REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS

The numbers in brackets are assigned according to the revised indexing system printed in Volume 28, Number 128, October 1974, pages 1191–1194.

5 [6.15].–CHRISTOPHER T. H. BAKER, *The Numerical Treatment of Integral Equations,* Oxford Univ. Press, Oxford, 1977, xiv + 1034 pp., 27 cm. Price $49.50.

This is the first comprehensive account of the numerical analysis of integral equations, giving both methods and their mathematical framework. It is a welcome addition to the small number of books on this subject, most of which are much more limited in scope. This book covers all major types of integral equations, and many more minor ones as well. Among the equations discussed are Fredholm and Volterra equations of both the first and second kinds, Cauchy singular integral equations, and nonlinear Fredholm integral equations. The book is directed toward the numerical analyst; although it should be easily readable and quite useful to people from the sciences, who may not have much formal background in numerical analysis.

It is a very long book (1034 pages), and its development is often very leisurely. Complete presentations are given of most numerical methods, including many examples and complete discussions of the error in the methods. The author has tried to make all discussions as concrete as possible, avoiding highly abstract arguments whenever possible. This has a number of advantages, including greater flexibility in designing proofs of convergence. But it also results in overly long convergence analyses in a number of cases. It is probably a matter of personal preference as to which approach is better.

The book contains six chapters. Chapter 1 gives a general introduction to integral equations, including a classification of them, theoretical results, and many interesting examples. It also contains an introduction to notation and results from functional analysis. Chapter 2 reviews material from numerical analysis that will be needed in later chapters. Topics included are interpolation, approximation of functions, numerical integration, and numerical linear algebra.

Chapter 3 covers the eigenvalue problem for Fredholm integral operators with smooth kernel functions. Many numerical methods are presented in the first twelve sections; and the remaining sections cover the convergence theory, including calculation of error bounds and estimates. Methods covered include the quadrature method, projection methods (Ritz-Galerkin, collocation), degenerate kernel approximations, the least squares method, and the Rayleigh-Ritz quotient. Relatively more space is given to Hermitian integral operators. There are many examples illustrating the methods, including a number for integral operators defined using a Green's function. There is also a relatively large amount of material on correction and extrapolation methods, such as the deferred corrections method using the Gregory numerical integration rule.

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The presentation of Chapter 3 is continued into Chapter 4, for the nonhomogeneous Fredholm integral equation of the second kind with a smooth kernel function. All major methods are presented and illustrated, along with a number of less known methods, e.g. the use of linear programming. Complete convergence analyses are given, generally using the least possible amount of functional analysis. But the use of more abstract approaches is also discussed, including the Anselone theory using collectively compact operator approximations. A deficiency in the chapter is the lack of any discussion of iterative methods for solving the linear systems of equations which arise with most numerical methods. This becomes a problem with larger systems, which are likely to occur in solving integral equations in more than one space dimension.

Chapter 5 contains a wide variety of material, including a discussion of all those Fredholm equations not included in Chapters 3 and 4, mostly equations with singular kernel functions. In addition, methods are presented for Cauchy singular integral equations, Wiener-Hopf equations, Fredholm equations of the first kind, and nonlinear Fredholm equations. Chapter 6, the final chapter, is on Volterra integral equations. It gives a very complete coverage of numerical methods for equations of both the first and second kinds, including equations with singular kernel functions or integrands. Stability questions are explored in depth, often using exact numerical solutions for simpler model equations; a number of numerical examples are given.

This book is a timely and worthwhile addition to the literature on numerical methods for integral equations. It collects together many results which previously were scattered throughout the research literature. There are also a number of new results; and the many examples and complete analyses of numerical methods make the book very useful to the beginning research student. My main criticism would be with the leisurely pace of many of the presentations, but that is a personal preference. The book is produced by the photo-offset process from typed copy. This is generally acceptable in terms of the visual impact it makes on the reader, although the highlighting of the section and subsection headings and of the main results could have been improved. Finally, the price is exceedingly high, especially for a book produced by the photo-offset process.

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