Convection in Porous Media
Combustion Thermodynamics and Dynamics
Linear Parameter- Varying and Time-Delay Systems
Stochastic Processes, Multiscale Modeling, and Numerical Methods for Computational Cellular Biology
Proceedings of the International Conference on Bifurcation Theory and Its Numerical Analysis
Self- Propagating High- Temperature Synthesis of Materials
Bifurcation Analysis and Nonstandard Finite Difference Schemes for Kermack and McKendrick Type Epidemiological Models
Continuation and Bifurcations: Numerical Techniques and Applications
Bifurcation: Analysis, Algorithms, Applications
Analysis and Control of Complex Dynamical Systems
Numerical Bifurcation Analysis for Reaction- Diffusion Equations
Reactive Distillation
Mathematical Reviews
Turing Patterns in Linear Chemical Reaction Systems with Nonlinear Cross Diffusion
Quantitative Models for Microscopic to Macroscopic Biological Macromolecules and Tissues
Hopf Bifurcation Analysis
Eurosymposium Computer Aided Process Engineering
Spatial Dynamics and Pattern Formation in Biological Populations
SIAM Journal on Scientific Computing
European Symposium on Computer- Aided Process Engineering
Lecture Notes in Computational Science and Engineering
Springer's series
Lecture Notes in Computational Science and Engineering
The corresponding report of SPPEXA's first funding phase, and provides an overview of SPPEXA's contributions towards exascale computing.
Computing” (SPPEXA) of the German Research Foundation (DFG) presented at the SPPEXA Symposium in Dresden during October 21-23, 2019. In that respect, it both represents a continuation of Vol.
113 in Springer's series Lecture Notes in Computational Science and Engineering, the corresponding report of SPPEXA's first funding phase, and provides an overview of SPPEXA's contributions towards exascale computing in today's supercomputer technology. The individual chapters address one or more of the research directions:
(1) computational algorithms,
(2) system software,
(3) application software,
(4) data management and exploration,
(5) programming,
(6) software tools.
The book has an interdisciplinary appeal: scholars from computational sub-fields in computer science, mathematics, physics, or engineering will find it of particular interest.
Stochastic Processes, Multiscale Modeling, and Numerical Methods for Computational Cellular Biology This book is the first to report on theoretical breakthroughs on control of complex dynamical systems developed by collaborative researchers in the two fields of dynamical systems theory and control theory. As well, its basic point of view is of three kinds of complexity: bifurcation phenomena subject to model uncertainty, complex behavior including periodic/quasi-periodic orbits as well as chaotic orbits, and network complexity emerging from dynamical interactions between subsystems. Analysis and Control of Complex Dynamical Systems offers a valuable resource for mathematicians, physicists, and biophysicists, as well as for researchers in nonlinear science and control engineering, allowing them to develop a better fundamental understanding of the analysis and control synthesis of such complex systems.

Proceedings of the International Conference on Bifurcation Theory and Its Numerical Analysis This book focuses on the modeling and mathematical analysis of stochastic dynamical systems along with their simulations. The collected chapters will review fundamental and current topics and approaches to dynamical systems in cellular biology. This text aims to develop improved mathematical and computational methods with which to study biological processes. At the scale of a single cell, stochasticity becomes important due to low copy numbers of biological molecules, such as mRNA and proteins that take part in biochemical reactions driving cellular processes. When trying to describe such biological processes, the traditional deterministic models are often inadequate, precisely because of these low copy numbers. This book presents stochastic models, which are necessary to account for small particle numbers and extrinsic noise sources. The complexity of these models depend upon whether the biochemical reactions are diffusion-limited or reaction-limited. In the former case, one needs to adopt the framework of stochastic reaction-diffusion models, while in the latter, one can describe the processes by adopting the framework of Markov jump processes and stochastic differential equations. Stochastic Processes, Multiscale Modeling, and Numerical Methods for Computational Cellular Biology will appeal to graduate students and researchers in the fields of applied mathematics, biophysics, and cellular biology.

Self-Propagating High-Temperature Synthesis of Materials Probably the first book to describe computational methods for numerically computing steady state and Hopf bifurcations. Requiring only a basic knowledge of calculus, and using detailed examples, problems, and figures, this is an ideal textbook for graduate students.

Bifurcation Analysis and Nonstandard Finite Difference Schemes for Kermack and McKendrick Type Epidemiological Models The book provides an introduction to deterministic (and some stochastic) modeling of spatiotemporal phenomena in ecology, epidemiology, and neural systems. A survey of the classical models in the fields with up to date applications is given. The book begins with detailed description of how spatial dynamics/diffusive processes influence the dynamics of biological populations. These processes play a key role in understanding the outbreak and spread of pandemics which help us in designing the control strategies from the public health perspective. A brief discussion on the functional mechanism of the brain (single neuron models and network level) with classical models of neuronal dynamics in space and time is given. Relevant phenomena and existing modeling approaches in ecology, epidemiology and neuroscience are introduced, which provide examples of pattern formation in these models. The analysis of patterns enables us to study the dynamics of macroscopic and microscopic behaviour of underlying systems and travelling wave type patterns observed in dispersive systems. Moving on to virus dynamics, authors present a detailed analysis of different types models of infectious diseases including two models for influenza, five models for Ebola virus and seven models for Zika virus with diffusion and time delay. A Chapter is devoted for the study of Brain Dynamics (Neural systems in space and time). Significant advances made in modeling the reaction-diffusion systems are presented and spatiotemporal patterning in the systems is reviewed. Development of appropriate mathematical models and detailed analysis (such as linear stability, weakly nonlinear analysis, bifurcation analysis, control theory, numerical simulation) are presented. Key Features Covers the fundamental concepts and mathematical skills required to analyse reaction-diffusion models for biological populations. Concepts are introduced in such a way that readers with a basic knowledge of differential equations and numerical methods can understand the analysis. The results are also illustrated with figures. Focuses on mathematical modeling and numerical simulations using basic conceptual and classic models of population dynamics, Virus and Brain dynamics. Covers wide range of models using spatial and non-spatial approaches. Covers single, two and multispecies reaction-diffusion models from ecology and models from biochemistry. Models are analysed for stability of equilibrium points, Turing instability, Hopf bifurcation and pattern formations. Uses Mathematica for problem solving and MATLAB for pattern formations. Contains solved Examples and Problems in Exercises. The Book is suitable for advanced undergraduate, graduate and research students. For those who are working in the above areas, it provides information from most of the recent works. The text presents all the fundamental concepts and mathematical skills needed to build models and perform analyses.

Continuation and Bifurcations: Numerical Techniques and Applications This reference work provides a comprehensive insight into past developments in the application of non-linear dynamics, such as production systems in the manufacturing and process engineering, mechanical engineering and plant construction and automation technology. As such, it is the first publication to document the successful implementation of non-linear dynamics into current tasks or problems of engineering thus far unsolved. The interdisciplinary team of contributors from research and industry establishes ties between mechanical methods of manufacturing and new methods reaching the dynamics of production lines and complete production systems.

Bifurcation: Analysis, Algorithms, Applications

Analysis and Control of Complex Dynamical Systems The International Conference on Computational Science (ICCS 2004) held in Krakow, Poland, June 6–9, 2004, was a follow-up to the highly successful ICCS 2003 held at two locations, in Melbourne, Australia and St. Petersburg, Russia; ICCS 2002 in Amsterdam, The Netherlands; and ICCS 2001 in San Francisco, USA. As computational science is still evolving in its quest for subjects of investigation and clients, ICCS 2004 was devised as a forum for scientists from mathematics and computer science, as the basic computing disciplines and application areas, interested in advanced computational methods for physics, chemistry, life sciences, engineering, arts and humanities, as well as computer system vendors and software developers. The main objective of this conference was to...
discuss problems and solutions in all areas, to identify new issues, to shape future directions of research, and to help users apply various advanced computational techniques. The event harvested recent developments in computational grids and next generation computing systems, tools, advanced numerical methods, data-driven systems, and novel application fields, such as complex systems, nanotechnology, and mobile networks, graphics, and hybrid computation.

Numerical Bifurcation Analysis The book begins with a pedagogical presentation of some of the basic theory, with chapters on biochemical reactions, diffusion, excitability, wave propagation and cellular homeostasis. The second, more extensive part discusses particular physiological systems, with chapters on calcium dynamics, bursting oscillations and secretion, cardiac cells, muscles, intercellular communication, the circulatory system, the immune system, wound healing, the respiratory system, the visual system, hormone physiology, renal physiology, digestion, the visual system and hearing. New chapters on cellular homeostasis. The second, more extensive part discusses particular physiological systems, with chapters on calcium dynamics, bursting oscillations and secretion, cardiac cells, muscles, intercellular communication, the circulatory system, the immune system, wound healing, the respiratory system, the visual system, hormone physiology, renal physiology, digestion, the visual system and hearing. New chapters on calcium dynamics, Neuroendocrine Cells and Regulation of Cell Function have been included. Reviews from first edition: Keener and Sneyd's Mathematical Physiology is the first comprehensive text of its kind that deals exclusively with the interplay between mathematics and physiology. Writing a book like this is an audacious act! -Society of Mathematical Biology Keener and Sneyd's is unique in that it attempts to present one of the most important subfields of biology and medicine, physiology, in terms of mathematical "language", rather than organizing materials around mathematical methodology. SIAM review

Turing Patterns in Linear Chemical Reaction Systems with Nonlinear Cross Diffusion An alternative title for this book would perhaps be Nonlinear Analysis, Bifurcation Theory and Differential Equations. Our primary objective is to discuss those aspects of bifurcation theory which are particularly meaningful to differential equations. To accomplish this objective and to make the book accessible to a wider audience, we have presented in detail much of the relevant background material, in particular the material on bifurcation theory and the qualitative theory of differential equations. Since there is no good reference for some of the material presented in this book, its inclusion seemed necessary. Two distinct aspects of bifurcation theory are discussed in this paper. Static bifurcation theory is concerned with the changes that occur in the structure of the set of zeros of a function as parameters in the function are varied. If the function is a gradient, then variational techniques play an important role and can be employed effectively even for global problems. If the function is not a gradient or if more detailed information is desired, the general theory is usually local. At the same time, the theory is constructive and valid when several independent parameters appear in the function. In differential equations, the equilibrium solutions are the zeros of the vector field. Therefore, methods in static bifurcation theory are directly applicable.

Quantitative Models for Microscopic to Macroscopic Biological Macromolecules and Tissues

Hopf Bifurcation Analysis This updated edition of a widely admired text provides a user-friendly introduction to the field that requires only routine mathematics. The book starts with the elements of fluid mechanics and heat transfer, and covers a wide range of applications from fibrous insulation and catalytic reactors to geological strata, nuclear waste disposal, geothermal reservoirs, and the storage of heat-generating materials. As the standard reference in the field, this book will be essential to researchers and practicing engineers, while remaining an accessible introduction for graduate students and others entering the field. The new edition features 2700 new references covering a number of rapidly expanding fields, including the heat transfer properties of nanofluids and applications involving local thermal non-equilibrium and microfluidic effects.
Spatial Dynamics and Pattern Formation in Biological Populations This book contains papers presented at the 14th European Symposium on Computer Aided Process Engineering (ESCAPE-14). The ESCAPE symposia bring together scientists, students and engineers from academia and industry, who are active in the research and application of Computer Aided Process Engineering. The objective of ESCAPE-14 is to highlight the use of computers and information technology tools on five specific themes: 1. Product and Process Design, 2. Synthesis and Process Integration, 3. Process Control and Analysis, 4. Manufacturing & Process Operations, 5. New Challenges in CAPE. - Provides this year’s comprehensive overview of the current state of affairs in the CAPE community - Contains reports from the frontiers of science by the field’s most respected scientists - Special Keynote by Professor Roger Sargent, Long Term Achievement CAPE Award winner

SIAM Journal on Scientific Computing This book presents cutting-edge research on the use of physical and mathematical formalisms to model and quantitatively analyze biological phenomena ranging from microscopic to macroscopic systems. The systems discussed in this compilation cover protein folding pathways, gene regulation in prostate cancer, quorum sensing in bacteria to mathematical and physical descriptions to analyze anomalous diffusion in patchy environments and the physical mechanisms that drive active motion in large sets of particles, both fundamental descriptions that can be applied to different phenomena in biology. All chapters are written by well-known experts on their respective research fields with a vast amount of scientific discussion and references in order the interested reader can pursue a further reading. Given these features, we consider Quantitative Models for Microscopic to Macroscopic Biological Macromolecules and Tissues as an excellent and up-to-date resource and reference for advanced undergraduate students, graduate students and junior researchers interested in the latest developments at the intersection of physics, mathematics, molecular biology, and computational sciences. Such research field, without hesitation, is one of the most interesting, challenging and active of this century and the next.

European Symposium on Computer-Aided Process Engineering-15 In a reactive distillation column, both the chemical conversion and the distillative separation of the product mixture are carried out simultaneously. Through this integrative strategy, chemical equilibrium limitations can be overcome, higher selectivities can be achieved and heat of reaction can be directly used for distillation. Increased process efficiency and reduction of investments and operational costs are the direct results of this approach. Highly renowned international experts from both industry and academia review the state-of-the-art and the future directions in application, design, analysis and control of Reactive Distillation processes. Part I surveys various industrial applications and covers both established large scale processes as well as new chemical reaction schemes with high future potential. Part II provides the vital details for analysis of reactive phase equilibria, and discusses the importance of chemical reaction kinetics, while Part III focuses on identifying feasible column configurations and designing their internal structure. Analysis and control of the complex dynamic and steady-state behavior of reactive distillation processes are described in Part IV. Reactive Distillation - a very promising alternative to conventional reaction-distillation flow schemes.

Computational Science — ICCS 2004 Eurosymposium Computer Aided Process Engineering Computational Science -- ICCS 2005 The two-volume set LNCS 11973 and 11974 constitute revised selected papers from the Third International Conference on Numerical Computations: Theory and Algorithms, NUMTA 2019, held in Crotone, Italy, in June 2019. This volume, LNCS 11974, consists of 19 full and 32 short papers chosen among regular papers presented at the the Conference including also the paper of the winner (Lorenzo Fiaschi, Pisa, Italy) of The Springer Young Researcher Prize for the best NUMTA 2019 presentation made by a young scientist. The papers in part II explore the advanced research developments in such interconnected fields as local and global optimization, machine learning, approximation, and differential equations. A special focus is given to advanced ideas related to methods and applications using emerging computational paradigms.

Nonlinear Dynamics of Production Systems Methods of Bifurcation Theory Computational Science - ICCS This book provides an introduction to the analysis and control of Linear Parameter-Varying Systems and Time-Delay Systems and their interactions. The purpose is to give the readers some fundamental theoretical background on these topics and to give more insights on the possible applications of these theories. This self-contained monograph is written in an accessible way for readers ranging from undergraduate/PhD students to engineers and researchers willing to know more about the fields of time-delay systems, parameter-varying systems, robust analysis, robust control, gain-scheduling techniques in the LPV fashion and LMI based approaches. The only prerequisites are basic knowledge in linear algebra, ordinary differential equations and (linear) dynamical systems. Most of the results are proved unless the proof is too complex or not necessary for a good understanding of the results. In the latter cases, suitable references are systematically provided. The first part pertains on the representation, analysis and control of LPV systems along with a reminder on robust analysis and control techniques. The second part is concerned with the representation and analysis of time-delay systems using various time-domain techniques. The third and last part is devoted to the representation, analysis, observation, filtering and control of LPV time-delay systems. The book also presents many important basic and advanced results on the manipulation of LMIs.
Progress in Industrial Mathematics at ECMI 2004 ECMI has a brand name in Industrial Mathematics and organises successful biannual conferences. This time, the conference on Industrial Mathematics held in Eindhoven in June 2004 Mathematics focused on Aerospace, Electronic Industry, Chemical Technology, Life Sciences, Materials, Geophysics, Financial Mathematics and Water flow. The majority of the invited talks on these topics can be found in these proceedings. Apart from these lectures, a large number of contributed papers and minisymposium papers are included here. They give an interesting (and impressive) overview of the important place mathematics has achieved in solving all kinds of problems met in industry, and commerce in particular.

Hopf Bifurcation Analysis Combustion Thermodynamics and Dynamics builds on a foundation of thermal science, chemistry, and applied mathematics that will be familiar to most undergraduate aerospace, mechanical, and chemical engineers to give a first-year graduate-level exposition of the thermodynamics, physical chemistry, and dynamics of advection-reaction-diffusion. Special effort is made to link notions of time-independent classical thermodynamics with time-dependent reactive fluid dynamics. In particular, concepts of classical thermochemical equilibrium and stability are discussed in the context of modern nonlinear dynamical systems theory. The first half focuses on time-dependent spatially homogeneous reaction, while the second half considers effects of spatially inhomogeneous advection and diffusion on the reaction dynamics. Attention is focused on systems with realistic detailed chemical kinetics as well as simplified kinetics. Many mathematical details are presented, and several quantitative examples given. Topics include foundations of thermochemistry, reduced kinetics, reactive Navier-Stokes equations, reaction-diffusion systems, laminar flame, oscillatory combustion, and detonation.

Numerical Continuation Methods for Dynamical Systems

European Symposium on Computer Aided Process Engineering - 14 The conference on BIFURCATIONS: ANALYSIS, ALGORITHMS, APPLICATIONS took place in Dortmund in August 18 - 22, 1986. More than 150 Scientists from 16 countries participated in the meeting, among them mathematicians, engineers, and physicists. A broad spectrum of new results on bifurcation was covered by 49 talks. The diversity of the range of treated topics and of involved fields inspired fruitful discussions. 36 refereed papers are contained in these proceedings. The subjects covered treat bifurcation problems, ranging from theoretical investigations to numerical results, with emphasis placed upon applications. The more theoretical cal papers include the topics symmetry breaking, delay differential equations, Cornu spirals, homoclinic orbits, and self-similarity. Different kinds of bifurcations are treated: Hopf bifurcation, bifurcation from continuous spectrum, complex bifurcation, and bifurcation near tori. Several numerical as pects are discussed, among them continuation, block elimination, and spectral methods. Algorithms are proposed for approximating manifolds, calculating per iodic solutions and handling multi-parameter problems. Ample space is devoted to applications. Classical phenomena from fluid mechanics (such as convection rolls and the Taylor vortex problem), buckling, and reaction-diffusion pro blems are considered. Other applications of bifurcations include railway vehicle dynamics, computer graphics, semiconductors, drilling processes, simulation of oil reservoirs, and rotor dynamics. The proceedings reflect current research in bifurcation. They are an attempt to bring together researchers from different disciplines to stimulating common effort towards a better understanding and handling of bifurcation problems.

Practical Bifurcation and Stability Analysis

Mathematical Physiology This book is devoted to the frequency domain approach, for both regular and degenerate Hopf bifurcation analyses. Besides showing that the time and frequency domain approaches are in fact equivalent, the fact that many significant results and computational formulas obtained in the studies of regular and degenerate Hopf bifurcations from the time domain approach can be translated and reformulated into the corresponding frequency domain setting, and be reconﬁrmed and rediscovered by using the frequency domain methods, is also explained. The description of how the frequency domain approach can be used to obtain several types of standard bifurcation conditions for general nonlinear dynamical systems is given as well as is demonstrated a very rich pictorial gallery of local bifurcation diagrams for nonlinear systems under simultaneous variations of several system parameters. In conjunction with this graphical analysis of local bifurcation diagrams, the deﬁning and nondegeneracy conditions for several degenerate Hopf bifurcations is presented. With a great deal of algebraic computation, some higher-order harmonic balance approximation formulas are derived, for analyzing the dynamical behavior in small neighborhoods of certain types of degenerate Hopf bifurcations that involve multiple limit cycles and multiple limit points of periodic solutions. In addition, applications in chemical, mechanical and electrical engineering as well as in biology are discussed. This book is designed and written in a style of research monographs rather than classroom textbooks, so that the most recent contributions to the ﬁeld can be included with references. Contents: Introduction The Hopf Bifurcation TheoremContinuation of Bifurcation Curves on the Parameter PlaneDegenerate Bifurcations in the Space of System ParametersHigh-Order Hopf Bifurcation FormulasHopf Bifurcation in Nonlinear Systems with Time DelaysBirth of Multiple Limit CyclesAppendixReferencesArthur IndexSubject Index Readership: Nonlinear scientists, applied mathematicians, and systems engineers. keywords:Bifurcation;Harmonic Balance Approximation;Graphical Hopf Bifurcation;Degenerate Hopf Bifurcation;High-Order Hopf Bifurcation;Multiple Limit Cycles;Hopf;Frequency;Harmonic Balance;Feedback;Oscillations;Nonlinear;Delay;Limit Cycles;Degenerate Bifurcations

Computational Flame Diagnostics with Bifurcation Analysis and Chemical Explosive Mode Analysis Covers the determination of complex reaction mechanisms in chemistry, chemical engineering, biochemistry, biology, biotechnology, and genomics. Topics covered include the pulse method, correlation functions, genetic algorithms, general theory of response methods, prescriptions for oscillatory reactions, and more.

Numerical Methods for Bifurcations of Dynamical Equilibria Small scale features and processes occurring at nanometer and femtosecond scales have a profound impact on what happens at a larger scale and over an extensive period of time. The primary objective of this volume is to reflect the state-of-the-art in multiscale mathematics, modeling, and simulations and to address the following barriers: What is the information that needs to be transferred from one model or scale to another and what physical principles must be satisfied during the transfer of information? What are the optimal ways to achieve such transfer of information?
How can variability of physical parameters at multiple scales be quantified and how can it be accounted for to ensure design robustness? The multiscale approaches in space and time presented in this volume are grouped into two main categories: information-passing and concurrent. In the concurrent approaches various scales are simultaneously resolved, whereas in the information-passing methods the fine scale is modeled and its gross response is infused into the continuum scale. The issue of reliability of multiscale modeling and simulation tools which focus on a hierarchy of multiscale models and an a posteriori model error estimation including uncertainty quantification, is discussed in several chapters. Component software that can be effectively combined to address a wide range of multiscale simulations is also described. Applications range from advanced materials to nanoelectromechanical systems (NEMS), biological systems, and nanoporous catalysts where physical phenomena operates across 12 orders of magnitude in time scales and 10 orders of magnitude in spatial scales. This volume is a valuable reference book for scientists, engineers and graduate students practicing in traditional engineering and science disciplines as well as in emerging fields of nanotechnology, biotechnology, microelectronics and energy.

Dynamical systems arise in all fields of applied mathematics. The author focuses on the description of numerical methods for the detection, computation, and continuation of equilibria and bifurcation points of equilibria of dynamical systems. This subfield has the particular attraction of having links with the geometric theory of differential equations, numerical analysis, and linear algebra.

Software for Exascale Computing - SPPEXA 2016-2019 This monograph is the first to provide readers with numerical tools for a systematic analysis of bifurcation problems in reaction-diffusion equations. Many examples and figures illustrate analysis of bifurcation scenario and implementation of numerical schemes. Readers will gain a thorough understanding of numerical bifurcation analysis and the necessary tools for investigating nonlinear phenomena in reaction-diffusion equations.

Determination of Complex Reaction Mechanisms

Numerical Methods for Bifurcation Problems and Large-Scale Dynamical Systems Self-Propagating High-Temperature Synthesis of Materials is a collection of papers that reflects modern trends in self-propagating, high-temperature synthesis (SHS), a process for synthesis of modern materials carried out in the mode of autowave solid-flame combustion. To date, SHS-produced materials have found their application in different branches of modern science and technology, mechanical engineering, ferrous and nonferrous metallurgy, aerospace engineering, chemical industry, electrical engineering, and electronics. This book is useful not only for the SHS community, but also for researchers and engineers who are active in the following related fields of knowledge: theory and practice of combustion, materials science and technology, pure and applied chemistry, and metallurgy.

Numerical Computation: Theory and Algorithms Combines a systematic analysis of bifurcations of iterated maps with concrete MATLAB® implementations and applications.

Multiscale Methods Path following in combination with boundary value problem solvers has emerged as a continuing and strong influence in the development of dynamical systems theory and its application. It is widely acknowledged that the software package AUTO - developed by Eusebius J. Doedel about thirty years ago and further expanded and developed ever since - plays a central role in the brief history of numerical continuation. This book has been compiled on the occasion of Sebius Doedel's 60th birthday. Bringing together for the first time a large amount of material in a single, accessible source, it is hoped that the book will become the natural entry point for researchers in diverse disciplines who wish to learn what numerical continuation techniques can achieve. The book opens with a foreword by Herbert B. Keller and lecture notes by Sebius Doedel himself that introduce the basic concepts of numerical bifurcation analysis. The other chapters by leading experts discuss continuation for various types of systems and objects and showcase examples of how numerical bifurcation analysis can be used in concrete applications. Topics that are treated include: interactive continuation tools, higher-dimensional continuation, the computation of invariant manifolds, and continuation techniques for slow-fast systems, for symmetric Hamiltonian systems, for spatially extended systems and for systems with delay. Three chapters review physical applications: the dynamics of a SQUID, global bifurcations in laser systems, and dynamics and bifurcations in electronic circuits.

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Page 6/6