MATHEMATICS OF COMPUTATION

A M E R I C A N M A T H E M A T I C A L S O C I E T Y

EDITED BY

James H. Bramble E. W. Cheney James W. Demmel Walter Gautschi, Managing Editor Eugene Isaacson Heinz-Otto Kreiss 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 Ridgway Scott Daniel Shanks 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

Editorial Committee

WALTER GAUTSCHI, Chairman. Dept. of Computer Sciences, Purdue Univ., West Lafayette, IN 47907 ANDREW M. ODLYZKO, AT&T Bell Laboratories, 600 Mountain Avenue, Murray Hill, NJ 07974 FRANK W. J. OLVER, Inst. for Physical Science and Technology, Univ. of Maryland, College Park, MD 20742

LARS B. WAHLBIN, Dept. of Mathematics, Cornell Univ., Ithaca, NY 14853

Technical Editor

ERIKA GAUTSCHI, Dept. of Computer Sciences, Purdue Univ., West Lafayette, IN 47907

Board of Associate Editors

JAMES H. BRAMBLE, Dept. of Mathematics, Cornell Univ., Ithaca, NY 14853

E. W. CHENEY, Dept. of Mathematics, Univ. of Texas at Austin, Austin, TX 78712-1082

JAMES W. DEMMEL, Dept. of Mathematics, Univ. of California, Berkeley, CA 94720

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 Institute of Technology, Pasadena,

JAMES N. LYNESS, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439

HARALD NIEDERREITER, Institute for Information Processing, Austrian Academy of Sciences, Sonnenfelsgasse 19, A-1010 Vienna, Austria

JORGE J. NOCEDAL, Dept. of Electrical Engineering and Computer Science, Northwestern Univ., Evanston, IL 60208-3118

SYVERT P. NØRSETT, Div. of Numerical Mathematics, The University of Trondheim and The Norwegian Institute of Technology, Alfred Getz vei 1, N-7034 Trondheim-NTH, Norway

JOHN E. OSBORN, Dept. of Mathematics, Univ. of Maryland, College Park, MD 20742 STANLEY OSHER, Dept. of Mathematics, Univ. of California, Los Angeles, CA 90024

CARL POMERANCE, Dept. of Mathematics, The Univ. of Georgia, Athens, GA 30602

RENÉ SCHOOF, Dipartimento di Matematica, Università degli Studi di Trento, I-38050 Povo (Trento),

RIDGWAY SCOTT, Dept. of Mathematics, Univ. of Houston, Houston, TX 77204-3476

DANIEL SHANKS, Dept. of Mathematics, Univ. of Maryland, College Park, MD 20742

FRANK STENGER, Dept. of Mathematics, Univ. of Utah, Salt Lake City, UT 84112

HANS J. STETTER, Institut für Numerische Mathematik, Technische Universität Wien, Wiedner Hauptstrasse 6-10, A-1040, Wien, Austria

G. W. STEWART, Dept. of Computer Science, Univ. of Maryland, College Park, MD 20742

NICO M. TEMME, Stichting Mathematisch Centrum, Centrum voor Wiskunde en Informatica, Kruislaan 413, 1098 SJ Amsterdam, The Netherlands

VIDAR THOMÉE, Mathematics Dept., Chalmers Univ. of Technology, S-412 96 Göteborg, Sweden HUGH C. WILLIAMS, Dept. of Computer Science, Univ. of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2

JOHN W. WRENCH, JR., 102 Mt. Olivet 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 58 and 59 (1992) are \$221 list; \$177 instibered serially since volume 1, Number 1. Subscription prices for Volumes 38 and 39 (1992) are \$221 list; \$177 listitutional member; \$144 member of CBMS organizations; \$133 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 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. Combination paper and microfiche subscription prices are \$294 list; \$235 institutional member. Microfiche of each issue will be mailed the fastest way before the issue is mailed by the printer.

BACK NUMBER INFORMATION: Back number prices per volume are for Volumes 1–21, \$95 list, \$76 member; for Volumes 22–33, \$143 list, \$114 institutional member; for Volumes 34–43, \$95 list, \$76 institutional member; Volumes 44–45, \$133 list, \$106 institutional member; Volumes 46–47, \$146 list, \$117 institutional member; Volumes 48–49, \$155 list, \$124 institutional member; Volumes 50–51, \$156 list, \$125 institutional member; for Volumes 52–53, \$160 list, \$128 institutional member; for Volumes 54–55, \$151 list, \$121 institutional member; for Volumes 56–57, \$162 list, \$130 institutional member. Back volumes may be purchased on microfilm or microfiche from University Microfilms International, 300 North Zeeb Road, Ann Arbor, MI 48106.

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.

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

MATHEMATICS OF COMPUTATION is published quarterly by the American Mathematical Society, 201 Charles Street, Providence, RI 02904-2213. 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 02940-6248.

> Copyright © 1992, American Mathematical Society. All rights reserved. Printed in the United States of America.

> The paper used in this journal is acid-free and falls within the guidelines

established to ensure permanence and durability.

This publication was typeset using AMS-TEX, the American Mathematical Society's TEX macro system.