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Modern Control Engineering (4th Edition)

Synopsis

This comprehensive treatment of the analysis and design of continuous-time control systems provides a gradual development of control theoryÃ¢â ¬â •and shows how to solve all computational problems with MATLAB. It avoids highly mathematical arguments, and features an abundance of examples and worked problems throughout the book. Chapter topics include the Laplace transform; mathematical modeling of mechanical systems, electrical systems, fluid systems, and thermal systems; transient and steady-state-response analyses, root-locus analysis and control systems design by the root-locus method; frequency-response analysis and control systems design by the frequency-response; two-degrees-of-freedom control; state space analysis of control systems and design of control systems in state space. For control systems engineers.

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Customer Reviews

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This book presents a comprehensive treatment of the analysis and design of control systems. It is written at the level of the senior engineering (mechanical, electrical, aerospace, and chemical) student and is intended to be used as a text for the first course in control systems. The prerequisite on the part of the reader is that he or she has had introductory courses on differential equations, vector-matrix analysis, circuit analysis, and mechanics. The main revision made in the fourth edition of the text is to present two-degrees-of-freedom control systems to design high performance control systems such that steady-state errors in following step, ramp, and acceleration inputs become zero. Also, newly presented is the computational (MATLAB) approach to determine the pole-zero locations of the controller to obtain the desired transient response characteristics such that the maximum overshoot and settling time in the step response be within the specified values. These subjects are discussed in Chapter 10. Also, Chapter 5 (primarily transient response analysis) and Chapter 12 (primarily pole placement and observer design) are expanded using MATLAB. Many new solved problems are added to these chapters so that the reader will have a good understanding of the MATLAB approach to the analysis and design of control systems. Throughout the book computational problems are solved with MATLAB. This text is organized into 12 chapters. The outline of the book is as follows. Chapter 1 presents an introduction to control systems. Chapter 2 deals with Laplace transforms of commonly encountered time functions and some of the useful theorems on Laplace transforms. (If the students have an adequate background on Laplace transforms, this chapter may be skipped.) Chapter 3 treats mathematical modeling of dynamic systems (mostly mechanical, electrical, and electronic systems) and develops transfer function models and state-space models. This chapter also introduces signal flow graphs. Discussions of a linearization technique for nonlinear mathematical models are included in this chapter. Chapter 4 presents mathematical modeling of fluid systems (such as liquid-level systems, pneumatic systems, and hydraulic systems) and thermal systems. Chapter 5 treats transient response analyses of dynamic systems to step, ramp, and impulse inputs. MATLAB is extensively used for transient response analysis. Routh's stability criterion is presented in this chapter for the stability analysis of higher order systems. Steady-state error analysis of unity-feedback control systems is also presented in this chapter. Chapter 6 treats the root-locus analysis of control systems. Plotting root loci with MATLAB is discussed in detail. In this chapter root-locus analyses of positive-feedback systems, conditionally stable systems, and systems with transport lag are included. Chapter 7 presents the design of lead, lag, and lag-lead compensators with the root-locus method. Both series and parallel compensation techniques are discussed. Chapter 8 presents basic materials on frequency-response analysis. Bode diagrams, polar plots, the Nyquist stability criterion, and closed-loop frequency response are discussed including the MATLAB approach to obtain frequency response plots. Chapter 9 treats the design and compensation techniques using frequency-response methods. Specifically, the Bode diagram approach to the design of lead, lag, and lag-lead compensators is discussed in detail. Chapter 10 first deals with the basic and modified PID controls and then presents computational (MATLAB) approach to obtain optimal choices of parameter values of controllers to satisfy requirements on step response characteristics. Next, it presents two-degrees-of-freedom control systems. The chapter concludes with the design of high performance control systems that will follow a step, ramp, or acceleration input without steady-state error. The zero-placement method is used to accomplish such performance. Chapter 11 presents a basic analysis of control systems in state space. Concepts of controllability and observability are given here. This chapter discusses the transformation of system models (from transfer-function model to state-space model, and vice versa) with MATLAB. Chapter 12 begins with the pole placement design technique, followed by the design of state observers. Both full-order and minimum-order state observers are treated. Then, designs of type 1 servo systems are discussed in detail. Included in this chapter are the design of regulator systems with observers and design of control systems with observers. Finally, this chapter concludes with discussions of quadratic optimal regulator systems. In this book, the basic concepts involved are emphasized and highly mathematical arguments are carefully avoided in the presentation of the materials. Mathematical proofs are provided when they contribute to the understanding of the subjects presented. All the material has been organized toward a gradual development of control theory. Throughout the book, carefully chosen examples are presented at strategic points so that the reader will have a clear understanding of the subject matter discussed. In addition, a number of solved problems (A-problems) are provided at the end of each chapter, except Chapter 1. These solved problems constitute an integral part of the text. Therefore, it is suggested that the reader study all these problems carefully to obtain a deeper understanding of the topics discussed. In addition, many problems (without solutions) of various degrees of difficulty are provided (B-problems). These problems may be used as homework or quiz purposes. An instructor using this text can obtain a complete solutions manual (for B-problems) from the publisher. Most of the materials including solved and unsolved problems presented in this book have been class tested in senior level courses on control systems at the University of Minnesota. If this book is used as a text for a quarter course (with 40 lecture hours), most of the materials in the first 10 chapters (except perhaps Chapter 4) may be covered. The first nine chapters cover all basic materials of control systems normally required in a first course on control systems. Many students enjoy studying computational (MATLAB) approach to the design of control systems presented in Chapter 10. It is recommended that Chapter 10 be included in any control courses. If this book is used as a text for a semester course (with 56 lecture hours), all or a good part of the book may be covered with flexibility in skipping certain subjects. Because of the abundance of solved problems (A-problems) that might answer many possible questions that the reader might have, this book can also serve as a self-study book for practicing engineers who wish to study basic control theory. I would like to express my sincere appreciation to Professors Athimoottil V Mathew (Rochester Institute of Technology), Richard Gordon (University of Mississippi), Guy Beale (George Mason University), and Donald T. Ward (Texas A & M University), who made valuable suggestions at the early stage of the revision process, and anonymous reviewers who made many constructive comments. Appreciation is also due to my former students, who solved many of the A-problems and B-problems included in this book. Katsuhiko Ogata

Provides problems that aid in learning material. Written material sometimes not in depth enough but otherwise adequate. I would suggest using MATLAB examples on your own in order to gain a boost in learning material.

It is a good book, it covers most on linear theory in a clear way, but with a lack of organization of content.

This book holds its own among other continous controls books. Problem sets and examples are very helpful to discover the more difficult problems of contol engineering.

great book

Great book but lacks application problems. I am told this book is more for an indepth analysis of topics already learned from other coureses with the addition of Observers,state observer feedback, Intro to the use of Kalman filters, state variable feedback, and optimization. The optimization section could be better but if you have a great teacher its a good reference. I had used this book as an undergrad and told its a reference for grad students.

excellent

I needed this for class. It was good for the class but it can definitely put you to sleep.

This is a very easy to read textbook that gives a great introduction to classical and modern control theory. The text covers PID and Lead-Lag in both root-locus and bode plot design, nyquist plots, stability, state-space, optimal and LQR control, as well as some robust control. Good beginner textbook for controls

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