sion of the use of perturbation theory in the analysis of nonlinear systems. Examples are presented for lumped parameter and distributed parameter systems.

The book was designed for undergraduate and graduate level courses. At the end of each chapter a large number of problems are given with an indication of their level of difficulty. That portion of the text concerned primarily with lumped parameter systems has been designated as suitable for an undergraduate course. Since some type of chemical reactor is used as the basic example in many discussions, students should have a reactor design course as part of their preparation.

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Chemical Technology: An Encyclopedic Treatment. The Economic Application of Modern Technological Developments, Barnes and Noble, New York. 8 volumes.

The encyclopedia (8 volumes) is prepared in such a way that the information is accessible to a large number of readers whose knowledge of science and technology is limited. A nonspecialist in need of brief accurate data about materials and processes can refer to a single reference work that correlates technical facts with economic and financial data in a simple yet highly organized and readily understandable fashion. This encyclopedia is a comprehensive guide, broad enough in scope to include information about all the world's raw materials. The primary manufacturing and agricultural processes involved, world output prices, and other related information are all presented in such a way that the reader can rapidly gain an overall view of a subject or a variety of subjects.

The wealth of economic information presented in these volumes should be immense value to those engaged in business, manufacturing, finance, economics, journalism, public relations, research, analysis, government, and indeed to everyone involved in commercial applications in marketing of raw materials. This work may be considered a successor to Dr. J. V. van Oss's Systematic Encyclopedia of Technology (Warenkennis en Technologie). The present encyclopedia, however, has been thoroughly updated and comprises an entirely new work that is in every way a far more ambitious and elaborate project than its predecessor.

The first three volumes are now available with five volumes in preparation ($40.00 single copy, $35.00 per copy to subscribers):

Vol. I. Air, Water, Inorganic Chemicals and Nucleonics. 1968. 703 pages.
Vol. II. Non-Metallic Ores, Silicate Industries and Solid Mineral Fuels. 1971. 828 pages.
Vol. III. Metals and Ores. 1971. 918 pages.
Vol. IV Petroleum, Organic Chemicals and Plastics.
Vol. V. Natural Organic Materials and Related Synthetic Products.
Vol. VI. Wood, Paper, Textiles and Photographic Materials.
Vol. VII. Vegetable Food Products and Luxuries.
Vol. VIII. Edible Oils and Fats, and Animal Food Products.

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Cryogenic Fundamentals, G. G. Haselden, Ed., Academic Press, New York (1972). 757 pages.

The publisher's description of this book as "the first comprehensive source book covering the full cryogenic temperature range from liquid methane down to the lowest temperatures reached by physicists" is justified by its 12 chapters, each written by one or more experts. The longest 3 chapters, Heat Transfer, Expanders and Pumps, and Superconductivity stand out. Heat transfer as it relates to low temperatures is treated in depth, with an impressive 6 pages of supporting references. Both fluid dynamic and mechanical aspects of the design and operation of expanders and pumps (both centrifugal and reciprocating) are summarized in a way that should be useful as an introduction to design or as a primer for users of this type of equipment. The phenomenon of superconductivity is described in basic terms (with a minimum of mathematics), practical materials are discussed, and the dynamic behavior of superconductors is given extensive coverage.

The chapters on Refrigeration and Liquefaction Cycles and Materials of Construction and Techniques of Fabrication also excel. The thermodynamics of refrigeration and liquefaction cycles is effectively explained, and comprehensive descriptions of cooling methods (even the vortex tube), liquefaction cycles, practical liquefiers (including methane cycles), and closed-cycle refrigerators are presented. The discussion of materials and fabrication techniques is incisive, with emphasis on fundamentals. Other chapters deal with Insulation, Fluid Dynamics, Adsorption, Instrumentation, Safety, and Thermophysical Data.

The salient features of the book are its diversity of subject matter, extensive references, and a healthy mixture of theory and practice. It will be valuable both to those already working in cryogenics and related fields, and to newcomers. Specialists will inevitably find omissions in areas of their interest, probably in recent developments; but even the specialist may find the book useful as a source of information in areas outside his specialty.

RAYMOND W. MOORE, JR.
ARTHUR D. LITTLE, INC.
CAMBRIDGE, MASS.

Process Control, Alan Pollard, American Elsevier Publ. Co., New York (1972). 393 pages. $14.00.

The author, a Senior Lecturer at the University of Leeds, has covered thoroughly and clearly the fundamental aspects of process dynamics and control. The book seems to be designed adequately for a reader with a background of differential equations and basic unit operations, or as the author states, a knowledge "compatible with the penultimate-year honours course." A knowledge of LaPlace techniques would be very helpful as there is a minimum of material included on these techniques. This book appears to be one of the better books available for self-study in process control for a person with some knowledge of LaPlace transforms because in general it is thorough, clear, and includes numerous examples. It covers most of the usual undergraduate material in this field, process dynamics, control functions, closed-loop analysis, root-locus, frequency response and some discussions and examples of controller mechanisms and complex control loops. It does not appear to be intended for advanced courses or reading in dynamics or control. It does not go deeply into instrument mechanics, valve characteristics, or the selection and location of process instrumentation. The units used may be somewhat unfamiliar to American engineers, but this should not be a significant problem.

The desired contents of a book such as this depend to a large degree on the individual reader or instructor preferences. My preferences would be for more coverage of basic theory of frequency response, Nyquist criteria, and phase-plane analysis. Also, as seems to be true of all books on control, there is little to help the inexperienced engineer select and locate instruments and controls for new process designs or process improvements, and this is where much of the chemical engineering control work is involved.

The examples used might have been selected better in frequency response and they seemed repetitious in on-off control, but in most portions of the book they were very good and thorough. The treatment seemed to be especially good in linearization, stability criteria (except Nyquist), root-locus methods, and some complex control material.

This book should prove valuable for an undergraduate textbook and for self-study and reference on basic control theory by the practicing engineer.

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Statistical Fluid Mechanics, A. S. Monin and A. M. Yaglom, M.I.T. Press, Cambridge, Mass. (1971). $18.50.

This book is a timely addition to the field of turbulence and turbulent flows. It includes necessary background material (chapters 1 and 2) for those having only advanced classical fluid mechanics training and little previous background in turbulence. The sections dealing with averages and moments will be particularly valuable to this group. The first two chapters, together with the section on semiempirical theories and Reynolds equations, will be a welcome review for persons returning to the field. The serious reader should have a good background in probability theory in order to effectively use and appreciate the material presented in the later sections.

The authors have extended and expanded the application of fluid mechanics to problems involving the atmosphere. Of particular interest are the sections dealing with thermal effects, suspended particles and their dispersion, and the determination of turbulent fluxes of momentum, heat, and water vapor. Included are many references and extensive experimental data (atmospheric) not generally available in the United States.

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LETTERS TO THE EDITOR

TO THE EDITOR: STABILITY OF TUBULAR REACTORS

We would like to comment on a paper which recently appeared in this journal by Clough and Ramirez (1972) relating to the stability of tubular reactors; the comments also apply to some other papers by these authors (1971a, 1971b).

Firstly, in Appendix A, following Equation (A10), they state that "$\underline{\underline{PA}}_{bb}$ is symmetric" which is not obvious unless P is suitably chosen to satisfy this condition: such a statement should be unambiguously included as an additional condition on the theorem. It so happens in the cases quoted that this condition is satisfied, but certainly it cannot be expected to hold in general.

Secondly, and more important, it appears that it is not appreciated that for the quadratic form $\underline{u}^T \underline{\underline{C}}\, \underline{u}$ (quoted in Appendix A) to be negative definite is not the equivalent to saying that matrix $\underline{\underline{C}}$ is negative definite unless $\underline{\underline{C}}$ is a symmetric matrix. Since $\underline{\underline{C}}$ is not in fact symmetric, it is necessary for the symmetric matrix $\frac{1}{2}(\underline{\underline{C}} + \underline{\underline{C}}^T)$ to be negative definite. Consequently the second condition imposed on $\underline{\underline{C}}$ should be applied to $\frac{1}{2}(\underline{\underline{C}} + \underline{\underline{C}}^T)$.

The following example will help to clarify the point. The quadratic form $ax_1^2 + 2b\, x_1x_2 + Cx_2^2$ can be written in matrix form as

$$(x_1\, x_2) \begin{pmatrix} a & 0 \\ 2b & c \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

According to the procedure recommended by Clough and Ramirez the conditions for $\begin{pmatrix} a & 0 \\ 2b & c \end{pmatrix}$ to be positive definite should be $a > 0$ and $ac > 0$. However, it is well known that the above quadratic will be positive definite if $a > 0$ and $ac > b^2$, as can be verified directly by expressing it in the symmetric matrix form

$$(x_1\, x_2) \begin{pmatrix} a & b \\ b & c \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

This error completely invalidates the results quoted in the paper for the dispersive case but would not alter the final conclusion for the nondispersive case, although the argument should be slightly modified.

The consequences of this are that:

1. For the nondispersive case, inequality (12) should read

$$\left(\frac{\partial P_1}{\partial x} + 2B_nR_1P_1\right)\left(\frac{\partial P_2}{\partial x} - 2B_yR_2B_2\right) - (B_nR_2P_1 - B_yR_1P_2)^2 > 0$$

By choosing $P_1 = P_2 = \exp(-Kx)$, it possible to satisfy inequalities (11) and (12) by letting $K \to \infty$.

2. For the dispersive case and also in Appendix B, inequality (B13) should read

$$\left(r_2 \frac{\partial P_1}{\partial x} + 2P_1\, B_1\, R_1\right) \left(r_2 \frac{\partial P_2}{\partial x} - 2P_2\, B_2\, R_2\right) - (P_1B_1R_2 - P_2B_2R_1)^2 > 0$$

All the arguments presented in Appendix B are invalid from this point on, and it does not seem possible to obtain any simple criteria for stability.

The theory used by the authors is most suitable for treating first-order partial differential equations. For parabolic or elliptic second-order partial differential equations, other approaches can be used (for example, Murphy and Crandall, 1970; Yang, 1971) and will be the subject of a forthcoming publication.

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