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 **Beresford Parlett** Lawrence E. Payne Philip Rabinowitz John R. Rice **Daniel Shanks** Hans J. Stetter Vidar C. Thomée Hugh C. Williams John W. Wrench, Jr.

January 1980 Volume 34, Number 149, Pages 1–332

Published by the American Mathematical Society Providence, Rhode Island USA ISSN 0025-5718

Editorial Committee

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

CARL DE BOOR, Mathematics Research Center, Univ. of Wisconsin, Madison, WI 53706 WALTER GAUTSCHI, Computer Sciences Dept., Purdue Univ., West Lafayette, IN 47907 DANIEL SHANKS, Dept. of Mathematics, Univ. of Maryland, College Park, MD 20742

Technical Editor

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

Board of Associate Editors

TODD DUPONT, Dept. of Mathematics, Univ. of Chicago, Chicago, IL 69637

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 MORRIS NEWMAN, Dept. of Mathematics, Univ. of California, Santa Barbara, CA 93106

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

LAWRENCE E. PAYNE, Dept. of Mathematics, Cornell Univ., Ithaca, NY 14853

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

HANS J. STETTER, Institut für Numerische Mathematik, Technische Universität 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 34 and 35 (1980) are \$65.00 list; \$45.00 institutional member; \$35.00 individual member; \$25.00 member of CBMS organizations. Combination paper and microform (microfiche or microfilm) subscription prices are \$87.00 list; \$60.00 institutional member; \$47.00 individual member; \$33.00 member of CBMS organizations. 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 1-27, \$36.00 list, \$27.00 member; for Volumes 28-29, \$54.00 list, \$40.50 member; for Volume 30, \$72.00 list, \$54.00 member; for Volumes 31-33, \$84.00 list, \$63.00 member. Back volumes are also available on 16mm positive or negative microfilm. The microfilm may be mounted on spools or in Kodak or 3M cartridges. Only current subscribers are eligible to purchase back volumes on microfilm. 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.

Orders for subscriptions and publications of the American Mathematical Society should be addressed to the AMS, P.O. Box 1571, Annex Station, Providence, R.1. 02901. All orders must be accompanied by payment. Other correspondence should be addressed to P.O. Box 6248, Providence, R.1. 02940.

Second class postage paid at Providence, Rhode Island, and additional mailing offices. U. S. Postal Service Publication No. 333980 Copyright © 1980, American Mathematical Society Printed in the United States of America

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 **Beresford Parlett** Lawrence E. Payne Philip Rabinowitz John R. Rice **Daniel Shanks** Hans J. Stetter Vidar C. Thomée Hugh C. Williams John W. Wrench, Jr.

VOLUME 34 · 1980 · NUMBERS 149–150

Providence, Rhode Island, USA ISSN 0025-5718

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, Center for Applied Mathematics, 275 Olin Hall, Cornell University, Ithaca, New York 14853. 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 selfcontained 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 \$40.00 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., Operations Center, P.O. Box 765, Schenectady, New York 12301. 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.

MATHEMATICS OF COMPUTATION TABLE OF CONTENTS January 1980

Michael G. Crandall and Andrew Majda, Monotone Difference Approximations for	
Scalar Conservation Laws	1
Ragnar Winther, A Conservative Finite Element Method for the Korteweg-de Vries	
Equation	23
Bjorn Engquist and Stanley Osher, Stable and Entropy Satisfying Approximations	
for Transonic Flow Calculations	45
Alfred H. Schatz, A Weak Discrete Maximum Principle and Stability of the Finite	
Element Method in L_{∞} on Plane Polygonal Domains. I	77
Vidar Thomée, Negative Norm Estimates and Superconvergence in Galerkin Meth-	
ods for Parabolic Problems	93
Ragnar Winther, Initial Value Methods for Parabolic Control Problems	115
Seymour V. Parter, On the Roles of "Stability" and "Convergence" in Semidis-	
crete Projection Methods for Initial-Value Problems	127
Arthur G. Werschultz, Computational Complexity of One-Step Methods for Sys-	
tems of Differential Equations	155
B. A. Troesch, The Shooting Method Applied to a Cyclic Inequality	175
George J. Miel, Majorizing Sequences and Error Bounds for Iterative Methods	185
John W. Evans, William B. Gragg and Randall J. LeVeque, On Least Squares Ex-	
ponential Sum Approximation with Positive Coefficients	203
J. N. Lyness and G. Monegato, Quadrature Error Functional Expansions for the	
Simplex When the Integrand Function Has Singularities at Vertices	213
Bradley W. Dickinson, Solution of Linear Equations With Rational Toeplitz Ma-	
trices	227
George Marsaglia, Generating Random Variables With a t-Distribution	235
J. L. Schonfelder, Very High Accuracy Chebyshev Expansions for the Basic Trig-	
onometric Functions	237
Wilhelm Plesken and Michael Pohst, On Maximal Finite Irreducible Subgroups of	
GL(n, Z) III. The Nine Dimensional Case	245
Wilhelm Plesken and Michael Pohst, On Maximal Finite Irreducible Subgroups of	
$GL(n, \mathbf{Z})$ IV. Remarks on Even Dimensions with Applications to $n = 8$	259
Wilhelm Plesken and Michael Pohst, On Maximal Finite Irreducible Subgroups of	
$GL(n, \mathbf{Z})$ V. The Eight Dimensional Case and a Complete Description of	
Dimensions Less Than Ten	277
Mark Templer, On the Primality of $k + 1$ and $2 * 3 * 5 * \cdots * p + 1$	303
Richard P. Brent and Edwin M. McMillan, Some New Algorithms for High-Pre-	
cision Computation of Euler's Constant	305
D. W. MacLean, Residue Classes of the Partition Function	313
Richard K. Guy and J. L. Selfridge, Corrigendum to "What Drives an Aliquot Se-	
quence?"	319
Herbert E. Salzer, Misstatements in Milne-Thomson, Calculus of Finite Differences,	
Macmillan, London, 1933	323

Reviews and Descriptions of Tables and Books	325
de Boor 1, Brezinski 2, Fried 3, Fettis and Caslin 4, Conde and Kalla 5,	
Conde and Kalla 6, Conde and Kalla 7, MacLean 8	
Table Errata	331
Fettis and Caslin 566, Hobson 567, Jordan 568, Magnus, Oberhettinger and	
Soni 569, Spiegel 570	
Corrigendum	332
Levine and Dalton	
Microfiche Supplement	
Wilhelm Plesken and Michael Pohst, On Maximal Finite Irreducible Sub-	
groups of GL(n, Z) V. The Eight Dimensional Case and a Complete Descrip-	
tion of Dimensions Less Than Ten	

Reviews and Descriptions of Tables and Books	325
de Boor 1, Brezinski 2, Fried 3, Fettis and Caslin 4, Conde and Kalla 5,	14
Conde and Kalla 6, Conde and Kalla 7, MacLean 8	
Table Errata	331
Fettis and Caslin 566, Hobson 567, Jordan 568, Magnus, Oberhettinger and	
Soni 569, Spiegel 570	19449
Corrigendum	332
Levine and Dalton	202
Microfiche Supplement	
Wilhelm Plesken and Michael Pohst, On Maximal Finite Irreducible Sub-	The state
groups of $GL(n, Z)$ V. The Eight Dimensional Case and a Complete Descrip-	

tion of Dimensions Less Than Ten

MATHEMATICS OF COMPUTATION TABLE OF CONTENTS

January 1980

Michael G. Crandall and Andrew Majda, Monotone Difference Approximations for	
Scalar Conservation Laws	1
Ragnar Winther, A Conservative Finite Element Method for the Korteweg-de Vries	
Equation	23
Bjorn Engquist and Stanley Osher, Stable and Entropy Satisfying Approximations	
for Transonic Flow Calculations	45
Alfred H. Schatz, A Weak Discrete Maximum Principle and Stability of the Finite	
Element Method in L_{∞} on Plane Polygonal Domains. I	77
Vidar Thomée, Negative Norm Estimates and Superconvergence in Galerkin Meth-	
ods for Parabolic Problems	93
Ragnar Winther, Initial Value Methods for Parabolic Control Problems	115
Seymour V. Parter, On the Roles of "Stability" and "Convergence" in Semidis-	
crete Projection Methods for Initial-Value Problems	127
Arthur G. Werschultz, Computational Complexity of One-Step Methods for Sys-	
tems of Differential Equations	155
B. A. Troesch, The Shooting Method Applied to a Cyclic Inequality	175
George J. Miel, Majorizing Sequences and Error Bounds for Iterative Methods	185
John W. Evans, William B. Gragg and Randall J. LeVeque, On Least Squares Ex-	
ponential Sum Approximation with Positive Coefficients	203
J. N. Lyness and G. Monegato, Quadrature Error Functional Expansions for the	
Simplex When the Integrand Function Has Singularities at Vertices	213
Bradley W. Dickinson, Solution of Linear Equations With Rational Toeplitz Ma-	
trices	227
George Marsaglia, Generating Random Variables With a t-Distribution	235
J. L. Schonfelder, Very High Accuracy Chebyshev Expansions for the Basic Trig-	
onometric Functions	237
Wilhelm Plesken and Michael Pohst, On Maximal Finite Irreducible Subgroups of	
GL(n, Z) III. The Nine Dimensional Case	245
Wilhelm Plesken and Michael Pohst, On Maximal Finite Irreducible Subgroups of	
$GL(n, \mathbb{Z})$ IV. Remarks on Even Dimensions with Applications to $n = 8$	259
Wilhelm Plesken and Michael Pohst, On Maximal Finite Irreducible Subgroups of	
GL(n, Z) V. The Eight Dimensional Case and a Complete Description of	
Dimensions Less Than Ten	277
Mark Templer, On the Primality of $k ! + 1$ and $2 * 3 * 5 * \cdots * p + 1$	303
Richard P. Brent and Edwin M. McMillan, Some New Algorithms for High-Pre-	
cision Computation of Euler's Constant	305
D. W. MacLean, Residue Classes of the Partition Function	313
Richard K. Guy and J. L. Selfridge, Corrigendum to "What Drives an Aliquot Se-	
quence?"	319
Herbert E. Salzer, Misstatements in Milne-Thomson, Calculus of Finite Differences,	
Macmillan, London, 1933	323