Preface

It is well known that the benefits from control engineering are numerous including the improved product/life quality, minimized waste materials, reduced pollution, increased safety and reduced energy consumption etc. One can observe that the notion of feedback and control plays an important role in most socio-technological aspects. A slogan, “Control Will Be the Physics of the 21st Century”, appeared in a plenary session of the 40th IEEE International Conference on Decision and Control\cite{1} suggests that at least all engineering students should take a first course on systems control.

It is also widely accepted that the “control” subject is more “engineering” than “science” although the trend in the “control” subject seems to evolve along the reversal way of more “science” than “engineering”. This dilemma caused the “Theory/Practice Gap” which has recently been discussed in the Special Section in IEEE Control Systems Magazine\cite{2}.

Using a computer to apply the control theory in control practice is now unavoidable. MATLAB/Simulink is considered as the dominant software platform for control system analysis and design with numerous off-the-shelf toolboxes dedicated for control systems related topics. From what Confucius said that The craftsman who wishes to work well has first to sharpen his implements\cite{3}, it is clear that MATLAB is the right, already sharpened “implement”. However, the “gap” between a beginner and the existing rich resources or “implements” available for control systems is also obvious. Therefore, between the “Theory/Practice Gap”, for beginners, there exists another party - CACSD (computer-aided control systems design) or MATLAB. That is, the gap “Theory-MATLAB-Practice” should be minimized in the first control course for all engineering students. For example, one may not even know how to enter the system model into the form understandable by MATLAB. This textbook aims at minimizing the “Theory-MATLAB” gap via reduced mathematics and increased MATLAB illustrations glued within the texts as smoothly as possible. With a broad coverage of the contents essential for the analysis and design of feedback control systems in control engineering practice, this book can also be used as a handy desk top reference during control applications. Therefore, in general, this book will positively contribute to reducing the gap mentioned above.

The most distinguished feature of the current textbook lies in its course material organization and presentation. Based on our teaching, research and
industrial experience, we choose to present the course materials following the sequence of system models, time and frequency domain analysis with introduction to various model reduction techniques, model-based control design methods, PID techniques, robust control. Especially, from practical point of view, we put more emphasis on various techniques on PID control and model-based controller/compensator designs using MATLAB. In addition, we include a chapter on fractional-order control as an alternative for practical robustness tradeoffs.

Extensively used in this textbook are MATLAB scripts and plots to deliver the basic concepts and examples. A dedicated toolbox CtrlLAB developed by the authors can be served as an effective teaching and learning aid. CtrlLAB is freely downloadable from the ftp site of The MathWorks Inc. It should be noted that CtrlLAB is the most downloaded package in the Control Systems category in the File Exchange of MATLAB Central (http://www.mathworks.com/matlabcentral/index.shtml).

We hope that the readers could enjoy playing with the scripts and changing them as they wish for a better understanding and deeper exploration with reduced efforts. In doing so, additionally, each chapter comes with a set of problems to strengthen the understanding of the chapter contents.

This book can be used as the first control course textbook for undergraduates in all engineering schools. The coverage of topics in feedback control subject is practically broad yet with balanced depth, which provides a solid foundation for the subsequent control engineering practice in both industry and research institutes. For graduates and researchers not majoring in systems control, this textbook is good for self-learning purpose. The authors also believe that this book will be a good desktop reference for systems control engineers.

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