

Preface

It is well known that the benefits from the wise use of control engineering are numerous and include improved product/life quality, minimized waste materials, reduced pollution, increased safety, reduced energy consumption etc. One can observe that the notions of feedback and control play important roles in most sociotechnological aspects. The phrase “control will be the physics of the 21st century”¹ implies that all engineering students should take an introductory course on systems control.

It is widely accepted that control is more “engineering” than “science,” but it does require a firm theoretical underpinning for it to be successfully applied to ever more challenging projects. This attention to theory in academia has led to discussions through the years on the “theory/practice Gap” which culminated in a recent special issue of the *IEEE Control Systems Magazine* (Volume 19, Number 6, 1999).

The development of computer software for control has provided many benefits for teaching, research, and the development of control systems design in industry. MATLAB[®] and Simulink[®] are considered the dominant software platforms for control system analysis and design, with numerous off-the-shelf toolboxes dedicated to control systems and related topics. As Confucius said, “The craftsman who wishes to work well has first to sharpen his implements,”² and it is clear that MATLAB provides a suitable implement for control engineering. The major objective of this book is to provide information on how MATLAB can be used in control system design by covering many methods and presenting additional software routines. Many students today view control theory as difficult because of the mathematics involved in evaluating frequency responses, plotting root loci, and doing the many other calculations which can be easily accomplished in MATLAB, as shown in this book. It is therefore our opinion that the educational objective today should be to give students sufficient knowledge of these techniques to understand their relevance and teach how to use them correctly without the burden of the calculations which MATLAB can accomplish.

A distinguishing feature of the book is the organization and presentation of the material. Based on our teaching, research, and industrial experience, we have chosen to present the course materials in the following sequence: system models, time and frequency domain analysis, introduction to various model reduction techniques, model-based control design methods, PID techniques and robust control. In addition, a chapter is included on fractional-order

¹Doyle J. C. ‘A new physics?’. plenary talk presented at the 40th IEEE Conference on Decision and Control Orlando, FL, Dec. 2001.

²<http://www.confucius.org/lunyu/ed1509.htm>.

control as an alternative for practical robustness trade-offs. MATLAB scripts and plots are extensively used in this textbook to illustrate basic concepts and examples. A dedicated toolbox called CtrlLAB developed by the authors can be used as an effective teaching and learning aid. CtrlLAB was developed to support our objective of enabling control studies to be done in MATLAB by students with no knowledge of MATLAB, thus avoiding the need to replace less mathematics with the requirement of learning a programming language (although this is not difficult). CtrlLAB is the most downloaded package in the Control Systems category in the File Exchange of MATLAB Central.³

We hope that readers will enjoy playing with and changing the scripts as they gain better understanding and accomplish deeper exploration with reduced effort. Additionally, each chapter comes with a set of problems to strengthen the readers' understanding of the chapter contents.

This book can be used as a reference text in the introductory control course for undergraduates in all engineering schools. The coverage of topics is broad, yet balanced, and should provide a solid foundation for the subsequent control engineering practice in both industry and research institutes. For graduates and researchers not majoring in control, this textbook is useful for knowledge enhancement. The authors also believe that this book will be a good desktop reference for control engineers.

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Dingyü Xue, Northeastern University, Shenyang, China.
YangQuan Chen, Utah State University, Logan, USA.
Derek P. Atherton, The University of Sussex, Brighton, UK.

³<http://www.mathworks.com/matlabcentral/index.shtml>