MATHEMATICAL ASSOCIATION OF AMERICA

Official Reports and Communications

MAY MEETING OF THE ROCKY MOUNTAIN SECTION

The forty-ninth annual meeting of the Rocky Mountain Section of the MAA was held at Colorado State University, Fort Collins, Colorado, on Friday and Saturday, May 13 and 14, 1966.

There were 122 people registered for the meeting, including Dean W. E. Briggs, Sectional Governor and Professor F. M. Stein, Section Chairman.

An invited address, "Algebraic Topology for Undergraduates(?)" was given on Friday afternoon by Professor A. B. Willcox, Amherst College, Second Vice-President of the Mathematical Association of America. On Saturday morning Professor George Seifert of Iowa State University delivered the SIAM invited address. His title was "Almost Periodic Solutions for Nonautonomous Systems of Ordinary Differential Equations."

At the banquet Friday night Professor M. L. Madison of Colorado State University presided. The Section was welcomed by President W. E. Morgan of Colorado State University. Following the banquet mathematical films were shown and card tables were available.

The business meeting was held on Saturday morning, at 8:45 A.M., with Professor Stein presiding.

Professor R. E. Doutt reported for the Meeting Committee that the 1967 meetings would be held at Western State College in Gunnison, Colorado. He announced that the University of Denver had extended an invitation to meet there in 1968. It was moved, seconded and carried that this invitation be accepted.

It was announced that a letter had been received from Southern Colorado State College at Pueblo requesting that that institution be listed on the rotation list for future meetings. The motion was made, seconded and carried that Southern Colorado State be added to the list of those institutions in District D.

The following officers were elected for 1966–67: Chairman, W. E. Dorgan, Western State College; Vice-Chairman, Kenneth Noble, University of Denver; and Secretary-Treasurer, W. N. Smith, University of Wyoming.

The chairman announced the appointment of Professor R. L. Eisenman of the Air Force Academy, and Professor Neville Hunsaker of Utah State University, to serve on the Meeting and Nomination Committees, respectively. These standing committees are now:

Meeting Committee: R. E. Doutt, South Dakota School of Mines; Chairman: R. W. Ellingwood, University of Colorado; R. L. Eisenman, Air Force Academy.

Nomination Committee: F. N. Fisch, Colorado State College; Chairman: W. E. Dorgan, Western State College; Neville Hunsaker, Utah State University.

Professor E. R. Deal of Colorado State University, Contest Chairman for the Annual High School Mathematics Contest, reported that 140 schools had participated—18 from Wyoming, 24 from Utah and 98 from Colorado.

The following 17 papers were presented at the meeting:

1. *Hilbert space with an indefinite inner product*, by R. W. McKelvey, University of Colorado.

An indefinite inner product $[x, y]$ on a vector space V is a symmetric bilinear functional such that $[x, x]$ may be positive, negative or zero. A Nevanlinna space is a Hilbert space with positive definite inner product (x, y) and a second indefinite inner product given by $[x, y]=(Jx, y)$ where J and J^{-1} are bounded self-adjoint operators. The talk is a brief exposition of the theory of Nevanlinna space: subspaces, orthogonal projectors, Cartesian sum decompositions, and the spectral resolution for a self-adjoint operator.

2. *The generalized Jordan canonical form*, by D. W. Robinson, Brigham Young University.

One of the topics usually considered in a course in linear algebra is the study of various matrix representations for a linear transformation on a vector space over a field. If the field is algebraically closed, then the most useful and well-known representation is the Jordan canonical form. However, it is not as well known that, by means of a slight extension, this form may essentially be used over a much larger class of fields. The purpose of this paper is to suggest a way to bring this "generalized Jordan canonical form" into the classroom.

3. *Approximate continuity*, by J. E. Kimber, Jr., Utah State University.

4. *Trilinear equations in a finite field*, by A. Duane Porter, University of Wyoming.

Let $F=GF(q)$ be the finite field of $q=p^r$ elements, p arbitrary, and let $N(n,a)$ denote the number of solutions in F of $a_1x_1y_1z_1+\cdots+a_nx_ny_nz_n=a$. Also, let $N(n, a_i, b_i, a, b)$ denote the number of solutions in F of the system $a_1x_1y_1z_1+\cdots+a_nx_ny_nz_n=a$, $b_1x_1y_1z_1+\cdots+b_nx_ny_nz_n=b$, where all coefficients are from F. Explicit formulas for both $N(n, a)$ and $N(n, a_i, b_i, a, b)$ are obtained. To evaluate $N(n, a_i, b_i, a, b)$, two cases are considered. First, when $a_i, b_i\neq 0$, $1\leqq i\leqq n$, a, b arbitrary, and second, when a_i, b_i are all arbitrary.

5. *On Ramanujan's sum*, by G. S. Donovan, University of Colorado.

6. *Compound stochastic processes*, by S. A. Patil and M. M. Siddiqui, Colorado State University.

7. *A simple remark on Waring-type problems and linear Diophantine equations*, by A. J. Kempner, University of Colorado.

"Obvious, but not trivial": $1x_1+2x_2+3x_3+\cdots+kx_k+\cdots=n$, $n, x_1, x_2, x_3, \cdots$ integers $\geqq 0$, has for all n solutions $3\geqq x_1\geqq x_2\geqq x_3\geqq\cdots$ (0 from same point on). Similarly $1x_1+3x_2+5x_3+\cdots+(2k-1)x_k+\cdots=n$ has for all n solutions $4\geqq x_1\geqq x_2\geqq x_3\geqq\cdots$ (0 from same point on). Corresponding statements are given for Waring's general theorem, for Fermat's $x^n+y^n=F^n$, etc.

8. *A problem on integral operators*, by G. H. Meisters, University of Colorado.

Because everywhere-defined linear transformations of Hilbert space are bounded whenever they (1) are closed, (2) have adjoints with dense domains, (3) have a matrix representation—and for other reasons, the author conjectures first (vaguely) that linear transformations which are "constructively" defined everywhere on Hilbert space (or any B-space) are necessarily bounded, and second (precisely) that everywhere-defined (absolutely convergent Lebesgue) integral operators on Hilbert space are necessarily bounded. The author proves that if there exists a measurable set $E_1\subset E(=\text{measurable }\subset R^n)$ such that $m(E-E_1)=0$ and that for all $x\in E_1$ and all $f\in L_2(E)$, $Kf(x)=\int_E k(x, y)f(y)dy$ exists and belongs to $L_2(E)$, where k is measurable, then $K:L_2(E)\to L_2(E)$ is bounded.

9. *Differential inequalities with exceptional sets*, by J. W. Bebernes and G. H. Meisters, University of Colorado.

The following two theorems are slightly generalized versions of results of G. H. Meisters and this author. THEOREM 1: If $D_+u(t)\leqq f(t, u(t))$ a.e., and $D_+u(t)<+\infty$ nearly everywhere on $[a, b]$ (n.e. allows a countable exceptional set) where u and f are continuous, then any maximal solution ϕ_m of $x'=f(t, x)$ with $\phi_m(a)\geqq u(a)$ satisfies $u(t)\leqq\phi_m(t)$ on its interval of existence. THEOREM 2: Suppose there is a nonnegative continuous function $h(t, u)$ such that $u'=h(t, u)$, $u(t_0)=0$, has zero as its unique (right) solution and that $x_1\leqq x_2$ implies $f(t, x_2)-f(t, x_1)\leqq h(t, x_2-x_1)$ a.e. on $[a, b]$. If $D^+u(t)<+\infty$, $D^+v(t)>-\infty$ n.e., and if $D^+u(t)-f(t, u(t))\leqq D^+v(t)-f(t, v(t))$ a.e., for continuous u and v with $u(a)\leqq v(a)$, then $u(t)\leqq v(t)$ on $[a, b]$.

10. *The approximate solution of Riccati's equation*, by Ronald Huffstutler and F. M. Stein, Colorado State University.

This paper discusses the approximate solution of the Riccati equation $L(y)\equiv y'-P(x)y-Q(x)y^2=R(x)$ over $[0, 1]$ by a sum of zero-th order Bessel functions $S_n(x)=\sum_{m=1}^{n}B_mJ_0(\lambda_m x)$,

satisfying $y_0=y(x_0)$, that is the *best approximation* in the sense that $\int_0^1 |R(x)-L[S_n(x)]|^m dx$, $m>0$, is a minimum. Particular use is made of the fact that $J_0'(x)=-J_1(x)$, and thus both the solution $y(x)$ and its derivative $y'(x)$ can be uniformily approximated by $S_n(x)$ and $S_n'(x)$ respectively throughout $[0, 1]$.

11. *On triples of quasi-conjugate matrices*, by L. S. Johnson and V. J. Varineau, University of Wyoming.

The concept of quasi-conjugate n-tuples of matrices is re-examined and some of its most interesting properties are discussed. A similarity relation for quasi-conjugate n-tuples is defined. The set of quasi-conjugate triples over a finite field is examined with respect to the similarity partition and the number of triples in each class is determined. The number of similarity classes for a finite field with m elements is found to be m.

12. *Geometry and vision: A plea for perspective geometry in senior high school*, by A. J. Kempner, University of Colorado.

Few of our students realize that we live our daily lives in two mutually contradictory worlds of geometry: the tactile (Euclidean) and the optical (perspective). An understanding of this situation—apparently totally lacking under our present high-school training—would be of marked scientific, cultural and philosophical value. To mention only one aspect: it would prepare the ground for psychological acceptance of the various non-Euclidean geometries and of the Einstein-Minkowski geometry of relativity, etc. A course including a satisfactory foundation of projective geometry could well be fitted into our present high school set-up.

13. *The statistics program at Colorado State University*, by J. S. Williams, Colorado State University.

14. *Implementation of CUPM Recommendations, Levels I and III*, Panel on Teacher Training, by J. J. Fisher, Colorado State Department of Education.

15. *The junior college mathematics curriculum*, by T. D. Cavanagh, Colorado State College.

The speaker discussed a study he had made of the junior college mathematics curriculum. The study was primarily a questionnaire study. A survey of the catalogues available from the junior colleges in the sample was included as a part of the study. The speaker discussed the present mathematics offerings of the junior colleges, the ways in which these offerings are changing, and the factors which influence such changes. He also made some recommendations for change in the junior college mathematics curriculum.

16. *Use of modern language techniques in the teaching of mathematics*, by Miss Ann Pape, Lakewood, Colorado.

Over a four year period, the audio-lingual methods used in the teaching of languages, including extensive use of tape recorders, have been applied in mathematics classes. Postulates and theorems are taught like grammar drills in a language situation. There are a number of advantages to this method. Necessary repetition is attained with less effort; slow learners and chronic absentees are helped without infringing upon teacher time; novelty and variety are added. The progress of groups using audio-lingual methods shows a significant improvement in accomplishment over control groups.

17. *Information feedback for mathematics student teachers*, by J. M. Moser, University of Colorado.

The paper discussed a study of the mathematics student teaching experience. The study attempted to minimize the subjective nature of evaluations of student teaching through the medium of feeding back objective information to the student teacher by means of audio tape recordings and discussions of teaching behavior matrices which are part of the Minnesota System of Interaction Analysis. Observations made during a year indicated that student teachers tend to become fairly

rigid in the pattern of their teaching behavior once they have found one which suits their personality. The greatest amount of student participation and teacher-student interaction was found in those classes which used SMSG or UICSM text materials.

W. N. SMITH, *Secretary-Treasurer*

CALENDAR OF FUTURE MEETINGS

Forty-eighth Summer Meeting, University of Toronto, Toronto, Ontario, Canada, August 28–30, 1967.

Fifty-first Annual Meeting, San Francisco, California, January 25–27, 1968.

ALLEGHENY MOUNTAIN, West Virginia University, Morgantown, May 6, 1967.

ILLINOIS, University of Illinois, Urbana, May 12–13, 1967.

INDIANA, Wabash College, Crawfordsville, May 13, 1967.

IOWA, Drake University, Des Moines, April 21, 1967.

KANSAS, Fort Hays State College, Hays, April 22, 1967.

KENTUCKY, Murray State University, Murray, April 1, 1967.

LOUISIANA-MISSISSIPPI, Jung Hotel, New Orleans, Louisiana, March 4–5, 1967.

MARYLAND-DISTRICT OF COLUMBIA-VIRGINIA, University of Virginia, Charlottesville, April 22, 1967.

METROPOLITAN NEW YORK, Long Island University, Brooklyn Division, March 18, 1967.

MICHIGAN, University of Michigan, Ann Arbor, March 18, 1967.

MINNESOTA, St. John's University, Collegeville, May 6, 1967.

MISSOURI, Northeast Missouri State Teachers College, Kirksville, April 29, 1967.

NEBRASKA, University of South Dakota, Vermillion, May 6, 1967.

NEW JERSEY

NORTHEASTERN, Mt. Allison University, Sackville, New Brunswick, June 23–24, 1967.

NORTHERN CALIFORNIA

OHIO, Ohio State University, Columbus, April 22, 1967.

OKLAHOMA-ARKANSAS, Northeastern State College, Tahlequah, Oklahoma, April 1–2, 1967.

PACIFIC NORTHWEST, University of Montana, Missoula, June 16–17, 1967.

PHILADELPHIA, University of Delaware, Newark, November 18, 1967.

ROCKY MOUNTAIN, Western State College of Colorado, Gunnison, May 12–13, 1967.

SOUTHEASTERN, Florida Presbyterian College, St. Petersburg, Florida, March 31–April 1, 1967.

SOUTHERN CALIFORNIA, San Diego State College, San Diego, March 11, 1967.

SOUTHWESTERN, University of Arizona, Tucson, March 31–April 1, 1967.

TEXAS, Austin College, Sherman, April 14–15, 1967.

UPPER NEW YORK STATE, State University College, Plattsburgh, May 20, 1967.

WISCONSIN, St. Norbert College, DePere, May 6, 1967.

FUTURE MEETINGS OF OTHER ORGANIZATIONS

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, New York, N. Y., December 26–31, 1967.

AMERICAN MATHEMATICAL SOCIETY, Toronto, Ontario, Canada, Aug. 29–Sept. 1, 1967.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION, Michigan State University, June 19–23, 1967.

ASSOCIATION FOR COMPUTING MACHINERY, Sheraton-Park, Washington, D. C., August 29–31, 1967.

ASSOCIATION FOR SYMBOLIC LOGIC

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, Chicago, November 23–25, 1967.

INSTITUTE OF MATHEMATICAL STATISTICS

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS, Convention Center, Las Vegas, Nevada, April 16–20, 1967.

OPERATIONS RESEARCH SOCIETY OF AMERICA, New York Hilton Hotel, May 31–June 2, 1967.

PI MU EPSILON

SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS, Shoreham Hotel, Washington, D. C., June 12–15, 1967 (Symposium on applied probability and fluid dynamics).