a rather limited appreciation of the flexibility and power of modern digital computers. For instance, on page 214 he states: "It now appears that digital computers, too, may have some applications in the field of simulation, particularly when the system to be simulated has a digital nature." Digital computers have for years been used to simulate very complex physical systems, for example, the temperature distribution within the core of a nuclear reactor.

This book can serve as a simple and not too technical introduction to computers. In the opinion of the reviewer, however, the interested reader can find a number of other books recently published that will more adequately serve this purpose, and probably at a lower price.

H. P.

1. T. E. IVALL, Editor, *Electronic Computers*, Philosophical Library, New York, RMT 118, *MTAC*, v. 12, 1958, p. 255.

32[Z].—WALTER J. KARPLUS, *Analog Simulation, Solution of Field Problems*, McGraw-Hill, New York, 1958, xv + 434 p., 23 cm. Price $10.00.

Analog Simulation by Karplus is essentially unique. There are neither competitive contemporary treatises nor older works with which to compare it in review. It almost automatically, then, belongs in any complete library of machine computation. The real question, on the other hand, is whether a real need exists for either a text or a reference book on its subject matter. As a research engineer, the reviewer has a strong affirmative answer to the second half of this question. He can now throw away the collection of reprints and notes which he has been carrying around for years. Its merit as a text is more debatable.

The subject matter of the book should be made clear first. The title, *Analog Simulation*, conveys to most American engineers devices like aircraft and missile simulators and electronic amplifier differential analyzers. Even the subtitle, "Solution of Field Problems," evokes a momentary picture of a fire control computer in the "field." The full title is correctly descriptive of the category of physical problems considered, but a title like "Analog Techniques for Partial Differential Equations" would have made the material covered more readily apparent.

The book is divided into three major parts. Part 1 (Chapters 2–4) gives 98 pages of mathematical background for analog study of field problems. In Part 2 (Chapters 5–10), the actual "hardware" is discussed in 165 pages. Part 3 returns to a mathematically organized discussion of the applications of the previously discussed analog techniques to different classes of partial differential equations (Chapters 11–14, 115 pages). It may be seen that most of the book is problem-oriented.

In spite of this problem orientation, the book is highly recommended as a reference on analog techniques. This is in large part a consequence of the superb list of references at the end of each chapter and the excellent 22-page general bibliography. The only serious omission is *Dynamical Analogies* by H. F. Olson, the closest equivalent to Karplus, although almost solely concerned with acoustics and vibration. If for no other reason, it would be recommended for a place on the engineer's bookshelf alongside good source books on digital computers and electronic differential analyzers.

The reviewer feels that information on direct analog simulators should be more readily available to engineers. The practitioners of the computing art tend to develop rather strong prejudices for the techniques with which they are more familiar. In fact, the three major classes of computers (digital data processors, electronic differential analyzers, and direct analog devices) all figure with equal importance in current engineering research work for which the reviewer is responsible. Not only do we have the continual rather pointless argument about the relative merits of digital versus analog computation, but computer engineers working with operational amplifier machines tend to disparage passive-network and other direct analog devices. The Introduction (Chapter 1) and Chapter 9 on "Electronic Analog Computers" do an excellent job of putting this controversy into proper perspective. The analog systems discussed in Part 2 are not diminishing in importance to engineering. These are: Chapter 5, "Conductive-Solid Analogs"; Chapter 6, "Conductive Liquids—The Electrolytic Tank"; Chapter 7, "Resistance Networks"; Chapter 8, "Resistance-Reactance Network Analogs"; Chapter 10, "Nonelectric-analog Simulation Systems." The value of *Analog Simulation* as a unique reference on distributed system analogs is indisputable.

Some consideration must be given to the merits of the book as a student text, since it is intended for such by the author. The first proposed use for the second half of a one-semester upper-undergraduate or first-graduate introduction to analog computation does not appeal to the reviewer. At this level, I have strong prejudices in favor of orientation along the line of "mathematical and physical principles of engineering analysis," with all techniques of computation introduced for illustration and some familiarization, plus some other topics such as scale modeling and dimensional analysis. My principal reason for objecting to a course based on Karplus is that I feel mathematics beyond an engineering course in ordinary differential equations is required; probably at least an introduction to complex variables or the usual survey course in applied mathematics. As a text for a full-semester course for graduate students, however, it appears excellent. Part 1, "The Mathematical Model," would be an excellent "refresher" on the mathematical and physical principles involved. Graduate engineering students working in mechanical engineering areas should benefit by the familiarization with electrical engineering techniques.

The reviewer's major criticisms of the book are very few. The weakest part is Chapter 3, "Transformations." Although it is a reasonably adequate condensed summary with useful reference tables of transformations, as a text for someone with no previous introduction to the subject it would be useless. The caution on page 66 about applicability of conformal transformations in space, although quite correct, would only be mystifying after a four-page discussion of the subject. The only misprint of any consequence noted is also in this chapter, namely $F(t)$ for $f(t)$ in formula (3.23). There are also occasional implications that physical intuition can be substituted for mathematical understanding, as on pages 11, 12, where it is stated that "It is entirely possible to develop analogs without taking a mathematical route—namely, by applying direct physical insight." Again, on page 79, Karplus warns that use of finite-difference expansions requires an understanding of errors and approximations inherent in the process, and conditions for a valid solution then immediately suggest that physical reasoning and insight may be substituted for mathematical understanding. To the reviewer, a contradiction is implied, which, it is doubtful, was intended. It is considered dangerous to suggest to students that physical intuition may be used in solving problems, without parallel mathematical analysis of the properties of the analogous systems involved. Otherwise, there is nothing that can be cited to detract from the value of *Analog Simulation* as a unique contribution to its field.

W. H. KEEN

Bureau of Naval Weapons
Navy Department
Washington, D. C.

33[Z].—W. OPPELT, Compiler, *Anwendung von Rechenmaschinen bei der Berechnung von Regelvorgängen* (*Application of Computing Machines to the Computation of Servomechanisms*), R. Oldenbourg, Verlag, Munich, 1958, 128 p., 24 cm. Price DM 16.80.

This book consists of ten papers presented at a meeting in Düsseldorf on November 8, 1957. The authors and titles are:

1. E. Bucovics	On the Use of Small Digital Computers for the Solution of Fundamental Problems of Servomechanics
2. J. B. Reswick	A Simple Graphical Method for Deconvolution
3. A. Ieonhard	A Special Computer for Polynomials
4. R. Herschel	On the Design of Analog Circuits for Problems of Servomechanics
5. O. Foellinger & G. Schneider	Comparison of Computations for Servomechanisms using Computing Machines of Different Types
6. E. Buehler	On the Mechanical System with Friction and its Electronic Equivalent
7. H. Witsenhausen	Application of Analog Computers for Optimizing Discontinuous Control Circuits with Randomly Varying Input Parameters
8. D. Ernst	Practical Work with Analog Computers
9. Th. Stein	On the Usefulness of Analog Experiments in Practical Applications
10. W. Roth	Investigation of the Control Characteristics of Electric Generator Sets by the Use of Analog Computers

(All papers are in German, except the second.)

Only two papers consider digital computers: No. 1 describes in much detail the use of an IBM 604 calculating punch for some basic problems; No. 5 compares the accuracy and speed of two analog computers (one mechanical, one electronic) with that obtained on the IBM 650 in the BELL interpretative mode. The comparison is unfair, however, since the Runge-Kutta method is used for solving a system of linear differential equations with constant coefficients (time: 27 sec./step for a system of six equations!).

There is no space here for reviewing each paper separately, so that the following statements may do some injustice to individual papers. Most authors report mainly on their practical work and experiences, not on new theoretical results. There are a