OTHER AIDS TO COMPUTATION

BIBLIOGRAPHY Z–XVIII

9. SUMNER ACKERMAN, "Precise solutions of linear simultaneous equations using a low cost analog," *Rev. Sci. Instr.*, v. 22, 1951, p. 746–748.

The author describes a simplified adjuster type of electic analog simultaneous linear equation solver, which is used to find the quasi-inverse matrix, this is applied to transform the original matrix to a quasi-diagonal form to expedite numerical solution.

The machine uses uncalibrated potentiometers to set in coefficients and determines these by a measurement process using a voltmeter. The unknowns are also controlled by potentiometers, and are adjusted to the desired solution by the operator. The operator's indication is a meter displaying an error-function proportional to the sum of the squares of the equation errors. Results are read by a voltmeter.

It is claimed that with this type of machine, the quasi-solutions required for the diagonalizing process are easier to obtain than direct solutions which require a real minimizing of the error-function.

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10. WILHELM BADER, "Auflösung von Polynomgleichungen auf elektrischem Wege," *Zeit. angew. Math. Mech.*, v. 30, 1950, p. 289–291.

A device is described for solving polynomial equations, $P(z) = 0$, by means of n alternating current generators of frequency ν, 2ν, $\cdots$, $n\nu$. The amplitude of the generator with output $k\nu$ is controlled to be r^k and the real and imaginary part of the polynomial $P(z)$ are obtained in the obvious way and applied to the deflection plates of an oscilloscopic tube so that for $r = |z|$ fixed, the oscilloscope shows the locus of the values of $P(z)$. r is varied by a manual control until this locus goes through zero. The argument θ for the root $z = r \exp (i\theta)$ is located by means of a magnetic "marker" mounted on the generator of the fundamental frequency which will cause a bright dot to appear on the locus, at a point corresponding to any fixed value of θ. A photograph of the device appears. An electrolytic tank device for this purpose is also planned.

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11. HANS BÜCKNER, "Zum Zirkeltest der Integrieranlagen," *Zeit. angew. Math. Mech.*, v. 31, 1951, p. 224–226.

The author considers two wheel and disk integrators with equations $dz_i = y_i dx$, $i = 1,2$ so connected that $y_1 = -z_2$, $y_2 = z_1$ (*). These equations yield $\ddot{z}_i + z_i = 0$, $i = 1,2$, the equations of harmonic motion. In a perfect integrator the curve in the z_1, z_2 plane would be a circle (say of radius C). He considers two problems. (i) Suppose that instead of (*), $y_i = -z_2 - f(z_2) \equiv -\varphi(z_2)$ and $y_2 = z_1 + g(z_1) \equiv \psi(z_1)$, where φ and ψ are continuous monotonic functions in the infinite interval and f and g are bounded. Then he shows that the curves in the z_1, z_2 plane will be closed curves, free of double points. (ii) The second problem considers the effects of backlash. He assumes $y_1 = -z_2 + \Delta z_2$, $y_2 = z_1 - \Delta z_1$ (**), where $\Delta z_2 = a_2 \operatorname{sgn} \dot{z}_2$, $\Delta z_1 = a_1 \operatorname{sgn} \dot{z}_1$ (except in the neighborhood of $\dot{z}_1 = 0 = \dot{z}_2$). The constants $a_i \geqslant 0$, $i = 1,2$ are due to the play in the driving mechanisms. By integration of the non-homogeneous equations (**) the author determines that instead of closed curves in the z_1, z_2 plane, spirals are obtained. The radius of the spirals is approximately $8n(a_1 + a_2)C$, where n is the number of turns. No other types of errors in mechanical integrators are considered.

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12. J. B. Carroll & C. C. Bennett, "Machine shortcuts in the computation of chi-square and the contingency coefficient," *Psychometrika*, v. 15, 1950, p. 441–447.

"The methods presented here are particularly adapted to the more recent models of desk calculating machines. . . ."

13. G. F. Castore & W. S. Dye III, "A simplified punch card method of determining sums of squares and sums of products," *Psychometrika*, v. 14, 1949, p. 243–250.

14. S. Charp, "A new Fourier series harmonic analyzer," *Electrical Engineering*, v. 68, 1949, p. 1057.

The coefficients $a_n = \pi^{-1} \int_0^{2\pi} f(x) \sin nx \, dx$ and the corresponding b_n are obtained from a graph of the function $f(t)$ by means of ball and roller integrators. $f(x)$ is traced by an operator from the graph and the sine and cosine are obtained by a Scotch yoke mechanism.

15. Lisbeth Crowell, "The airflow slide rule," *Aero Digest*, v. 59, 1949, No. 6, p. 66, 76, 78. Also, Franklin Inst. *Jn.*, v. 249, 1950, p. 328–332.

16. H. J. Dreyer, "Automatisches lichtelektriches Kurvenabtasten bei Integrieranlagen," *Zeit. angew. Math. Mech.*, v. 30, 1950, p. 291–292.

The device described in the title is for use in the Darmstadt differential analyzer.

17. E. D. Jarema, "Noise figure chart," *Electronics*, v. 23, 1950, No. 3, p. 114.

18. K. Krienes, "Ein Polarplanimeter zur Bestimmung des polaren Trägheitsmomentes," *Zeit. angew. Math. Mech.*, v. 30, 1950, p. 62.

A mathematical derivation of the theory for this device.

19. G. Lyon, "Some experience with a British A. C. network analyzer," Inst. Elec. Engrs., *Proc.*, v. 97, part II, 1950, p. 697–714. Discussion p. 714–725.

The author describes a British built post-war network analyser which uses a 500 c.p.s. supply system. The number, range, accuracy, construction and composition of each of the various components are given. The remainder of the paper is concerned with the application of this device to a wide range of engineering problems of power network design.

20. J. L. Meriam, "Differential analyzer solution for the stresses in a rotating bell-shaped shell," Franklin Inst., *Jn.*, v. 250, 1950, p. 115–133.

The author obtains a fourth order ordinary linear differential equation for the stress in a rotating shell which consists of a portion of a torus with zero hole. This differential equation was solved on the UCLA differential analyzer. The problem was solved under various boundary conditions on the two edges. Since the equations are linear, no basic difficulty is involved in obtaining a solution from the solutions available in the differential analyzer but the author indicates useful techniques.

F. J. M.

21. Thomas M. Moore, "German missile accelerometers," *Electrical Engineering*, v. 68, 1949, p. 996–999.

These accelerometers for V-2 rockets are tied in with an integrating process to yield a specified velocity at the point where the fuel is cut off. For this purpose accelerometers based on precessing gyroscopes were inadequate. A system was devised in which an electric current from a linear inertia accelerometer was fed into an electroplating cell. After a certain prescribed amount of electricity was fed into the cell, a change in character of the electrolytic process caused a definite voltage jump. This permitted an integration process precise to .03 percent. To provide a compensation for distance covered, a further integration is necessary. The article also discusses the lateral control of these rockets.

F. J. M.

22. K. Ramsayer, "Die Funktionsrechenmaschine," *Zeit. angew. Math. Mech.*, v. 30, 1950, p. 294–295.

The author discusses the addition of a function table to a desk type calculating machine which is provided with (mechanical) storage facilities. The values are to be stored on a template and provision is to be made for linear interpolation. A similar machine was constructed in Germany during the war but is no longer available.

F. J. M.

23. Reference Sheet Section, *Electronics*, v. 23, 1950, "Buyers Guide," p. R1–R40.

This section contains 21 articles involving graphs and tables of assistance in computation for electrical engineering, for instance, one is on "vector computation," another on the "square root of a complex number." It also includes a complete index of all such articles published in *Electronics* since 1930.

24. M. G. Say, "Analogies," Inst. Elec. Engrs., *Proc.*, v. 97, 1950, part I, p. 21–22.

25. G. B. WALKER, "Factors influencing the design of a rubber model," Inst. Elec. Engrs., *Proc.*, v. 96, part II, 1949, p. 319–324. Discussion of this paper v. 97, part II, 1950, p. 439–444.

In the design of vacuum tubes a rubber membrane is often used to give a gravitational reproduction of the potential field in the tube and steel balls are used to reproduce the electrons. The author discusses the errors due to the fact that the surface of the membrane does not exactly satisfy the Laplace equation, the error due to spin of the ball around the axis normal to the surface and frictional forces. The surface error depends on the maximum gradient and is shown to be negligible in certain special cases. The effect of the "spin" terms is shown to be dependent on the scale factor. Frictional losses are the most important, and a method of measuring these in a special set up is described. The author concludes that the model should be as small as possible and that the error in the ball's kinetic energy (due to friction) can be kept less than 2 per cent of the maximum potential differences between points of the boundary.

In connection with the discussion on this paper the electrolytic tank of BOOTHROYD, CHERRY and MAKAR [cf. *MTAC*, v. 33, p. 49–50] and the resistance networks of E. E. HUTCHINGS and of G. LIEBMANN [cf. *MTAC*, v. 35, p. 179] were demonstrated. The accuracies of the various systems were compared also in these discussions.

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NOTES

129. ZEROS OF $I_{n+1}(x)J_n(x) + J_{n+1}(x)I_n(x)$. A table of the first ten zeros of $f_n(x) \equiv I_{n+1}(x)J_n(x) + J_{n+1}(x)I_n(x)$ for $n = 0, 1, 2$, and 3, was published by AIREY[1]. This table is extended herewith to include all zeros ≤ 20. For the sake of completeness, Airey's values are reproduced here, with the kind permission of the editors of the *Proceedings*.

Airey's values were compared with those of CARRINGTON,[2] who gave all zeros ≤ 16. Corresponding to $n = 0$, Airey gave the first zero as 3.1955, whereas Carrington gave 3.1961. This entry was recomputed; the true value to five decimals is 3.19622. Other entries in Airey's differ from Carrington's by at most a unit in the third decimal place, where both authors give the same zeros. Differences of Airey's values show no obvious errors, but his entries were not otherwise verified by us.

G. FRANKE[3] published the first two zeros for $n = 4$ and the first zero for $n = 5, 6$, and 7, to one, two, or three decimals. Comparison of his entries with those published here shows that his last place is not correct.

The entries given here were computed by inverse interpolation in $[\exp(-x)]f_n(x)$, with the aid of values of $I_n(x)$ which were made available to us in manuscript form by J. C. P. MILLER. The extensive tables of $J_n(x)$ of the Harvard Computation Laboratory provided the other required tabular values. GLADYS FRANKLIN of the NBSINA performed the computations. Entries for $n > 3$ are correct to within $\pm.00002$. The work was carried out with the aid of funds provided by the ONR, in connection with an eigenvalue problem investigated by N. ARONSZAJN.