Modern Control Engineering, Maxwell Noton, Pergamon Press, New York (1972). 277 pages. $17.50.

A professor teaching a graduate level control theory course has a very difficult task in selecting a textbook, since auxiliary courses, the background and orientation of the students, and the particular discipline (chemical, electrical, etc.) influence the decision. *Modern Control Engineering* somehow obtains a least-squares satisfaction of all of these criteria.

Noton's textbook is designed as a detailed introduction to control theory for the first-year graduate student in any discipline. Although chemical process systems have their idiosyncrasies—"a system is a system is a system"—and in this light the material in this book is quite applicable to chemical process problems. In fact, Noton's clarity throughout makes the book quite suitable for the engineer who does not specialize in process control. However, elementary knowledge of classical control theory and the rudiments of optimization theory is desirable and would increase the student's appreciation for the material presented.

Noton first introduces the student to dynamic systems (state representation, eigenvalues, etc.) and then reviews the principles of finite-dimensional, or static, optimization. A very comprehensive and up-to-date survey of optimization techniques follows. Having laid this groundwork, he then proceeds to present the theory and practice of infinite-dimensional, or dynamic, optimization. This is the largest of six chapters in the book and rightfully so. Noton consistently uses the minimum principle, which circumvents possible confusion over minimum versus maximum principle. Special emphasis is placed on handling nonlinear systems and state and control constraints; however, Noton does not discuss the treatment of large-scale systems, a research area of great activity and of special relevance to chemical engineers.

The author then moves to the subject of dynamic programming, with an emphasis on computation, for which he provides rather complete coverage. The next chapter is "Introductory Stochastic Estimation and Control"—a very readable discussion of observer and filtering theory, both of which are topics of current interest in chemical engineering. His example of driving in a "foggy car rally" clearly illustrates optimal decision-making under uncertainty.

Noton closes with a chapter documenting actual applications of dynamic optimization; in an earlier chapter he indicates that steady state optimization has more potential ($) than dynamic optimization. The brevity of this final chapter probably reinforces the idea that further basic research in process control should not be funded.

In summary, the book appears to be well-suited for use in an introductory graduate chemical engineering course; homework problems, some requiring computer solutions, are presented after each chapter. In its scope, the book is comparable to McCausland's *Introduction to Optimal Control,* but it is not as detailed as the control theory books of Sage, Bryson and Ho, Lapidus and Luus, Koppel, and Denn. I am planning to adopt the book as the principal text for a graduate course in optimal control (spring, 1973).

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Kinetics of Electrode Processes, Tibor Erdey-Gruz, transl. by L. Simandi; transl. revised by D. A. Durham, Wiley, New York (1972). 482 pages. $27.50.

The author describes the kinetics of electrode processes in both aqueous solutions and molten salts. The book is organized such that the first three chapters treat the general principles of electrode processes, including detailed discussions of the kinetics of electron exchange and the rate-determining effects of diffusion and prior chemical reactions. In Chapter 4 the kinetics of specific electrodes are described: H_2 electrode, O_2 electrode, Cl_2 electrode, redox electrodes, and the kinetics of metal dissolution and deposition. Some 20 pages are devoted to an all too brief review of anodic and cathodic processes in molten salts. Chapters on semiconductor electrode processes and anodic film formation kinetics complete the book, except for an appendix. A 46-page appendix defines and discusses a number of fundamental electrochemical concepts, including absolute reaction rate theory and a few pages on experimental procedures.

The book is very readable and contains few typographical errors. It is highly theoretical in its viewpoint and rather complete in its derivations and literature references (covering the period up to the middle of 1970).

This book, with its wealth of information, should be of value to anyone engaged in the theoretical or practical aspects of electrochemistry.

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Fluid Mechanics, Theodore Allen, Jr. and Richard L. Ditsworth, McGraw Hill Book Company, New York (1972). 415 pages, $15.50.

As stated by the authors, this book "is intended as a text for a first course in fluid mechanics offered to engineering students" who have had courses in vectorial mechanics and thermodynamics. It is subdivided into nine chapters (382 pages) with six appendices (26 pages). Chapter 1 contains basic definitions regarding a flowing continuum as well as some concepts and theorems (without proof) of field theory. The reader is led to the derivation of the Navier-Stokes equations (Chapter 4) through a statement of the mass conservation law (Chapter 2) and an introduction into the nature of forces and associated stresses in fluids (Chapter 3). Chapters 5 and 6 are devoted to integral forms of the momentum equation and energy laws, respectively. The remaining three chapters deal with irrotational flow, dimensional analysis, and an introduction to turbulence and boundary layer flows. The book has been written in simple language and contains numerous examples used effectively to apply and expand the theory. One feature which teachers may find attractive is the large number of problems and self-study questions accompanying each chapter.

In the reviewer's opinion a textbook for an introductory fluid mechanics course should be rather comprehensive while retaining a fairly high degree of thoroughness. Of these two characteristics, comprehensiveness appears to be highly desirable because, in the words of Professor G. K. Batchelor, "students are apt to derive their ideas of the content of a subject from the topics treated in the textbooks they can lay hands on." Therefore, despite the fact that it is practically impossible to present a thorough account of the science of fluid mechanics in a single book of reasonable size, an effort should be made to keep a balance between comprehensiveness and thoroughness. The authors apparently have not paid special attention to this type of consideration. For instance, the topic of flow at low Reynolds number has been ignored (even the Stokes law of drag of a slowly moving sphere appears nowhere in the text) while other topics, such as flow separation and flow of non-Newtonian fluids, have not been adequately treated. On the other hand, more than ten pages have been devoted to tables of compressible flow data.

The system of references does not seem to make up for deficiencies in the presentation. Actually the authors frequently refrain from discussing a topic, indicate that it is treated in more advanced texts, but fail to cite an appropriate reference (see for example pp. 132, 252, 264, 286, 355).

In general the authors have presented the basic equations and discussed many techniques and analytical procedures to solve fluid mechanical problems but have provided very little information about the conditions under which these techniques should be applied. This lack of emphasis on the relationship between observations and mathematical models is quite evident. For instance, experimental data are presented only in one or two places and the Reynolds number, which is normally used to characterize flow regimes according to their physical significance, is introduced almost at the end (Chapter 8) of the book.

In conclusion, although the book may be useful to teachers of introductory courses, it is doubtful whether it can make fluid mechanics more attractive to students than other textbooks currently available.

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Physicochemical Processes for Water Quality Control, Walter J. Weber, Jr. (with eight contributors), Interscience, New York (1972). 640 pages. $19.95.

The author's preface states that this volume is to be used as a text for a one or two-semester course in physicochemical processes for water and wastewater treatment technology, graduate or upper-division undergraduate level. The book is also intended as a reference for practicing engineers, in which class this reviewer falls. Both of these intents are carried out in a noteworthy manner; however, the principle emphasis of the text is on fundamental principles, and as such, will be of great value in the academic field.

The book is divided into twelve chapters, each chapter written separately by the author and/or other experts. Each section can be used independently of others for study. The first chapter (Process Dynamics, Reactions, and Reactors), gives an adequate review of kinetics, reaction equilibrium considerations, process dynamics, and energy and mass transport, and presents basic theory for the remaining eleven sections.

The remaining eleven chapters (Coagulation and Flocculation, Sedimentation, Filtration, Adsorption, Ion Exchange, Membrane Processes, Chemical Oxidation, Disinfection, Corrosion and Corrosion Control, Aeration and Gas Transfer, Sludge Treatment), cover their respective subjects thoroughly.

These individual sections are presented in a logical and informative manner. Fundamentals and theory are emphasized; however, many useful correlations, descriptions of general categories of equipment used in the subject process of the section, a review of the state of the art, and comparisons of the specific sections process with similar processes make these sections independently useful.

Problems and solutions are provided at the end of each section. It might be more useful for teaching purposes if the problem solutions are presented separately; however, these adequately cover the subject matter of each chapter.

This reviewer felt that the omission of the Zeta Potential concept from the Coagulation and Flocculation chapter deprives the student and engineer of a principle of growing importance in the field of solids/liquid separation. This reviewer was unable to find the identity of all of the parameters shown on Figures 9-3 and 9-4 in the chapter on Disinfection.

The engineer or scientist should find this book of value as a reference for designing and selecting water and wastewater treatment processes in specific problem areas. It should also be helpful in studying existing processes.

With the federal Water Pollution Act amendments of 1972 imposing a hefty burden on industry to further purify industrial wastewater emissions, this text will be useful as a comprehensive reference to many scientists, engineers, and students. This reviewer found many new ideas, as well as several thorough reviews of well-known wastewater treatment concepts.

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Process Dynamics and Control, Vol. 2, Control System Synthesis, J. M. Douglas, Prentice-Hall, Englewood, N. J. (1972). $18.95.

Volume 2 of Professor Douglas' book is a continuation of Volume 1. It discusses the control of a variety of processes of chemical engineering interest. Many of the examples and problems on control are based on process dynamics models derived in the first volume. This book should be of value to the chemical engineering student, the practicing control engineer, and the researcher.

The concept of control is approached from a rather broad viewpoint that includes regulatory control at a fixed set point and controlled cycling that might improve overall system performance. Control of various types of chemical reactors is analyzed throughout the book. Heat exchangers and distillation processes are used as examples in some discussions.

Chapter 7 (the first chapter) discusses regulator control of a single variable, starting with an example of how a controller can make an unstable chemical reactor controllable. Feedback control of simple linear processes with standard control modes is given, followed by a short, but excellent, presentation of criteria for stability. Control system synthesis based on Bode' diagrams and root locus plots is discussed at length for theoretical models. The chapter closes with topics on nonlinear effects, feedforward control, and distributed parameter systems.

The next chapter on multivariable control starts with cascade control and interaction between controllers in feedback systems. After a discussion of controllability and observability of variables, feedforward control systems are analyzed. Some of the practical difficulties encountered when multivariable techniques are applied to a complete chemical plant are given.

Optimal control of fixed set point processes is presented starting with performance criteria and mathematical tools required. Pontryagin's *minimum* principle is then applied to a variety of single variable and multivariable examples. The effect of performance criterion on the optimal control law is examined. The chapter closes with a brief discussion of optimal control of distributed parameter systems.

The last chapter challenges the assumption that an optimum steady state design gives the best plant performance. Examples of processes that demonstrate improved performance with pulsed operation are discussed. The concept of the chemical oscillator is explained with care and the necessary conditions for the existence of such a phenomena are developed.