MATHEMATICS OF COMPUTATION
Volume 65, Number 216
October 1996, Pages 1757–1768

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.

38[65-01, 65Bxx, 65Cxx, 65Dxx, 65Fxx, 65Gxx]—*Numerical analysis: A first course in scientific computation*, by Peter Deuflhard and Andreas Hohmann, (translated from the German by F. A. Potra and F. Schulz), Walter de Gruyter, Berlin, 1995, xiv+355 pp., 23 cm, hardcover $69.95, paperback $39.95

The authors present pseudocodes which clearly define algorithms that solve many of the basic types of problems arising in Scientific Computing today. The mathematical explanation of the numerical methods is well motivated, precise, and carefully considers the notions of condition and stability. Well-drawn figures exhibit the geometric interpretation of the mathematical arguments used in the areas of Bézier approximation, bifurcation, B-splines, continuation, orthogonality, stability, etc. The reader is assumed to have "basic knowledge of undergraduate Linear Algebra and Calculus". This reviewer believes that mathematical maturity on at least the upper level undergraduate or beginning graduate level is required to master material of this depth. The English translation is an excellent mathematical presentation.

The reviewer highly recommends the work as a textbook and as a reference resource for all. The material is organized into nine chapters and is ample for a fine full-year course. The authors indicate various ways to incorporate some of the chapters into special topics courses. The book leads up to but does not discuss numerical methods for solving differential equations.

Each chapter contains pseudocodes, illustrative numerical examples (some taken from the engineering literature), and concludes with a set of well-chosen exercises for the reader. The authors state that all of the algorithms mentioned in the text are freely available via the Internet and give directions for accessing them at the electronic library, eLib, of the Konrad Zuse Center.

The title, number of exercises (ex), and number of pages (pg) is listed for each chapter in the Contents:

1. Linear Systems,	13 ex, 22 pg.
2. Error Analysis,	22 ex, 39 pg.
3. Least Squares Problems,	8 ex, 27 pg.
4. Nonlinear Systems and Least Squares Problems,	12 ex, 40 pg.
5. Symmetric Eigenvalue Problems,	7 ex, 22 pg.
6. Three Term Recurrence Relations,	11 ex, 31 pg.
7. Interpolation and Approximation,	9 ex, 63 pg.
8. Large Symmetric Systems of Equations and Eigenvalue Problems,	5 ex, 36 pg.

9. Definite Integrals,	11 ex,	59 pg.
References (85 listed),		6 pg.
Notation,		2 pg.
Index,		7 pg.

E.I.

39[65N30, 65N50, 65N55, 82D99]—*Multigrid methods for semiconductor device simulation*, by J. Molenaar, CWI Tract, Vol. 100, Centre for Mathematics and Computer Science, Amsterdam, 1993, vi+134 pp., 24 cm, softcover, Dfl. 40.00

In recent years, multigrid methods have found their way into a number of important application areas. Often it seems that the careful analysis which would lead to a useful evaluation of multigrid as a viable method for such problems is ignored or lost along the way. However, from time to time an article or book appears which studies a specific application in depth, and also examines in detail the theoretical and computational properties of the multigrid method for the particular problem. The book is an example of such a study.

The book, based on the author's PhD thesis, is concise and well organized, consisting of seven chapters and two appendices. The material begins in Chapter 1 with an overview of the three main approaches to device simulation, followed by a more detailed description of one of these approaches, namely the numerical solution of the drift-diffusion equations proposed by Van Roosbroeck in the 1950s. The drift-diffusion equations are examined carefully, including the scaling problems, which lead to the use of various formulations as alternatives to the Slotboom variable representation. Basic discretization issues for the drift-diffusion model are also presented, including a discussion of the importance of the well-known Scharfetter-Gummel discretizations, leading into a discussion of the mixed finite element approach (the subject of Chapter 2). The introductory chapter ends with a quick look at methods for the resulting discrete equations (multigrid, Newton-type methods, etc.), and with a detailed outline of the remainder of the book.

Chapter 2 consists of a careful discussion of mixed finite element discretization of the semiconductor drift-diffusion equations, in both one and two dimensions. The motivation for the use of a dual mixed finite element approach is that it can be viewed as a mechanism for extending the Scharfetter-Gummel scheme to more than one dimension, at the same time having available the complete analysis framework that the finite element method provides for an examination of the error. A discretization of a general model elliptic equation is derived in two dimensions on a rectangular mesh. However, as has been shown in other contexts [1], such a discretization is not stable in the sense that an M-matrix is not obtained (a discrete maximum principle is then not available). However, the author obtains an M-matrix through the use of mass-lumping, and his analysis shows that the quadrature rule this corresponds to does not spoil the accuracy of the discretization. (The author does not make it clear that such an approach will not work in three dimensions, since an M-matrix cannot be recovered simply by mass lumping [1].) Applying the discretization to drift-diffusion equations yields the sought-after two-dimensional extension of the Scharfetter-Gummel scheme.