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Elementary Stability and Bifurcation Theory
Springer Science & Business Media
This textbook develops the essential tools of linear algebra, with the goal of imparting technique alongside contextual understanding. Applications go hand-in-hand with theory, each reinforcing and explaining the other. This approach encourages students to develop not only the technical proficiency needed to go on to further study, but an appreciation for when, why, and how the tools of linear algebra can be used across modern applied mathematics. Providing an extensive treatment of essential topics such as Gaussian elimination, inner products and norms, and eigenvalues and singular values, this text can be used for an in-depth first course, or an application-driven second course in linear algebra. In this second edition, applications have been updated and expanded to include numerical methods, dynamical systems, data analysis, and signal processing, while the pedagogical flow of the core material has been improved. Throughout, the text emphasizes the conceptual connections between each application and the underlying linear algebraic techniques, thereby enabling students not only to learn how to apply the mathematical tools in routine contexts, but also to understand what is required to adapt to unusual or emerging problems. No previous knowledge of linear algebra is needed to approach this text, with single-variable calculus as the only formal prerequisite. However, the reader will need to draw upon some mathematical maturity to engage in the increasing abstraction inherent to the subject. Once equipped with the main tools and concepts from this book, students will be prepared for further study in differential equations, numerical analysis, data science and statistics, and a broad range of applications. The first author ' s text, Introduction to Partial Differential Equations, is an ideal companion volume, forming a natural extension of the linear mathematical methods developed here.

An Introduction To Nonautonomous Dynamical Systems And Their Attractors
CRC Press
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.

Global Formulations of Lagrangian and Hamiltonian Dynamics on Manifolds CRC Press

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.

Stability and Oscillations in Delay Differential Equations of Population Dynamics Montréal : Écoles des hautes études commerciales

Introductory Differential Equations, Fourth Edition, offers both narrative explanations and robust sample problems for a first semester course in introductory ordinary differential equations (including Laplace transforms) and a second course in Fourier series and boundary value problems. The book provides the foundations to assist students in learning not only how to read and understand differential equations, but also how to read technical material in more advanced texts as they progress through their studies. This text is for courses that are typically called (Introductory) Differential Equations, (Introductory) Partial Differential Equations, Applied Mathematics, and Fourier Series. It follows a traditional approach and includes ancillaries like Differential Equations with Mathematica and/or Differential

Equations with Maple. Because many students need a lot of pencil-and-paper practice to master the essential concepts, the exercise sets are particularly comprehensive with a wide array of exercises ranging from straightforward to challenging. There are also new applications and extended projects made relevant to everyday life through the use of examples in a broad range of contexts. This book will be of interest to undergraduates in math, biology, chemistry, economics, environmental sciences, physics, computer science and engineering. Provides the foundations to assist students in learning how to read and understand the subject, but also helps students in learning how to read technical material in more advanced texts as they progress through their studies Exercise sets are particularly comprehensive with a wide range of exercises ranging from straightforward to challenging Includes new applications and extended projects made relevant to "everyday life" through the use of examples in a broad range of contexts Accessible approach with applied examples and will be good for non-math students, as well as for undergrad classes

On the Global Asymptotic Stability of Equilibrium Solutions for Open-loop Differential Games Createspace Independent Publishing Platform

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.

Applied Linear Algebra 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.

Exploring Modeling with Data and Differential Equations Using R Springer

This introductory text combines models from physics and biology with rigorous reasoning in describing the theory of ordinary differential equations along with applications and computer simulations with Maple. Offering a concise course in the theory of ordinary differential equations, it also enables the reader to enter the field of computer simulations. Thus, it is a valuable read for students in mathematics as well as in physics and engineering. It is also addressed to all those interested in mathematical modeling with ordinary differential equations and systems. Contents Part I: Theory Chapter 1 First-Order Differential Equations Chapter 2 Linear Differential Systems Chapter 3 Second-Order Differential Equations Chapter 4 Nonlinear Differential Equations Chapter 5 Stability of Solutions Chapter 6 Differential Systems with Control Parameters Part II: Exercises Seminar 1 Classes of First-Order Differential Equations Seminar 2 Mathematical Modeling with Differential Equations Seminar 3 Linear Differential Systems Seminar 4 Second-Order Differential Equations Seminar 5 Gronwall ' s Inequality Seminar 6 Method of Successive Approximations Seminar 7 Stability of Solutions Part III: Maple Code Lab 1 Introduction to Maple Lab 2 Differential Equations with Maple Lab 3 Linear Differential Systems Lab 4 Second-Order Differential Equations Lab 5 Nonlinear Differential Systems Lab 6 Numerical Computation of Solutions Lab 7 Writing Custom Maple Programs Lab 8 Differential Systems with Control Parameters Academic Press

Based on a streamlined presentation of the authors ' successful work Linear Systems, this textbook provides an introduction to systems theory with an emphasis on control. Initial chapters present necessary mathematical background material for a fundamental understanding of the dynamical behavior of systems. Each chapter includes helpful chapter descriptions and guidelines for the reader, as well as summaries, notes, references, and exercises at the end. The emphasis throughout is on time-invariant systems, both continuous- and discrete-time.

Stability Analysis of Impulsive Functional Differential Equations Walter de Gruyter GmbH & Co KG Active Calculus 2018Createspace Independent Publishing Platform

Fundamentals of Dynamics and Analysis of Motion University of Ottawa 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 Models Springer Science & Business Media

This book is devoted to impulsive functional differential equations which are a natural generalization of impulsive ordinary differential equations (without delay) and of functional differential equations (without impulses). At the present time the qualitative theory of such equationsis under rapid development. After a presentation of the fundamental theory of existence, uniqueness and continuability of solutions, a systematic development of stability theory for that class of problems is given which makes the book unique. It addresses to a wide audience such as mathematicians, applied researches and practitioners.

Introductory Differential Equations Elsevier

Nonlinear Differential Equations: Invariance, Stability, and Bifurcation presents the developments in the qualitative theory of nonlinear differential equations. This book discusses the exchange of mathematical ideas in stability and bifurcation theory. Organized into 26 chapters, this book begins with an overview of the initial value problem for a nonlinear wave equation. This text then focuses on the interplay between stability exchange for a stationary solution and the appearance of bifurcating periodic orbits. Other chapters consider the development of methods for ascertaining stability and boundedness and explore the development of bifurcation and stability analysis in nonlinear models of applied sciences. This book discusses as well nonlinear hyperbolic equations in further contributions, featuring stability properties of periodic and almost periodic solutions. The reader is also introduced to the stability problem of the equilibrium of a chemical network. The final chapter deals with suitable spaces for studying functional equations. This book is a valuable resource for mathematicians.

A Course in Mathematical Methods for Physicists Springer

Create physically realistic 3D Graphics environments with this introduction to the ideas and techniques behind the process. Author David H. Eberly includes simulations to introduce the key problems involved and then gradually reveals the mathematical and physical concepts needed to solve them. He then describes all the algorithmic foundations and u

Nonlinear Differential Equations and Dynamical Systems Springer Science & Business Media

An ideal companion to the new 4th Edition of Nonlinear Ordinary Differential Equations by Jordan and Smith (OUP, 2007), this text contains over 500 problems and fully-worked solutions in nonlinear differential equations. With 272 figures and diagrams, subjects covered include phase diagrams in the plane, classification of equilibrium points, geometry of the phase plane, perturbation methods, forced oscillations, stability, Mathieu's equation, Liapunov methods, bifurcationsand manifolds, homoclinic bifurcation, and Melnikov's method.The problems are of variable difficulty; some are routine questions, others are longer and expand on concepts discussed in Nonlinear Ordinary Differential Equations 4th Edition, and in most cases can be adapted for coursework or self-study.Both texts cover a wide variety of applications whilst keeping mathematical prequisites to a minimum making these an ideal resource for students and lecturers in engineering, mathematics and the sciences.

A Minimum Principle for the Smallest Eigenvalue for Second Order Linear Elliptic Equations with Natural Boundary Conditions OUP Oxford

For ordinary differential equations it is well known that an equilibrium solution is stable if the linearized equation has only exponentially decaying solutions. The differential-difference equation u' (t+s) - u' (t) + au (t +)s) = g (t, u (t), u (t+ s)), a > O, s > O, when linearized, also has decaying exponentials exp (st), but the characteristic roots s approach the imaginary axis. The problem arises -- do solutions of this equation decay. An affirmative answer is obtained for this problem, the rate of decay depending upon the smoothness of the initial data and nonlinear term and the rate of approach of the characteristic roots to the imaginary axis. Then this result is applied to a transmission line problem. Also, an example is given of a homogeneous linear ordinary differential-difference equation with constant coefficients, whose characteristic roots all lie in the left half plane, having an unbounded solution. (Author).

On the Global Asymptotic Stability of Equilibrium Solutions for Open-loop Differential Games Walter de Gruyter

Based on the author ’ s junior-level undergraduate course, this introductory textbook is designed for a course in mathematical physics. Focusing on the physics of oscillations and waves, A Course in Mathematical Methods for Physicists helps students understand the mathematical techniques needed for their future studies in physics. It takes a bottom-up approach that emphasizes physical applications of the mathematics. The book offers: A quick review of mathematical prerequisites, proceeding to applications of differential equations and linear algebra Classroom-tested explanations of complex and Fourier analysis for trigonometric and special functions Coverage of vector analysis and curvilinear coordinates for solving higher dimensional problems Sections on nonlinear dynamics, variational calculus, numerical solutions of differential equations, and Green's functions

A Course in Ordinary Differential Equations CRC Press

Exploring Modeling with Data and Differential Equations Using R provides a unique introduction to differential equations with applications to the biological and other natural sciences. Additionally, model parameterization and simulation of stochastic differential equations are explored, providing additional tools for model analysis and evaluation. This unified framework sits "at the intersection" of different mathematical subject areas, data science, statistics, and the natural sciences. The text throughout emphasizes data science workflows using the R statistical software program and the tidyverse constellation of packages. Only knowledge of calculus is needed; the text ’ s integrated framework is a stepping stone for further advanced study in mathematics or as a comprehensive introduction to modeling for quantitative natural scientists. The text will introduce you to: modeling with systems of differential equations and developing analytical, computational, and visual solution techniques. the R programming language, the tidyverse syntax, and developing data science workflows. qualitative techniques to analyze a system of differential equations. data assimilation techniques (simple linear regression, likelihood or cost functions, and Markov Chain, Monte Carlo Parameter Estimation) to parameterize models from data. simulating and evaluating outputs for stochastic differential equation models. An associated R package provides a framework for computation and visualization of results. It can be found here: https://cran.r-project.org/web/packages/demodelr/index.html.

Control Systems CRC Press

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 CRC 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.

A Linear Systems Primer Wellesley-Cambridge Press

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.