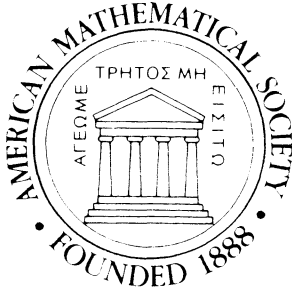


Mathematics of Computation



EDITED BY

James H. Bramble
Bille C. Carlson
Walter Gautschi, *Managing Editor*
Donald Goldfarb
Eugene Isaacson
Heinz-Otto Kreiss
James N. Lyness
Morris Newman
Syvert P. Nørsett
Andrew M. Odlyzko
Frank W. J. Olver
John E. Osborn
Stanley Osher
Beresford Parlett
Philip Rabinowitz
Larry L. Schumaker
Ridgway Scott
Daniel Shanks
Frank Stenger
Hans J. Stetter
G. W. Stewart
Vidar C. Thomée
Lars B. Wahlbin
Hugh C. Williams
John W. Wrench, Jr.

October 1986

Volume 47, Number 176, Pages 387–790

**Published by the American Mathematical Society
Providence, Rhode Island USA**

ISSN 0025-5718

Editorial Committee

WALTER GAUTSCHI, Chairman, Dept. of Computer Sciences, Purdue Univ., West Lafayette, IN 47907
DONALD GOLDFARB, Dept. of Industrial Engineering and Operations Research, Seely W. Mudd Building,
Columbia Univ. in the City of New York, New York, NY 10027
JOHN E. OSBORN, Dept. of Mathematics, Univ. of Maryland, College Park, MD 20742
HUGH C. WILLIAMS, Dept. of Computer Science, Univ. of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2

Technical Editor

MIRIAM E. PORILE, Dept. of Computer Sciences, Purdue Univ., West Lafayette, IN 47907

Board of Associate Editors

JAMES H. BRAMBLE, Dept. of Mathematics, Cornell Univ., Ithaca, NY 14853
BILLE C. CARLSON, Dept. of Mathematics, Iowa State Univ., Ames, IA 50011
EUGENE ISAACSON, Courant Institute of Mathematical Sciences, New York Univ., 251 Mercer Street, New
York, NY 10012
HEINZ-OTTO KREISS, Dept. of Applied Mathematics, California Institute of Technology, Pasadena, CA
91125
JAMES N. LYNESS, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439
MORRIS NEWMAN, Dept. of Mathematics, Univ. of California, Santa Barbara, CA 93106
SYVERT P. NØRSETT, Div. of Numerical Mathematics, The University of Trondheim and The Norwegian
Institute of Technology, Alfred Getz vei 1, N-7034 Trondheim-NTH, Norway
ANDREW M. ODLYZKO, AT & T Bell Laboratories, 600 Mountain Avenue, Murray Hill, NJ 07974
FRANK W. J. OLVER, Inst. for Physical Science and Technology, Univ. of Maryland, College Park, MD 20742
STANLEY OSHER, Dept. of Mathematics, Univ. of California, Los Angeles, CA 90024
BERESFORD PARLETT, Dept. of Mathematics, Univ. of California, Berkeley, CA 94720
PHILIP RABINOWITZ, Dept. of Applied Mathematics, The Weizmann Institute of Science, Rehovot, Israel
LARRY L. SCHUMAKER, Center for Approximation Theory, Dept. of Mathematics, Texas A & M Univ.,
College Station, TX 77843-3368
RIDGWAY SCOTT, Dept. of Mathematics, Univ. of Michigan, Ann Arbor, MI 48109
DANIEL SHANKS, Dept. of Mathematics, Univ. of Maryland, College Park, MD 20742
FRANK STENGER, Dept. of Mathematics, Univ. of Utah, Salt Lake City, UT 84112
HANS J. STETTER, Institut für Numerische Mathematik, Technische Universität Wien, Wiedner Hauptstrasse
6-10, A-1040, Wien, Austria
G. W. STEWART, Dept. of Computer Science, Univ. of Maryland, College Park, MD 20742
VIDAR C. THOMÉE, Mathematics Dept., Chalmers Univ. of Technology, Göteborg, Sweden
LARS B. WAHLBIN, Dept. of Mathematics, Cornell Univ., Ithaca, NY 14853
JOHN W. WRENCH, JR., 6310 Jefferson Blvd., Frederick, MD 21701

SUBSCRIPTION INFORMATION: MATHEMATICS OF COMPUTATION is published quarterly, with issues numbered serially since Volume 1, Number 1. Subscription prices for Volumes 46 and 47 (1986) are \$164.00 list; \$131.00 institutional member; \$107.00 member of CBMS organizations; \$98.00 individual AMS member. A late charge of 10% of the subscription price will be imposed upon orders received from nonmembers after January 1 of the subscription year. Subscribers outside the United States and India must pay a postage surcharge of \$8.00; subscribers in India must pay a postage surcharge of \$18.00. Combination paper and microfiche subscription prices are \$218.00 list; \$174.00 institutional member. Microfiche of each issue will be mailed the fastest way before the issue is mailed by the printer.

BACK NUMBER INFORMATION: Back number prices *per volume* are for Volumes 1–21, \$80.00 list, \$64.00 member; for Volumes 22–33, \$120.00 list, \$96.00 institutional member; for Volumes 34–43, \$80.00 list, \$64.00 institutional member; Volumes 44–45, \$113.00 list, \$90.00 institutional member. Back volumes may be purchased on microfilm or microfiche from University Microfilms International, 300 North Zeeb Road, Ann Arbor, MI 48106.

UNPUBLISHED MATHEMATICAL TABLES: The editorial office of the journal maintains a repository of Unpublished Mathematical Tables (UMT). When a table is deposited in the UMT repository a brief summary of its contents is published in the section *Reviews and Descriptions of Tables and Books*. Upon request, the chairman of the editorial committee will supply copies of any table for a nominal cost per page. All tables and correspondence concerning the UMT should be sent to Walter Gautschi, Chairman, Editorial Committee, Mathematics of Computation, Department of Computer Sciences, Purdue University, West Lafayette, IN 47907.

Orders for subscriptions and publications of the American Mathematical Society should be addressed to the AMS, P.O. Box 1571, Annex Station, Providence, RI 02901-1571. *All orders must be accompanied by payment.* Other correspondence should be addressed to P.O. Box 6248, Providence, RI 02940.

MATHEMATICS OF COMPUTATION is published quarterly by the American Mathematical Society, 201 Charles Street, Providence, RI 02904. Second-class postage is paid at Providence, Rhode Island, and additional mailing offices. Postmaster: Send address changes to Mathematics of Computation, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

Copyright © 1986, American Mathematical Society. All rights reserved.
Printed in the United States of America

The paper used in this journal is acid-free and falls within the guidelines
established to ensure permanence and durability. ♾

MATHEMATICS OF COMPUTATION

TABLE OF CONTENTS

October 1986

Claude Greengard , Convergence of the Vortex Filament Method.....	387
Harry Yserentant , The Convergence of Multi-Level Methods for Solving Finite-Element Equations in the Presence of Singularities	399
E. A. Socolovsky , Difference Schemes for Degenerate Parabolic Equations ...	411
Lloyd N. Trefethen and Laurence Halpern , Well-Posedness of One-Way Wave Equations and Absorbing Boundary Conditions	421
Robert L. Higdon , Absorbing Boundary Conditions for Difference Approximations to the Multi-Dimensional Wave Equation	437
Arthur G. Werschulz , What is the Complexity of Related Elliptic, Parabolic, and Hyperbolic Problems?.....	461
George Majda , Stability with Large Step Sizes for Multistep Discretizations of Stiff Ordinary Differential Equations	473
Robert D. Skeel , Construction of Variable-Stepsize Multistep Formulas	503
Thomas A. Manteuffel and Andrew B. White, Jr. , The Numerical Solution of Second-Order Boundary Value Problems on Nonuniform Meshes.....	511
H.-O. Kreiss, T. A. Manteuffel, B. Swartz, B. Wendroff, and A. B. White, Jr. , Supra-Convergent Schemes on Irregular Grids.....	537
Eugene O'Riordan and Martin Stynes , A Uniformly Accurate Finite-Element Method for a Singularly Perturbed One-Dimensional Reaction-Diffusion Problem.....	555
John Lund , Symmetrization of the Sinc-Galerkin Method for Boundary Value Problems	571
I. H. Sloan and A. Spence , Integral Equations on the Half-Line: A Modified Finite-Section Approximation	589
W. McLean , A Spectral Galerkin Method for a Boundary Integral Equation	597
C. T. Kelley , A Shamanskii-Like Acceleration Scheme for Nonlinear Equations at Singular Roots	609
Philip Rabinowitz , Rates of Convergence of Gauss, Lobatto, and Radau Integration Rules for Singular Integrands	625
Franca Caliò, Walter Gautschi, and Elena Marchetti , On Computing Gauss-Kronrod Quadrature Formulae	639
J. I. Maeztu , An Estimate of Goodness of Cubatures for the Unit Circle in \mathbf{R}^2	651
Joaquin Bustoz and Mourad E. H. Ismail , On Gamma Function Inequalities	659
S. Lewanowicz , Properties of the Polynomials Associated with the Jacobi Polynomials.....	669
N. M. Temme , A Double Integral Containing the Modified Bessel Function: Asymptotics and Computation	683
R. Creutzburg and M. Tasche , Number-Theoretic Transforms of Prescribed Length.....	693
H. C. Williams and Harvey Dubner , The Primality of $R1031$	703
A. Pethö and B. M. M. de Weger , Products of Prime Powers in Binary Recurrence Sequences, Part I: The Hyperbolic Case, with an Application to the Generalized Ramanujan-Nagell Equation	713

B. M. M. de Weger , Products of Prime Powers in Binary Recurrence Sequences, Part II: The Elliptic Case, with an Application to a Mixed Quadratic- Exponential Equation.....	729
Lawrence C. Washington , Some Remarks on Cohen-Lenstra Heuristics.....	741
Reviews and Descriptions of Tables and Books	749
Atkinson 36 , Oden and Carey 37 , Ingham and Kelmanson 38 , Teo and Wu 39 , Dekker and Verwer 40 , Aiken, Editor 41 , Hundsdorfer 42 , Pincus 43 , Van der Laan and Temme 44 , Kennedy, Odeh and Davenport, Editors 45 , Späth 46 , Kaufmann and Gupta, Editors 47 Preparata and Shamos 48 , Fredricksen and Ward 49	
Table Errata	767
Hansen 606 , Gradshteyn and Ryzhik 607	
Corrigendum	769
Skeel	
Indexes to Volumes XLVI and XLVII	771
Supplement to “Stability with Large Step Sizes for Multistep Discretizations of Stiff Ordinary Differential Equations” by George Majda	S41
Supplement to “Construction of Variable-Stepsize Multistep Formulas” by Robert D. Skeel	S45
Supplement to “The Numerical Solution of Second-Order Boundary Value Problems on Nonuniform Meshes” by Thomas A. Manteuffel and Andrew B. White, Jr.	S53
Supplement to “On Computing Gauss-Kronrod Quadrature Formulae” by Franca Caliò, Walter Gautschi, and Elena Marchetti	S57

Information for Contributors and information on Copying and Reprinting
can be found after the supplements section at the end of this issue.