## Mathematics of Computation



EDITED BY
James H. Bramble, Managing Editor
Carl de Boor
Todd Dupont
Walter Gautschi
Donald Goldfarb
Eugene Isaacson
Heinz-Otto Kreiss
Yudell L. Luke
James N. Lyness
Morris Newman
John E. Osborn
Beresford Parlett
Philip Rabinowitz
John R. Rice
Daniel Shanks
Charles C. Sims
Hans J. Stetter
Vidar C. Thomée
Hugh C. Williams
John W. Wrench, Jr.
October 1982
Volume 39, Number 160, Pages 309-775

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

Editorial Committee
JAMES H. BRAMBLE, Chairman. Dept. of Mathematics, White Hall, Cornell Univ., Ithaca, NY 14853
CARL DE BOOR, Mathematics Research Center, Univ. of Wisconsin, Madison, WI 53706
MORRIS NEWMAN, Dept. of Mathematics, Univ. of California, Santa Barbara, CA 93106
DANIEL SHANKS, Dept. of Mathematics, Univ. of Maryland, College Park, MD 20742
Technical Editor
ANITA WAHLBIN, Dept. of Mathematics, White Hall, Cornell Univ., Ithaca, NY 14853

## Board of Associate Editors

TODD DUPONT, Dept. of Mathematics, Univ, of Chicago, Chicago, IL 60637
WALTER GAUTSCHI, Computer Sciences Dept., Purdue Univ., West Lafayette, IN 47907
DONALD GOLDFARB, Dept. of Computer Sciences, School of Engineering, The City College of the
City Univ. of New York, 139th Street \& Convent Avenue, New York, NY 10031
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 Inst. of Technology, Pasadena, CA 91125
YUDELL L. LUKE, Dept. of Mathematics, Univ. of Missouri at Kansas City, Kansas City, MO 64110
JAMES N. LYNESS, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439
JOHN E. OSBORN, Dept. of Mathematics, Univ. of Maryland, College Park, MD 20742
BERESFORD PARLETT, Dept. of Computer Science, Univ. of California, Berkeley, CA 94720
PHILIP RABINOWITZ, Dept. of Applied Mathematics, The Weizmann Institute of Science, Rehovot, Israel
JOHN R. RICE, Division of Mathematical Sciences, Purdue Univ., Lafayette, IN 47907
CHARLES C. SIMS, Dept. of Mathematics, Rutgers Univ., New Brunswick, NJ 08903
HANS J. STETTER, Institut für Numerische Mathematik, Technische Universitat Wien, Karlsplatz 13, A-1040, Wien, Austria
VIDAR C. THOMÉE, Mathematics Dept., Chalmers Univ. of Technology, Göteborg, Sweden
HUGH C. WILLIAMS, Dept. of Computer Science, Univ. of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2
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 38 and 39 (1982) are $\$ 80.00$ list; $\$ 56.00$ institutional member; $\$ 40.00$ member of CBMS organizations; $\$ 32.00$ individual AMS member. Combination paper and microform (microfiche or microfilm) subscription prices are $\$ 107.00$ list; $\$ 75.00$ institutional member; $\$ 54.00$ member of CBMS organizations; $\$ 43.00$ individual AMS member. Microfiche of each issue will be mailed the fastest way before the camera copy is sent to the printer.

BACK NUMBER INFORMATION: Back number prices per volume are for Volumes $1-29, \$ 64.00$ list, $\$ 48.00$ member; for Volumes $30-33, \$ 100.00$ list, $\$ 75.00$ member; for Volumes 34-37, $\$ 60.00$ list, $\$ 48.00$ member. Beginning with Volume 32, back volumes are also available on 16 mm positive or negative microfilm or on microfiche; Volumes 1-31 are available on microfilm only, not microfiche. The microfilm may be mounted on spools or in Kodak or 3M cartridges. Only current subscribers are eligible to purchase back volumes on microform. Write to the AMS for a detailed price list.
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 James H. Bramble, Chairman, Department of Mathematics, White Hall, Cornell University, Ithaca, NY 14853.

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

# MATHEMATICS OF COMPUTATION <br> TABLE OF CONTENTS <br> OCTOBER 1982 

Charles I. Goldstein, A Finite Element Method for Solving Helmholtz Type Equa- tions in Waveguides and Other Unbounded Domains ..... 309
Laurent Veron, Some Remarks on the Convergence of Approximate Solutions of Nonlinear Evolution Equations in Hilbert Spaces ..... 325
Garth A. Baker, Vassilios A. Dougalis and Ohannes A. Karakashian, On a Higher Order Accurate Fully Discrete Galerkin Approximation to the Navier-Stokes Equations ..... 339
Joseph W. Jerome and Michael E. Rose, Error Estimates for the Multidimensional Two-Phase Stefan Problem ..... 377
J. Paine, Correction of Sturm-Liouville Eigenvalue Estimates. ..... 415
Peter A. Markowich, Eigenvalue Problems on Infinite Intervals ..... 421
Yves Jaccard and Hugo Evéquoz, Approximation of the Spectrum of an Operator Given by the Magnetohydrodynamic Stability of a Plasma ..... 443
Randolph E. Bank and Donald J. Rose, Analysis of a Multilevel Iterative Method for Nonlinear Finite Element Equations ..... 453
J. H. Freilich and E. L. Ortiz, Numerical Solution of Systems of Ordinary Differen- tial Equations With the Tau Method: An Error Analysis ..... 467
Eckart Gekeler, Linear Multistep Methods for Stable Differential Equations $y^{*}=$ $A y+B(t) y^{\cdot}+c(t)$ ..... 481
J. D. Day and D. N. P. Murthy, Two Classes of Internally $S$-Stable Generalized Runge-Kutta Processes Which Remain Consistent With an Inaccurate Jaco- bian ..... 491
C. J. Gladwin, On Optimal Integration Methods for Volterra Integral Equations of the First Kind. ..... 511
Ivan G. Graham, Galerkin Methods for Second Kind Integral Equations With Singu- larities ..... 519
M. Lax and G. P. Agrawal, Evaluation of Fourier Integrals Using $B$-Splines ..... 535
Masaaki Sugihara and Kazuo Murota, A Note on Haselgrove's Method for Numer- ical Integration ..... 549
H. Jager, On the Speed of Convergence of the Nearest Integer Continued Fraction.. ..... 555
H. A. van der Vorst, A Generalized Lanczos Scheme ..... 559
Abraham Ziv, Relative Distance-An Error Measure in Round-Off Error Analysis. ..... 563
Jeff Chow, On the Uniqueness of Best $L_{2}[0,1]$ Approximation by Piecewise Poly- nomials With Variable Breakpoints ..... 571
B. Gabutti and J. N. Lyness, An Acceleration Method for the Power Series of Entire Functions of Order 1 ..... 587
U. Grothkopf and G. Opfer, Complex Chebyshev Polynomials on Circular Sectors With Degree Six or Less. ..... 599
C. A. Wills, J. M. Blair and P. L. Ragde, Rational Chebyshev Approximations for the Bessel Functions $J_{0}(x), J_{1}(x), Y_{0}(x), Y_{1}(x)$ ..... 617
Keith R. Lassey, On the Computation of Certain Integrals Containing the Modified Bessel Function $I_{0}(\xi)$. ..... 625
Andrés Cruz and Javier Sesma, Zeros of the Hankel Function of Real Order and of
Its Derivative. ..... 639
K. S. Kölbig, Closed Expressions for $\int_{0}^{1} t^{-1} \log ^{n-1} t \log ^{p}(1-t) d t$ ..... 647
Francis J. Murray, Formulas for Factorial $N$. ..... 655
Gregory Butler and John J. Cannon, Computing in Permutation and Matrix Groups
I: Normal Closure, Commutator Subgroups, Series ..... 663
Gregory Butler, Computing in Permutation and Matrix Groups II: Backtrack Algo- rithm ..... 671
R. P. Brent, J. van de Lune, H. J. J. te Riele and D. T. Winter, On the Zeros of the Riemann Zeta Function in the Critical Strip. II ..... 681
P. Llorente and A. V. Oneto, On the Real Cubic Fields ..... 689
F. J. van der Linden, Class Number Computations of Real Abelian Number Fields. ..... 693
Don Zagier, On the Number of Markoff Numbers Below a Given Bound. ..... 709
Richard H. Hudson and Kenneth S. Williams, Class Number Formulae of Dirichlet Type. ..... 725
Reviews and Descriptions of Tables and Books. ..... 733Engels 21, Powell 22, Wimp 23, Doolan, Miller and Schilders 24, Glowinski,Lions and Tremoliers 25, Salzer, Levine and Serben 26, Knopp, Editor 27
Table Errata ..... 747Brillhart, Lehmer and Selfridge 588, Gradshteyn and Ryzhik 589
Corrigendum759
Williams
Indices to Volumes XXXVIII and XXXIX. ..... 761
Microfiche SupplementsC. A. Wills, J. M. Blair and P. L. Ragde, Rational Chebyshev Approximationsfor the Bessel Functions $J_{0}(x), J_{1}(x), Y_{0}(x), Y_{1}(x)$K. S. Kölbig, Closed Expressions for $\int_{0}^{1} t^{-1} \log ^{n-1} t \log ^{p}(1-t) d t$

# Mathematical Reviews Sections 

## enjor the CONVENIENCE OF HAVING MATHEMATICAL REVIEWS AT YOUR DESK. have You thought how really handy it would be to have the sections RELEVANT TO YOUR RESEARCH RIGHT BEFORE YOU? MR has been divided into 37 affordable

Sets for individual subscribers. Each month you can receive the Section Sets you have chosen with an author index. With your June sets you will receive a semiannual author index (just as you would for MR) and in December an annual author and subject index (as with MR). Also available for 1982 Section subscribers are three-ring binders of sturdy quality in the familiar tangerine color of MR to hold your subscription. The binders have a two-inch spine and are adequate to hold 400 pages.
Section Sets are divided into Class 1 and Class 2 according to the estimated number of pages per year.

| Set | Sections 00, 01 | Subjects |  | $\square 21$ | 42, 43, 44, 45 | Harmonic analysis, integral |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\square 1 \mathrm{~A}$ | $00,01$ | General, history, biography (Class 1) |  | ㅁ1J | 46 | Functional analysis (Class 1) |
| $\square 1 B$ | 03, 04 | Logic, foundations, set theory (Class 1) |  | $\square 1 K$ $\square 21$ | 47 | Operator theory (Class 1) Calculus of variations, optimiz- |
| $\square 1 \mathrm{C}$ | 05 | Combinatorics (Class 1) |  |  |  | ation (Class 2) ${ }^{\text {a }}$ (Class 2) |
| -2A | 06, 08 | Order, lattices, general systems (Class 2) |  | $\begin{aligned} & \square \mathbf{2 K} \\ & \square \mathbf{1 L} \end{aligned}$ | 51, 52 | Geometry, convex sets (Class 2) Differential geometry (Class 1) |
| $\begin{aligned} & \square 1 D \\ & \square 2 B \end{aligned}$ | 10 | Number theory (Class 1) <br> Algebraic number theory, field theory, polynomials (Class 2) |  | $\square 2 \mathrm{~L}$ | 54 | General topology (Class 2) |
|  | 12 |  |  | $\square 1 \mathrm{M}$ | 55, 57 | See $1 \mathrm{E}(18,55,57)$ Global analysis, analysis on |
| $\square 2 \mathrm{C}$ | 13, 14 | Commutative rings and algebras, algebraic geometry (Class 2) |  | $\square 1 \mathrm{~N}$ | 60 | manifolds (Class 1) Probability theory and stochas- |
| -2D | 15 | Linear and multilinear algebra, matrix theory (Class 2) |  | $\square 19$ | 62 | tic processes (Class 1) Statistics (Class 1) |
| - 2E | 16, 17 | Associative/nonassociative rings, algebras (Class 2) |  | $\begin{aligned} & \square 1 Q \\ & \square 1 R \end{aligned}$ | 65 | Numerical analysis (Class 1) Computer science (including |
| $\square 1 \mathrm{E}$ | 18, 55, 57 | Category theory, algebraic topology, manifolds (Class 1) |  | $\square \mathbf{~ 2 M}$ | 70,73 | automata) (Class 1) <br> Mechanics of particles, systems, |
| -1F | 20 | Group theory, generalizations (Class 1) |  | $\square 2 N$ | 76, 78, 80 | (Class 2) <br> Fluid mechanics, optics, elec- |
| $\square \mathbf{2 F}$ | 22 | Topological groups,'Lie groups (Class 2) |  |  |  | tromagnetics, thermodynamics (Class 2) |
| -2G | 26, 28 | Real functions, measure, integration (Class 2) |  | $\begin{aligned} & \square 1 S \\ & \square 2 P \end{aligned}$ | 82, 83, 85,81 | Quantum mechanics (Class 1) Other physics, astronomy, astro- |
| $\square 1 \mathrm{G}$ | 30, 31, 32, 33 | Complex analysis, potential theory, special functions (Class 1) |  | $\square 1 T$ | 90 | physics, geophysics (Class 2) <br> Economics, operations research, programming, games |
| $\square 1 \mathrm{H}$ | 34 | Ordinary differential equations (Class 1) |  | $\square 2 Q$ | 92 | (Class 1) <br> Biology and behavioral sci- |
| -11 | 35 | Partial differential equations (Class 1) |  | $\square 10$ | 93 | ences (Class 2) <br> Systems theory; control (Class 1) |
| $\square \mathbf{2 H}$ | 39, 40, 41 | Finite differences, sequences, approximations (Class 2) |  | -1V | 94 | Information and communication, circuits (Class 1) |
|  |  | First Set |  | Each Add'I Set |  | Optional Binder |
|  |  | Class 1 | Class 2 | Class 1 | Class 2 | \$5.00 each |
|  | Individual member Reviewer | $\begin{array}{r} \$ 36 \\ 24 \end{array}$ | $\begin{array}{r} \$ 27 \\ 18 \end{array}$ | \$30 $\mathbf{2 0}$ | $\$ 21$ 14 |  |

USE THIS PAGE OR A PHOTOCOPY TO ORDER.
Date
\$ $\qquad$ enclosed for subscriptions selected and marked above.
$\$ 5.00$ enclosed for $2^{\prime \prime}$ tangerine binder stamped MATHEMATICAL. REVIEWS SECTIONS on spine and front cover. ( It is not required that one buy a binder.)
$\$ \longrightarrow$ Total prepaid order.

Name Your AMS code

Address

## Springer for Computational Physics

## A Computational Method in Plasma Physics

F. Bauer, O. Betancourt, and P. Garabedian

This volume presents a numerical method for computation and analysis of the equilibrium and stability of a plasma in toroidal geometry. The book also includes a description of the computer code which implements the method, as well as a Fortran listing.
1978/ 144 pp./ 22 illus./ Cloth $\$ 19.00$ Springer Series in Computational Physics
ISBN 0-387-08833-4
Finite-Difference Techniques for Vectorized Fluid Dynamics Calculations

Edited by D.L. Book

Faster than standard scalar routines, the techniques described in this volume are based on methods designed for vector computers. Theoretical background, competitive and kindred techniques, examples,
and lists of program modules are also given. This is an excellent introduction to the topic.
1981/ 226 pp./ 60 illus./ Cloth $\$ 32.00$ Springer Series in Computational Physics
ISBN 0-387-10482-8

## Computational Methods for Fluid Flow

R. Peyret and T.D. Taylor

In describing practical finite difference, finite element, and spectral methods, this volume serves as a guide to computational methods for fluid flow which avoid complex mathematical proofs. This approach
will be invaluable to engineers and scientists in solving viscous and inviscid problems for compressible and incompressible flows.
1982/ 416 pp./ 129 illus./ Cloth $\$ 42.50$
Springer Series in Computational Physics
ISBN 0-387-11147-6

## Unsteady Viscous Flows

D.P. Telionis

The problems posed by the effects of viscosity in unsteady flows require sensitive numerical techniques for their solution. This volume reviews such techniques, offers a description of perturbation methods, and discusses research done by the author in turbulent boundary layers.
1981/ 408 pp./ 132 illus. Cloth $\$ 38.00$ Springer Series in Computational Physics
ISBN 0-387-10481-X

## Implementation of Finite Methods for Navier-Stokes Equations

F. Thomasset

The author's rather unique approach separates this book from other texts of its kind. This volume surveys the finite element methods for numerical solutions to Navier-Stokes equations, but requires no knowledge of structural mechanics, and at the same time reduces mathematical concepts to a minimum.
1981/ 161 pp./ 86 illus./ Cloth $\$ 28.00$ Springer Series in Computational Physics
ISBN 0-387-10771-1
To order, write:


Springer-Verlag New York Inc.
Dept. S5470
P.O. Box 2485

Secaucus, N.J. 07094

## Information for Contributors

Manuscripts should be typewritten double-spaced in the format used by the journal. For journal abbreviations, see the latest Mathematical Reviews volume index. An author should submit the original and two copies of the manuscript and retain one copy. The author may suggest an appropriate editor for his paper. It is recommended that the author acquaint himself with the pertinent material contained in " A Manual for Authors of Mathematical Papers," which is available from the American Mathematical Society. All contributions intended for publication and all books for review should be addressed to James H. Bramble, Chairman, Editorial Committee, Mathematics of Computation, Department of Mathematics, White Hall, Cornell University, Ithaca, New York 14853. The date received, which is published with the final version of an accepted paper, is the date received in the office of the Chairman of the Editorial Committee, and it is the responsibility of the author to submit manuscripts directly to this office. Institutions sponsoring research reported in the journal are assessed page and microfiche charges.

Each article submitted for publication must be accompanied by a brief and reasonably self-contained abstract, and by 1980 Mathematics Subject Classification numbers. If a list of key words and phrases is included, it will be printed as a footnote on the first page. A list of the classification numbers may be found in the 1978 Subject Index to Mathematical Reviews.

The research journals of the American Mathematical Society carry a page charge of $\$ 50.00$ per page to help defray the cost of publication. This amount is charged to the institution or to a contract supporting the research reported in the published paper. The publication charge policy of the United States Federal Council for Science and Technology (FCST) is reported on page 112 of the February, 1975 issue of the NOTICES of the American Mathematical Society. In no case is the author personally responsible for paying the page charge, nor is acceptance of the author's paper for publication dependent upon payment of the page charge.

## Copying and Reprinting

Individual readers of this publication, and nonprofit libraries acting for them are permitted to make fair use of the material, such as to copy an article for use in teaching or research. Permission is granted to quote brief passages from this publication in reviews provided the customary acknowledgement of the source is given.

Republication, systematic copying, or multiple reproduction of any material in this publication (including abstracts) is permitted only under license from the American Mathematical Society. Requests for such permission should be addressed to the Executive Director, American Mathematical Society, Box 6248, Providence, Rhode Island 02940.

The appearance of the code on the first page of an article in this journal indicates the copyright owner's consent for copying beyond that permitted by Sections 107 or 108 of the U. S. Copyright Law, provided that the copier pay the stated per copy fee through the Copyright Clearance Center, Inc., 21 Congress Street, Salem, Massachusetts 01970 . This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotion purposes, for creating new collective works, or for resale.
Andrés Cruz and Javier Sesma, Zeros of the Hankel Function of Real Order and of Its Derivative. ..... 639
K. S. Kölbig, Closed Expressions for $\int_{0}^{1} t^{-1} \log ^{n-1} t \log ^{p}(1-t) d t$ ..... 647
Francis J. Murray, Formulas for Factorial $N$. ..... 655
Gregory Butler and John J. Cannon, Computing in Permutation and Matrix Groups
I: Normal Closure, Commutator Subgroups, Series ..... 663
Gregory Butler, Computing in Permutation and Matrix Groups II: Backtrack Algo- rithm ..... 671
R. P. Brent, J. van de Lune, H. J. J. te Riele and D. T. Winter, On the Zeros of the Riemann Zeta Function in the Critical Strip. II ..... 681
P. Llorente and A. V. Oneto, On the Real Cubic Fields. ..... 689
F. J. van der Linden, Class Number Computations of Real Abelian Number Fields. ..... 693
Don Zagier, On the Number of Markoff Numbers Below a Given Bound. ..... 709
Richard H. Hudson and Kenneth S. Williams, Class Number Formulae of Dirichlet Type. ..... 725
Reviews and Descriptions of Tables and Books ..... 733Engels 21, Powell 22, Wimp 23, Doolan, Miller and Schilders 24, Glowinski,Lions and Tremoliers 25, Salzer, Levine and Serben 26, Knopp, Editor 27
Table Errata747
Brillhart, Lehmer and Selfridge 588, Gradshteyn and Ryzhik 589
Corrigendum759Williams
Indices to Volumes XXXVIII and XXXIX ..... 761
Microfiche SupplementsC. A. Wills, J. M. Blair and P. L. Ragde, Rational Chebyshev Approximationsfor the Bessel Functions $J_{0}(x), J_{1}(x), Y_{0}(x), Y_{1}(x)$K. S. Kölbig, Closed Expressions for $\int_{0}^{1} t^{-1} \log ^{n-1} t \log ^{p}(1-t) d t$

# MATHEMATICS OF COMPUTATION TABLE OF CONTENTS <br> <br> OCTOBER 1982 

 <br> <br> OCTOBER 1982}
Charles I. Goldstein, A Finite Element Method for Solving Helmholtz Type Equa- tions in Waveguides and Other Unbounded Domains ..... 309
Laurent Veron, Some Remarks on the Convergence of Approximate Solutions of Nonlinear Evolution Equations in Hilbert Spaces. ..... 325
Garth A. Baker, Vassilios A. Dougalis and Ohannes A. Karakashian, On a Higher Order Accurate Fully Discrete Galerkin Approximation to the Navier-Stokes Equations ..... 339
Joseph W. Jerome and Michael E. Rose, Error Estimates for the Multidimensional Two-Phase Stefan Problem ..... 377
J. Paine, Correction of Sturm-Liouville Eigenvalue Estimates ..... 415
Peter A. Markowich, Eigenvalue Problems on Infinite Intervals ..... 421
Yves Jaccard and Hugo Evéquoz, Approximation of the Spectrum of an Operator Given by the Magnetohydrodynamic Stability of a Plasma. ..... 443
Randolph E. Bank and Donald J. Rose, Analysis of a Multilevel Iterative Method for Nonlinear Finite Element Equations. ..... 453
J. H. Freilich and E. L. Ortiz, Numerical Solution of Systems of Ordinary Differen- tial Equations With the Tau Method: An Error Analysis ..... 467
Eckart Gekeler, Linear Multistep Methods for Stable Differential Equations $y^{*}=$ $A y+B(t) y+c(t)$ ..... 481
J. D. Day and D. N. P. Murthy, Two Classes of Internally $S$-Stable Generalized Runge-Kutta Processes Which Remain Consistent With an Inaccurate Jaco- bian. ..... 491
C. J. Gladwin, On Optimal Integration Methods for Volterra Integral Equations of the First Kind ..... 511
Ivan G. Graham, Galerkin Methods for Second Kind Integral Equations With Singu- larities. ..... 519
M. Lax and G. P. Agrawal, Evaluation of Fourier Integrals Using $B$-Splines ..... 535
Masaaki Sugihara and Kazuo Murota, A Note on Haselgrove's Method for Numer- ical Integration ..... 549
H. Jager, On the Speed of Convergence of the Nearest Integer Continued Fraction. ..... 555
H. A. van der Vorst, A Generalized Lanczos Scheme ..... 559
Abraham Ziv, Relative Distance-An Error Measure in Round-Off Error Analysis. ..... 563
Jeff Chow, On the Uniqueness of Best $L_{2}[0,1]$ Approximation by Piecewise Poly- nomials With Variable Breakpoints. ..... 571
B. Gabutti and J. N. Lyness, An Acceleration Method for the Power Series of Entire Functions of Order 1 ..... 587
U. Grothkopf and G. Opfer, Complex Chebyshev Polynomials on Circular Sectors With Degree Six or Less. ..... 599
C. A. Wills, J. M. Blair and P. L. Ragde, Rational Chebyshev Approximations for the Bessel Functions $J_{0}(x), J_{1}(x), Y_{0}(x), Y_{1}(x)$ ..... 617
Keith R. Lassey, On the Computation of Certain Integrals Containing the Modified Bessel Function $I_{0}(\xi)$ ..... 625

