The remaining three chapters are: *Conjugate Direction Methods*, *Conjugate Gram-Schmidt Processes* and *Conjugate Gradient Algorithms*. These chapters contain a unified treatment of each class of methods first derived for quadratic problems and then generalized to nonquadratic problems. The algorithms are stated in a concise manner with equivalent formulations mentioned in the text. The exercises at the end of each section are a valuable supplement and an integral part of the text.

There has long been a need for a book making this material available. Rich as the book is in algorithms, it is a valuable contribution to both theoretician and practitioner. Rounding errors are frequently discussed and alternative choices of the parameters are suggested. However, there are no complete error analyses. This is even more apparent when the matrix-vector product of the Hessian matrix and a vector is replaced by a finite difference approximation involving only gradients. This points to an open research area.

A textbook is still needed to cover a major area omitted; namely, solving large and sparse linear systems of equations and the use of preconditioning matrices. The references are incomplete and contain numerous misprints. The index should have been expanded to serve as a cross-reference and an author index should have been included.

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**3[2.10, 4.00].**—A. H. STROUD, *Numerical Quadrature and Solution of Ordinary Differential Equations*, Appl. Math. Sciences, Vol. 10, Springer-Verlag, New York, 1974, xi + 338 pp., $25\frac{1}{2}$ cm. Price $12.50.

The subtitle of this book reads "A Textbook for a Beginning Course in Numerical Analysis"; therefore one must not expect a monograph on the subject area specified in the title.

As an introduction, the text has a number of definite didactic merits. The level of mathematics used does not go beyond basic calculus and algebra, there are motivating and explanatory analytic and numerical examples throughout the book, proofs are either presented in all details, or omitted altogether (with references to relevant presentations). Thus, the text should be suitable for self-study as well as in the classroom. On the other hand, for an introduction to Numerical Analysis, the near neglection of round-off and the total neglection of the concept of condition is an essential weakness.

The selection of the material shows a wise restriction to fundamental problems and methods; even so there are a number of commendable features: One is the systematic use of Peano kernel error terms, with a detailed discussion of their implications, including a large number of graphs of Peano kernel functions for the situations under discussion; this also leads to a more qualified evaluation of the merits of Gauss quadrature formulas. The Riemann sum character of reasonable quadrature formulas is pointed out.

In the section on ordinary differential equations (initial value problems only), the emphasis is on explicit Runge-Kutta methods. The discussion of stepsize control remains unsatisfactory; there is neither sufficient motivation nor a serious justification for the suggested control mechanism (due to Zonneveld). In the treatment of multistep methods, $D$-stability is not distinguished from relative stability.

There are a number of complete Fortran programs for various tasks; the use of library programs is not emphasized. On the whole, the author has succeeded in composing an instructive and balanced "Textbook for a Beginning Course in Numerical Analysis", which is not at all an easy task.

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**4[9.05].**—WALTER E. BECK & RUDOLPH N. NAJAR, *A Lower Bound For Odd Triperfects—Computational Data*; a typed manuscript of 61 pages deposited in the UMT file.

The data contained in this manuscript constitute a tree, each node of which corresponds to a restriction on the canonical decomposition of an odd integer $n$ such that $3 \mid n$ and $\sigma(n) = 3n$. The branching process is dependent on the determination of the prime factors of $\sigma(p^{2\alpha})$ where $p$ is a prime factor of $n$ and $\alpha$ runs through the set of natural numbers. In most cases the complete factorization of $\sigma(p^{2\alpha})$ is given. Roughly speaking, the nodes immediately "following" $p^{2\alpha}$ are those involving $q$ where $q$ is the greatest prime factor of $\sigma(p^{2\alpha})$. When a node (or case) is reached for which either $n > 10^{50}$ or $3^t \parallel n$ while $3^{t+2} \mid \sigma(n)$, an obvious contradiction, the tree is truncated. Since the nodes considered exhaust the logical possibilities and since it is easy to show (see [2]) that $n > 10^{108}$ if $(6, n) = 1$ and $\sigma(n) = 3n$, the finiteness of the tree generated establishes a lower bound of $10^{50}$ for the set of odd triperfect numbers. This set may, of course, be empty since no odd multiperfect numbers (integers $n$ such that $\sigma(n)/n$ is an integer greater than 2) have, as yet, been found. A list of more than 200 even multiperfect numbers, including the six known triperfect numbers, may be found in [1]. The present paper is very well organized and the details are easy to follow. Mathematicians doing research on perfect or amicable numbers will find this manuscript a valuable source of data on the factors of $\sigma(p^{2\alpha})$.

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1. ALAN L. BROWN, "Multiperfect numbers—cousins of the perfect numbers—No. 1," *Recreational Mathematics Magazine*, Jan.—Feb. 1964, Issue No. 14, pp. 31–39.

2. WALTER E. BECK & RUDOLPH M. NAJAR, "A lower bound for odd triperfects," *Math. Comp.*, v. 38, 1982, pp. 249–251.