linear difference equations, and the method of Lewanowicz for the construction of recurrence relations for the coefficients of series expansions in Gegenbauer polynomials.

Except for the expansions of solutions of ordinary differential equations, most of the applications are to difference equations satisfied by higher transcendental functions, particularly those belonging to the hypergeometric family. Another immense source of linear difference equations is the numerical discretization of ordinary differential equations. This area is not touched by Wimp, yet it is difficult to quarrel with this exclusion. The discretization process introduces its own convergence problems and sources of error, and a comprehensive treatment would have taken the subject matter well away from the main thrust of this reasonably-sized volume. Moreover, some aspects of this application have been treated in a recent book by J. R. Cash [1].

The remaining part of the main text, Chapters 12 to 14, treats systems of nonlinear difference equations. The aspects here are somewhat different. The emphasis is on convergence to fixed points of the corresponding operators, rather than on error analysis and stability. These chapters provide a brief introduction to convergence questions, invariants and divergence theory (strange attractors). Examples include arithmetic-harmonic means, arithmetic-geometric means, infinite products and generalizations of the algorithm of Gauss and Landen. Much of the applications centers on the computation of definite and indefinite integrals of elliptic type. Some aspects, for example, methods for the acceleration of convergence, are complemented by results given in an earlier book by the same author [2].

On the cover, the publisher claims "This book will be of interest to computer scientists, applied mathematicians, physicists and engineers. It contains a comprehensive, state-of-the-art, account of computational techniques based on the general recurrence relation $\mathbf{x}(n+1) = \mathbf{f}[\mathbf{x}(n), n]$". This reviewer endorses this claim wholeheartedly.

F. W. J. O.

1. J. R. CASH, *Stable Recursions, with Applications to the Numerical Solution of Stiff Systems*, Academic Press, London, 1979.

2. J. WIMP, *Sequence Transformations and Their Applications*, Academic Press, New York, 1981.

**22[46-01, 65J05].**—R. E. MOORE, *Computational Functional Analysis*, Ellis Horwood Series, Mathematics and its Applications (G. M. Bell, Editor), Halsted Press, Wiley, Chichester, New York, 1985, 156 pp., $23\frac{1}{2}$ cm. Price \$34.95.

Most areas of mathematics have their roots in the sciences. In fact, entire branches of mathematics arose from attempts to understand and analyze certain physical phenomena. As a discipline matures, however, it can often stray from its origins until it reaches a point in its evolution where it becomes self-sufficient. Its subsequent development can become so esoteric that students (even experts) have no inkling of its practical origins and applications, and indeed are amazed when informed of its usefulness in solving "real-world" problems. A frequently mentioned example is functional analysis.

During the past several years, there has been a trend in mathematics textbooks which parallels the recent emphasis on applied mathematics. This trend takes the form of an increased awareness of the origins of a subject and is evidenced by the growing number of textbooks with the words "applied" and "computational" in their titles. Although these efforts are commendable, unfortunately they are all too often thinly disguised attempts to repackage familiar material in popular terminology.

The first impression one gets of this textbook is that it is unexpectedly short (about 150 pages) for such an ambitious undertaking. How is it possible in so small a book to "taste the flavor of numerical functional analysis" as the author suggests? Perhaps that is possible, but it has not been done in this book.

The book actually fails on two counts. First, it fails as a traditional textbook in functional analysis. Moreover, it does not convey the essence of *computational* functional analysis. Let's consider these two points in greater detail.

In the first several chapters and scattered throughout the remainder of the book, many of the usual functional-analytic topics are presented in an extremely terse machine-gun style. Topics such as linear spaces, topological spaces, metric spaces, Banach and Hilbert spaces, linear functionals, convergence, operators, compact operators, contraction mappings, and Fréchet differentiation are zipped through with whirlwind speed with little or no motivation. Few results are proved in the textbook; rather, the author prefers to leave most of the standard theorems as exercises, and the book does contain many exercises. A reader who is not already familiar with functional analysis would get little out of the presentations and become frustrated and discouraged with attempts to do the exercises. Chapter 8 on types of convergence in function spaces provides a typical example. After defining strong, weak, pointwise, uniform, *, and weak-* convergence, the author immediately gives a series of exercises on the relationships among those various types of convergence. The entire treatment occupies a mere two pages!

The author's terse style does not lend itself to enlightening discussion of the *applications* of functional analysis either. Although most of the applications in the book should appeal to anyone with an interest in how functional analysis can be used, enthusiasm is bound to be replaced again by frustration and discouragement while struggling through the often sketchy presentations. For example, Newton's method in Banach spaces and its variants are introduced briefly in Chapters 17 and 18 (19 pages total), some general results are mentioned, and then the reader is referred to the literature for details. The discussion of homotopy and continuation methods in Chapter 19 includes a fair general description of those powerful techniques, but all the cited references are old, the computational aspects are dismissed in vague terms, and no mention is made of recent work.

The author states in the preface that this textbook is designed for a one-semester, first-year graduate introductory course which can be expanded into two semesters. It is claimed that the only prerequisites are some knowledge of linear algebra and differential equations. That seems to be much too optimistic. At the very least, a student should have a solid grounding in advanced calculus and the corresponding mathematical maturity *before* tackling the material in this book. Otherwise, it simply would not be accessible. In particular, how could anyone without advanced calculus experience be able to handle the exercises on convergence in Chapter 8 or have a chance of understanding the difficult and more advanced notion of Fréchet differentiation in Chapter 16? Even with good backgrounds in advanced calculus, most students must struggle to absorb the concepts of functional analysis.

In addition, a more extensive knowledge of applied mathematics is necessary before a student can appreciate the powerful methods of functional analysis and how they aid in the understanding and solution of applied problems. Undergraduate courses in differential equations usually do not include applications of sufficient complexity to require functional-analytic techniques in their solutions. A complex real-world problem, such as the fluid-flow problem discussed in Chapter 20, is probably beyond the grasp of a student whose applied mathematical experience consists of a single course in differential equations.

I am always attracted by analysis textbooks, and especially by those which purport to explore the rich and fruitful relationships between analysis and the applications. My on-going search will not end with this book.

JAMES P. FINK

Institute for Computational Mathematics and Applications
University of Pittsburgh
Pittsburgh, Pennsylvania 15260

**23[65B05, 65J05].**—K. BÖHMER & H. J. STETTER, Editors, *Defect Correction Methods—Theory and Applications*, Springer-Verlag, Wien, New York, 1984, vi + 242 pp., $24\frac{1}{2}$ cm. Price \$20.00.

Numerical analysis is rich in iterative methods of diverse types, for example, Newton-Raphson, Gauss-Seidel, multigrid, iterative refinement, and deferred correction. A talk given at the 1973 Dundee Conference by P. E. Zadunaisky, which proposed estimating errors in the numerical solution of ODEs by determining the errors in the numerical solution of a neighboring problem with a known analytical (piecewise polynomial) solution, stimulated H. J. Stetter to propose yet another iterative method. It became apparent that this new method shared with so many other iterative methods the idea of computing a correction based on the computation of a relatively accurate residual, and hence Stetter formulated the "defect correction principle" in a paper which appeared in 1978. The use of the distinctive term "defect" for "residual" had been introduced by R. Frank and C. W. Ueberhuber and was probably helpful in attracting interest to this novel approach to iterative processes. Indicative of its rapid acceptance is the inclusion of a section entitled "Splitting methods and defect corrections" in the 1984 report of the NRC Committee on Applications of Mathematics.

This book is the proceedings of a 1983 Oberwolfach working conference on "Error Asymptotics and Defect Corrections." It is not an attempt to compile a book on defect correction. Rather it is a heterogeneous collection of papers tied together by the common thread of defect correction. Authors and titles follow:

Böhmer, Hemker, Stetter: Introduction: the defect correction approach.
Frank, Hertling, Lehner: Defect correction algorithms for stiff ODEs.