Sprott, Julien Clinton

Chaos and time-series analysis. (English) Zbl 1012.37001
Oxford: Oxford University Press. xx, 507 p. (2003).

This is definitely one of the best new textbooks on chaos and nonlinear dynamics which introduces the subject at the advanced undergraduate/ intermediate graduate level. The author poses an ambitious goal to explain most important concepts and techniques of the modern theory of dynamical systems asking as a prerequisite only the elementary knowledge of calculus, and perfectly carries out the task. Although the book does not concentrate on mathematical background of the results and does not build on rigorous proofs, it clearly explains all necessary physical concepts and emphasizes important mathematical results and techniques. The author gives the reader an excellent opportunity to feel the flavor of nonlinear dynamics through the acquaintance with its numerous facets, and to choose the level and depth of mastering the subject by following the references suggested by the author in the text and exploring additional ones from the exhaustive bibliography. Although the book is easy to read, it discusses the concepts and methods which are far from being trivial, and thus constitutes a good source of information for undergraduate and graduate students, researchers, and engineers.

There are many excellent features of this textbook which the reviewer would like to stress. First of all, the exposition is very friendly, transparent, and informative. Numerous brief historical comments on personalities and concepts are lovely and helpful. There are quite a few very nice tables where useful facts are collected and therefore can be easily compared and analyzed. Carefully selected high quality black and white illustrations help to understand better the material. The exercises are thoroughly chosen to allow the reader to practice the most important techniques and constitute an integral part of the book. There is a very nice appendix entitled “Common chaotic systems” – here the author has collected important data related to most widely encountered chaotic systems (parameter values, initial conditions, Lyapunov exponent, Kaplan-Yorke dimension, correlation dimension) together with graphical representations. All these nice features make the text a full-size encyclopedia of nonlinear dynamics both for beginners and more experienced readers.

Logically the text is divided into fifteen chapters with very descriptive titles: Introduction, One-dimensional maps, Non-chaotic multidimensional flows, Dynamical systems theory, Lyapunov exponents, Strange attractors, Bifurcations, Hamiltonian chaos, Time-series properties, Nonlinear prediction and noise reduction, Fractals, Calculation of the fractal dimension, Fractal measure and multifractals, Nonchaotic fractal sets, Spatiotemporal chaos and complexity. Each chapter contains enough material and exercises for designing a nice course with possibility for the instructor to adjust the level of difficulty. This well-written textbook is a valuable contribution to the existing literature on dynamical systems and will immediately find appreciative audience.

Reviewer: Yuri V.Rogovchenko (Famagusta)

MSC:

37-01	Introductory exposition (textbooks, tutorial papers, etc.) pertaining to dynamical systems and ergodic theory
37M10	Time series analysis of dynamical systems
37D45	Strange attractors, chaotic dynamics of systems with hyperbolic behavior
37N99	Applications of dynamical systems
30D05	Functional equations in the complex plane, iteration and composition of analytic functions of one complex variable
37C70	Attractors and repellers of smooth dynamical systems and their topological structure
37E05	Dynamical systems involving maps of the interval
37G15	Bifurcations of limit cycles and periodic orbits in dynamical systems
37F45	Holomorphic families of dynamical systems; the Mandelbrot set; bifurcations (MSC2010)
37H15	Random dynamical systems aspects of multiplicative ergodic theory, Lyapunov exponents
37J20	Bifurcation problems for finite-dimensional Hamiltonian and Lagrangian systems
37J45	Periodic, homoclinic and heteroclinic orbits; variational methods, degree-theoretic methods (MSC2010)

Keywords:

chaos; dynamical systems; stability; bifurcations; Lyapunov exponents; strange attractors; periodic orbits; Hamiltonian chaos; time-series; fractals