Lunze, Jan

Control theory. 2: Multivariable systems, digital control. 4th revised ed. (Regelungstechnik. 2: Mehrgrößensysteme, digitale Regelung.) (German) Zbl 1107.93001
Springer-Lehrbuch. Berlin: Springer (ISBN 3-540-32335-X/pbk). xxiii, 651 p. (2006).

This is the 4th edition of the second volume of an introductory German textbook on (linear) control theory for engineering students (for a review of the first edition of Volume 2 see [(Berlin): Springer. (1997; Zbl 0881.93001)], for a review of the fourth edition of Volume 1 see [Springer-Lehrbuch. (Berlin): Springer. (2004; Zbl 1054.93001)]). The main topics of the book are multi-input multi-output (MIMO) systems and digital control.

The book consists of three main parts, the first two dealing with analysis of MIMO systems and the design of MIMO controllers, respectively, and the third with digital control. Part 1 starts with a basic introduction to MIMO systems, in particular highlighting the differences to single-input single-output systems. In Chapter 2 the description in time and frequency domain, the behavior of MIMO systems and the role of poles and zeros is discussed. Controllability and observability are treated in Chapter 3.

Part 2 starts with a detailed discussion of different controller structures in Chapter 4 followed by tuning rules for PI controllers in Chapter 5. Chapter 6 presents controller design techniques based on pole placement while Chapter 7 treats the LQ optimal controller design. The design of (Luenberger) observers is the topic of Chapter 8 which also contains an illuminating discussion about the relation between the Luenberger observer and the Kalman filter. In the final Chapter 9 of the second part design methods based on the Nyquist criterion are presented.

Part 3 on digital control starts with an introduction to the subject in Chapter 10, which nicely motivates the reason to study digital and sampled-data control systems and illustrates some of the pitfalls of sampling. The ensuing Chapters 11 and 12 deal with the description of discrete time systems in time and frequency domain, respectively. Digital controller structures and some basic stability considerations can be found in Chapter 13 while Chapter 14 finishes the third part presenting sampled-data controller design techniques, mainly in analogy to the respective continuous time design techniques with the exception of the dead beat controller design which does not have a continuous time counterpart.

These three main parts are complemented by a brief chapter summarizing further topics, a comprehensive bibliography and several useful appendices containing solutions to selected exercises, suggestions for students' projects, mathematical basics, a brief introduction to MATLAB, a table of Laplace and Z transforms and a brief German-English Dictionary of technical terms.

Although proofs of mathematical theorems are mostly omitted, the book is very rigorous and precise concerning mathematical formulations. At the same time, the author gives a lot of engineering intuition like heuristic rules for tuning of controller parameters or the choice of the instantaneous cost in optimal regulation. Many illustrative examples and exercises as well as bibliographical notes complement each chapter. Furthermore, wherever applicable an introduction to the corresponding commands from MATLAB's control system toolbox are given which allows to explore the performance of the proposed methods via computer experiments. For these reasons, the book is very well suited both as a text book for lectures as well as for self study.

From a mathematician's point of view, virtually the only point of criticism is that nonlinear systems are not treated at all. Given that this book is supposed to be an advanced textbook, one might wish that at least an introduction to some basic principles (like linearization techniques) were added in the next edition. Apart from that, this book can certainly be strongly recommended for anyone interested in control theory and control engineering.

Reviewer: Lars Grüne (Bayreuth)

MSC:

93-01	Introductory exposition (textbooks, tutorial papers, etc.) pertaining to systems and control theory	Cited in **3** Reviews
93C35	Multivariable systems, multidimensional control systems	
93C62	Digital control/observation systems	
93C05	Linear systems in control theory	
93B51	Design techniques (robust design, computer-aided design, etc.)	
93D15	Stabilization of systems by feedback	

Keywords:

linear systems; time-domain; frequency-domain; stability; controller design; closed loop system; digital control; MATLAB

Software:

Matlab