Book Reviews

Approximations for Digital Computers. Cecil Hastings, Jr., assisted by Jeanne T. Hayward and James P. Wong, Jr. Princeton Univ. Press, Princeton, N.J., 1955. viii + 201 pp. $4.

The advent of automatic computing machinery has raised a host of problems and necessitated a thoroughgoing reexamination of numerical techniques. A striking example of this is to be found in the treatment of special functions. The computer whose only mechanical aid is a desk calculator must lean heavily upon tables. If a differential equation is to be solved, the first endeavor will be to express the solution in terms of tabulated functions. Even an expansion into an infinite series of such functions may be worth while, provided that the convergence is fast enough that relatively few terms contribute significantly to the result.

The use of punched-card machines did not substantially affect this approach. Numerous tables were set up on punched cards at various computing centers and often made available for duplication as needed elsewhere. Apart from the ad hoc methods of circulation, the major novelty lies in the tendency toward higher-order interpolation to permit reducing the number of tabular entries. The Harvard MARKS, all slow by current standards, and the ENIAC, with very limited general purpose storage, each had a few tables built in.

With most of the machines that have begun operating during the current decade, the built-in table has been abandoned, and for several reasons. An obvious factor is that the built-in table ties up a great deal of hardware that might better be used more flexibly, although this was probably as true of the ENIAC, which had tables, as of the UNIVACS which have none. More to the point is the fact that at current speeds it is generally more economical to compute a function, from a power series or continued fraction, or even by solving numerically a differential equation, than it is to refer to a table and do the necessary interpolation. An exponential, for example, can be computed in a few milliseconds whenever needed, under the direction of a program prepared once and for all and occupying only a very small amount of memory space. This very fact implies that there is less need for the function itself than would otherwise be the case. Instead of attempting to transform a differential equation into a form whose solutions are tabulated, one will attempt to transform it into a form more readily amenable to direct numerical solution.

Nevertheless, the need for evaluating special functions has certainly not disappeared, and, furthermore, there is a higher synthesis of the superficially disparate points of view. Clearly in its actual utilization a power-series expansion is always truncated, and it therefore provides only a polynomial approximation to the function. But a table itself ordinarily provides also, by way of a suitable algorithm, a polynomial approximation, or rather many such, according to the interval and the interpolatory technique. But if, in either case, the function is being represented by a polynomial, it seems in order to make a direct attack and ask explicitly for the best polynomial.

The problem of obtaining an optimal representation of an arbitrary, but fixed, continuous function by means of a polynomial of given degree was investigated extensively by the Russian mathematician Chebyshev about a century ago and has been under study ever since. *Optimal* means, here, that the maximal departure of the representation from the function being represented is minimized. Chebyshev proved the basic theorems. If one allows the polynomial to be of degree n, then there will be $n+2$ points at least where the maximum departure is actually reached. It is understood that the representation is required over only a given finite segment of the x-axis. The best approximating function then exists and is even unique.

For machine purposes one can just as well use a quotient of two polynomials instead of a single one. The theory is very much the same, and the flexibility is much greater. In either event the machine has only to store the coefficients (usually six or seven) and a short program to direct the evaluation of the polynomial or fraction.

Unfortunately the proof of the existence of the best approximation is not a constructive proof, and although the best approximations are known for a few simple functions, these are very few indeed. Every case must be handled laboriously on its own. During the late 1940's, Cecil Hastings of the Rand Corporation began constructing Chebyshev approximations (or approximately (!) Chebyshev approximations) for various functions arising in the course of the computing at Rand. The "Hastings approximations" came to be well known and rather extensively used in this country and, doubtless, abroad. The approximations themselves, with error plots, were circulated, but without explanation, and the results gave no hint as to how one might go about constructing other approximations or improving upon those available.

The present little volume is designed to let the computing world in on the preparation and to collect together some of the results. Almost as laconic as the original memoranda, the volume is made up of a series of sketches, each with a brief legend. These illustrate the basic Chebyshev theorem and proceed step by step to show how one can start with an initial crude approximation and subsequently improve it. There are no mathematical demonstrations, but the presentation is admirably intuitive. The computing world is greatly indebted to Hastings for this tour of his workshop.

A. S. Householder
Mathematics Panel,
Oak Ridge National Laboratory

Speech: Code, Meaning, and Communication. John W. Black and Wilbur E. Moore. McGraw-Hill, New York–London, 1955. vii + 430 pp. Illus. $4.50.

This book is distinctive in its field by virtue of the information it contains about the neurophysiological processes of abstracting and projecting that are necessarily involved in speaking. These basic organic activities are either disregarded or markedly subordinated to other matters in most textbooks concerned with speech. By comparison, therefore, this textbook by John W. Black, of Ohio State University, and Wilbur E. Moore, of Central Michigan College of Education, is distinguished by its vital and meaningful treatment of vocabulary, meaning, evaluative reactions, logic, probability, semantics, and the related facets of communicative behavior. Any old grad who gets as far as Chapter 6, "The speaker's meanings: speech and evaluation," is likely to wedge a forefinger in the book at that point and go looking for his old speech teacher to show him how he could have made "Freshman Speech" a whale of an interesting and significant course.

Other aspects of speech, dealt with in

traditional textboks, are covered in this book also. These include the anatomy and physiology of the speech mechanism, phonetics, acoustics, gesture and body movement in speaking, the organization of speeches, types of speeches, motivational appeals, and oral style.

The level at which the authors treat their subject is definitely introductory; they state in the preface that their coverage of subject matter is "general in nature and limited in detail" and that they assume the student will eventually take more advanced courses. It is a sobering comment on our high schools that a beginning textbook at the college level, even one written by authors whose sensitivity to the depths and ramifications of their field is clearly evident, would reflect as much regard as this one does for the representative freshman's unfamiliarity with anything resembling substantial knowledge and the discipline involved in theorizing.

The major purpose of the authors appears to be that of stimulating the student's interest in speech, and they provide an abundance of practical exercises, materials to be analyzed and evaluated, and suggestions for speaking performances. Moreover, as has been suggested, they introduce the student to ways of thinking about thinking and talking about talking that are decidedly likely to be corrosive of apathy and self-satisfaction. After studying this book it should be harder for the student to feel at home at home and easier for him to live comfortably, and even a bit creatively perhaps, in mid-air, which is where modern men seem to have taken up their abode for the foreseeable future.

WENDELL JOHNSON
Speech Pathology and Psychology, University of Iowa

Methods of Quantitative Micro-Analysis. R. F. Milton and W. A. Waters, Eds. St. Martin's, New York, and Arnold, London, ed. 2, 1955. xi + 742 pp. Illus. $15.

Quantitative microanalysis has grown so rapidly that the editors found it necessary to revise and expand the first edition of this book, which appeared in 1949. Two chapters have been added: one dealing with chromatographic analysis and the other describing microbiological techniques, each written by specialists in the respective field. Of necessity only comprehensive presentations of typical examples of each experimental method have been included, but each has been augmented by fully referenced tables of similar published analytic procedures placed at the end of each chapter. Thus it has been possible to present a representative account of modern microanalysis in one volume.

The book consists of eight parts and covers the following topics: gravimetric and general microchemical techniques, microanalysis of organic compounds, volumetric analysis, colorimetric analysis, electrochemical methods of microanalysis, gasometric methods of microanalysis, chromatographic analysis, and biological methods of microanalysis. Apparatus and the presentation of data are well illustrated with figures. Author and subject indexes conclude the book. The printing, paper, and binding are good.

The second edition of this valuable book will be welcomed by all analysts who make use of microtechniques.

JOHN H. YOE
Department of Chemistry, University of Virginia

Elementary Theory of Nuclear Shell Structure. Maria Goeppert Mayer and J. Hans D. Jensen. Wiley, New York; Chapman & Hall, London, 1955. xiv + 269 pp. Illus. $7.75.

This is a good book for those who want to evaluate the current status of the nuclear shell model and for those who want to get a short, clear summary of the fundamental concepts and salient facts of nuclear physics today.

Since the proposal of the shell model in its present form in 1949, mainly by the authors of this monograph, it has become a dominant idea in nuclear physics. Although it is not yet derivable from laws about nuclear forces, it nevertheless provides a satisfactory framework for systematizing hundreds of facts about both stable and radioactive nuclei. It is perhaps the concept most used by the nuclear scientist today in assimilating new data. Do they or do they not conform to shell-model expectations? If not, are they related to other misfits?

Here will be found comprehensive discussions of nuclear moments, beta decay, gamma radiation, and light nuclei in relation to the model. Conveniently collected in this one book are Schmidt diagrams, graphs showing variation as a function of nucleon number of quadrupole moments, isotope shifts, energies of first excited states of even-even nuclei, tables of ground state data, beta-decay data, stripping-process data, and so on. The authors realize that a possible step toward understanding why the shell model works so well is the assessment of its breakdowns. The failures of the model are carefully pointed out. Some of the individual chapters have interesting summaries, but there is no over-all summing up.

The experienced scientist may be disappointed at the lack of a fairly complete bibliography of theoretical papers related to the model. The authors excuse this deficiency on the grounds that the book is intended as an introduction and not as a compilation.

The brevity and compactness will appeal to the beginning student or nuclear technologist who wants to familiarize himself with ideas fundamental in all nuclear discussions today. For the newcomer this book offers many short, but beautifully clear, explanations of such concepts as parity, isobaric spin, pairing energy, nuclear matrix element. There is a convenient review of atomic structure to help with the nuclear ideas. Acquaintance with quantum mechanics is taken for granted. Mathematical details are not omitted but are collected in several appendixes. Indeed, as the authors clearly intend, the novice can gain, with the help of this book, a pretty good working knowledge of the main facts about radioactivity and stable nuclei. He will find quickly in what a spectacular way many of these facts are given order and meaning by the shell model and will learn certain of the limitations of this systematization. These perceptions will illuminate the whole field of nuclear physics for him and will perhaps lead him to the deeper understanding of nuclear structure we are all seeking today.

KATHARINE WAY
National Research Council

Canadian Cancer Conference. vol. I. Proceedings of the first Canadian Cancer Research Conference, Honey Harbour, Ontario, 16 June 1954. R. W. Begg, Ed. Academic Press, New York, 1955. xii + 443 pp. Illus. $8.80.

The Canadian National Cancer Institute ensembled grantees and research fellows from all over the country to a 4-day informative conference in which 33 Canadian, one Danish, and seven United States scientists discussed results and methods of experimental cancer research. The main issues were induction and transplantation of tumors (8 papers), tumor-host relationship (9 papers), enzymes and metabolism (9 papers), and biological effects of ionizing radiations (3 papers). In some studies, developments in the respective fields were extensively reviewed (Andervont, Armstrong, Furth, Johns, McHenry, Mider, More, Parker, Quastel, Rossiter); in others impressive accounts were given on laboratory research in Canada (Allard, Begg, Cantero, Franks and associates, Goranson, McEwen, Selye, Skipper, Skoryna and others).

Four papers dealt with human cancer and cancer in general. The conference