

# NONLINEAR PHENOMENA IN POWER ELECTRONICS

ATTRACTORS, BIFURCATIONS,  
CHAOS, AND NONLINEAR  
CONTROL

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# Nonlinear Phenomena In Power Electronicsattractorsbifurcationschaosand Nonlinear Control

**Charles W. Wang**

## **Nonlinear Phenomena In Power Electronicsattractorsbifurcationschaosand Nonlinear Control:**

*Nonlinear Phenomena in Power Electronics* Soumitro Banerjee,2001      [Bifurcations And Chaos In Piecewise-smooth Dynamical Systems: Applications To Power Converters, Relay And Pulse-width Modulated Control Systems, And Human Decision-making Behavior](#) Zhanybai T Zhusubaliyev,Erik Mosekilde,2003-06-25 Technical problems often lead to differential equations with piecewise smooth right hand sides Problems in mechanical engineering for instance violate the requirements of smoothness if they involve collisions finite clearances or stick slip phenomena Systems of this type can display a large variety of complicated bifurcation scenarios that still lack a detailed description This book presents some of the fascinating new phenomena that one can observe in piecewise smooth dynamical systems The practical significance of these phenomena is demonstrated through a series of well documented and realistic applications to switching power converters relay systems and different types of pulse width modulated control systems Other examples are derived from mechanical engineering digital electronics and economic business cycle theory The topics considered in the book include abrupt transitions associated with modified period doubling saddle node and Hopf bifurcations the interplay between classical bifurcations and border collision bifurcations truncated bifurcation scenarios period tripling and quadrupling bifurcations multiple choice bifurcations new types of direct transitions to chaos and torus destruction in nonsmooth systems In spite of its orientation towards engineering problems the book addresses theoretical and numerical problems in sufficient detail to be of interest to nonlinear scientists in general

**Chaos in Circuits and Systems** Guanrong Chen,Tetsushi Ueta,2002 In this volume leading experts present current achievements in the forefront of research in the challenging field of chaos in circuits and systems with emphasis on engineering perspectives methodologies circuitry design techniques and potential applications of chaos and bifurcation A combination of overview tutorial and technical articles the book describes state of the art research on significant problems in this field It is suitable for readers ranging from graduate students university professors laboratory researchers and industrial practitioners to applied mathematicians and physicists in electrical electronic mechanical physical chemical and biomedical engineering and science

**Nonlinear Dynamical Systems with Self-Excited and Hidden Attractors** Viet-Thanh Pham,Sundarapandian Vaidyanathan,Christos Volos,Tomasz Kapitaniak,2018-02-26 This book highlights the latest findings on nonlinear dynamical systems including two types of attractors self excited and hidden attractors Further it presents both theoretical and practical approaches to investigating nonlinear dynamical systems with self excited and hidden attractors The book includes 20 chapters contributed by respected experts which focus on various applications such as biological systems memristor based systems fractional order systems finance systems business cycles oscillators coupled systems hyperchaotic systems flexible robot manipulators electronic circuits and control models Special attention is given to modeling design circuit realization and practical applications to address recent research problems in nonlinear dynamical systems The book provides a valuable reference guide to nonlinear dynamical systems for engineers

researchers and graduate students especially those whose work involves mechanics electrical engineering and control systems **Study of Nonlinear Phenomena in Power Electronic Circuits and Electric Motion Systems** Sen Li,2020 The power electronic circuits and electric motion systems are among the most representative types of dynamical systems which are ubiquitous in a variety of commercial products in modern industry Apart from the normal operation under certain parametric settings a range of complex dynamic behaviors can be observed in these systems This dissertation presents the comprehensive investigation of bifurcations and chaos in the electronic power electronic circuits and motor drive systems including Chua's circuit switched mode DC DC power converters and the switched reluctance motor SRM drive employing digital speed regulator and hysteresis current controller By conducting the mathematical modelling stability analysis simulation and experimental tests including the time domain and frequency domain analyses phase portraits and bifurcation diagrams the characteristics and mechanisms of the nonlinear behaviors in these systems have been uncovered The presented study can provide scholars and engineers with critical insight to the nonlinear dynamics within the electronic power electronic circuits and electric motion systems and also serve as a valuable reference for practical design of these systems

**Dynamics, Bifurcations and Control** Fritz Colonius,Lars Grüne,2002-01-11 This volume originates from the Third Nonlinear Control Workshop namics Bifurcations and Control held in Kloster Irsee April 1-3 2001 As the preceding workshops held in Paris 2000 and in Ghent 1999 it was organized within the framework of Nonlinear Control Network funded by the European Union <http://www.supelec.fr/lss/NCN> The papers in this volume center around those control problems where phenomena and methods from dynamical systems theory play a dominant role Despite the large variety of techniques and methods present in the contributions a rough subdivision can be given into three areas Bifurcation problems stabilization and robustness and global dynamics of control systems A large part of the fascination in nonlinear control stems from the fact that it is deeply rooted in engineering and mathematics alike The contributions to this volume reflect this double nature of nonlinear control We would like to take this opportunity to thank all the contributors and the referees for their careful work Furthermore it is our pleasure to thank Franchise Lamnabhi Lagarrigue the coordinator of our network for her support in organizing the workshop and the proceedings and for the tremendous efforts she puts into this network bringing the cooperation between the different groups to a new level In particular the exchange and the active participation of young scientists also reflected in the Pedagogical Schools within the Network is an asset for the field of nonlinear control

**Control Of Chaos In Nonlinear Circuits And Systems** Bingo Wing-kuen Ling,Herbert Ho-ching Iu,Hak-keung Lam,2008-12-22 In this book leading researchers present their current work in the challenging area of chaos control in nonlinear circuits and systems with emphasis on practical methodologies system design techniques and applications A combination of overview tutorial and technical articles the book describes state of the art research on significant problems in this area The scope and aim of this book are to bridge the gap between chaos control methods and circuits and systems It is

an ideal starting point for anyone who needs a fundamental understanding of controlling chaos in nonlinear circuits and systems [New Trends in Nonlinear Control Theory](#) J. Descusse, Michel Fliess, A. Isidori, D. Leborgne, 1989-06-16 This conference on nonlinear control theory was organized within a special Nonlinear Year of the French Centre National de la Recherche Scientifique This volume is a collection of invited papers giving an overview of new trends in research all over the world It was the aim of the editors to bring together theoretical contributions by pure mathematicians and more applied communications dedicated to robotics electrical engines biology and computer science **Time-Delayed Chaotic**

**Dynamical Systems** Tanmoy Banerjee, Debabrata Biswas, 2017-12-06 This book describes systematic design techniques for chaotic and hyperchaotic systems the transition from one to the other and their implementation in electronic circuits It also discusses the collective phenomena manifested by these systems when connected by a physical coupling scheme Readers will be introduced to collective behaviours such as synchronization and oscillation suppression and will learn how to implement nonlinear differential equations in electronic circuits Further the book shows how the choice of nonlinearity can lead to chaos and hyperchaos even in a first order time delayed system The occurrence of these phenomena together with the efficiency of the design techniques described is presented with theoretical studies numerical characterization and experimental demonstrations with the corresponding electronic circuits helping readers grasp the design aspects of dynamical systems as a whole in electronic circuits The authors then discuss the usefulness of an active all pass filter as the delay element supported by their own experimental observations as well as theoretical and numerical results Including detailed analysis as well as computations with suitable dedicated software packages the book will be of interest to all academics and researchers who wish to expand their knowledge of the subtlety of nonlinear time delayed systems It also offers a valuable source of information for engineers linking the design techniques of chaotic time delayed systems with their collective phenomena

**Nonlinear Dynamics of Electronic Systems** Valeri M. Mladenov, Plamen Ch. Ivanov, 2014-06-30 This book constitutes the refereed proceedings of the 22nd International Conference on Nonlinear Dynamics of Electronic Systems NDES 2014 held in Albena Bulgaria in July 2014 The 47 revised full papers presented were carefully reviewed and selected from 65 submissions The papers are organized in topical sections on nonlinear oscillators circuits and electronic systems networks and nonlinear dynamics and nonlinear phenomena in biological and physiological systems **Nonlinear Circuits and**

**Systems with Memristors** Fernando Corinto, Mauro Forti, Leon O. Chua, 2020-10-31 This book presents a new approach to the study of physical nonlinear circuits and advanced computing architectures with memristor devices Such a unified approach to memristor theory has never been systematically presented in book form After giving an introduction on memristor based nonlinear dynamical circuits e g periodic chaotic oscillators and their use as basic computing analogue elements the authors delve into the nonlinear dynamical properties of circuits and systems with memristors and present the flux charge analysis a novel method for analyzing the nonlinear dynamics starting from writing Kirchhoff laws and

constitutive relations of memristor circuit elements in the flux charge domain This analysis method reveals new peculiar and intriguing nonlinear phenomena in memristor circuits such as the coexistence of different nonlinear dynamical behaviors extreme multistability and bifurcations without parameters The book also describes how arrays of memristor based nonlinear oscillators and locally coupled neural networks can be applied in the field of analog computing architectures for example for pattern recognition The book will be of interest to scientists and engineers involved in the conceptual design of physical memristor devices and systems mathematical and circuit models of physical processes circuits and networks design system engineering or data processing and system analysis Dynamics of Nonlinear Time-Delay Systems Muthusamy Lakshmanan,Dharmapuri Vijayan Senthilkumar,2011-01-04 Synchronization of chaotic systems a patently nonlinear phenomenon has emerged as a highly active interdisciplinary research topic at the interface of physics biology applied mathematics and engineering sciences In this connection time delay systems described by delay differential equations have developed as particularly suitable tools for modeling specific dynamical systems Indeed time delay is ubiquitous in many physical systems for example due to finite switching speeds of amplifiers in electronic circuits finite lengths of vehicles in traffic flows finite signal propagation times in biological networks and circuits and quite generally whenever memory effects are relevant This monograph presents the basics of chaotic time delay systems and their synchronization with an emphasis on the effects of time delay feedback which give rise to new collective dynamics Special attention is devoted to scalar chaotic hyperchaotic time delay systems and some higher order models occurring in different branches of science and technology as well as to the synchronization of their coupled versions Last but not least the presentation as a whole strives for a balance between the necessary mathematical description of the basics and the detailed presentation of real world applications

New Trends in Nonlinear Dynamics and Control, and their Applications Wei Kang,Mingqing Xiao,Carlos Borges,2003-09-16 A selection of papers exploring a wide spectrum of new trends in nonlinear dynamics and control such as bifurcation control state estimation and reconstruction analysis of behavior and stabilities dynamics of nonlinear neural network models and numerical algorithms The papers focus on new ideas and the latest developments in both theoretical and applied research topics of nonlinear control Because many of the authors are leading researchers in their own fields the papers presented in this volume reflect the state of the art in the areas of nonlinear dynamics and control Many of the papers in this volume were first presented at the highly successful Symposium on New Trends in Nonlinear Dynamics and Control and Their Applications held October 18 19 2002 in Monterey California **Nonlinear Dynamics, Chaos, Control, Energy Transfer and Their Applications in Engineering Sciences** Jose Manoel Balthazar,Paulo Batista Gonçalves,Angelo Marcelo Tusset,Grzegorz Litak,Julijana Simonovic,2025-08-23 The book gathers review papers in emergent engineering applications and new horizons in nonlinear dynamics and originates from DYCAELS 2023 the IV Conference on Dynamics Control and Applications to Applied Engineering and Life Science which was held in Ponta Grossa Brazil on November 6 11

2023 The contributions cover diverse topics such as linear and nonlinear control vibro impact systems energy harvesting robotics bioengineering flexible structures non ideal excitation aeroelastic instabilities new materials synchronization stochastic dynamics multistable systems nonstationary dynamics and different time scales wave propagation chaotic dynamics and mechanisms and machine science

### **Dynamical Chaos, Models And Experiments: Appearance Routes**

**And Stru Of Chaos In Simple Dyna Systems** Vadim S Anishchenko,1995-09-19 In this book bifurcational mechanisms of the development structure and properties of chaotic attractors are investigated by numerical and physical experiments based on the methods of the modern theory of nonlinear oscillations The typical bifurcations of regular and chaotic attractors which are due to parameter variations are analyzed Regularities of the transition to chaos via the collapse of quasiperiodic oscillations with two and three frequencies are investigated in detail The book deals with the problems of chaotic synchronization interaction of attractors and the phenomenon of stochastic resonance The problems of fluctuation influence on the bifurcations and properties of chaotic attractors are investigated more closely All principal problems are investigated by the comparison of theoretical and numerical results and data from physical experiments

### **Bifurcation Phenomena in**

**Power System - Subsynchronous Resonance** Majdi Alomari,2012-05 A bifurcation theory is applied to multimachine power system to investigate the complex dynamics of the system The second system of the IEEE second benchmark model of Subsynchronous Resonance SSR is considered The system can be mathematically modeled as a set of first order nonlinear ordinary differential equations with the compensation factor as a bifurcation control parameter Therefore bifurcation theory can be applied to nonlinear dynamical systems Initially the system is modeled as a set of first order nonlinear ordinary differential equations with the compensation factor as a bifurcation parameter The effect of machine components i e damper winding Automatic Voltage Regulator AVR and Power System Stabilizer PSS and machine saturation are considered Linear and nonlinear controllers are used to control the Hopf bifurcation and chaos utilizing bifurcation theory and center manifold theory Furthermore Flexible AC Transmission System FACTS controllers such as the Thyristor Controlled Series Capacitor TCSC the Static Synchronous Series Compensator SSSC and the Static Compensator STATCOM are used to control bifurcations of SSR in the considered system

### **Nonlinear Phenomena Research Perspectives** Charles W. Wang,2007

Non linear or chaotic behaviour in real world systems has been reported in electronic circuits and communications systems chemical reactions biological behaviour Applications include solitons integrable systems cellular automata pattern formation qualitative structure and bifurcation theory onset of chaos and turbulence analytic dynamics and transport phenomena This book presents important new research in this dynamic field

### **Nonlinear Wave Methods for Charge Transport** Luis L.

Bonilla,Stephen W. Teitsworth,2009-12-09 The present book introduces and develops mathematical techniques for the treatment of nonlinear waves and singular perturbation methods at a level that is suitable for graduate students researchers and faculty throughout the natural sciences and engineering The practice of implementing these techniques and their value

are largely realized by showing their application to problems of nonlinear wave phenomena in electronic transport in solid state materials especially bulk semiconductors and semiconductor superlattices The authors are recognized leaders in this field with more than 30 combined years of contributions *Nonlinearity, Bifurcation and Chaos* Jan Awrejcewicz, Peter Hagedorn, 2012-10-24 Nonlinearity Bifurcation and Chaos Theory and Application is an edited book focused on introducing both theoretical and application oriented approaches in science and engineering It contains 12 chapters and is recommended for university teachers scientists researchers engineers as well as graduate and post graduate students either working or interested in the field of nonlinearity bifurcation and chaos *Nonlinear Evolution and Chaotic Phenomena* Giovanni Gallavotti, Paul F. Zweifel, 2012-12-06 This volume represents the proceedings of a NATO Advanced Study Institute held at Noto Sicily June 8 19 1987 The director was Giovanni Gallavotti Roma with co directors Marcello Anile Catania and P F Zweifel Virginia Tech Other members of the scientific organizing committee included Mitchell Feigenbaum Rockefeller University and David Ruelle IHES The attendance at the school consisted of 23 invited speakers and approximately 80 students the term student being in quotation marks because many of them were of post doctoral or even professorial status although there were also a goodly number of actual graduate students in attendance also Because of the disparate background of these students it was felt advisable to include at the conference special tutorials each afternoon in which the contents of the morning's lectures were reviewed and clarified as necessary These tutorials organized by Gallavotti involved various of the speakers organizers and other senior members of the school and contributed in no little way to the overall success of the school The organizers of the school would like to take this opportunity to thank all of those who assisted in these sessions and to assure them that the results were definitely worth the effort Also contributing to the success of the school were a number of contributed papers presented during the course of the afternoon tutorials Three of those papers are included in these proceedings they are the papers of DiFrancesco Gallimbeni Miari and Sertorio presented by Sertorio and Vittot

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