BOOKS

Polymer Materials Science, Jerold M. Schultz, Prentice-Hall, Inc., Englewood Cliffs, N.J. (1974). 524 pages. $20.00.

Heretofore, textbooks of polymer science have been written from the chemist's or chemical engineer's viewpoint, with a heavy emphasis on polymer synthesis. However, polymers have become so ubiquitous that their further development and utilization require the disciplines of the mechanical and the materials engineer. It was the author's intention to provide a text or self-study guide which assumes the reader has a basic knowledge of physics, crystallography, solid mechanics, and mathematics, with a lesser familiarity with organic chemistry. This approach is commendable because new advances in polymeric materials will be primarily based on process improvements and control of morphology rather than on the chemical design of new molecules.

Although Professor Schultz's approach is promising, to this reviewer the product was disappointing. The treatment often varies from great detail to offhand comments: several pages are devoted to details of transmission electron microscopy but only two sentences to scanning electron microscopy; the molecular weight distribution for addition polymerization with termination by recombination is treated in detail, whereas termination by disproportionation or transfer is ignored. Some theories are presented by rather unconventional approaches, with little indication why these may have any more merit than the classical derivations. It is disturbing to find derivations that are based on oversimplified models which are later generalized. More rigorous derivations would appear preferable. The book has many flaws, the most serious of which is the excessive number of typographical errors; Figure 2.55 exists in four parts but has no caption or coordinate details; Figures 2.56 and 2.57 also lack coordinate details; some micrographs lack specific scaling factors; Figures 5.8 and 7.3 are wrong; Figure 7.9 contains data on natural and GR-S rubbers but is cited in the text as containing data on poly(diethyl siloxane); a few electron micrographs are too cluttered and obscure to be easily understood; equations contain misprints and omissions, and are sometimes incorrectly cited. There are also some erroneous statements; namely, the reader is first introduced to rubbers ". . . as coiled chains, held together by interchain crosslinks," an incorrect definition as this class of materials also includes uncrosslinked but vulcanizable elastomers. Further on in the same chapter, in the discussion of the effect of crosslink density on properties, appears another erroneous statement: "rubber-like materials are characterized as highly crosslinked polymers;" the term *highly crosslinked* is usually reserved for inelastic resins and thermosets. Fillers in rubbery materials are treated as reinforcing particles only. The important aspects of nonreinforcing particles are ignored.

The concepts and examples are not well presented, and an unwary reader could be easily misled into making unwarranted generalizations.

L. H. PEEBLES, JR.
OFFICE OF NAVAL RESEARCH
495 SUMMER STREET
BOSTON, MASS. 02210

An Introduction to Process Dynamics and Control, Thomas W. Weber, John Wiley, New York (1974). 434 pages. $19.95.

There have been so many texts published in this subject area that it seems we should run out of possible titles, but Professor Weber's book is both originally and appropriately titled. A serious attempt has been made to establish some physical insight in the reader rather than to illustrate design techniques for feedback systems. Considerable space is devoted to the elementary techniques for developing the correct differential equations. Operational techniques are not used in the first fourth of the book, and the concept of frequency response is not even mentioned until the final chapter. Examples of transient response of many simple processes are presented, and these results are used to illustrate the characteristics of control systems.

The nature of the dimensions of the controller gain, which tends to confuse students, is treated here by introduction of a dimensioned transmitter gain K_T as part of a controller with a nondimensional gain. An alternate approach would be to make the variables dimensionless with respect to the controller spans, which is consistent with the convention for industrial controllers and which yields a dimensionless gain. The temptation presented to an eager student to convert a gain from psi/GPM to $lb._F$-min./$ft.^5$ is then avoided.

The explanations in the text are clear and detailed, and many problems are included which should be both illuminating and challenging. The detailed discussions and relatively slow pace of this book should appeal to students but may not interest many professors who have unbounded confidence in their classes when selecting texts. Except for the chapter on distributed systems, the material presented in the text could be used at the sophomore or junior level. This book might be most appropriate for a first course in a curriculum which had space for a later course on more advanced topics.

A. D. BAER
DEPT. OF CHEMICAL ENGINEERING
UNIVERSITY OF UTAH
SALT LAKE CITY, UTAH

Transport Phenomena and Living Systems: Biomedical Applications of Momentum and Mass Transfer, E. N. Lightfoot, John Wiley, New York (1974). 495 pages. $22.50.

Student and practitioners of transport phenomena with interests in solving biomedical problems will welcome this fine text. The book clearly shows its lineage and includes numerous cross-references to its parent. It is, however, a distinct and unique being in its own right. While the temptation must have been great simply to exercise the methodology of transport phenomena in a biological context, Professor Lightfoot has chosen to approach real biological problems from a transport perspective. This is an important distinction. Deduction from fundamentals is pursued to practical limits in a number of areas, and the pursuit is both stimulating and challenging to follow. But practical physiologic, pharmacologic, and engineering problems are not avoided merely because useful results cannot yet be obtained a priori. There is a clear statement of the heuristic process which demands judgment in equipment design and model development. The book thus integrates the art and science of chemical engineering in an unusually creative way and illustrates how necessary practical simplifications may be tested in magnitude against theory.

The text is devoted exclusively to momentum and mass transfer with somewhat greater emphasis on the latter. Much of it is comprised of examples which illustrate and enlarge upon basic material, and many thoughtfully conceived problems are included. Subject matter is chosen well and discussed; a carefully selected bibliography has been included for each section.

This book represents the thoughts of a teacher and scholar who articulates both the substance of chemical engineering and its significance to the solution of biomedical problems. Individuals with a thorough knowledge of classical transport phenomena can easily expand that knowledge in a new and exciting direction. Others must be prepared to read carefully and to expend a certain amount of scratch paper to follow some sections. Those who take the effort will find it a rewarding experience.

Robert L. Dedrick
Biomedical Eng. and
Instrumentation Branch
Division of Research Services
National Institutes of Health
Bethesda, Maryland 20014

Process Modeling, Estimation, and Identification, John H. Seinfeld and Leon Lapidus, Vol. 3 of ***Mathematical Methods in Chemical Engineering,*** Prentice-Hall, Englewood Cliffs, N.J. (1974). $19.95. 545 pages.

The mathematical method employs models that represent engineering processes; occasionally, it is used to actually generate the model. By comparison of model prediction with observed behavior, one attempts to estimate the numerical values of the model parameters and to, incidentally, assess the quality of the proposed model. Investigations of this type are common, indeed necessary, in research and development, with particular emphasis on model assessment and systematic parameter evaluation, and in the engineering practice, when the parameters of an accepted model need be finely tuned for optimal representation in some application. Consequently, parameter estimation techniques are important for both the (academic or industrial) researcher and the practicing engineer in the plant.

Today's development of these techniques is rapid and diversified; hence, a textbook which specializes in this branch of engineering mathematics, allowing for the specific circumstances and conditions of chemical engineering, is badly needed. The authors are eminently qualified for the task on account of their productive involvement in this area.

The book is well balanced with respect to informative contents, describing and explaining the several techniques and the logical interrelation of the presented material. Wherever the size of the book limits the extent of the discussion of offered material or precludes the presentation of additional topics, sources of further information are clearly stated. Examples taken primarily from chemical engineering situations promote the realistic understanding of abstract concepts. Extensive sets of carefully assembled problems are appended to Chapters 2 to 10; solutions are not included.

The authors explain the objectives of the book in the very brief Chapter 1; they argue in favor of a separate course in process modeling within the chemical engineering curriculum. In fact, the mathematical background of a senior engineering student satisfies the prerequisites of the book; some basic knowledge of matrix algebra and of matrix analysis is presumed throughout the book.

Mathematical formulations (for continuous and for discrete variables) of deterministic models for processes, with attention to state variable representation, are introduced in Chapter 2.

Chapters 3, 4, and 5 offer auxiliary material in the form suitable for subsequent use. The Laplace-transformation is introduced in Chapter 3, via the Fourier-transformation, and extended (for discrete data sets) into the Z-transformation; properties and theorems are presented, with special emphasis on the transfer function concept, and then employed in the solution of several challenging problems. Chapter 4 provides a compact introduction to the fundamentals of probability theory, covering that portion of an undergraduate course which is required in the subsequent chapters. In particular, it serves as basis for Chapter 5, Stochastic Mathematical Models, a topic which is not yet generally included in the undergraduate engineering programs in spite of its importance. The chapter includes the stochastic process, its several specialized forms (Markov, Poisson, Wiener), correlation, autocorrelation, and the Fokker-Planck equations, thus supplementing the deterministic models of Chapter 2.

Chapter 5 guides one naturally into Chapter 6, Residence Time Distribution Theory. The development of this theory, which is prerequisite for many other theories of chemical engineering, employs both the deterministic and the stochastic model; thus, it provides an application of the latter and an opportunity of comparison. The estimation of model parameters is systematically developed in Chapter 7; in particular, the discussion includes models expressed by algebraic, differential, or partial differential equations, and methods of least squares, maximum likelihood, Bayesian estimation, moments, and transfer functions with deterministic or stochastic inputs. The development of the principles of estimation is supplemented by algorithms for actual evaluation and assisted by several examples. Methods for the estimation of the reliability of the parameter evaluation together with logical consequences for the design of experiments intended for the estimation of some specific parameter are presented in Chapter 8, Design of Experiments for Parameter Estimation. Chapters 9 and 10, Process Indentification for Linear and Nonlinear Systems, respectively, provide a brief introduction into the task of process identification. In the former, it is shown how a state variable representation of minimum dimension can be constructed for a linear process, when the response to impulse input (or control) variables is known. In the last Chapter 10, the difficulties and possible techniques of identification (Wiener theory, finite Volterra series) of nonlinear systems are explained.

Indeed, the authors have not only suggested the introduction of a course in process modeling, they have also given us the textbook upon which such a course can be built. Of course, one must remember the already crowded curriculum. At the graduate level, Chapters 2 and 5 to 8 (possibly 9 or 10) would form the basis of an interesting and inspiring one-semester course; possibly, through reorientation of an existing graduate course in applied mathematics. Similar thoughts apply to modifications of the undergraduate program. Of great help would be the prior introduction of the stochastic process; possibly, though reorganization of the usual undergraduate course in probability and statistics.

Equally important is the help which this book offers the practicing engineer; familiarized with concepts and with terminology of process modeling, he can follow and appreciate the extensive literature, practically benefit from theoretical and experimental results, and stimulate the development with suggestions and requests.

This is a professional book; engineering as well as mathematical contents are written for the engineer, not for the abstract mathematician; the latter might occasionally disagree with the presentation. For instance, the Dirac (pseudo-) function of the impulse is not presented in the modern, mathematically consistent theory of distributions (Schwartz, 1950). A number of misprints have escaped detection in the proofreading process; fortunately, most of these are easily discovered and corrected.

Walter K. Nader
Dept. of Chemical Engineering
University of Alberta
Edmonton 7 Canada