REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS

The numbers in brackets are assigned according to the indexing system printed in Volume 28, Number 128, October 1974, page 1191.

16 [**2.00**, **3**, **4**].—R. W. HAMMING, *Numerical Methods for Scientists and Engineers,* 2nd ed., McGraw-Hill Book Co., New York, 1973, ix + 721 pp., 24 cm. Price $14.95.

After eleven years, the first edition of Hamming's text had gradually vanished from the consciousness of numerical analysts. Thus, the encounter with this second edition will be a first encounter for many of the younger scientists in the computer field. Moreover, the text has been rewritten and expanded to such an extent that it reads like new, even to those who have known the previous version rather well. What has remained and is even more present than before is the author's original opinion on many subjects in numerical mathematics, an attitude which is based on a wealth of experience and a continuous striving to understand what happens in numerical computations. "The purpose of computing is insight, not numbers"; the author's motto for this book indeed describes his basic attitude well. (And his pun "the purpose of computing numbers is not yet in sight" characterizes a lot of the work that keeps our computers busy.)

Although most sections treat standard problems of numerical mathematics, there is hardly a page in the book which does not contain something of interest even to those who have handled these problems for a long time. Here it is a particularly intuitive approach to a well-known result, there a new illustrative example, here an ironic side-remark, there a statement which throws new light onto a whole line of development. The careful consideration of the interaction between mathematics and digital computing is ever present.

The material is arranged into three main and two supplementary chapters. The first one ("fundamentals and algorithms") begins with an exposition of the author's ideas on numerical methods. Then he considers machine numbers (including the frequency distribution of mantissas), evaluation of functions, and finding zeros (with an unusual attention to complex zeros). The treatment of linear equations is very short and yet displays a few original thoughts on what constitutes ill-conditioning. A section on (pseudo-) random numbers and their generators is followed by an introduction into the computationally relevant parts of the difference and the summation calculus. Numerical summation of infinite series is discussed and various techniques are illustrated; difference equations and recurrences are studied. The discussion of round-off and its estimation includes the statistical approach; interval analysis is dismissed perhaps too lightly.

The second chapter is named "polynomial approximation—classical theory" to be followed by chapter three on "Fourier approximation—modern theory". This confrontation emphasizes the author's opinion that the frequency approach to the finite approximation of analytic operations is more relevant than the classical truncation error analysis. Nevertheless, he devotes a considerable effort to an excellent introduction into the classical ideas. The derivation of Peano's theorem and the discussion of its applications are beautifully clear and elementary. Formulas using differences are given a fair attention while splines receive less emphasis than one would expect. The treatment of ordinary differential equations is introduced by a discussion of indefinite integrals where the stability problem is simpler; the author then describes predictorcorrector and Runge-Kutta methods and points out special situations like stiff systems. The essentials of both least squares and Chebyshev approximation are presented and the importance of orthogonal functions and Chebyshev polynomials, resp., is well explained. The "classical" chapter ends with a section on approximation by rational functions.

Chapter 3 distinguishes this book from virtually any other in the field. Of course, numerical Fourier analysis does appear in most books, but only as one of many ways of approximation in the "time" domain whereas the "frequency" domain is hardly ever considered. The basis of Hamming's treatment is the "aliasing" effect of equidistant sampling which makes higher frequencies appear in the disguise of lower ones. This idea permits a new and often very natural appraisal of sampling distances in general when it is extended to nonperiodic functions by the consideration of the Fourier transform, and it also provides an interesting comparison with the polynomial error theory of Peano's theorem. It makes it natural to attempt a minimization of the error in the frequency domain which yields new types of formulae. While smoothing, filtering and similar subjects are treated at length, an explicit discussion of attenuation factors is strangely missing. Of course, the fast Fourier transform appears prominently. A section on the quantization of signals concludes this chapter.

Two short chapters follow. The one on exponential approximation discusses the characteristics and pitfalls of the approach; Prony's method is suggested for the determination of unknown exponents. The author then gives a short introduction to the Laplace transform; finally, he discusses some of the inherent problems of simulation, again emphasizing the frequency approach. The last chapter presents the author's view of some unrelated subjects: Numerical treatment of singularities, nonlinear optimization, and eigenvalues of Hermitian matrices. Two more "philosophic" sections, on linear independence and on general aspects of scientific computing, round up the heavy volume.

It may be difficult to use the book as a text for a course on numerical mathematics: Math majors may miss the formal rigor, science students may shun some of the mathematics, beginning computer adepts will not appreciate the wisdom of the author's remarks and more advanced ones may be deceived by the elementary looking treatment. Nevertheless, the book is a must for everybody teaching numerical mathematics at any level to any audience: There is hardly a subject in the field on which such a person will not find some new stimulation for his teaching job. And for those whom Hamming is addressing directly—scientists and engineers with numerical computing needs and some computing experience—the book is probably the best there is.

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17 [2.00, 3, 4].—THE OPEN UNIVERSITY, *Course Books,* Harper and Row, New York, 1973.

In 1969, The Open University (United Kingdom) received its charter to bring higher education into the private home. It uses radio, television, specially written correspondence material, cassettes and tapes, residential summer schools and local study centers. The readings and assignments are carefully coordinated with the BBC's broadcasts.

In Mathematics, there are four courses so far: Foundations (36 units), Linear Mathematics (33 units), Elementary Mathematics for Science and Technology (17 units), Mechanics and Applied Calculus (16 units). As an illustration, here are the topics in