Mathematics of Computation

Coden MCMPAF
Volume 29, Number 130

Pages 343 – 675
April 1975

Published by the American Mathematical Society
PROVIDENCE, RHODE ISLAND

Editorial Committee

JAMES H. BRAMBLE, Chairman. Center for Applied Mathematics, 275 Olin Hall, Cornell Univ., Ithaca, NY 14853

WALTER GAUTSCHI, Computer Sciences Dept., Purdue Univ., Lafayette, IN 47907

ALSTON D. HOUSEHOLDER, Dept. of Mathematics, Ayres Hall, The Univ. of Tennessee, Knoxville, TN 37916

JOHN W. WRENCH, JR., Route 5, Box 258A, Frederick, MD 21701

Technical Editor

CAROL A. HOLLAND, Center for Applied Mathematics, 275 Olin Hall, Cornell Univ., Ithaca, NY 14853

Board of Associate Editors

JAMES W. DANIEL, Dept. of Mathematics, Univ. of Texas at Austin, Austin, TX 78712

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, New York Univ., Courant Institute of Mathematical Sciences, 251 Mercer Street, New York, NY 10012

HEINZ-OTTO KREISS, Computer Science Dept., Univ. of Uppsala, Uppsala, Sturegaten 4, Sweden

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

MORRIS NEWMAN, Mathematics Division, National Bureau of Statistics, Washington, DC 20234

BERESFORD PARLETT, Dept. of Computer Science, Univ. of California, Berkeley, CA 94720

LAWRENCE E. PAYNE, Dept. of Mathematics, Cornell Univ., Ithaca, NY 14850

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

DANIEL SHANKS, Naval Ship Research and Development Center, Bethesda, MD 20084

HANS J. STETTER, Institut für Numerische Mathematik, Technische Hochschule Wien, Karlsplatz 13, A-1040, Wien, Austria

VIDAR C. THOMÉE, Mathematics Dept., Chalmers Univ. of Technology, Göteborg, Sweden

Information for Subscribers

The journal is published quarterly in one volume per year, with issues numbered serially since Volume 1, Number 1. Annual subscription rates are: list $36, institutional member $24, individual AMS member $10, member of CBMS organizations $15. All back volumes are available; list prices per volume are as follows: $20 for Vols. 1 – 19 (1943 – 1965); $24 for Vols. 20 – 23 (1966 – 1969); $30 for Vols. 24 – 26 (1970 – 1972); $36 for Vol. 27 (1973); and $54 for Vol. 28 (1974).

Back volumes of Mathematics of Computation are available on 16 mm. microfilm. Volumes 1 – 27 (1943 – 1973) are available as a set; prices are $200 for spools and $218 for cartridges (either Eastman or 3M). Only current subscribers will be eligible to purchase back volumes on microfilm.

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.

Subscriptions and orders for publications of the American Mathematical Society should be addressed to American Mathematical Society, 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.

Copyright © 1975, American Mathematical Society

Second-class postage paid at Providence, Rhode Island, and at additional mailing offices

Mathematics of Computation

TABLE OF CONTENTS

APRIL 1975

Error Estimates for a Finite Element Approximation of a Minimal Surface . . . . . CLAES JOHNSON & VIDAR THOMÉE 343

Finite Element Multistep Discretizations of Parabolic Boundary Value Problems . . . . . MILOŠ ZLÁMAL 350

The Effect of Interpolating the Coefficients in Nonlinear Parabolic Galerkin Procedures . . . . . JIM DOUGLAS, JR. & TODD DUPONT 360

A Lower Bound on the Angles of Triangles Constructed by Bisecting the Longest Side . . . . . IVO G. ROSENBERG & FRANK STENGER 390

The Convergence Rate for Difference Approximations to Mixed Initial Boundary Value Problems . . . . . BERTIL GUSTAFSSON 396

Explicit-Implicit Schemes for the Numerical Solution of Nonlinear Hyperbolic Systems . . . . . G. R. MCGUIRE & J. LL. MORRIS 407

Seven-Point Difference Schemes for Hyperbolic Equations AVISHAI LIVNE 425

GAP—A PIC-Type Fluid Code . . . . . B. M. MARDER 434

Coupled Sound and Heat Flow and the Method of Least Squares ALFRED CARASSO 447

Approximation Methods for Nonlinear Problems with Application to Two-Point Boundary Value Problems . . . . . H. B. KELLER 464

Optimal L_∞ Error Estimates for Galerkin Approximations to Solutions of Two-Point Boundary Value Problems JIM DOUGLAS, JR., TODD DUPONT & LARS WAHLBIN 475

On the Stability of the Ritz-Galerkin Method for Hammerstein Equations . . . . . JÖRG HERTLING & ALEXANDRU I. ŞCHIOP 484

Some New Multistep Methods for Solving Ordinary Differential Equations . . . . . G. K. GUPTA & C. S. WALLACE 489

Two-Parameter, Arbitrary Order, Exponential Approximations for Stiff Equations . . . . . BYRON L. EHLE & ZDENEK PICEL 501

A Numerical Comparison of Integral Equations of the First and Second Kind for Conformal Mapping JOHN K. HAYES, DAVID K. KAHANER & RICHARD G. KELLNER 512

Restricted Range Approximation and Its Application to Digital Filter Design . . . . . JAMES T. LEWIS 522

Discrete Rational L_p Approximation . . . . . JERRY M. WOLFE 540

Chebyshev Approximation by Interpolating Rationals on $[\alpha, \infty)$ CHARLES B. DUNHAM 549

A Difficulty in Williams' Algorithm for Interpolating Rationals CHARLES B. DUNHAM 552

An Algorithm for Winding Numbers for Closed Polygonal Paths KENNETH O. LELAND 554

Some Properties of Orthogonal Polynomials . . . . . D. B. HUNTER 559

Conversion of Continued Fractions into Power Series A. J. ZAJTA & W. PANDIKOW 566

On Laplace Transforms Near the Origin . . . . . R. WONG 573
Differential-Difference Properties of Hypergeometric Polynomials
JET WIMP 577
Complex Zeros of the Jonquière or Polylogarithm Function
B. FORNBERG & K. S. KÖLBIG 582
Gershgorin Theory for the Generalized Eigenvalue Problem $Ax = \lambda Bx$
G. W. STEWART 600
A Generalization of the Method of Averages for Overdetermined Linear Systems . . . . . NED ANDERSON 607
A Class of Hessenberg Matrices with Known Pseudoinverse and Drazin Inverse . . . . INDERJIT SINGH, GEORGE POOLE & THOMAS BOULLION 615
New Primality Criteria and Factorizations of $2^m \pm 1$
JOHN BRILLHART, D. H. LEHMER & J. L. SELFRIDGE 620
REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS 648
ALBRECHT & COLLATZ, Editors **26**, ANDRÉE, ANDRÉE & ANDRÉE **35**, ANGELL **33**, BRIGHAM **29**, CLATWORTHY, CAMERON & SPECKMAN **31**, DAHLQUIST & BJÖRCK **18**, FEINERMAN & NEWMAN **20**, HAMMING **16**, HARTER & OWEN, Coeditors **32**, LIEBERSTEIN **37**, LORENTZ, Editor **19**, MURRAY, Editor **24**, NIEVERGELT, FARRAR & REINGOLD **25**, OLVER **22**, OLVER **23**, ROMAN **28**, SALZER **21**, STROUD **30**, TABAKOVA **34**, TEMAN **27**, THE OPEN UNIVERSITY **17**, WEINGARTEN **36**
TABLE ERRATA 670
CAYLEY **515**, ERDÉLYI, MAGNUS, OBERHETTINGER & TRICOMI **516**, HAYASHI **517**, HAYASHI **518**, MAGNUS, OBERHETTINGER & SONI **519**
CORRIGENDA 673
BENKOSKI & ERDÖS, FETTIS, MICULA
An Addendum to "12,758" . . . ROBERT E. DRESSLER & THOMAS PARKER 675

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 one copy 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 "Information for Contributors to Mathematics of Computation" and "Manual for Authors," both of which are available upon request 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, Cornell University, Ithaca, New York 14850. 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 AMS (MOS) 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 Index to Mathematical Reviews, Volume 39 (June 1970).