REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS

The numbers in brackets are assigned according to the American Mathematical Society classification scheme. The 1991 Mathematics Subject Classification can be found in the annual subject index of *Mathematical Reviews* starting with the December 1990 issue.

1[65–02, 65Gxx, 65Nxx, 65Rxx, 65F05, 65F10].—SOLOMON G. MIKHLIN, *Error Analysis in Numerical Processes* (Translated from the German edition by Reinhard Lehmann), Pure and Applied Mathematics, A Wiley-Interscience Series of Texts, Monographs, and Tracts, Wiley, Chichester, 1991, 283 pp., $23\frac{1}{2}$ cm. Price $87.95.

This book is an extended and somewhat reorganized translation of the author's book "Fehler in numerischen Prozessen", published by the Akademie-Verlag Berlin in 1985. In it, a classification of errors in numerical methods into four different types, named the approximation error, the perturbation error, the algorithm error, and the rounding error, is used and applied in several of the major problem areas in numerical analysis. In the case of the standard finite element method for an elliptic boundary value problem, the approximation error is the error between the exactly computed solution of the discretized problem and the continuous solution, the perturbation error results from not solving the discretized problem exactly, for instance by using quadrature rules for the inner products occurring in its formulation, an algorithm error could be the error resulting from using a finite number of iterations in an iterative method for solving the system of linear equations, and the rounding error, of course, derives from the finite precision in the computer used. The discussion of the perturbation error is based on notions of stability of numerical processes with respect to associated sequences of pairs of Banach spaces.

The different types of error are analyzed for various numerical approaches to ordinary and partial differential equations and to integral equations, including singular ones, and for direct and iterative methods in linear algebra. In the differential equations area, variational methods are emphasized but finite difference and collocation methods are also touched upon.

The latter part of the book is devoted to numerical methods for nonlinear problems such as unilateral variational problems. One of the chapters in this part contains an appendix written by B. V. Tyukhtin, surveying estimates for the approximation error in finite element methods applied to obstacle problems, which have been developed in the Western literature.

Most of the material of the book is quoted from earlier books and papers by the author and members of his school. Sometimes one discerns a certain lack of regard for relevant work from outside this circle. In reading the book,

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however, one has to be impressed by the width of the scope of the study and the very considerable mathematical culture of academician Mikhlin. This makes for quite pleasant reading.

V. T.

2[65–01, 65N30].—Barna Szabó & Ivo Babuška, *Finite Element Analysis*, Wiley, New York, 1991, xv +368 pp., 24 cm. Price $59.95.

Babuška and Szabó have pioneered the use of high-order polynomials as an alternative to mesh refinement in the finite element method. That this is a significant part of the subject of the book is therefore no surprise. However, given the different primary disciplines represented by the two authors, one could not predict a priori whether such a book would take a mathematical or an engineering approach, or perhaps some novel combination of the two. The order of authorship hints that an engineering approach is to be emphasized, and this is reflected in the "matrix method" notation that is used, but the use of mathematical ideas is also an essential part of the text.

The goals of the book are best stated by the authors themselves in the Preface.

> Our purpose in writing this book is to introduce the finite element method to engineers and engineering students in the context of the engineering decision-making process. Basic engineering and mathematical concepts are the starting points. Key theoretical results are summarized and illustrated by examples. Focus is on the developments in finite element analysis technology during the 1980s and their impact on reliability, quality assurance procedures in finite element computations, and performance. The principles that guide the construction of mathematical models are described and illustrated by examples.

Numerous books on the finite element method with a variety of objectives have appeared recently, so many that it would be quite lengthy to compare even a representative number of them. However, we will venture one comparison with a mathematical audience in mind. The present book has extensive detail with regard to examples, and its coverage of topics in linear elasticity is exhaustive. Both of these are essential for the book to be successful with an engineering audience. The book by Claes Johnson [2], on the other hand, offers a more conventionally mathematical approach to the subject. That book covers a more diverse set of topics than do Babuška and Szabó, but it lacks details of computer implementation and omits many practical issues covered by them.

In addition to providing an up-to-date survey of high-order-polynomial methods, the book includes other material not previously available in textbook form. The book presents one chapter on efficient computation of stresses using post-processing techniques to enhance the quality of the solution, and another on error estimation and control.

There is a chapter on "Miscellaneous Topics" that gives some hints about areas for further study. Included are a discussion of mixed methods and a sample nonlinear problem. However, there are some standard topics not covered in the book that may be of interest to students, such as that of viscous fluid flow