[Review published in *SIAM Review*, Vol. 56, Issue 3, pp. 568–569.]

Analytic Perturbation Theory and Its Applications. *By Konstantin E. Avrachenkov, Jerzy A. Filar, and Phil G. Howlett.* SIAM, Philadelphia, 2014. $89.00. x+369 pp., hardcover. ISBN 978-1-611973-13-6.

Konstantin Avrachenkov received a Ph.D. in 1999 from the University of South Australia, with Jerzy Filar and Phil Howlett as advisors. Since that time, the authors have further developed and applied the subject of analytic perturbation theory, together with a variety of coauthors, in both finite- and infinite-dimensional contexts. The end result is an authoritative SIAM monograph, intended as a textbook, filled with outstanding exposition and explicitly detailed examples.

The classical topic, linear and polynomial systems of algebraic equations depending analytically on a small parameter, is an important and challenging subject. Singular perturbations occur when the solution involves a Laurent expansion. (Thus, the setting is far removed from the usual differential equations formulations.) The focus here is on generalized inverses, Puiseux series, Groebner bases, the Newton polygon, mathematical programming, and Markov decision processes, in lovely series and matrix equations. Who would guess that the Google PageRank can be efficiently described as a singularly perturbed Markov chain?

Such problems become more varied as linear operators in Hilbert and Banach spaces, where some functional analysis must be introduced. The authors clearly explain and motivate their development, leaving problems at chapter ends as well as bibliographic notes. If your interests include linear analysis, complex variables, optimization, and their applications, you'll find much of practical value here, eloquently presented.

Readers will find that there's much new to learn since Kato and Vishik and Lyusternik appeared in the 1960s!

Robert E. O'Malley, Jr.
University of Washington

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