BOOK REVIEWS

Process Dynamics and Control, 2nd Edition

By Dale E. Seborg, Thomas F. Edgar, and Duncan A. Mellichamp, Wiley, Hoboken, NJ, 2003, 736 pp., $138.95.

The second edition of this leading textbook on process control has now been in use for several academic years, enough time for its thorough evaluation and classroom testing. Significant revision of the original text reflects changing process control practice, and recognition of an increased importance of improved process control at all levels—from regulatory to plant-wide, thus, placing a premium on process engineers capable of understanding, maintaining and designing the traditional and advanced process control systems.

The revised textbook consists of 24 chapters organized into four parts, plus five appendices. The presentation style is clear and concise which, according to students' feedback, resulted in a very readable textbook. The introductory part discusses the need for process control, introduces key terminology, and gives illustrative examples, some of which are revisited in the subsequent chapters to introduce alternative and increasingly complex control solutions. Examples of both continuous and batch processes are included. The discussion of the hierarchy of control problems, and the roadmap to the design of control systems conclude the first chapter.

Chapter 2 and Appendix B summarize the methodology of obtaining theoretical models of dynamic systems. Specific emphasis is on thermal, fluid, reaction and separation processes; numerous examples are used to illustrate the derivation of dynamic models based on theoretical considerations.

The dynamic behavior of linear systems (Chapters 3 to 7) is the subject of the second part of the book. The topics include linearization of nonlinear models, Laplace transform and transfer functions, dynamic behavior of simple processes, the effect of poles and zeros on the system response, multivariable systems, and systems with time delays. Compared to the first edition, a greater emphasis is placed on state-space models and the relationship between models of different types. Part Two is concluded with a concise summary of several methods for obtaining dynamic models from process response data, including graphical and regression techniques. An introduction to system identification methods, not covered in the first edition, has been added.

Analysis and design of feedback and feed forward controllers is the subject of the third part of the book. Chapters 8, 9 and Appendix A introduce fixed-structure (PID and on-off) controllers and the associated control instrumentation. In Chapter 10, a procedure for selecting the controlled, manipulated and measured variables, and the discussion of consequences of process design decisions (such as heat integration and material recycle) on the operation of control systems has been added since the first edition.

Dynamic behavior and stability of the closed-loop systems is the subject of Chapter 11. In Chapter 12 design, tuning, and troubleshooting of PID control loops have been substantially revised, and organized into a single chapter.

The frequency response methods in analysis and design of control systems are considered in Chapters 13, 14 and Appendix D. In this new edition, the introductory concepts of robust control have been added, while frequency-domain identification of empirical models has been eliminated.

In all chapters, the presentation is richly illustrated with examples. The exercise problems encourage students to use computer simulations to further investigate theoretical concepts. An introduction to Matlab and Simulink has been added (Appendix C).

Several specialized and advanced topics are collected in Part Four of the book. The enhancements of single-loop controllers, such as cascade control and time delay compensation, are the subject of Chapter 16, which also includes the introduction to selective, adaptive and nonlinear control systems. Design and tuning of digital control systems is discussed in Chapter 17. Overall, z-transform methods receive less attention than in the first edition, while the emphasis on time-domain methods is increased throughout the text.

Control of multivariable processes is discussed in Chapters 18–20. First, the authors introduce relative gain and singular value analysis as methods for systematic pairing of input and output variables in order to minimize interactions between multiple, independently-designed, single-loop controllers. The strategies for reducing interactions between multiple single-loop controllers are also considered. Real-time optimization of multivariable processes is discussed in Chapter 19, while the model predictive control of multivariable processes is the subject of Chapter 20.

Part Four concludes with several new topics, including an introduction to statistical process control and process monitoring (Chapter 21), control of batch processes (Chapter 22), and design of plant-wide control systems (Chapters 23–24, and Appendix E).

The revised text is primarily intended for use in teaching undergraduate process control. During a 15-week course an instructor can cover most of the material from the first three parts of the text, plus selected topics from Part 4. End-of-chapter problems are very good, and now include a substantial number of Matlab/Simulink exercises. A useful tool in teaching from the textbook is an access-controlled instructor's companion Web site, which contains the solution manual, PowerPoint presentations for all chapters, and a gallery of figures and images appearing in the text.

The second edition preserves the attributes that made the original textbook a success—the balanced and concise presentation with clarity and pedagogical skill—and incorporates significant revisions that reflect the changing process control practice, maturation of several theoretical directions, and an evolution of the chemical engineering curriculum in response to technological and economic changes. Despite the introduction of several new topics and expanded coverage of others, the authors maintained approximately the same page count by eliminating less important and outdated material. The presentation is readable and amply illustrated with examples. One of the best features of the textbook is a large number of well-designed exercises, ranging in difficulty from simple to challenging. In some cases, the exercises resemble troubleshooting situations when only symptoms of the problem are apparent, and the students must find a way to apply their theoretical knowledge to diagnose and resolve the problem.

Overall, the revised book is one of the best textbook choices for teaching process control. It is also suitable for a self-study of the subject, or as a reference for practicing process control engineers.

Mikhail Skliar
Dept. of Chemical Engineering
University of Utah
50 S. Central Campus Dr.
Salt Lake City, UT 84112
E-mail: mikail.skiar@utah.edu

AiChE Journal, Vol. 54, 3026 (2008)

DOI 10.1002/aic.11628
Published online September 24, 2008 in Wiley InterScience (www.interscience.wiley.com).