and academics. The authors are well-suited to the task having made substantial contributions to the research literature. Several other books and monographs have appeared that attempt to do the similar things, but they are generally written for audiences with a background in linear systems theory rather than process control.

The book is broken into five parts. The first presents a theory in the context of internal model control for the robust design of single variable control systems. It is a comprehensive treatment, discussing different performance measures, two-degree-of-freedom design, and control of unstable processes. The reader will gain some nice insights into "perfect" control, and how model uncertainty, time-delay, and right half-plane zeros conspire against it. Chapter 6 then quantitatively interprets in this new light existing process control technologies, such as PID, feedforward, and cascade control.

Parts II–IV of the book extend these developments to sampled data and multivariable systems. The mathematical level is somewhat higher, particularly in the discussion of multivariable control. The level is on the order of a first-year graduate course in engineering mathematics with a strong component of linear algebra. While this is not done unnecessarily, the presentation might have benefitted from a somewhat more relaxed approach. But this is quibbling, the interested reader will find the effort worthwhile.

Chapter 14 presents an interesting discussion of decentralized control. Several measures of "interaction" are used widely in process control practice. This chapter demonstrates some of the relationships among them, firmly grounding these more or less empirical techniques in the framework of robust control analysis. This is a valuable synthesis of new and old technologies that is not widely available outside of the research literature.

The final part is a case study presenting the analysis of multivariable control for a high-purity distillation column. A complete model for the column is included as an appendix.

This book represents more than just another research monograph or an updated book on process control. The authors attempt to reformulate the basic problems of process control using the advances that have occurred in robust control theory over the past decade. They give new insights into conventional techniques for process control and show the fundamental place that model uncertainty occupies in determining achievable control performance. Of course, this is not the end of the story. The role of constraints, nonlinearity, and discrete events are topics not covered in this book and, in fact, continue to be challenging research problems. But within its declared scope, the book does an excellent job of synthesizing available results for robust process control.

The book could be used independently as a guide to this area of process control or as a book to supplement a graduate course in process control. In my opinion, Part I is must reading for anyone involved with control theory, no matter what discipline. The book would not be suitable as a stand-alone text for a first course in control, since it lacks coverage of other topics, nor does it contain end-of-chapter exercises. However, I don't think it will be too long before the structure of this book becomes the framework for basic control education.

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## Basic Bioreactor Design

*By Klaas van't Riet and Johannes Tramper, Marcel Dekker, Inc., New York, 472 pp., $135.00 ($55.00 for orders of 5 or more copies, for classroom use only)*

According to the authors, this book is based on the course material of the graduate school in biochemical engineering at Wageningen Agricultural University. Part of it originated from earlier lectures given by K. van't Riet, J. J. Hiejnen, and N. W. F. Kossen in a biochemical engineering course at Delft Technical University. Its intention is to be used as a textbook for graduate students as well as a handbook of fermenter design and engineering.

The book has many positive features. The topic of bioreaction engineering is covered appropriately. In addition to topics such as balances, yield, kinetics, mass transfer, and heat transfer, it includes separate chapters on stability, shear, mixing, and foam. The expertise of the authors and their contributions to biochemical engineering are reflected in such chapters as the one on shear, which is the most current and extensive treatment of this topic in a biochemical engineering textbook.

The treatment covers the topics that one would expect in a traditional bioreactor design course that has been developed over a period of years. The prior employment of one of the authors with Gist Brocades N.V. gives the book an element of practical biochemical engineering. Relevant principles and current industrial methods for process engineering are emphasized. The book does not treat modern cell engineering topics; and genetics, plasmid, and mutation do not appear in the subject index. It does not cover reaction engineering at the cellular level, nor does it include any specialized treatment of the environmental biochemical engineering topics of bioremediation and wastewater treatment.

There are a number of good references at the end of each chapter; however, there is no attempt to include all of the important references. The references contain many contributions of the authors and their coworkers.

One of the features of an excellent textbook is an assortment of good homework problems. This book has some example problems, but there are no homework problems. Despite this shortcoming, it can be used effectively as one of the textbooks for a biochemical engineering course. Many faculty will find material from this new book useful as they attempt to cover this rapidly developing field of chemical engineering. Those who are responsible for commercialization of biotechnology will find it to be an excellent addition to a personal or corporate library.

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