A review of the book "Time-delay systems. Lyapunov functionals and matrices" by Vladimir Kharitonov, Control Engineering, Birkhaeuser, Boston, MA, 2013.

This monograph deals with the analysis of systems described by linear delay differential equations (DDEs). The book, written by a leading expert in the field, lies on a solid applied mathematics background, but it is mostly targeted to a systems control engineering readership. The focus is on Lyapunov's second method to stability analysis: convergence of the DDE solution to the origin is studied by seeking positive definite energy-like functionals which are decreasing with time. In the context of time-delay systems, these are generally called Lyapunov-Krasovsky functionals, and they depend on the whole state history.

The book is structured into two parts. Part 1 deals with retarded DDEs (for which the derivative at a given time depends on the solution at prior times), whereas part 2 deals with neutral DDEs (for which the derivative at a given time depends on the derivative at prior times). The author introduces himself his book as an account of a linear DDE counterpart of the classical Lyapunov theory for linear ordinary differential equations (ODEs). Indeed, the focus is exclusively on linear DDE, and hence only quadratic-in-the-state Lyapunov-Krasovsky functionals are considered.

The author's preference goes to algebraic-differential matrix equation techniques, combined sometimes with spectral analytic conditions. He resists the temptation to write down systematically positivity conditions on quadratric state functionals as linear matrix inequalities (LMIs, amenable to numerical optimization techniques), a strategy (and paper-producing industry) that has prevailed in the systems control literature during the last two decades. The author must be praised for these efforts, which are well motivated in the context of linear DDEs, just as algebraic Riccati equation approaches for linear ODEs should be preferred to LMI approaches. Several sections in the book are dedicated to computational and implementation issues, which clearly shows the author's concern for developments of engineering significance.

Chapters 1 and 2 collect elementary material on linear DDEs, and the author suggests that these chapters can be used as teaching support for an introductory course on time-delay systems. Part of the remaining chapters can be used for more advanced courses, and researchers in DDEs and time-delay control systems will certainly find this book very useful as a reference work, as well as a timely complement to the existing technical literature.

Didier Henrion, Toulouse, May 2014.