Book Review: Robust Control Design with Matlab By D.-W. Gu, P. Hr. Petkov and M.M. Konstantinov, Springer, Second Edition.

This is a Springer Series book from the excellent 'Advanced Textbooks in Control and Signal Processing' Series. The authors are world-leading authorities in Robust Control Theory and the current book reflects their expertise. Overall, they have done, an excellent job at making this advanced topic more accessible to the wider Engineering community.

The first edition was divided in two parts, the first covering the modeling of uncertain systems and the incorporation of robust design specifications, a theoretical formulation of H-infinity design methods, including loop shaping design procedures (LSDP), μ-analysis and synthesis as well as a section on methods for designing lower order controllers, whereas the second part was devoted to selected design examples.

The new edition is now divided into three parts. In addition to the chapters found in the first part of the first edition, the newly expanded first part now includes a very concise and well written section on Linear Matrix Inequalities(LMI). The LMI framework is used to solve Linear Quadratic Regulator (LQR) problems solving the associated Algebraic Riccati Equation (ARE). The authors highlight the advantages of formulating control problems as constrained optimization problems with the cost as well as constraint inequalities in quadratic forms.

The second part now provides an introduction to the Robust Control Toolbox v3 and step-by-step guidance on building uncertain models for linear time invariant (LTI) systems, as well as ways of investigating several properties of uncertain models in the time or frequency domains. There is a discussion on how to build models of systems with unstructured uncertainty and additional sections on robust stability and performance analysis, H-infinity design, μ-synthesis and the analysis and design of parameter dependent systems. A strength of the book is the way parameter-dependent systems are discussed using descriptor formulations as well as the use of polytopic models and numerical methods. The authors discuss how an affine-parameter dependent system may be converted to an equivalent polytopic model. The advantage of descriptor based representations is that one can easily derive several results concerning closed-loop stability and controller design. This approach is both pedagogical as well as a reflection of trends in the current control theory literature.

The third part of the book provides many of the examples found in the first edition although two new ones are added to place emphasis on the new topics discussed. Several non-linear system examples are discussed. The inclusion of this section provides new researchers entering this field excellent opportunities to quickly grasp the essence of the techniques by applying the points discussed in the first parts of the book. Some of the examples chosen are very interesting from an educational perspective; the example of a twin rotor aerodynamic system illustrates the difficulties arising in the control of strongly coupled two-channel nonlinear systems and the good disturbance attenuation and channel decoupling possible for a linearized plant model using the proposed strategies. Another significant strength of the book is the accompanying downloadable M- and MDL- Matlab files provided. The book is written in a way so as to be used in conjunction with the Robust Control Toolbox3, the Control Systems Toolbox v9.1 and Simulink v7.7. Matlab notation is used throughout the book as well as in the examples provided.

Any researcher interested in the subject of Robust Control Theory will find this book invaluable. Interdisciplinary researcher in the subject areas of Measurement Science, Chemical Engineering as well as those in the newly emerging disciplines such as Systems Biology and Synthetic Biology that have some understanding of classical control theory and state space methods but might not had a full exposure to Robust Control Theory will be able to quickly grasp the techniques discussed and tailor to their needs the formulations in the numerous examples provided. My PhD student who had no prior exposure in control theory was able to simulate metabolic networks and investigate their robustness within weeks. It is not often that one comes across such a useful book, so I would strongly recommend it. The new Edition is significantly expanded over the first one, to the extent that a replacement should be considered even if one already owns the first edition. Because of the way the material is distributed in three parts, an instructor can spend half a semester course on theory with the other half of the course devoted to Matlab based design examples and simulations. I therefore consider this book ideal as a teaching aid for control practitioners in final year undergraduate or first year graduate courses. Once the topics discussed in the book are mastered, I would also encourage interested readers to follow the authors numerous scientific papers, they will realize that they can also eventually become experts in this important field!

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