Preface

This book is the first book talking about periodic motions to chaos in time-delay systems. Time-delay systems extensively exist in engineering. For a long time, the stability of time-delay systems at equilibriums has been of great interest from the Lyapunov theory-based methods, and one cannot achieve the ideal results. Thus, discretization of time delay in time-delay systems was used for investigating the stability of time-delay systems. For periodic motions in time-delay systems, perturbation methods have been adopted. Since the perturbation methods changed the vector fields of dynamical systems, the accurate periodic motions in nonlinear time-delay systems cannot be obtained. Further, one cannot find chaos caused by the bifurcation trees of periodic motions in nonlinear time-delay systems. In this book, an accurate method based on the finite Fourier series is presented to determine periodic motions in nonlinear time-delay systems. The stability and bifurcation of periodic motions are determined by the time-delayed system of coefficients in the Fourier series. The method presented in this book for nonlinear time-delay systems is equivalent to the Laplace transformation method for linear time-delay systems.

This book consists of five chapters. The first chapter briefly discusses solutions and stability in linear time-delay systems. In Chap. 2, stability and bifurcations of equilibrium in nonlinear time-delay systems are discussed. Periodic motions in nonlinear time-delay systems are presented through the finite Fourier series in Chap. 3. Quasiperiodic motions in nonlinear time-delay systems are also discussed in Chap. 4. In Chap. 5, bifurcation trees of periodic motions to chaos in time-delayed Duffing oscillator are discussed. Through such an engineering example, one can understand analytical routes from periodic motions to chaos and motion complexity in nonlinear time-delay systems.

Finally, I would like to thank my master student (Hanxiang Jin) for computing numerical results. In addition, I would like to thank my family's support for this work. The authors hope the materials presented herein can last long for science and engineering.

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