

tion of research, which, though not new to the readers of *Physics Today* (cf. Jan., Nov., Dec., 1951, Dec., 1952), requires an adequate and up-to-date guide. Though in some minor respects this work is already out-of-date, it nevertheless is a very good guide to the sources of government documents. **Joseph Hilsenrath**
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Synchros, Self-Synchronous Devices, and Electrical Servo-Mechanisms. By Leonard R. Crow. 222 pp. The Scientific Book Publishing Co., Vincennes, Ind., 1953. \$4.20.

Here, at last, is a simple description of synchro-type devices. With many pictures and a text containing almost no mathematics, the author describes the construction, operation, and some basic applications of these units. Representative commercially made devices are shown in cutaway sketches, while the operating characteristics of some are given in tabular form.

The first chapter is devoted to general information regarding construction, types of synchros, their ratings, and their accuracy. In other chapters, single and poly-phase drives, synchro control transformers, and differential synchros are considered, while an entire chapter deals with "Instructive Experiments With Synchros". If one simply takes the stated experimental results in this series on faith without bothering to confirm them oneself, one will have gained much information on the behavior of the devices considered. The experiments themselves form a useful series for instructional purposes in a laboratory course.

Later chapters include one on servo-control units, error detection, coordinate transformation, and resolvers, and another on dc devices, electrical gearing, synchro ties between separate drives, and power synchros.

The last portion of the book is on devices depending on magnetic saturation for induction or motion. Simple mathematical explanations are given for these, and there is a good description of educational devices of this type.

For the person who requires a general knowledge of "how they work" without going into the actual design considerations of synchro devices, here is an excellent book.

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Introduction to the Theory of Functions of a Complex Variable. By Wolfgang J. Thron. 230 pp. John Wiley and Sons, Inc., New York, 1953. \$6.50.

When one approaches a new book on the subject of complex variables it is natural to expect a fresh approach to this subject which is usually the product of the author's teaching experience. Although there are numerous treatises on complex variable theory and several of these are rated as classics it is not unusual for a student to find that his instructor will recommend several texts as references and then proceed to develop the subject according to his own interests.

The thesis which is presented here is that the student of mathematics is deserving of a rigorous treatment development from first principles. The claim that no previous mathematical knowledge is required is literally true—but it goes without saying that it is advisable to approach this book with some degree of mathematical maturity.

The book may not appeal to the engineer or physicist since the point of view taken here is not of application to their problems but rigorous development of the subject. However, it can be said that those applied scientists who have not had the opportunity of studying complex variable theory as presented by Thron will always have had a gap in their mathematical training. Here they will have the opportunity of laying a foundation for themselves in rigorous mathematical thinking and the ability to tackle their problems with a bit more than "intuition".

It is usual to claim for a new work in mathematics the property of enabling the prospective reader to be able to pursue the study of the material by personal study. There is no question but that this volume meets this requirement. The student who has already had a course in complex variable will find that the development here will give a deeper understanding of the subject. The more mature mathematician who wishes to refresh his knowledge of complex variables will find not only this but an introduction to a number of other subjects of importance. The teacher will find here an excellent outline which he may follow in his lectures. The material is self-contained and although there are no references to other works, this omission will not be felt.

A deliberate and successful attempt has been made to present the material in a logical step-by-step manner. The style followed here is that followed in the classical works of Landau, namely that of "theorem-proof" without any intermediate discussion. This method of stating precisely what one wishes to prove is particularly helpful to the student. It goes a long way in helping to understand the proof itself. Professor Thron has emphasized the continuity of his presentation by calling the subdivisions of his work sections rather than chapters. This serves to remind the reader of the dependence on previous developments. There are thirty-one such sections followed by an index. Those ideas that are of importance to the logical development are introduced so that one finds here an introduction to such topics as set theory and topology. A critical study is made of the Jordan arc theorem and its presentation as given here fills a long felt need in complex variables texts in the English language. The Cauchy-Riemann equations have been accorded their proper place in one of the later sections devoted to conformal mapping. Most of the earlier works derive these conditions at the start and tend to confuse the student in his understanding of the importance of the Cauchy integral theorems.

The first three sections discuss the fundamental notions of sets, real numbers and cardinal numbers. In section four, complex numbers are introduced with par-

ticular attention to those inequalities which are of particular importance in the later developments. The generalization of associative and commutative laws for sums and products is made in section five and is followed by an introduction in section six to the basic ideas of Hausdorff spaces. This is followed by the definition of metric spaces with an application to the set of complex numbers in which a proof of the Heine-Borel theorem is given. In section nine there is a study of limits, continuity and differentiability of complex functions, followed by some basic theorems for functions of real variables in section ten. The next three sections are devoted to a study of curves and regions, some notions of topology and a careful analysis of Jordan arcs, highlighted by a proof of the Jordan arc theorem. This is followed by a section on rectifiable curves and a careful exposition of the notion of directed curves. The material up to this point may be classified as introductory to the important question of complex integration and the reader can approach the sequel with a feeling of having been well grounded in fundamentals.

Section fifteen discusses all the important theorems necessary for a proof of the Cauchy integral which is taken up in what follows. After this, such topics as function sequences, power series are developed with clear, concise statements and proofs of the Taylor and Laurent series. This is followed by some short chapters on function spaces and definitions of the elementary transcendental functions.

In section twenty-three, the subject of analytic continuation and singular points is studied, concluding with a proof of Weierstrass' theorem on essential singularities. The remainder of the volume is devoted to consideration of the theorem of residues, conformal mapping, linear transformations and a proof of the Riemann mapping theorem. The book concludes with a section on the difficult topic of elliptic modular functions and Picard's theorem on exceptional values.

Professor Thron has included a large amount of material in a relatively small volume. One finds theorems here that would ordinarily be found in highly specialized treatises on complex functions. The reader will find himself being introduced to other important and interesting fields of mathematics. There has long been need for such a volume and the present work stands a good chance of becoming a standard textbook on the subject.

Milton Abramowitz

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Electromagnetics. By John D. Kraus. 604 pp. McGraw-Hill Book Company, Inc., New York, 1953. \$9.00.

The material of this book was developed in electrical engineering courses, but the author offers it for use in physics courses as well. In the first half of the book he begins with Coulomb's law and leads up, by way of the usual intermediate topics, to Maxwell's equations. Thereafter he covers, in order, the following topics: plane waves in dielectrics, plane waves in conductors, transmission lines, wave guides, antennas, and bound-

ary-value problems. Vector analysis is used, but the vector concepts and theorems are developed as they are needed. Useful mathematical formulas are assembled in a series of appendixes.

The range of topics is wide, yet the thoroughness of coverage is surprisingly large. Each general principle is first developed with the aid of carefully planned and drawn diagrams; then it is illustrated with worked-out examples; finally it is applied in problems at the end of the chapter. The treatment of the more advanced topics is necessarily somewhat elementary, not only because of space limitations, but because Bessel and Legendre functions are not discussed until the last chapter and are therefore not available for use in earlier chapters. I would have introduced these functions early enough to use them, or else have left them out; but this is a minor point. I have only two serious adverse criticisms.

First, the author has failed to purge his subject of the internal inconsistencies introduced into it by Maxwell's editors and emulators, and since copied uncritically by each author from his predecessors. The fatal step in this version of the theory is the insertion of a dielectric constant in the denominator of Coulomb's law. This step fills the whole universe, except perhaps its field-free spaces, with a single homogeneous fluid. The subsequent transformation of this universe into one occupied by a multitude of materials, with non-linear, anisotropic, electrostrictive, or piezoelectric properties, can be accomplished only by pedagogical legerdemain. The error and its remedy have been discussed in the report of the Coulomb's Law Committee of the AAPT, in the *American Journal of Physics* for January and February 1950.

My second criticism is that there are places where the logic is faulty. On page 16, linear superposability of the potentials of several charges is alleged to follow from proportionality of the potential to the charge for a single point charge. On page 66, a demonstration that the energy-localization postulate yields the correct total energy is interpreted as a demonstration of the postulate. On pages 62 and 79, the series and parallel formulas and the image method are introduced without indication of their relation to the general field theorems from which they could have been derived. The term "lamellar" is first used on page 117 but first defined on page 194; transmission line analogies are drawn upon before transmission lines have been discussed; and statements in the text are often qualified by footnotes about things still to come.

The following remarks, though suggested by Dr. Kraus's book, do not concern it specifically; they have to do rather with the general philosophy of the subject. Electromagnetics would benefit by a critical overhauling on the basis of modern ideas about the role of theoretical models. Most forms of electromagnetic theory contain elements that do not affect the predicted values of measurable quantities; such elements are physically nonessential, and decisions about them may be made arbitrarily. Among these elements I in-