Servomechanisms

Servomechanisms and Regulating System Design. Volume 1, Second Edition. By Harold Chestnut and Robert W. Mayer. John Wiley & Sons, Inc., New York, N. Y., 1959. Cloth, 6 × 9½ in., xvii and 680 pp. $11.75.

REVIEWED BY JOHN R. WARD[1]

THIS book is so well known that little need be said here to describe its contents and philosophy. In this second edition sections on root loci and analog computers have been added, and some reorganization and extension have taken place in the sections relating to Bode plots and error coefficients—the latter with an unfortunate typographical omission of a complete line of text.

The authors have aimed at a wide and comprehensive coverage of the technology of lumped parameter linear systems at a rather elementary level. In fact, the reviewer cannot but feel that the chapters on complex numbers and on the classical solution of linear differential equations are largely redundant and could either have been omitted entirely or relegated to a short appendix. It is also felt that the introduction of the root-locus method should have made possible a rather tighter integration of the allied concepts of transient and sinusoidal response in terms of the poles and zeros of the transfer functions. There is, however, little doubt that this text will be as popular as the previous edition, in view of its wide and now updated coverage.

Thermodynamics

An Introduction to the Physical Theories of Equilibrium Thermostatics and Irreversible Thermodynamics. By Herbert B. Callen. John Wiley & Sons, Inc., New York, N. Y., 1960. Cloth, 5⅞ × 9 in., xvi and 376 pp. $8.

REVIEWED BY J. KESTIN[2]

THE flow of new text and reference books on thermodynamics continues without interruption, testifying to the elusive subtlety of the subject and the prevalent dissatisfaction with those already available. However, the present book does not belong to the category in which the author provides yet one more permutation on the theme of a course of x credit-hours during y semesters. Its appearance constitutes that rare event, a fresh concept of the whole basis of the subject, arrived at after a sustained and successful intellectual effort.

Professor Callen has adopted in his book what he calls the postulational approach conceived by his former teacher, Professor Laszlo Tisza of the Massachusetts Institute of Technology. In doing so, he drives to their logical conclusion some of the ideas first incorporated in E. A. Guggenheim's "Thermodynamics" (North Holland, 1957). The postulational approach leads to a direct and logically simple development of fundamentals and endows them with a quality which can only be described by the nonscientific word—elegance. Nevertheless, this kind of approach is not without its shortcomings. The inherent difficulty in adopting a postulational approach is, first, to choose postulates which, as the author says "can be made plausible and instinctive," and, second, to demonstrate that the postulates are truly "justified by *a posteriori* success rather than by *a priori* proof." The reviewer, perhaps unconsciously influenced by the classical and nonetheless elegant expositions of M. Planck and A. Sommerfeld, prefers the methods of formulating (and suitably generalizing) easily derivable principles from properly selected critical experiments. This is largely a matter of scientific temperament and taste. The second aspect, the *a posteriori* justification of the postulates, in the reviewer's opinion, has not been given adequate weight in the book, and one gains the impression that a nonspecialist student is expected to take too much on trust.

To quote one of the author's own examples, the postulational presentation of thermodynamics is analogous to the study of nonrelativistic mechanics conceived as a derivation of the consequences of Lagrange's or Hamilton's formulations, rather than on the basis of Newton's laws. The former results in great generality and elegance but the latter keeps the student in much closer touch with physical reality.

The book begins with a study of Basic Concepts and Postulates (Chap. 1) during which, as is proper, it is discovered that the science is based on more postulates than the four "laws" of thermodynamics (zeroth, first, second, and third). Although the postulates are phrased in terms of macroscopic concepts, the microscopic point of view is skillfully woven into the canvas. But this intimate intertwining of the two points of view, without the full statistical apparatus, begs many questions and is very hard on the nonspecialist reader. Once again, the reviewer's instinct would cause him to prefer a clear-cut distinction and a separate study of the two approaches in the traditional manner.

The reviewer wishes to criticize somewhat the author's formulation of Postulate II (the Second Law). Although suitably circumscribed in a preceding section, the statement is apt to be misleading if read out of context, in that insufficient stress is put on the fact that it applies to adiabatically enclosed systems only. Similarly, the choice of a dimensionless unit for entropy, perfectly correct in itself, puts a good deal of strain on the student who may later concentrate on applications and may find himself compelled to use dimensional analysis.

Chaps. 2 and 3 continue the exposition with a penetrating study of the Conditions of Equilibrium and Some Formal Relationships, including the Euler equation and the Gibbs-Duhem relation, but not the Maxwell Relations which receive a chapter all to themselves (Chap. 7).

In Chap. 4 (Processes and Thermodynamic Engines) a distinction is made between quasi-static and reversible processes, the need for which is not clear to the reviewer. A quasi-static process is defined as a succession of equilibrium states (a *reversible* process in the usual terminology), but it is not made clear to the reader that, in general, a quasi-static process involves the exchange of heat with the surroundings. A reversible process is defined as one for which the entropy increase vanishes. It is clear that the distinction, to use conventional language, is a matter of choice of system and depends on whether the transfer of heat from the sources to the system is reversible or not. Again, the reviewer feels that for a nonspecialist reader and for one who studies the subject because of its applicability to real processes, the distinc-

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tion is not a useful one. It has some merit only if it is decided to analyze all processes in terms of closed systems confined within adiabatic walls.

Chap. 5 on Alternative Formulations and Legendre Transformations and Chap. 6 on the Extremum Principle in the Legendre Transformed Representations are beautifully written and impart to the reader a real sense of perspective and a deep understanding of the equivalence of alternative formal schemes in thermodynamics. Chaps. 8 and 9 constitute masterful expositions of stability and phase transitions and include a general formulation of the Le Chatelier-Braun principle. Chaps. 9 and 10 conclude the treatment of fundamentals and complete Part I of the book. They deal with the Third Law (Chap. 9) in a convincing way and provide a summary of principles (Chap. 10).

Parts II and III (Chaps. 12 to 17) deal with Representative Applications (II) and Fluctuations and Irreversible Thermodynamics (III). Together they occupy less than half of the book and are necessarily sketchy. They analyze selected topics in an authoritative way and the reviewer regrets that they are so short —particularly Chap. 16 on Irreversible Thermodynamics, a subject of which the author is a recognized master. The science of Thermodynamics, or, as the author prefers, of thermostatics, is applicable to so many and varied phenomena, ranging from very low temperature physics to internal-combustion engines through thermoelasticity, chemical, electrochemical, and magnetic phenomena, that every author is forced to make an "agonizing appraisal" and concentrate on topics for which he has a particular liking or whose importance he regards as overwhelming. This aspect is, perhaps, the one most responsible for the long string of books on the subject. The present, all too short, treatise stands out as a unique example of rare mastery. No serious thermodynamicist will omit to accord it pride of place on the shelves of his library and to devote a good deal of time to its careful study.

Photoelasticity

Einfuhrung in die Spannungsoptik. By Albrecht Kuske. Wissenschaftliche Verlagsgesellschaft MBH, Stuttgart, Germany, 1959. Cloth, $9^1/_2 \times 7$ in., xi and 220 pp., illus. 38 DM.

REVIEWED BY ROSCOE GUERNSEY, JR.[3]

According to the preface, it is the intent of this book to stimulate increased application of photoelasticity to practical problems. Emphasis is therefore placed on surveying the types of problems that can now be solved, and the more recent methods available for their solution.

The early chapters are devoted to an exposition of the fundamentals of stress analysis in two and three dimensions, and the optical principles employed in photoelasticity. The optical behavior of polariscope and model is explained by means of the so-called *j*-circle method developed by Dr. Kuske. This graphical procedure for analyzing transmitted polarized light will probably be unfamiliar to most American readers. Two chapters are devoted to a description of photoelastic apparatus and a rather complete survey of the properties of available photoelastic plastics.

The last six chapters cover the application of photoelasticity to a variety of two and three-dimensional problems. Among the topics treated are conventional two-dimensional methods with an extensive treatment of singular points; solution of plate problems by means of the two-sheet method and the superposition method; the stress freezing method of three-dimensional analysis using conventional stress patterns and also convergent light patterns; solution of three-dimensional problems with transmitted light and the *j*-circle procedure; and brief introductions to scattered light methods and dynamic problems.

In each case, the theory of the method is explained, and procedures for determining interior stresses as well as boundary stresses are covered in some detail. Illustrations of the application of these methods to practical problems are given by means of examples taken from Dr. Kuske's work over the past 20 years. For the most part, the illustrations are treated qualitatively, relatively few quantitative results being given.

American readers may be most interested in the treatment given to the study of plates and shells. The discussions of scattered light and dynamic problems are too short to be of much value. The remainder of the book covers material which is rather well known.

[3] General Electric Company, Schenectady, N. Y.

Flames

Flames, Their Structure, Radiation and Temperature. Second Revised Edition. By A. G. Gaydon and H. G. Wolfhard. The Macmillan Company, New York, N. Y., 1960. Cloth, $8^1/_2 \times 5^1/_2$ in., xiii and 383 pp. $14.

REVIEWED BY S. S. PENNER[4]

This second edition constitutes a somewhat revised and slightly enlarged version of the text that first appeared six years ago. Some of the more recent literature is covered through addition of about 200 new references. The chapter arrangement in the second edition is as follows: Chap. I (6 pp.): qualitative introductory remarks concerning flames; II (34 pp.): premixed flames; III (15 pp.): flow patterns and flame shapes; IV (27 pp.): measurement of burning velocities; V (45 pp.): mechanism of flame propagation; VI (27 pp.): diffusion flames; VII (14 pp.): unstable flames; VIII (35 pp.): solid carbon in flames; IX (24 pp.): radiation processes in flames; X (22 pp.): flame temperature measurements by use of the spectrum-line reversal method; XI (27 pp.): other methods for measuring flame temperatures; XII (19 pp.): calculation of flame temperatures; XIII (21 pp.): ionization in flames; XIV (27 pp.): combustion processes of rocket-type fuels; XV (5 pp.): recent progress on some flame problems.

Reference to the spatial distribution shows, for example, that roughly one third of the total volume of the book deals specifically with temperature measurements and radiation studies, whereas less than 8 per cent of the available space is devoted to a discussion of diffusion flames. These figures may serve to underscore the fact that books tend to reflect the tastes and preferences of authors rather than the topical material that is of most vital importance to the "average" reader. This type of individual topical selection is present not only in the broad outlines of the text and in the quoted references, but it is also carried over into the analytic treatment of specific topics. The informed reader may perhaps question the authors' judgment in presenting in 1960 lengthy discussions of thermal and diffusion "theories" of laminar flame propagation and, at the same time, dismissing the more complete and necessarily more complex analytical work as "beyond the scope of this book."

The book of Gaydon and Wolfhard constitutes a useful, intuitive first introduction to combustion phenomena. The discussion is not encyclopedic and the description of physical phenomena tends to be oversimplified. Nevertheless, the viewpoint of the authors should be stimulating to laymen and informed readers alike since it represents one of the classical approaches to combustion phenomena.

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