

Communication

Statistical Theory of Communication. By Y. W. Lee. John Wiley & Sons, Inc., New York, N. Y., 1960. Cloth, 6 × 9 in., xvii and 509 pp. \$16.75.

REVIEWED BY V. E. BENES¹

PROFESSOR LEE's book is an introductory account intended for an engineering audience. Except for very few passages, the presentation is detailed, at an elementary level, and slow enough so that the book could be used by undergraduates who know some Fourier analysis and electrical engineering. The principal emphasis is on harmonic analysis rather than on stochastic processes and probability. The part of probability theory that is covered in the text consists of elementary probability and simple random wave-forms, e.g., shot noise. The bulk of the book is devoted to the properties and uses of spectra and correlation functions in linear systems, e.g., the Wiener-Hopf equation.

Since mechanical and electrical systems differ mostly in point of the bandwidths and frequencies of the signals, the emphasis on harmonic analysis in the book makes it more interesting to mechanical engineers than would have been a treatise (equally well described by the title) on abstract information after the style of Feinstein or Khinchin. The book is valuable in two chief respects: (a) It contains a careful explanation of generalized harmonic analysis; (b) it gives a usable exposition and a collection of examples from the classical theory of linear optimum least-squares filtering and prediction. Further than this it does not go, because the statistical and probabilistic aspects of the theory occupy such an elementary and ancillary place in the exposition.

No attempt is made to present the material in the context of the general theory of stochastic processes. The sophisticated detection methods suggested by mathematical statistics (e.g., maximum likelihood, likelihood ratios) are not mentioned, and neither are the linear representations and Hilbert space methods of Karhunen, Loève, Grenander, and Parzen. Perhaps these topics do not belong in even a graduate text. Still, there are other, simpler topics (covered by the title) that could have been included; e.g., the special properties of Gaussian processes, particularly in regard to nonlinear prediction with a concave even error criterion (instead of the squared error), the role of conditional expectations, the use of Fokker-Planck equations to describe the passage of white noise through a dynamical system (linear or not), and so forth.

The attenuated nature of the probabilistic material may leave unsophisticated readers with erroneous impressions of simplicity or complexity. For example, the distinction between the autocorrelation of a function and the covariance of an ensemble (stochastic process) is blurred, and the senses in which harmonic analysis can be applied to a process are not adequately explained. On the other hand, during the lip service to statistical mechanics in the chapter on ensemble averages it is not explained that ergodic hypotheses are not necessary for the existence of a covariance function, and so for harmonic analysis of the process.

The work is a gracious, well-deserved tribute to N. Wiener from his former student. Nevertheless, some references to other contributors to the field were in order. The reviewer was surprised to find no mention of Khinchin and Kolmogorov, nor of Bochner. The methods of Shannon and Bode for optimal filtering and prediction, with their useful physical interpretations in terms of

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white noise, deserved mention in connection with the Wiener-Hopf equation. The author's debt to his mentor sometimes beclouds the exposition: the phrase "the Wiener theorem" occurs too frequently to be informative for someone who is not already familiar with the signal contributions of Wiener to harmonic analysis and cannot tell from the context which theorem of Wiener is meant.

Combustion

The Internal Combustion Engine in Theory and Practice. By C. F. Taylor. John Wiley & Sons, Inc., New York, N. Y., 1960. Cloth, x and 574 pp., illus. \$16.

REVIEWED BY E. GLAISTER²

A SPECIFICATION for the production of a definitive book on the theory and practice of internal-combustion engines might require the author to have spent at least 20 years in personal research and in directing the work of others, to possess a sound knowledge of thermodynamics, preferably some teaching experience, a critical and balanced judgment which takes account of the contributions of other workers in the field, an awareness of the needs both of the advanced student and the designer, and the ability for lucid exposition. Such a specification might well have been written around the qualifications of the author of the present book, who is Director of the Sloan Laboratories for Aircraft and Automotive Engines and Professor of Automotive Engineering at M.I.T., and it can be said at once, almost without reserve, that his book comes well up to our expectations.

The present volume, the first of two, deals with thermodynamics, fluid flow, and performance. Vol. II is to cover fuels, combustion, materials, dynamics, and design procedure. On the whole, the treatment is well-balanced, and although it is only natural that topics in which the author and his team have been personally involved should be given more detailed consideration than others, the author's outlook is comprehensive.

Chap. I is introductory; Chap. II contains a succinct and lucid treatment of the air cycle and emphasizes the essential interrelation of the constant-volume, constant-pressure, and "mixed" variants. The use of dimensionless ratios both here and in Chap. IV for the idealized fuel-air cycle is valuable in affording a concise statement of the effect of compression ratio on cycle quantities. Chap. III contains a rather brief discussion of the thermodynamics of the working fluid, leading to the use of the charts provided at the end of the book, and Chap. IV extends the discussion to the evaluation of the indicator diagram and the efficiency of fuel-air cycles. Chap. V discusses the actual cycle and the effect of operating variables on the indicator diagram. The M.I.T. balanced-pressure indicator is described—the Bibliography contains a reference to the "Farnboro" prototype (but not to the first description of this indicator by Wood in *Rep. and Memo.* 807 of April, 1922, or *Proc. I. Mech. E.*, 1923).

Chap. VI contains a useful discussion of the factors which control volumetric efficiency, a topic whose importance is often insufficiently stressed, and Chap. VII presents a very complete treatment of the 2-stroke engine and the scavenging process, much of it based on original work at M.I.T. The discussion on heat loss and engine cooling in Chap. VIII is valuable, although in view of the supremacy (until the advent of the gas turbine) of the air-

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cooled aero engine, it is perhaps surprising that the discussion should be virtually confined to liquid-cooled engines. Chaps. IX and X deal respectively with engine friction and pumping losses and with types of compressor and exhaust turbines. In Chap. XI, which discusses the effect of cylinder size on performance, some striking comparisons justify the simple analysis which indicates that bhp/in.^2 of piston area should be nearly independent of cylinder size. The effect of decreasing cylinder size for a given total engine displacement is mentioned, but one would have welcomed some discussion of the related topic of bore/stroke ratio, particularly in view of the marked trend toward "oversquare" cylinders shown in the author's Fig. 12.3(d) in the following chapter.

Chap. XIII, on the performance of supercharged engines, gives an impression of undue condensation, although the illustrative examples are valuable. To your reviewer it seems a pity to omit any mention of methods of predicting the performance of a supercharged aero engine at altitude (obsolescent though the type may be), especially when this might logically follow the excellent treatment of volumetric efficiency given in Chap. VI. The Bibliography is an excellent one.

These minor and personal criticisms apart, the book can be confidently recommended as a major and significant contribution to the literature of the internal-combustion engine.

Analog and Digital Computers

Handbook of Automation, Computation, and Control, vol. II. By Eugene M. Grabbe, Simon Ramo, and D. E. Wooldridge. John Wiley & Sons, Inc., New York, N. Y., 1959. Cloth 6 × 10 in., xxiii and 1070 pp. \$17.50.

REVIEWED BY JOHN R. WARD³

THIS second volume of a three-volume handbook maintains the level of excellence achieved in the first volume, which was reviewed in the September, 1959, issue of the *JOURNAL OF APPLIED MECHANICS*.

A wide coverage of the principles of design, application, and programming of analog and digital machines is presented with, naturally, a heavy emphasis on the digital instrument. Applications are restricted to computation and data processing, since the control aspect is to be covered in the third volume. Somewhat more applied than the first volume, reference is frequently made to systems and circuits currently in use.

Once again the treatment is extremely concise, permitting a rapid review of any particular area, a review which may be deepened by way of the useful and extensive references provided.

This volume belongs beside its forerunner.

Transport Phenomena

Transport Phenomena. By R. B. Bird, W. E. Stewart, and E. N. Lightfoot. John Wiley & Sons, Inc., New York, 1960. Cloth, 6 × 10 in., xxi and 780 pp. \$13.75.

REVIEWED BY D. B. SPALDING⁴

THE activities of the Wisconsin group of chemical engineers in strengthening the foundations and developing the structure of the theory of transport phenomena have attracted considerable attention in teaching circles. The publication of the present handsome volume is therefore an important occasion and an opportunity for appraising the work which has been accomplished.

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This work is, however, too massive for the present review to contain more than provisional comments and reflections; time, and experience of using the book as an aid to teaching, are needed before a full appraisal will be possible.

The authors take the view that the transport of momentum, energy, and material ought to be considered as a single subject which should rank with thermodynamics, mechanics, and other basic engineering sciences. Despite the facts that the law of conservation of momentum is incompletely similar to those of energy and matter, and that radiative transfer is a tiresome anomaly, there is much to be said for this view. The authors exploit its possibilities to the full, emphasizing and re-emphasizing the similarities between the three types of transport phenomena by parallel treatment and by cross-referencing.

Since they are writing what would normally be three books within one pair of covers, and since they have clearly resolved to discuss thoroughly every topic that they treat at all, it is inevitable that the book fails to cover all the ground which it has been customary to require undergraduate and postgraduate students of fluid mechanics, heat transfer, and mass transfer to know about; additional texts will be needed in every case. Since there are numerous suitable texts available for fluid mechanics and heat transfer, gaps in these subjects (or rather branches of the subject) can easily be filled. It is more questionable, however, whether the student can pass easily from Bird, Stewart, and Lightfoot's section on mass transfer to the relatively few alternative works on the subject; for the authors have not here provided many bridges leading to the traditional procedures of chemical engineers. Nor, which is perhaps more surprising in view of their interests in mathematical techniques and in "similarities," have they made connection with the studies of fuel combustion and of ablation made in the past decade; they do not mention the important class of problems involving simultaneous heat transfer, mass transfer, and chemical reaction which are rendered soluble by the assumption of a Lewis number of unity.

Because of the relative newness of mass transfer as a scientific discipline, the reviewer has concentrated on this portion of the book; he opened the book with two questions in mind: Have the authors succeeded in the important task of effecting a smooth juncture between the subjects of mass transfer and fluid mechanics, so that the resources of aerodynamic theory (particularly boundary-layer theory) can be freely used by chemical engineers? And have they made accessible to undergraduates (and their teachers) the relevant advances in the theory of multi-component gases as represented by the book of Hirschfelder, Curtiss, and Bird?

The answer cannot, in the reviewer's opinion, be an unqualified affirmative in either case. To take the second question first, the authors give their greatest attention to binary mixtures where they do an excellent job; they also explain clearly the influence of the choice of reference plane (mass-centered or mole-centered) on the magnitude of the diffusion flux. Yet most practical diffusion problems take place in multicomponent mixtures, and something of more relevance to these might have been expected than a brief citation of some of the results of Hirschfelder, et al., followed by a single application to a one-dimensional three-component problem.

To tackle now the second question, the authors do make an approach to boundary-layer theory; they treat the flat plate in laminar flow with a binary mixture in which all fluid properties are uniform. However, the reader may be left in doubt as to how to proceed when these properties are not uniform, if only because in one attack on the problem the authors' concentration variable is the molal density, while in the second it is the mole fraction. Which should be used when a density gradient is present? In the reviewer's opinion the answer is: neither; for, since the solution of the momentum equation only gives the mass-flux den-