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### **Bifurcation Diagrams**

In recent years, due primarily to the proliferation of computers, dynamical systems has again returned to its roots in applications. It is the aim of this book to provide undergraduate and beginning graduate students in mathematics or science and engineering with a modest foundation of knowledge. Equations in dimensions one and two constitute the majority of the text, and in particular it is demonstrated that the basic notion of stability and bifurcations of vector fields are easily explained for scalar autonomous equations. Further, the authors investigate the dynamics of planar autonomous equations where new dynamical behavior, such as periodic and homoclinic orbits appears.

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The present book builds upon an earlier work of J. Hale, "Theory of Functional Differential Equations" published in 1977. We have tried to maintain the spirit of that book and have retained approximately one-third of the material intact. One major change was a complete new presentation of linear systems (Chapters 6~9) for retarded and neutral functional differential equations. The theory of dissipative systems (Chapter 4) and global attractors was completely revamped as well as the invariant manifold theory (Chapter 10) near equilibrium points and periodic orbits. A more complete theory of neutral equations is presented (see Chapters 1, 2, 3, 9, and 10). Chapter 12 is completely new and contains a guide to active topics of research. In the sections on supplementary remarks, we have included many references to recent literature, but, of course, not nearly all, because the subject is so extensive. Jack K. Hale Sjoerd M. Verduyn Lunel Contents

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Including: An Introduction to the Homotopy Theory in Noncompact Spaces

State-of-the-art in qualitative theory of functional differential equations; Most of the new material has never appeared in book form and some not even in papers; Second edition updated with new topics and results; Methods discussed will apply to other equations and applications

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 we have presented in detail much of the relevant background audience, material from nonlinear functional analysis and the qualitative theory of differential equations. Since there is no good reference for some of the material, its inclusion seemed necessary. Two distinct aspects of bifurcation theory are discussed-static and dynamic. Static bifurcation theory is concerned with the changes that occur in the structure of the set of zeros of a function as

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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.

?This collection covers a wide range of topics of infinite dimensional dynamical systems generated by parabolic partial differential equations, hyperbolic partial differential equations, solitary equations, lattice differential equations, delay differential equations, and stochastic differential equations. Infinite dimensional dynamical systems are generated by evolutionary equations describing the evolutions in time of systems whose status must be depicted in infinite dimensional phase spaces. Studying the long-term behaviors of such systems is important in our understanding of their spatiotemporal pattern formation and global continuation, and has been among major sources of motivation and applications of new developments of nonlinear analysis and other mathematical theories. Theories of the infinite dimensional dynamical systems have also found more and more important applications in physical, chemical, and life sciences. This book collects 19 papers from 48 invited lecturers to the International Conference on Infinite Dimensional Dynamical Systems held at York University, Toronto, in September of 2008. As the conference was dedicated to Professor George Sell from University of Minnesota on the occasion of his 70th birthday, this collection reflects the pioneering work and influence of Professor Sell in a few core areas of dynamical systems, including non-autonomous dynamical systems, skew-product flows, invariant manifolds theory, infinite dimensional dynamical systems, approximation dynamics, and fluid flows.?

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Perturbation of the boundary is a rather neglected topic in the study of PDEs for two main reasons. First, on the surface it appears trivial, merely a change of variables and an application of the chain rule. Second, carrying out such a change of variables frequently results in long and difficult calculations. In this book, first published in 2005, the author carefully discusses a calculus that allows the computational morass to be bypassed, and he goes on to develop more general forms of standard theorems, which help answer a wide range of problems involving boundary perturbations. Many examples are presented to demonstrate the usefulness of the author's approach, while on the other hand many tantalizing open questions remain. Anyone whose research involves PDEs will find something of interest in this book.

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