Mathematics of Computation

Volume 22, Number 104 October, 1968

Published by the American Mathematical Society PROVIDENCE, RHODE ISLAND

Editorial Committee

EUGENE ISAACSON, Chairman, New York University, Courant Institute of Mathematical Sciences, 251 Mercer Street, New York, New York 10012 Assistant to the Chairman: CHARLOTTE W. JOHN

- C. W. CLENSHAW, Mathematics Division, National Physics Laboratory, Teddington, Middlesex, England
- AVRON DOUGLIS, Department of Mathematics, University of Maryland, College Park, Maryland 20740
- WALTER GAUTSCHI, Computer Sciences Department, Purdue University, Lafavette, Indiana 47907
- GENE H. GOLUB, Computer Science Department, Stanford University, Stanford, California 94305

A. S. HOUSEHOLDER, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830

- HEINZ O. KREISS, Computer Science Department, University of Uppsala, Uppsala, Sturegatan 4, Sweden
- PETER D. LAX, New York University, Courant Institute of Mathematical Sciences, 251 Mercer Street, New York, New York 10012

Y. L. LUKE, Midwest Research Institute, Kansas City, Missouri 64110

- JAMES M. ORTEGA, Computer Science Center, University of Maryland, College Park, Maryland 20740
- HARRY POLACHEK, Research Division, U. S. Atomic Energy Commission, Washington. D. C. 20545
- DANIEL SHANKS, Naval Ship Research and Development Center, Washington, D. C. 20007
- J. W. WRENCH, JR., Naval Ship Research and Development Center, Washington, D. C. 20007

Information for Subscribers

The journal is published quarterly in one volume per year, with issues numbered serially since Volume 1, Number 1. The subscription price is \$16.00. All back volumes are available. For Volumes 1-22 (1943-1968), prices are \$20.00 per volume and \$6.00 per issue.

Unpublished Mathematical Tables

The editorial office of the journal maintains a repository of Unpublished Mathematical Tables (UMT).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, address changes, business communications and payments should be sent to:

> AMERICAN MATHEMATICAL SOCIETY P. O. Box 6248 Providence, Rhode Island 02904

Mathematics of Computation

TABLE OF CONTENTS

October 1968

Stability Theory for Difference Approximations of Mixed Initial Boundary	
Value Problems. I	703
A Multistep Formulation of the Optimized Lax-Wendroff Method for Non-	
linear Hyperbolic Systems in Two Space Variables	
A. R. GOURLAY & J. LL. MORRIS	715
Numerical Methods and Existence Theorems for Parabolic Differential	
Equations whose Coefficients are Singular on the Boundary	
Pierre Jamet	721
Numerical Solution of the Navier-Stokes Equations	•
ALEXANDRE JOEL CHORIN	745
Numerical Solution of Symmetric Positive Differential Equations	110
Theodore Katsanis	763
The Calculation of the Eigenvectors of a General Complex Matrix by Inverse	105
	705
Iteration J. M. VARAH	785
Rigorous Machine Bounds for the Eigensystem of a General Complex Matrix	=00
J. M. VARAH	793
Global Convergence of the Basic QR Algorithm on Hessenberg Matrices	
Beresford Parlett	803
On the Triangular Decomposition of Cauchy Matrices . Choong Yun Cho	819
A Note Concerning the Properties of a Certain Class of Test Matrices	
Harold Willis Milnes	827
Comparison of the Method of Averages with the Method of Least Squares	
G. Dahlquist, B. Sjöberg & P. Svensson	83 3
The Optimum Addition of Points to Quadrature Formulae	
T. N. L. Patterson	847
The Riemann Hypothesis and Pseudorandom Features of the Möbius Se-	
quence I. J. Good & R. F. Churchhouse	857
TECHNICAL NOTES AND SHORT PAPERS	
Primitive Trinomials of High Degree	
EUGENE R. RODEMICH & HOWARD RUMSEY, JR.	863
On the Relations between Eigenvalues and Eigenvectors for Matrices	
Resulting from Pre and Post Multiplication by the Transpose	
V. J. LAW & R. H. FARISS	867
An Iterative Procedure for Computing the Maximal Root of a Positive	
Matrix	869
Unicity in Approximation of a Function and its Derivatives	000
Lee Johnson	873
On Some Gauss and Lobatto Based Integration Formulae	510
T. N. L. PATTERSON	877
Efficient Calculation of Clausen's Integral VAN E. WOOD	
Emotion Calculation of Clauson & Integral	000

High Accuracy Gamma Function Values for Some Rational Arguments	
D. C. GALANT & P. F. BYRD	885
Error Bounds for the Gauss-Chebyshev Quadrature Formula of the	
Closed Type M. M. Chawla	889
REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS	893
Ascari 84, Brand 83, Gamkrelidze 77, Greenspan 82, Klerer &	
Korn 78, Lal & Russell 85, Lal & Lunnon 86, Milton 88, Mond 81,	
Moursund & Duris 79, Roosen-Runge 87, Saxon, Englander &	
Englander 89, Snyder 80	
TABLE ERRATA	903
Erdélyi, Magnus, Oberhettinger & Tricomi 427, Gradshteyn &	
Ryshik 428, Luke 429, Magnus & Oberhettinger 430	
Corrigenda	911
Jones, Lal & Blundon, Hirsch	
bones, and a bhonon, innsen	
INDICES TO VOLUME XXII.	913
	913 913
INDICES TO VOLUME XXII.	0.2.0
INDICES TO VOLUME XXII	913
INDICES TO VOLUME XXII. Index of Papers and Technical Notes by Authors Index of Reviews by Author of Work Reviewed	913 916
INDICES TO VOLUME XXII. Index of Papers and Technical Notes by Authors Index of Reviews by Author of Work Reviewed Index of Reviews by Subject of Work Reviewed	913 916 922
INDICES TO VOLUME XXII. Index of Papers and Technical Notes by Authors Index of Reviews by Author of Work Reviewed Index of Reviews by Subject of Work Reviewed Index of Reviews by Subject of Work Reviewed Index of Table Errata	 913 916 922 936
INDICES TO VOLUME XXII. Index of Papers and Technical Notes by Authors Index of Papers and Technical Notes by Authors Index of Reviews by Author of Work Reviewed Index of Reviews by Subject of Work Reviewed Index of Table Errata Index of Corrigenda Index of Corrigenda	 913 916 922 936 936
INDICES TO VOLUME XXII. Index of Papers and Technical Notes by Authors Index of Reviews by Author of Work Reviewed Index of Reviews by Subject of Work Reviewed Index of Table Errata Index of Corrigenda Index of Notes	913 916 922 936 936 936

Information for Contributors

Manuscripts should be typewritten double-spaced in the format used by the journal. For journal abbreviations, see *Mathematical Reviews*, v. 28, 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 Eugene Isaacson, Chairman, Editorial Committee, Mathematical Sciences, 251 Mercer Street, New York, New York 10012. Institutions sponsoring research reported in the journal are assessed page charges.

Beginning with the January 1969 issue of MATHEMATICS OF COMPUTATION, we will publish an author's abstract at the head of each article. Authors should submit a brief and reasonably self-contained abstract with each paper.

Microcard Edition

Volumes 1–14 (1943–1960) are available on Microcards at \$39.00 for the complete set and may be purchased from Microcard Editions, Inc., 901 26th Street, N. W., Washington, D. C. 20037.

Contents of Contemporary Mathematical Journals

A NEW BLV/BERLY SERVICE JOURNAL PURLISHED BY THE AMERICAN MATHEMATICAL SOCIETY

On January 10, 1969 a new serial entitled Contents of Contemporary Mathematical Journels will become available from the American Markothe matical Society. This publication will build to you the tables of contents of

1003

R.D

10.044

for approval copies, write Box 903

neb

0.0

 のないというないのないで

COMPUTATION: Finite and Infinite Machines by Marvin L. Minsky, Professor of Electrical Engineering, Massachusetts: Institute of Technology. Provides an introduction to the theories of finite-state madMines, programmed-computers, Tuping machines and formal Languages (in the form of Post Systems), 1967, 317 pp., \$12.95

natheira mhé virtece et e terre

APUTER

Algoi: Intro

1113.97

10917

COMPUTERS AND THE POLICY MAKING COMMUNITY Application to Infernational Relations by Davis B. Bobrów, Senior Social Scientist, Oak Ridge National Laboratory and Judah L. Schwartz, Education Research Center, Massachusetts Institute of Technology. An introduction to the nature of the composer and its applications to the alignesis conduct and teaching of International relations. In the Prentice Half Automatic Computation Series, Editoring Seorge Forsythe. 400 pp., New 68; \$12.50

PhogRAMMING LANGUAGES: History and Fundamentals by Jean E. Sammel, Programming Language Technology Manager, Federal Systems Division, IBM Corporation. Presents an overall view of higher level languages; bringing together in one place, fundamental information on programming languages, including history, general characteristics, similarities and differences. Provides specific, basic information on all significant and most mindr programming languages. In the Prentice-Hall Automatics Computation Series, Edited by George Forsythe. Nov. 68, approx. 704 pp., \$12.95

PRENTICE-HALL ENGLEWOOD CLIFFS NEW JERSEY 07632



Algol: Introduction to Algol Programming

SECOND EDITION

By TORGIL EKMAN and CARL-ERIK FRÖBERG

The Second Edition of this work features the complete Algol report in the appendix, fuller explanation of several concepts, and substitution of more suitable examples. The report includes a definition of the language, a survey of the basic constituents and features, listings of the basic symbols and syntactic units, rules for forming expressions, the operational units of the language, the defining of declarations, and ends with two detailed examples of the use of the language and alphabetic index of definitions. The text will prove useful for applications having a background of mathematics and natural sciences, and also for problems from the medical and social sciences.

1968 172 pp. illus. \$5.00

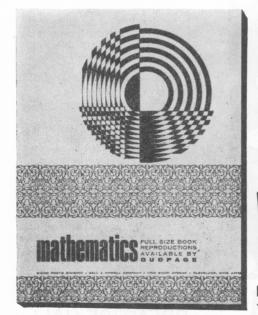
OXFORD UNIVERSITY PRESS 200 Madison Ave., New York, N.Y. 10016

Contents of Contemporary Mathematical Journals

A NEW BI-WEEKLY SERVICE JOURNAL PUBLISHED BY THE AMERICAN MATHEMATICAL SOCIETY

On January 10, 1969 a new journal entitled Contents of Contemporary Mathematical Journals will become available from the American Mathematical Society. This publication will bring to you the tables of contents of about 250 mathematical journals in 26 issues a year at a subscription rate of \$18.00 list, \$15.30 agents and \$9.00 individuals. Please send orders to:

AMERICAN MATHEMATICAL SOCIETY P. O. Box 6248 Providence, R.I. 02904



WRITE TODAY FOR FREE CATALOG:

mathematics books REPRODUCED FULL-SIZE BY DUOPAGE

Send for 32-page catalog listing out-of-print mathematics books available in many languages.

Catalog also includes information on how you can now obtain the other hard-to-get books you need.

MICRO PHOTO DIVISION 1700 SHAW AVE. CLEVELAND, OHIO 44112



REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS	893
Ascari 84, Brand 83, Gamkrelidze 77, Greenspan 82, Klerer &	
KORN 78, LAL & RUSSELL 85, LAL & LUNNON 86, MILTON 88, MOND 81,	
Moursund & Duris 79, Roosen-Runge 87, Saxon, Englander &	
Englander 89, Snyder 80	
TABLE ERRATA	903
Erdélyi, Magnus, Oberhettinger & Tricomi 427, Gradshteyn &	
Ryshik 428, Luke 429, Magnus & Oberhettinger 430	
Corrigenda	911
Jones, Lal & Blundon, Hirsch	
INDICES TO VOLUME XXII	913
Index of Papers and Technical Notes by Authors	913
Index of Reviews by Author of Work Reviewed	916
Index of Reviews by Subject of Work Reviewed	922
Index of Table Errata	936
Index of Corrigenda	936
Index of Notes	936
Index of Addenda	937
Index of Microfiche Supplements	937

The editorial committee would welcome readers' comments about this microfiche feature. Please send comments to Professor Eugene Isaacson, MATHEMATICS OF COMPUTATION, Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, New York 10012.

Mathematics of Computation

TABLE OF CONTENTS

October 1968

Stability Theory for Difference Approximations of Mixed Initial Boundary	709
Value Problems. I	703
linear Hyperbolic Systems in Two Space Variables	
A. R. GOURLAY & J. LL. MORRIS	715
Numerical Methods and Existence Theorems for Parabolic Differential	. 10
Equations whose Coefficients are Singular on the Boundary	
Pierre Jamet	721
Numerical Solution of the Navier-Stokes Equations	
ALEXANDRE JOEL CHORIN	745
Numerical Solution of Symmetric Positive Differential Equations	
THEODORE KATSANIS	763
The Calculation of the Eigenvectors of a General Complex Matrix by Inverse	
	785
Rigorous Machine Bounds for the Eigensystem of a General Complex Matrix	
	793
Global Convergence of the Basic QR Algorithm on Hessenberg Matrices	
	803
On the Triangular Decomposition of Cauchy Matrices . CHOONG YUN CHO	819
A Note Concerning the Properties of a Certain Class of Test Matrices	007
HAROLD WILLIS MILNES Comparison of the Method of Averages with the Method of Least Squares	827
	833
The Optimum Addition of Points to Quadrature Formulae	000
T. N. L. PATTERSON	847
The Riemann Hypothesis and Pseudorandom Features of the Möbius Se-	
	857
TECHNICAL NOTES AND SHORT PAPERS	
Primitive Trinomials of High Degree	
Eugene R. Rodemich & Howard Rumsey, Jr.	863
On the Relations between Eigenvalues and Eigenvectors for Matrices	
Resulting from Pre and Post Multiplication by the Transpose	
V. J. LAW & R. H. FARISS	867
An Iterative Procedure for Computing the Maximal Root of a Positive	
Matrix	869
Unicity in Approximation of a Function and its Derivatives	
Lee Johnson	873
On Some Gauss and Lobatto Based Integration Formulae	077
T. N. L. PATTERSON Efficient Calculation of Clausen's Integral VAN E. Wood	877
High Accuracy Gamma Function Values for Some Rational Arguments	883
	885
Error Bounds for the Gauss-Chebyshev Quadrature Formula of the	000
Closed Type M. M. CHAWLA	889