great variety of wave phenomena and of mathematical techniques associated with them. For instance, one could mention the topic of nonlinear wave propagation and the notion of shocks: this wave phenomenon is not touched upon in the book. Even in the realm of small amplitude waves, the phenomenon of wave dispersion and the asymptotic methods associated with it are omitted, even though Fourier transforms and asymptotic techniques are discussed. I make these points in order to warn the prospective user about the fact that this book does not contain everything one needs to know about wave phenomena.

The above remarks are in no way meant as a criticism of the book. *Au contraire.* By focusing on those aspects of wave phenomena (propagation of small amplitude, high-frequency waves in inhomogeneous media—refraction, if you will) which the author has had to use in his own research on seismic exploration, he has succeeded in producing an excellent book. In particular, one of its greatest virtues is that it is written in a crystal clear style: there is never any waffling, since the author is never on thin ice. Also, the book contains an unusual mix of topics which are not ordinarily found in any one textbook. (I am thinking of partial differential equations, asymptotics and geometrical optics.) The book has a freshness which is in marked contrast to most elementary textbooks on partial differential equations used for an introduction to these topics. For instance, it has one of the best presentations of the theory of first-order partial differential equations and of ray tracing. Finally, need I add that this book can serve as an ideal introduction to the field of inverse problems of seismic prospecting.

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7[65-01].—T. R. F. NONWEILER, *Computational Mathematics, An Introduction to Numerical Approximation*, Ellis Horwood Series in Mathematics and its Applications, G. M. Bell, Series Editor, Ellis Horwood Limited, Chichester and Halsted Press, Wiley, New York, 1984, 431 pp., 23 cm. Price $59.95.

Was this just one of those mornings when I was being unusually dense? I was gazing steadfastly at the page, which was telling me

> The maximum number of digits available to the mantissa is called the **precision**, or number of **significant digits**. Suppose, for example, a decimal floating-point number is to be represented with 3 significant digits (albeit, not a very generous allocation), then the number $2^{1/2} = 1.414213\ldots$ would be written as 0.141×10^1 if the standardization (1.2.2) is used, or as 1.41×10^0 if (1.2.3) is used.

"Wait! I've taught this material," I reassured myself; "it can't be this abstruse." Had the time come to retire? This same gauze of unknowing seemed to be inserted between me and every paragraph of the book. In desperation, I pulled from the shelf that old warhorse from which I learned (and became enlivened by) the subject, *Numerical Mathematical Analysis*, by James B. Scarborough, opened it and read

> A significant figure is any one of the digits 1, 2, 3, ..., 9; and 0 is a significant figure except when it is used to fix the decimal point or to fill the places of unknown or discarded digits. Thus, in the number .000263 the significant figures are 2, 6, 3 ....

Well, it could be argued that the first author is telling us more than the second. I won't debate the point, since I haven't quite sorted it out yet. But I really believe that what he is telling us isn't all that important to anything that follows. And in text writing, *how* something is being told is often more important than *what* is being told. In fact, as generation of students have discovered, without the *how* there is no *what*.

A recent writer has decried the fact that all over the world houses remain unpainted, pets unfed, diapers unchanged, gardens untended as penurious professors of mathematics slave to produce the perfect numerical analysis textbook. What are we to make of this quixotic search for *the* numerical analysis book? Does each new book occupy its dutiful place in a Platonic progression towards *the* book, the perfect one that waits out there somewhere, just over the horizon? It reminds me of the schoolchildren in Huxley's *Brave New World* who were made to stand in a circle and chant, "New is good! New is good!" The sane part of us knows, on the contrary, that new is only new, and often not that. The quotations above show that the quality of exposition in textbooks isn't monotone increasing, and it's a real shame that this fixation on the new has resulted in the out-of-print status of many noble books. When I want to teach out of one of the old books and find it is out of print, I'm more certain than ever that the New is being crammed down my throat. And then, in a gesture of pure defiance, I pick that sturdy, perennial, pellucid, cheap Schaum's outline volume as the text. My students have never complained.

The present book, unfortunately, is a pedagogical quagmire. It's numerical analysis as Macaulay might have written it, in a rhetoric appropriate to leisurely political reflection, but not to the nitty-gritty process of getting core basics through resistant student skulls. Too often, otherwise comprehensible statements are undercut and muted, qualified unnecessarily by phrases such as *indeed*, *it is possible*, *in this sense*, *in any event*, *this would suggest*, *could be developed* (all from one paragraph, page 233). On page 63 we find

> An alternative is to accept what appears to be a convenient and relatively easy way of generating such expansions, in the hope, or maybe expectation, that it will be of assistance. One such method leads to a curious construction called a **continued fraction**.... Because they may be unfamiliar, some brief description here will not be amiss.

Curious constructions. As well as any other, this expression describes the book. It is seldom apparent whether the author is merely suggesting or adumbrating, or whether he is giving honest-to-God advice—an abiding fear of the untrammeled flow of information. Would that the word *would* were excised completely. We ache to see: *Here is the formula! Here are the numbers! Now use them!!*

Only two effective methods of encapsulating information in a mathematical text have ever been devised. One is the theorem-proof approach; the other is explication by example. Either has the advantage that, no matter how complex or abstract the material is, the student can usually understand what it is that he doesn't understand. While most textbooks use a combination of both, elementary numerical analysis texts (such as Scarborough) generally prefer the latter because of the lack of mathematical maturity of the students. This book uses neither. Exposition is by indirection. The lack of in-text examples is crippling. There is a crucial deficiency of displayed equations. Many, many pages have no equations whatsoever, which inevitably means that mathematical facts are being displaced by verbiage. Pick up any of the good old books and you'll find almost all the pages filled with formulas. Formulas don't need to be apologized for. They *are* the mathematics. This book needed the sternest, the most implacable of editorial red pencils. But instead, it got unbridled license. Editors alone, it's true, can't produce good books, but they can certainly protect authors from themselves. Any one of us who writes a textbook should pray for an editor as ruthless as a Dickensian orphanage master. In the present case, the series in which the book appeared (and which seems to handle each manuscript as gingerly as a research monograph) is probably the utterly wrong one for a textbook.

An unusual feature is that the entire second half of the book is devoted to problems for which hints and solutions are provided. The author has obviously worked very hard to accumulate and organize this wealth of material—it all clearly derives from his experience. And it should have worked. But it doesn't. The writing is suffused with the same crepuscular rhetoric as the rest of the text. Too often the very choice of words obscures what is being asked, or masks the importance of what can be discovered. *Example*: "Write a sequence of machine instructions which serves to assign the value of $\Gamma(z)$ to the variable *gamma*. ... If the programming language you use allows the definition of recursive functions, then *gamma* may be assumed to be such a function." *Suggested emendation*: "Write a program to compute $\Gamma(z)$. This is one of a number of cases where a mathematical function can be computed from a recursion relation."

Was the author misguided by his appraisal of the text's market? The tone of the book suggests a second level or graduate student user; but the material is appropriate for anyone with only a calculus background. And, at any rate, clear exposition is clear exposition. Rudin and Royden, though a lot harder, are just as clear as Scarborough, or Titchmarsh, or Apostol, or any other first-rate book.

The subject matter is entirely traditional. Chapter 1, devoted to computational arithmetic, is perhaps too long. And it's in this chapter that the author's communication with the reader seriously falters. If the lecturer covered the material using a different book or from his own notes, the remainder of the book could probably serve as well as many others. Chapter 2 talks about function evaluation: infinite series, asymptotic expansions (why does the author call them *semi-convergent series*? —a high-button shoes expression used by no one doing research in the field), comparison series, continued fractions. The discussion of convergence of continued fractions badly needs some theorems. The criteria are too deeply buried in the text to be of much use. Chapter 3 takes up curve fitting, polynomial approximation, interpolation and extrapolation, splines. The lack of displayed algorithms and formulas and of crisply stated theorems makes the subject matter seem unduly soft and ethereal. This is particularly disappointing in the treatment of minimax approximations, for few subjects in applied mathematics are so inherently elegant. Chapter 4 discusses the solution of equations in a single variable and Chapter 5, numerical quadrature. The discussion of polynomial equations treats only Sturm sequences and polynomial deflation. I have never known anyone (except luckless numerical analysis students) to use these methods. Research scientists hardly ever have to find real zeros; they want complex zeros.

The present book has as many difficulties with *what* as *how*. I often teach courses which are taken at night by people who work in industry, and I always make a point of asking them what problems in numerical analysis they encounter most frequently in their jobs. The problems most commonly mentioned are

1) Solving PDE's;

2) Finding eigenvalues and eigenvectors of partial differential operators;

3) Solving systems of equations (often overdetermined) and inverting matrices (of very large order, say, 100×100);

4) Finding eigenvalues and eigenvectors of matrices (again, very large matrices);

5) Determining all the complex roots of polynomial equations of high degree;

6) Multivariate numerical integration;

7) Solving ODE's, often large systems;

8) Linear and nonlinear programming problems.

Concerning all these vital issues the present book maintains an obstinate silence. And I know the reasons. The material is terribly messy, inherently inelegant, and nearly impossible to organize. It's so much easier to expound lucidly on iteration procedures of higher order, Hermite-Birkhoff interpolation, and specialized quadrature formulas. But the topics itemized above are precisely those required if the instructor is to be faithful to the needs of his students. A conscientious teacher will present at least some of the material. Sadly, this book will be of little help.

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8[65-01, 65Mxx, 65Nxx, 76-01, 76-08, 80-01, 80-08].—DALE A. ANDERSON, JOHN C. TANNEHILL & RICHARD H. PLETCHER, *Computational Fluid Mechanics and Heat Transfer*, Hemisphere Publishing Corp., McGraw-Hill, New York, 1984, xii + 599 pp., 24 cm. Price $39.95.

This is a textbook for advanced undergraduates or first-year graduate students, who have had "at least one basic course in fluid dynamics, one course in ordinary differential equations, and some familiarity with partial differential equations. Of course, some programming experience is also assumed."

At Iowa State University, their engineering students, primarily of aerospace and mechanics, have benefitted from this material during the past ten years. The book deals with finite-difference methods.