OTHER AIDS TO COMPUTATION

Bibliography Z–XXI

9. Anon., "The Radar Range Calculator," *Bell Lab. Record*, v. 29, 1951, p. 312–313.

A circular slide rule calculator for computing the function of seven parameters which describes the effective range of a radar system. This function is a product of fractional powers of the parameters.

F. J. M.

10. A. A. Currie, "The general purpose analog computer," *Bell Lab. Record*, v. 29, March 1951, p. 101–108.

This article describes an analog computer using a basic three stage feedback amplifier for integration, differentiating and forming linear combinations and with servo driven potentiometers for multiplication and finding functions like sin x. The computer contains 30 adders, 1 differentiator, 12 integrators, 9 servos which can drive 45 linear potentiometers and 15 function potentiometers, with 41 additional potentiometers which can be set by hand. There are six output recorders, two of which may be modified to be used as function input tables from graphs. The machine is set up by means of a three panel patch bay.

F. J. M.

11. L. L. Grandi & D. Lebell, "Analogue computers solve complex problems," *Radio and Television News*, Radio Electronic Eng. ed., v. 46, No. 5, Nov. 1951, p. 70–71, 138–139.

The Engineering Department of the Univ. of Calif. at Los Angeles has four continuous computers, an electrical differential analyzer, a mechanical differential analyzer, a network analyzer and a thermal analyzer. This article describes the problems for which each may be used and contains eight photographs including a color photograph on the cover.

F. J. M.

12. W. G. James, *Logarithms in Instrumentation*. United States Atomic Energy Commission ORNL-413, Oak Ridge National Laboratory, Oak Ridge, Tenn., 54 p.

The author surveys the methods used for taking logarithms in instruments and indicates the accuracy and ranges available from the different methods. The logarithmic devices described include diodes with negative anodes, contact rectifiers, variable μ tubes and potentiometers either wound with a special taper or with shunts between taps.

F. J. M.

13. L. H. Johnson, *Nomography and Empirical Equations*. New York, Wiley; London, Chapman & Hall, 1952, ix + 150 p., 22.9 × 14.3 cm. Price $3.75.

This book is an elementary text with the minimum of theory, and judged as such it is excellent. In particular the author considers questions of arranging nomograms for maximum accuracy. He also has a number of good points in curve fitting, though his treatment of least square fitting could be improved a bit.

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14. E. LAKATOS, "Problem solving with the analog computer," *Bell Lab. Record*, v. 29, March 1951, p. 109–114.

A process is given for translating a differential equation into a form to which the differential analyzer is applicable. Two examples are briefly discussed.

F. J. M.

15. Y. W. LEE & J. B. WIESNER, "Correlation functions and communication applications," *Electronics*, v. 23, June 1950, p. 86–92.

This article describes, largely in quantitative terms, some of the techniques and applications arising out of recent developments in the theory of communication, based on the statistical concept of information. The meanings of autocorrelation functions and cross-correlation functions are discussed for stationary random processes, and these functions are applied to periodic processes. An electronic correlator, built at MIT, for obtaining and recording the autocorrelation curve of a random function is briefly described. The correlator obtains two sets of sampled values of the random function at regular intervals and forms pulses whose height and width are proportional to the two sets of sampled values, respectively. The autocorrelation function is found (approximately) by integrating the pulse areas.

The problem of detection of periodic signals is discussed, and experimental results obtained with the correlator, showing a 30 db. gain for a signal which is 15 db. below the noise level, are presented. Additional applications of the correlator to the determination of the impulse response of networks and the measurement of crosstalk in multichannel communication systems are indicated briefly. Finally, the importance of correlation functions in Wiener's statistical prediction and filter theory is discussed. More quantitative information on many of the topics included in this article may be found in another paper by the same authors.[1] Details concerning the correlator are given in a technical report.[2]

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[1] Y. W. LEE, T. P. CHEATHAM, JR., & J. B. WIESNER, "Application of correlation analysis to the detection of periodic signals in noise," I. R. E., *Proc.*, v. 38, 1950, p. 1165–1171.

[2] T. P. CHEATHAM, "Experimental determination of correlation functions and their application to the statistical theory of communications," *Technical Report* No. 122, Research Laboratory of Electronics, MIT.

16. A. B. MACNEE, "Some limitations on the accuracy of electronic differential analyzers," I. R. E., *Proc.*, v. 40, 1952, p. 303–308.

The author considers the errors that arise in solving a linear differential equation

$$\sum_{n=0}^{m} A_n y^{(n)} = F(t) \tag{1}$$

with constant coefficients by means of an electronic analogue computer. Only adders and integrators are necessary. The steady state response of the simplest physically realizable adder is of the form

$$E_{\text{out}} = K(E_1 + E_2 + \cdots + E_n)/(1 + j\omega t_1).$$

Similarly, for an integrator

$$E_{\text{out}}/E_{\text{in}} = [1/j\omega k][1/(1 + 1/j\omega \mu k)][1/(1 + j\omega T)]$$

where μ is the gain of the base amplifier and the last factor is due to the imperfect high frequency response of a physical integrator. Using these approximations, the author derives simple approximate expressions for the difference e_n, $n = 1, \cdots, m$ of the characteristic roots s_n (assumed distinct) of (1) and the characteristic roots s_n' of the differential analyzer. The $m + 1$ additional roots of the machine solution [introduced by the "$1/(1 + j\omega T)$" factors which raise the order of (1)] are, under physically reasonable assumptions, widely separated from the s_n roots and have negative real parts. Numerical examples are included. The case in which (1) has multiple roots is briefly touched upon; the phenomena which arise when the Jordan normal form is not diagonal are not mentioned.

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17. R. E. Scott, *An analog device for solving the approximation problem of network synthesis. Technical Report* No. 137, June 8, 1950, *Research Laboratory of Electronics*, Massachusetts Institute of Technology, Cambridge, Mass.

Mathematically the problem treated here is that in which one endeavors to find a rational function which is a good approximation on the imaginary axis to a prescribed complex valued function. The desired function is the "network response" function from which a network can be synthesized with a given frequency response corresponding to the prescribed values along the imaginary axis. The rational function must satisfy a number of conditions, for instance, the numerator and denominator must be expressible as real polynomials and the roots of the denominator must all be in the left half of the complex plane. It is possible to represent the logarithm of a rational function with a prescribed set of zeros and poles as the potential function of a planar flow of electric current with corresponding sources and sinks.

The device described in this report has as its conducting plane a sheet of "Teledeltos" paper. Current sources are provided and also probes which are stuck into the paper to represent the sources and sinks. The values of the potential function along the imaginary axis are sampled from fixed contacts by a commutator and displayed on an oscilloscope. The movable probes are adjusted until the desired behavior is obtained. One major problem in this process is due to the finite extent of the conductor. A number of solutions for this have been proposed.[1] In this device, a logarithmic transformation is made which with certain symmetry considerations permits one to substitute a strip instead of the infinite plane. The strip is terminated at each end at some distance from the computing portion to represent zero and infinity. To obtain the equivalent of phase the fixed contacts along the imaginary axis are doubled so that potential slope can be indicated. The report contains considerable information on both the construction and use of this device and an analysis of the effect of individual errors. A photograph shows the entire machine mounted on a laboratory cart.

F. J. M.

[1] Cf. A. R. Boothroyd, E. C. Cherry & R. Makar, Inst. Elect. Eng., *Proc.*, v. 96, 1949, p. 163–177; *MTAC*, v. 5, p. 49–50.

18. J. R. Shah & L. Jacobs, "Investigation of field distributions in symmetrical electron lens," *Jn. Appl. Physics*, v. 22, 1951, p. 1236–1241.

The potential field for the electron lens is obtained by the use of an electrolytic tank. It was determined experimentally that an impedance of 30 megohms for the probe was necessary. With these methods, the crossing of the nodes at the central symmetry point was accurate to within about a quarter of a degree. The field obtained from the electrolytic tank was compared with that obtained by a relaxation method. The maximum difference is about 1.5%.

F. J. M.

19. B. A. Sokoloff, "Principe et réalisation d'une machine mathématique dite 'Operateur Mathématique Electronique' OME," *Annales des Télécommunications*, v. 5, no. 4, April 1950, p. 143–159.

The mathematical machine described is an electronic differential analyzer with the customary feedback amplifier integration and addition. The output indicator is an oscilloscope and camera combination. Multiplication is by servo driven potentiometers. A discussion of stability is given for the constant coefficient case of linear differential equations, including the use of the determinantal conditions for positive definiteness.

F. J. M.

20. G. J. Tauxe & R. L. Stoker, "Analytical studies in the suppression of wood fires," A. S. M. E., *Trans.*, v. 73, 1951, p. 1005–1020.

Different methods of suppression of wood fires are analyzed thermally using electrical analogy methods. The latter effect the solution of the heat equation by means of an R-C network. The method has been previously described.[1]

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[1] V. Paschkis & H. D. Baker, "A method for determining unsteady-state heat transfer by means of an electrical analogy," A. S. M. E., *Trans.*, v. 64, 1942, p. 105–110.

NOTES

139. The RAND Collection of Illustrative Approximations.—In recent years, the Numerical Analysis Department at RAND has been preparing loose leaf sheets that contain interesting and useful approxima-