MONOGRAPHS

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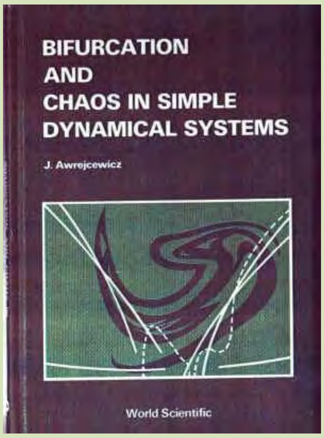
Bifurcation and Chaos in Simple Dynamical Systems

World Scientific Singapore, 1989
monograph, 126 pages, ISBN-10: 9810200382

SUMMARY



[Preface & Contents]

[Book Review]

This book consists of three chapters. In the first chapter, analytical methods to solve the Hopf bifurcation problem are presented. These methods are based on the perturbation and harmonic balance techniques well known in nonlinear dynamics. One parameter Hopf bifurcation, biparameter Hopf bifurcation and bifurcation into quasiperiodic orbits in autonomous systems are considered. Then the analytical approach for detecting Hopf bifurcation solutions in Duffing, Mathieu and Mathieu-Duffing oscillators are demonstrated.

The second chapter includes a numerical approach for a systematic study of the behaviour of mechanical and bio-mechanical systems governed by the nonautonomous and autonomous nonlinear differential equations. The procedure presented is based on solving a boundary value problem using the shooting method. The behaviour of the dynamical systems is traced along variations of the selected parameters. Observation of the evolution of the characteristic multipliers gives information about stability and possibly further branching of the investigated solutions. In the case of nonautonomous systems, periodic orbits are traced and the transition to chaos when one of the multipliers crosses the unit circle at + 1 or -1 (period doubling) are discussed and illustrated. An example is given for chaos, which has appeared after the simultaneous passage of a pair of multipliers through the unit circle of the complex plane. An autonomous system of three nonlinear differential equations, which governs the oscillations of human vocal cords, is considered more detailed. Steady state solutions, Hopf bifurcations and the branches of periodic orbits which emanate from bifurcation points are calculated. Tracing the evolution of characteristic multipliers allows the observation of alternations of stability and possibly branching to other periodic or quasiperiodic motion.

In Chapter 3 the attention concentrates on formulating the analytical condition for Hopf bifurcation of the periodic orbit or the Hopf type bifurcation of the quasiperiodic orbit which yields to nonlinear algebraic bifurcation equations. Three examples show the occurrence of chaotic orbits after bifurcations.

The contents of this book are considerably influenced by my experience from the seminar at the Polish Academy of Sciences in Warsaw (1984-1987) and from the seminar organized by the Stefan Banach International Mathematical Center (September 19-December 18, 1986). I express my thanks to Prof. W. Szemplińska-Stupnicka for her knowledgeable comments on the part of the results presented in Chapters 1 and 3. A majority of results presented in this book are based on a research project supported by the Alexander von Humboldt Foundation. I would like to acknowledge many useful discussions with Prof. E. Brommundt, Prof. D. Ottl and H. Staben regarding the material presented in Chapter 2. I wish to express my sincere thanks for the hospitality of the Institute of Technical Mechanics of the Carolo

Wilhelmina University of Braunschweig, where part of the work presented in this book was carried out. Finally, I acknowledge a very fruitful collaboration with R. Klopp from the University of Waterloo, who has helped to avoid many difficulties with the style and presentation of my work.