE With & Without Integrating Factor * Strategies for First-Order DE * Existence and Uniqueness Theorem SECOND-ORDER DE * Second-Order DE with Constant Coefficients (Characteristic Eqns., Existence & Uniqueness, Wronskian Determinant) * Higher-Order DE with Constant Coefficients * Non-Homogeneous DE with Constant Coefficients (Undetermined Coefficients, Variation of Parameters) * Euler's DE * Reduction of Order * Mechanical and Electrical Vibrations (Spring Mass System, Electrical Vibrations) SERIES SOLUTIONS of DE * Power Series (Review) * Series Solution near an Ordinary Point * Types of Singular Points * Series Solution near Regular Singular Point * Bessel's DE LAPLACE TRANSFORM of DE * Improper Integration * Definition of Laplace Transform and Gamma Functions * Step Functions * Impulse Functions * Convolution Integrals SYSTEMS of FIRST-ORDER DE * Systems of First-Order Linear DEs * Eigenvalues and Eigenvectors * Homogeneous and Non-Homogeneous Systems * The Phase Plane * Locally Linear Systems * Competing Species * Predator-Prey Systems The last, and perhaps most interesting, chapter of this book includes phase portraits and discusses the stability of equilibrium solutions for non-linear systems of differential equations. The book concludes with fascinating applications such as competing species and predator-prey systems.

A First Course in Differential Equations CRC Press

The first contemporary textbook on ordinary differential equations (ODEs) to include instructions on MATLAB, Mathematica, and Maple A Course in Ordinary Differential Equations focuses on applications and methods of analytical and numerical solutions, emphasizing approaches used in the typical engineering, physics, or mathematics student's field o

Applied Linear Algebra CRC Press

Students who have used Smith/Minton's Calculus say it was easier to read than any other math book they've used. That testimony underscores the success of the authors’ approach, which combines the best elements of reform with the most reliable aspects of mainstream calculus teaching, resulting in a motivating, challenging book. Smith/Minton also provide exceptional, reality-based applications that appeal to students’ interests and demonstrate the elegance of math in the world around us. New features include: • A new organization placing all transcendental functions early in the book and consolidating the introduction to L'Hôpital's Rule in a single section. • More concisely written explanations in every chapter. • Many new exercises (for a total of 7,000 throughout the book) that require additional rigor not found in the 2nd Edition. • New exploratory exercises in every section that challenge students to synthesize key concepts to solve intriguing projects. • New commentaries ("Beyond Formulas") that encourage students to think mathematically beyond the procedures they learn. • New counterpoints to the historical notes, "Today in Mathematics," that stress the contemporary dynamism of mathematical research and applications, connecting past contributions to the present. • An enhanced discussion of differential equations and additional applications of vector calculus.

Ordinary Differential Equations Springer Science & Business Media

You're outnumbered, in fear for your life, surrounded by flesheating zombies. What can save you now? Mathematics, of course. Mathematical Modelling of Zombies engages the imagination to illustrate the power of mathematical modelling. Using zombies as a "hook," you'll learn how mathematics can predict the unpredictable. In order to be prepared for the apocalypse, you'll need mathematical models, differential equations, statistical estimations, discretetime models, and adaptive strategies for zombie attacks—as well as baseball bats and Dire Straits records (latter two items not included). In Mathematical Modelling of Zombies, Robert Smith? brings together a highly skilled team of contributors to fend off a zombie uprising. You'll also learn how modelling can advise government policy, how theoretical results can be communicated to a nonmathematical audience and how models can be formulated with only limited information. A forward by Andrew Cartmel—former script editor of Doctor Who, author, zombie fan and all-round famous person in science-fiction circles—even provides a genealogy of the undead. By understanding how to combat zombies, readers will be introduced to a wide variety of modelling techniques that are applicable to other real-world issues (biology, epidemiology, medicine, public health, etc.). So if the zombies turn up, reach for this book. The future of the human race may depend on it.

Existence, Uniqueness, and Stability for Nonlinear Differential-difference Equations in the Neutral Case CRC Press

Control Systems: Classical, Modern, and AI-Based Approaches provides a broad and comprehensive study of the principles, mathematics, and applications for those studying basic control in mechanical, electrical, aerospace, and other engineering disciplines. The text builds a strong mathematical foundation of control theory of linear, nonlinear, optimal, model predictive, robust, digital, and adaptive control systems, and it addresses applications in several emerging areas, such as aircraft, electro-mechanical, and some nonengineering systems: DC motor control, steel beam thickness control, drum boiler, motional control system, chemical reactor, head-disk assembly, pitch control of an aircraft, yaw-damper control, helicopter control, and tidal power control. Decentralized control, game-theoretic control, and control of hybrid systems are discussed. Also, control systems based on artificial neural networks, fuzzy logic, and genetic algorithms, termed as AI-based systems are studied and analyzed with applications such as auto-landing aircraft, industrial process control, active suspension system, fuzzy gain scheduling, PID control, and adaptive neuro control. Numerical coverage with MATLAB® is integrated, and numerous examples and exercises are included for each chapter. Associated MATLAB® code will be made available.

Game Physics Springer

Version 6.0. An introductory course on differential equations aimed at engineers. The book covers first order ODEs, higher order linear ODEs, systems of ODEs, Fourier series and PDEs, eigenvalue problems, the Laplace transform, and power series methods. It has a detailed appendix on linear algebra. The book was developed and used to teach Math 286/285 at the University of Illinois at Urbana-Champaign, and in the decade since, it has been used in many classrooms, ranging from small community colleges to large public research universities. See https: //www.jirka.org/diffyqs/ for more information, updates, errata, and a list of classroom adoptions.

Exploring Modeling with Data and Differential Equations Using R Springer Science & Business Media

For lecture courses that cover the classical theory of nonlinear differential equations associated with Poincare and Lyapunov and introduce the student to the ideas of bifurcation theory and chaos, this text is ideal. Its excellent pedagogical style typically consists of an insightful overview followed by theorems, illustrative examples, and exercises.

Scientific Computing with Mathematica® Elsevier

For lecture courses that cover the classical theory of nonlinear differential equations associated with Poincare and Lyapunov and introduce the student to the ideas of bifurcation theory and chaos, this text is ideal. Its excellent pedagogical style typically consists of an insightful overview followed by theorems, illustrative examples, and exercises.

Active Calculus 2018 Walter de Gruyter

Many interesting behaviors of real physical, biological, economical, and chemical systems can be described by ordinary differential equations (ODEs). Scientific Computing with Mathematica for Ordinary Differential Equations provides a general framework useful for the applications, on the conceptual aspects of the theory of ODEs, as well as a sophisticated use of Mathematica software for the solutions of problems related to ODEs. In particular, a chapter is devoted to the use ODEs and Mathematica in the Dynamics of rigid bodies. Mathematical methods and scientific computation are dealt with jointly to supply a unified presentation. The main problems of ordinary differential equations such as, phase portrait, approximate solutions, periodic orbits, stability, bifurcation, and boundary problems are covered in an integrated fashion with numerous worked examples and computer program demonstrations using Mathematica. Topics and Features:*Explains how to use the Mathematica package ODE.m to support qualitative and quantitative problem solving *End-of- chapter exercise sets incorporating the use of Mathematica programs *Detailed description and explanation of the mathematical procedures underlying the programs written in Mathematica *Appendix describing the use of ten notebooks to guide the reader through all the exercises. This book is an essential text/reference for students, graduates and practitioners in applied mathematics and engineering interested in ODE's problems in both the qualitative and quantitative description of solutions with the Mathematica program. It is also suitable as a self-

Nonlinear Ordinary Differential Equations: Problems and Solutions:A Sourcebook for Scientists and Engineers Academic Press

Suitable as both a reference and a text for graduate students, this book stresses the fundamentals of setting up and solving dynamics problems rather than the indiscriminate use of elaborate formulas. Includes tutorials on relevant software. 2015 edition.

Stability Theory of Nonlinear Operational Differential Equations in Hilbert Space Springer Science & Business Media

Active Calculus 2018Createspace Independent Publishing Platform

Mathematical Models Createspace Independent Publishing Platform

Mathematical Modelling with Case Studies: Using MapleTM and MATLAB®, Third Edition provides students with hands-on modelling skills for a wide variety of problems involving differential equations that describe rates of change. While the book focuses on growth and decay processes, interacting populations, and heating/cooling problems, the mathematical techniques presented can be applied to many other areas. The text carefully details the process of constructing a model, including the conversion of a seemingly complex problem into a much simpler one. It uses flow diagrams and word equations to aid in the model-building process and to develop the mathematical equations. Employing theoretical, graphical, and computational tools, the authors analyze the behavior of the models under changing conditions. The authors often examine a model numerically before solving it analytically. They also discuss the validation of the models and suggest extensions to the models with an emphasis on recognizing the strengths and limitations of each model. The highly recommended second edition was praised for its lucid writing style and numerous real-world examples. With updated MapleTM and MATLAB® code as well as new case studies and exercises, this third edition continues to give students a clear, practical understanding of the development and interpretation of mathematical models.

Introductory Differential Equations CRC Press

This paper gives a new characterization of the smallest eigenvalue for second order linear elliptic partial differential equations, not necessarily self-adjoint, with both natural and Dirichlet boundary conditions, and also give a new alternative numerical method for calculating both the smallest eigenvalue and corresponding eigenvector in the case of natural boundary conditions. The smallest eigenvalue, if appropriate sign changes are made, determines the stability of equilibrium solutions to certain second order nonlinear partial differential equations. The corresponding eigenvector enables one to determine the first approximation of the solution of the nonlinear equation to variations of the initial conditions from the equilibrium solution. These nonlinear equations are important in the applications. For these reasons it is important to have these characterizations of the smallest eigenvalue and eigenvector. Our method converts the determination of the eigenvalue and eigenvector to determining the solution of a stationary stochastic control problem. This latter problem is solved and from it a numerical scheme arises naturally. This method appears to have applications in solving other problems.

Mathematical Modelling with Case Studies Academic Press

Active Calculus - single variable is a free, open-source calculus text that is designed to support an active learning approach in the standard first two semesters of calculus, including approximately 200 activities and 500 exercises. In the HTML version, more than 250 of the exercises are available as interactive WeBWorK exercises; students will love that the online version even looks great on a smart phone. Each section of Active Calculus has at least 4 in-class activities to engage students in active learning. Normally, each section has a brief introduction together with a preview activity, followed by a mix of exposition and several more activities. Each section concludes with a short summary and exercises; the non-WeBWorK exercises are typically involved and challenging. More information on the goals and structure of the text can be found in the preface.