# 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.

October 1980 Volume 35, Number 152, Pages 1039-1458

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

ANITA WAHLBIN, 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,

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

Israel

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. All tables and correspondence concerning the UMT should be sent to James H. Bramble, Chairman, Center for Applied Mathematics, 275 Olin 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

# TABLE OF CONTENTS

## October 1980

I. Babuška, J. Osborn and J. Pitkaranta, Analysis of Mixed Methods Using Mesh Dependent Norms
Claes Johnson and J. Claude Nedelec, On the Coupling of Boundary Integral and
Finite Element Methods
Joseph E. Pasciak, Spectral and Pseudo Spectral Methods for Advection Equa
tions
Mitchell Luskin, A Finite Element Method for First-Order Hyperbolic Systems.
Juhani Pitkäranta, Local Stability Conditions for the Babuška Method of La grange Multipliers
Charles I. Goldstein, Variational Crimes and $L^{\infty}$ Error Estimates in the Finite
Element Method
G. J. Cooper and A. Sayfy, Additive Methods for the Numerical Solution of
Ordinary Differential Equations
Peter Alfeld, A Method of Skipping the Transient Phase in the Solution of Sep arably Stiff Ordinary Initial Value Problems
C. P. Katti, Five-Diagonal Sixth Order Methods for Two-Point Boundary Value
Problems Involving Fourth Order Differential Equations
George F. Corliss, Integrating ODE's in the Complex Plane — Pole Vaulting
Beny Neta, On Determination of Best-Possible Constants in Integral Inequal
ities Involving Derivatives
Martin Stynes, On Faster Convergence of the Bisection Method for all Triangles.
Warren E. Ferguson, Jr., The Construction of Jacobi and Periodic Jacobi Ma
trices With Prescribed Spectra
Günter Meinardus and G. D. Taylor, Optimal Partitioning of Newton's Method
for Calculating Roots
Steven M. Serbin, On Factoring a Class of Complex Symmetric Matrices Withou
Pivoting
Indu Mati Anand, Numerical Stability of Nested Dissection Orderings
Thomas Ericsson and A. Ruhe, The Spectral Transformation Lanczos Method
for the Numerical Solution of Large Sparse Generalized Symmetric Eigen value Problems
M. Madalena Martins, On an Accelerated Overrelaxation Iterative Method fo
Linear Systems with Strictly Diagonally Dominant Matrix
Philip Rabinowitz, The Exact Degree of Precision of Generalized Gauss-Kronroo
Integration Rules
Richard F. King, An Efficient One-Point Extrapolation Method for Linear Con
vergence
Luigi Gatteschi, On Some Orthogonal Polynomial Integrals
J. P. Vigneron and Ph. Lambin, Gaussian Quadrature of Integrands Involving
the Error Function

John P. Boyd, The Rate of Convergence of Hermite Function Series	1309
Andres Cruz and Javier Sesma, Modulus and Phase of the Reduced Logarithmic	
Derivative of the Cylindrical Bessel Function	1317
Henry E. Fettis, On Some Trigonometric Integrals	1325
David Levin, On Accelerating the Convergence of Infinite Double Series and In-	
tegrals	1331
Peter Wilker, An Efficient Algorithm Solution of the Diophantine Equation	
$u^2 + 5v^2 = m \dots$	1347
Michael Willett, Arithmetic in a Finite Field	1353
David W. Boyd, Reciprocal Polynomials Having Small Measure	1361
John Brillhart, Note on Irreducibility Testing	1379
Bennett Setzer, The Determination of all Imaginary, Quartic, Abelian Number	
Fields with Class Number 1	1383
Curt Noll and Laura Nickel, The 25th and 26th Mersenne Primes	1387
Robert Baillie and Samuel S. Wagstaff, Jr., Lucas Pseudoprimes	1391
G. V. Cormack and H. C. Williams, Some Very Large Primes of the Form	
$k \cdot 2^m + 1$	1419
H. C. Williams, Improving the Speed of Calculating the Regulator of Certain	
Pure Cubic Fields	1423
Richard P. Brent, The First Occurrence of Certain Large Prime Gaps	1435
Reviews and Descriptions of Tables and Books	1437
Conde 13, Davis 14, Duff & Stewart 15, Jablon & Simon 16, Wend-	
land 17, Parter 18, Te Reile 19, Mäki 20.	
Table Erratum	1444
Gradshteyn and Ryzhik 572; Morrison and Brillhart 573	
Corrigendum	1445
Krogh	
Indices to Volumes XXXIV and XXXV	1447

#### 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 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 \$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., 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.



# REVIEWS IN GRAPH THEORY

# Compiled and Edited by William G. Brown McGILL UNIVERSITY DEPARTMENT OF MATHEMATICS

This publication is a four-volume compendium of about 9,600 reviews in graph theory published by **Mathematical Reviews** in Volumes 1 through 56, i.e. between 1940 and 1978 inclusive. Reviews were selected from the several sections of **Mathematical Reviews** which were the usual repositories of such items; from the subject lists in **Mathematical Reviews** indexes, where available; and through a systematic perusal of about half of all reviews published by **Mathematical Reviews** during the 39 years under consideration. Every review cited in a selected review was also read, and the process iterated until stable.

A classification scheme containing over 500 categories was developed for the purpose. Every review has been assigned one primary classification and, on the average, one secondary classification. Reviews are reprinted in strict chronological order of **Mathematical Review** numbers in their primary subject area, with a brief citation at each secondary location.

The final volume provides a detailed author index, which can serve as an effective bibliography of the subject.

These volumes are a research tool. They are directed to anyone who has occasion to consult the literature of graph theory: mathematicians, computer scientists, engineers, and management scientists, as well as students, teachers, and practicing researchers.

The potential reader requires no more background than would be required to read papers which are reviewed in the compendium. These vary from highly erudite papers in other areas of mathematics where graph theory is used as a tool to solve specific problems, to elementary descriptive papers which would be understandable to high school students.

A few of the reviews are themselves gems of the mathematical literature. But, for the most part, the reader will use this book as a research tool—to determine what has been done in a particular area of the subject, or to locate known papers when the values of not all parameters are available.

There has been nothing of this scope or magnitude in the subject before. This is the first major bibliography in graph theory which incorporates reviews.

The editor's previous work includes research papers in graph theory and related fields, and many reviews.

List	Inst. Memb.	Indiv. Memb.	Student
\$200	\$150.00	\$50	\$25.00
68	52.50	17	8.50
68	52.50	17	8.50
68	52.50	17	8.50
40	30.00	10	5.00
	68 68 68	\$200 \$150.00 68 52.50 68 52.50 68 52.50	\$200 \$150.00 \$50 68 52.50 17 68 52.50 17 68 52.50 17

Prepayment is required for all American Mathematical Society publications. Send for the book(s) above to: AMS, P.O. Box 1571, Annex Station, Providence, RI 02901.

John P. Boyd, The Rate of Convergence of Hermite Function Series	1.
Andrés Cruz and Javier Sesma, Modulus and Phase of the Reduced Logarithmic	
Derivative of the Cylindrical Bessel Function	1
Henry E. Fettis, On Some Trigonometric Integrals	1.
David Levin, On Accelerating the Convergence of Infinite Double Series and In-	
tegrals	13
Peter Wilker, An Efficient Algorithm Solution of the Diophantine Equation $u^2 + 5v^2 = m$	1
Michael Willett, Arithmetic in a Finite Field	1
David W. Boyd, Reciprocal Polynomials Having Small Measure	1
John Brillhart, Note on Irreducibility Testing	1
Bennett Setzer, The Determination of all Imaginary, Quartic, Abelian Number	
Fields with Class Number 1	1
Curt Noll and Laura Nickel, The 25th and 26th Mersenne Primes	1
Robert Baillie and Samuel S. Wagstaff, Jr., Lucas Pseudoprimes	1
G. V. Cormack and H. C. Williams, Some Very Large Primes of the Form	
$k \cdot 2^m + 1$	1
H. C. Williams, Improving the Speed of Calculating the Regulator of Certain  Pure Cubic Fields	1
Richard P. Brent, The First Occurrence of Certain Large Prime Gaps	1
Reviews and Descriptions of Tables and Books	1
Conde 13, Davis 14, Duff & Stewart 15, Jablon & Simon 16, Wend-	
land 17, Parter 18, Te Reile 19, Mäki 20.	, t
Table Erratum	1
Gradshteyn and Ryzhik 572; Morrison and Brillhart 573	
Corrigendum	1
Krogh	
Indices to Volumes XXXIV and XXXV	1

No microfiche supplement in this issue

# MATHEMATICS OF COMPUTATION TABLE OF CONTENTS

### October 1980

Dependent Norms
Claes Johnson and J. Claude Nedelec, On the Coupling of Boundary Integral and
Finite Element Methods
Joseph E. Pasciak, Spectral and Pseudo Spectral Methods for Advection Equations
Mitchell Luskin, A Finite Element Method for First-Order Hyperbolic Systems
Juhani Pitkäranta, Local Stability Conditions for the Babuška Method of Lagrange Multipliers
Charles I. Goldstein, Variational Crimes and $L^{\infty}$ Error Estimates in the Finite
Element Method
G. J. Cooper and A. Sayfy, Additive Methods for the Numerical Solution of Ordinary Differential Equations
Peter Alfeld, A Method of Skipping the Transient Phase in the Solution of Sep-
arably Stiff Ordinary Initial Value Problems
C. P. Katti, Five-Diagonal Sixth Order Methods for Two-Point Boundary Value
Problems Involving Fourth Order Differential Equations
George F. Corliss, Integrating ODE's in the Complex Plane — Pole Vaulting
Beny Neta, On Determination of Best-Possible Constants in Integral Inequal-
ities Involving Derivatives
Martin Stynes, On Faster Convergence of the Bisection Method for all Triangles
Warren E. Ferguson, Jr., The Construction of Jacobi and Periodic Jacobi Matrices With Prescribed Spectra
Günter Meinardus and G. D. Taylor, Optimal Partitioning of Newton's Method
for Calculating Roots
Steven M. Serbin, On Factoring a Class of Complex Symmetric Matrices Without
Pivoting
Indu Mati Anand, Numerical Stability of Nested Dissection Orderings
Thomas Ericsson and A. Ruhe, The Spectral Transformation Lanczos Method
for the Numerical Solution of Large Sparse Generalized Symmetric Eigen-
value Problems
M. Madalena Martins, On an Accelerated Overrelaxation Iterative Method for
Linear Systems with Strictly Diagonally Dominant Matrix
Philip Rabinowitz, The Exact Degree of Precision of Generalized Gauss-Kronrod
Integration Rules
Richard F. King, An Efficient One-Point Extrapolation Method for Linear Con-
vergence
Luigi Gatteschi, On Some Orthogonal Polynomial Integrals
J. P. Vigneron and Ph. Lambin, Gaussian Quadrature of Integrands Involving
the Error Function