PUKHOV, G. Ye., prof.doktor tekhn.nauk

Analog computor for bent rods suggested by Corbett and Calvert. Trudy RISI no.11:124-129 '58. (MIRA 13:5)

1. Taganrogskiy radiotekhnicheskiy institut.
(Elastic rods and wires--Electromechanical analogies)

PUKHOV, G.Ye., prof., doktor tekhn.nauk; IL'YENKO, O.V., kand.tekhn.nauk

Electric analyzers for beams and frames on solid eleastic basis and rigid supports. Trudy RISI no.11:130-135 '58, (MIRA 13:5)

1. Taganrogskiy radiotekhnicheskiy institut.
(Structural frames--Electromechanical analogies)
(Girders--Electromechanical analogies)

SOV/144-59-1-2/21

AUTHOR: Pukhov, G.Ye., Dr.Tech.Sci., Professor

TITLE: Electrical Analogue of the Scalar Product of Multi-Dimensional Vectors

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Elektromekhanika, 1959, Nr 1, pp 11-12 (USSR)

ABSTRACT: In computing techniques it is often necessary to evaluate the expressions of the type:

$$a_1x_1 + a_2x_2 + \dots + a_nx_n = b \qquad (1)$$

where a_i and x_i can be either negative or positive. It is seen from Eq (1) that the quantity b represents the scalar product of two n-dimensional vectors, that is $b = \vec{a}.\vec{x}$. The product can be evaluated by means of a simple electrical circuit shown in Fig 1. This consists of two n-pointed stars whose star points are joined through the conductance g_0. The circuit obeys the relationship expressed by Eq (3) provided all the switches $\Pi_1, \Pi_2, \dots \Pi_n$ are in the right-hand position. If one of the switches, for example Π_2, is in the left-hand position, the system is described by Eq (4). The

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SOV/144-59-2-1/19

AUTHOR: Pukhov, G.Ye., Doctor of Technical Sciences, Professor

TITLE: The Construction of Electrical Networks 25 for Integrating Difference and Differential Equations

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Elektromekhanika, 1959, Nr 2, pp 3 - 10 (USSR)

ABSTRACT: A peculiarity of so-called networks of the first kind is that for given boundary conditions the distribution of voltages (currents) in the network is determined only by the detailed structure of the modelling system and no operator intervention is required. This is because the original set of equations resembles very closely those of the network itself. Where this is not so, as in Eq (1) for example, the method encounters difficulties. For such an expression (an algebraic), networks of the second kind must be used. A typical instance is a root-solver (Ref 5). The present paper examines some theoretical topics and illustrates the solution of comparatively high order equations for various boundary conditions. Figure 1 shows a certain function y(x) and the simulating network consisting of a number of voltage dividers. The solution

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of the equation $f[y(x)] = 0$ may be found using a system like the block-diagram of Figure 2. The block $f[y(x)]$ is a scalar product analogue (АСП in the original or, here, SPA) consisting, in the linear case, of ohmic elements and described previously by the author (Ref 4). The block OC is a feedback device. The entire loop forms a self-adjusting system. Suppose the linear difference equation (5) is given and a solution is required for the initial conditions of Eq (6). The solution depends on Euler's algorithm or, what is known in engineering as the method of successive ordinates. For the sake of definiteness the corresponding practical circuit of Figure 3 assumes $n = 2$. The basic components are: 1) the network y on which the required function $y(k)$ is found as a result of the operations; 2) the network φ, setting up the function k ; 3) the SPA representing Eq (5); 4) the null-indicator NI for registering the deviation $\varepsilon(k)$ in Eq (7) for $n = 2$; 5) commutator K with four moving contacts. The procedure is as follows: a) set up

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$\varphi(k)$ on φ; b) set up $a_o(o)$, $a_1(o)$, $a_2(o)$ and λ on the SPA; c) set initial conditions y_o, y_1 on y; d) divider 2 on y is adjusted to give zero-indication (this gives y_2); e) the moving contacts on K are displaced one step to the right and $a_o(1)$, $a_1(1)$, $a_2(1)$ are set on the SPA; f) divider 3 on y is set to restore zero-indication, thus finding y_3. Operations e) and f) are carried out again on dividers 4, 5, 6, ... finding y_4, y_5, y_6; etc. These operations could be automated. The use of a digital voltmeter would enable the bulk of y to be reduced. The arrangement also simplifies when the coefficients of Eq (5) are constants (independent of k). The question of accuracy requires special consideration and it is merely stated that the error is reduced the higher the sensitivity of the null indicator, the more accurately the initial values and $a_n(k)$ are set in. The use of the integrator is then described for

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solving the difference equation (5) within the interval $0 \leqslant k \leqslant N$ subject to the boundary conditions of Eq (9). The additional components required, a network Y, commutator K-2, SPA (ACR-2) and null-indicator NI-2 are shown in Figure 4. When there is an extended system of equations such as Eq (16), the components must be organised as in Figure 5. After setting in ordinate values there is a procedure similar to the above for finding the y_n.

The method may also be extended to partial differential equations such as that for transverse vibrations of a straight rod, Eq (17), with boundary conditions, Eq (18). By quantizing the x and t coordinates a substitute difference equation (19) is found which can be solved by interconnecting K, SPA and NI, considered as building blocks, as in Figure 6. The conductances in the SPA are chosen proportional to the coefficients of Eq (19).

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During the process of solution these conductances are connected in turn by K to the points y(x,t) in accordance with the table of Eq (20), until a multiple null is found. There are 6 figures and 5 Soviet references.

ASSOCIATION: Kiyevskiy institut grazhdanskogo vozdushnogo flota (Kiyev Civil Aviation Institute)

SUBMITTED: February 4, 1959

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SOV/144-59-5-2/14

AUTHOR: Pukhov, G.Ye., Doctor of Technical Sciences, Professor

TITLE: Yet One More Analogue Scalar Multiplier for n-Dimensional Vectors

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Elektromekhanika, 1959, Nr 5, pp 12 - 13 (USSR)

ABSTRACT: In an earlier note, (Ref 1) the expression (1) was simulated by voltages for the x's and for b and by the conductances of 2 n-rayed stars for the a's. It is shown that the even simpler circuit of Figure 1 may also be used. The relation between the individual divider currents and the difference between those in the 2 bus-bars is Eq (2), where the α's are the ratios of the parts into which each current divider is separated by the slider. It will be seen that Eq (2) may be used to simulate Eq (1). Introducing scale factors in Eqs (4) and (5) the necessary boundary conditions to α and a are Eqs (6) and (7) respectively. An advantage is that the sign of a may be

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Yet One More Analogue Scalar Multiplier for n-Dimensional Vectors

changed without switching. A drawback is the use of currents, amd not voltages, to simulate x and b. There is 1 figure and 1 Soviet reference.

ASSOCIATION: Kiyevskiy institut grazhdanskogo vozdushnogo flota (Kiyev Institute of the Civil Air Fleet)

SUBMITTED: April 3, 1959.

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SOV/144-59-8-1/14

AUTHOR: Pukhov, G.Ye., Doctor of Technical Sciences, Professor

TITLE: A Possible Principle of Construction of Mathematical Machines

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Elektromekhanika, 1959, Nr 8, pp 3-11 (USSR)

ABSTRACT: It is suggested that the simplicity and reliability of the analogue computer can be combined with the accuracy and "controlability" of the digital computer in a "continuous-discrete" (NDD) machine. The basic operation is that of finding the components of n-dimensional vectors when these are orthogonal (see Refs 1 and 2). The vectors $\vec{x}$ and $\vec{a}$ are defined in Eq (1) and the operation carried out by the machine is Eq (2). This latter condition is conveniently satisfied by the circuit of Fig 1 in which each α is a controlled voltage divider and each β is a controlled current divider. If the conductance G joining the dividers is smaller than that of the dividers then Eq (4) is valid. The settings of the dividers for each x and a is calculated from Eq (5). The block diagram of the complete, general-purpose machine is Fig 2 in which 3y is the store, consisting of the α-dividers,

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Ay is the arithmetic unit comprising the β-dividers, the conductances G and the current-difference amplifier needed to operate the tracking system, KП is the patching panel, yy is the control unit. The store accepts and delivers values in discrete (divider position) form. The arithmetic unit also has a memory function since it also holds the values of the vector components of $\vec{a}$. The voltage dividers in Зy and Ay are preferably helical potentiometers driven by motors excited from the amplifier which magnifies the current difference. The patching panel is in two parts, one of which connects the store and the arithmetic unit, the other connects the latter to the control unit. In Section 2 the various portions describe possible operations with symbolic notation as follows: a) addition and subtraction; б) linear forms; в) multiplication and division; г) multiplication and division of linear forms; д) first and higher derivations; е) definite integrals; ж) logical operations. The compilation of a typical programme is illustrated using the example of a second order differential equation, Eq (30), which is solved by

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finite differences, a typical iteration being Eq (33). There are 2 figures and 2 Soviet references.

ASSOCIATION: Kiyevskiy institut grazhdanskogo vozdushnogo flota (Kiyev Institute of Civil Aviation)

SUBMITTED: June 5, 1959

PHASE I BOOK EXPLOITATION SOV/5166

Pukhov, Georgiy Yevgen'yevich

Elektricheskoye modelirovaniye sterzhnevykh i tonkostennykh konstruktsiy (Electrical Simulation of Truss and Thin-Walled Structures) Kiyev, Izd-vo AN UkrSSR, 1960. 149 p. 3,000 copies printed.

Sponsoring Agency: Akademiya nauk Ukrainskoy SSR.

Resp. Ed.: P.F. Fil'chakov, Doctor of Physical and Mathematical Sciences; Ed. of Publishing House: N.M. Labinova; Tech. Ed.: N.P. Rakhlina.

PURPOSE: This book is intended for scientists, technicians, and students concerned with the theory and application of electrical simulation methods in scientific and technical computation.

COVERAGE: The book presents the theory of balanced electrical resistor networks and discusses its application in solving problems of construction engineering for such truss structures as beams, frames, and girders and for such thin-walled structures as box-type shells and plates. Special electrical models

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designed and manufactured for the purppse of computing these systems, in particular the EMSS-7 model designed at the Vychislitel'nyy tsentr AN USSR (Computing Center AS UkrSSR), are described. The author thanks V.M. Glushkov, Corresponding Member AS UkrSSR for his advice, and Engineers V.V. Vasil'yeva, L.V. Konstantinova, and O.N. Tokareva for their assistance in preparing the manuscript for publication. There are 67 references: 61 Soviet (including 4 translations), and 6 English.

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9,3230

AUTHOR: Pukhov, G.Ye., Doctor of Technical Sciences, Professor, ~~Head of the~~ Chair

TITLE: Approximate Method of Calculating the Electrical Networks

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Elektromekhanika, 1960, Nr 1, pp 37-42 (USSR)

ABSTRACT: The method described is analogous to that employed in mechanics for the design of frame structures. The method is known as the method of the balancing of node torques. By analogy, when applied to electrical networks the method can be referred to as the node-current balance method. It is assumed that if an electrical network contains several nodes one of these is referred to as the base node, while the remaining are the ordinary nodes. The method is based on determining the actual currents by balancing the currents successively from node to node. By balancing the currents in the first node, the balance currents in the neighbouring branches are found as well as in the secondary short-circuited nodes. The unbalance current of the second node will be equal to the sum of the initial and secondary short-circuit currents.

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Next, by balancing the currents in the second node, the balance currents and the secondary currents are found in the remaining nodes (including the second node). The first balancing cycle is completed when the currents in all the ordinary nodes are balanced once. By repeating the balancing procedure several times, it is possible to find the non-balance currents of successive cycles and these will be very small. At this stage the calculations can be terminated, since additional balancing does not result in a substantial change of the current distribution. The actual currents in the branches are now determined by adding all the short-circuit currents and the balance currents of all the cycles. It is now necessary to show that the above process is convergent. This is done by considering a network having 3 nodes (see Fig 1). The current I in Fig 1 is the unknown, while K_a and K_b are the current transfer coefficients from the nodes a and b into a given branch; the coefficients K_{ab} and K_{ba}

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represent the transfer of the currents from the node a into the node b and vice versa. The superposition of the balance currents and the short-circuit currents is expressed by:

$$I = I_k + K_a I_a + K_b(K_{ab} I_a + I_b) + K_a K_{ba}(K_{ab} I_a + I_b) + + \ldots\ldots\ldots \qquad (1)$$

If $K_{ab} K_{ba} = \lambda$, Eq (1) can be expressed as Eq (2), from which it follows that the process is convergent provided $|\lambda| < 1$. In applying the method to the calculation of the currents in a practical system, it is convenient to record the results in a specially constructed table. The method of tabulating the results is shown in the Table on page 40, which gives the results for the bridge circuit shown in Fig 3. From the Table it is seen that after four balancing operations the method gives the values which are about 1% different from the actual currents.

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Approximate Method of Calculating the Electrical Networks

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There are 3 figures, 1 table and 3 Soviet references.

ASSOCIATION: Kafedra teoreticheskikh osnov elektrotekhniki, Kiyevskiy institut grazhdanskiy vozdushnyy flota (Chair of Theoretical Fundamentals of Electrical Engineering, Kiyev Institute of Civil Aviation)

SUBMITTED: September 1, 1959

Card 4/4

KALYAYEV, Anatoliy Vasil'yevich; PUKHOV, G.Ye., otv. red.; LABINOVA, N.M., red.; MEL'NIK, T.S., red.

[Introduction to the theory of digital integrators] Vvedenie v teoriiu tsifrovykh integratorov. Kiev, Naukova dumka, 1964. 290 p. (MIRA 17:9)

1. Chlen-korrespondent AN Ukr.SSR (for Pukhov).

69198

S/144/60/000/02/002/019
E192/E182

9.3230

AUTHOR: Pukhov, G.Ye., Doctor of Technical Sciences, Professor, ~~Head of the Chair~~

TITLE: The Conditions of Convergence for the Balancing of an Electrical Networks containing Quasi-Negative Resistances

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Elektromekhanika, 1960, Nr 2, pp 8-14 (USSR)

ABSTRACT: Quasi-negative resistances can be obtained in the following way. Fig 1a shows a bipole consisting of an ohmic resistance r and an ideal source of electromotive force, E, connected in series with it. A voltage u is measured between the midpoint of E and the second terminal of the resistance. It is seen that the following equations are true for the bipole:

$$U_{AB} = E + rI_{AB}, \quad U_{AB} = \tfrac{1}{2}E + u \qquad (1)$$

If E is eliminated from the above, one obtains:

$$U_{AB} = -rI_{AB} + 2u \qquad (2)$$

From the above it follows that by changing the magnitude and the direction of the electromotive force E, it may

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The Conditions of Convergence for the Balancing of an Electrical Network containing Quasi-Negative Resistances

be possible to achieve situations in which the voltage u is equal to 0. In this case the bipole will behave as a negative resistance $r_{AB} = -r$. A similar result can be obtained by means of the second network shown in Fig 1, which consists of a resistance r and a current source I. This case is described by Eqs (3) and (4). Again by changing the magnitude and the direction of I it is possible to obtain the conditions when i = 0 and the network will behave as a negative resistance. Since the above networks do not in fact contain any negative parameters, resistances are referred to as the quasi-negative resistances. Such resistances can play an important part in the solution, in particular the synthesis, of electrical networks. However, the application of such elements is not always possible. This is due to the fact that while adjusting the electromotive force of a bipole in such a manner as to obtain the negative resistances, the other elements of the system may be misaligned and the process of balancing may

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The Conditions of Convergence for the Balancing of an Electrical Network containing Quasi-Negative Resistances

not necessarily be convergent. It is now necessary to consider the convergence conditions for the balancing process in a network. The process results in the reduction of the so-called deviation currents and voltages, of the type u and i to zero. For the purpose of analysis it is assumed that the bipoles of Fig 1 can be represented as shown in Fig 2. If the network is not balanced, the deviation voltages U_i are not equal to 0 and due to the linearity of the system, can be expressed by Eq (5), where P_{ij} are dimensionless coefficients depending on the configuration of the network and the magnitudes of the resistances; $\overline{U}_i$ are the components of the voltages u_i which are determined by the electromotive forces of those sources which are not being adjusted. Mathematically the balancing process amounts to selecting the electromotive forces E_j in such a way that the deviations u_j are equal to 0. The convergence of the process will depend on the method of balancing. It is shown that the condition sufficient for

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the convergence is equivalent to the condition of the diagonality of the matrix of the coefficients of Eq (5). The condition is expressed by Eq (7). This can also be expressed by the equivalent condition defined:

$$2|u_j| - \sum_{i=1}^{i=n} |u_i| > 0 \qquad (j = 1,\ldots\ldots, n), \qquad (8)$$

where $E_j = 1$ while all the remaining electromotive forces (as well as the current sources) are equal to 0. If the quasi-negative resistances are realised by means of the current sources (see Fig 2), the system can be described by (Eq 9). For this case the condition sufficient for the convergence of the balancing process is expressed by Eq (10). If the above is checked experimentally it is more convenient to employ

$$2|i_j| - \sum_{i=1}^{i=n} |i_i| > 0, \qquad (j = 1,\ldots\ldots, n), \qquad (11)$$

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where $I_j = 1$, while the currents of all the remaining current sources are equal to 0. In a practical application of the networks with quasi-negative resistances, it may be necessary to replace one type of negative resistance (with a voltage source) by another type (with a current source). In order to determine if such a transformation effects the convergence of the balancing process it is necessary to determine the relationship between the coefficients p_{ij} and q_{ij}. The circuits for determining these coefficients are illustrated in Figs 3 and 4. The relationships between the coefficients take form of Eqs (12), (13), (14) and (15), where k_{ij} is defined by Eq (16). From the above equations it is concluded that the replacement of the resistances with voltage sources, by the resistances with current sources, or vice versa, does not influence the convergence of the balancing process. The above methods of balancing can be secured by minimising the sum of moduli of the deviations or the sum of the squares of

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deviations. The sum of the moduli of the deviations can easily be produced by employing a set of rectifiers and an adding circuit; the resulting sum is then expressed by Eq (18). The above balancing process is illustrated by a practical example; the actual network (which analogues a beam) is shown in Fig 5. The circuit is described by Eqs (19) and (20) from which it follows that the coefficients P_{ij} are given by Eq (21).

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There are 5 figures and 10 references, of which 2 are English and 8 Soviet. Two of the Soviet references are translated from English.

ASSOCIATION: Kafedra teoreticheskikh osnov elektrotekhniki, Kiyevskiy institut grazhdanskogo vozdushnogo flota (Chair of Theoretical Fundamentals of Electrical Engineering, Kiyev Institute of Civil Aviation)

SUBMITTED: December 7, 1959

69408

S/144/60/000/04/003/017
E194/E455

16.6800

AUTHOR: Pukhov, G.Ye., Doctor of Technical Sciences, Professor

TITLE: The Analogue Representation of Three-and Five-Term Equations of Structural Mechanics

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Elektromekhanika, 1960, Nr 4, pp 17-19 (USSR)

ABSTRACT: Many problems of structural mechanics involve the solution of three- and five-term algebraic equations. The three-term equations are of the form of Eq (1) with coefficients satisfying the conditions given by Eq (2); the five-term equations have the form of Eq (3), whose coefficients satisfy the conditions of Eq (4). Articles by other authors have shown that the system of equations (1) with conditions (2) may be represented by an electrical circuit consisting of 3n - 2 ohmic resistances. When some or all of the auxiliary coefficients are positive, the circuit has twice the number of loops than when all are negative. The present article shows that Eq (1) may be represented by an analogue which contains not more than 2n - 1 resistances and examines the conditions under which the analogue may also be used to

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find the roots of five-term equations by a method of successive approximation. If all the auxiliary coefficients of Eq (1) are negative, the analogue circuit is of the form shown in Fig 1. It is demonstrated that, by appropriate reversal of current at particular points in the system, this same circuit may be used to represent Eq (1) when the auxiliary coefficients have other signs. The circuit for the case when all the auxiliary coefficients are positive is shown in Fig 2 and Eq (8) apply. Eq (1), (6) and (7) may then be used to determine the voltages, currents and conductivities of the circuit. If some of the auxiliary coefficients are negative and others positive, combined circuits may be formulated: an example of this kind is shown in Fig 3. The conditions under which electrical analogues of three-term equations may be used to solve five-term equations are then considered. Eq (3) is rewritten in the form of Eq (9), that is in a three-term form. The method of successive approximations

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is then explained. It is shown that the five-term equations can be solved provided that the moduli of the main coefficients are greater than the sum of the moduli of the auxiliary coefficients in each line of Eq (3). This condition is frequently fulfilled in calculations on various thin-walled or rod structures. There are 3 figures and 5 Soviet references.

ASSOCIATION: Kiyevskiy institut grazhdanskogo vozdushnogo flota (Kiyev Institute of Civil Aviation)

SUBMITTED: September 20, 1959

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82918
S/144/60/000/006/003/004
E041/E121

16.6800

AUTHOR: Pukhov, G.Ye. (Doctor of Technical Sciences, Professor)

TITLE: Some Design Principles for Electrical Models of Frames with Displaced Joints

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Elektromekhanika, 1960, 3, No 6, pp 17-27

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TEXT: Previously the use of the EMSS-1, -5 and -6 machines for simulating structural problems of this kind has encountered difficulties because only part of the task could be loaded; the rest was a manual calculation. The present paper describes methods avoiding this disadvantage. Fig 1 shows the general case of a freely supported rod subject to transverse loads at the supports, bending moments at either end and a continuous, arbitrarily distributed external loading. The relations between the mean and terminal slopes and the forces and moments are Eqs (1), (2) and (3). When the ends of the rod are rigidly fixed the equations are Eqs (4), (5) and (6). The 'free' and 'restrained' equations are combined in Eqs (7), (8) and (9). It is pointed out at this stage that simulation is greatly facilitated by working in terms of either sum or differences of bending moments as in

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Eqs (9), (10). The equations may be generalized as in Eqs (16), (17), to allow for the moment of inertia of the cross-section to be variable along the length of the rod. It is also shown that these latter equations can cater for longitudinal loadings as well as continuous elastic support. The active T-circuit of Fig 2 is described in Eq (25) and can be used to simulate the structural problem if the resistance r is allowed to be negative. This disadvantage may be overcome by three distinct methods: adding a bridging element to the T-circuit; incorporating conditional voltage or current sources which enable a positive resistance to appear negative; changing the form of analogue. Figs 3 and 4, together with Eqs (30) and (33) show how the second method is used. The first method has been described in Ref 3. The preferred approach is to base the analogy on the Π-circuit of Fig 5. The relevant set of identities are Eqs (41), (42). If a structure is made up of a number of members then the circuit analogue is similarly built up with circuit nodes corresponding to structural

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Some Design Principles for Electrical Models of Frames with Displaced Joints

joints. The two-storey, single-span frame of Fig 6 is represented by the circuit of Fig 7 when T- circuit analogues are used, and by Fig 11 when the Π-form is used. In order to work in terms of moment-differences the expression of Eq (47) must be represented using the sub-circuit of Fig 8. A more elegant solution is the "warp-circuit" of Fig 10. The methods described have been used on the EMSS-7 machine at the computing centre of the Ukr.SSR AS. There are 11 figures and 10 references: 8 Soviet and 2 English.

ASSOCIATION: Kafedra teoreticheskikh osnov elektrotekhniki Kiyevskiy institut grazhdanskogo vozdushnogo flota (Department of Theoretical Electrical Engineering, Kiyev Institute of Civil Aviation).

SUBMITTED: November 11, 1959

Card 3/3

PUKHOV, Georgiy Yevgen'yevich, doktor tekhnicheskiy nauk, prof.

Simulation of girders by means of balancing electric nets. Izv. vys. ucheb. zav.; elektromekh. 3 no.9:6-10 '60.
(MIRA 15:5)

1. Zaveduyushchiy kafedroy teoreticheskikh osnov elektrotekhniki Kiyevskogo instituta grazhdanskogo vozdushnogo flota.
(Electric networks) (Girders--Models)

87988

S/144/60/000/011/002/008
E031/E255

9.7000

AUTHORS: ~~Pukhov, G. Ye.~~, Doctor of Technical Sciences, Professor and Borkovskiy, B. A., Post-graduate Student

TITLE: On the Electrical Simulation of a System of Linear Algebraic Equations with Arbitrary Coefficient Matrix

PERIODICAL: Izvestiya Vysshikh Uchebnykh Zavedeniy, Elektromekhanika, 1960, No. 11, pp. 36-37
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TEXT: It is usually assumed (Ref. 1) that electrical analogues consisting of the elements R, L, and C can only be constructed for systems of linear algebraic equations with symmetric matrices of coefficients, while systems of equations with unsymmetric matrices can be simulated by electrical circuits only if transformers and amplifiers are used (Refs. 1, 2, 3). The present article aims to extend the domain of usefulness of models for symmetric algebraic systems constructed from the elements R, L and C, and to show how to apply them to the solution of systems of algebraic equations with arbitrary matrices. In order to solve the system AX = F with arbitrary matrix A on an electrical model, an electrical analogy of the following algebraic

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On the Electrical Simulation of a System of Linear Algebraic Equations with Arbitrary Coefficient Matrix

system:

$$\begin{vmatrix} 0 & A \\ A^* & B \end{vmatrix} \cdot \begin{vmatrix} Z \\ X \end{vmatrix} = \begin{vmatrix} F \\ 0 \end{vmatrix}$$

must be constructed. X and F are the vectors of the unknowns and right hand sides of the system (1). A^* is the transpose of A. B is an arbitrary symmetric matrix and Z is a vector of spurious (undetermined) unknowns. This is always possible since the matrix of the system (2) is symmetric and no other restrictions are imposed on systems simulated by electrical circuits containing R, L and C elements (Ref. 1). One of the possible methods of constructing an electrical circuit simulating the system (2) is clear from Fig. 1. Fig. 1 represents an electrical circuit described by the following system of 2n equations:

$$(Y_{10}+Y_{11}+Y_{12}+ \dots +Y_{1k}+ \dots +Y_{1n})\ddot{U}_1'+Y_{11}\ddot{U}_1+Y_{12}\ddot{U}_2+ \dots +Y_{1k}\ddot{U}_k+ \dots +Y_{1n}\ddot{U}_n=I_1;$$

$$\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$

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$$(Y_{n0}+Y_{n1}+Y_{n2}+\cdots+Y_{nk}+\cdots+Y_{nn})\ddot{U}_n'+Y_{n1}U_1+Y_{n2}\ddot{U}_2+\cdots+Y_{nk}\ddot{U}_k+\cdots+Y_{nk}U_n=I_n$$

$$Y_{11}\ddot{U}_1+Y_{12}\ddot{U}_2+Y_{13}U_3+\cdots+Y_{1k}\ddot{U}_k+\cdots+Y_{1n}\ddot{U}_n'+(Y_{11}+Y_{12}+\cdots+Y_{1n})U_1=0.$$

$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$$Y_{n1}\ddot{U}_1+Y_{n2}\ddot{U}_2+Y_{n3}\ddot{U}_3'+\cdots+Y_{nk}\ddot{U}_k'+\cdots+Y_{nn}\ddot{U}_n'+(Y_{n1}+Y_{n2}+\cdots+Y_{nn})\ddot{U}_n=0. \qquad (3)$$

If the equations $Y_{io}+Y_{i1}+Y_{i2}+\cdots+Y_{ik}+\cdots+Y_{in}=0 \quad (i = 1, 2, \ldots, n) \qquad (4)$

are satisfied then the system (3) can be written shortly as

$$\begin{array}{|c|c|}\hline 0 & Y \\ \hline Y^{\#} & Y \\ \hline \end{array} \cdot \begin{array}{|c|}\hline U' \\ \hline \ddot{U} \\ \hline \end{array} = \begin{array}{|c|}\hline \ddot{I} \\ \hline 0 \\ \hline \end{array} \qquad (5)$$

By comparing equations (2) and (5) it follows that the circuit (Fig. 1) simulates equations (2). The elements a_{ik} of the matrix A are simulated by the conductivities Y_{ik} the components F_i of

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the vector of the right hand sides F are simulated by the currents I_i and the components x_k of the vector of unknowns X are represented by the voltages $\dot{U}_k$. The conductivities of capacitors simulate the positive elements of A, and the conductivities of inductors simulate the negative elements of A. The conductivities Y_{i0} are chosen so that the Equations (4) are satisfied, i.e. so that the particular conductivities of the nodes $1', 2', \dots, i', \dots N'$ at which the current I_i representing the right hand side of the equations are introduced are zero. By measuring the components of the vector $\dot{U}$ in amplitude and phase the values of the unknown vector X in Equations (1) may be obtained in some scale. The circuit (Fig. 1) requires n^2+n L and C elements to simulate a system of the n-th order with an arbitrary matrix. There are 3 Soviet references.

ASSOCIATION: Kafedra teoreticheskikh osnov elektrotekhniki Kievskiy institut grazhdanskogo flota
(Department of Basic Theory of Electrical Engineering Kiev Institute of the Civil Air Fleet)

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S/144/60/000/011/002/008
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On the Electrical Simulation of a System of Linear Algebraic Equations with Arbitrary Coefficient Matrix

Fig. 1

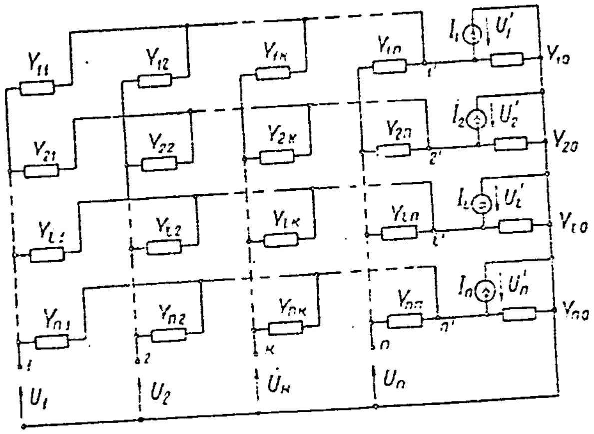

Рис. 1.

Card 5/5

PUKHOV, Georgiy Yevgen'yevich, doktor tekhn.nauk, prof.; SAMUS', Vladimir Mikhaylovich, aspirant

Electric circuits for integrating the equation $y^{IV} - 2r^2 y'' + s^4 y = q$. Izv. vys. ucheb. zav.; elektromekh. 3 no.12:20-25 '60. (MIRA 14:5)

1. Zaveduyushchiy kafedroy teoreticheskikh osnov elektrotekhniki Kiyevskogo instituta grazhdanskogo vozdushnogo flota (for Pukhov). 2. Kafedra teoreticheskoy i obshchey elektrotekhniki Kiyevskogo instituta grazhdanskogo vozdushnogo flota (for Samus').
(Electronic calculating machines)

PUKHOV, Georgiy Yevgen'yevich; GLUSHKOV, V.M., akademik, otv.red.;
LABINOVA, N.M., red.izd-va; DAKHNO, Yu.M., tekhn. red.

[Calculus of complexes and its application] Kompleksnoe ischislenie i ego primenenie. Kiev, Izd-vo Akad.nauk USSR, 1961. 229 p.
(MIRA 14:12)

1. Akademiya nauk USSR (for Glushkov).
(Complexes) (Calculus, Operational)

28163

S/144/61/000/009/001/001
D201/D303

9,7200

AUTHOR: Pukhov, G.Ye., Corresponding member AS UkrSSR, Doctor of Technical Sciences, Professor, Head

TITLE: Foundations of the general theory of quasi-analogue systems

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Electromekhanika, no. 9, 1961, 3 - 21

TEXT: This article was written from a report, submitted at the session of the Physico-Mathematical Section AS UkrSSR on March 29, 1960. The author describes methods of mathematical representation of some complex systems by equations which could be set on electronic computers leading to qualitative and quantitive solutions. Quasi-analogue systems are defined as systems, whose representing models have different structures and equations. A quasi-analogue model of an equation (a) is such that it is a model of different equation (b) which may be partly different from a given equation (a), but such that it satisfies some determined conditions (the criteria of equivalence) and all, or some of the unknowns of the Eq. (b) coincide with the

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unknowns of the initial Eq. (a). If the conditions of equivalence are such that their representation does not require the use of the unknowns resulting from model (b), then the quasi-analogue model does not differ from an analogue model. These models are called by the author, models of the first kind, or unbalanced models. If the conditions of the equivalence require the use of the resulting quantities, then it is necessary to introduce a special process, called by the author a balancing model process to satisfy the above stated conditions, these models are called quasi-analogue models of the second kind, or balanced models. Fig. 2 shows the classification of Mathematical models. Basic problems in a quasi-analogue system are: (a) Deduction and construction of quasi-analogue models of the first kind, and of quasi-analogues and balancing systems of models of the second kind; deducting signs of mathematical equivalence of an initial object and that of a model, and obtaining criteria of equivalence; (b) detection of and obtaining methods of study of convergence, establishing the criteria of convergence; (c) working out ideal systems of quasi-analogue models applicable for the typical objects. (d) solving the problems of accuracy, automation of balancing, stability of the models. The purpose of introducing a quasi-analogue is that by introducing known vectors F, G and of a known balancing vector Φ, the value of the unknown vector X could be obtained. The balancing system is used to transform the vectors Z and H into Φ. It is practically convenient that vector Z obtains, apart from the unknown X, and a vector of auxiliary unknown Y, also the difference factor $\mathcal{E}$, whose conversion to zero would mean the fullfillment of the condition of equivalence. The requirements with respect to operators are formulated by the author as follows: (a) The operators B and C should allow for the possibility of construction of a model continuing given elements. b) The operators B and C should be such that the equation of a quasi-analogue model should be found without calculations. This applies also to operator K and vector ℓ used to determine vector G = K (ℓ) which, if possible, should be found without long calculations. c) The operators C and D should satisfy the conditions of convergence. The author then examines a particular case the construction of models of equations in which there are no auxiliary unknowns, and also of equations in which the conditions of equivalence are not directly obtained. Also examples of quasi-analogue models of the first kind are given. The difficulty of the problem is in obtaining a quasi-analogue system. The balancing of this system is effected either by hand, or by simple detecting schemes. Depending on the method of introducing the error 4

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vector $\mathcal{E}$ and of the balancing vector ϕ there could result different equivalent equations which are suggested by the author. A simple way of constructing mesh quasi-analogues is of the type

$$AX = F + \lambda \varepsilon , \tag{24}$$

4

where λ is a diagonal matrix, dependent on the structure of the electric circuit. Models of Eq. (24) are called α-analogues. In Fig. 9 the equations are of the form

$$\begin{aligned}
&\pm a_{11}X_1 \pm a_{12}X_2 \pm \dots \pm a_{1n}X_n = F_1 + \lambda_1 \mathcal{E}_1 , \\
&\pm a_{21}X_1 \pm a_{22}X_2 \pm \dots \pm a_{2n}X_n = F_2 + \lambda_2 \mathcal{E}_2 , \\
&\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\
&\pm a_{n1}X_1 \pm a_{n2}X_2 \pm \dots a_{nn}X_n = F_n + \lambda_n \varepsilon_n ,
\end{aligned} \tag{25}$$

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In the above scheme the unknowns are represented by the voltages X_i and the error functions by the voltage $\mathcal{E}_i$. The condition of equivalence is $\mathcal{E} = 0$. The balancing of a scheme shown in Fig. 9 could be solved by Seidel's method. This method consists of the consecutive equating to zero of the error functions $\mathcal{E}_i$ by the matching of the values of Φ_i (for scheme in Fig. 9, $\Phi_i = X_i$). This is feasible if the system is convergent. The method consists of constructing an equation linking the vectors Φ and $\mathcal{E}$ by an analysis of a matrix of coefficients of this equation.

$$P\Phi + \mathcal{E} = 0 \qquad (28)$$

For α-analogue models it follows from (24) and (28) and $\Phi = X$, that the matrix P is

$$P_\alpha = \lambda^{-2} A \qquad (30)$$

When changing in differential equations with ordinary, or with partial derivatives, it may appear that some of the members of the matrix A repeat. Then the model could be substantially simplified. It would then consist of source of voltage X_i, source of current F_i and a change over switch. If the matrix P_α does not satisfy Seidel's condition then the balancing of α-analogues should be found differently. It is possible to apply the relaxation method of balancing. The author considers a system shown in Fig. 12, which he calls a γ-analogue. The part M is represented by

$$MX = F + \Phi, \tag{34}$$

and the part D by

$$DX = \Phi + \lambda \varepsilon, \tag{35}$$

where

$$M = A + D, \tag{36}$$

and λ is a diagonal matrix. To deduce the condition of convergence in the Seidel's method of balancing, eliminating the unknowns from (34) and (35), one gets

$$\lambda^{-1} (DM^{-1} - E) \Phi + \lambda^{-1} DM^{-1} F = \varepsilon. \tag{37}$$

As long as $D = M - A$, the matrix determining the convergence is

$$P_{\gamma} = -\lambda^{-1} AM^{-1} . \qquad (38)$$

The convergence is quicker the nearer matrix M is to matrix A. A gamma - analogue model is illustrated by a mesh model of a differential equation

$$x^{IV} - 2r^{2}x'' + s^{4}x = q, \qquad (39)$$

This model permits the solving of a number of two-dimension differential equations with partial derivatives of a higher than the second order by a pure machine manner. Such problems are solved on the known mesh electronic integrators. The author also considered a two member analogue represented by

$$MX = F + \phi, \qquad (43)$$

$$DY = \phi, \qquad (44)$$

where M is determined from (36) and the matrix D is selected so that there

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are analogue models (43) and (44). The condition of equivalence is at Y = X.

$$\varepsilon = X - Y \qquad (45)$$

which is zero. This model is called δ-analogue by the author. As a last example the author considered a model with quasi-analogue models with quasi-negative resistances (Fig. 14) The resistance of this type are used in a modernized mesh mathematical machine ЭМСС-7 (EMSS-7) for calculating beams and frames. The link S consists of ohmic resistances, and R_o, R_1 ... R_N are such that the negative model is a total analogue of the equations of the object. The magnitudes and signs of the p.d. E_o, E_1 ... E_N are obtained by the change over arithmetic structure, consisting of two equal resistances $R_a = R_b = R$ and of a zero indicator. E_i is set so that the indicator shows zero deviation ε_i and all p.d. are selected in this manner. The auxiliary unknowns are current I_i, voltages U_i at the points of function of two-terminal networks. The author quotes many other applications. There are 15 figures and 29 references: 23 Soviet-bloc and 6 non-Soviet-bloc. The 4 most recent to English-language publications read as follows: W.J. Karplus, Analog. Simulation solution of field problems. New York. 1958; R.H. Mac Neal, the solution of elastic plate problems by electrical analogies. Journ. Appl. Mech. V.18, pp. 59 - 67, 1951; W.T. Russel, R.H. Mac Neal. Improved electrical analogy for analysis of beams in beinding. Journ. Appl. Mech. v. 20, pp. 349 355, 1953; G.W. Swenson. T.J.A. Higgins direct-current network analyser for solving wave-equation boundary-value problems. Journ. Appl. Physics. v.23, 1952, no. 1

ASSOCIATION: Otdel analogovykh matematicheskikh mashin vychislitel'nogo tsentra AN USSR (Analogue Computer Section, Computer Center AS UkrSSR)

SUBMITTED: March 3,1961 (Initially)
May 3, 1961 (After revision)

KEROPYAN, K.K., prof., doktor tekhn. nauk, red.; PUKHOV, G.Ye.,
prof., doktor tekhn. nauk, red.; UGODCHIKOV, A.G., prof.,
doktor tekhn. nauk, red.; SADETOV, S.Ya., dots., kand. tekhn.
nauk, red.; GUNKIN, I.I., assistent, red.;CHEGOLIN,[illegible].M.,dots.,kand.
tekhn.nauk,red.(Minsk)

[Proceedings of the Inter-University Conference on Electric Modeling of Problems of Structural Mechanics, Theory of Elasticity, and Strength of Materials] Trudy Mezhvuzovskoi nauchno-tekhnicheskoi konferentsii po elektricheskomu modelirovaniiu zadach stroitel'noi mekhaniki, teorii uprugosti i soprotivleniia materialov. Pod red. K.K.Keropiana i A.G. Ugodchikova. Novocherkassk, Rostovskii inzhenerno-stroitel'nyi in-t, 1962. 176 p. (MIRA 17:4)

1. Mezhvuzovskaya nauchno-tekhnicheskaya konferentsiya po elektricheskomu modelirovaniyu zadach stroitel'noy mekhaniki, teorii uprugosti i soprotivleniya materialov. 2d, Rostov-na-Donu, 1962. 2. Rostovskiy-na-Donu inzhenerno-stroitel'nyy institut (for Keropyan, Sadetov, Gunkin). 3. Chlen-korrespondent AN Ukr.SSR i Vychislitel'nyy tsentr AN SSSR (for Pukhov). 4. Gor'kovskiy inzhenerno-stroitel'nyy institut (for Ugodchikov).

33961

S/144/62/000/001/001/002
D224/D301

9,7000

AUTHOR: Pukhov, G.Ye., Doctor of Technical Sciences, Professor, Corresponding Member of the AS UkrSSR

TITLE: Iteration method of integrating differential equations on electronic computers

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy. Elektromekhanika, no. 1, 1962, 3-9

+

TEXT: The suggested method of treating linear differential equations consists in the preliminary computing of an approximete matrix $\tilde{G}$ or its inverse one $\tilde{B}=\tilde{G}^{-1}$ which is set on an electronic computer, and of subsequent feeding into the computer of a correcting equation. The author derives conditions for convergence of the iteration process and expressions for obtaining the necessary accuracy in determining the components of the correcting matrix. The author states that a special device (iterator) has been developed and connected to an existing industrial type of electronic computer. Automatic solution of a boundary problem was achieved. Owing to rapid convergence of the process of iteration the suggested

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method permitted quicker and simpler solving than by the usual method of minimization. The approximate matrix $\tilde{G}$ is obtained from the set of linear differential equations of the form $PZ+p=X_{in}$, $Q.X_f+q=0$ (Eq.2), where X_{in}, X_f are unknown values of the initial and final state of the vector at $t=0$ and $t=T$ respectively, P,Q - matrices, p,q - vectors with known constant components, Z - a vector composed of unknown components of the initial vector X_{in}. Vectors X_{in} and X_f are connected by the equation $DX_{in} + d = X_f$ where D is a square matrix. Operation (3) could be performed by any integrating device permitting the solution of Cauchy's problem. Solving for X_{in} and X_f gives $GZ+g=0$, in which $G=QDP$. With matrix $\tilde{B}$ known, the iteration process for each cycle consists of five operations: The initial vector X_{in} (i) is obtained as a result of (i-1) th cycle of calculation from vector $Z_{(i)}$. The vector $X_{in(i)}$ is fed into the integrator and the vector $X_{f(i)}$ is found. Substituting the latter into Eq. (2) gives on the right-hand side the vector of deviations (i)

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instead of a zero. This permits calculation of the correction vector $\Delta Z_{(i)}$, and the new value of vector $Z = Z_{(i+1)}$ is found. Vector $Z_{(i+1)}$ obtained as result of i-order iteration could be expressed in terms of a vector Z(o) selected initially:

$Z_{(i+1)} = F^{i+1} Z_{(0)} - (E + F + F^2 + \dots + F^i)\tilde{B}g$ (14) where E is unit matrix, and $F \equiv E - BG$. The condition of convergence requires that $\|F\| < 1$. The initial differential equation could be transformed so that the known components of the final vector, instead of those of the initial vector, are used for the integration. The iteration method is applicable to problems with given boundary conditions for several points. A numerical example of an equation $\frac{d^4x(t)}{dt^4} = x^{IV}(t) = \varphi$ is considered in detail. There are 1 table and 5 Soviet-bloc references.

ASSOCIATION: Vychislitel'nyy tsentr AN USSR (Computer Center, AS UkrSSR)

SUBMITTED: December 9, 1960

Card 3/3

S/271/63/000/003/030/049
A060/A126

AUTHOR: Pukhov, G.Ye.

TITLE: Theory and use of an invertible operational amplifier

PERIODICAL: Referativnyy zhurnal, Avtomatika, telemekhanika i vychislitel'naya tekhnika, no. 3, 1963, 15, abstract 3B83 (Dokl. 4-y Mezhvuz. konferentsii po primeneniyu fiz. i matem. modelirovaniya v razlichn. otraslyakh tekhn. Sb. 3, Moscow, 1962, 63 - 72)

TEXT: The author notes the possibility of extending the capabilities of analog computers in the case of utilizing besides directed components also undirected components. The circuit of an invertible operational amplifier is described, the output potential on any terminal of which may be obtained by setting potentials at all the remaining terminals of that amplifier. Special cases of a circuit of an invertible amplifier are considered which may be used with various versions of combining the two-terminal components of the external network of the amplifier as an invertible multiplier-divider, invertible integrator-differentiator, and a function generator. The possibility is indicated of

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Theory and use of an invertible operational amplifier S/271/63/000/003/030/049
AC60/A126

applying the invertible operational amplifier to the solution of systems of linear algebraic equations and the conditions of stability for a network containing the operational amplifiers are formulated. The author also considers the application of invertible operational amplifiers to the solution of systems of ordinary differential equations. There are 7 figures and 3 references.

I.V.

[Abstracter's note: Complete translation]

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Pukhov, G Ye.

36273
S/021/62/000/004/008/012
D299/D302

9.7200

AUTHOR: Pukhov, H.Ye., Corresponding Member of the AS UkrRSR

TITLE: Reversible operational amplifier

PERIODICAL: Akademiya nauk UkrRSR. Dopovidi, no. 4, 1962, 466-468

TEXT: An operational-amplifier circuit is proposed for simulating algebraic, differential, and certain other equations. The amplifier incorporates, in addition to the elements of an irreversible amplifier, also elements such that the application of voltages at one pole leads to the appearance of corresponding voltages at other poles. The elements of the circuit are the amplifier proper with fairly large gain factor K, a series of principal two-terminal networks, and a series of auxiliary two-terminal networks. The reversibility of the circuit is due to the symmetrical position of the auxiliary poles with respect to the input of the amplifier. Two variants of the circuit are considered: a) A reversible multiplier-divider. Depending on the pole at which the voltage X is applied, multiplication or division is performed:

$$X_1 = -\lambda X_2 \quad \text{or} \quad X_2 = -(1/\lambda)X_1,$$

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where $\lambda = R_1/R_2$ (R_1 and R_2 being ohmic resistances (constant or variable)). If $R_1 = R_2$, one obtains a sign inverter. b) A reversible integrator-differentiator. In this case one obtains

$$\frac{X_1}{R} + C\,\frac{dX_2}{dt} = 0.$$

Hence, by applying at one pole the function $X_1(t)$, one obtains at the other the integral $X_2 = -\int X_1 dt$ (with $RC = 1$); applying to the second pole the function X_2, one obtains at the first pole the derivative $X_1 = dX_2/dt$. The simulator can be also used for nonlinear voltage transformations. If differential- or algebraic equations of the type

$$\sum_{i=1}^{i=n} a_{ij}X_i = f_i, \quad i = 1, \ldots, n \tag{9}$$

S/021/62/000/006/004/013
D251/D308

AUTHOR: Pukhov, H.Ye., Corresponding Member of the AS UkrSSR

TITLE: Simulation of systems of linear algebraic equations

PERIODICAL: Akademiya nauk Ukrayins'koyi RSR. Dopovidi, no. 6, 1962, 739 - 742

TEXT: The author attempts a solution of the problem of simulating a homogeneous system of equations

$$Ax = 0 \qquad (1)$$

where A is a rectangular matrix having m rows and n columns. The author shows that it is possible to solve the problem with the aid of the inverted operational transducer proposed in his earlier work (DAN URSR, 466 /1962/). (1) is put into partitioned form

$$A_{(m)} x_{(m)} + A_{(n-m)} x_{(n-m)} = 0 \qquad (2)$$

and A represented as the difference of two matrices having non-negative components. Hence an equivalent system giving the roots x_i

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of (1) is found. A simulation scheme for transforming the vectors $x_{(m-n)}$ into vectors x_m, as is required for the solution, is proposed using an inverted operational linear transducer. Transducers operating in parallel and in series are considered. It is shown that in both cases the process of transforming the vectors is stable. There are 2 figures.

ASSOCIATION: Obchyslyuval'nyy tsentr AN URSR (Computer Center of the AS UkrSSR)

SUBMITTED: December 22, 1961

Card 2/2

16.6900

S/021/62/000/007/004/008
1050/1250

AUTHOR: Pukhov, H.Ye. Associate Member ASUkrSSR

TITLE: Quasi-analogue electronic computor for the solution of the general problem of mathematical programing

PERIODICAL: Akademiya nauk Ukrayns'koy RSR Dopovidi, no.7, 1962, 868-870

TEXT: The general problem of mathematical programing is defined as follows: Find the minimax (minimum or maximum) of a linear function

$$\mu = c_1x_1 + c_2x_2 + \dots + c_nx_n \quad (1)$$

where the variables $x_1, \dots x_n$ are not negative and satisfy a set of linear equation

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n + b_1 &= 0 \\ \dots\dots\dots\dots\dots\dots\dots\dots & \\ a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mn}x_n + b_m &= 0 \end{aligned} \quad (3)$$

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I050/I250

Quasi-analogue electronic...

c_j and b_j are constants which may be positive, negative or zero. The coefficients a_{ij} are not negative. The model of a computor for the solution of this problem is described. The method of solution is similar to the simplex method. Since the problem has a unique solution, this method gives a value closely approaching the exact solution in a certain finite number of steps. The operations applied in the use of the computor are described. The value of a given variable is changed until no further increase (or decrease) of it changes the value of in the desired direction. There is 1 figure.

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ASSOCIATION: Obchislyuval'niitsentr AN URSR (Computing Center, AS UKrSSR)

SUBMITTED: December 22,1961

Card 2/2

PUKHOV, G.Ye. (Pukhov, H.IE.)

Electric modeling of algebraic objects by sections. Dop. AN URSR no.8:1022-1024 '62. (MIRA 18:2)

1. Vychislitel'nyy tsentr AN UkrSSR. Chlen-korrespondent AN UkrSSR.

VASIL'YEV, V.V. [Vasyl'iev, V.V.]; PUKHOV, G.Ye. [Pukhov, H.IE.]

Reversible electronic models of structural frames. Dop. AN URSR no.9:1158-1161 '62. (MIRA 18:4)

1. Vychislitel'nyy tsentr AN UkrSSR. 2. Chlen-korrespondent AN UkrSSR (for Pukhov).

PUKHOV, Georgiy Yevgen'yevich, doktor tekhn.nauk, prof.

Inertial method for integrating differential equations using electronic computers. Izv.vys.ucheb.zav.; elektromekh. 5 no.1:3-9 '62. (MIRA 15:2)

1. Chlen-korrespondent AN USSR, zaveduyushchiy otdelom analogovykh matematicheskikh mashin Vychislitel'nogo tsentra AN USSR.
(Differential equations) (Electronic calculating machines)

PUKHOV, G.Ye., prof., otv. red.; LABINOVA, N.M., red.; DAKHNO,
Yu.B., tekhn. red.

[Mathematical modeling and electrical networks] Matematicheskoe modelirovanie i elektricheskie tsepi; trudy. Kiev, Izd-vo AN Ukr.SSR. No.1. 1963. 244 p. (MIRA 16:10)

1. Seminar po metodam matematicheskogo modelirovaniya i teorii elektricheskikh tsepey. 2. Chlen-korrespondent AN Ukr. SSR (for Pukhov).
(Electric networks--Mathematical models)
(Electronic computers)

BARDILA, Tadey Il'ich [Bardyla, T.I.], inzh.; PUKHOV, G.Ye.
[Pukhov, H.E.], retsenzent

[Frequency transformation] Peretvorennia chastoty. Kyiv,
Derzhtekhvydav URSR, 1963. 87 p. (MIRA 17:8)

S/144/63/000/002/001/004
A055/A126

AUTHOR: Pukhov, G.Ye.

TITLE: Reversible quasi-analogue models, their theory and some applications

PERIODICAL: Elektromekhanika, no. 2, 1963, 158 - 173

TEXT: The theory of the reversible operational amplifiers is briefly stated and some of their possible applications as computing and controlling devices are examined. All the models described in the article belong to the quasi-analogue category. The balancing amplifier has a sufficiently high negative amplification factor; 1, ..., n are the main two-terminal networks (TTN) whose inner structure and elements are determined by the required mathematical links between the variables $x_1, \ldots, x_n$ (simulated by voltages); $1', \ldots, n'$ are auxiliary TTN through which the exterior poles $1^*, \ldots, n^*$ of the device are connected to the balancing amplifier output; ε and Φ are, respectively, its input and output voltages. The auxiliary TTN are so designed that the TTN i and i' ($i = 1, \ldots, n$) should be similar. Owing to symmetry, the device as a

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A055/A126

Reversible quasi-analogue models, their ....

whole is reversible with respect to the exterior poles; applying certain voltages to any of the n - 1 of these poles, we obtain, at the remaining pole, a voltage determined by the inner structure and the nature of the elements of the main TTN. If the amplification factor is sufficiently high, ε is small and, the main TTN being linear, the basic equation is:

$$\frac{x_1}{Z_1} + \frac{x_2}{Z_2} + \dots + \frac{x_n}{Z_n} = 0, \qquad (1)$$

$Z_1, \dots, Z_n$ being the operator impedances of the main TTN. By choosing in different manners the main TTN, it is possible to obtain the corresponding reversible solving elements; for instance, the choice of $Z_1 = R_1$, $Z_2 = R_2$ in a two-pole amplifier $(n = 2)$ permits obtaining a reversible multiplier-divisor for which:

$$\frac{x_1}{R_1} + \frac{x_2}{R_2} = 0. \qquad (2)$$

The formula giving the output voltage is:

$$\Phi \sim \left(2 + \frac{Z_1}{Z_1}\right) x_1, \qquad (5)$$

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Z_i, being the i-th pole-to-ground impedance. The author describes next some applications of the reversible amplifiers. He deals first with a reversible linear converter consisting of m reversible operational amplifiers parallel-connected with respect to the exterior poles to which can be applied n-m voltages and obtained m voltages; he proves that the operation of this "parallel action" converter is stable when n-m voltages are applied to any of the poles. The operation of the "series-action" reversible linear converter, obtained by replacing the amplifiers $A_1, \ldots, A_m$ by memory cathode-followers and using one balancing amplifier, is next described. The application of the reversible converters in the following problem is examined: simulation of linear algebraic objects; design of an electric model for the solution of linear planning problems; solution of differential equations. There are 10 figures.

SUBMITTED: January 5, 1962

Card 3/3

PUKHOV, G.Ye. [Pukhov, H.IE.]; BOROKOVSKIY, B.A. [Borkovs'kyi, B.A.]; STEPANOV,
A.Ye. [Stepanov, A.IE.]

Method of continuous operator modeling. Dop. AN URSR no.3:325-331 '63. (MIRA 17:10)

1. Institute kibernetiki AN UkrSSR. 2. Chlen-korrespondent AN UkrSSR (for Pukhov);

ACCESSION NR: AP3006952 S/0021/63/000/008/1006/1009

AUTHOR: Pukhov, G. Ye. (Cor. Member, Acad. Sci. UkrSSR)

TITLE: Linear Algebraic transformer

SOURCE: AN UkrSSR. Dopovidi, no. 8, 1963, 1006-1009

TOPIC TAGS: analog computer, linear algebraic transformation, matrix algebra, vector transformation

ABSTRACT: An analog computer is proposed for the transformation of an n - dimensional vector y into an m - dimensional vector x (m can be greater or less than n), corresponding to the system of equations Ax + By = 0, where A is a non-singular mxm matrix and B is an mxn matrix. The elements of A and B are simulated by ohmic conductors such that the conductance aij (or bij) is proportional to the element aij (bij). The vectors x and y are simulated by electrical voltages. Memory function is provided by capacitors.

It is proved that the process of the transformation of the vectors for any matrix A will be convergent. Orig. art. has 8 numbered equations and 2 block diagrams.

~~Card 1/2~~ Inst Cybernetics, AS UkrSSR

PUKHOV, G.Ye., doktor tekhn., prof.

Direct method for calculating electrical networks. Elektrichestvo no.10:1-4 O '63. (MIRA 16:11)

1. Institut kibernetiki AN UkrSSR. Chlen-korrespondent AN UkrSSR.

L 47720-65 EWT(d)/EWP(v)/EWP(k)/EWP(h)/EWP(l) Pf-4/Pg-4 IJP(c)
ACCESSION NR AM4047288 BOOK EXPLOITATION S/
18
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Pukhov, Georgiy YEvgen'yevich

Selected problems on the theory of electronic computers (Izbrannyye voprosy teorii matematicheskikh mashin), Kiev, Izd-vo AN USSR, 1964, 263 p. illus., biblio. 4,000 copies printed.

14

TOPIC TAGS: computer, computer engineering, automatic control system, modeling, differential equation 16

PURPOSE AND COVERAGE: This book discusses certain problems in the theory of continuous action mathematical machines and their use as computer and control installations. The book is intended for a broad audience of researchers, engineers, students and graduate students interested in mathematical machines.

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ACCESSION NR AM4047288

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SUBMITTED: 20Nov63 SUB CODE: DP, MA

NO REF SOV: 090 OTHER: 014

Card 2/2

TOZONI, Oleg Valentinovich; FUKHOV, G.Ye., otv. red.; MEL'NIK,
T.S., red.

[Mathematical models for the calculation of electrical and magnetic fields] Matematicheskie modeli dlia rascheta elektricheskikh i magnitnykh polei. Kiev, Naukova dumka, 1964. 303 p. (MIRA 17:8)

1. Chlen-korrespondent AN Ukr.SSR (for Pukhov).

LYUSTERNIK, L.A., otv. red.; VOLYNSKIY, B.A., kand. tekhn. nauk, zam. otv. red.; LUK'YANOV, V.S., doktor tekhn. nauk, red.; PUKHOV, G.Ye., red.; TETEL'BAUM, I.M., doktor tekhn. nauk, red.; MEL'NIK, T.S., red.

[Analog methods and techniques for solving boundary value problems; transactions of the All-Union Conference, Moscow, October 1962] Analogovye metody i sredstva resheniia kraevykh zadach; trudy Vsesoiuznogo soveshchaniia, Moskva, oktiabr' 1962 g. Kiev, Naukova dumka. 1964. 354 p. (MIRA 17:12)

1. Chlen-korrespondent AN SSSR (for Lyusternik). 2. Chlen-korrespondent AN Ukr.SSR (for Pukhov).

PUKHOV, G.Ye., otv. red.; LASINOVA, N.M., red.; MEL'NIK, T.S., red.

[Mathematical modeling and electrical circuits; transactions] Matematicheskoe modelirovanie i elektricheskie tsepi; trudy. Kiev, Naukova dumka. No.2. 1964. 395 p. (MIRA 17:8)

1. Seminar po metodam matematicheskogo modelirovaniya i teorii elektricheskikh tsepey. 2. Chlen-korrespondent AN Ukr.SSR (for Pukhov).

FUKHOV, G. Ye.; BORKOVSKIY, B. A.

"Circuit analysis over terminal internal."

report submitted for Intl Conf on Microwaves Circuit Theory & Information Theory, Tokyo, 7-11 Sep 64.

Inst of Cybernetics, AS UkSSR.

L 27234-65 EWT(d)/EWP(1) Po-4/Pq-4/Pg-4/Pae-2/Pk-4/Pl-4 IJP(c) BC/GS

ACCESSION NR: AT5003905 S/0000/64/000/000/0059/0063

AUTHOR: Pukhov, G. Ye.

40

31

B+1

TITLE: One method for the synthesis of control systems

SOURCE: Vsesoyuznaya konferentsiya-seminar po teorii i metodam matematicheskogo modelirovaniya. 3d, 1962. Vychislitel'naya tekhnika v upravlenii (Computer technology in control engineering); sbornik trudov konferentsii. Moscow, Izd-vo Nauka, 1964, 59-63

TOPIC TAGS: control system synthesis, control simulator, automatic control research

ABSTRACT: The author considers a method for synthesizing a control system for an object described by an equation

$$X = \varphi_1(F, Y), \qquad (1)$$

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ACCESSION NR: AT5003905

where φ_1 -- operator determining the connection between the vector Y of the controlling quantities, the vector X of the obtained quantities, and the vector F whose components constitute the external disturbances. It is assumed that the control problem consists of finding a vector Y such that X satisfies the condition

$$\varepsilon = \varphi_2(H, X) \qquad (2)$$

where φ_2 is an operator defining the connection between some specified vector $\bar{H}$, the vector X, and the vector representing the error ε, which does not exceed a certain definite value m. The method employed, which is called by the author the method of inverse operators, consists in constructing the control system in the form of an aggregate of units that realize transformations that are inverse to those performed on the corresponding variables in the object and in a unit that serves as the mathematical analog of the constraints (2). This method was described by the author in several papers, starting with

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ACCESSION NR: AT5003905

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Izv. Vuzov, Elektromekhanika, No. 9, 1961. Such operators are realized by means of irreversible, reversible, and quasi-reversible decision elements, and it is assumed that reversible or quasi-reversible models can be constructed for both the object equations (1) and for the constraints (2). The operating principle of the system, which is shown schematically in Fig. 1 of the enclosure, is described briefly. Orig. art. has: 3 figures and 11 formulas.

ASSOCIATION: None

SUBMITTED: 17Aug64 ENCL: 01 SUB CODE: IE

NR REF SOV: 018 OTHER: 000

Card 3/4

L 16360-65 ESD(dp)/SSD/AFWL/ASD(a)-5/AFMD(p)/AFETR/AFTC(b)

ACCESSION NR: AT4045640 S/2943/64/000/002/0066/0085 B+1

AUTHOR: Pukhov, G. Ye. (Corresponding member AN UkrSSR); Borkovskiy, B. A.

TITLE: Method of construction of reversible and quasi-reversible electronic models

SOURCE: Seminar po metodam matematicheskogo modelirovaniya i teorii elektricheskikh tsepey. Matematicheskoye modelirovaniye i elektricheskiye tsepi (Mathematical modeling and electrical circuits); trudy* seminara, no. 2, Kiev, Izd-vo Naukova dumka, 1964, 66-85

TOPIC TAGS: electronic model, reversible electronic model, automation, computer

ABSTRACT: The usual electronic modeling arrangements are irreversible, that is, the poles of these models are differentiated as input and output. If, for example, in the model of the equation $\frac{d^2x}{dt^2} + x = f(t)$, the input pole is fed the voltage which corresponds to the function f(t), the voltage x(t) will be obtained at the output. It is not possible to obtain the voltage f(t) at the first pole by feeding

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ACCESSION NR: AT4045640

the second pole with x(t), because of the irreversibility. Thus, in these models, the transformation of the information flux can go only in one direction. The present paper describes methods for construction of models in which the information can be transformed in any direction. In these reversible and quasireversible models, the external poles are equivalent. This can be accomplished in reversible models without commutations, in the quasireversible ones it is achieved with simple switching arrangements. Orig. art. has: 12 figures and 37 equations.

ASSOCIATION: None

SUBMITTED: 19Jan62 ENCL: 00

SUB CODE: DP, EC NO REF SOV: 011 OTHER: 001

Card 2/2

L 26648-65 EED-2/EWA(h)/EWP(k)/EWT(d)/EWT(m)/EWA(d)/EWP(1)/EWP(w)/EWP(v)
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ACCESSION NR: AT5002509 S/0000/64/000/000/0306/0311

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41
B+1

AUTHOR: Pukhov, G. Ye., Grezdov, G. I.

16

TITLE: The electronic device "Iterator-1" for the solution of ordinary differential equations with boundary conditions on continuously operating machines

16

SOURCE: Analogovyye metody i sredstva resheniya krayevykh zadach (Analog methods and means of solving boundary value problems); trudy Vsesoyuznogo soveshchaniya, Moskva, 1962 g. Kiev, Naukova dumka, 1964, 306-311

TOPIC TAGS: iteration, differential equation, boundary value problem, ordinary differential equation, analog computer, electrosimulation

ABSTRACT: The paper describes the analog computer "Iterator-1," and illustrates its application to solving systems of linear differential equations of the first order of the form

$$\frac{dX}{dt} = AX + F \qquad (1)$$

with the boundary conditions

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$$\Gamma_0 X_0 = \gamma_0. \quad (2)$$

$$\Gamma_i X_i + \Gamma_k - \gamma = 0. \quad (3)$$

where X, Xi, Xo are vector functions of time, A is a matrix function of time, Γ i are constant matrices and F, γo and γ are vector functions of time. The paper describes the iteration procedure used to solve such systems. Up to 4 conditions, as in equation (3), are permitted. There are 17 operational amplifiers. The boundary conditions can be specified to within 3%. An example of the use of "Iterator-1" to solve a problem on the deformation of a cylindrical shell is given. Orig. art. has: 4 figures, 1 table, and 9 formulas.

ASSOCIATION: None

SUBMITTED: 05Sep64

ENCL: 00

SUB CODE: MA, DP

NO REF SOV: 007

OTHER: 000

Card 2/2

ACCESSION NR: AP4012585 S/0021/64/000/002/0181/0184

AUTHOR: Pukhov, G. Ye. (Corresponding member)

TITLE: Variable structure algebraic transformers

SOURCE: AN UkrRSR. Dopovidi, no. 2, 1964, 181-184

TOPIC TAGS: computer, algebraic transformer, vector transformation, Seidel iteration process

ABSTRACT: Methods for the simplification of algebraic transformer circuits of continuous voltages are considered. Numerically controlled conductances are applied in the methods in question. Absolute convergence for the trans- formation process is proven. The problem is to obtain a device for transforming an n-dimensional vector y into an m-dimensional vector x with linear limitations Ax + By = 0. The iteration process of Seidel is realized in the transformer, which should always converge when limitations are placed on matrix. The methods of simplification of transformers can be simplified even more if matrices A and B contain a large number of zeros.

Association: Insty*tut Kibernety*ky, AN URSR (Institute of Cybernetics. AN Ukr. SSR.

Card 1/[illegible]

VITENBERG, I.M., doktor tekhn. nauk, red.; PETROV, G.M., kand.
tekhn. nauk, red.; PUKHOV, G.Ye., red.; GUTCHINA, N.Ya., red.

[Problems of the theory and application of mathematical modeling] Voprosy teorii i primeneniia matematicheskogo modelirovaniia. Moskva, Sovetskoe radio, 1965. 646 p. (MIRA 18:4)

1. Chlen-korrespondent AN Ukr.SSR (for Pukhov).

L 27628-65 EWT(d)/EEC(k)-2/EWP(1)/EED-2 Po-4/Pq-4/Pg-4/Pk-4 IJP(c) BB/GG
ACCESSION NR: AP5004243 S/0021/65/000/001/0031/0032

AUTHOR: Pukhov, H. Ye. (Pukhov, G. Ye.) (Corresponding member, AN UkrSSR)

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30
B

TITLE: A design for mathematical machines

SOURCE: AN UkrRSR. Dopovidi, no. 1, 1965, 31-32

TOPIC TAGS: analog computer, linear capacitor, nonlinear capacitor, capacitive memory

ABSTRACT: A design of a d-c analog computer utilizing linear and nonlinear capacitors is proposed. Operation is based on the ability of the capacitors to serve as memory elements.16 The advantage of 16 capacitive computers and devices consists in their simplicity and low power consumption. Practical utilization depends to a considerable extent on the quality of the switching elements, which must exhibit low conductivity in the open position. Orig. art. has: 1 figure. [KM]

ASSOCIATION: Instytut kibernetyky AN URSR (Institute of Cybernetics, AN UkrSSR)

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L 27628-65
ACCESSION NR: AP5004243

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SUBMITTED: 16Apr64 ENCL: 00 SUB CODE: DP

NO REF SOV: 002 OTHER: 000 ATD PRESS: 3190

Card 2/2

PUKHOV, Georgiy Yevgen'yevich; GREZDOV, Gennadiy Ivanovich;
VERLAN', Anatoliy Fedorovich; MEL'NIK, T.S., red.

[Methods for solving boundary value problems using analog computers] Metody resheniia kraevykh zadach na elektronnykh modeliakh. Kiev, Naukova dumka, 1965. 144 p.
(MIRA 18:3)

1. Chlen-korrespondent AN Ukr.SSR (for Pukhov).

L 54582-65 EWT(d)/EWP(v)/EWP(k)/EWP(h)/EWP(l) Pf-4

ACCESSION NR: AP5012126 UR/0378/65/000/001/0083/0091
51:621.3.001.1

AUTHOR: Pukhov, G. Ye.; Vasil'yev, V. V.

25
B

TITLE: Theory and application of a method of electric circuit control

SOURCE: Kibernetika, no. 1, 1965, 83-91

TOPIC TAGS: electric circuit control, zero potential point, parametric circuit control, control theory, voltage equilizer, voltage inverter, analog computer

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ABSTRACT: During the design and use of various measuring, computing, and control devices containing electronic circuits as elements, one must often choose control interactions in such a way that the potential becomes zero at definite points of the circuit. This article describes a particular method (which the author calls parametric), which is distinguished by the use of the circuit proper not only for the production of the error signals but also for their transformation, aiming at a convergent control process. The voltages of the control sources are chosen in such a way that they make the changes in current within the sources caused by the introduction of variable ohmic or other conductances zero at points which should be at zero potential. The article shows several illustrative examples

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of direct or feedback devices of analog computer technology (parametric voltage inverter, summator, squarer, voltage equalizer, quasi-negative resistance). Orig. art. has: 34 formulas, 9 figures, and 2 tables.

ASSOCIATION: None

SUBMITTED: 26Sep64 ENCL: 00 SUB CODE: EE, IE

NO REF SOV: 005 OTHER: 000

PUKHOV, G.Ye.

Method for deriving potentially-zero and equipotential points in analog computers. Kibernetika no.2:71-72 Mr-Ap '65.
(MIRA 18:5)

L 10415-66 EWT(d)/EWT(m)/EWP(w)/EWP(v)/T/EWP(k)/EWP(h)/EWP(l)/EWA(h)/ETC(m) IJP(c)
AM5023898 BB/WW/EM/GG/JXT Monograph UR/ /65
8
B+

Vitenberg, I. M.; Petrov, G. M.; Pukhov, G. Ye., eds.

Problems of theory and application of mathematical modeling (Voprosy teorii i primeneniya matematicheskogo modelirovaniya). Moscow, Izd-vo "Sovetskoye radio," 1965. 646 p. illus., biblio. 5800 copies printed.

TOPIC TAGS: analog computer, simulation, mathematical modeling

PURPOSE AND COVERAGE: This book presents the present state and development of Soviet analog computer technology and its significance in various brances of Soviet science and national economy. Problems of the theory of analog computers and mathematical modeling of systems described by partial differential equations and ordinary differential equations are discussed. Readers are familiarized with experience gained in operating modern computers. The book contains articles by several well-known specialists in computer technology which are based on material from the First All-Union Conference on Analog Computer Technology. This book is

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UDC: 681.142.1.01

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intended for a wide range of specialists engaged in designing and operating analog and digital computers, also teachers and students in engineering institutes and State universities.

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The application of analog computers to calculating transients in a circuit with diodes (V. A. Kochegurov, and A. A. Tereshchenko) -- 490

A method for calculating circuits with rectifier elements by means of analog computers (I. A. Gruzdev, L. A. Kuchumov, and Yu. A. Maksimov) -- 494

Experience in using analog computers for electric power calculations (I. A. Gruzdev, and L. A. Kuchumov) -- 508

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The application of an MNB-1 analog computer to selecting and