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# Linear Delay-Differential Systems with Commensurate Delays: An Algebraic Approach



Springer

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# Preface

The term delay-differential equation was coined to comprise all types of differential equations in which the unknown function and its derivatives occur with various values of the argument. In these notes we concentrate on (implicit) linear delay-differential equations with constant coefficients and commensurate point delays. We present an investigation of dynamical delay-differential systems with respect to their general system-theoretic properties. To this end, an algebraic setting for the equations under consideration is developed. A thorough purely algebraic study shows that this setting is well-suited for an examination of delay-differential systems from the behavioral point of view in modern systems theory. The central object is a suitably defined operator algebra which turns out to be an elementary divisor domain and thus provides the main tool for handling matrix equations of delay-differential type. The presentation is introductory and mostly self-contained, no prior knowledge of delay-differential equations or (behavioral) systems theory will be assumed.

There are a number of people whom I am pleased to thank for making this work possible. I am grateful to Jan C. Willems for suggesting the topic “delay-differential systems in the behavioral approach” to me. Agreeing with him, that algebraic methods and the behavioral approach sound like a promising combination for these systems, I started working on the project and had no idea of what I was heading for. Many interesting problems had to be settled (resulting in Chapter 3 of this book) before the behavioral approach could be started. Special thanks go to Wiland Schmale for the numerous fruitful discussions we had in particular at the beginning of the project. They finally brought me on the right track for finding the appropriate algebraic setting. But also later on, he kept discussing the subject with me in a very stimulating fashion. His interest in computer algebra made me think about symbolic computability of the Bezout identity and Section 3.6 owes a lot to his insight on symbolic computation. I wish to thank him for his helpful feedback and criticisms. These notes grew out of my Habilitationsschrift at the University of Oldenburg, Germany. The readers Uwe Helmke, Joachim Rosenthal, Wiland Schmale, and Jan C. Willems deserve special mention for their generous collaboration. I also want to thank the Springer-Verlag for the pleasant cooperation. Finally, my greatest thanks go

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*Oldenburg, July 2001*

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