NOTICES
OF THE
AMERICAN MATHEMATICAL SOCIETY

Edited by John W. Green and Gordon L. Walker

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# MEETINGS

## Calendar of Meetings

NOTE: This Calendar lists all of the meetings which have been approved by the Council up to the date at which this issue of the *Notices* was sent to press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change. This is particularly true of the meetings to which no numbers have yet been assigned.

<table>
<thead>
<tr>
<th>Meeting No.</th>
<th>Date</th>
<th>Place</th>
<th>Deadline for Abstracts*</th>
</tr>
</thead>
<tbody>
<tr>
<td>629</td>
<td>December 29, 1965</td>
<td>Berkeley, California</td>
<td>Sept. 28</td>
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<tr>
<td></td>
<td>(72nd Annual Meeting)</td>
<td></td>
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<tr>
<td>631</td>
<td>February 26, 1966</td>
<td>New York City</td>
<td>Jan. 13</td>
</tr>
<tr>
<td>632</td>
<td>April 4-7, 1966</td>
<td>New York City</td>
<td>Feb. 18</td>
</tr>
<tr>
<td>633</td>
<td>April 9, 1966</td>
<td>Honolulu, Hawaii</td>
<td>Feb. 18</td>
</tr>
<tr>
<td>634</td>
<td>April 21-23, 1966</td>
<td>Chicago, Illinois</td>
<td>Feb. 18</td>
</tr>
<tr>
<td>635</td>
<td>June 18, 1966</td>
<td>Victoria, British Columbia</td>
<td></td>
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<tr>
<td></td>
<td>August 29-September 2, 1966 (71st Summer Meeting)</td>
<td>New Brunswick, New Jersey</td>
<td></td>
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<tr>
<td></td>
<td>January 24-28, 1967 (73rd Annual Meeting)</td>
<td>Houston, Texas</td>
<td></td>
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<tr>
<td></td>
<td>August 28-September 1, 1967 (72nd Summer Meeting)</td>
<td>Toronto, Ontario, Canada</td>
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<tr>
<td></td>
<td>January, 1968</td>
<td>San Francisco, California</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(74th Annual Meeting)</td>
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<td></td>
</tr>
</tbody>
</table>

* The abstracts of papers to be presented in person at the meetings must be received in the Headquarters Offices of the Society in Providence, Rhode Island, on or before these deadlines. The deadlines also apply to news items. The next two deadline dates for the by title abstracts are November 26, 1965 and January 6, 1966.

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The *Notices* of the American Mathematical Society is published by the Society in January, February, April, June, August, October, November and December. Price per annual volume is $7.00. Price per copy $2.00. Special price for copies sold at registration desks of meetings of the Society, $1.00 per copy. Subscriptions, orders for back numbers (back issues of the last two years only are available) and inquiries should be addressed to the American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02904.

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Six Hundred Twenty-Seventh Meeting  
University of Kentucky  
Lexington, Kentucky  
November 12-13, 1965

PROGRAM

The six hundred twenty-seventh meeting of the American Mathematical Society will be held at the University of Kentucky in Lexington, Kentucky on November 12-13, 1965.

By invitation of the Committee to Select Hour Speakers for Southeastern Sectional Meetings, the Society will be addressed at 2:00 P.M. Friday, November 12, in the Student Center Theatre, by Professor Tatsuo Homma of Florida State University. Professor P. S. Mostert of Tulane University will address the Society Saturday, November 13 at 9:00 A.M. in the Student Center Theatre. The title of Professor Homma's talk will be "Piecewise linear approximations of embeddings of manifolds". The title of Professor Mostert's talk will be "The structure of compact connected semigroups". All sessions of the meeting will be held in the Student Center. The registration desk located in the Student Center will be open from 11:00 A.M.-4:00 P.M. Friday and from 8:30 A.M.-10:00 A.M. Saturday morning.

By invitation of the Committee to Select Hour Speakers for Southeastern Sectional Meetings there will be a special session of 15-minute papers on "Semigroups and Topological Algebra" organized by R. J. Koch and chaired by Wayman Strother. The speakers will be L. W. Anderson, Haskell Cohen, R. J. Koch, Pierre Conner, C. T. Yang and L. E. Ward. This session will be held on Saturday afternoon starting at 2:00 P.M. in room 111 McVey Hall.

RESERVATIONS

A listing of hotels and motels appeared in Preliminary Announcements in the October issue of these Notices. Reservations should be made directly with the hotels and motels.

TRAVEL

Lexington is served by Southern Railway, L & N Railroad; American, Piedmont, Eastern and Delta airlines and the Greyhound Bus Company. There will be ample parking facilities on campus. Lexington is in the Eastern Standard time zone.

MAIL ADDRESS

Registrants at the meeting may receive mail addressed in care of the American Mathematical Society, The Department of Mathematics, University of Kentucky, Lexington, Kentucky.

PROGRAM OF THE SESSIONS

The time limit for each contributed paper is ten minutes. To maintain the schedule, the time limit will be strictly enforced.
Invited Address. Student Center Theatre

Piecewise linear approximations of embeddings of manifolds
Professor Tatsuo Homma, Florida State University

Session on Topology. Student Center Theatre

3:15-3:25
(1) Stable homeomorphisms on manifolds with boundary
Professor D. B. Coleman* and Professor C. A. Greathouse, Vanderbilt University (627-31)

3:30-3:40
(2) Union of flat cell theorems. Preliminary report
Dr. R. Christopher Lacher, University of Georgia (627-5)

3:45-3:55
(3) A "duality" between certain spheres and arcs in $S^3$
Professor C. D. Sikkema, Florida State University (627-44)

4:00-4:10
(4) A class of mappings
Professor A. Lelek, Louisiana State University, Baton Rouge (627-34)
(Introduced by Professor R. D. Anderson)

4:15-4:25
(5) On Fox's property of a surface in a 3-manifold
Professor Shin'ichi Kinoshita, Florida State University (627-33)

4:30-4:40
(6) Stable manifolds with boundary
Professor C. A. Greathouse, Vanderbilt University (627-30)

4:45-4:55
(7) Some wild imbeddings in codimension two
Mr. Ralph Tindell, Florida State University (627-16)
(Introduced by Professor O. G. Harrold)

5:00-5:10
(8) An algorithm for establishing isomorphism between tame prime knots in $E^3$
Professor D. E. Penney, Louisiana State University, New Orleans (627-25)

5:15-5:25
(9) A sufficient condition that a compact metric continuum be chainable
Professor J. B. Fugate, University of Kentucky (627-4)

Session on Analysis. 245 Student Center

3:15-3:25
(10) Weak*-density and bounded approximation
Professor J. H. Wells* and Professor C. N. Kellogg, University of Kentucky (627-1)

3:30-3:40
(11) Linear functions from a set of analytic functions to the numbers. Preliminary report
Mr. W. L. Bynum, University of North Carolina (627-35)

*For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.
3:45-3:55
(12) Disconjugate properties of a system of differential equations
Professor D. B. Hinton, University of Georgia (627-41)

4:00-4:10
(13) A convergence criterion with application to series in linear topological spaces
Professor C. W. McArthur, Florida State University (627-13)

4:15-4:25
(14) Solutions of the Dirichlet problem in the place by approximation with Faber polynomials
Professor J. H. Curtiss, University of Miami (627-8)

4:30-4:40
(15) An exponential formula for one-parameter semi-groups of nonlinear transformations
Professor J. W. Neuberger, Emory University (627-9)

4:45-4:55
(16) Contraction semi-groups in a function algebra
Professor J. R. Dorroh, Louisiana State University, Baton Rouge (627-17)

5:00-5:10
(17) Constant multipliers in an inner product space of functions. Preliminary report
Professor J. S. MacNerney, University of North Carolina (627-36)

5:15-5:25
(18) Exact and attaining projections. Preliminary report
Mr. Robert Silber* and Professor Andrew Sobczyk, Clemson University (627-37)

FRIDAY, 3:15 P.M.

Session on Algebra. 309 Student Center

3:15-3:25
(19) The representation of a polynomial as a sum of three irreducibles
Professor D. R. Hayes, University of Tennessee (627-15)

3:30-3:40
(20) Large subgroups and small homomorphisms
Dr. C. K. Megibben, University of Houston (627-24)

3:45-3:55
(21) Transformation groups on a group
Professor Hidegoro Nakano, Wayne State University (627-29)

4:00-4:10
(22) On overrings of Prüfer domains
Professor R. W. Gilmer, Jr., Florida State University (627-2)

4:15-4:25
(23) Representations of affine semigroups
Professor Michael Friedberg, Emory University (627-42)
(Introduced by Dr. S. H. Gould)

4:30-4:40
(24) On the inertia of some classes of partitioned matrices
Professor E. V. Haynesworth*, Auburn University, and Professor A. M. Ostrowski, Universität Basel, Switzerland (627-43)

4:45-4:55
(25) Generalized radical rings
Mr. W. E. Clark, University of Florida (627-45)

5:00-5:10
(26) Some theorems on factorable irreducible polynomials
Professor Andrew Long, St. Andrews Presbyterian College (627-18)
5:15-5:25
(27) Finite models of identities
Professor Trevor Evans, Emory University (627-40)

SATURDAY, 9:00 A.M.

Invited Address. Student Center Theatre

The structure of compact connected semigroups
Professor P. S. Mostert, Tulane University

SATURDAY, 10:15 A.M.

Session on Analysis and Geometry. 309 Student Center

10:15-10:25
(28) On w*-sequential convergence and quasi-reflexivity
Professor R. D. McWilliams, Florida State University (627-14)

10:30-10:40
(29) A certain class of cardinal numbers
Professor S. G. Mrowka, The Pennsylvania State University (627-11)

10:45-10:55
(30) Concerning sets with one point kernel
Professor W. R. Hare, Jr.*, and Professor J. W. Kenelly, Jr., Clemson University (627-39)

11:00-11:10
(31) The lexicographic product of graphs
Professor R. L. Hemminger, Vanderbilt University (627-6)

11:15-11:25
(32) A uniqueness theorem for a singular Cauchy problem
Professor D. W. Lick, University of Tennessee (627-22)

11:30-11:40
(33) A predictor-corrector method with a new corrector at each step. Preliminary report
Professor J. R. Wesson, Vanderbilt University (627-27)

11:45-11:55
(34) An invariant curve theorem for analytic mappings of an annulus
Dr. T. G. Procter, Clemson University (late paper)
(Introduced by Professor Clayton Aucoin)

12:00-12:10
(35) A non-uniqueness result for a generalization of the Euler-Poisson-Darboux (EPD) problem
Dr. B. A. Fusaro, University of South Florida (late paper)

SATURDAY, 10:15 A.M.

Session on Algebra and Topological Algebra. Student Center Theatre

10:15-10:25
(36) A classification of direct sums of closed groups
Professor Paul Hill, University of Houston (627-21)

10:30-10:40
(37) Relative ideals and their complements
Professor A. R. Bednarek* and Professor A. D. Wallace, University of Florida (627-28)

10:45-10:55
(38) Groups of permutation polynomials over finite fields
Professor Charles Wells, Western Reserve University (627-10)
(Introduced by Dr. S. H. Gould)
11:00-11:10
(39) Subdirect and direct decompositions of generalized algebras
Professor F. M. Sioson, University of Florida (627-32)
(Introduced by Professor A. D. Wallace)

11:15-11:25
(40) On compact uniquely divisible semigroups
Mr. J. A. Hildebrant, University of Tennessee (627-12)

11:30-11:40
(41) A generalization of a theorem of Faucett
Mr. J. M. Day*, and Professor A. D. Wallace, University of Florida
(627-47)

SATURDAY, 10:15 A.M.

Session on Topology. 245 Student Center
10:15-10:25
(42) Fiber spaces and n-regularity
Professor L. F. McAuley* and Professor P. A. Tulley, Rutgers, The
State University (627-23)

10:30-10:40
(43) The space of n or less points of a manifold
Professor R. M. Schori, Louisiana State University, Baton Rouge (627-26)

10:45-10:55
(44) On sets homeomorphic to the countable infinite product of lines
Professor R. D. Anderson, Louisiana State University, Baton Rouge
(627-20)

11:00-11:10
(45) Continua with the same class of homeomorphisms
Professor Y. -L. Lee, University of Florida (627-46)

11:15-11:25
(46) On simple extensions of topologies
Professor C. J. R. Borges, University of California, Davis (627-19)

11:30-11:40
(47) Prime mappings
Professor L. B. Treybig, Tulane University (627-7)

11:45-11:55
(48) A tameness condition for 3-cells
Mr. L. R. Howell, Jr., Florida State University (late paper)
(Introduced by Professor H. C. Griffith)

12:00-12:10
(49) On reducibility of continua
Professor E. L. Bethel, Clemson University (late paper)

12:15-12:25
(50) The simple dimension of a topological space
Professor Andrew Sobczyk, Clemson University (627-38)

SATURDAY, 2:00 P.M.

Special Session for Topological Algebra and Semigroups. 111 McVey Hall
2:00-2:15
(1) Cross-sections and congruences in semigroups
Professor L. W. Anderson and Professor R. P. Hunter, Pennsylvania
State University (627-51)

2:20-2:35
(2) Multiplications on the 2-sphere
Professor Haskell Cohen, University of Massachusetts (627-52)
2:40-2:55
(3) Indecomposable cobordism classes
Professor P. E. Conner, University of Virginia (627-48)

3:00-3:15
(4) Some open questions concerning topological semigroups
Professor R. J. Koch, Louisiana State University, Baton Rouge (627-49)

3:20-3:35
(5) Remarks on partial order in topology
Professor L. E. Ward, Jr., University of Oregon (627-50)

3:40-3:55
(6) Differentiable actions on homotopy 7-spheres
Professor C. T. Yang*, University of Pennsylvania and Professor Deane Montgomery, Institute for Advanced Study (627-53)

Tallahassee, Florida

O. G. Harrold
Associate Secretary
The six hundred and twenty-eighth meeting of the American Mathematical Society will be held at the University of Iowa on Friday, November 26 and Saturday, November 27. In conjunction, there will be a meeting of the Iowa section of SIAM on Saturday. Registration and all sessions will be in the Physics Building. All the A.M.S. lectures and sessions will be in Room 301, Physics Building.

By invitation of the Committee to Select Hour Speakers for Western Sectional Meetings, Professor F. V. Atkinson of the University of Toronto will speak on "Multiparameter spectral theory" on Friday at 2:00 P.M. and Professor Jim Douglas, Jr. of Rice University will speak on "Unstable physical problems and their numerical approximation" on Saturday at 11:00 A.M.

In addition, Professor R. H. Bing of the University of Wisconsin will chair a Special Session of twenty-minute papers on Topology at 9:00 A.M. on Saturday. The speakers will be Professors Steve Armentrout, Edmund Burgess, Wolfgang Haken, and Russell McMillan.

Sessions for contributed papers will be held on Friday afternoon only. This represents a change from the Preliminary Announcement.

On Saturday afternoon, Dr. M. Papadopoulos of the Mathematics Research Center of the University of Wisconsin will address SIAM on Generalized functions.

A tea will be held on Friday afternoon at 5:00 P.M. at the Iowa Memorial Union, one block north of the Physics Building.

Iowa City may be reached by car on Interstate 80, five hours from Chicago, by bus via Continental or Greyhound, by rail on the Rock Island Lines, and by air on Ozark Airlines to Iowa City and on Ozark and United to Cedar Rapids, which is eighteen miles north of Iowa City.

Mail for those attending the meeting may be addressed to the Department of Mathematics, Room 110 Physics Building.

A reservation blank on Page 742 of the October Issue of these (Notes) provides information on housing. In addition, information on housing, restaurants and parking will be available at the Registration Desk in the Physics Building. The Amana Colonies and the Herbert Hoover Birthplace and Library are points of interest within fifteen miles of Iowa City.

PROGRAM OF THE SESSIONS

The time limit for each contributed paper is ten minutes. To maintain the schedule, the time limit will be strictly enforced.

All sessions will be held in the Physics Building

FRIDAY, 2:00 P.M.

Invited Address, Room 301, Physics Building
Multiparameter spectral theory
Professor F. V. Atkinson, University of Toronto
FRIDAY, 3:15 P.M.

General Session, Room 301, Physics Building
3:15-3:25
(1) Open continuous mappings of spaces having bases of countable order
   Dr. H. H. Wicke* and Dr. J. M. Worrell, Jr., Sandia Corporation, Albuquerque, New Mexico (628-4)

3:30-3:40
(2) Decompositions of $E^3$ which are definable by tori
   Mr. H. W. Lambert, University of Utah (628-8)
   (Introduced by Professor C. E. Burgess)

3:45-3:55
(3) Connected open topology for function spaces
   Professor S. A. Naimpally, University of Alberta and Mr. A. Irudayahanathan*, Iowa State University (628-3)

4:00-4:10
(4) On near-rings related to dense rings
   Professor R. E. Williams, Kansas State University (628-7)

4:15-4:25
(5) The decision problem for a class of formulas of first-order logic in which all
    disjunctions are binary
   Professor M. R. Krom, University of California, Davis (628-5)

4:30-4:40
(6) Gaussian Markov processes and a boundary value problem
   Dr. J. A. Beekman, Ball State University (628-1)

4:45-4:55
(7) On Volterra's population equation
   Professor R. K. Miller, University of Minnesota (628-6)

5:00-5:10
(8) Relativistic models
   Professor M. Z. v. Krzywoblocki, Michigan State University (628-2)

SATURDAY, 9:00 A.M.

Special Session on Recent Developments in Topology, Room 301 Physics Building
9:00-9:20
(9) Surfaces in $E^3$
   Professor C. E. Burgess, University of Utah (628-10)

9:30-9:50
(10) Concerning cellular decompositions of 3-manifolds that yield 3-manifolds
    Professor Steve Armentrout, University of Iowa (628-11)

10:00-10:20
(11) Canonical neighborhoods in 3-manifolds
    Professor D. R. McMillan, Jr., University of Virginia (628-9)

10:30-10:50
(12) On homotopy 3-spheres
    Mr. Wolfgang Haken, University of Illinois (628-12)

SATURDAY, 11:00 A.M.

Invited Address, Room 301, Physics Building
Unstable physical problems and their numerical approximation
Professor Jim Douglas, Jr., Rice University

S. Sherman
Associate Secretary

Bloomington, Indiana 756
Six Hundred Twenty-Ninth Meeting
University of California
Berkeley, California
December 29, 1965

PROGRAM

The six hundred twenty-ninth meeting of the American Mathematical Society will be held on Wednesday, December 29, 1965 at the University of California at Berkeley. This meeting will be part of the Annual Meeting of the American Association for the Advancement of Science.

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, an hour address will be presented by Professor T. M. Cherry of the University of Melbourne and the University of Washington. Professor Cherry's talk, entitled "Biharmonic boundary value problems", will be given at 1:30 P.M. in Room 155 Dwinelle Hall. There will be sessions for contributed papers at 10:00 A.M. and at 3:00 P.M. in California Hall. Abstracts of the papers to be presented at these sessions appear on pages 806-813 of these Notices. There are cross references to the abstracts in the program. Late papers will be accepted for this meeting. A program of the late papers will be available at the registration desk.

The AAAS meeting will begin on Sunday, December 26, and will end on Friday, December 31. Other events at this meeting which may be of special interest to mathematicians include sessions of Section A (Mathematics) of AAAS on Monday, December 27, and a meeting of the Society for Industrial and Applied Mathematics on Thursday, December 30. Further information concerning the AAAS program can be found in recent issues of Science magazine.

The main registration desk for the meeting will be located on the ground level of the Student Union Building. The registration desk will be open from 8:00 A.M. to 8:00 P.M. throughout the meeting. The AAAS has a registration fee of $5.00. The return on this investment includes a copy of the General Program of the AAAS meeting, admission to the exhibits and the Science Theater, and the warm feeling of having helped pay a share of the expenses of the meeting. Nonmembers of the AAAS can register in advance or at the meeting on the same basis as members. Payment of the $5.00 registration fee will be welcomed, although this is not mandatory.

Accommodations near the campus are available either in hotels and motels, or else in the University of California Residence Halls. A $5.00 deposit is required by all hotels and motels. Rooms in the Residence Halls are available for one or two persons per room, for couples, and for children 14 years or older. The full amount for room rental will be collected in advance. The table at the top of the next page gives the rates at the hotels, motels and the Residence Halls.
**RATES PER DAY**

<table>
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<th>HOTELS</th>
<th>SINGLE</th>
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<td>Claremont (300)</td>
<td>$11.00</td>
<td>$15.00</td>
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<td>Durant (200)</td>
<td>8.50*</td>
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<td>Shattuck (250)</td>
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*A few single rooms at $5.50, twins at $7.50

**MOTELS**

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<td>Berkeley House (112)</td>
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<td>14.50</td>
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<td>Berkeley Plaza (52)</td>
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<td>9.50</td>
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<td>California Motel (42)</td>
<td>6.50</td>
<td>7.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Golden Bear (44)</td>
<td>7.00 - 8.00</td>
<td>8.00 - 10.00</td>
<td>10.00 - 12.00</td>
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**RESIDENCE HALLS**

Single occupancy - $7.50 without meals; $8.50 with breakfast and lunch
Two in a room - $6.50 each without meals; $7.50 each with breakfast and lunch

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Housing arrangements will be handled by the AAAS Housing Bureau. A reservation form will be found on Page 742 of the October issue of these Notices. Reservations for housing should be sent on or before December 5.

Meal service will be available throughout the meetings in the Dining Commons adjacent to the Student Union Building. Persons who stay in the Residence Halls can obtain breakfast and lunch where they are living by paying $1.00 each day. Of course, the San Francisco Bay area is noted for its many excellent restaurants. Berkeley and San Francisco are served by the Santa Fe, the Southern Pacific, and the Western Pacific Railroads. Most major transcontinental airlines have flights to the San Francisco International Airport. The Oakland International Airport is somewhat closer to Berkeley, but is served by fewer direct flights. There is helicopter service from the San Francisco and Oakland Airports to Berkeley. Reservations for helicopter transportation should be made along with flight reservations, since this generally brings a reduction in the cost of the helicopter ticket.

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**PROGRAM OF THE SESSIONS**

The time limit for each contributed paper is ten minutes. The contributed papers are scheduled at 15 minute intervals so that listeners can circulate between the different sessions. To maintain this schedule, the time limit will be strictly enforced.

**WEDNESDAY, 10:00 A.M.**

**General Session, Room 105, California Hall**

10:00-10:10  
(1) On real numbers having normality of order k  
Professor C. T. Long, Washington State University (629-9)

10:15-10:25  
(2) Jessen's theorem on Riemann sums for locally compact groups  
Professor K. A. Ross and Professor K. R. Stromberg*, University of Oregon (629-8)

*For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.
10:00-10:10
(7) Positive solutions of a quadratic integral equation
Dr. G. H. Pimbley, Los Alamos Scientific Laboratory, Los Alamos, New Mexico (629-16)

10:15-10:25
(8) Formulation of axially symmetric solutions of Laplace’s equation
Dr. J. E. Rosenthal, Melpar, Incorporated, Falls Church, Virginia (629-18)

10:30-10:40
(9) Regular degeneration of certain systems of linear partial differential equations with constant coefficients
Professor L. E. Bobisud, University of New Mexico (629-25)

10:45-10:55
(10) A general Perron integral
Professor P. S. Bullen, University of British Columbia (629-5)

11:00-11:10
(11) Analytic functions of polynomial growth on a polycylinder, I
Dr. D. E. Myers, University of Arizona (629-6)

11:15-11:25
(12) An extension of Pólya’s theorem on power series with integer coefficients
Professor R. M. Robinson, University of California, Berkeley (629-10)

WEDNESDAY, 10:00 A.M.

Session on Algebra, Logic and Foundations, Room 107, California Hall
10:00-10:10
(13) Two theorems about 1-predictable sets of tapes
Mr. Peter Kugel, Technical Operations Research, Burlington, Massachusetts (629-11)

10:15-10:25
(14) Extensions of the hyperarithmetic hierarchy
Mr. Joseph Harrison, Stanford University (629-2)
(Introduced by Professor J. R. Shoenfield)

10:30-10:40
(15) A theorem on recursively enumerable classes and splinters
Dr. P. R. Young, Stanford University (629-14)

10:45-10:55
(16) On Dehn’s result on the conjugacy problem
Professor Seymour Lipschutz, Temple University (629-12)

11:00-11:10
(17) A universal property of completions of an ordered set
Professor Jorg Mayer, University of New Mexico (629-26)
WEDNESDAY, 1:30 P.M.

Invited Address, Room 155, Dwinelle Hall

Biharmonic boundary value problems
Professor T. M. Cherry, University of Melbourne and the University of Washington

WEDNESDAY, 3:00 P.M.

Session on Geometry and Topology, Room 106, California Hall

3:00-3:10
(18) A new local property of embeddings
Professor O. G. Harrold, Florida State University (629-3)

3:15-3:25
(19) Proximate retracts
Professor A. L. Yandl, Western Washington State College (629-17)

3:30-3:40
(20) A paracompact semi-metric space which is not an M^3-space
Professor R. W. Heath, Arizona State University (629-23)

3:45-3:55
(21) On unions of two convex sets
Professor R. L. McKinney, University of Alberta (629-15)

4:00-4:10
(22) Remarks on nearest points in normed linear spaces
Professor Victor Klee, University of Washington (629-21)

WEDNESDAY, 3:00 P.M.

Second Session on Analysis, Room 107, California Hall

3:00-3:10
(23) On the local holomorphic hull of a real submanifold in several complex variables
Professor R. O. Wells, Jr., Rice University (629-1)

3:15-3:25
(24) Level curves of harmonic functions
Professor Leopold Flatto*, and Professor D. J. Newman, Yeshiva University, and Professor H. S. Shapiro, University of Michigan (629-22)

3:30-3:40
(25) The general Plateau problem with free boundary
Professor L. J. Lipkin, University of California, Berkeley (629-24)

3:45-3:55
(26) A note on the transformation theory for measure space
Professor Robin Chaney, Western Washington State College (629-20)

Seattle, Washington

R. S. Pierce
Associate Secretary
The seventy-second Annual Meeting of the American Mathematical Society will be held at the Sherman House in Chicago, Illinois. This meeting will be held in conjunction with the Annual Meeting of the Mathematical Association of America. The Society will meet from Monday, January 24 through Thursday, January 27. The Mathematical Association of America will meet from Wednesday through Friday, January 26-28.

The thirty-ninth Josiah Willard Gibbs Lecture, "The evolution of the stars," will be delivered by Professor Martin Schwarz-schild of Princeton University in the Grand Ballroom of the Sherman House at 8:00 P.M. on Monday, January 24, 1966.

As Past President of the Society, Professor J. L. Doob will give an address, "Application to analysis of a topological definition of smallness of a set," in the Grand Ballroom of the Sherman House at 3:00 P.M. on Wednesday, January 26.

By invitation of the Committee to Select Hour Speakers for the Annual and Summer Meetings, an address will be given by Professor Richard Askey of the University of Wisconsin on "Norm inequalities for some orthogonal expansion" and an address by Professor George Glauberman, of the University of Chicago, on "Sylow 2-subgroups of finite groups." Professor Askey will speak at 2:00 P.M. on Wednesday, January 26, and Professor Glauberman's talk will be given at 2:00 P.M. on Thursday, January 27. Both of these addresses will be presented in the Grand Ballroom.

The Veblen Prize will be awarded in the Grand Ballroom at 2:00 P.M. on Monday, January 24.

As at the past three Annual Meetings of the Society, there will be sessions of selected twenty-minute papers. The papers presented at these sessions will be partly by invitation, and partly drawn from the ten-minute papers submitted for the meeting, the authors of which will be permitted to expand their presentations to twenty minutes. The topics and chairmen of these sessions are planned as follows:

- **Partial Differential Equations**
  - Felix Browder

- **Combinatorial Mathematics**
  - Herbert Ryser

- **Algebraic Groups**
  - Robert Steinberg

- **Markov Processes**
  - Wendell Fleming

Those persons contributing abstracts to the Annual Meeting who feel that their papers would be appropriate for presentation at one of these special sessions should submit their abstracts by November 23; that is, one week earlier than the regular deadline.

There will be regular sessions for contributed ten-minute papers. However, there is a limit of two hundred on the number of such papers which will be accepted for presentation at this meeting. Papers will be accepted for the meeting until either two hundred have been received or until the deadline date of November 30 has passed. There will be no sessions for late papers.

The Business Meeting of the Society will be held at 11:00 A.M. on Monday, January 24 in the Grand Ballroom.

The Council of the Society will meet at 4:00 P.M. on Sunday, January 23 in the Ruby Room on the First Floor.

**REGISTRATION**

The Registration Desk for this meeting will be in the foyer of the Grand Ballroom on the Mezzanine Floor of the Sherman House. The Registration Desk will be open from 2:00 to 8:00 P.M. on Sunday, January 23, from 8:00 to 5:00 P.M., Monday through Thursday, and from 9:00 A.M. to
3 P.M. on Friday. An Advance Registration Form will be found on Page 834 of these Notices. It is requested that this form be completed and sent with the proper registration fee to the Society office in Providence no later than January 8, 1966. A schedule of registration fees is also given. Those persons who have sent in their Advance Registration can pick up badges at the Registration Desk. Others must go through the usual registration process. It is requested that everyone attending the meeting register or pick up his badge, if registered in advance, as soon as possible after arrival.

The Employment Register will be maintained from 9:00 A.M. to 5:00 P.M. Tuesday, Wednesday and Thursday on the Mezzanine Floor in Parlors J and K. Book and other exhibits will be in the Exhibit Hall on the Mezzanine Floor. The exhibits will be open from Tuesday through Thursday.

All mail and telegrams for those attending the meeting should be addressed in care of the American Mathematical Society, Sherman House, Clark & Randolph, Chicago, Illinois.

A Message Center will be maintained in the Registration Area providing a central location where members at the meeting may receive telephone calls. All calls will be taken and filed at this booth. These messages can be picked up from the operator at the booth. The number of the Message Center will be 726-9346. The Chicago Area Code is 312. The Center will be open from 1:30 to 8:00 P.M. on Sunday, January 23; from 8:00 A.M. to 5:00 P.M. on Monday through Thursday; and from 9:00 A.M. to noon on Friday.

ACCOMMODATIONS

Accommodations for the meeting will be handled by the Chicago Convention Bureau. The reservation form on Page 834 of the Notices is to be used in requesting accommodations. This form should be completed and sent to the Mathematics Housing Bureau, 332 South Michigan Avenue, Chicago, Illinois 60604. Reservations will be confirmed within one week of receipt of reservation form. The Housing Bureau will make reservations as nearly as possible in accordance with the request given on the reservation form. A deposit on room reservations is not required. Requests for reservations must be sent soon enough to arrive in Chicago no later than January 10, 1966. The accompanying map gives the location of the various hotels that have reserved rooms for the meeting, including the headquarters hotel, the Sherman House.

ENTERTAINMENT AND RECREATION

Illinois Institute of Technology and the University of Illinois, Chicago Circle, will be host at a tea to which all members of the American Mathematical Society and the Mathematical Association of America are cordially invited. The tea will take place on the Mezzanine Floor of the Sherman House on Wednesday afternoon, January 26, from 4:30 to 6:00 P.M.

Since the Sherman House is right in the heart of Chicago's busy Loop, it is convenient to many of the city's attractions and amenities. The Merchandise Mart, Marina City, theatres, fine restaurants, specialty shops, art galleries, book stores, as well as the celebrated department stores on State Street and the elegant shops that line Michigan Avenue's "Magnificent Mile," are all within easy walking distance.

The Art Institute of Chicago, with its collection of French impressionist paintings, considered the world's finest, is only a few blocks from the hotel; and such notable institutions as the Adler Planetarium, the Shedd Aquarium, and the Chicago Museum of Natural History are all readily accessible. There is an efficient transit system, radiating from the Loop, to take visitors to the many points of interest that lie outside the immediate area of downtown Chicago.

At the Registration Desk on the Mezzanine Floor of the Sherman House, brochures and folders can be obtained giving more detailed information on how members may add to the enjoyment of their stay in Chicago. Arrangements can be made for special trips to points of professional and educational interest as well as for general sight-seeing bus tours. Recommendations for restaurants, shops, and places of entertainment will also be available at the Registration Desk.
The normal temperature in Chicago during the month of January is 26°F, and the precipitation is normally 1.9 inches.

Chicago is easily reached from any part of North America. Its airport, O'Hare Field, is the world's busiest; and there are 22 railroad lines serving the city. Excellent expressways lead into Chicago for those who prefer to travel by car, and these expressways also permit frequent fast service by the bus lines.

The airport limousine service from O'Hare Field arrives and departs from the LaSalle Street entrance of the Sherman House every half hour; the fare is $2.00.

The railroad stations are well served by taxis, and the trip to the hotel from any of the stations should cost about $1.00. The Greyhound Bus Lines terminal is right across the street from the Clark Street entrance to the Sherman House.

ARRANGEMENTS

Committee on Arrangements: Haim Reingold, Chairman; H. L. Alder, Arthur Grad, Louis A. Kokoris, Joseph Landin, Josephine Mehlberg, Seymour Sherman, G. L. Walker, L. R. Wilcox.

Seymour Sherman
Bloomington, Indiana
Associate Secretary
C.L.E. MOORE INSTRUCTORSHIPS AT M.I.T.

The M.I.T. Department of Mathematics wishes to announce the availability of C.L.E. Moore instructorships in Mathematics for 1966-1967, open to young mathematicians with doctorates who show definite promise in research. The base salary for these instructorships will be at least $8600 and the teaching load will be six hours per week. The salary can be supplemented by summer work on a research grant, sponsored by the Air Force Office of Scientific Research, or by teaching in the summer session. The appointments are annual but are renewable for one additional year.

Applications should be filed not later than January 4, 1966, on forms obtained from the department.

SIAM VISITING LECTURESHIP PROGRAM

The Society for Industrial and Applied Mathematics has announced its 1965-1966 Visiting Scientist Lectureship Program. Though this program, institutions and industrial facilities may take advantage of the availability of eminent mathematicians for visiting their establishments for the purpose of lecturing to their staff and/or student bodies. Further information may be obtained by writing to: Visiting Lecture Program, Society for Industrial and Applied Mathematics, 33 South 17th Street, Philadelphia, Pennsylvania 19103.

SMITHSONIAN OFFERS RESEARCH GRANTS

Research appointments are available for those individuals interested in fields of mathematical study related to the activities of the Smithsonian Institute. Opportunities include independent research associateships for those scholars with the Ph.D. or equivalent degree. Selections of all research projects will be made by the National Academy of Sciences--National Research Council and be approved by the Smithsonian. Stipends range from $10,350 to $19,000 for single-year appointments. February 15, 1966 is the deadline for receipt of applications.

Internships are available for those graduate students who are candidates for the Ph.D. or equivalent degree, and whose departments or universities approve their working at the Smithsonian. Projects are arranged by the student and the supervising Smithsonian staff member. Stipends average approximately $100 a week. The deadline for receipt of applications is February 1, 1966.

Graduate students and undergraduates may apply for research assistantships. These grants are for a ten-week period, during either the summer or academic year. The summer program includes a series of lectures and interdisciplinary seminars in addition to regular research. Stipends range from $60 to $115 per week, according to education and experience. Applications must be received by March 1, 1966.

Requests for further information and application forms should be sent to the Division of Education and Training, Smithsonian Institution, Washington, D.C. 20560. The request should include the highest academic degree held, present academic status, proposed subject of research, and inclusive dates of the proposed project.

WARREN WEAVER RECEIVES AWARD

Dr. Warren Weaver received the first Arches of Science Award presented by the Pacific Science Foundation, on October 25th, in Seattle, Washington. The award, consisting of a cash prize of $25,000 and a gold medal, was given to Dr. Weaver on the basis of his contributions toward a better understanding of the meaning of science by contemporary men.
Dr. Weaver has been a longtime affiliate of the American Mathematical Society. He was council member-at-large from 1931 until 1933. He served on the Board of Trustees from 1941 until his resignation six years later in 1947. Dr. Weaver was instrumental in establishing the publication, Mathematical Reviews, in 1939. In addition to his work with the Society, Dr. Weaver has been associated with the Rockefeller Foundation and the Alfred P. Sloan Foundation since 1932.

As one of the foremost communicators of science, Dr. Weaver has written several books, including, The Electromagnetic Field, Elementary Mathematical Analysis, and The Mathematical Theory of Communication. He has been active in scientific education and has edited and contributed to many scientific journals.

INSTITUTE FOR ADVANCED STUDY
1965-1966 Memberships

The School of Mathematics of the Institute for Advanced Study, Princeton, New Jersey, will grant a limited number of memberships, in some cases with financial support, for research in mathematics at the Institute during the academic year 1966-1967. Candidates must have given evidence of ability in research comparable at least with that expected for a Ph.D. degree. Application blanks may be obtained from the Secretary of the School of Mathematics, and should be returned by January 15 (whether or not funds are expected from some other source).

APPLIED MATHEMATICS CENTER
FORMED AT LEHIGH

A Center for Applied Mathematics has recently been established at Lehigh University in Bethlehem, Pennsylvania. Under the direction of Dr. Everett Pitcher, head of the Mathematics Department, the Center incorporates a diverse research and teaching faculty in order to provide opportunity for mathematical applications in the social and biological sciences as well as in the physical sciences. The committee which guides the activities of the Center is staffed by members of the department of psychology, mechanics, philosophy, mechanical engineering and industrial engineering in addition to the director and the University president, Dr. Deming Lewis.

Among the main activities of the Center is the organization of research programs that will bring diversely trained scholars and scientists together to cooperate on single and related problems. The Center is also responsible for the developing and coordinating of courses in which the application of mathematics is a major factor, and for supervising research applications of computers. A Center on Informational Sciences is a smaller branch of the larger one, designed to cooperate with the Division of Informational Sciences in training specialists who can analyze and organize information and conduct investigations of the properties and behavior of recorded information, and the forces governing its flow.

PROGRAM ON STATISTICS ORGANIZED

A visiting lecturer program in statistics has been organized for the 1965-1966 academic year. The program is sponsored jointly by the principal statistical organizations in the United States, the American Statistical Association, the Biometric Society and the Institute of Mathematical Statistics, with financial support provided by the National Science Foundation. Leading teachers and research workers in statistics, from universities, industry and government, have agreed to participate as lecturers. Lecture topics include subjects in experimental and theoretical statistics, as well as in such related areas as probability theory, information theory and stochastic models in the physical, biological, and social sciences. Further information may be obtained by writing to Visiting Lecturer Program in Statistics, Department of Statistics, 315 Phillips Hall, University of North Carolina, Chapel Hill, North Carolina 27515.
MEMORANDA TO MEMBERS

CORPORATE AND INSTITUTIONAL ASSOCIATE MEMBERS

The Society acknowledges with gratitude the support rendered by the following corporations who held either Corporate Membership or Institutional Associate Membership in the Society as of June 1, 1965.

Corporate Members
Academic Press, Incorporated
Bell Telephone Laboratories, Incorporated
Boeing Company
Corning Glass Works Foundation
E. I. Du Pont de Nemours and Company
Eastman Kodak
Ford Motor Company
General Dynamics Corporation
General Motors Corporation
Hughes Aircraft Corporation
International Business Machines Corporation
Lockheed Missiles and Space Company
Marathon Oil Company
Radio Corporation of America
Shell Development Company
Socony Mobil Oil Company
Space Technology Laboratories, Incorporated
Standard Oil Company
United Gas Corporation

Institutional Associate Members
Chelsea Publishing
Consultants Bureau Enterprises
Dover Publications
McGraw-Hill Company, Incorporated
Union Oil Company

RETIRERED MATHEMATICIANS

The next issue of the List of Retired Mathematicians Available for Employment will be published in February, 1966, by the Mathematical Sciences Employment Register. The List is distributed to academic and industrial employers who request it from the Register. Retired Mathematicians who are interested in being included in the List are invited to send the following information to the Register: name, date of birth, highest degree earned and where it was obtained, most recent employment, present address, date available, and references, including preference for academic or industrial employment. The address of the Mathematical Sciences Employment Register is P. O. Box 6248, Providence, Rhode Island 02904.

SUMMER EMPLOYMENT OPPORTUNITIES

The annual list of Opportunities for Summer Employment for Mathematicians and College Mathematics Students is being compiled presently and will be issued early in January, 1966. The list will be available free of charge at the Annual Meeting in Chicago in January, 1966, and on request from the Mathematical Sciences Employment Register.

Institutions which have summer job openings and would welcome applications from mathematicians and students of mathematics may request forms for the listing of summer employment from the Mathematical Sciences Employment Register, P. O. Box 6248, Providence, Rhode Island 02904.

THE EMPLOYMENT REGISTER

The Mathematical Sciences Employment Register, established by The American Mathematical Society, The Mathematical Association of America, and The Society for Industrial and Applied Mathematics, will be maintained at the Annual Meeting at the Sherman House, Chicago, Illinois on January 24-28, 1966. The Register will be conducted from 9:00 A.M. to 5:00 P.M. on Tuesday, Wednesday and Thursday on the mezzanine in Parlor J and K. It is important that applicants and employers
register at the Employment Register Desk promptly upon arrival at the meeting to facilitate the arrangement of appointments.

There is no charge for registration, either to job applicants or to employers, except when the late registration fee for employers is applicable. Provision will be made for anonymity of applicants upon request and upon payment of $5.00 to defray the cost involved in handling anonymous listings.

Job applicants and employers who wish to be listed should write to the Employment Register, P. O. Box 6248, Providence, Rhode Island 02904 for applicants forms or for position description forms. These forms must be completed and returned to Providence not later than December 15, 1965 in order to be included in the listings at the Annual Meeting in Chicago. Position description forms which arrive after this closing date, but before December 31, 1965 will be included in the Register at the meeting for a late registration fee of $5.00. The printed listings will be mailed to subscribers on January 5, 1966 and available for distribution both during and after the meeting.

A subscription which includes all three issues (January, May, and August) of both the list of applicants and the list of positions is obtainable for $15.00 per year. The individual issues of both lists may be purchased in January, May, and August for $7.50. Copies of only the list of positions may be purchased for $3.00.

Persons wishing either a year's subscription or individual issues, should make checks payable to the American Mathematical Society and send them to the Mathematical Sciences Employment Register, in care of the American Mathematical Society, Box 6248, Providence, Rhode Island 02904.

EDINBURGH MATHEMATICAL SOCIETY

Members of the American Mathematical Society who take advantage of the reciprocity agreement with the Edinburgh Mathematical Society should note that the dues have been increased from $1.50 to $2.00, corresponding to a recent increase in the dues for ordinary members. Dues, which were due in October for the following season, should be sent to: The Honorary Treasurer, Edinburgh Mathematical Society, 20 Chambers Street, Edinburgh 1, Scotland. The Edinburgh Society would appreciate payment in sterling. Most banks will arrange sterling payments for a small service charge.

A reciprocity membership in the Edinburgh Society can be established by submitting application on a form obtained from that Society. Members under the reciprocity agreement are entitled to present papers at Edinburgh meetings, may purchase the Proceedings and Edinburgh Mathematical Notes, and other publications at reduced rates.
"New Applications in Mathematics and Their Implications for Mathematical Education" is the theme of a session to be held at the annual AAAS meeting at Berkeley, California, on December 30, 1965. The program is sponsored jointly by Section A (Mathematics) of the American Association for the Advancement of Science and by the Society for Industrial and Applied Mathematics.

The session chairman and discussion leader will be Dr. B. H. Colvin, Boeing Scientific Research Laboratories. The program includes lectures by the following: George B. Dantzig, Chairman, Operations Research Center, Industrial Engineering Department, University of California, Berkeley; Victor Klee, Mathematics Department, University of Washington, Seattle; Leo Katz, Director of the Statistics Laboratory, Michigan State University, East Lansing.

NEWS ITEMS AND ANNOUNCEMENTS

PENNSYLVANIA STATE UNIVERSITY ESTABLISHES GRADUATE PROGRAM IN STATISTICS

A new graduate program in statistics has recently been developed at Pennsylvania State University. The program includes a Master of Arts course of study for those interested in statistical theory and a Master of Science program for applied statistics. The department also grants a Ph.D. degree in statistics.

Presently, the faculty for the Section on Statistics in the Department of Mathematics includes James B. Bartoo, head of the Department; Professor G. P. Patil; Associate Professors, William L. Harkness and Frederick G. Schmitt; and Assistant Professor Marilyn T. Boswell. As the Section is expanded, additional members of the Mathematics Department and various other departments will share teaching and research responsibilities.

The Section in Statistics offers more than forty courses, including statistical training for scientists and educators who wish to apply statistics to other disciplines, as well as curricula concerned with expanding statistical theory and developing new statistical methods.

The newly initiated Computer Science Department at Pennsylvania State has just been given permission to grant the Ph.D. degree as of this winter. A master's degree program had previously been approved.
CHARTER FLIGHT PLANS REARRANGED

The original plans for the American Mathematical Society's charter flight from New York to Moscow, as announced in the August issue of the Notices, have been adjusted so that participants may take advantage of Russian tours and/or conferences held shortly before and after the 1966 International Congress.

The date for departure from Moscow, originally set for August 27, directly following the conclusion of the conference, has been extended to August 30. Thus, participants will be able to visit various Russian cities on tours arranged in connection with the conference. Tour routes and respective dates are as follows: Tour #1 Moscow-Leningrad-Moscow, August 27-30; Tour #2 Moscow-Keiv-Moscow, August 27-30; Tour #3 Moscow-Tbilisi-Moscow, August 27-30; Tour #4 Moscow-Erevan-Moscow, August 27-30; Tour #5 Moscow-Tashkent-Samar-kand-Bukhara-Tashkent-Moscow, August 27-September 3; Tour "Holiday" Moscow-Sukhumi-Moscow; Tour #6 Moscow-Vladimir-Suzdale-Moscow, August 27-29; Tour #7 Moscow-Zagorsk-Moscow, one day.

In view of the large number of responses to the AMS charter and because of the many special conferences that are usually organized in Europe directly preceding and following the International Congress, the Society is planning to charter additional flights, to and from Paris. One flight will leave New York for Paris two weeks prior to the Congress on or about August 2. The other will depart from Paris to New York two weeks after the conclusion of the Congress, on or about September 10. Individuals taking advantage of either of the Paris flights are responsible for arranging their own transportation in Europe.

Although there are four possible charter plans available to those interested, New York-Moscow, Moscow-New York; New York-Paris, Paris-New York; New York-Moscow, Paris-New York; New York-Paris, Moscow-New York, the present information regarding fares includes only those prices for round trip flights. The present approximate round trip fare from New York to Moscow by charter would be about $434, round trip from New York to Paris, $295. Participants should realize that charter fares are based on the fixed price for a 148 passenger jet. However, the price for each individual will be prorated to the number of passengers participating in the flight. Plans and arrangements will be based on a minimum of 120 persons, although as many seats as possible up to the 148 limit will be sold. If more than the required 120 seats should be sold, individuals will be entitled to a refund. Fares stipulated are in accordance with existing fare structures for international chartered carriers. However, these structures may be altered in the near future and fares reduced. In this event, the arrangements for the AMS flights will be changed accordingly.

Those submitting application for charter flights should list their first three preferences for flight plans and any flight plan that would definitely not be suitable, in order that substitutions may be made if necessary. In addition the applicant should include his name, both home and business addresses, names and ages (if children) of any dependents which would be accompanying him. A deposit of $50 must be included for each passenger. Preferred travel arrangements will be given to those applications received at the earliest date. Therefore, individuals should submit their applications to Providence as soon as possible, and no later than December 1, 1965. Applicants will be notified January 1, 1966, regarding their flight plans.
The Division, considering the changing conditions affecting the support of scientific research and education, at its meeting on March 15 voted to establish Committee on Support of Research in the Mathematical Sciences. The committee is charged with reporting on the state of mathematics and its applications, the tasks faced by mathematical education in colleges and universities, and the current forms and level of support for mathematics by federal and private agencies. It is hoped that the report will be of interest to scientists in fields other than mathematics and to people responsible for science policy. The committee will work closely with the NAS-NRC Committee on Science and Public Policy. It will have the collaboration of the Survey Committee of the Conference Board of the Mathematical Sciences. The committee hopes to complete the major portion of its work by September, 1966.

The several advisory committees on the evaluation of applications for fellowships and other awards to mathematicians reviewed 2,819 applications in 10 programs. Awards to 877 mathematicians were made following these evaluations.

The third edition of the World Directory of Mathematicians is currently in preparation. The directory, published by the Tate Institute of Fundamental Research, Bombay, India, is produced under the general guidance of the International Mathematical Union. The U. S. National Committee for Mathematics has begun its part of the work, which consists of supplying a list of U. S. mathematicians.

At the request of the International Commission on Mathematical Instruction, the U. S. National Commission on Mathematical Instruction is preparing a report on the following topics:

(a) What special programs, if any, in mathematics should be offered for the benefit of prospective physicists?
(b) The use of the axiomatic method in high school teaching.
(c) The role of problems in mathematical education.

The report will be presented at the 1966 meeting of the International Mathematical Union.

On the recommendation of the Committee on Applications of Mathematics, an article on "What Can Be Done About Teaching the Applications of Mathematics in Colleges and Universities" was prepared by B. Friedman and H. H. Goldstine, published in the American Mathematical Monthly, February, 1965. Copies were distributed to some 800 departments of mathematics in colleges and universities.

Complete responsibility for the publication of "Mathematics of Computation" was transferred to the American Mathematical Society. The journal was begun as "Mathematical Tables and Other Aids to Computation" in 1943 and was until now a responsibility of the NAS-NRC through the Division.

The Committee on Travel Grants has begun its work in finding funds and reviewing applications for support of travel of U. S. mathematicians to the International Congress of Mathematicians scheduled for August, 1966, in Moscow.

The Committee on Regional Development reported at the March meeting of the Division on a variety of steps which point toward broadening the stimulation of mathematical research and graduate education.

The officers of the Division of Mathematics for 1965-1966 are: Mark Kac, Chairman; G. A. Hedlund, Past Chairman;
Lipman Bers, Chairman Designate; and Leon W. Cohen, Executive Secretary.

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Copies of the complete annual report of the Division of Mathematics may be obtained by writing to:
Division of Mathematics
National Academy of Sciences
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418.

COMMITTEE ON SUPPORT OF RESEARCH
IN THE MATHEMATICAL SCIENCES

At its annual meeting in March, 1965 the Division of Mathematics of the National Academy of Sciences--National Research Council voted to establish the Committee on Support of Research in the Mathematical Sciences (COSRMS). The Committee was to be charged with preparing (i) a study of the current state of research in the mathematical sciences and of mathematics education at the undergraduate, graduate, and post-doctoral levels; (ii) a study of the current levels and forms of support of mathematical research by federal and private agencies; (iii) an indication of appropriate support in the immediate future if a healthy state of mathematical activity is to be maintained.

At the same time the Division of Mathematics authorized its Chairman, Mark Kac, to nominate the chairman and members of COSRMS. Following preliminary organizational work during the spring and summer, final appointment of the chairman and members was made by the President of the National Academy of Sciences--National Research Council, Frederick Seitz, in September, 1965. These are as follows:

Lipman Bers, Columbia University
(Chairman)
T. W. Anderson, Columbia University
R. H. Bing, University of Wisconsin
H. W. Bode, Bell Telephone Laboratories, Incorporated
R. P. Dilworth, California Institute of Technology
G. E. Forsythe, Stanford University
Mark Kac, Rockefeller Institute
C. C. Lin, Massachusetts Institute of Technology
J. W. Tukey, Princeton University
F. J. Weyl, Office of Naval Research
Hassler Whitney, Institute for Advanced Study
C. N. Yang, Institute for Advanced Study

The membership of the Committee provides authoritative coverage of various branches of the mathematical community and includes people involved in the applications of mathematics to other sciences.

In addition, COSRMS is served by four panels: a panel on graduate mathematics education under the chairmanship of R. P. Boas of Northwestern University, a panel on undergraduate mathematics education under the chairmanship of John Kemeny of Dartmouth College, a panel on levels and forms of support of mathematical research under the chairmanship of Mina Rees of City University of New York, and a panel on new mathematical centers under the chairmanship of Mark Kac of the Rockefeller Institute.

COSRMS is closely cooperating with the recently organized Survey Committee of the Conference Board of the Mathematical Sciences under the chairmanship of Gail S. Young of Tulane University.

COSRMS has its headquarters at Columbia University where it is holding its first meeting on October 8-9, 1965. It is hoped that the major portion of the work of the Committee will be completed within 12 months, though an additional 6 months may be required to prepare the publication of the results. COSRMS will not enter into the important problems of curriculum reforms on the secondary and elementary school level, except insofar as these matters affect the teaching assignments of the colleges or the general research picture.

Clearly the value and success of COSRMS will depend on the full support of the entire mathematical community. Every effort will be made that the final report of the Committee represent, as far as possible, the common opinions of the whole mathematical community and also reflect the opinions of the scientific users of
mathematics. The Committee earnestly solicits the ideas, suggestions, and opinions of all of these. Communications to the Committee may be sent to its Executive Director, Truman Botts, at the Department of Mathematics, Columbia University, New York, New York 10027.

NEWS ITEMS AND ANNOUNCEMENTS

FELLOWSHIP AND RESEARCH OPPORTUNITIES IN MATHEMATICS

The Division of Mathematics, National Academy of Sciences--National Research Council, calls attention to a variety of fellowship and other support for basic research in mathematics at both the predoctoral and postdoctoral levels to be awarded during the year 1965-1966. Copies of the complete announcement are available from the Division of Mathematics, National Academy of Sciences--National Research Council, 2101 Constitution Avenue, N. W., Washington, D. C. 20418.

CORNELL UNIVERSITY ESTABLISHES NEW DEPARTMENT OF COMPUTER SCIENCE

On July 1, 1965, Cornell University established an intercollege Department of Computer Science in the Colleges of Engineering and Arts and Sciences. To aid the creation of this department and further its growth the Alfred P. Sloan Foundation has awarded Cornell University a grant of one million dollars.

The new department already has a faculty of seven, Professors R. W. Conway, J. Hartmanis (Chairman) and R. J. Walker, Associate Professors P. C. Fischer and G. Salton, Assistant Professors C. Pottle and S. Saltzman. In addition to the staff of the Department the graduate field of computer science at Cornell University includes Professors H. D. Block (Mechanics), C. F. Hockett (Linguistics), W. L. Maxwell (Operations Research), A. Nerode and L. E. Payne (Mathematics), and S. Searle (Statistics). The fields of study and research now represented include programming languages and systems, numerical analysis, data processing and information retrieval, and automata theory and theory of computation.

The Department of Computer Science is authorized to grant the Ph.D. and M.S. degrees in Computer Science.

Further information can be obtained by writing to Professor J. Hartmanis, Department of Computer Science, Upson Hall, Cornell University, Ithaca, New York.

PACIFIC JOURNAL OF MATHEMATICS INCREASES PUBLICATION RATE

The Pacific Journal of Mathematics will appear monthly starting with Issue 1, Volume 16, January 1966. The issues will be printed in four volumes per year, at a subscription price of $8.00 per volume or $32.00 per year, with a discount of 50% to individual faculty members of supporting institutions and to individual members of the American Mathematical Society. In order to help meet the financial demands of the increased publication rate, the Journal has instituted contributory publication charges of $20.00 per page beginning with the 1965 volume.
NEW AMS PUBLICATIONS

MEMOIRS

Number 58
A HANKEL CONVOLUTION COMPLEX INVERSION THEORY
By Frank M. Cholewinski

68 pages. List Price: $1.40; Member Price: $1.05.

In this Memoir a complex inversion theory associated with the Hankel Convolution of Delsarte is developed for a suitably restricted class of kernels. A theory concerning the Hankel convolution of decreasing functions is developed and is exploited to determine the properties of a class of auxiliary kernels. Corresponding to the complex inversion operator, a representation theory is developed. This study parallels to a large extent the complex inversion theory of Hirschman and Widder for the ordinary convolution on the real line.

Number 59
SPECIAL TRIGONOMETRIC SERIES IN k-DIMENSIONS
By Stephen Wainger

104 pages. List Price: $1.60; Member Price: $1.20.

The author studies the behaviour of certain special classes of multiple trigonometric series and integrals. The series examined are analogous to well studied one dimensional trigonometric series. Applications to various points in the theory of multiple Fourier Series are given.

NORBERT WIENER MEMORIAL

Approximately 136 pages. Prepublication Price before December 23, 1965, List Price: $3.10; Member Price: $2.33. After that date at least $3.40 List Price; $2.55 Member Price.

A special issue of the BULLETIN, appearing as Part II for January, 1966 (Volume 72, No. 1), will be "dedicated to the memory of Norbert Wiener in recognition of his towering stature in American and World mathematics, his remarkably many-sided genius, and the originality and depth of pioneering contributions to science."


This special issue of the BULLETIN will be distributed to all subscribers as part of the 1966 volume. However, those desiring a cloth bound library edition of the Memorial can obtain one at the prices listed above.
VISITING FOREIGN MATHEMATICIANS

The following list contains the names of foreign mathematicians who are visiting at various institutions in the United States this year. The list is compiled from responses received on or before October 8, to requests sent out by the Society to academic institutions.

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<td>University of California, Los Angeles</td>
<td>Algebra</td>
<td>7/65-6/66</td>
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<td>Meyer, W. T. (Germany)</td>
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<td>2/66-5/66</td>
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<td>Morimoto, Akihiko (Japan)</td>
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<td>9/65-6/66</td>
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<td>Mukhoti, S. (India)</td>
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<td>Nagabhushanam, Kandula (India)</td>
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<td>9/65-8/66</td>
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<td>Nakai, M. (Japan)</td>
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<td>7/65-12/65</td>
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<td>Nardi, Vittorio (Italy)</td>
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<td>10/65-6/67</td>
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<td>Negrepontis, Stelios (Greece)</td>
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<td>Topology</td>
<td>1965-1966</td>
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<td>Nisbet, Andrew (Scotland)</td>
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<td>Mathematics and Physics</td>
<td>9/65-6/66</td>
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<td>Oberschelp, Arnold (Western Germany)</td>
<td>University of California, Berkeley</td>
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<td>Oberst, U. H. G. (Germany)</td>
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<td>Ozawa, Mitsuru (Japan)</td>
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<td>Functional Analysis, Singular Integral Equations</td>
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<td>Reilly, N. R. (Scotland)</td>
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<td>1965-1966</td>
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<td>Plasma Physics</td>
<td>9/65-8/66</td>
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<td>Name and Home Country</td>
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<td>1964</td>
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<td>Zisman, Michel (France)</td>
<td>Johns Hopkins University</td>
<td>Algebraic Topology</td>
<td>9/65-6/66</td>
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PERSONAL ITEMS

Professor N. L. ALLING of Purdue University has been appointed to an associate professorship at the University of Rochester.

Dr. G. D. ANDERSON of Eastern Michigan University has been appointed to an assistant professorship at Michigan State University.

Dr. LUCIO ARTIAGA of Assumption University has been appointed to an assistant professorship at Dalhousie University, Halifax, Nova Scotia, Canada.

Dr. S. M. BERMAN of Columbia University has been appointed to an associate professorship at New York University.

Dr. SIDNEY BIRNBAUM of The Martin Company, Denver, Colorado has been appointed to an associate professorship at the University of South Carolina.

Dr. N. J. BLOCH of the University of Rochester has been appointed to an assistant professorship at Wayne State University.

Professor VOLODYMYR BOHUN-CHUDYNIV of Morgan State College has been appointed to a professorship at Seton Hall University.

Professor W. E. BONNICE of the University of New Hampshire has been appointed to a visiting assistant professorship at Michigan State University.

Professor TRUMAN BOTTS of the University of Virginia is on a year's leave of absence to serve as Executive Director of the National Academy of Science's Committee on Support of Research in the Mathematical Sciences (COSRMS) with headquarters at Columbia University.

Professor W. G. BRADY of the Washington and Jefferson College has been appointed to a professorship at the University of Bridgeport.

Dr. POU-SHUN CHIANG of Kalamazoo, Michigan has been appointed to an assistant professorship at Western Michigan University.

Dr. R. A. CHRISTIANSEN of the University of Iowa has been appointed to an assistant professorship at the University of Victoria.

Professor L. A. COBURN of New York University has been appointed to an assistant professorship at Purdue University.

Dr. PETER COLWELL of the University of Minnesota has been appointed to an assistant professorship at Iowa State University.

Dr. C. H. COOK of the University of Oklahoma has been appointed to an assistant professorship at the University of Maryland.

Dr. H. S. DAVIS of the University of Illinois has been appointed to an assistant professorship at Michigan State University.

Dr. J. R. DAVIS of the University of California, Berkeley has been appointed to an assistant professorship at the University of New Mexico.

Professor M. D. DAVIS of Yeshiva University has been appointed to a professorship at New York University.

Professor J. T. DAY of Michigan State University will be on leave at the U. S. Army Research Center at the University of Wisconsin.

Dr. J. D. DEPREE of Oregon State University has been appointed to an associate professorship at Virginia Polytechnic Institute.

Dr. P. H. DOYLE of the Virginia Polytechnic Institute has been appointed to a professorship at Michigan State University.

Mr. R. G. DUDLEY of Carnegie Institute of Technology has accepted a position as an Operations Research Analyst with General Mills Incorporated, Minneapolis, Minnesota.

Dr. J. A. DYER of the Southern Methodist University has been appointed to an assistant professorship at Iowa State University.

Dr. F. J. FLAHERTY of San Francisco State College has been appointed to an assistant professorship at the University of Southern California.

Mr. R. D. FRAY of Duke University has been appointed to an assistant professorship at Florida State University.

Dr. A. R. FREEDMAN of Oregon State University has been appointed to an assistant professorship at Simon Fraser Uni-
versity.

Dr. M. B. FREEMAN of the University of California, Berkeley has been appointed a Lecturer at Brandeis University.

Mrs. MARCELLE FRIEDMAN of New York University has been appointed to an assistant professorship at Seton Hall University.

Dr. C. C. GANSER of the University of Wisconsin has been appointed to an assistant professorship at Michigan State University.

Dr. CLINTON GASS of DePauw University is on a leave of absence to serve as Associate Program Director, Summer Study Program, with the National Science Foundation.

Professor D. L. GEORGE of Charlotte College has been appointed to an associate professorship at Trinity University.

Dr. C. F. GODINO of Columbia University has been appointed to an assistant professorship at Brooklyn College.

Dr. W. J. GORMAN of Purdue University has been appointed to an assistant professorship at Iowa State University.

Dr. R. J. GRIEGO of the University of Illinois has been appointed to an assistant professorship at the University of California, Riverside.

Professor BRANKO GRUNBAUM of the Hebrew University, Jerusalem, Israel has been appointed to a visiting professorship at Michigan State University.

Dr. THEODORE GUINN of the Douglas Aircraft Corporation, Santa Monica, California has been appointed to an assistant professorship at Michigan State University.

Dr. T. G. HALLAM of the University of Missouri has been appointed to an assistant professorship at Florida State University.

Dr. F. C. HOPPENSTEADT of the University of Wisconsin has been appointed to an assistant professorship at Michigan State University.

Professor CHEN-JUNG HSU of Taiwan University, Taipei, Formosa has been appointed to a professorship at the Kansas State University.

Dr. E. C. INGRAHAM of the University of Oregon has been appointed to an assistant professorship at Michigan State University.

Dr. J. M. IRWIN of New Mexico State University has been appointed to a professorship at Wayne State University.

Professor R. E. JOHNSON of the University of Rochester has been appointed to a professorship at the University of Montana.

Dr. J. R. KINNEY of the Lincoln Laboratory of the Massachusetts Institute of Technology has been appointed to a professorship at Michigan State University.

Dr. B. O. KOOPMAN of Columbia University has returned after a leave of absence of almost 2 years at the Institute for Defense Analyses.

Dr. C. F. KOSSACK of the Graduate Research Center of the Southwest has been appointed Professor of Statistics and Head of the Department of Statistics at the University of Georgia.

Dr. K. W. KWUN of Florida State University has been appointed to an associate professorship at Michigan State University.

Dr. P. A. LAPPAN of Lehigh University has been appointed to an associate professorship at Michigan State University.

Dr. W. J. LEAHEY of the University of Illinois has been appointed to an assistant professorship at the University of Hawaii.

Professor K. O. LELAND of Ohio State University has been appointed to an assistant professorship at the University of Virginia.

Dr. HILBERT LEVITZ of Williams College has been appointed to an assistant professorship at New York University.

Dr. BERTRAND LEVY of the Office of Naval Research, Washington, D.C. has been appointed to an associate professorship at New York University.

Dr. M. M. LIPSCHUTZ of Fairleigh Dickinson University has been appointed to a professorship at the University of Bridgeport.

Mr. R. L. LUDWIG of the University of California at Los Angeles has accepted a position as Senior Research Engineer with Autonetics, a division of North American Aviation, Inc., Anaheim, California.

Mr. V. J. MANCUSO of Rutgers, The State University has been appointed to an assistant professorship at St. John's University.

Professor C. C. MANERI of Syracuse University has been appointed to an associate professorship at Ohio State University and Miami University, Ohio.

Dr. E. A. MARES of the University of
Pennsylvania has accepted a position as Senior Research Mathematician with HRB-Singer Incorporated, State College, Pennsylvania.

Dr. J. J. MASTERTON of Purdue University has been appointed to an assistant professorship at Michigan State University.

Dr. H. Y. MOCHIZUKI of the University of California, Berkeley has been appointed to an assistant professorship at the University of California, Santa Barbara.

Dr. RALPH NIEMANN of Colorado State University has been appointed to a visiting professorship at New York University.

Dr. B. V. O'NEILL, JR. of Brown University has been appointed to an assistant professorship at New York University.

Dr. K. L. PHILLIPS of the University of Wisconsin has been appointed to an assistant professorship at the California Institute of Technology.

Professor WILLIAM PRAGER of Brown University has been appointed to a professorship at the University of California, San Diego.

Professor JAMES RADLOW of Purdue University has been appointed to a professorship at the University of New Hampshire.

Professor ANTHONY RALSTON of Stevens Institute of Technology has been appointed to Professor of Mathematics and Director of the Computing Center at the State University of New York, Buffalo.

Professor A. A. RAMSAY of Brandeis University has been appointed to an assistant professorship at the University of Rochester.

Professor J. R. REAY of the Western Washington State College has been appointed to a visiting assistant professorship at Michigan State University.

Dr. W. A. ROSEKRANTZ of Dartmouth College has been appointed to an assistant professorship at New York University.

Mr. F. K. RUMFORD of the University of Colorado has been appointed to an assistant professorship at the Colorado State College.

Dr. J. W. SALTER of the University of Pittsburgh has been appointed to an assistant professorship at The College of Steubenville.

Dr. R. I. Sandler of the Institute for Defense Analyses has been appointed to an associate professorship at the University of Illinois, Chicago Circle.

Professor M. B. SMITH, JR. of the University of Utah has been appointed Professor and Vice Chancellor of the University Center System at the University of Wisconsin.

Professor A. P. STOKES of the Catholic University of America has been appointed to a professorship at Georgetown University.

Mrs. PHYLLIS STRAUSS of Columbia University has been appointed to an assistant professorship at New York University.

Dr. J. D. TARWATER of the University of New Mexico has been appointed to an assistant professorship at Western Michigan University.

Dr. D. H. TRAHAN of the University of Pittsburgh has been appointed to an assistant professorship at New York University.

Professor P. M. WEICHSEL of the University of Illinois is spending the year 1965-1966 at the Institute for Advanced Studies, Australian National University, Canberra, Australia.

Dr. W. W. WHITMAN of Cornell University has been appointed to an assistant professorship at the University of California, Berkeley.

Dr. N. M. WIGLEY of the Los Alamos Scientific Laboratory, Los Alamos, New Mexico has been appointed to an assistant professorship at the University of Arizona.

Dr. F. D. WILLIAMS of the University of Wisconsin has been appointed to an assistant professorship at New Mexico State University.

Dr. D. L. WINTER of the University of Chicago has been appointed to an assistant professorship at Michigan State University.

Dr. S. W. YOUNG of the University of Texas has been appointed to an assistant professorship at the University of Utah.

The following promotions are announced:

J. E. ADNEY, Michigan State University, to a professorship.

JACK BAZER, New York University, to a professorship.

JEROME BERKOWITZ, New York University, to a professorship.
ALBERT BLANK, New York University, to a professorship.
ROBERT FROYD, California State College at Long Beach, to an associate professorship.
E. D. GAUGHAN, New Mexico State University, to an associate professorship.
MALCOLM GOLDMAN, New York University, to an associate professorship.
R. J. GREGORAC, Iowa State University, to an assistant professorship.
F. C. KARAL, New York University, to an associate professorship.
D. R. LICK, Western Michigan University, to an associate professorship.
G. W. LOGEMANN, New York University, to an assistant professorship.
J. C. MATHEWS, Iowa State University, to an associate professorship.
C. B. MILLHAM, Iowa State University, to an assistant professorship.
J. A. PETERSON, University of Montana, to an associate professorship.
JOHN PETRO, Western Michigan University, to an associate professorship.
MARTIN SCHECHTER, New York University, to a professorship.
J. K. SHAHIN, Lehigh University, to an assistant professorship.
W. T. SLEDD, Michigan State University, to an associate professorship.
A. H. SMITH, California State College at Long Beach, to a professorship.
J. G. STAMPFLI, New York University, to an associate professorship.
M. L. TOMBER, Michigan State University, to a professorship.
JOHN VOLLMER, Western Michigan University, to an associate professorship.
C. E. WATTS, University of Rochester, to an associate professorship.
TI YEN, Michigan State University, to a professorship.

The following appointments to instructorships are announced:


Deaths:

Professor Emeritus CLARIBEL KENDALL of the University of Colorado died on April 17, 1965 at the age of 76. She was a member of the Society for 45 years.

NEWS ITEMS AND ANNOUNCEMENTS

BENJAMIN PEIRCE INSTRUCTORSHIPS

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SUPPLEMENTARY PROGRAM—Number 35

During the interval from September 4, 1965 through September 21, 1965 the papers listed below were accepted by the American Mathematical Society for presentation by title. After each title on this program there is an identifying number. The abstracts of the papers will be found following the same number in the section on Abstracts of Contributed Papers in this issue of these Notices. One abstract presented by title may be accepted per person per issue of the Notices. Joint authors are treated as a separate category; thus in addition to abstracts from two authors individually one joint abstract by them may be accepted for a particular issue.

(1) Representation of simply ordered sets and the generalized continuum hypothesis, II
Professor Alexander Abian and Mr. D. L. Deever, The Ohio State University (65T-456)

(2) An interior regularity theorem for three-dimensional minimal surfaces in \( \mathbb{R}^4 \) and an extension of Bernstein's theorem to nonparametric four-dimensional minimal surfaces in \( \mathbb{R}^5 \)
Mr. F. J. Almgren, Jr., Institute for Advanced Study (65T-461)

(3) Potential theory in \( \mathbb{R}^+ \) defined by a measure
Mr. G. A. Brosamler, University of Illinois (65T-463)

(4) A new integralgeometric formula
Mr. J. E. Brothers, Warrenton, Virginia (65T-462)

(5) Galois theory for separable algebras. Preliminary report (65T-464)
Mr. L. N. Childs, Cornell University (65T-464)
(Introduced by Professor Alex Rosenberg)

(6) Distinctness and strong distinctness of certain semigroups of operators. Preliminary report
Mr. R. P. Dickinson, Jr., Lawrence Radiation Laboratory, Livermore, California (65T-477)
(Introduced by Professor Takayuki Tamura)

(7) Decidability of the weak second-order theory of two successors
Mr. J. E. Doner, University of California, Berkeley (65T-468)

(8) On the basis and chromatic number of a graph
Dr. C. J. Everett, Los Alamos Scientific Laboratory, Los Alamos, New Mexico (65T-453)

(9) The co-simple isols
Professor Louise Hay, Mount Holyoke College (65T-473)

(10) Semirecursive sets. Preliminary report
Mr. C. G. Jockusch, Jr., Massachusetts Institute of Technology (65T-457)
(Introduced by Professor Hartley Rogers)

(11) The number of permutation polynomials (mod m)
Professor G. E. Keller, University of Minnesota and Professor F. R. Olson, SUNY at Buffalo (65T-471)

(12) On representing relation algebras in groups
Mr. Ralph McKenzie, University of Colorado (65T-472)

(13) Weak composition of relations and functions. Preliminary report
Professor G. J. Minty, Indiana University (65T-467)

(14) A persistent local maximum of the pth power deviation of an interval, \( p < 1 \)
Professor T. S. Motzkin, University of California, Los Angeles and Professor J. L. Walsh, Harvard University (65T-451)

(15) Semi-Hausdorff spaces
Professor M. G. Murdeshwar, University of Alberta, Canada (65T-476)

(16) New results on generalized arithmetic functions
Mr. A. A. Mullin, University of California, Livermore (65T-458)

(17) Quasi-analyticity of trajectories of semi-groups of bounded linear transformations
(18) The differential ideal generated by $y^2 z$
Mr. M. E. Newton, University of Santa Clara (65T-470)

(19) On diagonal congruences modulo a prime power. Preliminary report
Mr. K. K. Norton, University of Illinois (65T-474)

(20) Lower bounds for solutions of parabolic inequalities. Preliminary report
Professor Hajimu Ogawa, University of California, Riverside (65T-475)

(21) On topologies in locally compact groups
Professor M. Rajagopalan, University of Illinois (65T-452)

(22) The product of an interval and a torus admits an expansive homeomorphism
Dr. W. L. Reddy, Ft. Huachuca, Arizona (65T-465)

(23) II. On some problems of Erdős and

Hajnal
Mr. J. H. Silver, University of California, Berkeley (65T-459)

(24) Generalized finite automata
Mr. J. W. Thatcher and Mr. J. B. Wright, IBM Watson Research Center, Yorktown Heights, New York (65T-469)

(25) The idempotent separating congruences of a bisimple inverse semigroup with identity
Professor R. J. Warne, West Virginia University (65T-455)

(26) On finite metric sets III. The minimal point
Professor Dorothy Wolfe, Pennsylvania Military College (65T-460)

(27) Differences, convolutions, primes. I
Mr. Benjamin Volk, Yeshiva University (65T-466)
627-1. J. H. WELLS and C. N. KELLOGG, University of Kentucky, Lexington, Kentucky. Weak*-density and bounded approximation.

Let \((X, m)\) be a finite measure space. If \(A\) is a conjugate-closed subalgebra of \(L^\infty(dm)\) and \(1 \leq p < \infty\), the following are equivalent: (i) \(A\) is dense in \(L^p(dm)\), (ii) \(A\) is weak*-dense in \(L^\infty(dm)\). This result for \(p = 2\) is due to Srinivisan and Hasumi (Doubly invariant subspace. II, Pacific J. Math. 14 (1964), 525-535) by means of invariant subspace arguments. Our approach is free of invariant subspace theory, and in the course of the proof we establish that (ii) implies that every function in \(L^\infty(dm)\) is the pointwise limit of a uniformly bounded sequence from \(A\). (Received May 14, 1965.)


Let \(D\) be an integral domain with identity and let \(S\) be the set of maximal ideals of \(D\). We say \(D\) has property (\#) if for \(S_1\) and \(S_2\) distinct subsets of \(S\) we have \(\bigcap_{M \in S_1} D_M \neq \bigcap_{M \in S_2} D_M\).

Theorem 1. If \(D\) is a domain with the QR-property (Abstract 63T-106, these Notices 10 (1963), 203), \(D\) has property (\#) if and only if each maximal ideal is the radical of a principal ideal. Theorem 2. If \(D\) is a one-dimensional Prüfer domain, the following statements are equivalent: (a) \(D\) has property (\#), (b) each maximal ideal of \(D\) is the radical of a finitely generated ideal, (c) each nonunit of \(D\) belongs to only finitely many maximal ideals. Corollary 1. An almost Dedekind domain (Abstract 63T-26, these Notices 10 (1963), 130) having property (\#) is Dedekind. (Received June 23, 1965.)

627-3. WITHDRAWN

627-4. J. B. FUGATE, University of Kentucky, Lexington, Kentucky. A sufficient condition that a compact metric continuum be chainable.

The following theorems extend some results of R. H. Bing [Snake-like continua, Duke Math. J.
Suppose M is an a-triadic hereditarily unicoherent compact metric continuum such that each indecomposable subcontinuum of M is chainable. Then M is chainable. **Corollary.** If M is an a-triadic hereditarily unicoherent compact metric continuum and M is the union of countably many chainable continua, then M is chainable. (Received July 27, 1965.)

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**Lemma.** Let \( M^n \) be a compact manifold such that \( M^n \) and \( \hat{M}^n \) are combinatorial, let \( \hat{P}^k \) be a polyhedron, and let \( f: \hat{P}^k \times [0,1] \rightarrow \hat{M}^n \) be a locally tame embedding; suppose that \( \hat{M}^n \) is \((k+1)\)-connected and that \( n \geq 2k + 4 \); then there exists an extension \( F: P^k \times [0,1] \rightarrow M^n \) of \( f \) such that \( F|_{\hat{P}^k \times (0,1)} \) is a locally tame embedding of \( \hat{P}^k \times (0,1) \) into \( \hat{M}^n \); any two such extensions of \( f \) are ambient isotopic leaving \( \hat{M}^n \) fixed. **Conjecture.** \( \beta(n,m_1, m_2, k) \).

Theorem. (1) \( \beta(n,m_1, m_2, k) \) is true if \( m_1 \leq (1/2)n - 1 \); (2) \( \beta(n,m_1, m_2, k) \) is true if \( k \leq 4 \), \( k \leq (2/3)m_1 - 5/3 \), \( k \leq (1/2)n - 1 \), \( m_1 \leq (2/3)n - 1 \), and \( m_2 \leq m_1 \); (3) \( \beta(n,m_1, m_2, k) \) is equivalent to \( \beta(n, m_1, m_2, -1) \) if \( m_1 \leq m_2 \), \( k \leq (1/2)m_1 - 1 \), and \( k \leq (1/2) - n \); in particular, \( \beta(n,n,n,k) \) is equivalent to the annulus conjecture in dimension \( n \) if \( k \leq (1/2)n - 2 \). The proof of the lemma uses engulfing and a modification of the techniques used in [Gluck, Embeddings in the trivial range, Ann. of Math. Vol. 81, No. 2]. (1) follows immediately from the lemma. To establish (2) and (3), the lemma is used to prove, modulo certain unknotting conjectures in dimensions \( m_1 - 1 \) and \( m_2 - 1 \), that \( \beta(n,m_1, m_2, k) \) is equivalent to \( \beta(n,m_1, m_2, -1) \) if \( k \leq (1/2)n - 2 \). (Received August 12, 1965.)

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**The lexicographic product of graphs.**

If \( X \) and \( Y \) are from appropriate classes of graphs Sabidussi [Duke Math. J. 28 (1961), 573-578] has given necessary and sufficient conditions for \( G(X \circ Y) = G(X) \circ G(Y) \) where "\( \circ \)" denotes the lexicographic product on graphs and the wreath product on groups. We complete this problem by proving the **Theorem.** For graphs \( X \) and \( Y \), \( G(X \circ Y) = G(X) \circ G(Y) \) if and only if (1) \( Y \) is connected if \( R \neq \Delta \) (2) \( Y' \) is connected if \( S \neq \Delta \) (3) \( Y \) has a set of vertex disjoint section graphs \( \{Y_a\}_{a \in \Omega} \) such that \( Y_a \approx Y \) for all \( a \in \Omega - \{1\} \), \( 1 \in \Omega \), \( V(Y) = \bigcup_{a \in \Omega} V(Y_a) \), and for \( a, \beta \in \Omega \), either all or none of the possible edges between \( Y_a \) and \( Y_\beta \) exist in \( Y \), then \( X \) does not contain a section graph \( T \) on \( V(T) \) such that \( (y_a, x_\beta) \in E(T) \) if and only if \( (y_a, x_\beta) \in E(Y) \) for some \( y_a \in V(Y_a) \) and \( x_\beta \in V(Y_\beta) \).

(Received August 9, 1965.)

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**Prime mappings.**

Suppose \( 0 < a_1 < a_2 < \ldots < a_{2n} < 1 \) (\( n \geq 1 \)) and that \( W \) is a decomposition of \( A_n = \{a_1, \ldots, a_{2n}\} \) into two element sets. Let \( f: [0,1] \rightarrow \mathbb{R}^2 \) be a map such that (1) \( f(t) = f(t') \) for \( t < t' \) if and only if \( [t,t'] \in W \) (2) \( \text{Im} f = \sum_{i=1}^m B_i C_i \) where (a) each \( B_i C_i \) is a straight line interval, and (b)
f(A_n) \subset E^2 - \{B_1, \ldots, B_m, C_1, \ldots, C_m\}$, and (3) $f(t) \to f(0)$ as $t \to 1$. $W$ is said to determine the double point structure of $f$, and $f$ is said to be prime if given $U, V \subset W$ and $U = W - V$, then there exists $\{a, b\} \subset U$ and $\{c, d\} \subset V$ so that $a < c < b < d$ or $c < a < d < b$. \textbf{Theorem 2.} Given $A_n$ and $W$ as above, where $W$ determines the double point structure of the prime mappings $f$ and $g$, then there is a 1 - 1 function $k$ from the set of complementary domains of $\text{Im} f$ onto that of $\text{Im} g$, where $f^{-1}(B_dU) = g^{-1}(B_k(kU))$, for each complementary domain $U$ of $\text{Im} f$. \textbf{Theorem 3.} Given $A_n, W, f, g,$ and $k$ as in Theorem 2 and that $U$ and $k(U)$ are both unbounded for some $U$, then there is an onto homeomorphism $h: E^2 \to E^2$ such that $g = hf$. (Received August 16, 1965.)

627-8. J. H. CURTISS, P. O. Box 8052, University of Miami, Coral Gables, Florida 33146. \textit{Solutions of the Dirichlet problem in the plane by approximation with Faber polynomials.}

Two types of explicit approximate solution of the Dirichlet problem are constructed for a region bounded by an analytic Jordan curve. The basic technique consists in approximation with linear combinations of the Faber polynomials. In each of the constructions the coefficients of the linear combination are found by solving a system of linear algebraic equations which are derived from the internal structure of the Faber polynomials. Neither construction is related to ortho-normalization. One of them involves interpolation to the boundary values and has been previously studied by the author from a different point of view (Math. Z. 86 (1964), 75-92). Convergence in the uniform norm is demonstrated in both cases by first proving $L^2$ - norm convergence on the boundary. Essential parts of the convergence proofs depend on certain modification of results due to Ostrowski (Proc. Amer. Math. Soc. 3 (1952), 26-30) concerning the inverse of a matrix with dominant principal diagonal. (Received August 18, 1965.)

627-9. J. W. NEUBERGER, Emory University, Atlanta, Georgia 30322. \textit{An exponential formula for one-parameter semi-groups of nonlinear transformations.}

Denote by $S$ a complete normed linear space and by $T$ a function from $[0, \infty)$ to the set of all continuous transformations from $S$ to $S$. Suppose that (1) $T(x+y) = T(x)T(y)$ if $x, y \geq 0$, (2) $\|T(x)p - T(x)q\| \leq \|p - q\|$ if $x \geq 0$ and $p, q$ are in $S$, (3) if $p$ is in $S$ and $g_p(x) = T(x)p$ for all $x$ in $[0, \infty)$, then $g_p$ is continuous and $\lim_{x \to 0} g_p(x) = p$ and (4) there is a dense subset $D$ of $S$ such that if $p$ is in $D$, then $g_p$ is continuous with domain $[0, \infty)$. If $\delta > 0$, denote $(1/\delta)[T(\delta) - I]$ by $A_\delta$. \textbf{Theorem.} If $p$ is in $S$ and $x \geq 0$, then $\lim_{n \to \infty} \lim_{\delta \to 0+} \sup \|I - (x/n)A_\delta\|^n p - T(x)p\| = 0$. (Received August 18, 1965.)

627-10. CHARLES WELLS, Western Reserve University, Cleveland, Ohio 44106. \textit{Groups of permutation polynomials over finite fields.}

A polynomial $f$ with coefficients in $GF(q)$ is a permutation polynomial if its values $f(\xi)$ for $\xi \in GF(q)$ are all distinct. Several groups of permutation polynomials are found. Let $d = q - 1$. Polynomials of the form $x(g(x^d))^e$, where $g(x^d)$ has no roots in $GF(q)$, are permutation polynomials (shown by Dickson) and form an Abelian group of order $d^e$. If $(c, q - 1) = 1$ then polynomials $x^{c_1}(g(x^d))^e$ (with similar restrictions on $g$) form a noncommutative group $K_d^c$ of order $kd^e$, where $c$ belongs to $k (mod e)$. A necessary and sufficient condition is found for polynomials $x(g(x^d))$ to be permutations;
those that are permutations form a group $K_d$ of order $e!d^e$. The following isomorphisms hold:

$$K_d/K_d \cong S_e \quad \text{(the symmetric group on $e$ elements)} \quad \text{and} \quad K_d^{(c)}/K_d \cong \text{crs}(k).$$

Similar theorems about the group $K_d^{(c)}$ of permutation polynomials of the form $x^{c_1}(g(x^d))$ are also proved. A polynomial $x(g(x^d))^s$ in $K_d$ "belongs" to $t$ if $t$ is the smallest integer such that $(g(x^d))^s = 1$ for all $g$ in GF(q); the number belonging to each $t$ is found. A polynomial $x(g(x^d))^s$ is in $M_s$ if it is in $K_s$ and $s$ is maximal in this respect; the order of $M_s$ is found and in particular the order of $M_1$ is shown to be asymptotic to $(q - 1)!$ (Received August 11, 1965.)


Let $X_m$ denote a set of an infinite cardinality $m$ and let $V(X_m)$ be the class of all finitely additive 0-1 measures defined for all subsets of $X_m$ vanishing on points and nonvanishing identically. Consider two statements on infinite cardinals $m$ and $n$: 1. $S(m, n) = \text{"there exists a class of sequences } A_1^g, A_2^g, \ldots; g \in \mathbb{Z}, \text{ of subsets of } X_m \text{ such that } \text{card } \mathbb{Z} \leq m \text{ and for every } \mu \in V(X_m) \text{ the equality }

\mu(\bigcup\{A_k^g; k = 1, 2, \ldots\}) = \sup\{\mu(A_k^g); k = 1, 2, \ldots\} \text{ fails for at least one } g \in \mathbb{Z}^n\};

2. $S(L)(m, n) = \text{"there exists a class } R \text{ of subsets of } X_m \text{ such that card } R \leq m \text{ and for every } \mu \in V(X_m) \text{ the equality }

\mu(\bigcup R) = \sup\{\mu(A); A \in R\} \text{ fails for at least countable class } R \subset R."$

Theorems. (1) The statement "N-defect of $X_m" (see S. Mrowka, Abstract 625-159, these Notices, 12 (1965), 592) is equivalent to $S(m, n)$. (2) $S(m, n)$ implies $S(L)(m, n)$, and, if $n$ satisfies $n^{K_0} = n$, then $S(L)(m, n)$ implies $S(m, n)$. (3) Let $M$ be the class of all infinite cardinals $m$ satisfying $S(m, m)$. $M$ contains "almost all" nonmeasurable cardinals; the hypothesis that $M$ contains all nonmeasurable cardinals is consistent with the usual axioms of set-theory. (4) $S(m, K_0)$ does not hold for any $m > K_0$. (5) The continuum hypothesis implies $S(L)(2^{K_0}, K_0)$. (Received September 7, 1965.)


A semigroup $S$ is said to be uniquely divisible if for each $x \in S$ and each positive integer $n$, there exists an unique $y \in S$ such that $y^n = x$. Let $R$ denote the set of all positive rational numbers. Then for $x \in S$ and $r \in R$, we define $x^r = y^m$, where $r = m/n$ and $m$ and $n$ are positive integers such that $y^n = x$. Define $[x] = \{x^r; r \in R\}^*$ (closure in $S$). An $U$-semigroup is a semigroup which is isomorphic to $[0,1]$ under usual real multiplication. We use $E(S)$ to denote the set of idempotents of $S$. In the theorems that follow, $S$ denotes a compact, first countable semigroup in which each subgroup is totally disconnected. Theorem 1. If $S$ is uniquely divisible, then for each $x \in S \setminus E(S)$, $[x]$ is an $U$-semigroup. Theorem 2. The semigroup $S$ is uniquely divisible if and only if each point of $S \setminus E(S)$ lies on an unique $U$-semigroup in $S$. Theorem 3. Let $S$ be a commutative uniquely divisible semigroup on the two-cell such that $E(S) = \{0,1\}$. Then $S$ is isomorphic to $(I \times 1)/J$, where $I = [0,1]$ is an $U$-semigroup and $J$ is the ideal $\{(x,y): x = 0 \text{ or } y = 0\}$. (Received September 3, 1965.)


The following sequential convergence criterion is a main lemma for the paper: Let $(E, F)$
be a locally convex Hausdorff space and \( E^* \) the space of \( \mathcal{Y} \)-continuous linear functionals on \( E \). A \( w(E,E^*) \)-Cauchy sequence \( \{x_p\} \) in \( E \) if and only if whenever \( \{f_n\} \) is an equicontinuous sequence of elements of \( E^* \) such that \( \lim_{n \to \infty} f_n(x_p) = 0 \) for each \( p \in \omega \) it follows that \( \lim_{n \to \infty} f_n(x_p) = 0 \) uniformly with respect to \( p \in \omega \). With the aid of the above lemma we extend a number of results known for Banach spaces to locally convex spaces. For example, let \( \sum_{i=1}^{\infty} x_i \) denote a series in a locally convex Hausdorff space. Then, (1) \( \sum_{i=1}^{\infty} |f(x_i)| < +\infty \) for each \( f \in E^* \) if and only if \( \{x_p\} \) is a Cauchy sequence for each \( c = \{c_i\} \in (c_0) \). (2) \( \sum_{i=1}^{\infty} x_i \) is subseries Cauchy if and only if the mapping \( L(f) = \{f(x_i)\} \) from \( E^* \) into the space of sequences of scalars maps equicontinuous subsets of \( E^* \) into totally bounded subsets of \( \ell \). (Received September 7, 1965.)

627-14. R. D. McWILLIAMS, Florida State University, Tallahassee, Florida 32306.

On \( w^* \)-sequential convergence and quasi-reflexivity.

If \( X \) is a real Banach space, \( S \) a subspace of \( X^* \), and \( K_X(S) \) the \( w^* \)-sequential closure of \( S \) in \( X^* \), let \( \phi_n(t) = \inf \{\sup_{x \in \omega} ||f||: \{f_i\} \subseteq S, f_i \in w^* f \} \) for \( f \in K_X(S) \). If \( S \subseteq T \subseteq K_X(S) \), let \( C_X(S,T) = \sup_{T \subseteq T \subseteq K_X(S)} \phi_n(t): t \in T, ||t|| \leq 1 \). For each integer \( n \geq 0 \) let \( \mathcal{J}_n(S) \) be the family of all subspaces \( T \) of \( X^* \) such that \( S \subseteq T \subseteq K_X(S) \) and such that \( K_X(S) \) is the algebraic direct sum of \( T \) and a subspace of dimension \( \leq n \). Let \( C_X^{(n)}(S) = \inf \{C_X(S,T): T \in \mathcal{J}_n(S)\} \), and let \( Q^{(n)}(X) = \sup \{C_X^{(n)}(S): S \text{ a subspace of } X^*\} \). The space \( X \) has property \( P_n \) if and only if \( S \in \mathcal{J}_n(S) \) for every norm-closed subspace \( S \) of \( X^* \). Theorems. If \( X \) has property \( P_n \) then \( Q^{(n)}(X) = 1 \); if \( X \) does not have property \( P_n \) then \( Q^{(n)}(X) = \infty \). If \( X \) is quasi-reflexive of order \( \leq n \), then \( X \) has property \( P_n \). If \( X \) is separable and has property \( P_n \), then \( X \) is quasi-reflexive of order \( \leq n \). A space \( X \) is quasi-reflexive of order \( \leq n \) if and only if every norm-closed separable subspace \( Y \) of \( X \) has the property \( P_n \). A space \( X \) has property \( P_0 \) if and only if \( w \)-sequential convergence and \( w^* \)-sequential convergence coincide in \( X^* \). The above characterization of quasi-reflexivity depends upon a result of Singer [Math. Ann. 154 (1964), 77-87]. (Received September 9, 1965.)


Let \( k \) be a finite field of \( q \) elements, and let \( k[x] \) denote the polynomial ring over \( k \). A polynomial \( A \in k[x] \) is called even if \( q = 2 \) and \( A \) is divisible by a first degree polynomial. Otherwise, \( A \) is odd. Let \( \operatorname{sgn} A \) denote the leading coefficient of \( A \). If \( \operatorname{sgn} A = 1 \), then \( A \) is primary. The following analog of a well-known theorem of Vinogradov is proved. Theorem. Suppose \( M \in k[x] \) is odd and has degree \( r \), which is larger than some fixed constant depending only on \( q \). If \( a, \beta, \) and \( \gamma \) are any nonzero field elements such that \( a + \beta + \gamma = \operatorname{sgn} A \), then there exist primary irreducibles \( P_1, P_2, \) and \( P_3 \in k[x] \) each of degree \( r \) such that \( \alpha P_1 + \beta P_2 + \gamma P_3 = M \). It is also shown that if \( q \) is sufficiently large, then every polynomial \( M \in k[x] \) can be represented as a sum of three irreducibles of the same degree as that of \( M \). The proof of both results requires the Riemann Hypothesis for function fields proved by A. Weil. (Received September 16, 1965.)
627-16. RALPH TINDELL, Florida State University, Tallahassee, Florida. Some wild imbeddings in codimension two.

Theorem. For every \( n \geq 3 \), the following exist in \( E^n \):
- A wild \((n - 2)\)-sphere which is the union of two flat \((n - 2)\)-cells whose common boundary is a flat \((n - 3)\)-sphere;
- A wild \((n - 2)\)-cell which is the union of two flat \((n - 2)\)-cells intersecting in a flat \((n - 3)\)-cell common to their boundaries;
- A wild \((n - 2)\)-sphere which fails to be locally flat at precisely one point; moreover, it fails to be locally tame at that point;
- A wild \((n - 2)\)-cell which fails to be locally flat at precisely one point; moreover, the point is an interior point and the cell fails to be locally tame there.

The starting point of all the examples is the Fox-Artin mildly wild arc; the proofs use the following easy but interesting lemmas:

Lemma. If a \( k \)-manifold \( M \) in \( E^n \), \( \leq n - 2 \), is locally flat at \( p \in M \), then given any monotone sequence \( V_1 \supset V_2 \supset \ldots \) of closed neighborhoods of \( p \) in \( E^n \) such that \( \bigcap V_i = p \), there is an integer \( N \) for which the image of \( \pi_1(V_i \setminus M) \), obtained by inclusion, is cyclic or trivial.

Lemma. If a \( k \)-manifold \( M \) in \( E^n \), \( \leq n - 2 \), is locally tame at \( p \in M \), then for any \( \epsilon > 0 \), there is a closed neighborhood \( V \) of \( p \) (in \( E^n \)) of diameter less than \( \epsilon \) such that \( \pi_1(V \setminus M) \) is finitely generated.

(Received September 17, 1965.)

627-17. J. R. DORROH, Louisiana State University, Baton Rouge, Louisiana. Contraction semigroups in a function algebra.

Suppose that the collection \( X \) of bounded real valued functions on the set \( S \) is a real Banach algebra with identity under pointwise multiplication and supremum norm. If \( A \) is the infinitesimal generator of a contraction semigroup in \( X \) (that is, a strongly continuous semigroup of contraction operators in \( X \)), and \( p \) is a positive invertible function in \( X \), then \( pA \) is also the infinitesimal generator of a contraction semigroup in \( X \). This result has an extension to complex function algebras.

(Received September 21, 1965.)

627-18. ANDREW LONG, St. Andrews Presbyterian College, Laurinburg, North Carolina 28352.

Some theorems on factorable irreducible polynomials.

An irreducible polynomial \( P(x) \) over \( GF(q) \), \( q = p^n \), is said to belong to the exponent \( e \) if \( e \) is the least positive integer for which \( P \) divides \( x^e - 1 \). The present paper extends this concept to factorable irreducible polynomials in two variables. The development commences with an examination of the Moore determinant \( D^i(x_0x_1x_2) = |x_i^{s^i}| \), \( i = 0, 1, 2 \).

Definition 1. The homogeneous factorable irreducible polynomial \( P(x_0, x_1, x_2) = \prod_{j=0}^{s-1} (x_0 - \alpha_j x_1 - \beta_j x_2) \) belongs to the exponent pair \((e,f)\).

Theorem 1. \( P(x_0, x_1, x_2) \) belongs to the exponent pair \((e,f)\) if and only if \( e \) is the least positive integer such that \( P \) divides \( (x_0^{s^e} - x_1^{s^e} - x_2^{s^e} - 1)x_0 \) and \( f \) is the least positive integer such that \( P \) divides \( (x_0^{s^f} - x_1^{s^f} - x_2^{s^f}) \).

Theorem 2. The number \( N(e,f,q) \) of primary factorable irreducibles belonging to the exponent pair \((e,f)\) is \( \phi(e) \phi(f)/s \), where \( s \) is the least positive integer for which \( e|q^s \) and \( f|q^s - 1 \).

Definition 2. A factorable irreducible polynomial of degree \( s \) over \( GF(q) \) belonging to the exponent pair \((e,f)\) is primitive provided that \( [e,f] = q^s - 1 \).

Theorem 3. The number of primitive factorable irreducibles of degree \( s \) is \( \phi_2(q^s - 1)/s \). (Received September 21, 1965.)
If \((X, \tau)\) is a topological space (with topology \(\tau\)) and \(A\) is a subset of \(X\) then the topology \(\tau(A) = \{U \cup (U \cap A) | U, U' \in \tau\}\) is said to be a simple extension of \(\tau\). It seems that N. Levine [Amer. Math. Monthly 71 (1964), 22-25] first introduced this concept but failed to give necessary and sufficient conditions for \((X, \tau(A))\) to inherit the following topological properties from \((X, \tau)\): regularity, complete regularity, normality, paracompactness, stratifiability and metrizability. We will prove that for \((X, \tau(A))\) to inherit any of the above properties (except regularity) from \((X, \tau)\) it is necessary and sufficient that \((X, \tau(A))\) be a regular space (for normality or paracompactness we must require that \(X - A\) be respectively a normal or paracompact subspace of \((X, \tau)\)). Furthermore we will prove a very simple necessary and sufficient condition for \((X, \tau(A))\) to inherit regularity from \((X, \tau)\). (Received September 27, 1965.)

Let \(s\) denote the countable infinite product of lines. The following theorems are established: Theorem 1. Let \(K\) be a countable union of closed subsets of infinite deficiency in \(s\). Then \(s \setminus K\) is homeomorphic to \(s\). Theorem 2. For each \(i (i = 1, 2, \ldots)\), let \(C_i\) be a closed \(n\text{-cell} (0 < n_i < \infty)\) and let \(Y_i\) be a subset of \(C_i\) which contains the interior of \(C_i\). Then the product of the \(Y_i\)'s is homeomorphic to \(s\) if and only if each \(Y_i\) is a \(G_0\) set and, for infinitely many \(i, Y_i \not\subseteq C_i\). The principal arguments are given in terms of a sequence of theorems dealing with homeomorphisms of the Hilbert cube onto itself. Theorem 1 is a corollary of a somewhat stronger general theorem. For Theorem 2, the property that each \(Y_i\) must be a \(G_0\) set follows from a known result of Sierpinski. (Received September 27, 1965.)

Infinite direct sums of closed primary groups are classified by the metric function \(G \rightarrow m_G\) where \(m_G(x,y) = 1/1 + H(x - y)\) and where \(H(x)\) denotes the height of \(x\) in the group \(G\). (Received September 27, 1965.)

Let \(m\) be any positive real number, let \(I\) be any finite, closed interval of the \(x\)-axis, and let \(h(x,y)\) be a positive function for \(y \geq 0\). A uniqueness theorem for the singular Cauchy problem for the equation \(h(x,y)y^{2m}w_{xx} - w_{yy} + a(x,y)w_x + b(x,y)w_y + c(x,y)w = 0\), with initial conditions \(w(x,0) = w_y(x,0) = 0, x \in I,\) is proved. This is done by a method of successive bounds on an equivalent system of integral equations. (Received September 27, 1965.)
Let $p: T \rightarrow B$ be a fiber map with the polyhedral covering homotopy property. Suppose that each of $T$ and $B$ is metric. For $n \geq 0$, $S^n$ denotes an $n$-sphere and $D^{n+1}$, an $n + 1$-cell with $S^n = BdD^{n+1}$. The map $p$ is $n$-regular provided that for each $e \in T$ and $\epsilon > 0$, there is a $\delta > 0$ such that if $f: S^k \rightarrow p^{-1}(b) \cap N_\delta(e)$ for $b \in B$ and $0 \leq k \leq n$, then there is $F: D^{k+1} \rightarrow p^{-1}(b) \cap N_\epsilon(e)$ such that $F[S^k] = f$. Note that if $p$ is $n$-regular, then each fiber is locally $n$-connected. However, the $b$ in the above is not required to equal $p(e)$. Small homotopies of a space $X$ can be lifted to small homotopies for the map $p$ provided that for each $e \in T$ and $\epsilon > 0$, there is a $\delta > 0$ such that, if $H: X \times I \rightarrow N_\delta(p(e))$ and $g: X \rightarrow N_\epsilon(e)$ with $pg(x) = H(x,0)$ for each $x \in X$, then there is a $G: X \times I \rightarrow N_\epsilon(e)$ such that $pG = H$ and $G(x,0) = g(x)$ for each $x \in X$. The following theorems are proved. The first is used in proving the second. Theorem 1. Suppose that $(T,p,B)$ is as above, $T$ is locally $n$-connected, and $X$ is a polyhedron of dimension $\leq n$. Then small homotopies of $X$ can be lifted to small homotopies for the map $p$. Theorem 2. Suppose that $(T,p,B)$ is as above and that each of $T$ and $B$ is locally $n + 1$-connected. Then $p$ is $n$-regular. (Received September 27, 1965.)

627-24. C. K. MEGIBBEN, University of Houston, Houston, Texas 77004. **Large subgroups and small homomorphisms.**

The study of pairs $G,H$ of primary groups such that all homomorphisms of $G$ into $H$ are small has led to a number of interesting results--an essential uniqueness in certain direct decompositions, the existence of primary groups which are neither transitive nor fully transitive (see Kaplansky's *Infinite abelian groups*) and consequently the existence of unexpected fully invariant subgroups, the existence of a (necessarily uncountable) $p$-group $G$ in which not every automorphism of $p^G$ is induced by an automorphism of $G$, and a simple construction of members of that remarkable class (first discovered by Pierce, "Homomorphisms of primary groups" in *Topics in abelian groups*) of primary groups whose endomorphism rings are generated by $p$-adic integers and the ideal of small endomorphisms. It has also been shown that the structure of a large subgroup determines that of the containing group modulo a bounded direct summand. (Received September 27, 1965.)

627-25. D. E. PENNEY, Louisiana State University in New Orleans, New Orleans, Louisiana 70122. **An algorithm for establishing isomorphism between tame prime knots in $E^3$.**

A knot is a continuous one-to-one function $f: [0,1) \rightarrow E^3$ such that $\lim_{t \rightarrow 1} f(t) = f(0)$. Suppose $f: [0,1) \rightarrow K$ is a knot whose image is polygonal in the usual sense and in general position, $p$ is the projection of $E^3$ onto $E^2$, and $x_1,x_2,...,x_n$ are the points of $[0,1)$ in their natural order mapped two-to-one by $pf$. The formula of $f$ is $(pf(x_1))^{e(1)}(pf(x_2))^{e(2)}... (pf(x_n))^{e(n)}$, with $e(i)$ chosen to be $+1$ for overcrossings, $-1$ for undercrossings of $K$. Certain admissible operations on knot formulas are defined, such as cancellation of $xx^{-1}$ in any formula, and it is shown using recent results of Treybig that if $f$ and $g$ are tame polygonal knots with formulas $F$ and $G$ respectively, $G$ is prime (does not admit a splitting into disjoint sub-formulas), and $G$ can be obtained by applying a finite number of admissible operations to $F$, then the image of $f$ is isomorphic to the image of $g$ in the usual sense. (Received September 27, 1965.)
627-26. R. M. SCHOR!, Louisiana State University, Baton Rouge, Louisiana 70803. The space of $n$ or less points of a manifold.

If $X$ is a metric space and $n \geq 1$, let $X^{(n)}$ equal the space of all subsets of $X$ containing $\leq n$ points with the Hausdorff metric. Theorems. (1) If $X^n$ is the product of $n$ copies of $X$ and $(x_1,\ldots,x_n)$ = $(y_1,\ldots,y_n)$ iff $\{x_1,\ldots,x_n\} = \{y_1,\ldots,y_n\}$, then $X^{(n)} = X^n/\sim$. (2) If $M_n$ is an $n$-manifold with boundary and (a) $n \geq 2$ and $m \geq 3$ or (b) $n = 1$ and $m \geq 4$, then $M_n^{(m)}$ is not locally Euclidean. (3) Let $I$ be the closed unit interval. If $n = 1,2$, or 3, then $I^{(n)} = I^n$. (4) If $S$ is a 1-sphere, then $S^{(2)} = \text{Mobius band}$. (5) If $M$ is a 2-manifold, then $M^{(2)}$ is a 4-manifold. (6) Let $C(X) = \text{cone over } X$ and $P^n = \text{projective } n$-space. If $n \geq 1$, then $(P^n)^{2)} = C(P^{n-1}) \times I^n$. Corollary to theorem 6: (a) If $n = 1$ or 2, then $(P^n)^{2)} = I^{2n}$ and (b) (McCord) if $n > 2$, then $(P^n)^{2)}$ is not locally Euclidean. (Received September 27, 1965.)


It is well known that the choice of the best corrector in the "predictor-corrector" solution of $y' = f(x,y)$ depends on $K = hf_y$, and that the corrector $y_{k+1} = ry_k + (1 - r)y_{k-m} + \sum_{i=k-m}^{k} B_i(r)y_i' \text{ where } 0 \leq r \leq 1$, may be made to fit a given equation by the choice of $r$. A new choice of $r$ can be made at each step of the process so that a favorable balance between step error and propagated error results. At each step, the difference between the predicted value and the last corrected value of $y$ is used to approximate $K$, which in turn is used to compute $r$. The process competes very well with others. (Received September 27, 1965.)


Let $S$ be a topological semigroup and $T$ a nonvoid subset of $S$. For $A \subset S$ let $L(A) = A \cup TA$, $J(A) = A \cup TA \cup AT \cup TAT$, $R(A) = A \cup AT$ and $H(A) = L(A) \cap R(A)$. The set $A \subset S$ is called a left $T$-ideal if $A \neq \emptyset$ and $L(A) \subset A$. Similarly define right $T$-ideal using $R$ and $T$-ideal using $J$. Relativizing the relations of Green, let $\mathcal{L} = \mathcal{L}(T) = \{(x,y) \mid L(x) = L(y)\}$ with $\mathcal{R}$, $\mathcal{J}$ and $\mathcal{H}$ defined analogously. For $a \in S$ let $L_a = L_a(T) = \{x \mid L(a) = L(x)\}$ defining $R_a$, $J_a$ and $H_a$ in a similar way. In this paper our attention is focused on the structure of the complement $A$ (card $A > 1$) of a maximal proper $T$-ideal $J$, particularly in the case when $S$ is compact and $T$ is a closed subsemigroup of $S$ contained in $J$. Some typical results follow. Theorem. For each $a \in A$, $J_a(T) = A \cap J_a(S)$. Now assume that $ST \not\subset J$ and $TS \not\subset J$, and that for each $a \in A$, $aT$ and $Ta$ are subsemigroups, then Theorem. For each idempotent $e \in A$, $H_e(T) = H_e(S) \cap A$. Theorem. For each $a \in A$ either $H_a(T)$ is a subgroup contained in $A$ or (disjunctively) $G_a(a) = \{a^2, a^3, \ldots\} \subset a^2T \cap Ta^2 \subset J$. (Received September 27, 1965.)

627-29. HIDEGORO NAKANO, Wayne State University, Detroit, Michigan 48202. Transformation groups on a group.

Let $G$ be a group with the unit $e$, and let $L_G$ be the left transformation group on $G$ such that $yL_x = xy$ for all $x, y \in G$. A transformation group $\mathcal{G}$ on $G$ is said to be standard if $e\mathcal{G} = e$ for all
X ∈ G and L_G G = G L_G. If G is standard on G, then setting L_X X = (X D_X) L_X X for x ∈ G, X ∈ G we obtain a transformation D_X on G, which is called the deviation of x on G. Then we have D_X D_Y = D_X Y for all x, y ∈ G. A standard transformation group G is said to be simple on G if D_X = D_Y implies x = y. We can prove a dual theorem: If G is simple on G, then the deviation group D_G also is simple on G and for the deviation D_X(X ∈ G) on D_G we have D_X D_X = D_X X for x ∈ G; X ∈ G. (Received September 27, 1965.)

627-30. C. A. GREATHOUSE, Vanderbilt University, Nashville 5, Tennessee. Stable manifolds with boundary.

A homeomorphism f of U onto V, where U and V are open subsets of R^n or H^n (upper closed half space), is stable at x ∈ U if there is a stable homeomorphism of R^n which agrees with f on some neighborhood of x in U. A connected n-manifold (with or without boundary) M^n is stable if there is a collection \{(U_i, h_i)\}_i where \{U_i\}_i is an open cover of M^n and h_i is a homeomorphism from an open subset of R^n or H^n onto U_i, such that h_j^{-1}h_i is stable at each point of h_j^{-1}(U_i ∩ U_j) for i,j ∈ I and U_i ∩ U_j ≠ ∅. Theorem. An annular region (i.e., the closed region in S^n bounded by two disjoint locally flat n - 1 spheres) is an annulus iff it is a stable manifold. Theorem. An annular region crossed with a closed, open, or half-open interval is a stable manifold. Theorem. A connected, simply connected manifold with a connected, simply connected boundary is stable. (Received September 27, 1965.)


If M^n is a manifold with nonempty boundary, let (1) SH(M^n), (2) BSH(M^n), (3) HI(M^n), and (4) BHI(M^n) denote the groups of homeomorphisms f of M^n onto itself such that (1) f is stable, (2) f|Bd(M^n) is stable, (3) f is weakly isotopic to 1, and (4) f|Bd(M^n) is weakly isotopic to 1, respectively. Theorem. BHI(M^n) ⊆ SH(M^n), BHI(B^n) = HI(B^n) = SH(B^n) for the closed n-ball B^n. Theorem. If f ∈ BSH(B^n), then f is isotopic to 1. Theorem. The following four statements are equivalent.

1. If M^n is any stable manifold with connected boundary, then SH(M^n) = BSH(M^n).
2. If M^n is any stable manifold with connected boundary, then HI(Bd(M^n)) ⊆ SH(Bd(M^n)).
3. SH(B^n) = BSH(B^n).
4. HI(S^n-1) = SH(S^n-1). (Received September 27, 1965.)


In Abstract 619-139, these Notices 12 (1965), 98, an organic unification and generalization of all known algebraic structures was afforded by the notion of a generalized algebra, i.e. a structure = (A, F, B) consisting of sets A, F, B where each o ∈ F is a function o : A^m → B for some integer m = |o|. In the present communication, the notions of direct and subdirect product products in generalized algebras is considered and characterized in their various forms. It is proved, for instance, that any generalized algebra is a subdirect product of subdirectly irreducible generalized algebras. It is also illustrated that the present generalization renders decomposable certain universal algebras otherwise indecomposable. (Received September 27, 1965.)
627-33. SHIN'ICHI KINOSHITA, Florida State University, Tallahassee, Florida. On Fox's property of a surface in a 3-manifold.

We may say that an orientable triangulated 3-manifold \( M \) without boundary has Fox's property if for any closed orientable polyhedral surface \( F \) without boundary with positive genus there exists a polyhedral simple closed curve \( c \) on \( F \) such that \( c \) does not bound a disk on \( F \) but bounds a disk in \( M \) in such a way that \( D \cap F = \partial D = c \). Theorem. Any orientable 3-manifold with either a finite fundamental group or a free one has Fox's property. This is a generalization of a theorem of Fox, Ann. of Math. 49 (1948), 462-470. (Received September 27, 1965.)

627-34. A. LELEK, Louisiana State University, Baton Rouge, Louisiana. A class of mappings.

Let \( X \) and \( Y \) be compact metric spaces. A mapping \( g \) of \( X \) onto \( Y \) is said to be confluent (J. J. Charatonik, Fund. Math. 56 (1964), 213) if, for each subcontinuum \( C \) of \( Y \) and for each component \( K \) of \( g^{-1}(C) \), we have \( C = g(K) \). Every quasimonotone mapping (A. D. Wallace, Duke Math. J. 7 (1940), 138) of a locally connected continuum is confluent. On the other hand, every open mapping of a compact metric space is confluent (G. T. Whyburn, Analytic topology, p. 148). Theorem. If \( g \) is a confluent mapping of \( X \) onto \( Y \) and \( f \) is a mapping of \( Y \) into the circumference such that \( fg \) is null-homotopic, then \( f \) is null-homotopic. This theorem generalizes a theorem of S. Eilenberg (Fund. Math. 24 (1935), 165; 174) on monotone, or open, mappings of compacta. The proof will be published in Colloquium Mathematicum. (Received September 27, 1965.)

627-35. W. L. BYNUM, University of North Carolina, Chapel Hill, North Carolina 27515. Linear functions from a set of analytic functions to the numbers. Preliminary report.

Let \( H \) be a function such that if \(- \pi \leq x \leq \pi\), then for each point \( z \) in the unit disc \( U \), \( H(x)(z) = (e^{ix} + z)/(e^{ix} - z) \). Let \( B \) be the set to which \( f \) belongs provided that there is a real-valued function \( \Phi \) of bounded variation on \( [- \pi, \pi] \) such that \( \Phi(- \pi) = 0, \Phi(\pi) - \Phi(- \pi) = \Phi(- \pi +) \), and if \(- \pi < x < \pi\), \( \Phi(x) = 1/2(\Phi(x +) + \Phi(x -)) \), and for each point \( z \) in \( U \), \( f(z) = \int_{-\pi}^{\pi} H(t)(z) d\Phi(t) \). Call \( \Phi \) the integrator function of \( f \). Let \( N \) be a function such that if \( f \) is in \( B \), \( N(f) \) is the total variation on \( [- \pi, \pi] \) of the integrator function of \( f \). \([B, N]\) is a complete, normed, real-linear space. Let \( C \) be the subset of \( B \) to which \( f \) belongs provided that the integrator function of \( f \) is continuous on \( [- \pi, \pi] \) and let \( D \) be the closure with respect to \( N \) of the linear span of \( H([- \pi, \pi]) \). Let \( B^* \) be the set of all real-linear functions from \( B \) to the numbers, continuous with respect to \( N \). Typical theorem. If \( L \) is in \( B^* \), there is only one member \( \{P, Q\} \) of \( B^* \times B^* \) such that the contraction of \( P \) to \( D \) is 0, the contraction of \( Q \) to \( C \) is 0, and \( L = P + Q \). Moreover, if \( f \) is in \( B \) and \( \Phi \) is the integrator function of \( f \), \( Q(f) = 2L[H(\pi)\Phi(- \pi +) + \sum_{-\pi < t < \pi} H(t)(\Phi(t +) - \Phi(t -)) \). (Received September 27, 1965.)


Let \( \{S, Q\} \) be a complete inner product space, in which \( T \) is the space of continuous linear transformations, \( B \) be a set, and \( K \) be a function from \( E \times E \) to \( T \) such that \( \sum_i \tilde{\sum}_j Q(y_j, K(t_1, t_j)y_j) \geq 0 \) for all finite sequences \( \{t_1, y_j\} \) in \( E \times S \). Let \( \{S_K, Q_K\} \) be the complete inner product space of functions 796
from E to S in which K is the kernel \([J. Elisha Mitchell Sci. Soc. 76 (1960), 252-273; Th. 2.5]\), so that 
\[Q_K(f,K \cdot t) \cdot y) = Q(f(t),y) \text{ for all } \{f,t,y\} \text{ in } S_K \times E \times S.\] 
It is not true (even if \(S\) has dimension 2) \([\text{loc. cit., p. 272}]\) that, if \(A\) is in \(T\) and \(f\) is in \(S_K\) and \(g\) is defined on \(E\) by \(g(t) = Af(t)\), then \(g\) is in \(S_K\).

For each \(A\) in \(T\), let \(L_A\) be the (linear) function to which \(\{f,g\}\) belongs only in case \(f\) is in \(S_K\) and \(g\) is the function from \(E\) to \(S\) defined by \(g(t) = Af(t)\). \(\text{Theorem 1.}\) If \(A\) is in \(T\) and \(L_A(S_K)\) is a subset of \(S_K\), then \(L_A\) is a continuous transformation in the space \([S_K,Q_K]\).

\[L_A(S_K) \text{ is a subset of } S_K \text{ only in case } S_H \text{ is a subset of } S_K. \]

(Received September 27, 1965.)

627-37. ROBERT SILBER and ANDREW SOBCZYK, Clemson University, Clemson, South Carolina 29631. Exact and attaining projections. Preliminary report.

Call a bounded linear functional \(f\) on a Banach space \(Z\) attaining in case the support hyperplanes to the unit ball \(C\) of \(Z\) which are parallel to the null-space of \(f\) have points of contact with \(C\). A continuous projection \(P_0\) of \(Z\) onto a closed linear subspace \(M\) is exact if \(\|P\| \geq \|P_0\|\) for all projections \(P\) of \(Z\) onto \(M\); it is attaining if there is a unit vector \(z\) such that \(\|P_0z\| = \|P_0\|\). For any finite dimensional subspace \(M\), there is a projection onto \(M\) which is exact (Grünbaum-Isbell-Sernadeni); any projection through a finite dimensional \(N\) is attaining.

Studies are made of the following possibilities: \(P\) and \(I-P\) simultaneously exact; \(P\) exact for \(M\), and also of minimal bound for projections through its null-space \(N\). In a reflexive space, all bounded linear functionals are attaining; in any space in which all b.l.f.'s are attaining, each projection onto a finite dimensional subspace is attaining. Let \(B(Z,M)\) denote the space of bounded linear transformations on \(Z\) to \(M\). There is an exact projection onto \(M\) iff a flat of projections in \(B(Z,M)\) is parallel to the null-space of an attaining functional. (Received September 28, 1965.)

627-38. ANDREW SOBCZYK, Clemson University, Clemson, South Carolina 29631. The simple dimension of a topological space.

By the \textbf{simple dimension} \(d\) of a space \(S\) is meant the Hamel dimension of a minimal linear space \(D(S)\) of real continuous functions on \(S\) which separates the points of \(S\). Thus in case \(S\) is embeddable in a Euclidean space \(E_n\), \(d\) is the smallest possible \(n\). Quotient spaces for various decompositions of \(S\), including those formed by point-inverses of mappings from \(S\), correspond to subspaces of \(D(S)\). \(\text{Sample theorem.}\) In case \(S\) is a compact Hausdorff space, and if each point \(s \in S\) has a neighborhood \(O_s\) for which there is a finite dimensional separating space \(E(O_s)\), then \(D(S)\) must be finite dimensional. In other words, the space \(S\) cannot be both locally finite dimensional and infinitely dimensional in the large. (Received September 28, 1965.)


A problem of Valentine [\textit{Convex sets}] is solved. \(S \subset E_n(n \geq 2)\) is said to have property \(K_n\) if and only if, given any \(n\)-subset \(\{x_1, x_2, \ldots, x_k+1\}\) of affinely independent points \((2 \leq k \leq n)\), there exists a
unique \( p \in S \) such that each line segment \( px_i \subseteq S \). **Theorem.** A compact set \( S \subseteq \mathbb{R}^n \) has a one point kernel if and only if it has property \( K_n \) \((n \geq 2)\). (See Valentine, *Convex sets*, for definitions and a statement of the problem, especially pages 164 and 177.) (Received September 28, 1965.)

627-40. TREVOR EVANS, Emory University, Atlanta, Georgia 30322. *Finite models of identities.*

Let \( V \) be a variety (equationally defined class) of algebras. The spectrum of \( V \) is the set of orders of the finite algebras in \( V \). The main part of the paper consists of two examples. For any positive integer \( n \), a variety of groupoids is described having the set of all \( n \)th powers as spectrum. For \( n = 2 \), for example, the variety is defined by the identity \( xy \cdot yz = y \). In the second example, a variety of algebras is described whose spectrum is the union of \( \{1\} \) and the set of all multiples of a given positive integer. The paper also contains some elementary remarks on the general problem. The corresponding problem for general first order sentences rather than identities was first proposed by Scholz and a description is given of first order sentences which have the same spectrum as some variety. (Received September 28, 1965.)

627-41. D. B. HINTON, University of Georgia, Athens, Georgia. Disconjugate properties of a system of differential equations.

For a class \( \mathcal{A} \) of ordinary differential operators \( L \) of order \( n \) the following definition is made. If some nontrivial function \( y \) such that \( L(y) = 0 \) has \( n \) zeros, counting multiplicities, on \([a, \omega)\), then \( \eta(a) \) is defined as the greatest number \( b > a \) such that no nontrivial solution \( y \) of \( L(y) = 0 \) has \( n \) zeros, counting multiplicities, on \([a, b)\). **Theorem 1.** The number \( \eta(a) \) is the least number \( b > a \) such that for some \( k \), \( 1 \leq k \leq n - 1 \), there is a nontrivial solution \( y \) of \( L(y) = 0 \) with a zero of multiplicity \( n - k \) at \( a \) and a zero of multiplicity \( k \) at \( b \). **Theorem 2.** The function \( \eta \) is an increasing, continuous function with open domain. **Theorem 3.** If \( b = \eta(a) \), there is a nontrivial solution \( y \) of \( L(y) = 0 \) such that \( y \) has \( n \) zeros, counting multiplicities, on \([a, b)\) and is positive on \((a, b)\). The class \( \mathcal{A} \) contains the classical differential operators of order \( n \). (Received September 28, 1965.)

627-42. MICHAEL FRIEDBERG, Emory University, Atlanta, Georgia 30322. Representations of affine semigroups.

An affine semigroup is a convex subset of a locally convex topological linear space which is a topological semigroup with a doubly continuous separately affine multiplication. If the semigroup \( S \) is compact and its extreme points form a compact group, \( S \) is called group-extremal. By a representation of \( S \) we mean a continuous affine homomorphism of \( S \) into the set of \( n \times n \) matrices over the complexes for some \( n \). An affine semicharacter on \( S \) is a continuous affine homomorphism of \( S \) to the complexes. **Theorem.** A group-extremal affine semigroup \( S \) has sufficiently many representations \( P \) to separate points, and which satisfy \( P^*(s) \subseteq P(S) \) for each \( s \in S \) \((P^*(s) \) is the adjoint of \( P(s))\). **Theorem.** An abelian group-extremal affine semigroup \( S \) has sufficiently many affine semicharacters to separate points. (Received September 24, 1965.)
On the inertia of some classes of partitioned matrices.

The inertia of an Hermitian matrix $H$ is defined as the triplet, $\text{In } H = (\pi, \nu, \delta)$, these three numbers denoting respectively the number of positive, negative, and vanishing roots of $H$. Consider a matrix $A$ partitioned into blocks, $A = (A_{ij})$, $i, j = 1, \ldots, t$. For $t = 2$, assume that $A_{11}$ is nonsingular and form $B_{22} = A_{22} - A_{12} A_{11}^{-1} A_{12}$. Then we have $\text{In } A = \text{In } A_{11} + \text{In } B_{22}$. Assume on the other hand that for $t \geq 2$, $A_{11} = 0$ for $i + j > t + 1$, and for $i + j = t + 1$, the corresponding skew-diagonal blocks are square. $A$ is then an upper skew-triangular block matrix (an STB matrix). $A$ is nonsingular if and only if all skew-diagonal blocks, $A_{i,t-i+1}$, are nonsingular. Assume $t \geq 2$ and $A$ Hermitian. If $t$ is even, and all blocks on the skew-diagonal are nonsingular, then $\text{In } A = (m, m, 0)$, where the order of $A$ is $2m$. If $t$ is odd, $t = 2s + 1$, assume all skew-diagonal blocks nonsingular, except perhaps for the central block, $A_{s+1,s+1}$. Then if $\text{In } A_{s+1,s+1} = (p, q, z)$, we have $\text{In } A = (m + p, m + q, z)$. Several theorems on STB matrices with singular skew-diagonal blocks are also proved. (Received September 23, 1965.)

A "duality" between certain spheres and arcs in $S^3$.

If $\Sigma$ is a 2-sphere, in $S^3$, which is locally flat except possibly at one point $p$, then we associate with $\Sigma$ any arc in $\Sigma$ which has $p$ as an endpoint; conversely, if $a$ is an arc, in $S^3$, which is locally except possibly at one endpoint $p$, then we "blow up" $a$ into a little 2-sphere which tapers down to $p$ just as $a$ does and we associate this sphere with $a$. Theorem 1. These two correspondences induce the same one-to-one correspondence between equivalence classes. A generalized "duality" theorem implies the following result. Theorem 2. Let $a_{1i}^1, i = 1, \ldots, m$, be disjoint arcs in the standard closed 3-ball $B^3$ and let $a_{1j}^2, j = 1, \ldots, m$, be disjoint arcs in $B^3$ such that $a_{1i}^1$ intersects $BdB^3$ at one endpoint and $a_{1j}^2 \cup BdB^3$ is locally flat in $R^3$ except at the other endpoint, $i = 1, \ldots, m$, $j = 1, 2$. For each $j = 1, 2$, let $H_j$ be the decomposition space of $B^3$ whose nondegenerate elements are the arcs $a_{1i}^j, i = 1, \ldots, m$. If $H_1$ is homeomorphic to $H_2$, then, with a suitable ordering of the $a_{1i}^j$s, there is a homeomorphism of $B^3$ onto itself carrying $a_{1i}^1$ onto $a_{1i}^2, i = 1, \ldots, m$. (Received September 23, 1965.)

Generalized radical rings.

Let $R = (R, +, \cdot)$ be an (associative) ring. Let $\circ$ denote the circle composition ($a \circ b = a + b - a \cdot b$) on $R$. It is known that $R$ is a radical ring if and only if $(R, \circ)$ is a group and that $R$ is a strongly regular ring if and only if $(R, \cdot)$ is a union of groups. We call $R$ a generalized radical ring (g.r. ring) if $(R, \circ)$ is a union of groups. Theorem A. If $R$ is strongly regular then $R$ is a g.r. ring. Theorem B. A semisimple g.r. ring is a subdirect sum of division rings. Theorem C. A semiprimary SBI ring is a g.r. ring if and only if there is an idempotent $e$ in $R$ such that $R = eR \oplus J(R)$ (abelian group direct sum) where $eR$ is strongly regular and $J(R)$ is the Jacobson radical of $R$. Theorem C holds for any ring $R$ containing an idempotent $e$ which is an identity for $R$ modulo $J(R)$. (September 23, 1965.)

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627-46. YU-LEE LEE, University of Florida, Gainesville, Florida. Contiuas with the same class of homeomorphisms.

Let \( H(X, \mathcal{V}) \) be the class of all homeomorphisms of \((X, \mathcal{V})\) onto itself. It has been constructed by the author [Coarser topologies with the same class of homeomorphisms, Abstract 64T-502, these Notices 11 (1964), 770 and Finer topologies with the same class of homeomorphisms, Abstract 65T-37, these Notices 12 (1965), 136]. Many different topologies \( \mathcal{V} \) for \( X \) such that \( H(X, \mathcal{V}) = H(X, \mathcal{W}) \). However all topologies \( \mathcal{V} \) constructed for \( X \) ever since are either non-Hausdorff or non-compact. The rigid continua of J. DeGroot shows the existence of nonhomeomorphic continua with the same class of homeomorphisms. By repeatedly applying the following two theorems, we can construct nonrigid, nonhomeomorphic continua with the same class of homeomorphisms. **Theorem 1.**

Let \( p \) be a point in a Hausdorff space \((X, \mathcal{W})\). Then \( \mathcal{V} = \{ U \in \mathcal{W} : p \notin U \text{ or } X - U \text{ is compact} \} \) is a topology for \( X \). If \((X, \mathcal{V})\) satisfies: (a). \( f(p) = p \) for all \( f \in H(X, \mathcal{W}) \cup H(X, \mathcal{V}) \), (b). If \( p \in \text{Cl}(A) - A \) and \( g \in H(X - p, \mathcal{W}|X - p) \) then \( p \in \text{Cl}(g(A)) \). Then \( H(X, \mathcal{V}) = H(X, \mathcal{W}) \).

**Theorem 2.** Let \( p \) be a point in a Hausdorff space \((X, \mathcal{W})\) and \( V \in \mathcal{W} \). Let \( \mathcal{V}_q = \mathcal{V}_q \) if \( q \neq p \) where \( \mathcal{V}_q \) is the neighborhood system at \( q \) in \((X, \mathcal{W})\), and \( \mathcal{V}_q = \{ U - V : U \in \mathcal{W}, p \} \) and let \( \mathcal{V} \) be the topology generated by taking \( \mathcal{V}_q \) as a base of the neighborhood system at \( q \). If (a). \( f(p) = p \) for all \( f \in H(X, \mathcal{W}) \cup H(X, \mathcal{V}) \), (b). If \( p \in \text{Cl}(A) \), then \( p \in \text{Cl}(g(A)) \) for each \( A \subseteq X - p \) and \( g \in H(X - p, \mathcal{W}|X - p) \). Then \( H(X, \mathcal{V}) = H(X, \mathcal{W}) \). (Received September 24, 1965.)


Let \( T \) be a bing (continuum semigroup) acting on a continuum \( X \). If \( J \) is a maximal proper \( T \)-ideal \((TJ \subset J)\), if \( A \subseteq X \setminus J \), and if \( A \) is the intersection of a collection of nodal sets (continua with one-point boundaries), then cardinal \( A \leq 1 \). (Received September 28, 1965.)

### Abstracts for Special Session

627-48. P. E. CONNER, University of Virginia, Charlottesville, Virginia. Indecomposable cobordism classes.

We have investigated the general problem of deducing from the known properties of the fixed point set of an involution some structural information about the closed manifold on which the involution is defined. From several general results we are able to show that if \((T, V^{n+1})\) is a diffeomorphism of period 2 on a closed manifold whose fixed point set is \( \text{RP}(n) \) and if \( n = 2^t + 2^s \) or \( 2^t - 2^s \), where \( t > s > 0 \), then \( k + 1 = n \), \([V^{2n}]_2 = ([\text{RP}(n)]_2)^2 \). It has been conjectured that this result is still valid if the hypothesis is weakened to only assume that \( n \) is even. Our general framework was involutions with a connected manifold of fixed points whose cobordism class is indecomposable. (Received September 30, 1965.)

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627-49. R. J. COCH, Louisiana State University, Baton Rouge, Louisiana. Some open questions concerning topological semi-groups.

The present status of some question in topological semi-groups is discussed. Many of the problems were posed by A. D. Wallace and his students. Some of the problems deal with multiplications on the two-cell and the two-sphere, arcs in topological semi-lattices, the Euclidean structure near maximal idempotents in certain semi-groups, locally, compact nonthetic semi-groups, and the existence of multiplication with identity on absolute retracts. (Received September 29, 1965.)


A number of theorems on spaces admitting a "continuous" partial order are discussed. These fall into two general categories: Theorems on fixed points and theorems on the structure of continua. Among the former is a generalization of Borsuk's fixed point extensibility theorem. Extensions of Koch's Theorem on arcs are discussed as well as some unsolved problems. (Received September 30, 1965.)


It has been shown by the authors that the construction given in Clifford and Preston (Algebraic theory of semigroups, p. 128) for an inverse semigroup which is the union of groups can be generalized to a semigroup in which the /\ relation has a subsemigroup cross-section. Here we consider certain semigroups in which this condition obtains. Also, subsemigroup cross-sections are obtained for certain closed congruences on a compact semigroup. (Received October 1, 1965.)

627-52. HASKELL COHEN, University of Massachusetts, Amherst, Massachusetts. Multiplications on the 2-sphere.

The problem of making the 2-sphere into a topological semigroup is examined, and recent results on this question and related topics are discussed. (Received September 30, 1965.)


The following are proved: (1) There is a natural group structure on the set \( \pi \) of all differentiable equivalence classes of free differentiable actions of the circle group on homotopy 7-spheres. (2) The group \( \pi \) is infinite cyclic and there is a subgroup of \( \pi \) such that the set of all differentiable equivalence classes of free differentiable actions of the circle group on any homotopy 7-sphere is a coset. (3) On each homotopy 7-sphere, there are infinitely many free differentiable actions of the circle group not differentiably equivalent to one another. (Received October 1, 1965.)
November Meeting in Iowa City, Iowa
November 26-27, 1965

628-1. J. A. BEEKMAN, Ball State University, Muncie, Indiana. Gaussian Markov processes and a boundary value problem.

Let \( \{ x(t), s \leq t \leq t \} \) be a Gaussian Markov stochastic process with transition density function \( p(s, x; t, y) \). Let \( r(x, s; y, t) = E \{ \exp \int_s^t \theta(x(s), t) \, dt \} \) where \( E \{ \} \) is the function space integral on the sample functions of the process, and \( \theta \) is suitably restricted.

**Theorem.** \( r(x, s; y, t) \) uniquely satisfies (as a function of \( y \) and \( t \)): (1) \( A(t) \frac{\partial^2}{\partial y^2} r - B(t) \frac{\partial}{\partial y} (y r) + \theta r = \frac{\partial}{\partial t} r \) in a strip; \( A(t) \) and \( B(t) \) are determined from \( p \). (2) \( \int_{-\infty}^{\infty} g(x) r \, dx \rightarrow g(y) \) for every continuous bounded \( g \) as \( t \rightarrow s \). (3) \( r \rightarrow 0 \) as \( |y| \rightarrow \infty \). (4) The partial derivatives of \( r \) are continuous in the strip. \( r \) also satisfies a backward version of 1, 2, 3, 4. **Corollary 1.** \( Q(y, t) = r(0, 0; y, t) \) satisfies 1, 3, 4, and \( \int_{-\epsilon}^{\epsilon} Q(y, t) \, dy \rightarrow 1 \) as \( t \rightarrow 0^+ \) for all \( \epsilon > 0 \). **Corollary 2.** For given appropriate \( A(t), B(t), \theta(y, t) \), a function \( r \) can be constructed satisfying the two systems. **Example 1.** If \( a(x; s, x) = p \{ \int_s^t \rho(x(s), t) \, dt < a | x(s) = x \} \), then \( \sigma \) has characteristic function \( \int_{-\infty}^{\infty} \rho(\xi) d\alpha = \int_{-\infty}^{\infty} r(\xi) \, dy \) where \( i\xi \phi \) replaces \( \theta \) in \( r \). **Example 2.** \( P[\max_{0 \leq s \leq t} x(s) < a] = \lim_{u \rightarrow -\infty} \int_{-\infty}^{\infty} Q(y, t) \, dy \) where \( \theta = 0 \) for \( y < a, -u \) for \( y > a \). This is considered in detail for the Ornstein-Uhlenbeck process. (Received May 17, 1965.)


Relativistic models.

The author discusses relativistic models. In the special theory there are presented: classical Einstein model with the constant velocity of light in vacuum; extension to an accelerated motion; Rosen's relativities; relativity and Čerenkov effect; extension to a variable velocity of light in nonhomogeneous media of variable permittivity in the sub-light regime; relativistic energodynamics; variable mass (density); reduction of conservation laws. General relativity: classical Einstein field equation; gravitational field equation based on the relativistic energodynamics. (Received August 23, 1965.)


A function \( f: X \rightarrow Y \) is connected iff for each connected set \( K \subset X, f(K) \) is connected. S. Marcus suggested the following problems: -- Describe a convergence '' \( \Rightarrow \) '' such that if a sequence \( \{ f_n \} \) of real-valued connected (Darboux) functions \( \Rightarrow f \) then \( f \) is a connected function. In this paper the above problem is solved in a generalized form. For each connected set \( K \subset X \) and open subsets, \( U, V \) of \( Y \), let \( W(K; U, V) = \{ f \in Y^X | f(K) \subset U \cup V, f(K) \cap U \neq \emptyset \neq f(K) \cap V \} \). The set \( \{ W(K; U, V) \} \) is a subbasis for a topology \( T \), called connected-open topology, for \( Y^X \). **Theorem 1.** If \( Y \) is completely normal and a net of connected functions \( \{ f_n \} \) \( T \)-converges to \( f \), then \( f \) is a connected function. **Theorem 2.** \( T \) is
larger than the topology of pointwise convergence. **Theorem 3.** If \(X = Y = [0,1]\), then \(T\) is strictly larger than the topology of uniform convergence. **Theorem 4.** If \(X\) is locally connected then \(T\) contains the compact-open topology. (Received August 27, 1965.)


By a \(\lambda\)-base for a space \(S\) is meant a base \(B\) of countable order for \(S\) [Arhangel'ski, Uspehi Mat. Nauk 18 (5) (113) (1963), 139-145], such that if \(K\) is a perfectly decreasing subcollection [Abstract 64T-401, these **Notices** 11 (1964), 595] of \(B\), there exists a point \(P\) common to the closures of the elements of \(K\), such that every open set containing \(P\) includes some element of \(K\). **Theorem.** If \(M\) is an open continuous mapping of a space \(S\) having a \(\lambda\)-base and \(M(S)\) is \(T_1\), then \(M(S)\) has a \(\lambda\)-base. The significance of the completeness feature of the base property is emphasized with examples of Lindelöfian open and compact open continuous mappings, respectively, of metrizable and Hausdorff developable spaces onto nonmetrizable paracompact Hausdorff spaces. The following theorem is illustrative of some applications made of the main results. Let \(M\) denote an open continuous mapping of a space \(R\) having a base of countable order onto a paracompact Hausdorff space \(S\). If \(R\) has a \(\lambda\)-base, \(S\) is metrically topologically complete. If \(R\) is regular, and \(M\) is compact, then \(S\) is metrizable. (Received September 13, 1965.)

628-5. M. R. KROM, University of California, Davis, California. **The decision problem for a class of formulas of first-order logic in which all disjunctions are binary.**

A procedure is provided for deciding for any two formulas of a first-order logic without function symbols and without identity of the forms \((V_{a_1}) \ldots (V_{a_m})M\) and \((3b_1) \ldots (3b_n)(Vc_1)(Vc_2)(3d_1) \ldots (3d_p)N\) in which \(M\) and \(N\) are conjunctions of binary disjunctions of signed atomic formulas, whether the conjunction of these two formulas is satisfiable. If the condition that the disjunctions be binary is omitted in the description of the two formulas, then the class of conjunctions of such pairs of formulas is much more general than a known reduction class for satisfiability (cf. page 60 of **Reduktionstheorie Des Entscheidungsproblems** by Janos Suranyi). For the procedure there is established a criterion, based on the existence of chains, for satisfiability of sets of binary disjunctions of signed atomic formulas. For an example, if \(F, G,\) and \(H\) are atomic formulas then \(F \lor H, \neg H \lor G,\) and \(\neg G \lor F\) are binary disjunctions which form a chain from \(F\) to \(F\). (Received September 16, 1965.)

628-6. R. K. MILLER, University of Minnesota, Minneapolis, Minnesota 55455. **On Volterra's population equation.**

Volterra postulates a model for the growth of a biological population which leads to the equation

\[ N'(t)/N(t) = a - bN(t) - \int_0^t f(t - s)N(s)ds. \]

Concerning this equation we prove: **Theorem.** Suppose \(a > 0, b > 0, f \in C(0,\infty)\) and \(L_1(0,\infty)\). If \(f(t)\) is not identically zero for \(t > 0\) and if \(b > \int_0^\infty f(s)ds\) then for any positive initial point \(N_0 > 0\) there is a unique, bounded, positive solution. This solution tends to \(a/(b + \int_0^\infty f(s)ds)\) as \(t \to \infty\). A similar result holds if the lower limit of integration in the above equation is - \(\infty\). (Received September 20, 1965.)
628-7. R. E. WILLIAMS, Kansas State University, Manhattan, Kansas. On near-rings related to dense rings.

The investigation of rings associated with a certain class of near-rings is initiated. The near-rings considered have commutative addition and the associated rings are generated by left multiplications. As well as commutativity of addition, the near-rings considered satisfy axioms given by D. W. Blackett [Proc. Amer. Math. Soc. 4 (1953), 772-785] including $0x = 0$. Definitions and terminology generally conform to that paper. The concept of kern is generalized directly from nearfields. Definition. Let $N$ be a near-ring and $N^+$ its additive group. The subring $A$ of the ring of endomorphisms of $N^+$ generated by the mappings $L(n): x \rightarrow nx$ is called the associated ring of $N$.

Lemma. If a near-ring $N$ has an identity then the centralizer of $N^+$ as an $A$-module is isomorphic to $K$, the kern of $N$. Some results on the structure of near-rings with no left (right) $N$-modules are presented. These lead directly to the following result. Theorem. If $N$ is a near-ring with no proper left (right) $N$-modules and if $NK \neq 0$ then $N^+$ is a right vector space over $K$ and $A$ is a dense ring of linear transformations of $N^+$ over $K$. (Received September 27, 1965.)

628-8. H. W. LAMBERT, University of Utah, Salt Lake City, Utah 84112. Decompositions of $E^3$ which are definable by tori.

Let $G$ be an upper semi-continuous decomposition of $E^3$, $H_G$ the sum of the nondegenerate elements, and $E^3/G$ the associated decomposition space. Call $G$ definable by tori if there exists a sequence $\{T_1\}$ such that each $T_1$ is a finite collection of disjoint solid tori in $E^3$, each element of $T_{i+1}$ is contained in the interior of some element of $T_i$, and $Cl(H_G) = \bigcap_{\{T_1\}} T_i^*$ where $T_i^*$ is the union of all elements of $T_i$. Assume $G$ is definable by tori and, in addition, assume that each element of $T_{i+1}$ can be shrunk to a point in an element of $T_i$. Theorem. A sufficient condition that $E^3/G$ be homeomorphic to $E^3$ is that for each point $p$ of $E^3/G$ and each open set $U$ containing $p$ there exists an open set $U'$ such that $p \in U' \subseteq U$ and the boundary of $U'$ is a 2-sphere. (Received September 27, 1965.)

Abstracts for Special Session


Let $M$ be a piecewise-linear 3-manifold. If $X \subseteq \text{Int } M$, $X$ is said to have the cube-with-handles property if $X = \bigcap_{l=1}^{\infty} H_l$, where $H_1 \subseteq \text{Int } H_{l-1}$ and $H_l$ is a polyhedral cube-with-handles. Theorem 1. Let $K$ be a finite simplicial complex, $L$ a subcomplex of $K$ such that $K$ contracts to $L$, and $g: K \rightarrow \text{Int } M$ a homeomorphism. Then, if $g(L)$ has the cube-with-handles property, so does $g(K)$. A corollary is that, in any 3-manifold, topologically embedded collapsible complexes have the cube-with-handles property, and hence are cellular if and only if the "cellularity criterion" (Ann. of Math. 79 (1964), 327-337) is met. Also, in orientable 3-manifolds, topologically embedded 2-manifolds with nonempty boundary, and cubes-with-handles, have the cube-with-handles property. Using similar techniques, one obtains: Theorem 2. Let $S \subseteq \text{Int } M$ be a topologically embedded, 2-sided, closed 2-manifold.
Then, for given $\epsilon > 0$, the $\epsilon$-neighborhood of $S$ contains a polyhedral 3-manifold $H$ such that $S \subset \text{Int} H$, $S$ separates the two components of $\text{Bd} H$, and $H$ is homeomorphic to $S \times [0,1]$ plus handles of index one. (Received September 20, 1965.)

628-10. C. E. BURGESS, University of Utah, Salt Lake City, Utah 84112. Surfaces in $E^3$.

This is an expository discussion of developments by several authors during recent years on conditions which imply that a surface is tamely imbedded in $E^3$ or which imply that a subset of a surface lies on a tame surface in $E^3$. Most of the conditions for a surface to be tame can be changed slightly to include a study of wild surfaces which are tame or locally tame, from one side. Substantial papers by Moise [Affine structures in 3-manifolds. VIII. Invariance of knot-types; local tame embedding, Ann. of Math. (2) 59 (1954), 159-170], Papakyriakopoulos [On Dehn's Lemma and the asphericity of knots, Ann. of Math. (2) 66 (1957), 1-26], and Bing [Conditions under which a surface in $E^3$ is tame, Fund. Math. 47 (1959), 105-139 and Approximating surfaces from the side, Ann. of Math. (2) 77 (1963), 145-192] are fundamental for these developments. (Received September 27, 1965.)

628-11. STEVE ARMENTROUT, University of Iowa, Iowa City, Iowa 52240. Concerning cellular decompositions of 3-manifolds that yield 3-manifolds.

Bing raised the following question [Fund, Math. 50 (1962), 431-453]: Does a point-like decomposition of $E^3$ yield $E^3$ if it yields a 3-manifold? This question can be generalized to the following: If $K$ is a 3-manifold and $G$ is a cellular decomposition of $K$ such that the associated decomposition space $K/G$ is a 3-manifold, is $K/G$ homeomorphic to $K$? The following partial affirmative solution has been established. Theorem. Suppose that $K$ is a 3-manifold, $G$ is a cellular decomposition of $K$, and $K$ has a triangulation $T$ such that (1) no vertex of $T$ belongs to the closure of the image, under the projection map, of the union of all the nondegenerate elements of $G$ and (2) if $s$ is a 3-simplex of $T$, then the inverse image, under the projection map, of $s$ lies in an open 3-cell in $K$. Then $K/G$ is homeomorphic to $K$. This theorem has, as corollaries, certain previously established results as well as other results of interest. (Received September 27, 1965.)


Every compact 3-manifold $M^3$ without boundary possesses a decomposition into one open 3-cell, one vertex, and a certain number $r$ of 1-dimensional open cells $E^1_1, ..., E^1_r$ and of 2-dimensional open cells $E^2_1, ..., E^2_r$. We show: If $M^3$ is a homotopy 3-sphere then a decomposition of the kind described may be found such that each closure $\overline{E^1_i}$ ($i = 1, ..., r$) bounds a nonsingular (polyhedral) disk in $M^3$. (Received October 4, 1965.)
629-1. R. O. WELLS, JR., Rice University, Houston, Texas 77001. On the local holomorphic hull of a real submanifold in several complex variables.

Lewy's result on local analytic continuation from strongly pseudoconvex real smooth hypersurfaces in \( \mathbb{C}^2 \) is generalized to real smooth hypersurfaces in \( \mathbb{C}^n \) with a nonzero eigenvalue of the complex hessian on the complex tangent space (see H. Lewy, Ann. of Math, 64 (1956), 514-522).

Using this it is proved that a real smooth hypersurface in \( \mathbb{C}^n \) is locally an analytic hypersurface if and only if it is locally the countable intersection of domains of holomorphy. Using methods of embedding analytic discs due to E. Bishop the following related result for submanifolds of higher codimension is obtained. Let \( M^k \) be a real smooth \( k \)-dimensional submanifold of \( \mathbb{C}^n \), \( k > n \), and suppose that the complex dimension of the complex tangent space to \( M^k \) at \( p \in M^k \) is \( k - n \). If \( M^k \) contains no complex submanifolds near \( p \), then for any sufficiently small connected neighborhood \( N \) of \( p \), there exists a connected set \( Q \neq \emptyset \), with \( Q \cap M^k = \emptyset, \emptyset \cap N \cap M^k = \emptyset \), such that if \( f \) is holomorphic in a domain \( D_f \supset N \cap M^k \), then there is a holomorphic function \( F \) in a domain \( D_f \supset (N \cap M^k) \cup Q \), with \( D_F \supset D_f \), such that \( F|D_f = f \). (Received May 5, 1965.)

629-2. JOSEPH HARRISON, Stanford University, Stanford, California. Extensions of the hyperarithmetic hierarchy.

For background see my previous abstract, Further results on \( \mathcal{O}^* \), Abstract 65T-304, these Notices 12 (1965), 604. Definition. A hierarchy for \( a \in \mathcal{O}^* \) is a sequence of fns \( \{a^b\}_b \leq_0 a \) such that \( a^b = (a^b)^1 \) (ordinary jump operation), \( a^b (n) = a \{b\} (0) (n)_1 \). Let " \( \leq h" \) mean "hyperarithmetic in", " \( < h" \), "lower hyperdegree". Lemma. (i) If \( c \in \mathcal{O}^* \) \( < 0 \), there exists \( a < 0 \), \( a \in \mathcal{O}^* \) \( = 0 \), and a hierarchy \( \{a^b\}_b \leq_0 a \) for such a that if \( b = 0 \) a such that if \( b = 0 \) a then \( a^b < h 0 \), (ii) If \( a \in \mathcal{O}^* \) \( < 0 \) and \( \{a^b\}_b \leq_0 a \) is any hierarchy for \( a, b_1 < 0, b_2 \leq 0, b \} (y) (b) \leq b_2 \) is not well-ordered, then \( a^b_1 < h a^b_2 \). Theorem 1. If \( a \leq 0 \) then there exists a densely ordered set \( B \) of hyperdegrees without first element all strictly greater than the hyperdegree of \( a \) such that the hyperdegree of \( a \) is a greatest lower bound in hyperdegree for the hyperdegrees of \( B \). Theorem 2. If \( N < h a < h 0 \) and \( (3\beta)(x)R(\beta(x)) \) but \( (3\beta)HA(x)R(\beta(x)) \) where \( R \) is recursive, then \( (3\beta)((x)R(\beta(x))) \), \( N < h \beta \leq 0, a = h \beta, \beta = h \gamma \). Theorem 3. If \( \{a^b\}_b \leq_0 a \) is a hierarchy for \( a \in \mathcal{O}^* \) \( = 0, a \leq 0 \), \( \beta^b \leq_0 a \) for all \( b \leq 0 \), then there exists a hierarchy \( \{\beta^b\}_b \leq_0 a \) for such that \( \beta^b \leq 0 \) for all \( b \leq 0 \) and \( b \in \mathcal{O}^* \) \( = 0, a \leq \beta^b = h \). (Received July 15, 1965.)


Let \( p \) belong to a \( k \)-dimensional manifold \( M^k \) embedded in the \( n \)-dimensional Euclidean space \( \mathbb{E}^n \). Suppose \( \epsilon > 0 \). Let \( B^h \) be a ball of diameter less than \( \epsilon \) whose interior contains \( p \). For \( 0 < t \leq \epsilon \) let
B_t denote a ball whose interior contains p and is concentric to B^n, i.e., regard B^n as a topological product S^{n-1} x [0, t] with S^{n-1} x {0} identified with p. For all t such that \epsilon - t is sufficiently small we hypothesize that the pairs (B^n, (\tilde{B}^n \cap M^k) x I^2) = (B^n, S_1^{k-1} x I^2) are homeomorphic. If for a sequence of positive numbers \epsilon_1, \epsilon_2, ... converging to zero, this condition holds, we describe the embedding by saying M^k is locally weakly flat at p. If this holds for all p \in M^k, M^k is locally weakly flat in M^n, denoted by LWF. **Theorem.** Let M^{n-1} \subseteq E^n be a closed n - 1 manifold that is locally flat at each point except possibly at the points of a finite set Y. Suppose that M^{n-1} is LWF at each point. Then M^{n-1} is locally flat at each point. (Received July 26, 1965.)

629-4. J. L. BRENNER, Stanford Research Institute, Menlo Park, California. **Conditions for the nonsingularity of partitioned matrices.**

There are several sets of conditions known to be sufficient for the nonsingularity of a partitioned matrix. See Brenner, Proc. Nat. Acad. Sci. 40 (1954), 452-454; Ostrowski, J. Math. Anal. Appl. 2 (1961), 161-209; Varga and Feingold, Pacific J. Math 12 (1962), 1241-1250. The present paper gives, for the first time, sufficient conditions in which dominance is partly by rows and partly by columns. This generalizes some of the above known theorems. (Received August 6, 1965.)

629-5. P. S. BULLEN, University of British Columbia, Vancouver, British Columbia. **A general Perron integral.**

Let X be a locally compact space with a Bauer harmonic structure and such that there exists a real function locally strictly hypoharmonic on X, \mu(V; x)-summable for all harmonic measures \mu(V; x). A differential operator is defined that characterizes the hyperharmonic functions of the structure; its properties, essentially those of a generalized second order derivative, are established. A Perron integral that inverts this derivative is then defined and its properties investigated. This extends previous results of the author, A general Perron integral, Canad. J. Math, 17 (1965), 17-30. Second order elliptic and parabolic operators are specialization of this derivative, which also coincides with the characteristic operator of the Markov process associated with the harmonic structure. The integral generalizes the P^2-integral of James. (Received September 27, 1965.)


Mikusinski (Analytic functions of polynomial growth, Studia Math. 22 (1962-1963), 1-13) obtained a representation theorem for functions of polynomial growth, analytic in the right half plane, as the Laplace Transform of a tempered function. In this paper, this theorem is extended to functions of polynomial growth and analytic in a strip, this result is then extended to functions of n-variables. The proof proceeds by obtaining a lemma which includes Mikusinski's result as a case but with n = 1. The n-dimensional theorem is obtained by iterated application of the lemma. (Received August 23, 1965.)

The author discusses the mathematical model of the Dirac relativistic theory of electron (relativity-quantum relation) generalized to the relativistic energodynamics. (Received August 23, 1965.)


Let $G$ be a locally compact group and $\{H_n\}$ an increasing sequence of closed subgroups of $G$ whose union is dense in $G$. For each $n$, let $\lambda_n$ be a left Haar measure on $H_n$ and let $\lambda$ be a left Haar measure on $G$. If the $H_n$'s are compact or normal, then there is a sequence $\{a_n\}$ of positive numbers such that $f \in L^1(G, \lambda)$ implies that (*) $\lim_{n \to \infty} a_n \int_{H_n} f(xy) d\lambda_n(y) = \int_G f(y) d\lambda(y)$ for locally almost all $x$ in $G$. If $G$ is the compact group $[0,1]$ with addition modulo 1, if $H_n$ is the finite group $\{k \cdot 2^{-n} : 0 \leq k \leq 2^n - 1\}$ where $\lambda_n$ is counting measure, and if $a_n = 2^{-n}$, then the left side of (*) is a Riemann sum and (*) reduces to Jessen's theorem (Ann. Math. 35 (1934), 248-251). (Received September 7, 1965.)


This paper contains three theorems concerning real numbers having normality of order $k$.

The first theorem gives a simple construction of a periodic decimal having normality of order $k$ to base $r$. After introducing the notion of $c$-uniform distribution modulo one, we prove in the second theorem that a real number $a$ has normality of order $k$ to base $r$ if and only if the function $a \cdot x$ is $r^k$-uniformly distributed modulo one. In the third theorem we show that $a$ has normality of order $k$ to base $r$ if and only if, for every integer $b$ and every positive integer $t \leq k$, $\lim(N(b,n)/n) = r^{-t}$ where $N(b,n)$ is the number of integers $x$ with $1 \leq x \leq n$ for which $[a \cdot x] = b(\mod r^t)$. (Received September 7, 1965.)

629-10. R. M. ROBINSON, University of California, Berkeley, California. An extension of Pólya's theorem on power series with integer coefficients.

Pólya's theorem states that if $f(z)$ is regular outside a bounded closed set $E$ of transfinite diameter less than 1 whose complement is connected, and if $f(z)$ has an expansion at $\infty$ as a power series in $1/z$ with integer coefficients, then $f(z)$ must be rational. The condition on $E$ can be relaxed by strengthening the condition on $f(z)$. Suppose that $f(z)$ is regular outside $E$ and has expansions as power series in $1/z$ and in $(z - p_k)/q_k$ ($k = 1, \ldots, m$) with integer coefficients, where $p_1, \ldots, p_m$, $q_1, \ldots, q_m$ are integers with $q_k > 0$ and $p_j - p_k$ $\mod$ $q_k$ for $j \neq k$, and none of the points $p_k$ lie in $E$. Then if there is a rational function $h(z)$ having poles only at $\infty$ and at $p_1, \ldots, p_m$, with principal parts given by polynomials in $z$ and in $q_k/(z - p_k)$ having leading coefficients equal to 1, such that $|h(z)| < 1$ on $E$, then it follows that $f(z)$ is rational; conversely, if $E$ is symmetric to the real axis and there is no such $h(z)$, then nonrational $f(z)$ exist. When $m = 0$, the condition on $h(z)$ expresses that the transfinite
diameter of \( E \) is less than 1, and the above result reduces to Pólya's theorem; the converse is apparently new even when \( m = 0 \), since Pólya gave a counter-example only when the complement of \( E \) is simply connected. (Received September 13, 1965.)

629-11. PETER KUGEL, Technical Operations Research, South Avenue, Burlington, Massachusetts. Two theorems about \( 1 \)-predictable sets of tapes.

A set of tapes \( S \) is said to be "\( p \)-predictable" if and only if there exists a Turing machine (with inessential modifications) that predicts the symbols on any tape \( T \in S \) with a probability of being correct \( \leq p \) after having read only a finite number of symbols of \( T \). **Theorem.** There exist non-denumerable \( p \)-predictable sets of tapes if and only if \( p < 1 \). **Theorem.** The problem of predicting symbols on an arbitrary tape from a \( 1 \)-predictable set (without error after having read only a finite part of that tape) is equivalent to the problem of evaluating a predicate in \( R_2 \) of the Kleene-Mostowski hierarchy of arithmetic predicates. (Received September 13, 1965.)


Dehn solved the conjugacy problem for the fundamental group \( G = \text{gp}(a_1,b_1,\ldots,a_n,b_n; \prod_{i=1}^{n} [a_i,b_i] = 1) \). Now \( G \) is the free product of two free groups with a cyclic group amalgamated. Hence the following theorem generalizes Dehn's result. **Theorem.** The free product of free groups with an infinite cyclic group amalgamated has a solvable conjugacy problem. (Note. This theorem supercedes the stronger statement which appears as the third result in Abstract 619-50, these Notices 12 (1965), 69, of which the author now makes no claim.) (Received September 17, 1965.)


A theorem of J. L. Walsh on simultaneous interpolation and approximation is extended to normed linear spaces. **Theorem.** Let \( Y \) be a dense subspace of the normed linear space \( X \) and let \( L_1,\ldots,L_n \) be in \( X^* \). Then for each \( x \in X \) and each \( \epsilon > 0 \) there exists a \( y \in Y \) such that \( \|x - y\| < \epsilon \) and \( L_i(y) = L_i(x) \) (\( i = 1,\ldots,n \)). An analogous result in the dual space is valid and essentially arises by replacing \( X \) with \( X^* \). **Corollary** (Extended Stone-Weierstrass Theorem). Let \( S \) be a compact Hausdorff space and \( A \) a subalgebra of the real continuous functions on \( S, C(S) \), which contains the constant functions. Let \( L_1,\ldots,L_n \in C^*(S) \). Then for each \( x \in C(S) \) and each \( \epsilon > 0 \) there exists a \( y \in A \) such that \( \sup_{t \in S} |x(t) - y(t)| < \epsilon \) and \( L_i(y) = L_i(x) \) (\( i = 1,\ldots,n \)) if and only if \( A \) separates points in \( S \). The theorem also enables us to show the existence of various "rules" (e.g. quadrature) which are uniformly good over a linear space and are exact over a subspace. (Received September 20, 1965.)

629-14. P. R. YOUNG, Stanford University, Stanford, California. A theorem on recursively enumerable classes and splinters.

Using the Friedberg technique for splitting nonrecursive r.e. sets into disjoint nonrecursive r.e. sets, we obtain the following **Theorem.** Let \( A \) be a nonrecursive r.e. set; then there exists a
one-one total recursive function \( f \) such that the range of \( f \) is \( \tilde{A} \), each component of \( f \) intersects \( \tilde{A} \) exactly once, and each component of \( f \) is a nonrecursive r.e. set. We immediately obtain the following Corollary. There are one-one total recursive functions which have no recursive splinters. Taking the set \( \tilde{A} \) of the theorem to be maximal and letting \( H \) be the class of all components of \( f \), we obtain our final Corollary. \( H \) is an infinite r.e. class of r.e. sets which has no proper infinite r.e. subclass. This last result answers a question raised by Pour-El and Putnam. (Received September 20, 1965.)


Valentine [Pacific J. Math. 17 (1957), 1227-1235] defined a three-point convexity property \( P_3 \) and proved that a closed connected set in \( E_2 \) satisfying \( P_3 \) is the union of at most three convex subsets. In the present paper, a generalization of \( P_3 \) is defined as follows: \( S \) has property \( P_0 \) if for each finite subset \( x_1, \ldots, x_n, n \) odd, of \( S \) such that \( x_i \) and \( x_{i+1} \) are not visible \((i = 1, \ldots, n-1)\) it follows that \( x_1 \) and \( x_n \) are visible. \textbf{Theorem.} Let \( S \) be a closed nonconvex set in a topological linear space. Then \( S \) is the union of some two convex subsets if and only if \( S \) satisfies property \( P_0 \). (Received September 24, 1965.)

629-16. G. H. PIMBLEY, Los Alamos Scientific Laboratory of the University of California, Box 1663, Los Alamos, New Mexico. Positive solutions of a quadratic integral equation.

The equation \( u(x) = 1 + \lambda \int_0^1 u(y - x)u(y)dy = 1 + \lambda T[u] \), on \( 0 \leq x \leq 1 \), has the solution \( u(x) = 1 \) for \( \lambda = 0 \). From here, solution is extended for \( \lambda > 0 \) by method of continuation as long as \( 1 - \lambda T'[u] \) is invertible; here \( T'(u)h = \int_0^1 u(y-x)h(y)dy \). \( T'(u) \) has lowest characteristic value \( \nu_0 = \lambda/1 - \nu(1 - 2\lambda) \). At \( \lambda = 1/2 \), \( \nu_0 = 1/2 \) and \( 1 - \lambda T'(u) \) is singular. This is the limit of continuation. No real solutions exist for \( \lambda > 1/2 \). A bifurcation study at \( \lambda = 1/2 \) yields a second solution \( u^+(x) \), to be continued leftward. Thus there are two real solution branches in \( 0 < \lambda < 1/2 \). Detailed study of \( u^+(x) \) requires knowledge of higher characteristic values of \( T'(u) \). If these are complex, unhindered continuation to \( \lambda = 0 \) is possible with \( \max|u^+(x)| \rightarrow \infty \). There are indications this is the case. Every solution \( u(x) \) for \( \lambda > 0 \) has \( u(x) > 0 \), \( u'(x) < 0 \) and \( u''(x) > 0 \). Continuation of \( u(x) \) for \( \lambda < 0 \) is possible at least when \( |\lambda| < \nu_0 \). \( u(x) \) eventually becomes nonpositive for \( \lambda < 0 \). (Received September 24, 1965.)


This paper studies the replacement of continuity by \( \delta \)-continuity in the theory of AR's (see Abstract 625-149, these Notices 12 (1965), 589). This natural generalization leads to a new class of spaces for which some of the important properties of AR's can be extended. However, a member of this new class lacking the f.p.p. is exhibited. Thus, these spaces are called weak-proximate absolute retracts. (Strong proximate absolute retracts will be studied in a later paper.) If \( (M, \rho) \) is a metric space, \( X \subset M \) is called a weak-proximate retract of \( M \) (abbreviated WPR) if for any \( \epsilon > 0 \), there exists an \( \epsilon \)-continuous mapping \( r : M \to X \) such that \( \rho(x, r(x)) < \epsilon \) for each \( x \in X \). A metric space \( X \) is called a weak-proximate absolute retract (WPAR) provided it is compact and for
every topological image \( Y \) of \( X \) which is a closed subset of a compact metric space \( M \), it is true that \( Y \) is a WPR of \( M \). **Theorem.** A space \( X \) is a WPAR iff it is homeomorphic to a closed WPR of the Hilbert parallelopotope. **Theorem.** Chainable continua are WPAR. **Theorem.** Let \( C = A \cup B \) be compact metric with \( A \) and \( B \) closed and \( A \cap B \) a WPR of \( C \). Then \( C \) is a WPAR iff \( A \) and \( B \) are both WPAR's. Some "proximate" extension theorems are also obtained. (Received September 27, 1965.)


**Formulation of axially symmetric solutions of LaPlace's equation.**

An integral presented earlier (Bull. Amer. Math. Soc. 61 (1955), 46) as an axially symmetric solution of Laplace's equation with discontinuous boundaries is used in the modified form \( w(z,r) = u(z,r) + iv(z,r) = \int \mu(t)[(z + t)^2 + r^2]^{-1/2} \, dt \) (\( \lambda, \mu \) complex constants) to find \( u \) and \( v \) corresponding to different types of kernel function \( f(t) \). For a given simple \( f \), it is possible to work back and formulate the discontinuous boundary value problem satisfied by either \( u \) or \( v \). When \( f \) is a polynomial (including negative powers), \( w \) involves square roots and inverse sines, even if \( f \) is a polynomial only within discrete portions of the range of variation of \( t \) and vanishes outside of them. When \( f \) consists of square roots of linear expressions, \( w \) may be an elliptic function. It is shown why this approach from the integral expression for \( w \) is much more powerful than the one from \( \int_0^{\pi} F(z + ir \cos \omega) d\omega \). The examples \( f = 1/\sqrt{t} \) and \( f = 1 \) are worked out. Since the solutions are in closed form, the range of validity of various expansions is known. The approach seems well adapted to numerical computation. (Received September 27, 1965.)


Necessary conditions, which in many cases are also sufficient, are given for the existence of ample and canonical solutions of the functional equation \( fg = hf \) (\( g, h \) known functions, \( f \) unknown) on some arbitrary set. Here a solution \( f \) is ample if \( \text{Dom} \, f = \text{Dom} \, g \cup \text{Rang} \, g \); \( f \) is canonical if it is ample and if, for any other ample solution \( f_1 \), \( f(a) = f(b) \) implies \( f_1(a) = f_1(b) \). In particular, these conditions generalize the known necessary and sufficient conditions for the Abel and Schröder equations (see M. Kuczma: On the Schröder equation, Rozprawy Matem. 34 (1963)) by not requiring the function \( g \) to be invertible. (Received September 27, 1965.)

629-20. ROBIN CHANEY, Western Washington State College, Bellingham, Washington. **A note on the transformation theory for measure space.**

Reichelderfer has developed a transformation theory for a function \( T \) whose domain is a measure space \( \{S, M, u\} \) and whose range is a measure space \( \{S', M', u'\} \). (See Abstract 61T-267, these Notices) 8 (1961), 518). The terminology followed here is that used in the above abstract. Let \( \Theta \) be the family of those sets \( S \) each of which is the intersection of all \( D \)'s containing some point in \( S \). Assume that \( W' \) is a weight function for which there is a nonnegative extended real valued function \( w \) with domain \( \Theta \) such that each value \( W'(s',D) \) is the sum of all \( w \)'s where \( S \) is in \( \Theta \), \( S \subset D \), and \( TS = s' \). Assume \( f \) is a nonnegative \( u \)-integrable function with domain \( S \) for which \( WD = \int_D f \, du \) for each \( D \). Set \( S' = U \{S \in \Theta : W \geq 0\} \). Under certain standard conditions the following results

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are proved. If \( M \) is in \( M \) and \( f = 0 \) a.e. \( u \) on \( M \) then there is a \( u'-\text{null set} \ X' \) such that \( wS = 0 \) whenever \( S \) is in \( \emptyset \) and \( S \subset M - T^{-1}X' \). Moreover if \( M \) is a set in \( M \) for which \( M \cap S^+ \) is void then \( f = 0 \) a.e. \( u \) on \( M \). If we assume \( S^+ \) is in \( M \) then \( f = 0 \) a.e. \( u \) on \( X - S^+ \) and there is a \( u'-\text{null set} \ X' \) such that \( f(a) > 0 \) whenever \( a \) is in \( S^+ - T^{-1}X' \). (Received September 27, 1965.)


A subset \( X \) of a metric space \( M \) is called a \( C^-\text{set} \) provided each point of \( M \) admits a unique nearest point in \( X \). In a Euclidean space every \( C^-\text{set} \) is convex, but it is unknown whether the same is true in infinite-dimensional Hilbert spaces. The result on Euclidean space has been known for thirty years but only partial results have been obtained on the Hilbert space problem. Hoping to contribute to an eventual solution, the author conjectures that in some Hilbert space there is a proper \( C^-\text{set} \) whose complement is bounded and convex. (Of course such a \( C^-\text{set} \) would not itself be convex.) In support of the conjecture there are described two classes of sets (\( C_1^-\text{sets} \) and \( C_2^-\text{sets} \)) which are closely related to \( C^-\text{sets} \), and it is proved (for \( i = 1,2 \)) that in a Euclidean space every \( C_i^-\text{set} \) is convex, while every infinite-dimensional Hilbert space contains a proper \( C_1^-\text{set} \) whose complement is bounded and convex. (A set \( X \subset M \) is a \( C_1^-\text{set} \) provided \( X \) is closed and each point of \( M \) admits at most one nearest point in \( X \); it is a \( C_2^-\text{set} \) provided for each point of \( M \) the set of all nearest points in \( X \) is nonempty and contractible in itself.) The method of Vlasov is used to prove that in a smooth rotund Banach space, every boundedly compact \( C_2^-\text{set} \) is convex. (Received September 27, 1965.)

629-22. LEOPOLD FLATO, 282 West End Avenue, New York 23, New York, D. J. NEWMAN, Belfer Graduate School of Science, Yeshiva University, New York and H. S. SHAPIRO, University of Michigan, Ann Arbor, Michigan. Level curves of harmonic functions.

We discuss the problem of determining those algebraic curves which are level curves of functions which are harmonic in the entire \((x,y)\) plane. For conic sections this problem is completely solved. For curves of degree \( > 2 \) results are obtained which rule out various algebraic curves from being level curves of harmonic functions. In particular \( y = x^n \) (\( 1 \leq n < \infty \)) is not a level curve of a harmonic function except for \( n = 1,2 \). We also obtain a necessary condition for a curve to be a level curve of a harmonic polynomial. (Received September 27, 1965.)

629-23. R. W. HEATH, Arizona State University, Tempe, Arizona 85281. A paracompact semi-metric space which is not an \( M_3^-\text{space} \).

In [Some generalizations of metric spaces, Pacific J. Math 11 (1961), 105-125] Jack Ceder defined \( M_i^-\text{spaces} \) \((i = 1,2,3)\)--an \( M_1^-\text{space} \) being a \( T_3^-\text{space} \) with a \( \sigma \)-closure preserving basis and \( M_2^- \) and \( M_3^-\text{spaces} \) being similarly defined (and perhaps equivalent to \( M_1^-\text{spaces} \)). Ceder showed that a first countable \( M_3^-\text{space} \) is a paracompact semi-metric space and raised the question: is every paracompact semi-metric space an \( M_3^-\text{space} \)? In this paper an example is given of a Lindelöf (hence paracompact) semi-metric space which is not an \( M_3^-\text{space} \). The space is also a cosmic space.
continuous image of a separable metric space) which is not stratifiable (i.e. not an $M$-space) answering a question raised by C. J. R. Borges. (Received September 27, 1965.)

629-24, L. J. LIPKIN, University of California, Berkeley, California. The general Plateau problem with free boundary.

We extend the existence theory for the parametric Plateau problem for general integrals $I_0(z, Q) = \int_Q F(z, \lambda) dQ$ of the calculus of variations to the following "free boundary" problem. Let $T$ be a fixed solid torus in $E^3$ and let $H$ be a fixed simple closed curve in $E^3$ which links $T$ with linking number 1. We consider the class $S$ of those parametric Fréchet surfaces represented on the unit square $Q$ by vectors $z(w)$ having the properties: (i) $z(w) \in W^1_2(Q)$; (ii) $z(w)$ is continuous on the interior $Q^0$ of $Q$; (iii) there is a number $h > 0$ (depending upon the vector $z$) such that if $a_0$ is any simple closed curve lying in the strip $S_h$ bounded by $\partial Q$ and the curve $S^*_h = \{w \in Q^0 : \text{dist}[w, \partial Q] = h\}$, with a homotopic (in $S^*_h$) to $\partial Q$, then $z$ maps $a_0$ onto a (continuous) closed curve linking $H$; (iv) if $w_0 \in \partial Q$ and $w_n \in Q^0$, $n = 1, 2, ...,$, then $w_n \to w_0$ implies $\text{dist}[z(w_n), T] \to 0$. Then there exists a surface in $S$ for which the integral $I_0(z, Q)$ is minimized. Here $F(z, \lambda)$ is a parametric integrand satisfying the usual convexity and growth conditions. (Received September 27, 1965.)

629-25, L. E. BOBISUD, University of New Mexico, Albuquerque, New Mexico. Regular degeneration of certain systems of linear partial differential equations with constant coefficients.

Consider a system of partial differential equations of the form (1) $A(\epsilon)(\partial V_\epsilon / \partial t) + \sum_{|a| \leq p} B_a D^a V_\epsilon = 0$ where $p$ is a positive number, the $B_a$ are $N \times N$ matrices of constants, $A(\epsilon)$ is an $N \times N$ diagonal matrix with $N - m \epsilon$'s followed by $m$ one's ($1 \leq m \leq N - 1$), and $D^a = D^a_1 D^a_2 ... D^a_N$. For each $\epsilon > 0$ $V_\epsilon$ is to satisfy $V(0, x) = f(x)$. Under sufficient assumptions on (1), this problem can be solved for each $\epsilon > 0$ provided $f$ has a sufficient number of $L^1$ and continuous derivatives. If $M_1$ denotes the upper left $(N - m) \times (N - m)$ submatrix of $M = \sum_{|a| \leq p} (\epsilon - i)^a B_a$, then if $|\det M_1(\epsilon)| \cong k$ for some constant $k > 0$ the degenerate problem obtained from (1) by setting $\epsilon = 0$ can also be solved uniquely with the solution $U$ satisfying $U^2(0, x) = f^2(x)$, where for any $N$-vector $y$ we denote by $y^2$ the $m$-vector composed of the last $m$ entries of $y$. The question is, when does the behavior $V_\epsilon \to U + \text{boundary layer terms}$ obtain as $\epsilon \to 0$. By means of the Fourier transform this is shown to occur if the roots $\eta$ of $\det (i\eta A(\epsilon) + M(\epsilon))$ satisfy $\text{Im}(\eta) \geq c$ for some constant $c$ and if the roots $\mu$ of a certain auxiliary equation satisfy $\text{Im}(\mu) > 0$. (Received September 27, 1965.)

629-26, JORG MAYER, University of New Mexico, Albuquerque, New Mexico 87107. A universal property of completions of an ordered set.

Definition. Let $P$ and $Q$ be ordered sets, and $\mathcal{B}$ a family of order ideals (initial sets) on $P$. A function $f : P \to Q$ is called $\mathcal{B}$-continuous if the inverse image of every principal ideal in $Q$ is a member of $\mathcal{B}$. Theorem. Let $P$ be an ordered set. Let $\mathcal{R}$ be the category of complete lattices with sup-preserving functions as morphisms. Let $L_{\mathcal{B}}$ be a $\mathcal{R}$-dense completion of $P$, isomorphic to a family $\mathcal{B}$ of initial sets of $P$. Then, to every pair $(L, \phi)$, $L \in \mathcal{R}$, $\phi : P \to L$, $\phi$ sup-preserving and $\mathcal{B}$-continuous, there exists a morphism $f : L_{\mathcal{B}} \to L$ such that $f \circ i = \phi$, where $i$ is the injection $1 : P \to L_{\mathcal{B}}$. (Received September 27, 1965.)
ABSTRACTS PRESENTED BY TITLE


The deviation of the polynomial \( p_0(x) = c \) from the given function \( f(x) = |x|^{1/a}g(x)p + a > 2 \), \( w(x) \) non-negative, bounded, and integrable but not a null function, is defined as \( \delta(c) = \int w(x) |c - f(x)|^p \, dx \), whence \( \delta''(0) < 0 \). Thus the error function \( c - f(x) \) has a strong oscillation in the interval \([-1, 1]\), yet \( \delta(c) \) has a local maximum at \( c = 0 \) provided \( \delta'(0) = 0 \); this is true for every (allowable) choice of \( w(x) \). For suitably chosen \( w(x) \), the deviation \( \delta(c) \) has a global maximum at \( c = 0, |c| \leq 1 \). (Received July 15, 1965.)


(1) Let \( R^n \times K \) be an open subgroup of a locally compact group \( G \) with topology \( \tau_1 \) where \( n \geq 0 \) and \( K \) is compact. Let \( \phi: R^m \rightarrow K \) be a one-to-one continuous isomorphism of \( R^m \) into \( K \) for some integer \( m \). Let \( L \) be a compact subgroup of \( K \) such that \( L \cap \phi(R^m) = \{ 0 \} \). Let \( r \) be an integer such that \( 0 \leq r \leq n \). Let \( \tau_2 \) be a locally compact group topology on \( R^n \times K \) such that \( L \times \phi(R^m) \times R^r \) is open and \( L \) gets the relative topology from \( K \) and \( \phi(R^m) \) gets the topology to make \( \phi \) a topological isomorphism between \( R^m \) and \( \phi(R^m) \). Then \( \tau_2 \geq \tau_1 \) and \( (G, \tau_2) \) is a locally compact group. Conversely every locally compact group topology \( \tau_2 \) on \( G \) which is stronger than \( \tau_1 \) arises this way. (2) The only locally compact groups \( G \) which admit the discrete topology as the only strictly stronger topology making \( G \) a locally compact group are those which contain either the real line, or circle or \( p \)-adic integers with usual topology as an open subgroup. (\( p \) is prime). (3) Let \( G \) be an abelian group with two locally compact group topologies \( \tau_1 \) and \( \tau_2 \) on it. Let \( (G, \tau_1) \) be connected. Let a subgroup \( H \) of \( G \) be closed in \( \tau_1 \) if and only if it is closed in \( \tau_2 \). Then \( (G, \tau_1) \) and \( (G, \tau_2) \) are isomorphic as topological groups. (Received July 12, 1965.)

65T-453. C. J. EVERETT, 1334 43rd Street, Los Alamos, New Mexico. On the basis and chromatic number of a graph.

(1) A proof of the "basis theorem" for directed graphs is given, based on Zorn's lemma, which generalizes, and perhaps clarifies the exposition in Chapter 2 of C. Berge's Theory of graphs, Wiley, New York, 1964; (2) A symmetric graph \( G^* = (Q, F^*) \) without loops is defined on an arbitrary collection \( Q \) of non-null subsets of a set \( X \), including all its one-element subsets, by \( F^*(q) = \{ q_1; q_1 \in Q, q_1 \neq q, q_1 \cap q \neq \emptyset \} \). The partitions of \( X \) into \( Q \)-sets correspond to the kernels of \( G^* \), which are here identical with the maximal internally stable subsets of \( G^* \). Applied to the collection \( Q \) of non-null internally stable subsets of a graph \( G = (X, F) \) without loops, this identifies the chromatic number \( \gamma(G) \) with the least cardinal number of any kernel of \( G^* \). For a finite graph, the evaluation of \( \gamma(G) \) is therefore possible via known algorithms for kernels. (Received August 13, 1965.)
Denote by $S$ a normed linear complete space over the real or complex numbers and by $B$ the corresponding space of bounded linear transformations on $S$. Denote by $V$ the set of all functions $T$ from $[0,\infty)$ to $B$ such that (1) $T(x)T(y) = T(x+y)$ if $x,y \geq 0$, (2) $T(x)A \to T(0)A = A$ as $x \to 0$ for all $A$ in $S$ and (3) $\lim_{x \to 0^+} \sup |T(x) - I| < 2$. If $T$ is in $V$, then a trajectory of $T$ is a function $g$ from $[0,\infty)$ to $S$ such that for some $A$ in $S$, $g(x) = T(x)A$ for all $x$ in $[0,\infty)$. Theorem. The set of all trajectories of members of $V$ is a quasi-analytic collection in the sense that no two such trajectories agree on a nondegenerate sub-interval of $[0,\infty)$. The result relies heavily upon the author's paper: A quasi-analyticity condition in terms of finite differences, Proc. London Math. Soc., Third Ser., (54) XIV (1964), 245-259. (Received August 18, 1965.)

65T-455. R. J. WARNE, 428 Cedar Street, Morgantown, West Virginia. The idempotent separating congruences of a bisimple inverse semigroup with identity.

Theorem. Let $S$ be a bisimple inverse semigroup with identity and right unit subsemigroup $P$. A right normal divisor of $P$ is a subgroup $V$ of the group of units $U$ of $P$ such that $aV$ in $Va$ for all $a$ in $P$. There exists a 1-1 correspondence between the idempotent separating congruences of $S$ and the right normal divisors of $P$. In this case, each congruence is uniquely determined by the congruence class containing the identity. If $\rho^V$ is the congruence corresponding to the right normal divisor $V$, $\rho^V(a,b) = ((a,vb) : v \in V)$. Each idempotent separating congruence of $S$ is contained in $\mathcal{C}$. If $M = \{g \in U : g \text{ in } Ux \text{ for all } x \in P\}$, $\rho^M$ is the maximal idempotent separating congruence of $S$. We also give a class of examples of bisimple inverse semigroups with identity on which $\mathcal{C}$ (Green's relation) is not a congruence i.e., $\mathcal{C}$ properly includes each idempotent separating congruence of $S$.

(Received August 30, 1965.)

65T-456. ALEXANDER ABIAN and D. L. DEEVER, The Ohio State University, 231 West 18th Avenue, Columbus, Ohio 43210. Representation of simply ordered sets and the generalized continuum hypothesis, II.

Definition 1. Let $(s_i)$ and $(t_i)$ be two sequences of the same finite or transfinite type. $(s_i)$ is said to be less than or equal to $(t_i)$ according to the principle of strong first differences if $s_i = 1$ implies $t_i = 1$ (or, $t_i = 0$ implies $s_i = 0$) for every index $i$. Based on the definitions of a weakly dense and Hausdorff-dense subsets of a partially ordered set, as introduced in Abstract 65T-428, these articles 12 (1965), 718, the following theorems are established. Theorem 1. The Generalized Continuum Hypothesis is equivalent to the statement; for every ordinal number $\lambda$ if a simply ordered set is isomorphic to a set of sequences of type $\omega^\lambda$ made up of 0,1 and ordered by the principle of first differences then it has a Hausdorff-dense subset of power $\leq \kappa^\lambda$. Theorem 2. The Generalized Continuum Hypothesis is equivalent to the statement; for every ordinal number $\lambda$ if a simply ordered set has a weakly dense subset of power $\leq \lim_{1 < \lambda^\kappa}$ then it is isomorphic to a set of sequences of type $\omega^\lambda$ made up of 0,1 and ordered by the principle of strong first differences. (Received August 23, 1965.)
Semirecursive sets. Preliminary report.

See Abstract 65T-433, these Notices 12 (1965), 720, for notation. A set A is defined to be semirecursive if $A \times \overline{A}$ and $\overline{A} \times A$ are recursively separable. If $A$ is semirecursive and $B \leq_p A$, then (i) $B \leq_m A$, (ii) $B$ is semirecursive, and (iii) $B$ immune $\Rightarrow$ $B$ hyperimmune. Hence the p-degree of a semirecursive set consists of a single m-degree. If $A$ is productive (or creative) $A$ is not semirecursive. However, if $A$ is r.e. and $\overline{A}$ is regressive, $A$ is semirecursive. Since hypersimple sets constructed by Dekker have retraceable complements, it follows that every r.e. nonrecursive Turing degree contains a hypersimple semirecursive set. Thus there are hypersimple sets such that $A \times A \leq_m A$ and $A \times A$ is a cylinder. These results answer again the question of Young mentioned in the previous abstract and also answer a question of Rogers. If the conjecture that p-reducibility coincides with tt-reducibility on the nonrecursive r.e. sets is true, then there are r.e. nonrecursive tt-degrees which contain only one r.e. m-degree and contain no simple sets which are not hypersimple. If $A$ is maximal, it can be shown using a theorem of Young on maximal sets that $A$ is semirecursive iff $A \equiv_m A \times A$ iff $B \equiv_p A \Rightarrow B$ is recursive or $B =_m A$. (Received August 26, 1965.)

65T-458. A. A. MULLIN, Lawrence Radiation Laboratory, Box 808, Livermore, California 94551. New results on generalized arithmetic functions.

For nonstandard terminology see, e.g., Z. Math. Logik Grundlagen Math. 11 (1965), 117-119. This note gives a way to generate infinite sets of generalized multiplicative arithmetic functions (GMAF) which are not multiplicative (MAF), and analogously for generalized additive arithmetic functions (GAAF). **Lemma** 1. Let $f_1$ and $f_2$ be MAF. If $f_1 \neq f_2$ then $f_1(\psi(\cdot)) \neq f_2(\psi(\cdot))$, where $\psi$ is defined in, e.g., Bull. Amer. Math. Soc. 69 (1963), 446-447. **Lemma** 2. For every MAF, $f$, which is not completely multiplicative there exists a GMAF, $f(\psi(\cdot))$ which is not multiplicative. **Lemma** 3. There exists an infinite set of GMAF's which are not multiplicative. Similarly, replacing "multiplicative" by "additive". Finally, the author investigates the distribution of values of various generalized additive functions which are not additive (e.g., $\log \psi^2$, $\psi(\psi(\cdot))$, and $g_2(\cdot)$ which counts the number of distinct primes in the mosaic of $n$). Use is made of the strong law of large numbers and the central limit theorem. The distribution of values of arbitrary GAAF's remains an open question. (Received August 27, 1965.)


For terminology and references see Abstracts 65T-444 and 65T-445, these Notices 12 (1965), 723. Using methods of those abstracts and ideas of Frederick Rowbottom, it can be shown that all results of the second abstract hold for cardinals $K$ such that $K \rightarrow (K_0)^2 < K_0$. In particular, the first cardinal $K_1$ for which $K_1 \rightarrow (K_0)^n < K_0$ exceeds the first $\prod_0^n$-indescribable inaccessible cardinal for each $n$ and the first weakly compact cardinal. Also $K_1$ is inaccessible. These results answer additional questions of Erdös and Hajnal, and have implications concerning the Hanf numbers of certain infinitary languages. (Received September 1, 1965.)
On finite metric sets III: The minimal point.

Terminology is that of Abstract 65T-446, these Notice 12 (1965), 724. Given a metric set of n points \( S = \{ p_1, ..., p_n \} \) such that the maximal sum of n linked distances is T, let \( \phi(p) = \sum_{j=1}^{n} p_{p_j} \) where p is an element of any metric space containing S. Then the minimum value of \( \phi(p) \) is T/2. A minimal point, i.e., a point \( p_0 \) such that \( \phi(p_0) = T/2 \) is constructed. Distances \( p_0p_j \) are uniquely defined if n is odd and if (with proper numbering) \( T = p_1p_2 + p_2p_3 + ... + p_n \).P_1. (Received September 2, 1965.)

65T-461. F. J. ALMGREN, JR., Institute for Advanced Study, Fine Hall, Princeton University, Princeton, New Jersey. An interior regularity theorem for three-dimensional minimal surfaces in \( \mathbb{R}^4 \) and an extension of Bernstein's theorem to nonparametric four-dimensional minimal surfaces in \( \mathbb{R}^5 \).

We use the terminology of [H. Federer and W. H. Fleming, Normal and integral currents, Ann. of Math. 72 (1960), 458-520]. Theorem. Let \( T \in \mathcal{I}_3 (\mathbb{R}^4) \) be minimal, then \( \text{spt}(T) - \text{spt}(\partial T) \) is a real analytic three-dimensional submanifold of \( \mathbb{R}^4 \) satisfying the minimal surface equation. Theorem. Let \( S \) be a globally defined nonparametric minimal hypersurface of class \( C^3 \) in \( \mathbb{R}^5 \). Then \( S \) is a hyperplane. (Received September 7, 1965.)


Let \( G \) be a compact Lie group, I a closed subgroup of \( G \) and \( A, B \) proper \( k, \ell \)-submanifolds of class 1 of \( X = G/I \) such that \( G \) is transitive on the set of tangent spaces \( T_a(A), a \in A, \) of \( A \), and of \( B, \) respectively. Let \( G \) have a bi-invariant metric and \( X \) the \( G \)-invariant metric such that for each projection \( \pi: G \to X, \pi_g(g) \) is an orthogonal projection, \( g \in G, \) \( H^t \) is \( t \) dimensional Hausdorff measure; \( \dim X = n; r = \sup \{ \dim(T_a(A) + T_{g[B]}): g \in G, a \in A \cap g(B) \}. \) For \( r < \inf \{ k + \ell, n \} \), the following formulas are new; the results for \( r = k + \ell \) are \( r = n \) were announced in Abstract 64T-370, these Notice 11 (1964), 585. (The statement for \( r = k + \ell \) was erroneous; the formula holds for certain left invariant metrics on \( G \).) There exists \( a > 0 \) such that if \( C, D \) are Borel subsets, of \( A, B \), then \( \int_G H^{k + \ell - t} [C \cap (D)] dH^t + \dim I_g = a H^k(C) H^\ell(D). \) If instead of compact \( G \) one has \( G = \mathbb{E}_0 \times I, X = \mathbb{E}_n, \) where \( I \) is a closed subgroup of \( \mathbb{E}_n \), then \( \int_{\mathbb{E}_n} \int_{\mathbb{E}_n} H^{k + \ell - r} [C \cap (D)] dH^r \times \Phi (z, R) = a H^k(C) H^\ell(D) \), where \( \Phi \) is a Haar measure on I. The proofs are based on the following generalization of H. Federer's coarea formula: Let \( X, Y \) be separable Riemannian manifolds of class 1 with \( \dim X = n, f: X \to Y \) be a Lipschitzian map, \( s = \sup \{ \text{rank } f_\#(x): x \in X \} \) and \( J_g(s) = \sup \{ f_\#(v)(x): v \text{ is an } s \text{-vector at } x, |v| = 1 \}, x \in X. \) If \( A \) is an \( H^n \) measurable subset of \( X \), then \( \int_A J_g f dH^n = \int_Y H^{n-s} [A \cap f^{-1}(y)] dH^s y. \) (Received September 7, 1965.)

65T-463. G. A. BROSAMLER, University of British Columbia, Vancouver, B. C., Canada. Potential theory on \( \mathbb{R} \) defined by a measure.

A measure \( \mu \) on the Borel sets of \( \mathbb{R}^+ (= \text{non-negative real line}), \) satisfying \( \mu([\xi, \xi + 1]) \leq 1, \xi \in \mathbb{R}^+, \) defines a potential theory on \( \mathbb{R}^+: \) Call \( h \) on \( \mathbb{R}^+ \) regular if (I) \( 0 \leq h < \infty, \) (II) \( \int_{[\xi, \xi + 1]} h(\eta) \mu(d\eta) \)
Call \( u \) on \( \mathbb{R}^+ \) superregular if \((\Pi')0 \leq u \leq \infty, \ (\Pi') \int (\xi, \xi+1) \mu(d\eta) \leq u(\xi), \ \int (\xi, \xi+1) u(\eta) \mu(d\eta) < \infty. \) Let \( \phi = \lim_{n \to -\infty} \psi_n \), where \( \psi_0 = 1, \ \psi_{n+1}(\xi) = \int (\xi, \xi+1) \psi_n(\eta) \mu(d\eta). \) The measure \( \mu \) is said to satisfy (A) if \( \limsup_{\xi \to -\infty} \mu(\xi, \xi+1) > 0 \) and \( \int (0, \infty) \{1 - \mu(\xi, \xi+1)\} \mu(d\xi) < \infty. \) \textbf{Theorem 1:} \( \phi \neq 0 \) iff \( \mu \) satisfies (A). \textbf{Theorem 2:} Let \( \mu \) satisfy (A). Then: (a) The Martin space of the potential theory considered is the one-point compactification of \( \mathbb{R}^+ \). (b) The regular functions are the functions

For notation see Hochschild (Trans. Amer. Math. Soc. 69 (1950), 292-301). Let \( A \) be an Azumaya algebra over \( C \), where \( C \) is a Noetherian ring with no nontrivial idempotents such that every \( C \)-algebra automorphism of \( A \) is inner. Let \( \mathcal{G} \) be the family of all groups \( G \) of automorphisms of \( A \) such that \( \mu(B) < \infty \) and \( \lim_{\xi \to \infty} \xi B \in C \) \( \mu(\xi, \xi+1) \mu(d\xi) \) exists and is finite. (c) The class of sets thin at \( \infty \), and the class of transient sets and the class of sets of finite \( \mu \)-measure coincide. (For definitions see Doob's 1959 paper, J. Math. Mech.) (Theorems 1 and 2c extend results of Slater and Wilf in J. Math., 1960, where they consider the special case \( \mu(\xi) = K(\xi) d\xi, 0 \leq K \leq 1, K \) nondecreasing.) (Received September 7, 1965.)

65T-465. W. L. REDDY, 125 B Winrow Road, Ft. Huachuca, Arizona. The product of an interval and a torus admits an expansive homeomorphism.

Let \((x,y,z)\) represent a point of \( E_2 \times I \), where \( I \) is an interval, and identify points which differ by an integer in the first two coordinates, and not at all in the third. The homeomorphism \( f(x,y,z) = (x + y + z, x + 2y + 2z, z) \) of \( E_2 \times I \) onto itself induces an expansive homeomorphism of the identification space, which is the product of an interval and a torus. Previous examples of expansive homeomorphisms on manifolds have been closely related to automorphisms of toral groups. (Received September 7, 1965.)

65T-466. BENJAMIN VOLK, 1315 Dickens Street, Far Rockaway, New York 11691. Differences, convolutions, primes. I.

\textbf{Theorem 1.} Let \( Z \) be a set of points in the open unit disc having the origin as a limit point. Then the set \( W \) of the same cardinality as \( Z \) can be interpolated at the points of \( Z \) by an analytic
function \( w = w(z) \) having bounded coefficients in its Maclaurin series expansion if and only if
\[
|w(a,b,c,\ldots,t)| (1 - |a|)(1 - |b|)(1 - |c|) \ldots (1 - |t|)
\]
is not larger than \( M \) whenever \( a,b,c,\ldots,t \) are a finite number of distinct elements of \( \mathbb{Z} \). Here \( M \) denotes the bound on the modulus of the coefficients of \( w(z) \).

Also, if \( a,b,c,\ldots,t \) are \( n \) distinct points then \( w(a,b,c,\ldots,t) \) denotes the divided difference of order \( n - 1 \) of \( w(z) \) taken at the points \( a,b,c,\ldots,t \). Corollary 1 (Vitali). Let \( S \) be a sequence of functions each of which is regular in the region \( D \) and bounded by \( M \) in \( D \). Let the sequence tend to a limit at every one of a set of points having a limit point inside \( D \). Then the sequence tends uniformly to a limit in any region bounded by a contour interior to \( D \), the limit being a function which is analytic in \( D \).

Conjecture 1. Theorem 1 is true for any set \( Z \) of points in the open unit disc having a limit point in the open unit disc. Gratitude is due to Dr. Shisha for permission to present this at the August A.R.L. Symposium on inequalities. (Received September 13, 1965.)


Let \( H_1, H_2, H_3 \) be spaces; \( X \subset H_1 \times H_2, Y \subset H_2 \times H_3 \). (\( X \) and \( Y \) might be graphs of two functions.) In case \( H_1, H_3 \) are topological spaces and \( H_2 \) a uniform space, we define the weak composite of \( X \) and \( Y \) by: \( (a,c) \in X \circ W Y \) provided, for any neighborhoods \( N_1, N_3 \) of \( a \) and \( c \) respectively, and any "neighborhood of the diagonal" \( U \) of the uniformity in \( H_2 \), there exist \( (a',b') \in X \) and \( (b'',c') \in Y \) such that \( a' \in N_1, c' \in N_3, \) and \( (b',b'') \in U \). This operation has a rather simple "calculus", which becomes richer as stronger hypotheses are placed on \( H_1, H_2, H_3, X, Y \). It is proposed to utilize \( \circ \) to obtain useful definitions of "weak solution" for various functional equations, and the "calculus" to give simple proofs of properties of such solutions. The case where \( H_1,H_2,H_3 \) are topological vector spaces and \( X,Y \) are linear subspaces is especially interesting. (Received September 10, 1965.)

65T-468. J. E. DONER, University of California, Berkeley, California 94720. Decidability of the weak second-order theory of two successors.

For \( k < \omega \), let \( N_k \) be the set of finite sequences over a \( k \)-element alphabet \( \{a_0, \ldots, a_{k-1}\} \).

For \( w \in N_k \) and \( i < k \), let \( s_i(w) = w \sqcup a_i(w \text{ concatenated with } a_i) \). Let \( \mathcal{R}_k \) be the structure \( \langle N_k, s_0, \ldots, s_{k-1} \rangle \) and WMT(\( \mathcal{R}_k \)) be the weak second-order theory of \( \mathcal{R}_k \) restricted to monadic predicates. The decision problem for WMT(\( \mathcal{R}_1 \)) was settled positively by Buchi (Z. Math. Logik 6); he there raised the corresponding problem for \( \mathcal{R}_2 \). Theorem 1. For \( k < \omega \), WMT(\( \mathcal{R}_k \)) is decidable.

The proof is similar to Buchi's, but uses a generalized notion of finite automaton (similar to that discovered independently by Thatcher-Wright; cf Abstract 65T-469, these Notices 12 (1965), 469). For any class \( S \) of order types let \( \mathcal{L}(S) \) be the closure of \( S \) under +, *, and \( \ast \) (converse). Let \( \eta \) be the type of the rationals and \( OR \) be the class of ordinals. Theorem 2. For any \( \tau \) in \( \mathcal{L}(OR \cup \{\eta\}) \) and any order structure \( \mathcal{O} \) of type \( \tau \), WMT(\( \mathcal{O} \)) is decidable. (This generalizes the decidability of WMT(\( \omega < \omega, \leq \)) and \( \omega \) in OR, which was already known as a consequence of results of Ehrenfeucht and Buchi.) The proof, involving interpretation (in a sense analogous to that of Undecidable theories) into WMT(\( \mathcal{O}_2 \)), proceeds by establishing the theorem for \( \mathcal{L}(\{\eta, \omega\} \cup \omega) \) and then applying the methods of Ehrenfeucht (Fund, Math, 49). (Received September 17, 1965.)
A **species** is a pair \( S, r \) where \( S \) is a set and \( r: S \rightarrow \mathbb{N} \). An **\( \mathcal{L} \)-algebra** is a pair \( \langle A, h \rangle \) where \( A \) is a set and \( h \) is defined on \( S \) with \( h(s) \) an \( r(s) \)-place operation on \( A \). A multialgebra of species \( \mathcal{L} \) is like an algebra with \( h(s): A^{r(s)} \rightarrow 2^A \). A finite \( \mathcal{L} \)-automaton is a finite \( \mathcal{L} \)-algebra (set of \( A \), initial configuration \( h^{-1}(0) \), and direct transition functions \( h(s) \) for \( S \not\in r^{-1}(0) \)).

The nondeterministic automata of species \( \mathcal{L} \) are the multialgebras of that species. Relative to a set \( A' \) of final states an \( \mathcal{L} \)-automaton accepts a subset of the set of constant terms of the species. Our results are aptly summarized by saying that a large part of conventional finite automata theory goes through in the generalized context. Application. Under a natural interpretation of the terms of the species \( \mathcal{L}_{n,k} = \langle \{0,1\}^n \cup \{\lambda\}, r \rangle \), \( r(\lambda) = 0 \) and \( r(\delta) = k \), as denoting \( n \)-tuples of finite subsets of the set of strings on \( k \) symbols, we prove that every \( n \)-place relation definable in the weak second-order theory of \( k \) successor functions is accepted by some finite \( \mathcal{L}_{n,k} \)-automaton. Because the generalized emptiness problem is recursively solvable it follows that the weak second-order theory of \( k \) successor functions is decidable. This result was first obtained by J. E. Doner (see Abstract 65T-468, these Notices 12 (1965), 819) using finite automata methods which were developed independently. (Received September 17, 1965.)

**65T-470.** M. E. NEWTON, 97 Mill Creek Road, Fremont, California 94538. **The differential ideal generated by \( y^2z \).**

An extension to the differential ideal \( [y^2z] \) of the results of Levi in Trans. Amer. Math. Soc. 51 (1942), 532-568, containing an investigation of the differential ideals \( [P^P] \) and \( [uv] \), has been obtained. That is, we have a description of canonical forms and a reduction process which enables us to determine whether a given polynomial is or is not in \( [y^2z] \). However, \( [y^2z] \) is not a simple amalgamation of \( [y^2] \) and \( [uv] \), for although \( P = yy_2y_3z^4 \) is in \( [y^2z] \), by placing \( yy_2y_3 \) in its canonical form (as an element of \( [y^2] \)) and the resulting expression in its canonical form (as an element of \( [uv] \) with \( y^2 \) playing the role of either \( u \) or \( v \)) one would be tempted to conclude that \( P \) is not in \( [y^2z] \). A complete description of the reduction process will be given elsewhere and we limit ourselves to a description of the function corresponding to Levi's \( w(p,d) \) and \( w(d_1,d_2) \). We have shown that a power product \( P \) of degree \( d_1 \) in the \( y \)'s, degree \( d_2 \) in the \( z \)'s, and weight \( w \) is in \( [y^2z] \) if \( w < f(d_1,d_2) \) where \( f(d_1,d_2) = d_1(d_1 - 1) \) if \( d_2 \geq 2(d_1 - 1) \) and \( f(d_1,d_2) = \lceil (4d_1d_2 - 2d_2 - d_2^2)/4 \rceil \) if \( d_2 \leq 2(d_1 - 1) \). Also, given any \( w \geq f(d_1,d_2) \), there is a corresponding \( P \) not in \( [y^2z] \). (Received September 20, 1965.)

**65T-471.** G. E. KELLER, University of Minnesota, Minneapolis, Minnesota, and F. R. OLSON, Michael Hall, State University of New York, Buffalo, New York, 14214. **The number of permutation polynomials (mod \( m \)).**

Let \( f(x) \) be a polynomial with coefficients in the ring \( \mathbb{Z}_m \) of integers \((\mod m)\). If \( x \rightarrow f(x) \) is a 1-1 mapping of \( \mathbb{Z}_m \) onto \( \mathbb{Z}_m \), \( f(x) \) is called a permutation polynomial. Let \( O(p^n) \) be the number of permutation polynomials \((\mod p^n)\) for \( p \) a prime. It is shown that \( O(p^2) = p!p^{p(p - 1)} \) and that for \( n \geq 3 \) \( O(p^n) = O(p^2) \cdot p^{\psi(p^n)} \) where \( \psi(p^n) = \sum_{j=3}^{n} \mu(p^j) \) and \( \mu(p^j) \) is the smallest integer \( k \) such that \( p^j \) divides \( k! \). Since \( O(mn) = O(m) \cdot O(n) \) for \( (m,n) = 1 \), \( O(m) \) is determined for all \( m \). (Received September 21, 1965.)
Denote by $R$ the class of integral, representable relation algebras, and by $T$ the class of isomorphs of subalgebras of complex algebras of groups. The following theorem refutes the conjecture of Jónsson and Tarski (Bull. Amer. Math. Soc. 54 (1948), 80) that $R = T$. Theorem. There exists a universal class $S$ of relation algebras such that (i) $R \subseteq S > T$ and (ii) the elementary theory of $T$ is not a finite extension of the theory of $S$. Given a pair of groups $H, G$ with $H \subseteq G$, let $\mathcal{O}[G,H]$ be the algebra whose elements are the $V \subseteq G$ such that $H \cup H = V$, whose relative identity is $H$, and whose operations are the obvious ones. Then $S$ is the class of all isomorphs of subalgebras of algebras $\mathcal{O}[G,H]$. The proof of (ii) is by ultraproducts. There exists a sequence $\mathcal{O}_n$, ($n \in \omega$), $\mathcal{O}_n \in S \sim T$, such that an ultraproduct of the $\mathcal{O}_n$ belongs to $T$. It is not known whether $R = S$, however the algebra $\wp(P)$, which Lyndon (Michigan Math. J. 8 (1961), 21-28) associates with a projective plane $P$, belongs to $S$ if and only if the order of $P$ is a prime power or infinite. (Received September 21, 1965.)

**65T-473.** LOUISE HAY, Mount Holyoke College, South Hadley, Massachusetts 01075. The co-simple isols.

Let $\Omega =$ the recursive equivalence types, $\Lambda =$ the isols, $\Omega_P =$ those elements of $\Omega$ representable by the complement of a recursively enumerable (r.e.) set, $\Lambda_z =$ $\Lambda \cap \Omega_P$, $\Lambda^* =$ the ring of differences of isols, $\Lambda^*_z =$ the subring of differences of elements of $\Lambda_z$. Define an r.e. sequence of elements of $\Omega_P$ to be the sequence of types of the complements of an r.e. sequence of r.e. sets. Using the "priority" method in a (Baire) category setting, it is shown that most of the results of Nerode (Ann. of Math. 73 (1961), 362-403 and 75 (1962), 419-448) for $\Lambda$ and $\Lambda^*$ hold with domain of individuals restricted to $\Lambda_z$ and $\Lambda^*_z$. Sample results. (1) $\Omega^\omega_P$ is productive. (2) Let $f$ be a recursive function; then $f$ is eventually recursive combinatorial if and only if for all $x \in \Lambda_z^\omega$ there is exactly one $y$ with $(x,y) \in f_{\Lambda^*_z}$. Otherwise $\{x \in \Lambda_z^\omega | x \notin \text{domain } f_{\Lambda^*_z}\}$ is productive. (3) Let $R^0,...,R^p$ be r.e. $n$-ary relations in the integers and $x_{k+1},...,x_n \in \Lambda_z^*$. If there exist integers $m_1,...,m_p$, $1 \leq j \leq k$, $1 \leq i \leq p$, such that for each $i$, $\Lambda_z^* (m_1,...,m_1,...,x_{k+1},...,x_n)$ is false in $\Lambda_z^*$, then there exist $x_1,...,x_k \in \Lambda_z^*$ (which can be effectively found) such that $R^0(x_1,...,x_n)v...vR^p(x_1,...,x_n)$ is false in $\Lambda_z^*$. Corollary. There are no primes in $\Lambda_z^*$. (Received September 21, 1965.)


Small latin letters denote integers. For each $k > 0$, $\Gamma^*(k)$ denotes the least $s$ such that for every prime $p$, every $m \geq 1$, and all $a_1,...,a_s$, the congruence (*) $a_1 x_1^k + a_2 x_2^k + \ldots + a_s x_s^k = 0$ (mod $p^m$) has a solution with some $x_i \neq 0$ (mod $p$). It is shown that $\Gamma^*(k) \leq k \log_2 (k - 1)/\log_2 z + 1 + \log^2 (k - 1)/\log^2 z + 1/2$ + 1 for odd $k \geq 3$ (here $[ ]$ denotes the integral part), slightly improving a result of Chowla and Shimura (Norske Videns. Selsk. Forth. 36 (1963), 169-176). Using extensions of their methods, and some ideas of Davenport and Lewis (Proc. Roy. Soc. Ser. A 274 (1963), 443-460), numerous other results are obtained. In particular, $\Gamma^*(7) = 22$ and $\Gamma^*(9) = 37$. A lower bound for $\Gamma^*(k)$ is obtained in terms of the smallest prime $p = 1$ (mod $k$) (e.g., if $p \leq k(k - 3) + 1$, then $\Gamma^*(k) \geq 3k + 1$), and this can be improved in some cases. In determining $\Gamma^*(k)$, it is often sufficient to
consider (*) only for p odd, p \parallel k, and m = 1, and this implies that (**). \( \Gamma^*(k) = 1 \pmod{k} \) in many cases. E.g., (***) holds for every odd prime k for which 2k + 1 is also prime. Using these ideas, it can be shown that \( \Gamma^*(11) = 45 \) or 56; \( \Gamma^*(13) = 53, 66, 79, \) or 92; etc. (Received August 31, 1965.)

65T-475. HAJIMU OGAWA, University of California, Riverside, California 92502. Lower bounds for solutions of parabolic inequalities. Preliminary report.

Let D be a bounded domain in \( \mathbb{R}^n \) with boundary \( \Gamma \) and let \( I = [0,\infty) \). Suppose \( u(x,t) \) is a function having continuous derivatives of order 2m with respect to \( x = (x_1, \ldots, x_n) \) and one continuous derivative with respect to \( t \) on \( D \times I \) and assume \( D_x^a u = 0 \) on \( \Gamma \times I \) for \( |a| \leq m \). Define \( L u = u_t + A u \), where \( A \) is a symmetric, uniformly elliptic operator of order 2m on \( D \times I \); i.e., \( A = \sum_{|a| = k} \alpha_{ij} \frac{\partial^2}{\partial x_i \partial x_j} \), \( \alpha_{ij} = \beta_{ij} \) and there exist positive constants \( c_1 \) and \( c_2 \) such that

\[
\int_D D^a_x u \cdot u \, dx \geq c_1 \|u(t)\|_m^2 - c_2 \|u(t)\|^2_m,
\]

where \( \|u(t)\|^2_m = \sum_{|a| \leq k} \int_D (D_x^a u)^2 \, dx \).

Theorem. Let \( u \) be a solution of

\[
\int_D L u(t) \leq \psi(t) \|u(t)\|^m_m
\]

and suppose \( \psi \) is a function satisfying

\[
\sum_{|a| \leq m} \int_D D_x^a (\psi u) \cdot D_x^a u \, dx \leq \psi(t) \|u(t)\|^2_m.
\]

If \( \phi \) and \( \psi \) are in \( L^2(0,\infty) \) and \( u(0) \neq 0 \), then there are constants \( \lambda \) and \( \mu \) such that

\[
\|u(t)\|_0 \leq \exp(\lambda t + \mu t^{1/2}),
\]

This extends a result of Cohen and Lees (Pacific J. Math. 13 (1961), 331-345) on the asymptotic behavior of solutions of second-order parabolic inequalities. (Received August 31, 1965.)


Let a topological space \( X \) be called semi-Hausdorff if every sequence in \( X \) converges to at most one limit. It is well-known that this condition is strictly between \( T_1 \) and \( T_2 \). In this article, some properties of semi-Hausdorff spaces are proved. E.g., the semi-Hausdorff property is hereditary, productive and a topological invariant. Also, in a semi-Hausdorff space, every sequentially compact set is sequentially closed. The following two characterizations are also proved: "A space \( X \) is semi-Hausdorff iff the diagonal set \( \Delta \) is sequentially closed in \( X \times X \)," and "A space \( Y \) is semi-Hausdorff iff for every space \( X \) and sequentially continuous functions \( f: X \to Y \) and \( g: X \to Y \), the set \( \{x : f(x) = g(x)\} \) is sequentially closed." (Received August 31, 1965.)

65T-477. R. P. DICKINSON, JR., Lawrence Radiation Laboratory, Box 808, Livermore, California. Distinctness and strong distinctness of certain semigroups of operators. Preliminary report.

Let \( E \) be a set with \( n \) elements. Let \( S_E \) be the set of all relations on \( E \). Let \( R, S, T \) and \( C \) be operations on \( S_E \) defined respectively by (4.1), (4.2), (4.5) and (4.13) of [1]. Let \( G^* \) be the semigroup of Theorem 4.1 of [1]. Let \( N^* \) be the semigroup of Theorem 4.3 of [1]. \( G_n^* \), a homomorphic image of \( G^* \), is the semigroup generated by \( R, S, \) and \( T \). Similarly, \( N_n^* \) is the semigroup generated by \( R, S, T, \) and \( C \). If for any \( X, Y \in G^* \) \( \exists X \neq Y \), one can find a \( \rho \in S_E \) \( \rho X \neq \rho Y \), then we say \( G_n^* \) is distinct on \( S_E \). If \( \exists \rho \in S_E \) \( \rho X = \rho Y \), then we say \( G_n^* \) is strongly distinct on \( S_E \). Similar definitions apply to \( N_n^* \). It is known that: (1) \( G_n^* \) is not strongly distinct on \( S_E \), and if \( n \geq 5, G_n^* \) is strongly distinct on \( S_E \); (2) \( \exists \) a semigroup \( E \) or order \( 6 \) \( \exists N_6^* \) is strongly distinct on \( S_E \). Results: Theorem. (1) \( G_3^* \) and \( G_4^* \) are not strongly distinct on \( S_E \). Theorem. (2) \( N_5^* \) is not strongly distinct on \( S_E \); \( E \) a groupoid. Theorem. (3) \( \exists \) a semigroup \( E \) of

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order $n \geq 3 \Rightarrow N_n$ is distinct on $S_2$. Reference. [1], T. Tamura, Operations on binary relations and their applications, Bull. Amer. Math. Soc. 70 (1964), 113-120. (Received August 31, 1965.)

ERRATA—Volume 12


Line 7: Replace "All groups isomorphic to a given..." by "For fixed $q$, all groups of types (1) - (9) are conjugate to each other in $GL(3,q)$".


The announcement is withdrawn. R. G. Douglas has found a gap in the proof of the theorem.


Line 2: Replace $\lambda_n$ by $\lambda^p$.
Line 4: Replace $|B|^n$ by $|B|^q$.
Line 4: Replace $b_{p,n}$ by $b_{p,n}^p$.

T. T. ROBINSON. Prenex normal form in predicate calculi which are classical in implication and minimal in negation. Page 621, Abstract 65T-360.

Line 1: Replace "64T-381" by "64T-391".
Line 6: Replace $\neg A \supset A \supset B$ by $\neg A \supset A \supset B$.


Line 2: Replace $0 < |z_n | < |l|$ by "$0 < |z_n | \leq |z_{n+1}| < |l|$".

ALBERT WILANSKY. Between $T_1$ and $T_2$. Page 545, Abstract 625-4.

Line 7. Replace: "If $X$ is $YS$, so is $Y$," by "If $X$ is $US$, $Y$ need not be."
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<tr>
<td><strong>Test Evaluation Programers</strong></td>
<td></td>
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<tr>
<td>BS or advanced degree in Math or the Physical Sciences, with programming experience on high speed digital computers, and experience with scientific test data. Responsibilities will include mathematical and computational aspects of physical problems, and the formulation and programming of test evaluation computer problems, employing data obtained from various test facilities and systems, including flight test telemetry.</td>
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Chicago, Illinois Meeting
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