Dynamical Systems Stability Symbolic Dynamics And Chaos Studies In Advanced Mathematics

Dynamics, Games and Science I and II are a selection of surveys and research articles written by leading researchers in mathematics. The majority of the contributions are on dynamical systems and game theory, focusing either on fundamental and theoretical developments or on applications to modeling in biology, ecomonics, engineering, finances and psychology. The papers are based on talks given at the International Conference DYNA 2008, held in honor of Mauricio Peixoto and David Rand at the University of Braga, Portugal, on September 8-12, 2008. The aim of these volumes is to present cutting-edge research in these areas to encourage graduate students and researchers in mathematics and other fields to develop them further.

A dynamical system is a continuous self-map of a compact metric space. Topological dynamics studies the iterations of such a map, or equivalently, the trajectories of points of the state space. The basic concepts of topological dynamics are minimality, transitivity, recurrence, shadowing property, stability, equicontinuity, sensitivity, attractors, and topological entropy. Symbolic dynamics studies dynamical systems whose state spaces are zero-dimensional and consist of sequences of symbols. The main classes of symbolic dynamical systems are adding machines, subshifts of finite type, sofic subshifts, Sturmian, substitutive and Toeplitz subshifts, and cellular automata.

This volume presents a broad collection of current research by leading experts in the theory of dynamical systems.

Hirsch, Devaney, and Smale's classic Differential Equations,

Dynamical Systems, and an Introduction to Chaos has been used by professors as the primary text for undergraduate and graduate level courses covering differential equations. It provides a theoretical approach to dynamical systems and chaos written for a diverse student population among the fields of mathematics, science, and engineering. Prominent experts provide everything students need to know about dynamical systems as students seek to develop sufficient mathematical skills to analyze the types of differential equations that arise in their area of study. The authors provide rigorous exercises and examples clearly and easily by slowly introducing linear systems of differential equations. Calculus is required as specialized advanced topics not usually found in elementary differential equations courses are included, such as exploring the world of discrete dynamical systems and describing chaotic systems. Classic text by three of the world's most prominent mathematicians Continues the tradition of expository excellence Contains updated material and expanded applications for use in applied studies
Printed Edition of the Special Issue Published in Entropy
Abstract A - simplicial dynamical system is a simplicial map $g:K^* \rightarrow K$ where K is a finite simplicial complex triangulating a compact polyhedron X and K^* is a proper subdivision of K, e.g. the barycentric or any further subdivision. The dynamics of the associated piecewise linear map $g: X X$ can be analyzed by using certain naturally related subshifts of finite type. Any continuous map on X can be C^0 approximated by such systems. Other examples yield interesting subshift constructions.
Dynamical SystemsStability, Symbolic Dynamics, and ChaosCRC Press
A self-contained comprehensive introduction to the mathematical theory of dynamical systems for students and researchers in mathematics, science and engineering.

Several distinctive aspects make Dynamical Systems unique, including: treating the subject from a mathematical perspective with the proofs of most of the results included providing a careful review of background materials introducing ideas through examples and at a level accessible to a beginning graduate student

This book provides a broad introduction to the subject of dynamical systems, suitable for a one- or two-semester graduate course. In the first chapter, the authors introduce over a dozen examples, and then use these examples throughout the book to motivate and clarify the development of the theory. Topics include topological dynamics, symbolic dynamics, ergodic theory, hyperbolic dynamics, one-dimensional dynamics, complex dynamics, and measure-theoretic entropy. The authors top off the presentation with some beautiful and remarkable applications of dynamical systems to such areas as number theory, data storage, and Internet search engines. This book grew out of lecture notes from the graduate dynamical systems course at the University of Maryland, College Park, and reflects not only the tastes of the authors, but also to some extent the collective opinion of the Dynamics Group at the University of Maryland, which includes experts in virtually every major area of dynamical systems.

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.

There is no recent elementary introduction to the theory of discrete dynamical systems that stresses the topological background of the topic. This book fills this gap: it deals with this theory as 'applied general topology'. We treat all important concepts needed to understand recent literature. The book is addressed primarily to graduate students. The prerequisites for understanding this book are modest: a certain mathematical maturity and course in General Topology are sufficient.

This book treats the theory of global attractors, a recent development in the theory of partial differential equations, in a way that also includes much of the traditional elements of the subject. As such it gives a quick but directed introduction to some fundamental concepts, and by the end proceeds to current research problems. Since the subject is relatively new, this is the first book to attempt to treat these various topics in a unified and didactic way. It is intended to be suitable for first year graduate students.

This introduction to applied nonlinear dynamics and chaos places emphasis on teaching the techniques and ideas that will enable students to take specific dynamical systems and obtain some quantitative information about their behavior. The new edition has been updated and extended throughout, and contains a detailed glossary of terms. From the reviews: "Will serve as one of the most eminent introductions to the geometric theory of dynamical systems." --Monatshefte für Mathematik

This volume constitutes the proceedings of the International Conference on Dynamical Systems in Honor of Prof. Liao

Shantao (1920–97). The Third World Academy of Sciences awarded the first ever mathematics prize in 1985 to Prof. Liao in recognition of his foundational work in differentiable dynamical systems and his work in periodic transformation of spheres. The conference was held in Beijing in August 1998. There were about 90 participants, and nearly 60 talks were delivered. The topics covered include differentiable dynamics, topological dynamics, hamiltonian dynamics, complex dynamics, ergodic and stochastic dynamics, and fractals theory. Dynamical systems is a field with many difficult problems, and techniques are being developed to deal with those problems. This volume contains original studies of great mathematical depth and presents some of the fascinating numerical experiments. Contents: The Dynamics of the Henon-Like Maps (Y-L Cao)Nonchaos for Substitution Minimal Systems (Q-J Fan et al.)A Note on the Obstruction Sets of Discrete Systems (S-B Gan)Topological Pressure of Continuous Flows Without Fixed Points (L-F He et al.)Nonlinearity, Quasisymmetry, Differentiability, and Rigidity in One-Dimensional Dynamics (Y-P Jiang)The Stability of the Equilibrium of Planar Hamiltonian Systems (B Liu)Existence and Uniqueness of Analytic Solutions of Iterative Functional Equations (J-H Mai & X-H Liu)On Bimodal Collet-Eckmann Maps (L-Y Wang)An Introduction to the C1 Connecting Lemma (L Wen)Partial Entropy, Bundle-Like Entropy and Topological Entropy (F-P Zeng)and other papers Readership: Research mathematicians and graduates in analysis and differential equations. Keywords:Dynamical Systems;Periodic Transformation;Topological Dynamics;Hamiltonian Dynamics;Complex Dynamics;Ergodic;Stochastic Dynamics;Fractals Theory;Henon-Like Maps;Fixed Points;Nonlinearity;Quasisymmetry;Planar Hamiltonian Systems;Analytic Solutions;Iterative Functional Equations;Partial Entropy;Bundle-Like Entropy;Topological

Entropy
There is an explosion of interest in dynamical systems in the mathematical community as well as in many areas of science. The results have been truly exciting: systems which once seemed completely intractable from an analytic point of view can now be understood in a geometric or qualitative sense rather easily. Scientists and engineers realize the power and the beauty of the geometric and qualitative techniques. These techniques apply to a number of important nonlinear problems ranging from physics and chemistry to ecology and economics. Computer graphics have allowed us to view the dynamical behavior geometrically. The appearance of incredibly beautiful and intricate objects such as the Mandelbrot set, the Julia set, and other fractals have really piqued interest in the field. This is text is aimed primarily at advanced undergraduate and beginning graduate students. Throughout, the author emphasizes the mathematical aspects of the theory of discrete dynamical systems, not the many and diverse applications of this theory. The field of dynamical systems and especially the study of chaotic systems has been hailed as one of the important breakthroughs in science in the past century and its importance continues to expand. There is no question that the field is becoming more and more important in a variety of scientific disciplines. New to this edition: •Greatly expanded coverage complex dynamics now in Chapter 2 •The third chapter is now devoted to higher dimensional dynamical systems. •Chapters 2 and 3 are independent of one another. •New exercises have been added throughout.

Chaos is the idea that a system will produce very different long-term behaviors when the initial conditions are perturbed only slightly. Chaos is used for novel, time- or energy-critical interdisciplinary applications. Examples include high-performance circuits and devices, liquid mixing, chemical reactions, biological systems, crisis management, secure information processing, and critical decision-making in politics, economics, as well as military applications, etc. This book presents the latest investigations in the theory of chaotic systems and their dynamics. The book covers some theoretical aspects of the subject arising in the study of both discrete and continuous-time chaotic dynamical systems. This book presents the state-of-the-art of the more advanced studies of chaotic dynamical systems.

Discontinuous dynamical systems have played an important role in both theory and applications during the last several decades. This is still an area of active research and techniques to make the applications more effective are an ongoing topic of interest. Principles of Discontinuous Dynamical Systems is devoted to the theory of differential equations with variable moments of impulses. It introduces a new strategy of implementing an equivalence to systems whose solutions have prescribed moments of impulses and utilizing special topologies in spaces of piecewise continuous functions. The achievements obtained on the basis of this approach are described in this book. The text progresses systematically, by covering preliminaries in the first four chapters. This is followed by more complex material and special topics such as Hopf bifurcation, Devaney's chaos, and the shadowing property are discussed in the last two chapters. This book is suitable for researchers and graduate students in mathematics and also in diverse areas such as biology, computer science, and engineering who deal with real world problems.

In this book the theory of hyperbolic sets is developed, both for diffeomorphisms and flows, with an emphasis on shadowing. We show that hyperbolic sets are expansive and have the shadowing property. Then we use shadowing to prove that hyperbolic sets are robust under perturbation, that they have an asymptotic phase property and also that the dynamics near a transversal homoclinic orbit is chaotic. It turns out that chaotic dynamical systems arising in practice are not quite hyperbolic. However, they possess enough hyperbolicity to enable us to use shadowing ideas to give computer-assisted proofs that computed orbits of such systems can be shadowed by true orbits for long periods of time, that they possess periodic orbits of long periods and that it is really true that they are chaotic. Audience: This book is intended primarily for research workers in dynamical systems but could also be used in an advanced graduate course taken by students familiar with calculus in Banach spaces and with the basic existence theory for ordinary differential equations.

This book provides a self-contained introduction to ordinary differential equations and dynamical systems suitable for beginning graduate students. The first part begins with some simple examples of explicitly solvable equations and a first glance at qualitative methods. Then the fundamental results concerning the initial value problem are proved: existence, uniqueness, extensibility, dependence on initial conditions. Furthermore, linear equations are considered, including the Floquet theorem, and some perturbation results. As somewhat independent topics, the Frobenius method for linear equations in the complex domain is established and Sturm-Liouville boundary value problems, including oscillation theory, are investigated. The second part introduces the concept of a dynamical system. The Poincare-Bendixson theorem is proved, and several examples of planar systems from classical mechanics, ecology, and electrical engineering are investigated. Moreover, attractors, Hamiltonian systems, the KAM theorem, and periodic solutions are discussed. Finally, stability is studied, including the stable manifold and the Hartman-Grobman theorem for both continuous and discrete systems. The third part introduces chaos, beginning with the basics for iterated interval maps and ending with the Smale-Birkhoff theorem and the Melnikov method for homoclinic orbits. The text contains almost three hundred exercises. Additionally, the use of mathematical software systems is incorporated throughout, showing how they can help in the study of differential equations.

These notes are the result of a course in dynamical systems given at Orsay during the 1976-77 academic year. I had given a similar course at the Gradu ate Center of the City University of New York the previous year and came to France equipped with the class notes of two of my students there, Carol Hurwitz and Michael Maller. My goal was to present Smale's n-Stability Theorem as completely and compactly as possible and in such a way that the students would have easy access to the literature. I was not confident that I could do all this in lectures in French, so I decided to distribute lecture notes. I wrote these notes in English and Remi Langevin translated them into French. His work involved much more than translation. He consistently corrected for style, clarity, and accuracy. Albert Fathi got involved in reading the manuscript. His role quickly expanded to extensive rewriting and writing. Fathi wrote (5. 1) and (5. 2) and rewrote Theorem 7. 8 when I was in despair of ever getting it right with all the details. He kept me honest at all points and played a large role in the final form of the manuscript. He also did the main work in getting the manuscript ready when I had left France and Langevin was unfortunately unavailable. I ran out of steam by the time it came to Chapter 10. M.

This volume contains selected contributions from a very successful meeting on Number Theory and Dynamical Systems held at the University of York in 1987. There are close and surprising connections between number theory and dynamical systems. One emerged last century from the study

of the stability of the solar system where problems of small divisors associated with the near resonance of planetary frequencies arose. Previously the question of the stability of the solar system was answered in more general terms by the celebrated KAM theorem, in which the relationship between near resonance (and so Diophantine approximation) and stability is of central importance. Other examples of the connections involve the work of Szemeredi and Furstenberg, and Sprindzuk. As well as containing results on the relationship between number theory and dynamical systems, the book also includes some more speculative and exploratory work which should stimulate interest in different approaches to old problems.
This book originated from an introductory lecture course on dynamical systems given by the author for advanced students in mathematics and physics at ETH Zurich. The first part centers around unstable and chaotic phenomena caused by the occurrence of homoclinic points. The existence of homoclinic points complicates the orbit structure considerably and gives rise to invariant hyperbolic sets nearby. The orbit structure in such sets is analyzed by means of the shadowing lemma, whose proof is based on the contraction principle. This lemma is also used to prove S. Smale's theorem about the embedding of Bernoulli systems near homoclinic orbits. The chaotic behavior is illustrated in the simple mechanical model of a periodically perturbed mathematical pendulum. The second part of the book is devoted to Hamiltonian systems. The Hamiltonian formalism is developed in the elegant language of the exterior calculus. The theorem of V. Arnold and R. Jost shows that the solutions of Hamiltonian systems which possess sufficiently many integrals of motion can be written down explicitly and for all times. The existence proofs of global periodic orbits of Hamiltonian systems on symplectic manifolds are based on a variational principle for

the old action functional of classical mechanics. The necessary tools from variational calculus are developed. There is an intimate relation between the periodic orbits of Hamiltonian systems and a class of symplectic invariants called symplectic capacities. From these symplectic invariants one derives surprising symplectic rigidity phenomena. This allows a first glimpse of the fast developing new field of symplectic topology.

This book comprises an impressive collection of problems that cover a variety of carefully selected topics on the core of the theory of dynamical systems. Aimed at the graduate/upper undergraduate level, the emphasis is on dynamical systems with discrete time. In addition to the basic theory, the topics include topological, low-dimensional, hyperbolic and symbolic dynamics, as well as basic ergodic theory. As in other areas of mathematics, one can gain the first working knowledge of a topic by solving selected problems. It is rare to find large collections of problems in an advanced field of study much less to discover accompanying detailed solutions. This text fills a gap and can be used as a strong companion to an analogous dynamical systems textbook such as the authors' own Dynamical Systems (Universitext, Springer) or another text designed for a one- or two-semester advanced undergraduate/graduate course. The book is also intended for independent study. Problems often begin with specific cases and then move on to general results, following a natural path of learning. They are also well-graded in terms of increasing the challenge to the reader. Anyone who works through the theory and problems in Part I will have acquired the background and techniques needed to do advanced studies in this area. Part II includes complete solutions to every problem given in Part I with each conveniently restated. Beyond basic prerequisites from linear algebra, differential and integral calculus, and complex analysis and topology, in each chapter the authors recall the notions and results (without proofs) that are necessary to treat the challenges set for that chapter, thus making the text self-contained.

The study of nonlinear dynamical systems has exploded in the past 25 years, and Robert L. Devaney has made these advanced research developments accessible to undergraduate and graduate mathematics students as well as researchers in other disciplines with the introduction of this widely praised book. In this second edition of his best-selling text, Devaney includes new material on the orbit diagram fro maps of the interval and the Mandelbrot set, as well as striking color photos illustrating both Julia and Mandelbrot sets. This book assumes no prior acquaintance with advanced mathematical topics such as measure theory, topology, and differential geometry. Assuming only a knowledge of calculus, Devaney introduces many of the basic concepts of modern dynamical systems theory and leads the reader to the point of current research in several areas.

This book describes a family of algorithms for studying the global structure of systems. By a finite covering of the phase space we construct a directed graph with vertices corresponding to cells of the covering and edges corresponding to admissible transitions. The method is used, among other things, to locate the periodic orbits and the chain recurrent set, to construct the attractors and their basins, to estimate the entropy, and more.

Arising from a graduate course taught to math and engineering students, this text provides a systematic grounding in the theory of Hamiltonian systems, as well as introducing the theory of integrals and reduction. A number of other topics are covered too.

A First Course in Chaotic Dynamical Systems: Theory and Experiment, Second Edition The long-anticipated revision of this well-liked textbook offers many new additions. In the twenty-five years since the original version of this book was published, much has happened in dynamical systems. Mandelbrot and Julia sets were barely ten years old when the first edition appeared, and most of the research involving these objects then centered around iterations of quadratic functions. This research has expanded to include all sorts of different types of functions, including higher-degree polynomials, rational maps, exponential and trigonometric functions, and many others. Several new sections in this edition are devoted to these topics. The area of dynamical systems covered in A First Course in Chaotic Dynamical Systems: Theory and Experiment, Second Edition is quite accessible to students and also offers a wide variety of interesting open questions for students at the undergraduate level to pursue. The only prerequisite for students is a one-year calculus course (no differential equations required); students will easily be exposed to many interesting areas of current research. This course can also serve as a bridge between the low-level, often non-rigorous calculus courses, and the more demanding higher-level mathematics courses. Features More extensive coverage of fractals, including objects like the Sierpinski carpet and others that appear as Julia sets in the later sections on complex dynamics, as well as an actual chaos "game." More detailed coverage of complex dynamical systems like the quadratic family and the exponential maps. New sections on other complex dynamical systems like rational maps. A number of new and expanded computer experiments for students to perform. About the Author Robert L. Devaney is currently professor of mathematics at Boston University. He received his PhD from the University of California at Berkeley under the direction of Stephen Smale. He taught at Northwestern University and Tufts University before coming to Boston University in 1980. His main area of research is dynamical systems, primarily complex analytic dynamics, but also including more general ideas about chaotic dynamical systems. Lately, he has become intrigued with the incredibly rich topological aspects of dynamics, including such things as indecomposable continua, Sierpinski curves, and Cantor bouquets.

Given the ease with which computers can do iteration it is now possible for almost anyone to generate beautiful images whose roots lie in discrete dynamical systems. Images of Mandelbrot and Julia sets abound in publications both mathematical and not. The mathematics behind the pictures are beautiful in their own right and are the subject of this text. Mathematica programs that illustrate the dynamics are included in an appendix.

This new text/reference is an excellent resource for the foundations and applications of control theory and nonlinear dynamics. All graduates, practitioners, and professionals in control theory, dynamical systems, perturbation theory, engineering, physics and nonlinear dynamics will find the book a rich source of ideas, methods and applications. With its careful use of examples and detailed development, it is suitable for use

as a self-study/reference guide for all scientists and engineers.
.".. an unabridged and corrected republication of the edition originally published in the 'Wiley Series in Nonlinear Science' by John Wiley & Sons, Inc., New York, in 1998"--Title page verso.
The book is concerned with the concepts of chaos and fractals, which are within the scopes of dynamical systems, geometry, measure theory, topology, and numerical analysis during the last several decades. It is revealed that a special kind of Poisson stable point, which we call an unpredictable point, gives rise to the existence of chaos in the quasi-minimal set. This is the first time in the literature that the description of chaos is initiated from a single motion. Chaos is now placed on the line of oscillations, and therefore, it is a subject of study in the framework of the theories of dynamical systems and differential equations, as in this book. The techniques introduced in the book make it possible to develop continuous and discrete dynamics which admit fractals as points of trajectories as well as orbits themselves. To provide strong arguments for the genericity of chaos in the real and abstract universe, the concept of abstract similarity is suggested.
The theory of dynamical systems is a major mathematical discipline closely intertwined with all main areas of mathematics. It has greatly stimulated research in many sciences and given rise to the vast new area variously called applied dynamics, nonlinear science, or chaos theory. This introduction for senior undergraduate and beginning graduate students of mathematics,

physics, and engineering combines mathematical rigor with copious examples of important applications. It covers the central topological and probabilistic notions in dynamics ranging from Newtonian mechanics to coding theory. Readers need not be familiar with manifolds or measure theory; the only prerequisite is a basic undergraduate analysis course. The authors begin by describing the wide array of scientific and mathematical questions that dynamics can address. They then use a progression of examples to present the concepts and tools for describing asymptotic behavior in dynamical systems, gradually increasing the level of complexity. The final chapters introduce modern developments and applications of dynamics. Subjects include contractions, logistic maps, equidistribution, symbolic dynamics, mechanics, hyperbolic dynamics, strange attractors, twist maps, and KAM-theory.

This handbook is volume II in a series collecting mathematical state-of-the-art surveys in the field of dynamical systems. Much of this field has developed from interactions with other areas of science, and this volume shows how concepts of dynamical systems further the understanding of mathematical issues that arise in applications. Although modeling issues are addressed, the central theme is the mathematically rigorous investigation of the resulting differential equations and their dynamic behavior. However, the authors and editors have made an effort to ensure readability on a non-technical level for mathematicians from other fields and for other scientists and engineers. The eighteen surveys collected here do not aspire to encyclopedic completeness, but present selected paradigms. The surveys are grouped into those emphasizing finite-dimensional methods, numerics, topological methods, and partial differential equations. Application areas include the dynamics of neural networks, fluid flows, nonlinear optics, and many others. While the survey articles can be read independently, they deeply share recurrent themes from dynamical systems. Attractors, bifurcations, center manifolds, dimension reduction, ergodicity, homoclinicity, hyperbolicity, invariant and inertial manifolds, normal forms, recurrence, shift dynamics, stability, to name just a few, are ubiquitous dynamical concepts throughout the articles.

Although, bifurcation theory of equations with autonomous and periodic time dependence is a major object of research in the study of dynamical systems since decades, the notion of a nonautonomous bifurcation is not yet established. In this book, two different approaches are developed which are based on special definitions of local attractivity and repulsivity. It is shown that these notions lead to nonautonomous Morse decompositions.

Phase transitions in disordered systems and related dynamical phenomena are a topic of intrinsically high interest in theoretical and experimental physics. This book presents a unified view, adopting concepts from each of the disjoint fields of disordered systems and nonlinear dynamics. Special attention is paid to the glass transition, from both experimental and theoretical viewpoints, to modern concepts of pattern formation, and to the application of the concepts of dynamical systems for understanding equilibrium and nonequilibrium properties of fluids and solids. The content is accessible to graduate students, but will also be of benefit to specialists, since the presentation extends as far as the topics of ongoing research work.

This book provides an introduction to the topological classification of smooth structurally stable diffeomorphisms on closed orientable 2- and 3-manifolds.The topological classification is one of the main problems of the theory of dynamical systems and the results presented in this book are mostly for dynamical systems satisfying Smale's Axiom A. The main results on the topological classification of discrete dynamical systems are widely scattered among many papers and surveys. This book presents these results fluidly, systematically, and for the first time in one publication. Additionally, this book discusses the recent results on the topological classification of Axiom A diffeomorphisms focusing on the nontrivial effects of the dynamical systems on 2- and 3-manifolds. The classical methods and approaches which are considered to be promising for the further research are also discussed.“br> The reader needs to be familiar with the basic concepts of the qualitative theory of dynamical systems which are presented in Part 1 for convenience. The book is accessible to ambitious undergraduates, graduates, and researchers in dynamical systems and low dimensional topology. This volume consists of 10 chapters; each chapter contains its own set of references and a section on further reading. Proofs are presented with the exact statements of the results. In Chapter 10 the authors briefly state the necessary definitions and results from algebra, geometry and topology. When stating ancillary results at the beginning of each part, the authors refer to other sources which are readily available.

This book is devoted to recent developments in symbolic dynamics, and it comprises eight chapters. The first two are concerned with the study of symbolic sequences of "low complexity," the following two introduce "high complexity" systems. Chapter five presents results on asymptotic laws for the random times of occurrence of rare events. Chapter six deals with diophantine problems and combinatorial Ramsey theory. Chapter seven looks at the dynamics of symbolic systems arising from numeration systems, and chapter eight gives a complete description of the symbolic dynamics of Lorenz maps.

An authoritative treatment by leading researchers covering theory and optimal estimation, along with practical applications.

This is a graduate text in differentiable dynamical systems. It focuses on structural stability and hyperbolicity, a topic that is central to the field. Starting with the basic concepts of dynamical systems, analyzing the historic systems of the Smale horseshoe, Anosov toral automorphisms, and the solenoid attractor, the book develops the hyperbolic theory first for hyperbolic fixed points and then for general hyperbolic sets. The problems of stable manifolds, structural stability, and shadowing property are investigated, which lead to a highlight of the book, the ?-stability theorem of Smale. While the content is rather standard, a key objective of the book is to present a thorough treatment for some tough material that has remained an obstacle to teaching and learning the subject matter. The treatment is straightforward and hence could be particularly suitable for self-study. Selected solutions are available electronically for instructors only. Please send email to textbooks@ams.org for more information.

This book gives a mathematical treatment of the introduction to qualitative differential equations and discrete dynamical systems. The treatment includes theoretical proofs, methods of calculation, and applications. The two parts of the book, continuous time of differential equations and discrete time of dynamical systems, can be covered independently in one semester each or combined together into a year long course. The material on differential equations introduces the qualitative or geometric approach through a treatment of linear systems in any dimension. There follows chapters where equilibria are the most important feature, where scalar (energy) functions is the principal tool, where periodic orbits appear, and finally, chaotic systems of differential equations. The many different approaches are systematically introduced through examples and theorems. The material on discrete dynamical systems starts with maps of one variable and proceeds to systems in higher dimensions. The treatment starts with examples where the periodic points can be found explicitly and then introduces symbolic dynamics to analyze where they can be shown to exist but not given in explicit form. Chaotic systems are presented both mathematically and more computationally using Lyapunov exponents. With the one-dimensional maps as models, the multidimensional maps cover the same material in higher dimensions. This higher dimensional material is less computational and more conceptual and theoretical. The final chapter on fractals introduces various dimensions which is another computational tool for measuring the complexity of a system. It also treats iterated function systems which give examples of complicated sets. In the second edition of the book, much of the material has been rewritten to clarify the presentation. Also, some new material has been included in both parts of the book. This book can be used as a textbook for an advanced undergraduate course on ordinary differential equations and/or dynamical systems. Prerequisites are standard courses in calculus (single variable and multivariable), linear algebra, and introductory differential equations.