Gu, Keqin; **Kharitonov, V. L.**; **Chen, Jie**
Stability of time-delay systems. (English) Zbl 1039.34067
Control Engineering. Boston, MA: Birkhäuser (ISBN 0-8176-4212-9/hbk). xx, 353 p. (2003).

The book is written by famous scientists in the area of time-delay systems. It presents a systematic treatment of the theory of such systems and their stability. It is devoted to the study of the stability of time-delay systems, an area long pursued by mathematicians, physical and life scientists, engineers, and economists. The text consists of eight chapters and two appendices.

Chapter 1 begins with a number of practical examples in which time delays play an important role. It then continues with an introductory exposition of some basic concepts and results essential to stability analysis, such as functional-differential equation representation, characteristic quasipolynomials, Lyapunov-Krasovskij stability theorem, and Razumikhin theorem.

The next three chapters develop frequency-domain criteria for stability and robust stability of linear time-invariant systems. Chapter 2 focuses on systems with commensurate delays only. Chapter 3 studies systems with incommensurate delays. It starts with a brief exposure to key concepts found in robust stability analysis, such as the small gain theorem and the structured singular value, and ends with a formal analysis of the computational complexity inherent in the stability problem. Uncertain time-delay systems are addressed in Chapter 4. More specifically, this chapter examines uncertain quasipolynomials of systems with incommensurate delays, that are families of multivariate polynomials whose coefficients are permitted to vary in a prescribed set.

Chapters 5 to 7 are devoted to time-domain methods. Chapter 5 concentrates on systems with a single delay. While providing various stability conditions, this chapter also introduces a number of techniques prevailing in the analysis of time-delay systems, including model transformation, discretized Lyapunov functional methods, and LMI conditions. This paves the way for extensions to uncertain systems with memoryless uncertainty and systems with multiple incommensurate delays, pursued in Chapters 6 and 7, respectively. It is worth noting that, unlike in frequency-domain approaches, time-domain methods are more advantageous in accommodating nonlinear, time-varying systems.

The final Chapter 8 introduces an input-output stability formulation. The main purpose here is to consider robust stability problems under dynamical uncertainty. The method of comparison systems and the approximation of time-delay elements are discussed, too.

The book concludes with two appendices. Appendix A summarizes the key matrix facts and identities used throughout the book, and Appendix B provides basic concepts and techniques of LMIs.

The book is well written and contains a number of examples.

Reviewer: Alexander O. Ignatyev (Donetsk)

MSC:

34K20	Stability theory of functional-differential equations
34-02	Research exposition (monographs, survey articles) pertaining to ordinary differential equations
93-02	Research exposition (monographs, survey articles) pertaining to systems and control theory
93D05	Lyapunov and other classical stabilities (Lagrange, Poisson, L^p, l^p, etc.) in control theory
93D09	Robust stability
93C23	Control/observation systems governed by functional-differential equations

Keywords:

Time-delay systems; stability; Lyapunov-Krasovskij's functionals