Books

Rheology: Theory and Applications. Edited by Frederick R. Eirich. Vol. 1, 761 pp., $20.00. Vol. 2, 591 pp., $18.00. Academic Press Inc., New York, 1956 & 1958. *Reviewed by R. S. Marvin, National Bureau of Standards.*

Rheology is that branch of physics concerned with the properties of matter which determine its response to mechanical force. In basic rheological studies one seeks to determine which properties are dependent only on the material rather than on a particular experiment, to develop methods of measurement of such properties, and to determine the relationship of such properties to each other and to the structure of the material. In more applied studies one is interested in determining the applicability of a material, or a class of materials, to a particular use or in developing tests which are intended to check structure or composition against established criteria.

There is a further basic problem which complicates any review of the status of rheology today. Most of our thinking about material properties is based on the concepts of linear behavior developed in the classical theories of elasticity and hydrodynamics and most of our difficulties in understanding the properties of real materials are due to the fact that they refuse to confine their behavior to this linear region. Only recently have investigators begun to develop a strict mathematical treatment relating forces, deformations, and time, based on a minimum number of assumptions (such as continuity), and denying themselves the usual expedient of linearizing their equations. The transformation of this work from a field of mathematics to a branch of physics is only now beginning.

As is generally the case, those faced with applied rheological problems have been unable to await the solution of these basic questions in analysis, and have used various devices to extend essentially linear concepts to cover observed behavior. This has resulted, of course, in a wide divergence in viewpoint and many reflections of this are found in the treatise reviewed here.

In recent years the mathematical treatment of linear viscoelastic behavior, in which the ratio of stress to strain is a function of time but not of strain, has been applied in considerable detail to synthesize observations on several types of material, notably polymers and metals. Such work is well represented in the general chapters which form the whole of Volume 1 (1956) and are scattered through both Volumes 2 (1958) and 3 (in preparation). Both phenomenological treatments and those relating properties to structure are discussed and the authors include a large percentage of those who are chiefly responsible for our present understanding of linear rheological phenomena.

The developments in nonlinear theories are represented by a chapter by Rivlin covering his theoretical and experimental work on equilibrium deformations in rubber, one by Oldroyd on non-Newtonian flow in Volume 1, and in Volume 2 a chapter by Jobling and Roberts dealing primarily with normal stress phenomena. This latter chapter is rather unsatisfactory, since it does not discuss the more recent theoretical work (which may indeed be too recent for inclusion here) and does not include an adequate account of the rather considerable disagreement regarding the interpretation of certain measurements in this field.

The balance of Volume 2 consists of chapters devoted to the rheological properties of materials of industrial importance plus one chapter by Gutenberg on the rheology of the earth's interior.

This is not a single unified text on rheology, nor did the editor intend it to be such. Largely by virtue of the subjects covered, a general reader will find Volume 1 of much greater value than Volume 2, though he could read with profit several of the chapters of Volume 2. Throughout both volumes extensive references are given and this alone will make the work of great value to those working in the field. The divergence in nomenclature is not so annoying as might be expected, partly because of the editor's insistence that each author include a rather complete list of the symbols and terms he employs.

Networks Synthesis, Vol. 1. By David F. Tuttle, Jr. 1175 pp. John Wiley & Sons, Inc., New York, 1958. $23.50. *Reviewed by Louis Weinberg, Hughes Research Laboratories.*

Revolutions by their very nature are generally not quiet but explosive. Yet in the past decade what should be called a revolution has quietly transformed the character of the education of an electrical engineer. To cope with the research problems of today the engineer must be a cross between a physicist and a mathematician. Thus, to make room for the necessary physics and mathematic courses, much of the traditional engineering curriculum—like electrical machinery and strength of materials—is being dropped. One traditional course, however, is achieving new stature; this is a course in circuits or, more appropriately, network theory.

It is being increasingly recognized that a thorough course in network theory should be the core of a curriculum in electrical engineering. It is also being recognized, but more slowly, that network synthesis, rather than analysis alone, is an indispensable part of an engineer's training. Aside from their direct value, the perspective, techniques, and concepts taught in synthesis carry over into an engineer's attack on other problems. An engineer may never in his professional lifetime work out the Brune realization of a driving-point func-

tion; yet the study of Brune's classic thesis enlarges his engineering vision and may indeed become part of the very warp and woof of his critical intelligence, just as appreciation of a great novel or poem creates a new or heightened awareness of life.

For a long time few books that treated the modern aspects of network theory were available; then suddenly everyone was writing a book on "modern" network theory. As usual, some of these books are being done as a matter of duty, perfunctorily: a professor teaches a course, prepares notes, and before you can say "Jack Robinson", a new book is out. The only modern aspect of some of these books is that they use the complex-frequency plane. Other books are prepared as a labor of love. *Network Synthesis* by Professor Tuttle falls in the latter category.

There are many evidences of the loving care that has been bestowed on this book. The author is facile with words and has taken great pains to achieve clarity. He has also taken pains to achieve accuracy, for the book is remarkably free of errors of any kind. And though in his first chapter he calls the book an introduction, he has striven mightily to cover the subject more thoroughly than it is treated in any other text.

A first reaction on contact with the book is that it is heavy: it is 1175 pages long. It treats synthesis of the driving-point function only; treatment of the transfer function is reserved for Volume 2. The first three chapters are concerned with a review of analysis and function theory; the treatment of analysis is sketchy and in this reviewer's opinion could well have been omitted—or expanded. Chapter 4 derives network properties from energy considerations and Chapter 5 treats some properties of driving-point functions. Synthesis proper begins in Chapter 6 with the realization of the inductance-capacitance (LC) two-terminal network and is continued in Chapter 7, which covers the RC and RL networks. Chapter 8 then returns to a derivation of properties of driving-point functions. The remaining chapters cover RLC synthesis and some illustrative applications, and give an exhaustive treatment of approximation techniques. More than 300 pages are devoted to the approximation problem.

The book has a wealth of detail and contains a large number of problems. Most of it is fairly easy reading, except for repetitiousness and the author's disturbing use of parentheses. It is also a bit incongruous to discover in the book phrases like "shiny new tools" for our "tool kit" and "wonderland of function theory" along with "the second of two asseverations", "a list . . . of redactions", and Greek and Latin quotations heading some of the chapters.

One improvement in the theoretical discussions might be mentioned. On page 194 the discussion in the last ten lines gives the impression that the zeros of the numerator and denominator must be calculated in order to determine whether common factors exist. This of course is not necessary: Euclid's algorithm provides the greatest common factor directly. More important, in the discussion on the top of the page it is mentioned that Sturm's theorem is required to determine whether a remainder function $E(p)$ has right half-plane zeros. Though Sturm's theorem may be used, it is simpler to expand $E'(p)/E(p)$ in a continued fraction, where $E'(p)$ indicates the derivative of $E(p)$.

The book should serve as an excellent reference for research workers. Whether it is satisfactory for a course on synthesis is a moot point. Granting the importance of synthesis, the question can be raised whether so much time can be given to the driving-point problem. Surely the major parts of the book cannot be adequately taught in a three-month course, a claim the author makes in the preface. Too much of a burden is placed on the shoulders of a hypothetical "good teacher".

Thus one returns to one's first reaction. The repetitive form of writing and the use of unnecessary qualifying phrases make the book too long. The detail finally becomes cumbersome. This, of course, is a danger of falling in love.

Basic Physics. By A. R. Meetham. 144 pp. Pergamon Press, London & New York, 1957. $3.75. *Reviewed by Ira M. Freeman, Rutgers University.*

In compiling this book, the author set himself the task of describing physical phenomena in a purely objective way, completely free of any taint of anthropomorphism. He believes that "a description of the physical world which eliminated human subjectivity would deserve the name of pure physics." The result is a highly condensed running account of selected facts of physics which is neither a textbook nor an interpretive account for the general reader.

Dr. Meetham believes that his approach, since it eliminates all reference to experimental procedures, permits him to treat his topics in any order desired. The general sequence he employs threads its way through wave motion and optics, mechanics and properties of matter, electricity and magnetism and, finally, heat.

Important results are quoted as formulas, but their derivations are, except in a few instances, not given. This makes the body of the book a rather prosaic recital of some of the basic factual material of elementary physics, resembling perhaps much too closely the type of "cram book" often displayed on the counters of college bookstores. There are no problems or other exercises.

The question of the objectivity of the physical world is of course not a new one in the history of philosophy. Certainly there is always room for any discussion that comes to grips with this problem. However, it would seem questionable that Dr. Meetham's book, considering especially the audience for which it is intended, could add much that is significant in this regard. Besides, the author is not completely consistent. After repeatedly asserting his policy of keeping "our persons and our world out of basic physics wherever possible" he makes the statement: "The foundations of physics have been disturbed before now, by Newton, Planck, Rutherford and others, but there is no possibility what-