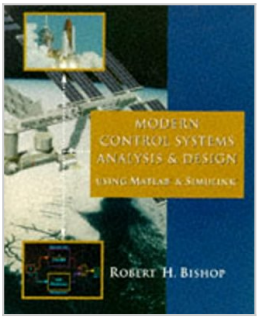

Modern Control Systems Analysis and Design Using MATLAB and Simulink

By Robert H. Bishop

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This supplement is meant for professors looking for ways to integrate more of the design process into their undergraduate controls course as well as improve their students' computer skills. In each chapter, a problem from the Modern Control Systems textbook has been changed into a design problem and various aspects of the design process are explored.

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Modern Control Systems Analysis and Design Using MATLAB and Simulink By Robert H. Bishop Bibliography

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Editorial Review

From the Inside Flap

This supplement is designed to be used as a companion to the main textbook, Modern Control Systems by Richard C. Dorf and Robert H. Bishop. The primary objective of this supplement is to strengthen the design emphasis by introducing a selected set of solved design problems. Each chapter focuses on one design problem adapted from Modern Control Systems. The problems are selected from a wide range of fields. In addition to the design problems, some chapters also include example problems that illustrate important points and concepts. Rather than focus just on the design issues of specific (and interesting) design problems, this supplement is built around the notion of a design process.

Design is the process of conceiving or inventing the forms, parts, and details of a system to achieve a reasoned purpose. Control system design is only one important example of design. Design is a creative endeavor, so there is not a unique methodology that guarantees a valid design solution. To help organize the design process, we suggest a series of steps leading to the final design. Every chapter addresses at least one step of the design process. In general, the early chapters focus on modeling, design specifications, and identification of important variables to be to controlled. The later chapters focus on controller selection and design and analysis of the controlled system. Of course the design process is inherently iterative, so some steps will be repeated as the design is refined. MATLAB and SIMULINK are valuable tools in the design process because they effectively assist in performing the repetitive steps quickly.

Now that powerful computers and software are available for control system design, some may ask the question, Why don't we program the full higher-order nonlinear equations, ignore all the modeling and analysis techniques, and use the computer to grind out an answer? There are many reasons why this is not a good way to solve an engineering problem. First, we do not get a feel for the problem. For example, suppose the team leader tells us the design specifications have been changed for the problem we are currently working. Which controller gain changes to meet the new design specifications? Do we need to change the controller structure? Without a feel for the problem, we may have few ideas on how to proceed. In this supplement we present the technique of obtaining approximate transfer function models to determine initial controller designs and then relying on MATLAB to fine-tune and analyze the closed-loop control system. In this manner, we can develop good engineering intuition regarding the design variables and how they affect the system response.

In this book we also use the notion of dominant poles to obtain initial control system designs. The idea is that we design the controller such that the closed-loop system response is dominated by certain poles placed appropriately to meet the design specifications. Again, we can use MATLAB to verify quickly that the design specifications have indeed been satisfied. Each time we use MATLAB in a problem solution in this supplement, we give the associated script. We can use the scripts to verify the results, but more importantly, they can be modified to solve other similar design problems.

To properly utilize this supplement it is essential to have access to Modern Control Systems. Many of the problems and examples in Dorf and Bishop are solved here using MATLAB and SIMULINK, but the background information presented in Modern Control Systems has not been repeated. For example, it is assumed that the reader is familiar with MATLAB. The main text Modern Control Systems contains relevant materials for new users of MATLAB and that material is not presented again in this supplement.

Organization

Each chapter of the supplement follows the corresponding chapter in Modern Control Systems. To allow the reader to relate the supplement chapters to the main textbook chapters, the chapter titles have remained the same. However, we have added a subtitle indicating the primary design problem of that chapter. Chapter 1: Introduction to Control Systems A Space Shuttle Example
Chapter 2: Mathematical Models of Systems Fluid Flow Modeling Example
Chapter 3: State Variable Models A Space Station Example
Chapter 4: Feedback Control System Characteristics Blood Pressure Control Example
Chapter 5: Performance of Feedback Control Systems Airplane Lateral Dynamics Example
Chapter 6: Stability of Linear Feedback Systems Robot-controlled Motorcycle Example
Chapter 7: Root Locus Method Automobile Velocity Control Example
Chapter 8: Frequency Response Methods Six-legged Ambler Example
Chapter 9: Stability in the Frequency Domain Hot Ingot Robot Control Example
Chapter 10: Design of Feedback Control Systems Milling Machine Control Example
Chapter 11: Design of State Variable Feedback Systems Diesel Electric Locomotive Example
Chapter 12: Robust Control Systems Digital Audio Tape Speed Control Example
Chapter 13: Digital Control Systems Fly-by-wire Control Surface Example

The design problems in each chapter are all adapted from Modern Control Systems. In most cases, the problems are end-of-chapter problems revisited. The relationship between the chapter design problems in the supplement and Modern Control Systems is shown in the following table.

Supplement Chapter Number	Design Problem	Relationship to Modern Control Systems
1	Space Shuttle	P9.9
2	Fluid Flow Modeling	P2.12
3	Space Station Modeling	Section 3.9
4	Blood Pressure Control	AP4.5
5	Airplane Lateral Dynamics	DP5.1
6	Robot-controlled Motorcycle	DP6.6
7	Automobile Velocity Control	DP7.12
8	Six-legged Ambler	DP8.2

9
Hot Ingot Robot Control
DP9.10
10
Milling Machine Control
P10.36
11
Diesel Electric Locomotive
DP11.3
12
Digital Audio Tape Speed Control
DP12.2
13
Fly-by-wire Control Surface
AP13.2

The Software

It is assumed that the readers have access to MATLAB and the Control System Toolbox. All of the MATLAB examples in this supplement were developed and tested on a Power Macintosh 7200/90 with MATLAB Version 4.2c and the Control System Toolbox. Since it is not possible to verify each example on all the available computer platforms that are compatible with MATLAB, we restrict the computer topics covered in this supplement to those that are platform independent. It will be very helpful to have access to the MATLAB Users Guide. Readers do not need access to SIMULINK to use this supplement effectively. Every design problem is solved using MATLAB, so skip the SIMULINK material if desired. It is clear, however, that SIMULINK provides valuable additional simulation capability; therefore, we introduce it in this supplement for those readers wishing to extend their knowledge base. We used SIMULINK 1.3c in the simulation development. It will be very helpful to also have access to the SIMULINK Users Guide.

A set of M-files, the Modern Control Systems Supplement Toolbox,have been developed by the author for this supplement. The M-files contain the scripts from each MATLAB example. You can retrieve the M-files from Addison-Wesley at ftp.aw. Please refer to the Addison-Wesley Computer Science and Engineering Web site at aw/cseng or call 1-800-322-1377 if you would like to purchase a copy of Modern Control Systems. Acknowledgements

We wish to express appreciation to the following individuals who assisted with the development of the supplement: Peter J. Gorder, Kansas State University; Randall S. Janka, Mercury Computer Systems (CPG); Mariusz Jankowski, University of Southern Maine; L. G. Kraft, University of New Hampshire; Pradeep Misra, Wright State University; Mark L. Nagurka, Marquette University; Hal Tharp, University of Arizona; John Valasek, Western Michigan University; Fred Weber, University of Tennessee, Knoxville; Marcus Benavides and Terry Hill, both undergraduate students at The University of Texas at Austin; Dr. Scott J. Paynter for his contribution to Chapter 3; and Tim Crain for checking the many MATLAB scripts on an IBM-compatible PC. Finally we would like to express appreciation to Lynda Bishop for assisting with the development of the manuscript. Open Lines Of Communication

The author and the staff at Addison-Wesley Publishing Company would like to establish an open line of communication with the users of this supplement. We encourage all readers to email Addison-Wesley with comments and suggestions for this and future editions. By doing this, we can keep you informed of any general interest news regarding the supplement and pass along interesting comments from other users. Keep in touch!

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From the Back Cover

Modern Control Systems Using MATLAB & SIMULINK by Robert H. Bishop is a mid-edition supplement to the leading controls text on the market, Modern Control Systems, 7e by Dorf and Bishop (0-201-50174-0). Primarily a design process book, Bishop uses examples from the main text, converts them into design problems, and then leads students step-by-step through the entire design process. Different aspects of the design process are illustrated by worked examples in each chapter with all the intermediate steps explained in detail, from choosing and modeling components through to analysis and iteration. The author assumes readers are already familiar with MATLAB and SIMULINK and uses both programs throughout the supplement as a tool for teaching design process. Features

* provides an introduction to the control design process
* emphasizes tight link between theory and applications of control systems and design process
* uses MATLAB 4.2 throughout the text and SIMULINK 1.1 in chapters 5 and 11

Supplements

Supplemental m-files (Coming Soon!)

About the Author
Robert H. Bishop holds the Myron L. Begeman Fellowship in Engineering in the Department of Aerospace Engineering and Engineering Mechanics at The University of Texas at Austin. A talented educator, Professor Bishop has been recognized for his contributions in the classroom with the coveted Lockheed Martin Tactical Aircraft Systems Award for Excellence in Engineering Teaching. An active member of AIAA, IEEE, and ASEE, he also serves as an Associate Editor for the American Astronautical Society,s Journal of Astronautical Sciences. Dr. Bishop is a distinguished researcher with an interest in guidance, navigation, and control of aerospace vehicles.

Users Review

From reader reviews:

Sharon Self:

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