VOLUME 62 NUMBER 205 JANUARY 1994

MATHEMATICS OF COMPUTATION

AMERICAN MATHEMATICAL SOCIETY

EDITED BY

James H. Bramble
Susanne C. Brenner
E. W. Cheney
James W. Demmel
Walter Gautschi, *Managing Editor*
Eugene Isaacson
James N. Lyness
Harald Niederreiter
Jorge J. Nocedal
Syvert P. Nørsett
Andrew M. Odlyzko
Frank W. J. Olver
John E. Osborn
Stanley Osher
Carl Pomerance
René Schoof
L. Ridgway Scott
Daniel Shanks
Chi-Wang Shu
Frank Stenger
Hans J. Stetter
G. W. Stewart
Nico M. Temme
Vidar Thomée
Lars B. Wahlbin
Hugh C. Williams
John W. Wrench, Jr.

PROVIDENCE, RHODE ISLAND USA

ISSN 0025-5718

Mathematics of Computation

This journal publishes research articles in computational mathematics. Areas covered include numerical analysis, the application of computational methods, algorithms for advanced computer architectures, computational number theory and algebra, and related fields. Table errata and reviews of books in areas related to computational mathematics are also included.

Subscription information. *Mathematics of Computation* is published quarterly. Subscription prices for Volumes 62 and 63 (1994) are $262 list; $210 institutional member; $170 member of CBMS organizations; $157 individual AMS member. A late charge of 10% of the subscription price will be imposed upon orders received from nonmember institutions and organizations after January 1 of the subscription year. Subscribers outside the United States and India must pay a postage surcharge of $9; subscribers in India must pay a postage surcharge of $18. Expedited delivery to destinations in North America $13; elsewhere $40.

Back number information. For back issues see the *AMS Catalog of Publications.*

Subscriptions and orders should be addressed to the American Mathematical Society, P. O. Box 5904, Boston, MA 02206-5904. *All orders must be accompanied by payment.* Other correspondence should be addressed to P. O. Box 6248, Providence, RI 02940-6248.

Unpublished Mathematical Tables. The editorial office of the journal maintains a repository of Unpublished Mathematical Tables (UMT).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.

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 acknowledgment 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 Manager of Editorial Services, American Mathematical Society, P. O. Box 6248, Providence, RI 02940-6248. Requests can also be made by e-mail to `reprint-permission@math.ams.org`.

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 fee of $1.00 plus $.25 per page for each copy be paid directly to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale.

Mathematics of Computation is published quarterly by the American Mathematical Society at 201 Charles Street, Providence, RI 02904-2213. Second-class postage is paid at Providence, Rhode Island. Postmaster: Send address changes to Mathematics of Computation, American Mathematical Society, P. O. Box 6248, Providence, RI 02940-6248.

© Copyright 1994 by the American Mathematical Society. All rights reserved.
Printed in the United States of America.
♾ The paper used in this book is acid-free and falls within the guidelines
established to ensure permanence and durability.
This publication was typeset using $\mathcal{AMS}$-TEX,
the American Mathematical Society's TEX macro system.
10 9 8 7 6 5 4 3 2 99 98 97 96 95 94

Editorial Information

As of November 3, 1993, the backlog for this journal was approximately 1 issue. This estimate is the result of dividing the number of manuscripts for this journal in the Providence office that have not yet gone to the printer on the above date by the average number of articles per issue over the previous twelve months, reduced by the number of issues published in six months (the time necessary for editing and composing a typical issue).

A Copyright Transfer Agreement is required before a paper will be published in this journal. By submitting a paper to this journal, authors certify that the manuscript has not been submitted to nor is it under consideration for publication by another journal, conference proceedings, or similar publication.

Information for Authors and Editors

The first page must consist of a *descriptive title*, followed by an *abstract* that summarizes the article in language suitable for workers in the general field (algebra, analysis, etc.). The *descriptive title* should be short, but informative; useless or vague phrases such as "some remarks about" or "concerning" should be avoided. The *abstract* must be brief and reasonably self-contained. Included with the footnotes to the paper, there should be the 1991 *Mathematics Subject Classification* representing the primary and secondary subjects of the article. This may be followed by a list of *key words and phrases* describing the subject matter of the article and taken from it. A list of the numbers may be found in the annual index of *Mathematical Reviews*, published with the December issue starting in 1990, as well as from the electronic service e-MATH [**telnet e-MATH.ams.com** (or **telnet 130.44.1.100**). Login and password are **e-math**]. For journal abbreviations used in bibliographies, see the list of serials in the latest *Mathematical Reviews* annual index. When the manuscript is submitted, authors should supply the editor with electronic addresses if available. These will be printed after the postal address at the end of each article.

Electronically prepared manuscripts. The AMS encourages submission of electronically prepared manuscripts in $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX or $\mathcal{A}\mathcal{M}\mathcal{S}$-LATEX because properly prepared electronic manuscripts save the author proofreading time and move more quickly through the production process. To this end, the Society has prepared "preprint" style files, specifically the amsppt style of $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX and the amsart style of $\mathcal{A}\mathcal{M}\mathcal{S}$-LATEX, which will simplify the work of authors and of the production staff. Those authors who make use of these style files from the beginning of the writing process will further reduce their own effort. Electronically submitted manuscripts prepared in plain TEX or LATEX do not mesh properly with the AMS production systems and cannot, therefore, realize the same kind of expedited processing. Users of plain TEX should have little difficulty learning $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX, and LATEX users will find that $\mathcal{A}\mathcal{M}\mathcal{S}$-LATEX is the same as LATEX with additional commands to simplify the typesetting of mathematics.

Guidelines for Preparing Electronic Manuscripts provides additional assistance and is available for use with either $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX or $\mathcal{A}\mathcal{M}\mathcal{S}$-LATEX. Authors with FTP access may obtain *Guidelines* from the Society's Internet node `e-MATH.ams.org` (130.44.1.100). For those without FTP access *Guidelines* can be obtained free of charge from the e-mail address `guide-elec@math.ams.org` (Internet) or from the Customer Services Department, American

Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248. When requesting *Guidelines*, please specify which version you want.

At the time of submission, authors should indicate if the paper has been prepared using $\mathcal{A}\mathcal{M}\mathcal{S}$-TEX or $\mathcal{A}\mathcal{M}\mathcal{S}$-LATEX. The *Manual for Authors of Mathematical Papers* should be consulted for symbols and style conventions. The *Manual* may be obtained free of charge from the e-mail address cust-serv@math.ams.org or from the Customer Services Department, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248. The Providence office should be supplied with a manuscript that corresponds to the electronic file being submitted.

Electronic manuscripts should be sent to the Providence office immediately after the paper has been accepted for publication. They can be sent via e-mail to pub-submit@math.ams.org (Internet) or on diskettes to the Publications Department, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248. When submitting electronic manuscripts please be sure to include a message indicating in which publication the paper has been accepted. No corrections will be accepted electronically. Authors must mark their changes on their proof copies and return them to the Providence office. Authors and editors are encouraged to make the necessary submissions of electronically prepared manuscripts and proof copies in a timely fashion.

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. All contributions intended for publication and all books for review should be addressed to Walter Gautschi, Chairman, Editorial Committee, Mathematics of Computation, Department of Computer Sciences, Purdue University, West Lafayette, Indiana 47907. 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.

Any inquiries concerning a paper that has been accepted for publication should be sent directly to the Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940-6248.

Editorial Committee

WALTER GAUTSCHI, Chairman. Department of Computer Sciences, Purdue University, West Lafayette, IN 47907; *E-mail*: wxg@cs.purdue.edu

ANDREW M. ODLYZKO, AT&T Bell Laboratories, 600 Mountain Avenue, Murray Hill, NJ 07974; *E-mail*: amo@research.att.com

FRANK W. J. OLVER, Institute for Physical Science and Technology, University of Maryland, College Park, MD 20742; *E-mail*: olver@bessel.umd.edu

LARS B. WAHLBIN, Department of Mathematics, Cornell University, Ithaca, NY 14853; *E-mail*: wahlbin@math.cornell.edu

Technical Editor

ERIKA GAUTSCHI, Department of Computer Sciences, Purdue University, West Lafayette, IN 47907; *E-mail*: exg@cs.purdue.edu

Board of Associate Editors

JAMES H. BRAMBLE, Department of Mathematics, Cornell University, Ithaca, NY 14853; *E-mail*: bramble@math.cornell.edu

SUSANNE C. BRENNER, Department of Mathematics, University of South Carolina, Columbia, SC 29208; *E-mail*: brenner@math.scarolina.edu

E. W. CHENEY, Department of Mathematics, University of Texas at Austin, Austin, TX 78712-1082; *E-mail*: cheney@cs.utexas.edu

JAMES W. DEMMEL, Department of Mathematics, University of California, Berkeley, CA 94720; *E-mail*: demmel@robalo.berkeley.edu

EUGENE ISAACSON, Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, NY 10012; *E-mail*: isaacson@acf7.nyu.edu

JAMES N. LYNESS, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439; *E-mail*: lyness@mcs.anl.gov

HARALD NIEDERREITER, Institute for Information Processing, Austrian Academy of Sciences, Sonnenfelsgasse 19, A-1010 Vienna, Austria; *E-mail*: nied@qiinfo.oeaw.ac.at

JORGE J. NOCEDAL, Department of Electrical Engineering and Computer Science, Northwestern University, Evanston, IL 60208-3118; *E-mail*: nocedal@eecs.nwu.edu

SYVERT P. NØRSETT, Division of Numerical Mathematics, The University of Trondheim and The Norwegian Institute of Technology, Alfred Getz vei 1, N-7034 Trondheim-NTH, Norway; *E-mail*: norsett@imf.unit.no

JOHN E. OSBORN, Department of Mathematics, University of Maryland, College Park, MD 20742; *E-mail*: jeo@julia.umd.edu

STANLEY OSHER, Department of Mathematics, University of California, Los Angeles, CA 90024; *E-mail*: sjo@math.ucla.edu

CARL POMERANCE, Department of Mathematics, The University of Georgia, Athens, GA 30602; *E-mail*: carl@joe.math.uga.edu

RENÉ SCHOOF, Dipartimento di Matematica, Università degli Studi di Trento, I-38050 Povo (Trento), Italy; *E-mail*: schoof@itnvax.cineca.it

L. RIDGWAY SCOTT, Department of Mathematics, University of Houston, Houston, TX 77204-3476; *E-mail*: scott@casc.math.uh.edu

DANIEL SHANKS, Department of Mathematics, University of Maryland, College Park, MD 20742; *E-mail*: dns@gaby.umd.edu

CHI-WANG SHU, Applied Mathematics Division, Brown University, Providence, RI 02912-0001; *E-mail*: shu@cfm.brown.edu

FRANK STENGER, Department of Computer Science, University of Utah, Salt Lake City, UT 84112; *E-mail*: stenger@sinc.utah.edu

HANS J. STETTER, Institut für Numerische Mathematik, Technische Universität Wien, Wiedner Hauptstrasse 6-10, A-1040, Wien, Austria; *E-mail*: stetter@uranus.tuwien.ac.at

G. W. STEWART, Department of Computer Science, University of Maryland, College Park, MD 20742; *E-mail*: stewart@thales.cs.umd.edu

NICO M. TEMME, Stichting Mathematisch Centrum, Centrum voor Wiskunde en Informatica, Kruislaan 413, 1098 SJ Amsterdam, The Netherlands; *E-mail*: nicot@cwi.nl

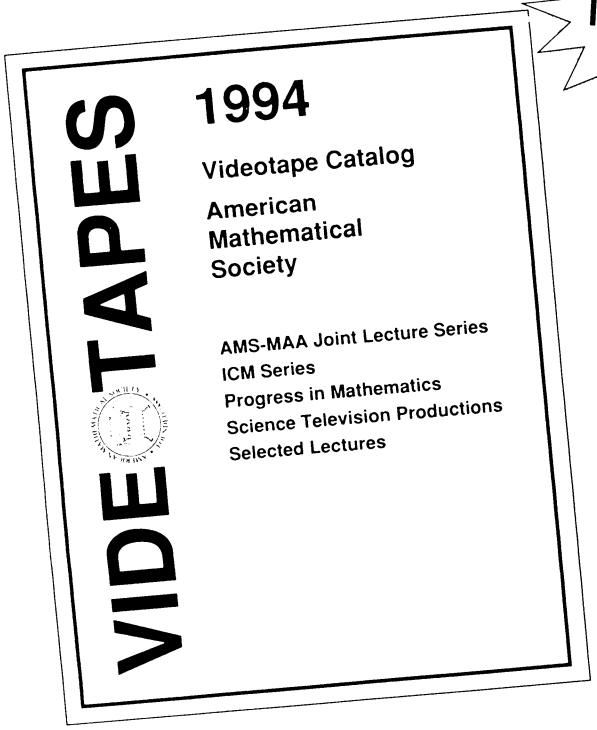
VIDAR THOMÉE, Mathematics Department, Chalmers University of Technology, S-412 96 Göteborg, Sweden; *E-mail*: thomee@math.chalmers.se

HUGH C. WILLIAMS, Department of Computer Science, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2; *E-mail*: Hugh_Williams@csmail.cs.umanitoba.ca

JOHN W. WRENCH, JR., 102 Mt. Olivet Boulevard, Frederick, MD 21701

FREE Videotape Catalog!

New!



Great Teaching Tools!

This broad collection of videotaped lectures helps to preserve a portrait of today's distinguished mathematicians while capturing the interest and enthusiasm of the speakers as they present material in their fields of expertise. The lectures are expository and are useful in courses, seminars, and general assemblies for students as well as researchers in the mathematical sciences community.

Order your FREE Catalog Today!

1-800-321-4AMS

American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248

(*Continued from back cover*)

Genet M. Edmondson, Jennifer Seberry, and Malcolm R. Anderson, On the existence of Turyn sequences of length less than 43 351
Greg Butler, An inductive schema for computing conjugacy classes in permutation groups 363
Miodrag Živković, A table of primitive binary polynomials 385
J. Buchmann, M. Pohst, and J. Graf v. Schmettow, On unit groups and class groups of quartic fields of signature (2, 1) 387
R. Ernvall and T. Metsänkylä, Computation of the zeros of p-adic L-functions. II 391
J. E. Cremona and E. Whitley, Periods of cusp forms and elliptic curves over imaginary quadratic fields 407
Reviews and Descriptions of Tables and Books 431
Lorentzen and Waadeland **1**, Brezinski **2**, Press, Teukolsky, Vetterling, and Flannery **3a,b**, Atkinson **4**, Griewank and Corliss, Editors **5**, Cheney, Chui, and Schumaker, Editors **6**, Ames **7**, Bank, Editor **8**, Heiliö, Editor **9**, Rathbun **10**, Rathbun and Granlund **11**, Rathbun and Granlund **12**
Microfiche Supplements
A. J. W. Duijvestijn, Simple perfect squared squares and 2×1 squared rectangles of order 25
Miodrag Živković, A table of primitive binary polynomials

MATHEMATICS OF COMPUTATION

CONTENTS

Vol. 62, No. 205 January 1994

Richard S. Falk and John E. Osborn, Remarks on mixed finite element methods for problems with rough coefficients 1
Guangyan Yin, Sinc-collocation method with orthogonalization for singular Poisson-like problems 21
Martti Hamina and Jukka Saranen, On the spline collocation method for the single-layer heat operator equation 41
A. Bendali and M. Souilah, Consistency estimates for a double-layer potential and application to the numerical analysis of the boundary-element approximation of acoustic scattering by a penetrable object 65
C. Palencia, On the stability of variable stepsize rational approximations of holomorphic semigroups 93
Jinn-Liang Liu, A finite difference method for symmetric positive differential equations 105
Brahim Khobalatte and Benoit Perthame, Maximum principle on the entropy and second-order kinetic schemes 119
Patrick J. Rabier and Werner C. Rheinboldt, On the computation of impasse points of quasi-linear differential-algebraic equations 133
Yves Tourigny and Michael Grinfeld, Deciphering singularities by discrete methods 155
Oliver Aberth, Computation of topological degree using interval arithmetic, and applications 171
Qiang Ye, A breakdown-free variation of the nonsymmetric Lanczos algorithms 179
Zhaojun Bai, Error analysis of the Lanczos algorithm for the nonsymmetric eigenvalue problem 209
Edward Neuman, A new formula for box splines on three-directional meshes 227
Ren-Cang Li, On perturbations of matrix pencils with real spectra 231
J. L. Lavoie, F. Grondin, A. K. Rathie, and K. Arora, Generalizations of Dixon's theorem on the sum of a ${}_3F_2$ 267
J. Bartolomeo and Matthew He, On Faber polynomials generated by an m-star 277
Zvi Drezner, Computation of the trivariate normal integral 289
Sven Ehrich, Error bounds for Gauss-Kronrod quadrature formulae 295
Richard Crandall and Barry Fagin, Discrete weighted transforms and large-integer arithmetic 305
A. J. W. Duijvestijn, Simple perfect squared squares and 2×1 squared rectangles of order 25 325
Don Coppersmith, Solving homogeneous linear equations over $GF(2)$ via block Wiedemann algorithm 333

(Continued on inside back cover)