"to bring to the individual researcher and engineer working at a PC all the power of modern control theory for design, simulation, and actual controls implementation." To accomplish this, it devotes a certain amount of space to discussing implementation of the optimal control and estimation algorithms on fixed-point processors, particularly on the Texas Instruments TMS320 C25 DSP (digital signal processor), and even provides examples written in assembly language. I found myself skipping these sections, which only make up a small part of the book anyway, while enjoying the review of optimal control and estimation theory. The author already has in his record successful books on the theory of both of these topics. In this book, he does an excellent job of providing clear and mathematically less demanding expositions of these topics. His deep understanding of the theory has allowed him to provide derivations of control and estimation laws that clearly convey the concepts behind the derivation, without getting bogged down in unnecessarily elaborate proofs. The author does not hesitate to sacrifice some mathematical rigor in order to keep the material accessible to those more interested in the results and their implications than the mathematics. This is exactly where the value of the book lies.

This book has five parts and ten chapters. Part I, Introduction, has two chapters. The first includes a history of automatic control, which is concise and well written with about 50 references that include many seminal papers. Such histories in introduction sections of control books usually serve little more than cosmetic purposes, but I caught myself reading this one with pleasure. The second chapter provides a review of linear system theory. The author uses both frequency and time domain approaches, depending on the subject. The section that covers both nonminimum phase systems, as well as the concepts of reachability (controllability) and observability, is particularly well written. The author says that "the meat of the book does not appear until Chapter 3," but I would recommend Part I to all first-year graduate students interested in process control. It provides a brief and readable review of basic material necessary to read most of today's control literature. Part II with two chapters covers optimal control of continuous systems. Chapter 3 does an excellent job of covering the standard linear quadratic regulator (LQR) problem with state feedback. Chapter 4 deals with output feedback design, but the techniques used are not of much interest to process control. Part III with three chapters covers digital control. Chapter 5 covers the basics, including discretization of continuous controllers, and represents a change of pace. The same material can, of course, be found in several books on digital systems, but it is convenient to have it in the same reference with material on optimal control and estimation. Chapter 6 discusses implementation aspects on a digital signal processor. I found the brief section on windup interesting in that it discusses antiwindup compensation in terms of observer dynamics. Chapter 7 covers several techniques for direct digital controller design, including the discrete versions of Chapters 3 and 4. Too many disparate techniques are thrown together in the same chapter, however. Part IV consists of a single chapter that attempts to cover the basics of robust control. There is really no connection to preceding material though. Part V with two chapters deals with the use of state observers. Chapter 9 is an excellent review of optimal state estimation. In the space of about 50 pages (if one excludes the material on DSP implementation), the author covers all the basics and goes through enough derivations to get the reader comfortable with the computation of propagation of means and covariances. I wish though that the author spent more than the one and a half pages on nonwhite process noise. Although the basic concept of augmenting the state space model to deal with colored noise is introduced, no further discussion on step-like (persistent) disturbances is given. Chapter 10, the final chapter, covers linear quadratic gaussian (LQG) design, including a discussion of the separation principle and the LQG/LTR (loop transfer recovery) design procedure. The book also includes several appendices, two of which are very good reviews of linear algebra and random processes material. Finally, it should be pointed out that throughout the book as well as in Appendix A, Fortran code is given for design computations and system simulation. I am not sure that this is such a good idea though, given the several packages that exist for control design that do not require the user to program in Fortran. The author mentions some of these packages and even uses them to perform some computations, but does not give examples of their use.

The book is meant as a textbook for a first-year graduate control course. However, I would not recommend it as the textbook for a graduate-level course on process control, as it does not touch on topics of importance to process control applications, like decentralized control and model-predictive control (with the exception of a one-page example introducing receding horizon control). Also, although the book is full of examples of the control of physical systems, none of them comes from chemical engineering. Still, the book can be an excellent supplemental text in a course that utilizes concepts from optimal control and estimation. The current directions of research on model-predictive control point more and more toward the need for such a background. The book's applied favor makes it a better choice for chemical engineering students than more theoretical books on these subjects.

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Inorganic Materials

By D. W. Bruce and D. O'Hare, Wiley, New York, 1992, 543 pp.

Duncan Bruce and Dermont O'Hare have assembled a volume devoted to inorganic materials. As stated in the preface, although there is an increasing interest in materials chemistry and more specifically in inorganic materials, few texts are available which cover this area. The editors have chosen a multiauthor format of mostly younger researchers since "their energy, enthusiasm and relatively new entry in these areas would provide new perspectives."

Each chapter is devoted to a different class of materials. Entries include molecular inorganic superconductors, inorganic magnetic materials, metal-containing materials for nonlinear optics, intercalation compounds, biogenic materials, clays, polymeric coordination complexes, metal-containing liquid crystals, and precursors for electronic materials. Each chapter contains a well-referenced introduction, followed by an overview of the area and then concentrating on selected representative examples. The historical background and the minitutorial in each chapter are designed to bring the uninitiated up-to-speed describing some of the breakthroughs as well as the challenges in the field. The practitioners will also find the volume useful for the up-to-date (some chapters cite work up to 1992) information in the area.

Although inorganic materials probably means different things to different people, the book might go unnoticed by readers who usually associate inorganic materials with ceramics.

Bruce and O'Hare have made a valuable contribution in this growing area of materials chemistry. For those interested in the subject, this book will provide a useful reference text while it can serve as a stimulus for the uninitiated.

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Mixing in Polymer Processing

Edited by Chris Rauwendaal, Marcel Dekker, New York, 1991, 496 pp., $160.00

This book is the outgrowth of a 1983 AIChE Diamond Jubilee Meeting on Mixing in Polymer Processing, whose organizer was the editor and where many of the chapter contributors were speakers. The eight years it took to write, edit and publish this book render the material dated; except for the editor's references, it is hard to find a reference which is more recent than 1985.

The book contains 11 chapters dealing with the fundamentals of distributive and dispersive mixing and with the performance of the main polymer mixing devices. All chapters are well referenced by and large.

In the area of the fundamentals of laminar distributive mixing of rheologically homogeneous mixtures, with passive interfaces, the chapter by Erwin is excellent, but brief and dated; the section of Valsamis and Tadmor on laminar distributive mixing in Corotating disk processors is brief but thorough for this device; the relevant major section by Rauwendaal dealing with single-screw helical channel flow mixing is also thorough, but with material that can be found in earlier texts on polymer processing. There is mention of chaotic laminar distributive mixing, an area of research which is quite active today.

There are two chapters on the fundamentals of laminar dispersive (intensive) mixing: one by Elmendorp dealing with immiscible fluids and the other by Manas-Zloczower on the dispersion of agglomerated solids in high-intensity batch mixers. Elmendorp's chapter, based on his thesis, treats the subjects of dispersion and coalescence thoroughly and with balance. Manas-Zloczower has also written a thorough chapter on this area of her speciality. Both chapters provide also some practical insights to dispersive mixing.

The difficult subject of measuring the degree and uniformity of mixing is addressed briefly, but lucidly, by Tucker. The important concepts involved in evaluating mixedness, as well as the associated pitfalls, are well presented.

The rest of the book is devoted to specific polymer processing/compounding equipment.

The chapter on single screw, though too long for a not-so-effective mixing device, contains a very good presentation of all the technologically important single-screw mixing elements, as well as static mixers.

Three chapters deal with twin-screw extruders. Janssen presents the equations governing the positive displacement conveying and drag leakage flows in fully intermeshing counterrotating devices. In a more practical and technological fashion, Drieblatt and Eise and Nichols treat the intermeshing, self-wiping, corotating and the tangential counterrotating extruders, respectively. Important subjects such as the effect of process and design variables on dispersive and distributive mixing, devolatilization, filler incorporation, and reactive processing are presented in an easy-to-follow fashion. The Nichols chapter is the better of the two.

Banbury-type intensive mixers are presented by Manas-Zloczower in connection with deagglomeration processes and the continuous version of these devices, the Farrel continuous mixer (FCM) by Kearney. Kearney's chapter is long in equipment considerations and short in the dicussion of the phenomena occurring in the FCM.

The important phenomenon of "dissipative mix-melting," which contributes greatly to mixing in compounding equipment, is discussed briefly by Nichols and by Valsamis and Tadmor.

This book can help enhance the basic understanding of distributive and dispersive mixing in polymer systems and of the most important compounding devices. In the latter area, the treatment could be more even and uniform by more extensive editing. We also believe that instead of a chapter on summation, an introductory chapter to mixing/compounding equipment, right after the fundamentals, would serve the reader well in guiding him through the relative advantages of each device.

Finally, this book does not address the ultimate question in polymer mixing: how is mixing performance affected by the combined effects of the mixer design, processing and material variables.

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