

Preface

Theory of matrix equations is an important branch of mathematics, and has broad applications in many engineering fields, such as control theory, information theory, and signal processing. Specifically, algebraic Lyapunov matrix equations play vital roles in stability analysis for linear systems, and coupled Lyapunov matrix equations appear in the analysis for Markovian jump linear systems; algebraic Riccati equations are encountered in optimal control. Due to these reasons, matrix equations are extensively investigated by many scholars from various fields, and the content on matrix equations has been very rich. Matrix equations are often covered in some books on linear algebra, matrix analysis, and numerical analysis. We list several books here, for example, *Topics in Matrix Analysis* by R.A. Horn and C.R. Johnson [143], *The Theory of Matrices* by P. Lancaster and M. Tismenetsky [172], and *Matrix Analysis and Applied Linear Algebra* by C.D. Meyer [187]. In addition, there are some books on special matrix equations, for example, *Lyapunov Matrix Equations in System Stability and Control* by Z. Gajic [128], *Matrix Riccati Equations in Control and Systems Theory* by H. Abou-Kandil [2], and *Generalized Sylvester Equations: Unified Parametric Solutions* by Guang-Ren Duan [90]. It should be pointed out that all the matrix equations investigated in the aforementioned books are in real domain. By now, it seems that there is no book on complex matrix equations with the conjugate of unknown matrices. For convenience, this class of equations is called complex conjugate matrix equations.

The first author of this book and his collaborators began to consider complex matrix equations with the conjugate of unknown matrices in 2005 inspired by the work [155] of Jiang published in *Linear Algebra and Applications*. Since then, he and his collaborators have published many papers on complex conjugate matrix equations. Recently, the second author of this book joined this field, and has obtained some interesting results. In addition, some complex conjugate matrix equations have found applications in the analysis and design of antilinear systems. This book aims to provide a relatively systematic introduction to complex conjugate matrix equations and its applications in discrete-time antilinear systems.

The book has 12 chapters. In Chap. 1, first a survey is given on linear matrix equations, and then recent development on complex conjugate matrix equations is summarized. Some mathematical preliminaries to be used in this book are collected in Chap. 2. Besides these two chapters, the rest of this book is partitioned into three parts. The first part contains Chaps. 3–5, and focuses on the iterative solutions for several types of complex conjugate matrix equations. The second part consists of Chaps. 6–10, and focuses on explicit closed-form solutions for some complex conjugate matrix equations. In the third part, including Chaps. 11 and 12, several applications of complex conjugate matrix equations are considered. In Chap. 11, stability analysis of discrete-time antilinear systems is investigated, and some stability criteria are given in terms of anti-Lyapunov matrix equations, which are special complex conjugate matrix equations. In Chap. 12, some feedback design problems are solved for discrete-time antilinear systems by using several types of complex conjugate matrix equations. Except part of Chap. 2 and Subsection 6.1.1, the other materials of this book are based on our own research work, including some unpublished results.

The intended audience of this monograph includes students and researchers in areas of control theory, linear algebra, communication, numerical analysis, and so on. An appropriate background for this monograph would be the first course on linear algebra and linear systems theory.

Since 1980s, many researchers have devoted much effort in complex conjugate matrix equations, and much contribution has been made to this area. Owing to space limitation and the organization of the book, many of their published results are not included or even not cited. We extend our apologies to these researchers.

It is under the supervision of our Ph.D. advisor, Prof. Guang-Ren Duan at Harbin Institute of Technology (HIT), that we entered the field of matrix equations with their applications in control systems design. Moreover, Prof. Duan has also made much contribution to the investigation of complex conjugate matrix equations, and has coauthored many papers with the first author. Some results in these papers have been included in this book. Therefore, at the beginning of preparing the manuscript, we intended to get Prof. Duan as the first author of this book due to his contribution on complex conjugate matrix equations. However, he thought that he did not make contribution to the writing of this book, and thus should not be an author of this book. Here, we wish to express our sincere gratitude and appreciation to Prof. Duan for his magnanimity and selflessness. We also would like to express our profound gratitude to Prof. Duan for his careful guidance, wholehearted support, insightful comments, and great contribution.

We also would like to give appreciation to our colleague, Prof. Bin Zhou of HIT for his help. The first author has coauthored some papers included in this book with Prof. Gang Feng when he visited City University of Hong Kong as a Research Fellow. The first author would like to express his sincere gratitude to Prof. Feng for his help and contribution. Dr. Yan-Ming Fu, Dr. Ming-Zhe Hou, Mr. Yang-Yang Qian, and Dr. Ling-Ling Lv have also coauthored with the first author a few papers included in this book. The first author would extend his great thanks to all of them for their contribution.

Great thanks also go to Mr. Yang-Yang Qian and Mr. Ming-Fang Chang, Ph.D. students of the first author, who have helped us in typing a few sections of the manuscripts. In addition, Mr. Fang-Zhou Fu, Miss Dan Guo, Miss Xiao-Yan He, Mr. Zhen-Peng Zeng, and Mr. Tian-Long Qin, Master students of the first author, and Mr. Yang-Yang Qian and Mr. Ming-Fang Chang have provided tremendous help in finding errors and typos in the manuscripts. Their help has significantly improved the quality of the manuscripts, and is much appreciated.

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Lastly, we thank in advance all the readers for choosing to read this book. It is much appreciated if readers could possibly provide, via email: agwu@163.com, feedback about any problems found.

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