NUMERICAL ANALYSIS

edited by

Gene H. Golub and Joseph Oliger

Lecture Notes from the Short Course sponsored by the AMS, Atlanta, January 3–4, 1978

"The papers given here are mainly of a mathematical nature. The results presented describe properties of computational methods that are only relevant in the context of that computation. It is the need to perform the computation which presents the problems to the subject and justifies it. For example, in the emerging field of Computational Physics methods are developed as they are *needed* for various problems. These methods are usually constructed via physical reasoning, experience, and intuition. They are often tested on problems with known solutions, but their validity is often judged on their behavior in physical terms. It is then the numerical analyst who attempts to give error estimates and describe the numerical behavior of these methods. The convergence results needed here differ from those of classical constructive analysis. Error estimates which hold for finite values of the discretization parameters are what are really needed, as opposed to asymptotic estimates as these parameters tend to zero. The effect of rounding errors is a central issue in numerical analysis and is a unique aspect of the subject. Algorithms which are otherwise exact may be useless because of rounding errors.

Though applications are discussed here, the important relationships between the problems, the algorithms, and the machines used for the computation which are vital to the spirit of the field cannot be found here. Numerical analysis is not a textbook subject; computational experience is essential.

We hope that these manuscripts and their bibliographies will prove useful to those who wish to learn something of the nature of numerical analysis and what some of the current problems of interest are."

– *From the Preface*

THE LECTURERS AND TITLES

CLEVE MOLER, Three Research Problems in Numerical Linear Algebra

J. E. DENNIS, JR., A Brief Introduction to Quasi-Newton Methods

CARL De BOOR, The Approximation of Functions and Linear Functionals: Best vs. Good Approximation

JAMES M. VARAH, Numerical Methods for the Solution of Ordinary Differential Equations

JOSEPH E. OLIGER, Methods for Time Dependent Partial Differential Equations

GEORGE J. FIX, Variational Methods for Elliptic Boundary Value Problems

Publication: November 1978, iv + 135 pages
Hard Cover: List $14.00, AMS Member $10.50. CODE: PSAPM/22
Soft Cover: List $10.00, Individual $7.50. CODE: PSAPMS/22

ORDERS MUST BE PREPAID, PLEASE SPECIFY CODE

American Mathematical Society, P. O. Box 1571, Annex Station
Providence, RI 02901

W. W. Stothers, Free Subgroups of the Free Product of Cyclic Groups 1274
R. E. Crandall, On the "$3x + 1$" Problem 1281
J. Fischer and J. McKay, The Nonabelian Simple Groups G, $|G| < 10^6$–Maximal Subgroups 1293
J. H. McCabe, A Further Correspondence Property of M Fractions 1303
H. C. Williams, Some Primes with Interesting Digit Patterns 1306
P. L. Walker, On an Integral Summable to $2\xi(s)/s(s-1)$ 1311
Reviews and Descriptions of Tables and Books 1317
Späth **19**, Karlin, Micchelli, Pinkus and Schoenberg **20**, Tikhonov and Arsenin **21**, Hall and Watt, Editors **22**, Fitzgibbon and Walker, Editors **23**, Heller **24**, Beard and West **25**, Jacobs, Editor **26**, Descloux and Marty, Editors **27**, Zwillinger **28**, Baillie **29**, Collatz, Meinardus and Wetterling, Editors **30**
Corrigenda 1328
Jeltsch, Shanks, Editor
Indices to Volume XXXII 1330
Microfiche Supplements
D. H. Lehmer and J. M. Masley, Table of the Cyclotomic Class Numbers $h^*(p)$ and Their Factors for $200 < p < 521$
I. Babuska and J. E. Osborn, Numerical Treatment of Eigenvalue Problems for Differential Equations with Discontinuous Coefficients
R. C. Y. Chin and G. W. Hedstrom, A Dispersion Analysis for Difference Schemes: Tables of Generalized Airy Functions

MATHEMATICS OF COMPUTATION

TABLE OF CONTENTS

OCTOBER 1978

James H. Bramble and Ridgway Scott, Simultaneous Approximation in Scales of Banach Spaces 947

H. B. Keller and V. Pereyra, Symbolic Generation of Finite Difference Formulas 955

J. Giroire and J. C. Nedelec, Numerical Solution of an Exterior Neumann Problem Using a Double Layer Potential 973

I. Babuška and J. E. Osborn, Numerical Treatment of Eigenvalue Problems for Differential Equations with Discontinuous Coefficients 991

R. Bruce Kellogg and Alice Tsan, Analysis of Some Difference Approximations for a Singular Perturbation Problem Without Turning Points 1025

Andrew Majda, James McDonough and Stanley Osher, The Fourier Method for Nonsmooth Initial Data 1041

R. A. Nicolaides, On Multigrid Convergence in the Indefinite Case 1082

Riaz A. Usmani, Discrete Variable Methods for a Boundary Value Problem with Engineering Applications 1087

Moshe Goldberg and Eitan Tadmor, Scheme-Independent Stability Criteria for Difference Approximations of Hyperbolic Initial-Boundary Value Problems. I. 1097

Rolf Jeltsch, Complete Characterization of Multistep Methods with an Interval of Periodicity for Solving $y'' = f(x, y)$ 1108

L. F. Shampine, Limiting Precision in Differential Equation Solvers. II: Sources of Trouble and Starting a Code 1115

D. L. Hicks, Stability Analysis of WONDY (A Hydrocode Based on the Artificial Viscosity Method of von Neumann and Richtmyer) for a Special Case of Maxwell's Law 1123

D. L. Barrow, C. K. Chui, P. W. Smith and J. D. Ward, Unicity of Best Mean Approximation by Second Order Splines with Variable Knots 1131

C. J. O'Neill and T. Downs, A Numerical Accuracy Consideration in Polynomial Deflation 1144

Baker Kearfott, A Proof of Convergence and an Error Bound for the Method of Bisection in $\mathbf{R}^n$ 1147

David F. McAllister and John A. Roulier, Interpolation by Convex Quadratic Splines 1154

R. C. Y. Chin and G. W. Hedstrom, A Dispersion Analysis for Difference Schemes: Tables of Generalized Airy Functions 1163

Paul W. Schmidt, An Asymptotic Approximation for a Type of Fourier Integral 1171

H. Wolkowicz and S. Zlobec, Calculating the Best Approximate Solution of an Operator Equation 1183

Paul S. Wang, An Improved Multivariate Polynomial Factoring Algorithm 1215

J. L. Schonfelder, Chebyshev Expansions for the Error and Related Functions ... 1232

Hansraj Gupta, Finite Differences of the Partition Function 1241

David W. Boyd, Pisot and Salem Numbers in Intervals of the Real Line 1244

Charles J. Parry, On the Class Number of Relative Quadratic Fields 1261

Lajos Takács, A Sum of Binomial Coefficients 1271