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.

4[01A55, 01A70, 68–03].—ANTHONY HYMAN, *Charles Babbage, Pioneer of the Computer*, Princeton Univ. Press, Princeton, N. J., 1982, xi + 287 pp., 23 cm. Price $9.95 (paperbound).

This meticulously researched, well-written, and profusely illustrated study of the life and accomplishments of Charles Babbage is an outstanding addition to the growing collection of such literature by many writers, including Edmund C. Berkeley, B. V. Bowden, Herman H. Goldstine, Daniel Halacy, Philip and Emily Morrison, and Maboth Moseley.

As Hyman acknowledges, the principal sources of information concerning Babbage's calculating engines have remained the fragmentary autobiographical *Passages from the Life of a Philosopher* and *Babbage's Calculating Engines*. The latter consists of relevant published papers of Charles Babbage, supplemented by posthumous notes by his youngest son, Henry.

The extraordinary range of Babbage's interests and inventions is fully revealed in the text and may also be inferred from an appended chronological list of more than eighty publications either directly written or inspired by him.

Appropriately, a significant portion of this book is devoted to a detailed account of the development of Babbage's plans for his successive difference engines and his analytical engines and of his frustration in prolonged, ineffectual attempts to obtain adequate financial support from the British government in that lifelong project.

In an epilogue, entitled "From the Analytical Engine to the Modern Computer", the author thus summarizes Babbage's enormous challenges and difficulties in his evolution of the concept of a universal computer: "And yet, in its versatility Babbage's achievement remains unrivalled. Where modern pioneers worked in teams and were part of a great movement, save for his assistants and occasional help from his sons, Babbage worked by himself, far ahead of contemporary thought. He had not only to elaborate the designs but to develop the concepts, the engineering, and even tools to make the parts. He had to develop the mathematics, and his notation through its successive stages, pioneer microprogramming and coding; even to conceive of the idea in the first place. Charles Babbage stands alone: the great ancestral figure of computing."

J. W. W.

0025-5718/86 $1.00 + $.25 per page

5[65-02, 65C05, 65D30, 65D32, 65V05].—PHILIP J. DAVIS & PHILIP RABINOWITZ, *Methods of Numerical Integration*, 2nd ed., Academic Press, Orlando, Fla., 1984, xiv + 612 pp., 23 cm. Price $52.00.

This book is the third volume on this subject by the same authors. The first was *Numerical Integration*, Blaisdell Publishing Co., Waltham, Mass., 1967 (see Review **43**, *Math. Comp.*, v. 22, 1968, pp. 459–460; *Math. Reviews*, v. 35, 1968, #2482); the second was *Methods of Numerical Integration*, Academic Press, Waltham, Mass., 1975 (see Review **28**, *Math. Comp.*, v. 30, 1976, pp. 666–667; *Math. Reviews*, v. 56, 1978, #7119). This latest version is larger by about $1/3$ than the previous. It is an update with an attempt to include some of the many new results that have been published during the interlude since the previous edition, but with more emphasis on applications. Although the organization is very similar to the previous well-organized edition, updates have been made in nearly every section. In addition, references to the many newly published texts and articles have been included.

The authors' previous texts on this subject were very well written, easy to read and understand, requiring only an understanding of calculus and in a few instances a concept of elementary analytic function theory. This is also true of the present version, except that it is more complete.

A glance at the table of contents reveals the following: Chapter 1, *Introduction* (with 16 sections); Chapter 2, *Approximate Integration over a Finite Interval* (with 13 sections); Chapter 3, *Approximate Integration over Infinite Intervals* (with 10 sections); Chapter 4, *Error Analysis* (with 9 sections); Chapter 5, *Approximate Integration in Two or More Dimensions* (with 10 sections); Chapter 6, *Automatic Integration* (with 6 sections); Appendix 1, *On the Practical Evaluation of Integrals* (by Milton Abramowitz); Appendix 2, *Fortran Programs*; Appendix 3, *Bibliography of Algol, Fortran, and PL/I Procedures*; Appendix 4, *Bibliography of Tables*; Appendix 5, *Bibliography of Books and Articles*; and Index.

I recommend this book highly, for both the numerical integration user and researcher.

F. S.

6[35-01, 78A05].—NORMAN BLEISTEIN, *Mathematical Methods for Wave Phenomena*, Computer Science and Applied Mathematics, A Series of Monographs and Textbooks, Werner Rheinboldt, Editor, Academic Press, Orlando, Fla., 1984, 23 cm. Price $55.00.

The present book contains nine chapters with the following headings: First-order partial differential equations; The Dirac delta function, Fourier transforms, and asymptotics; Second-order partial differential equations; The wave equation in one space dimension; The wave equation in two and three dimensions; The Helmholtz equation and other elliptic equations; More on asymptotics; Asymptotics techniques for direct scattering problems; Inverse methods for reflector imaging.

The above list of chapter headings is more revealing about the scope of the book than the title, which may mean different things to different people. Indeed, there is a 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.

The 175 page Part I, Fundamentals of finite-difference methods, consists of four chapters. Chapter 1 sketches the history of numerical methods. Chapter 2 describes the classification into elliptic, parabolic, and hyperbolic types for second order equations; discusses characteristics for simple equations and the notion of well-posed problems. Chapter 3 describes several ways to derive difference approximations, and derives several explicit and implicit schemes; how to deal with irregular meshes is described; the notion of stability is explained. Chapter 4 is the longest in Part I and treats the simplest model problems by difference methods. The solution of the difference equation, for a given mesh size, is shown to satisfy a modified differential equation. The amplification matrix, amplitude and phase errors, shock fitting and shock capturing, iterative methods for elliptic problems are all dealt with in Chapter 4.

Part II has 368 pages with the title, Application of finite-difference methods to the equations of fluid mechanics and heat transfer.

Ch. 5–Governing equations of fluid mechanics and heat transfer;

Ch. 6–Numerical methods for inviscid flow equations;

Ch. 7–Numerical methods for boundary-layer type equations;

Ch. 8–Numerical methods for the "parabolized" Navier-Stokes equations;

Ch. 9–Numerical methods for the Navier-Stokes equations;

Ch. 10–Grid generation.

It is in Part II that the real problems and methods for their solution are described. This field is rapidly developing, but it is not yet sufficiently mathematized. The authors present a description of most of the difference methods developed up to the early 1980's. They give advice as to how to select a good method for each physical problem. The method involves introducing appropriate physical variables (both the independent and dependent ones), formulating the system of differential equations, selecting a mesh, choosing a difference scheme and an algorithm for solving the resulting system of equations. They explain the good and bad features of the many methods.

In Appendices A and B, they supply subroutines for solving scalar and block tridiagonal systems of linear equations. Appendix C describes Schneider and Zedan's iterative difference scheme for solving the nonhomogeneous two-dimensional elliptic equation with variable coefficients. They supply a five page list of symbols and abbreviations, a twenty page bibliography of items referred to in the text, and an eight page index. The bibliography does not indicate where each item is cited in the text, even though most of these authors are not listed in the index.

Until the field becomes sufficiently mathematical, this textbook should be valuable both for engineering instruction and reference. The authors state that this work is joint and the toss of a coin was used to order their names.

E. I.

9[35-02, 35Jxx, 35Kxx, 35R35, 65P05].—JOHN CRANK, *Free and Moving Boundary Problems*, Clarendon Press, Oxford, 1984, x + 425 pp., 24 cm. Price $64.00.

The stated aim of this book is to provide a broad but reasonably detailed account of the mathematical solution of free and moving boundary problems. Given the scope of the subject, severe restrictions have had to be made: questions of existence and uniqueness are largely ignored; several moving-boundary problems are considered, but only porous flow free-boundary problems are treated in depth; for the most part, only scalar second order elliptic or parabolic equations in two dimensions are studied. Within this self-imposed framework, the author provides an excellent exposition of the problems, their history and formulation, their solution by analytical and numerical methods.

The book alternates between the two types of problem. There are chapters on the formulation of moving-boundary problems, on their analytical solution, and on their numerical solution. Similar chapters on free-boundary problems are interspersed.

Analytical methods for moving-boundary problems are represented by similarity solutions and integral equation formulations, while the solution of free-boundary problems using the hodograph method is treated in considerable detail. All current numerical methods receive attention: front-tracking (including the method of lines due to Meyer); front-fixing (including the isotherm migration method of Crank); the enthalpy method; trial-free-boundaries; and variational inequalities.

Several misprints were noted, none of them serious, but some of which, in formulae, might cause difficulties for readers new to the field. There is an excellent subject index and, as a bonus, an author index. In the list of references, the regrettable custom of not quoting the titles of papers is followed. In parts, the text reads like a lengthy review article with each paragraph devoted to the contributions of a different author, but for the most part the text flows along very smoothly.

In summary, this is a welcome addition to the literature on free and moving boundary problems, the coverage of the latter being particularly good. If supplemented by material on existence and uniqueness theorems, it also deserves serious consideration as a textbook.

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10[65–06, 68–06].—SEYMOUR V. PARTER (Editor), *Large Scale Scientific Computation*, Proceedings of a Conference Conducted by the Mathematics Research Center, The University of Wisconsin, Madison, May 17–19, 1983, Academic Press, Orlando, Fla., 1984, ix + 326 pp., $23\frac{1}{2}$ cm. Price \$26.00.

This volume contains twelve papers ranging from mathematical problems to management issues. Questions addressed include: specialized architectural considerations, efficient use of existing "state-of-the-art" computers, software developments, large-scale projects in diverse disciplines, and mathematical approaches to basic algorithmic and computational problems

L. B. W.

11[41–06].—S. P. SINGH, J. W. H. BURRY & B. WATSON (Editors), *Approximation Theory and Spline Functions*, NATO ASI Series C: Mathematical and Physical Sciences, Vol. 136, Reidel, Dordrecht, Holland, 1984, ix + 485 pp., $24\frac{1}{2}$ cm. Price \$69.50.

These are the proceedings of a NATO Advanced Study Institute on Approximation Theory and Spline Functions held at Memorial University of Newfoundland August 22–September 2, 1983. The 38 papers included cover a wide range of approximation theory and are devoted about equally to univariate and multivariate theory. There are six papers dealing specifically with spline functions and their applications.

W. G.

12[65–06].—DAVID F. GRIFFITHS (Editor), *Numerical Analysis*, Lecture Notes in Math., vol. 1066, Springer-Verlag, Berlin, 1984, ix + 275 pp., 24 cm. Price $14.00.

This volume contains the texts of 15 invited talks given at the Tenth Dundee Biennial Conference on Numerical Analysis, held June 28–July 1, 1983, at the University of Dundee, Scotland. Topics covered include high-accuracy floating-point algorithms for algebraic processes, spline approximation, numerical methods for optimization problems, bifurcation phenomena, stiff ordinary differential equations, partial differential equations and weakly singular integral equations.

W. G.

13[68–06, 68Q40].—JOHN FITCH (Editor), *EUROSAM 84*, Lecture Notes in Comput. Sci., vol. 174, Springer-Verlag, Berlin, 1984, xi + 396 pp., 24 cm. Price $18.00.

These are the proceedings of an International Symposium on Symbolic and Algebraic Computation, held in Cambridge, England, July 9–11, 1984. The 37 papers are grouped by topic under the headings: Differential Equations, Applications, Simplification and Algorithm Implementation, Algebraic Number Computation, Languages for Symbolic Computing, Groebner Basis Algorithms, Computational Group Theory, Factorization and GCD Computations, Number Theory Algorithms, Integration, Solution of Equations. The large number of categories attests to the great diversity of current potential, and actual, uses of symbolic computation. Specific applications discussed concern nonlinear control theory, quartic equations and Riemann tensor classification, the Dirichlet problem for Laplace's equation, code generation for finite element analysis, Padé approximation, and automatic control of error accumulation.

W. G.

14[65–06, 65F10, 65F50, 65N30, 65N35, 65N50, 68N99].—GARRETT BIRKHOFF & ARTHUR SCHOENSTADT (Editors), *Elliptic Problem Solvers II*, Academic Press, Orlando, Fla., 1984, xiii + 573 pp., $23\frac{1}{2}$ cm. Price $39.00.

These are the proceedings of the Elliptic Problem Solvers Conference held at the Naval Postgraduate School in Monterey, California, January 10–12, 1983. The 38 papers are grouped here, as they were at the conference, roughly by topic under the headings: I. Software Packages, II. Vector and Parallel Processing, III. Iterative Equation Solving, IV. Finite Element and Multigrid Methods, V. Advances in

Modeling and Physical Applications. Especially timely are the discussion of currently available software packages, such as ELLPACK, ITPACK, MODULEF, and the Yale Sparse Matrix Package; the possibilities offered by vector and parallel computers; and the numerical modeling of semiconductors.

W. G.

15[41-06, 30E10, 33A65, 41A05, 41A20, 41A21].—P. R. GRAVES-MORRIS, E. B. SAFF & R. S. VARGA (Editors), *Rational Approximation and Interpolation*, Lecture Notes in Math., vol. 1105, Springer-Verlag, Berlin, 1984, xii + 528 pp., 24 cm. Price $25.50.

This volume contains the proceedings of the Conference on Rational Approximation and Interpolation, held at the University of South Florida, Tampa, Florida, December 12–16, 1983. It opens with four survey papers: "The Faber Operator" by J. Milne Anderson, "Survey on Recent Advances in Inverse Problems of Padé Approximation Theory" by G. López Lagomasino & V. V. Vavilov, "Some Properties and Applications of Chebyshev Polynomial and Rational Approximation" by J. C. Mason, "Polynomial, Sinc and Rational Function Methods for Approximating Analytic Functions" by F. Stenger, and is followed by 39 research articles on such topics as approximation and interpolation theory, block structures of Padé and other tables, circuit theory, convergence theory, critical phenomena, location of zeros and poles, and numerical methods. The vitality of the field, and the excitement generated by some of the recent advances, can be felt even upon a cursory reading of these proceedings.

W. G.

16[78-06, 78A45].—WOLFGANG-M. BOERNER et al. (Editors), *Inverse Methods in Electromagnetic Imaging*, Parts 1 and 2, Reidel, Dordrecht, Holland, 1985, xxxii + 1347 pp., $24\frac{1}{2}$ cm. Price $145.00.

The proceedings of the NATO Advanced Research Workshop on Inverse Methods in Electromagnetic Imaging, held at Bad Windsheim, Germany, September 18–24, 1983, these volumes comprise 70 papers, organized into five topics: Mathematical inverse methods and transient techniques, numerical inversion methods, polarization utilization in the electromagnetic vector inverse problem, image quality and image resolution in remote sensing and surveillance, holographic and tomographic imaging and related phase problems. Dealing with notoriously ill-posed problems, the papers on numerical methods should be of particular interest to readers of this journal.

W. G.

17[58Fxx, 70Kxx].—P. FISCHER & WILLIAM R. SMITH (Editors), *Chaos, Fractals, and Dynamics*, Lecture Notes in Pure and Appl. Math., vol. 98, Marcel Dekker, New York and Basel, 1985, viii + 261 pp., 25 cm. Price $59.75 (U. S. and Canada), $71.50 (all other countries).

Irregular ("chaotic") behavior of nonlinear dynamical systems and related irregular shapes and patterns are currently the subject of renewed interest, owing in part to the feasibility of extensive computer simulation work. The volume under review collects 18 papers on this topic, presented at or resulting directly from two conferences held at the University of Guelph in March of 1981 and 1983.

W. G.

18[65-06, 41A65, 65D15, 65N30].—P. R. Turner (Editor), *Numerical Analysis Lancaster 1984*, Lecture Notes in Math., vol. 1129, Springer-Verlag, Berlin, 1985, xiv + 179 pp., 24 cm. Price $12.00.

The second Summer School in Lancaster, England, sponsored by the Science and Engineering Research Council, took place July 15–August 3, 1984 and was devoted to an in-depth study of special topics in numerical analysis, specifically constructive approximation theory, optimal recovery, and variational methods in elliptic boundary value problems. The volume under review contains the lecture notes of four main courses given on that occasion; two ten-lecture courses, "Optimal Methods in Approximation Theory" (73 pages) by C. A. Micchelli & T. J. Rivlin, and "Variational Theory and Approximation of Boundary Value Problems" (40 pages) by R. E. Showalter; and two five-lecture courses, "Algorithmic Aspects of Approximation Theory" (20 pages) by E. W. Cheney, and "An Introduction to the Analysis of the Error in the Finite Element Method for Second-Order Elliptic Boundary Value Problems" (46 pages) by A. H. Schatz. Two other main courses on multigrid methods by A. Brandt and W. Hackbusch were based on material now available in the Lecture Notes, vol. 960, and are therefore not included here, except for tables of contents.

W. G.