equation $B^T A^{-1} B\theta = -B^T A^{-1} F$. The matrices $B^T A^{-1} B$ have condition numbers bounded independently of the mesh size, and thus, e.g., the conjugate gradient method will converge rapidly. Each step involves solving a standard Poisson problem. After that, one easily solves for the velocities. Thus, an efficient iterative method is easily found.

On p. 254, in connection with an obstacle problem, the choice $K_h = \{v \in V_h : v \geq \psi \text{ in } \Omega\}$ for the approximate constraint set is given. This choice is hard to implement. Imposing the inequality only at nodes, say, is easier to implement (but somewhat harder to analyze).

In conclusion, this is an impeccable introduction to the subject for an audience with some mathematical maturity beyond sophomore calculus and linear algebra. I predict that, for many purposes, it will replace the well-known book by Strang and Fix, [2], which is, very naturally, out of date in many respects.

L. B. W.

1. R. E. WHITE, *An Introduction to the Finite Element Method with Applications to Nonlinear Problems*, Wiley-Interscience, New York, 1985. (Review **1**, *Math. Comp.*, v. 50, 1988, pp. 343–345.)

2. G. STRANG & G. FIX, *An Analysis of the Finite Element Method*, Prentice-Hall, Englewood Cliffs, N.J., 1973. (Review **35**, *Math. Comp.*, v. 28, 1974, pp. 870–871.)

2[65N30, 65M60, 76D05, 76D07].—GRAHAM F. CAREY & J. TINSLEY ODEN, *Finite Elements: Fluid Mechanics*, The Texas Finite Element Series, Vol. VI, Prentice-Hall, Englewood Cliffs, N.J., 1986, x+323 pp., $23\frac{1}{2}$ cm. Price $38.95.

This is the sixth in the series devoted to Finite Element methods for the numerical solution of problems in Mechanics governed by partial differential equations. The first four volumes were concerned with the general exposition of the method while the fifth volume specifically concentrated on problems in Solid Mechanics. As the authors point out, Finite Elements were originally used to solve problems in Structural Mechanics, and their application to Fluid Dynamics is comparatively recent, a prerequisite for this being the formulation of basic problems in Fluid Dynamics in variational form.

The volume is self-contained since the authors include a brief but complete description of the general Finite Element method in the first chapter, giving a lucid explanation in terms of problems associated with Laplace's equation. The second chapter, dealing with compressible flow, is concerned mostly with transonic flow, and makes a strong case for applying Finite Element methods to such challenging problems as supercritical flow past airfoils, previously treated almost exclusively by finite difference methods. The technique for shock fitting is particularly appealing.

The third chapter is probably the most important in the volume, since it contains a thorough derivation of the Navier-Stokes equations, including the variational formulation of associated viscous flow problems. The latter leads to a detailed description of Finite Element methods, developed in turn for slow flows governed by the Stokes' equation, and for higher-speed steady flows governed by the full Navier-Stokes equations, including unsteady and compressibility effects. Applications to cavity flows, corner flows and wakes are particularly instructive. The subsequent chapter, concerned with stream function—vorticity formulation, is more limited since it is confined to two-dimensional flows. The final chapter on transport processes appears to be of more academic interest than the earlier three chapters, although it does contain interesting remarks on numerical techniques.

The main text concludes with an impressive list of references. As a whole, the book covers new ground in Computational Techniques for Fluid Mechanics. It is clearly written and aids the understanding of a valuable approach only partially appreciated by those presently working in Computational Fluid Dynamics. The inclusion of a set of examples at the end of each important section enhances the value of the volume as a graduate course text.

MAURICE HOLT

Department of Mechanical Engineering
University of California, Berkeley
Berkeley, California 94720

3[15–02, 65F50].—I. S. DUFF, A. M. ERISMAN & J. K. REID, *Direct Methods for Sparse Matrices*, Monographs on Numerical Analysis, Clarendon Press, Oxford, 1986, xiii+341 pp., 24 cm. Price $42.50.

Iain Duff, Al Erisman, and John Reid have made an outstanding contribution to the literature on sparse matrices. *Direct Methods for Sparse Matrices* contains a wealth of information which is extremely well organized and is presented with exceptional clarity. The book will be a valuable addition to the libraries of practitioners whose problems involve working with sparse matrices; it also includes many fine exercises and is suitable for use as a textbook at the graduate or upper division undergraduate level. In addition, selected topics addressed in this book could profitably be included in courses not dedicated exclusively to sparse matrices, such as courses in data structures, algorithms, or numerical linear algebra.

Readers of *Direct Methods for Sparse Matrices* are assumed to be familiar with elementary linear algebra and to have some computing background. Other background material is included in the first four chapters. Students and general readers will appreciate finding that the concepts and techniques presented are illustrated with examples throughout. Practitioners whose primary goal in consulting this book is selection of library subroutines to solve their problems will find practical direction in the choice of library routines for specific problems. The authors draw on their extensive computational experience in making recommendations of one procedure over another for particular applications. Researchers will find a very well-organized survey of sparse matrix techniques along with abundant references to appropriate literature for more extensive exposition.

The first four chapters contain introductory material. In Chapter one, sparsity patterns are related to elementary concepts in graph theory, and issues associated with the efficient use of advanced computer architectures are introduced. Chapter two introduces data structures that are suitable for storing, accessing, and performing operations on sparse matrices and vectors. A summary of computational