The May Meeting of the Rocky Mountain Section

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4. *Solution of the integrodifferential equation of transfer by successive approximations*, by Dr. P. M. Anselone, Radiation Laboratory, Johns Hopkins University.

The equations

$$\mu \frac{\partial I(\tau, \mu)}{\partial \tau} = I(\tau, \mu) - 1/2 \int_{-1}^{+1} I(\tau, \mu')d\mu', \quad \int_{-1}^{+1} I(\tau, \mu')\mu' d\mu' = F \text{ (a constant)},$$

where $0 \leqq \tau < \infty$ and $-1 \leqq \mu \leqq 1$, plus certain auxiliary conditions, define a classical problem in transfer theory. The existence and uniqueness of the solution was established by E. Hopf, who obtained the Neumann series solution of a related integral equation. The Wick-Chandrasekhar technique for approximating I involves replacing the two integrals above by sums corresponding to the $2n$ point Gauss quadrature formula. The resulting problem is solved to yield an approximation, I_n, to I. The "double-Gauss" formula, in which the n point Gauss formula is applied separately to each of the intervals $-1 \leqq \mu \leqq 0$ and $0 \leqq \mu \leqq 1$, also yields an approximation. The principal result obtained is that the sequence $\{I_n: n \geqq 1\}$ corresponding to the double-Gauss formula converges to I uniformly on each compact subset of the domain of I.

5. *Matrix analysis for production scheduling and inventory control*, by Professor D. N. Chorafas, Catholic University of America.

With the use of high speed electronic data processing systems, mathematical techniques which seem to be very complicated or unduly involved became of importance and interest for the solution of engineering production problems.

Matrix analysis can be used to advantage for the solution of problems in Engineering Production. Commodity requirements for the initial, the intermediate and the final steps can be set in the form of a rectangular matrix. Then with a simple matrix multiplication engineering management is able to study the input-output requirements of any production system.

The speaker discussed the mechanics of the method from the conception of the model to the data processing through an electronic digital computer and evaluated the method with respect to its potentialities for future application in industry.

6. *Intermittent rotors*, by Mr. Michael Goldberg, Bureau of Ordnance, Navy Department, Washington, D. C.

The shape of the least area which, when placed at random on a square lattice of points, always includes at least one of the points was shown by J. J. Shaffer and D. B. Sawyer to be a square to which has been added the areas included by two parabolic arcs, one on each of two opposite edges of the square. The speaker showed that this shape is one of a family of convex curves which may be rotated through all orientations in the plane while passing through at least three of the four vertices of a square. Extensions to a series of similar problems were indicated.

In addition, the following hour lectures were presented by invitation of the joint program committee:

1. *Geometry in the mathematics curriculum*, by Professor W. L. Chow, The Johns Hopkins University (auspices of MAA).
2. *Quaternions and Clifford numbers*, by Professor Marcel Riesz, Institute of Fluid Dynamics, University of Maryland (auspices of SIAM).

R. P. Bailey, *Secretary*

THE MAY MEETING OF THE ROCKY MOUNTAIN SECTION

The fortieth annual meeting of the Rocky Mountain Section of the Mathematical Association of America was held at the Colorado School of Mines, Golden, Colorado, on Friday afternoon and evening and Saturday forenoon, May 3 and 4, 1957. Professor R. R. Gutzman, Chairman of the Section, presided at all three sessions. There were 116 persons registered for the meeting, including 68 members of the Association.

Officers elected at the meeting for 1957–1958 were: Chairman, Professor D. O. Patterson, Colorado State College; Vice-Chairman, Professor N. C. Hunsaker, Utah State Agricultural College; Secretary-Treasurer, Professor F. M. Carpenter, Colorado School of Mines.

The following papers were presented:

1. *On generalized Legendre polynomials*, by Professor Arne Magnus, University of Colorado, introduced by the Secretary.

A recurrence formula is developed for the polynomials $P_k = P_k(\phi_1, \cdots, \phi_n)$ defined by $[1+\phi_1 t + \cdots + \phi_n t^n](m/n) = 1 + P_1 t + \cdots + P_1 t^k + \cdots$ and application made to the polynomial solutions of the partial differential equation $u_x \cdot v_y - u_y \cdot v_x = 1$ where $u = u(x, y)$ and $v = v(x, y)$.

2. *The Laplace transform in discontinuous solutions of a partial differential equation*, by Professor V. W. Bauman, Colorado School of Mines, introduced by the Secretary.

Using the Laplace transform to solve problems involving the equation (1) $Y_{tt}(x, t) = a^2 Y_{xx}(x, t)$, equation is assumed to be (2) $s^2 L\{y\} = a^2(\partial^2/\partial x^2)[L\{Y\}]$. In some problems the solution, $Y(x, t)$, or its partial derivatives of first order are only sectionally continuous. In this case the members of (2) are not the transforms of members of (1), both members of (2) having additional terms which involve the salti in the discontinuous functions. It was shown in this paper that the true transformed equation always reduces to equation (2) if the solution or its partial derivatives of first order have only finite discontinuities on the lines in the xt-plane, $t = C \pm x/a$.

3. *The economic index numbers of Divisia*, by Professor E. A. Davis, University of Utah.

An expository account of the "historical" index numbers, for prices and quantities of goods traded, due to Divisia (F. Divisia, *Economique Rationelle*, Paris, 1928) was presented. Relationships between these quantities and the index formulae of Laspeyres were noted and, in particular, a device for approximating the former by means of products of Laspeyres indexes was indicated.

4. *A mathematical analysis of fuel burnout in nuclear reactors*, by Captain A. W. Banister, United States Air Force Academy, introduced by the Secretary.

Mathematical analysis of nuclear reactors is necessary in order to provide quantitative information regarding certain design and operational features. One such item is the effect of fuel burnout in modern reactors operating at high power levels. An approach to this problem can be made by writing a differential equation descriptive of a generalized reactor volume element, and introducing perturbations in the reactor constants to simulate burnout. By making certain approximations justifiable on physical grounds, the equation can be transformed into a linear, non-homogeneous type, easily solvable by the operator method. The solution then provides quantitative information on changes in the power distribution function, and adjustments necessary to maintain level operation.

5. *A characterization of n-groups*, by Professor D. W. Robinson, Brigham Young University.

The generalized groups defined by W. Dörnte (*Untersuchungen über einen verallgemeinerten Gruppenbegriff*, Math. Z., vol. 29, 1928, pp. 1–19) are systems of elements with a polyadic operation satisfying an extension of the associativity and solvability axioms for ordinary groups. This note points out that these systems can be characterized as well by replacing the solvability axiom with a generalization of the identity-inverse axiom for groups.

6. *Infinite exponentials*, by Professor W. J. Thron, University of Colorado.

For every $n > 1$ let $t_n(z) = e^{a_n z}$, where the a_n are complex numbers. Define $T_n(z)$ to be: $T_1(z) = t_1(z)$, $T_n(z) = T_{n-1}(t_n(z))$. Then $\{T_n(1)\}$ is called an infinite exponential. It is proved that an infinite exponential converges if $|a_n| \leq e^{-1}$ for all n.

7. *Speed-up college mathematics*, by Professor I. L. Hebel, Colorado School of Mines.

A review of the progress of a highly selected group of twenty entering freshmen who have been allowed to progress at an accelerated pace with a view to completing 21 semester hours of college mathematics (through Differential Equations) in three semesters. From the results of this first attempt to do something for the better-than-average student, the conclusion reached is that many additional students taking the "standard" courses could profitably be placed in the accelerated program. It is anticipated that about 50 of the next group of 300 entering freshmen will be assigned to a similar group.

8. *Antenna theory*, by Dr. James Wait, Boulder Laboratories, National Bureau of Standards. (Invited Address.)

The calculation of the radiation field of a flush mounted antenna in the tangent plane (the classical light-shadow boundary) is not readily treated by either geometrical optics or the residue-series. In the former case the field is indeterminate and in the latter case the convergence is extremely poor and would actually diverge in the illuminated region. Despite the fact that the harmonic series is cumbersome, it is valid in this transition zone between the illuminated and shadow regions of space. Therefore, it is desirable to attempt to adapt the harmonic-series representation to surfaces of large radius of curvature. This is the purpose of the present paper.

9. *Orthogonal functions whose k-th derivatives are also orthogonal*, by Professor F. M. Stein, Colorado State University.

Several sets of orthogonal functions possess the property that the k-th derivatives of these functions form sets of orthogonal functions, perhaps with a different weight function, $w_k(x)$, but over the same interval. This paper shows that the set $\{1, \cos nx, \sin nx\}$ possesses this property. Also, if the orthogonal functions are polynomials they must be those of Hermite, Jacobi, or Laguerre; and these are the only polynomials possessing this property under the definition of orthogonality that for $\{\phi_n(x)\}$,

$$\int_a^b w(x)\phi_n(x)\phi_m(x)dx = c_n\delta_{mn}.$$

10. *Introduction to SOMAC*, by Professor R. R. Gutzman, Colorado School of Mines.

The speaker explained the basic operating exponents of the analog computer. He discussed the methods of programming a differential equation of the type

$$a_0\frac{d^2y}{dx^2} + a_1(dy/dx)^2 + a_2y = F(x),$$

and simultaneous linear algebraic equations. Different ways of generating $F(x)$ were considered.

11. *The relation of regular semigroups to groups*, by Mr. H. G. Moore, University of Utah.

In this paper theorems are given which relate regular semigroups and inverse semigroups with groups. A regular semigroup with cancellation is a group as is every regular semigroup generated by a single element. Cancellation may be relaxed slightly if certain other conditions are imposed on the regular semigroup. Every regular semigroup possesses subsets which are groups, and if not all the elements of the semigroup are idempotent it possesses nontrivial subsets which are groups.

12. *Likes and dislikes—when and why?*, by Professor O. M. Rasmussen, University of Denver.

A preliminary report of a survey in progress as an attempt to find when and why students like or dislike mathematics. Thus far it appears that grades 7, 9, and 10 are the critical ones with the teachers receiving credit or blame in most cases. Parental encouragement appears to be a factor among those who now like mathematics. Information reported is from a survey of students at all levels in a university. Therefore, the results of changing conditions of the past five years are not included.

13. *The new Bachelor of Science Degree in Applied Mathematics at the University of Colorado*, by Professor L. W. Rutland and Professor J. R. Britton of the University, presented by Professor Rutland.

An announcement was made of the new degree being offered in the Department of Applied Mathematics at the University of Colorado. The curriculum includes study in the basic engineering sciences and applied mathematics subjects. The applied mathematics work includes intermediate differential equations, advanced calculus (*e.g.*, Taylor, *Advanced Calculus*), introduction to applied mathematics (*e.g.*, Wylie, *Advanced Engineering Mathematics*), statistics, algebraic methods, computing machines, and a senior seminar.

F. M. CARPENTER, *Secretary*

CALENDAR OF FUTURE MEETINGS

Forty-first Annual Meeting, University of Cincinnati and Hotel Sheraton-Gibson, Cincinnati, Ohio, January 31, 1958.

The following is a list of the Sections of the Association with dates of future meetings so far as they have been reported to the Associate Secretary.

ALLEGHENY MOUNTAIN, Washington and Jefferson College, Washington, Pennsylvania, May, 1958.
ILLINOIS, Illinois College, Jacksonville, May 9–10, 1958.
INDIANA, DePauw University, Greencastle, October 18, 1957.
IOWA
KANSAS
KENTUCKY, University of Kentucky, Lexington, April, 1958.
LOUISIANA-MISSISSIPPI, Loyola University, New Orleans, February 21–22, 1958.
MARYLAND-DISTRICT OF COLUMBIA-VIRGINIA, Georgetown University, Washington, D. C., December 7, 1957.
METROPOLITAN NEW YORK
MICHIGAN, University of Michigan, Ann Arbor, March, 1958.
MINNESOTA, State Teachers College, Mankato, October 5, 1957.
MISSOURI, University of Missouri, Columbia, Spring, 1958.
NEBRASKA, University of Nebraska, Lincoln, April 19, 1958.
NEW JERSEY, Fairleigh Dickinson University' Rutherford, November 2, 1957.
NORTHEASTERN, Dartmouth College, Hanover, New Hampshire, November 30, 1957.
NORTHERN CALIFORNIA, San Francisco State College, January 18, 1958.
OHIO, Denison University, Granville, April, 1958.
OKLAHOMA, Oklahoma City University, October 25, 1957.
PACIFIC NORTHWEST
PHILADELPHIA, November 30, 1957.
ROCKY MOUNTAIN, Colorado State College, Greeley, Spring, 1958.
SOUTHEASTERN, University of Florida, Gainesville, March 14–15, 1958.
SOUTHERN CALIFORNIA, Pasadena City College, March 8, 1958.
SOUTHWESTERN, University of New Mexico, Albuquerque, April 11–12, 1958.
TEXAS, Baylor University, Waco, April, 1958.
UPPER NEW YORK STATE, Ecole Polytechnique and University of Montreal, Montreal, Quebec, Canada, May, 1958.
WISCONSIN, Carroll College, Waukesha, May, 1958.