197[L].—A. Opler, *Table Related to the Error Function*. 20 leaves tabulated from punched cards deposited in the UMT File.

The table gives 6S values of the integral

$$2 \exp (z^2) \int_z^\infty \exp (-t^2)\, dt$$

for $z = -4.5(.1)100$, together with first differences. The table is probably good to only 5S for most of the range.

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AUTOMATIC COMPUTING MACHINERY

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Bibliography of Coding Procedure

68. J. L. Jones, *A Survey of Automatic Coding Techniques for Digital Computers.*

This MIT master's thesis is one of the first publications on the general subject of automatic coding. It includes chapters on the basic forms of automatic coding, a survey of present techniques, and a survey of contemplated techniques with comments. It includes an appendix of additional applications of the interpretive method and an appendix listing computer groups interested in automatic coding.

69. C. C. Elgot, U. S. Naval Ordnance Laboratory, White Oak, Md., *Single v. Triple Address Computing Machines* (NAVORD Report 2741).

By utilizing a slightly idealized notion of a single address computer, the author obtains a partial answer to the question of whether a single address or a triple address computing machine requires fewer words to specify a sequence of instructions. While he finds that fewer words are required to code by means of an "idealized" single address machine, it is interesting to note that the pseudo codes for single address machines tend to be three-address codes.

70. H. B. Curry, U. S. Naval Ordnance Laboratory, White Oak, Md. *A Program Composition Technique as Applied to Inverse Interpolation* (NOL Memorandum 10337).

71. J. W. Backus, International Business Machines Corporation. Operational Characteristics of the IBM 704.

The IBM 704 differs from the 701 in that among other things four floating point operations have been added along with automatic address modification. Here floating binary point representation similar to that presently used in pseudo-codes can be utilized directly by the computer.

72. W. Brown, J. DeTurk, H. Harner, E. Lewis, University of Michigan. The MIDSAC Computer.

The MIDSAC is a high-speed digital computer designed for use in an automatic control system. This 55 page booklet includes chapters on programming rules and operational characteristics, a detailed description of the computer, and the physical construction of the computer.

73. G. E. FORSYTHE, SWAC *computes all* 126 *distinct semigroups of order* 4. Manuscript 5 p.

The problem of finding all (non-isomorphic) groups of a given order is known to be very difficult unless the order is of a very special nature. The possibility of using electronic computing machines in this connection has occurred to a number of people, but until now no results have appeared. An idea of the complexity of the problem is obtained from a study of this computation of all distinct semigroups of order 4. By semigroup is meant a set of elements closed under an associative composition law, called multiplication for simplicity; two such sets are distinct if they are neither isomorphic nor anti-isomorphic. (Two systems are called isomorphic (anti-isomorphic) if a one-to-one mapping $X \rightarrow X'$ exists such that $(AB)' = A'B'$ $(= B'A')$.)

For machine purposes the elements of the semigroups are denoted by 0,1,2,3. The semigroup is then completely described by its multiplication table, i.e., the matrix (a_{ij}), $i,j = 0,1,2,3$, where a_{ij} is an integer which specifies the product of the elements i,j. Four SWAC codes have been prepared by Forsythe in order to make a table on punched cards of all 3492 semigroups of order 4 and to pick out the 126 distinct among them (in previous work only 121 have been found). The 4 rows of the multiplication table are listed in one line consecutively, e.g. 0000 0000 0023 0032. The distinct semigroups are represented by normal forms distinguished through lexicographic order.

The first code checks on the associativity. A direct test of all the 4^{16} multiplication tables would take SWAC about 13 years. However, by testing partial tables, and then rejecting blocks, the time was cut down to less than 80 minutes. The second code is for obtaining the normal form. The third code picks out the distinct semigroups. The fourth code converts the 126 tables from base 2 notation to base 4.

The codes used are on file at UCNAR and NBSCL.

OLGA TAUSSKY

NBS

BIBLIOGRAPHY Z

1147. H. J. GRAY, JR., "Numerical methods in real-time simulation," *Quart. of Applied Math.*, v. 12, 1954, p. 133–140.

Under the sponsorship of the Office of Naval Research, Special Devices Center, the University of Pennsylvania conducted a study to determine the feasibility of building a digital real-time simulator for a system described by thirteen first-order non-linear differential equations. It was found necessary to improve either the speed of the digital machine or the quality of the method of solution. The paper deals with the latter problem and especially with the buildup of errors.

The paper is introductory in nature, and only linear constant-parameter systems of ordinary differential equations are considered. The characteristic equation associated with the corresponding difference equation is found and solved by conformal mapping. A diagram is given showing the method of solution in a case of practical interest and not requiring high accuracy.

E. W. C.

1148. Alston S. Householder, "Generation of errors in digital computations," Amer. Math. Soc., *Bulletin*, v. 60, 1954, p. 234–247.

This paper is an address delivered before the Spartanburg meeting of the Society on November 28, 1953.

The problem of computing the numerical values of $f(x)$ is considered. In general one must use, in the computation, an approximation x^* to x, and an approximation $f_a(x^*)$ to the function $f(x^*)$. The error is expressed as a sum of three independent components: $f(x) - f(x^*)$, $f(x^*) - f_a(x^*)$ and $f_a(x^*) - f^*(x^*)$, called, respectively, the propagated error, the residual error and the generated error. The article treats the generated error. It is stated that differences among high-speed computing machinery are such that each machine demands a theory on the generated error. A specific computing system, the ORACLE, is described and the generated error for certain computational sequences is discussed.

E. W. C.

1149. L. Knight, "Valve reliability in digital calculating machines," *Electronic Engineering*, January, 1954, p. 9–13.

A survey is presented of some considerations in selecting vacuum tube types, designing circuits to provide useful tolerences for the tubes, testing them, and maintaining vacuum tube equipment in order to achieve a level of reliable operation demanded by digital calculating machines. Special consideration is given to effects that develop as tubes age. Results of some vacuum tube experience with the Hollerith type 541 multiplier and the Manchester University computer are given.

Russell A. Kirsch

NBSCL

1150. T. Pearcey, *Use of Punched Cards for Fourier Synthesis.* Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, RPR 121. Melbourne, November 1953, p. 1–20.

The synthesizing of series of orthogonal functions is described in detail for the case of two-dimensional Fourier synthesis. Hand selection and refiling of cards from two master files of about 4000 cards are performed. The master files should allow for adequate spacing of the variables and positive as well as negative coefficients. The accuracy obtainable by the described method is three digits. The only equipment necessary is a tabulator for summing, a sorter and possibly a collator.

Stanley Prusch

NBSCL

1151. R. M. Saunders, "Digital computers as an aid in electric machine design," *Communications & Electronics*, May 1954, p. 189.

An S.O.S. from Industry to the Electronic Brain to take over the drudgery of re-iterative computations required for designing electric machines.

There are tables showing the variables in the design of synchronous machines and a table of operations and sample calculations for ascertaining performance of a $\frac{1}{2}$-hp. induction motor. The "digital approach" and its advantage over hand computations is discussed.

Discussion, pro and con, by ROBERT L. FILLMORE and C. G. VEINOTT is followed with a rebuttal by Saunders.

A. R. COCK

NBSCL

NEWS

Numerical Analysis Research, UCLA.—Numerical Analysis Research, UCLA, is continuing much of the research program of the Institute for Numerical Analysis (INA) of the National Bureau of Standards; INA was disbanded on 30 June 1954 [*MTAC*, v. 8, p. 178].

The new organization, administered by the UCLA Mathematics Department, will receive support from the Office of Naval Research and the Office of Ordnance Research. Its primary mission includes pertinent fundamental research in mathematics and science and research in the application of computers to problems occurring in science and other applied fields. It will be aided in attaining these objectives by the use of the National Bureau of Standards Western Automatic Computer (SWAC) and other equipment which has been loaned to UCLA. In addition, the new organization has the use of INA's library. Most of the research staff of INA has joined the new organization.

The organization offers a training program in the efficient application of high-speed digital computers. A number of graduate assistantships offered in cooperation with various university departments are available each year. Seminars, and formal and informal courses in numerical analysis are conducted.

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OTHER AIDS TO COMPUTATION

A Useful Technique in Programming for Analog Computers

In programming for analog computers programmers have found certain types of linear differential equations difficult to handle even with the use of arbitrary function generators. In this paper a technique is presented which enables the analog computer to solve a heretofore difficult set of problems. The technique, while most useful in linear problems, is also useful in other problems. In many cases the technique will reduce the sensitivity of the solution to noise.

Let us consider the general ordinary differential equation

$$f(y,y',y'',\cdots,x) = 0 \tag{1}$$

with the parametric transformation

$$\phi(x,\dot{x},\ddot{x},\cdots,t) = 0. \tag{2}$$