REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS

The numbers in brackets are assigned according to the American Mathematical Society classification scheme. The 1980 Mathematics Subject Classification (1985 Revision) can be found in the December index volumes of Mathematical Reviews.

1[65-01, 65N30].—H. R. SCHWARZ, *Finite Element Methods*, Computational Mathematics and Applications (translated from the German by Caroline M. Whiteman), Academic Press, London, 1988, x+386 pp., 23 cm. Price $16.50 paperback.

This is an English translation of a book originally published in German in 1984. It is a descriptive introduction to finite element methods, starting with mathematical foundations, going through various elements, how to formulate the global equations, and how to solve them. Eigenvalue problems are then taken up, and the book ends with applications. Theory is given very little treatment. To quote from the Introduction: "It is intended for mathematicians, physicists, engineers and natural scientists who are interested in an elementary presentation of the methods of finite elements that has both an introductory character and gives some practical hints for efficient implementation on a computer".

Within its aims, the book succeeds admirably. The writing is both careful and lucid. The choice of material is standard but, in contrast to many other introductory books, pleasantly up to date; material from the seventies is included (and even some references to the eighties).

The book is recommended for its purpose.

L. B. W.

2[34-01, 34C35, 65L05, 65L07].—THOMAS S. PARKER & LEON O. CHUA, *Practical Numerical Algorithms For Chaotic Systems*, Springer, 1989, xiv + 348 pp., 24 cm. Price $49.50.

This is an unusual book: it combines components from the theory of dynamical systems, from numerical analysis, and from software engineering to achieve its purpose, which is "to present robust, reliable algorithms for simulating nonlinear dynamics". In none of the above areas, the reader is assumed to have more than a superficial knowledge; in consequence, the style remains introductory throughout. On the other hand, it is surprising and often delightful how the authors manage to acquaint the reader with important results from all these areas by viewing them in the context of their overall objective.

The use of the word "chaotic" in the book's title is a gross overstatement: no algorithms which would be particularly suitable for the analysis of chaotic systems have been presented, and within the algorithmic analysis of general dynamical systems, only two pages have been devoted to special aspects of chaotic systems. This is the more disappointing as the authors have succeeded well in introducing the reader to the mathematical and phenomenological aspects of chaotic solutions of dynamical systems. Hence, the title of the book should simply have been "Practical Numerical Algorithms for Dynamical Systems".

The first three chapters of the book are an introduction to the theory of dynamical systems, with a good deal of intuitive appeal, but sufficient mathematics to make the development quite rigorous. Autonomous and nonautonomous time-periodic systems are considered in parallel, and discrete-time systems are introduced as a preparation to Poincaré maps, which naturally form a major tool of analysis throughout. Chaos appears as a special kind of bounded steady-state behavior which becomes more distinctive in its Poincaré orbits and is finally characterized by the sign distribution of the Lyapunov exponents of its strange attractors. There are only two allusions to algorithmic tasks within this part: the location of hyperplane crossings (in Poincaré maps) and the determination of eigenvalues, for which reference is made to the QR algorithm in EISPACK or a similar subroutine library.

The next chapter is a short course on the numerical solution of systems of ODE's, with a very nice and up-to-date section dealing with the many modules, besides the integrator, which make up an ODE integration routine. This leads to the chapter on "Locating Limit Sets", which is fully in the spirit of the objectives of the book, with applications of the generalized Newton's method in various contexts.

Now the authors introduce the stable and unstable manifolds of equilibrium points, homoclinic and heteroclinic trajectories, and identify the presence of Smale horseshoes as a characteristic of unpredictive systems. Algorithms for the location of stable manifolds are discussed. A chapter on various dimension concepts is an interlude to the introduction, analysis and algorithmic determination of bifurcation diagrams. Here, too, the introductory, yet intuitive and rather rigorous level, is maintained. Specialists in the computation of bifurcation diagrams should not expect to find new material; but the book has clearly not been written for them.

The next chapter acquaints the reader with (numerical) software engineering; it is full of important remarks and observations. This is also an introduction to the package INSITE (Interactive Nonlinear Systems Investigative Toolkit for Everyone) developed by the authors. Its application to the generation of phase portraits, with limit sets and boundaries of bases of attraction, is the topic of the last chapter. Several appendices give short introductions to mathematical concepts which have been used offhand in the text.

It is difficult to characterize the audience which is likely to profit most from this experimentally-minded introduction to dynamical systems. Like the package's name indicates, it seems to be meant for "everyone". I do think that everyone interested in the subject (except the specialist) will actually find a good deal of stimulating material in some parts of the book, but may perhaps be indifferent to others. In any case, it should guide both mathematicians and application scientists to a hands-on experience with dynamical systems, which would be a very desirable effect.

H. J. S.

3[45-01, 45A05, 65R20].—Rainer Kress, *Linear Integral Equations*, Applied Mathematical Sciences, Vol. 82, Springer, 1989, xi + 299 pp., 24 cm. Price $49.00.

This is truly an exciting little textbook on the functional analysis treatment of linear integral equations. In writing this text, the author was careful to select a relatively broad range of topics from the area of linear integral equations which are important to applications and whose numerical solutions are currently sought after and studied. The principles studied in the text are precisely those needed to study the error and convergence of numerical methods for approximating solutions to these problems. Understanding the principles of the text would therefore also assist the reader in selecting a good numerical method for approximating the solution to a linear integral equation problem. It is a pleasure to see these topics treated in a text. His pretty presentation of the material demonstrates the author's love for this type of mathematics.

I believe this would be an excellent contender as a text for the first two quarters of a three-quarter graduate course on the numerical solution of integral equations. The third quarter could be spent illustrating the principles covered in the book on specific problems from applications. I look forward to using this text in a class.

The following list of chapter headings gives a fairly good idea about the topics covered: 1. Normed Spaces; 2. Bounded and Compact Operators; 3. The Riesz Theory; 4. Dual Systems and Fredholm Theory; 5. Regularization in Dual Systems; 6. Potential Theory; 7. Singular Integral Equations; 8. Sobolev Spaces; 9. The Heat Equation; 10. Operator Approximations; 11. Degenerate Kernel Approximations; 12. Quadrature Methods; 13. Projection Methods; 14. Iterative Solution and Stability; 15. Equations of the First Kind; 16. Tikhonov Regularization; 17. Regularization by Discretization; 18. Inverse Scattering Theory.

F. S.