# PROCEEDINGS 

OF THE

## American Mathematical Society

EDITED BY<br>R. P. BOAS<br>S. S. CHERN<br>RICHARD BRAUER<br>SHIZUO KAKUTANI

WITH THE COÖPERATION OF

RAOUL BOTT
BERNARD FRIEDMAN EDWIN HEWITT
R. H. BRUCK

PAUL CIVIN
W. H. GOTTSCHALK
J. A. JENKINS
R. M. THRALL

MARSHALL HALL, JR. WALTER RUDIN

VOLUME 7, NUMBER 1
FEBRUARY, 1956

PUBLISHED BY THE SOCIETY
MENASHA, WIS., and PROVIDENCE, R. I.

## Journals Published by the

## American Mathematical Society

## Bulletin of the American Mathematical Society

This journal is the official organ of the Society. It reports official acts of the Society and the details of its meetings, with abstracts of all research papers presented. It contains some of the officially invited addresses presented before the Society. It contains also announcements and notes on matters of current interest, and reviews of advanced mathematical books.

One volume of six numbers is planned for 1956. The subscription price is $\$ 7.00$. The prices of back volumes, insofar as they are available, are as follows: vols. 1-36 (1894-1930), $\$ 7.00$ each; vols. $37-53$ (1931-1947), \$9.00 each; vols. 54-55 (19481949), $\$ 11.00$ each; vols. 56-61 (1950-1955), $\$ 7.00$ each.

## Proceedings of the American Mathematical Society

This journal is devoted entirely to research in pure and applied mathematics, and is devoted principally to the publication of original papers of moderate length. Volume 1 appeared in 1950.

Articles for insertion in the Proceedings should be typewritten, double spaced, and the author should keep a complete copy. Papers in algebra, number theory, logic and foundations should be sent to Richard Brauer, 2 Divinity Avenue, Harvard University, Cambridge 38, Mass.; in geometry and topology to S. S. Chern, Department of Mathematics, University of Chicago, Chicago 37, Ill.; in probability, real variables, and abstract analysis to Shizuo Kakutani, Leet Oliver Memorial Hall, Yale University, New Haven 11, Conn.; in other branches of analysis, applied mathematics, and all other fields to R. P. Boas, Lunt Building, Northwestern University, Evanston, Ill. All other communications to the editors should be addressed to the Managing Editor, Richard Brauer.

One volume of six numbers is planned for 1956 . The subscription price is $\$ 11.00$. Vols. 1-6 (1950-1955) are available at the price of $\$ 11.00$ each.

## Transactions of the American Mathematical Society

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

Three volumes of two numbers each will be published in 1956. The price per volume is $\$ 6.00$. Volumes $1-36(1900-1934)$ consists of four numbers each. Volumes $66-67$ (1949) and 78-80 (1955) consist of two numbers each. The prices of back volumes, insofar as they are available, are as follows: vols. 1-21 (1900-1920), $\$ 7.00$ each; vols. 22-32 (1921-1930), $\$ 8.00$ each; vols. $33-36$ (1931-1934), $\$ 9.00$ each; vols. $37-80$ (1935-1955), $\$ 6.00$ each.

## Mathematical Reviews

This journal contains abstracts and reviews of the current mathematical literature of the world. It is sponsored by thirteen mathematical organizations, located both in the United States and abroad.

The publication of Mathematical Reviews was begun in 1940. It appears monthly, excepting July, and the price per annual volume is $\$ 20.00$. Orders for complete volumes only are accepted. Volumes 1-16 (1940-1955) are available at $\$ 20.00$ per volume.

The Proceedings of the American Mathematical Society is published bimonthly, in February, April, June, August, October, and December. Price per annual volume is $\$ 11.00$. Subscriptions, orders for back numbers, and inquiries in regard to nondelivery of current numbers should be addressed to the American Mathematical Society, 450 Ahnaip Street, Menasha, Wis., or 80 Waterman Street, Providence 6, R. I.

Entered as second-class matter at the post office at Menasha, Wisconsin. Authorization is granted under the authority of the act of August 24, 1912, as amended by the act of August 4, 1947 (sec. 34.21, P. L. \& R.). Acceptance for mailing at the special rate of postage provided for in section 35.40 paragraph d, P. L. \& R.

Copyright, American Mathematical Society, 1956
Printed in the United States of America

## PROCEEDINGS

OF THE

# American Mathematical Society 

## EDITED BY

R. P. BOAS<br>S. S. CHERN

RICHARD BRAUER
SHIZUO KAKUTANI

| with the coöperation of |  |  |
| :--- | :--- | :--- |
| RAOUL BOTT | R. H. BRUCK | PAUL CIVIN |
| BERNARD FRIEDMAN | W. H. GOTTSCHALK | MARSHALL HALL, JR. |
| EDWIN HEWITT | J. A. JENKINS | WALTER RUDIN |
|  | R. M. THRALL |  |

## VOLUME 7

1956

PUBLISHED BY THE SOCIETY
MENASHA, WIS., and PROVIDENCE, R. I.

## Books Published by the <br> American Mathematical Society

Colloquium Publications
36. W. H. Gottschalk and G. A. Hedlund, Topological dynamics, 1955, viii, 151 pp . ..... $\$ 5.10$
35. A. C. Schaeffer and D. C. Spencer, Coefficient regions for schlicht func- tions, 1950, xvi, 311 pp . ..... 6.00
34. J. L. Walsh, The location of critical points of analytic and harmonic functions, 1950, viii, 384 pp . ..... 6.00
33. J. F. Ritt, Differential algebra, 1950, viii, 184 pp. ..... 4.40
32. R. L. Wilder, Topology of manifolds, 1949, x, 402 pp . ..... 7.00
30. T. Rad6, Length and area, 1948, vi, 572 pp . ..... 6.75
29. A. Weil, Foundations of algebraic geometry, 1946, xx, 288 pp. ..... 5.50
28. G. T. Whyburn, Analytic topology, 1942; reprinted, 1955, x, 280 pp . ..... 4.75
27. S. Lefschetz, Algebraic topology, 1942; reprinted, 1955, vi, 389 pp. ..... 4.40
26. N. Levinson, Gap and density theorems, 1940, viii, 246 pp . ..... 4.00
25. G. Birkhoff, Lattice theory, 1940; enlarged and completely revised edi- tion, 1948, xiv, 283 pp. ..... 6.00
24. A. A. Albert, Structure of algebras, 1939; reprinted, 1952, xii, 210 pp . ..... 4.00
19. R. E. A. C. Paley and N. Wiener, Fourier transforms in the complex domain, 1934; reprinted, 1954, viii, 184 pp . + portrait plate. ..... 4.00
18. M. Morse, The calculus of variations in the large, 1934; reprinted, 1947, x, 368 pp . ..... 5.35
17. J. H. M. Wedderburn, Lectures on matrices, 1934; reprinted, 1949, x, 205 pp . ..... 3.35
15. M. H. Stone, Linear transformations in Hilbert space and their applica- tions to analysis, 1932; reprinted, 1951, viii, 622 pp. ..... 8.00
14. J. F. Ritt, Differential equations from the algebraic standpoint, 1932; reprinted, 1947, x, 172 pp. ..... 3.00
11. D. Jackson, The theory of approximation, 1930, reprinted, 1951, viii, 178
pp.
pp. ..... 3.35 ..... 3.35
10. A. B. Coble, Algebraic geometry and theta functions, 1929; reprinted, 1947, viii, 282 pp. ..... 4.00
9. (i. D. Birkhoff, Dynamical systems, 1927; reprinted, 1952, viii, 295 pp. ..... 4.60
8. I . P. Eisenhart, Non-Riemannian geometry, 1927; reprinted, 1949, viii, 184 pp. ..... 2.70
52. O. Veblen, Analysis situs, 1922, 2d ed., 1931, reprinted, 1951, x, 194 pp. ..... 3.35
3. E. Kasner, Differential-geometric aspects of dynamics, 1913; reprinted, 1947, iv, 117 pp. ..... 2.50

1. H. S. White, Linear systems of curves on algebraic surfaces; F. S. Whods, Forms of non-Euclidean space; E. B. Van Vleck, Selected topics in the theory of divergent series and of continued fractions; 1905, xii, 187 pp. ..... 3.00
Mathematical Surveys
2. C. Chevalley, Introduction to the theory of algebraic functions of onevariable, 1951, xii, 188 pp.$\$ 4.00$
3. S. Bergman, The kernel function and conformal mapping, 1950, viii, 161 pp . ..... 4.00
4. O. F. G. Schilling, The theory of valuations, 1950, viii, 253 pp . ..... 6.00
5. M. Marden, The geometry of the zeros of a polynomial in a complex variable, 1949 , x, 181 pp . ..... 5.00
6. J. A. Shohat and J. D. Tamarkin, The problem of moments, 1943; re- printed, 1950, xiv, 144 pp . ..... 3.35
Proceedings of Symposia in Applied Mathematics
7. Electromagnetic theory, 1950, iv, 91 pp . ..... $\$ 3.00$
8. Non-linear problems in mechanics of continua, 1949, iv, 219 pp . ..... 5.25 ..... 5.25

The price to members of the American Mathematical Society is $25 \%$ less than list. Volumes which are not listed above are out of print.

## CONTENTS

Vol. 7, No. 1 FEBRUARY, $1956 \quad$ Whole No. 37
page
Remark on S. N. Roy's paper "A useful theorem in matrix theory." By Béla Sz.-Nagy. ..... 1
The derivative of a matric function. By R. F. Rinehart ..... 2
A note on torsion-free nil groups. By Rimhak Ree and R. J. Wisner ..... 6
Witt's theorem and the isometry of lattices. By O. T. O'Meara ..... 9
Nonseparability of certain finite factors. By Jacob Feldman. ..... 23
A note on nonsingular forms in a finite field. By L. Carlitz. ..... 27
Remarks about a closure algebra in which closed elements are open. By Jean E. Rubin. ..... 30
Algebras over infinite fields. By A. S. Amitsur. ..... 35
On the shortest spanning subtree of a graph and the traveling salesman problem. By J. B. Kruskal, Jr. ..... 48
The number of lattice points in an $n$-dimensional tetrahedron. By S. Chowla and W. E. Mientika. ..... 51
A hyperbolic surface in 3 -space. By Robert Osserman ..... 54
A Tauberian theorem for $\alpha$-convergence of Cesàro means. By A. V. Boyd ..... 59
Asymptotic solution with respect to a parameter of a differen- tial equation having an irregular singular point. By N. D. Kazarinoff ..... 62
On Stieltjes integration. By E. J. McShane ..... 69
On a Bloch-Landau constant. By Edgar Reich ..... 75
On the optimum gradient method for systems of linear equa- tions. By M. Marcus ..... 77
Abel's integral equation as a convolution transform. By D. B. Sumner ..... 82
Some nonclassical problems in the calculus of variations. By Richard Bellman, Irving Glicksberg, and Oliver Gross ..... 87
The equivalence of linear and nonlinear differential equations. By R. T. Herbst. ..... 95
Quasi-equicontinuous sets of functions. By Chien Wenjen. ..... 98
Inclusion relations among some methods of summability. By N. J. Schoonmaker. ..... 102
Biorthogonality and integration. By Samuel Kaplan ..... 109
Normal families of subharmonic functions. By M. G. Arsove. ..... 115
On a mixed boundary value problem of harmonic functions. By Nora Pernavs ..... 127
One-parameter transformation groups of the three-sphere. By Robb Jacoby ..... 131
A note on recurrent flows. By C. D. Gorman. ..... 142
Chain homotopy and the de Rham theory. By V. K. A. M. Gugenheim and D. C. Spencer ..... 144
A theorem on disks By O. G. Harrold, Jr. ..... 153
The homology of Kummer manifolds. By E. Spanier. ..... 155
A fixed point theorem for continuous multi-valued transforma- tions. By R. L. Plunkett ..... 160
On interval recurrent sums of independent random variables. By Frank Spitzer ..... 164
On some properties of the normal and gamma distributions. By R. G. Laha ..... 172

