## PROCEEDINGS

OF THE

## American Mathematical Society

## EDITED BY

FRED G. BRAUER<br>W. H. J. FUCHS<br>IRVING GLICKSBERG<br>GEORGE B. SELIGMAN<br>ERNEST A. MICHAEL<br>JOSEPH J. ROTMAN<br>P. EMERY THOMAS

WITH THE COÖPERATION OF W. W. Boone

Joshua Chover
Allen Shields

VOLUME 25, NUMBER 1
MAY, 1970

PUBLISHED BY THE AMERICAN MATHEMATICAL SOCIETY PROVIDENCE, RHODE ISLAND

## Proceedings of the American Mathematical Society

This journal is devoted entirely to research in pure and applied mathematics, and the publication of original papers of moderate length. The maximum length of an acceptable paper is about 8 printed pages. Since a page of the Proceedings contains about 400 words, a rule of thumb is that under 10 typed pages is probably within the limit, but that over 12 typed pages is probably too long.

Shorter notes. Very short notes not to exceed 1 printed page of an unusual nature are also accepted, and appear under the heading Shorter Notes. Items deemed suitable include an elegant new proof of an important and well-known theorem, an illuminating example or counterexample, or a new viewpoint on familiar results. New results, if of a brief and striking character, might also be acceptable, though in general a paper which is merely very short will not be suitable for the Shorter Notes department.

Preparation of the manuscript. Articles for insertion should be typewritten and double spaced. Ditto is not generally satisfactory, although other modes of multiple reproduction may be. The Manual for Authors, available from the Society, should be consulted for symbols and style conventions. Authors should take the greatest possible care in preparing the original manuscript. Hand drawn symbols are satisfactory, if clearly done; directions to the printer should be included where necessary on a separate sheet, not in the accompanying letter. Authors must keep a complete copy of their manuscript, and editors will acknowledge receipt; manuscripts can therefore be sent by ordinary mail and any other kind (registered, certified) is entirely unnecessary.

FORM of Manuscript. The first page should consist of a descriptive title, followed by an abstract which summarizes the article in language suitable for workers in the general field (algebra, analysis, etc.). It should be at least one complete sentence, but not over 150 words, with the upper limit primarily for longer papers. The title should be short, but informative; useless vague phrases such as "some remarks about" or "concerning" should be avoided. At the end of the article, placed before the first footnote, there should be first the A.M.S. subject classification numbers representing the primary and secondary subjects of the article, followed by a list of key words and phrases describing the subject matter of the article and taken from it. A list of subject classification numbers is printed at the end of each volume of Mathematical Reviews. See the June 1969 Notices for more details, as well as illustrative examples.

Submission of manuscripts. See the last page of the issue.
Subscription information. Three volumes of four issues are planned for 1970. The subscription price is $\$ 60.00$ for the three volumes. Back issues of Volumes 1-16 are available at a price of $\$ 14.00$ each, Volumes $17-19$ at a price of $\$ 18.00$ each, and Volumes $20-23$ at a price of $\$ 30.00$ each.

The Proceedings of the American Mathematical Society is published monthly. Subscriptions, orders for back numbers, and inquiries in regard to nondelivery of current numbers should be addressed to the American Mathematical Soclety, 321 South Main Street, P.O. Box 6248, Providence, R.I. 02904.

Second-class postage paid at Providence, Rhode Island and additional mailing offices.
Copyright ©, American Mathematical Society, 1970
Printed in the United States of America

## PROCEEDINGS

OF THE

## American Mathematical Society

EDITED BY<br>FRED G. BRAUER<br>W. H. J. FUCHS<br>IRVING GLICKSBERG<br>ARTHUR MATTUCK<br>ERNEST A. MICHAEL<br>JOSEPH J. ROTMAN<br>P. EMERY THOMAS

WITH THE COÖPERATION OF
W. W. Boone
S. M. Shah

Allen Shields

VOLUME 25
MAY—AUGUST 1970

# RESEARCH AND REVIEW JOURNALS PUBLISHED BY THE AMERICAN MATHEMATICAL SOCIETY 

## Bulletin of the American Mathematical Society

The journal is the official organ of the Society. It reports official acts of the Society and the details of its meetings. It contains some of the officially invited addresses presented before the Society, reviews of advanced mathematical books, and a department of research announcements.

The current issue of the journal lists editors to whom prospective publications should be addressed. Publication is bimonthly.

## Transactions of the American Mathematical Sociery

This monthly journal is devoted entirely to research in pure and applied mathematics, and includes in general longer papers than the Proceedings.

The current issue of the journal lists editors to whom prospective publications should be addressed.

## Mathematics of Computation

A journal devoted to original papers in numerical analysis, the application of numerical methods and high-speed calculator devices, the computation of mathematical tables, the theory of high-speed calculating devices and other aids to computation. In addition it publishes reviews and notes in these and related fields.

Prospective publications should be addressed to the Editor, Professor Eugene Isaacson, Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, New York 10012. The author may suggest the name of an editor for review of his paper.

## Mathematical Reviews

This journal is devoted to abstracts and reviews of the current mathematical literature of the world. Currently publication is monthly; two volumes are published each year, each volume consisting of 6 regular issues plus an index issue. In each regular issue the abstracts and reviews are grouped under subject headings. Publication began in 1940.

## Soviet Mathematics-Doklady

This bimonthly is a translation journal containing the entire pure mathematics section of the Doklady Akademil Nauk SSSR, the Reports of the Academy of Sciences of the USSR. The Doklady for a year contains about 500 articles, each about 4 pages long.

## Mathematics of the USSR-Izvestija

This journal is a cover-to-cover translation of Izvestija Akademir Nauk SSSR Serija Matematičeskaja, published bimonthly by the Academy of Sciences of the USSR. It is a journal of current research in all fields of pure mathematics. Starting with Volume 1, Number 1, January-February 1967, which corresponds to the Russian original Tom 31, Number 1, the translation is prepared by the Plenum Publishing Corporation with the cooperation of the American Mathematical Society, and is published bimonthly by the American Mathematical Society.

## Mathematics of the USSR—Sbornik

This journal is a cover-to-cover translation of Matematičeskill Sbornik (New Series), published monthly by the Moscow Mathematical Society and the Academy of Sciences of the USSR. It is a journal of current research in all fields of pure mathematics. The translation is published monthly starting with Volume 1, Number 1, January 1967, which corresponds to the Russian original Tom 72 (114), No. 1.

Requests for information concerning any of these journals should be addressed to the American Mathematical Society, Box 6248, Providence, Rhode Island 02904. Papers for publication should be sent to an appropriate editor rather than to the Providence Office.

## SUBMISSION OF MANUSCRIPT

Send papers directly to one of the authors listed under the subject field of the paper.

## Algebra and number theory.

George B. Seligman, Department of Mathematics, Yale University, New Haven, Connecticut 06520
Joseph J. Rotman, Mathematics Department, University of Illinois, Urbana, Illinois 61801

Modern or classical analysis.
Irving Glicksberg, Mathematics Department, University of Washington, Seattle, Washington 98105
W. H. J. Fuchs, Department of Mathematics, White Hall, Cornell University, Ithaca, New York 14850
Allen Shields, Department of Mathematics, University of Michigan, Ann Arbor, Michigan 48104

Algebraic geometry.
George B. Seligman, Department of Mathematics, Yale University, New Haven, Connecticut 06520

Set-theoretic and general topology.
Ernest Michael, Mathematics Department, University of Washington, Seattle, Washington 98105

Algebraic topology and all other types of geometry.
P. Emery Thomas, Mathematics Department, University of California, Berke!ey, California 94720

Applied mathematics, differential equations, and related areas of analysis.
Fred Brauer, Mathematics Department, University of Wisconsin, Madison, Wisconsin 53706

Probability, statistics, and related fields.
Joshua Chover, Mathematics Department, University of Wisconsin, Madison, Wisconsin 53706

Logic, set theory, and related areas.
W. W. Boone, Mathematics Department, University of Illinois, Urbana, Illinois 61801

All other communications should be addressed to the Managing Editor, W. H. J.
Fuchs, at the above address.
Reprints and address changes. Any inquiries concerning a paper which has been accepted for publication, including information regarding reprints or changes of address for mailing proof, should be sent directly to the Editorial Department, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02904.
Contents-Continued from back cover
The normal completions of certain partially ordered vector spaces. By Alan G. Waterman ..... 141
On the multiplicity of an integral extension of a local ring. By David G. Whitman ..... 145
Complete continuity of the inverse of a positive symmetric operator. By James P. Fink ..... 147
A generalization of Sturm's separation theorem. By W. Allegretto ..... 151
Free coalgebras in a category of rings. By Robert Davis ..... 155
A real analogue of the Gelfand-Neumark theorem. By Tamio Ono ..... 159
On the semisimplicity of twisted group algebras. By D. S. PASSMAN ..... 161
Decomposability of finitely presented modules. By R. B. War- field, JR ..... 167
An infinite class of irreducible homology 3-spheres. By Jonatian L. Gross. ..... 173
The converse of Cauchy's theorem for arbitrary Riemann surfaces. By Myron Goldstein ..... 177
On the algebraic independence of symmetric functions. By G. K. Haeuslein ..... 179
Class number in constant extensions of elliptic function fields. By James R. C. Leitzel ..... 183
A note on finite metabelian p-groups. By J. D. Gillam ..... 189
On the factorization of integers. By R. L. Duncan. ..... 191
Weak sequential completeness in spaces of operators. By J. M. BAKER ..... 193
A property of torsion-free modules over left Ore domains. By Arthur Van de Water. ..... 199
Correction to: On ring structures determined by groups. By Klaus E. Eldridge ..... 202
Shorter Notes
The Toeplitz-Hausdorff theorem for linear operators. By Karl Gustafson ..... 203
Metric definition of the linear structure. By Russell G. Bilyeu ..... 205
An unsolvable equation. By P. R. Garabedian ..... 207

## CONTENTS

Vol. 25, No. 1 ..... MAY, 1970
Whole No. ..... 131
The algebra of log-summable functions. By Daniel O. Etter, Jr. ..... 1
Page
An approximate solution of the Riccati matrix equation. By M. S. Henry and F. M. Stein ..... 8
Overconvergence and $(C, 1)$ summability. By Vladimir Drobot ..... 13
On the measure of zero sets of coordinate functions. By JoHn E. Coury ..... 16
A flat integral for functionals defined on sample paths of a Brownian process with the parameter in $n$-dimensional space. By Peggy Tang Strait ..... 21
The automorphism group of a product of graphs. By Donald J. Miller ..... 24
Subdirect sums, hereditary radicals, and structure spaces. By A. G. Heinicke ..... 29
The Perron integral and existence and uniqueness theorems for a first order nonlinear differential equation. By Manoug N. Manougian. . ..... 34
Asymptotics in random ( 0,1 )-matrices. By Patrick Eugene O'Neil ..... 39
Generalized relative difference sets. By Stanley E. Payne. ..... 46
Common eigenvectors for commutative positive linear operators. By Robert E. Huff ..... 51
An invariance principle for reversed martingales. By R. M. Loynes ..... 56
Admissibility and nonlinear Volterra integral equations. By R. K. Miller ..... 65
Bounds for zeros of some special functions. By Herbert W. Hethcote ..... 72
Decomposable compact convex sets and peak sets for function spaces. By Leonard Asimow ..... 75
Note on nonnegative matrices. By D. Ž. DJoković ..... 80
The spectrum of a selfadjoint compression of a selfadjoint operator. By John M. Hosack ..... 83
Representation of abelian groups and rings by families of real-valued functions. By Carl W. Kohls ..... 86
On the asymptotic behavior of linear systems. By PHIL LOCKE ..... 93
Commuting unilateral shifts. By James A. Deddens. ..... 96
Decomposition numbers of $p$-solvable groups. By FORREST RICHEN ..... 100
A new definition of a reduced form. By E. H. Hadlock and T. O. Moore ..... 105
Note on the Shapiro polynomials. By John Brillhart and L. Carlitz ..... 114
Applications of stereographic projections to submanifolds in $E^{m}$ and $S^{m}$. By Robert C. Reilly. ..... 119
A nonembedding theorem for finite groups. By Ernest L. Stitzinger ..... 124
The structure and asymptotic behavior of polynomially compact operators. By Frank Gilfeather ..... 127
Automorphisms of countable primary abelian groups. By Paul Hill ..... 135

