METHODS FOR CALCULATING ELECTRICAL CIRCUITS.

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Abstract: *The direction of contour currents must be taken in the same direction: only clockwise movement or in the opposite direction to it, so that the signals of the resistors of different signs are the same. In a system of equations solution, whichever contour current comes out with a negative signal, the actual direction of that contour current is inverse to what was originally assumed. Two adjacent contour currents pass through the inter-contour resistance.*

Key words: *Electrical, chain, node, contour, network,Current, potential.*

Processes in any electrical circuit are expressed by Kirchhoff's 1st and 2nd laws.

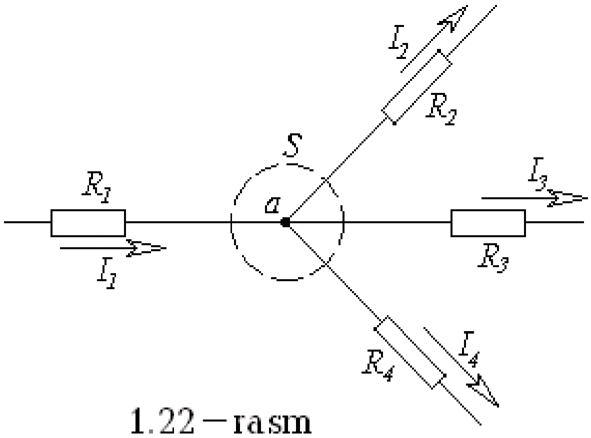
Law 1. Kirchhoff's 1st law applies to the nodes of the circuit, according to which the algebraic sum of the currents at any node of the circuit is zero, that is:

$$\sum_{k=1}^{m} I_k = 0$$

or the arithmetic sum of the currents entering any node of the electric circuit is equal to the arithmetic sum of the currents leaving this node, i.e.:

$$\sum_{i=1}^{m} I_i = \sum_{j=1}^{q} I_j .$$

Figure 1.22 shows node a of an electric circuit. If the currents entering node a are taken with a positive sign, the currents leaving the node are taken with a negative sign (or vice versa).



1.22 − rasm

According to Kirchhoff's 1st law: $I_1 - I_2 - I_3 - I_4 = 0$

yoki $I_1 = I_2 + I_3 + I_4$.

The physical meaning of Kirchhoff's 1st law: the movement of charges in a node of an electric circuit is continuous and charges do not accumulate in it

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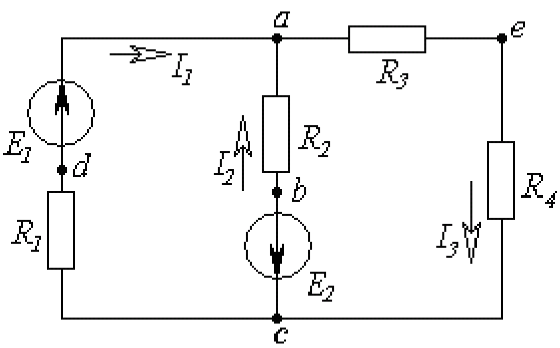
Law 2. Kirchhoff's 2nd law applies to closed circuits of the circuit, according to which the algebraic sum of voltage drops in any closed circuit of an electric circuit is equal to the algebraic sum of ЕУК in this circuit, i.e.:

$$\sum_{k=1}^{n} R_k I_k = \sum_{i=1}^{m} E_i.$$

If the direction of rotation of the circuit is the same as the direction of the current or EC, then the corresponding constituents of the sum are entered with a "positive" sign, and otherwise with a "negative" sign. Kirchhoff's 2nd law can also be written in another form: the algebraic sum of voltages in an arbitrary circuit circuit is zero:



1.23 − rasm

$$\sum_{k=1}^{n} U_k = 0.$$

For the contour in abc of Fig. 1.23

$U_{ab} + U_{bc} + U_{cd} + U_{da} = 0$ or

$R_1 I_1 - R_2 I_2 = E_1 + E_2$. Kirchhoff's laws can be used to calculate linear and non-linear electrical circuits.

Kirchhoff's laws are used to determine the currents in any circuit branch. If the number of nodes in the chain is T, the number of branches is Sh, and the number of current sources is defined as ShTM, a certain sequence can be recommended for calculating the current passing through each branch. In this case, since the value of the current passing through the branches connected to the current source is known, they are subtracted from the total number of currents, that is, Sh-ShTM. Before calculating the unknown currents in the remaining branches of the chain, the following must be done:

a) we select the directions of currents in each branch and mark them in the scheme;

b) To create equations according to Kirchhoff's 2nd law, we set the direction of rotation of the contours arbitrarily (clockwise or counterclockwise).

To create a system of independent equations based on Kirchhoff's 1st law, one less equation than the number of nodes should be created.

The number of equations based on Kirchhoff's 2nd law is calculated by subtracting the number of power source connected branches from the total number of outlets, the number of equations based on Kirchhoff's 1st law, i.e. the number of equations for contours:

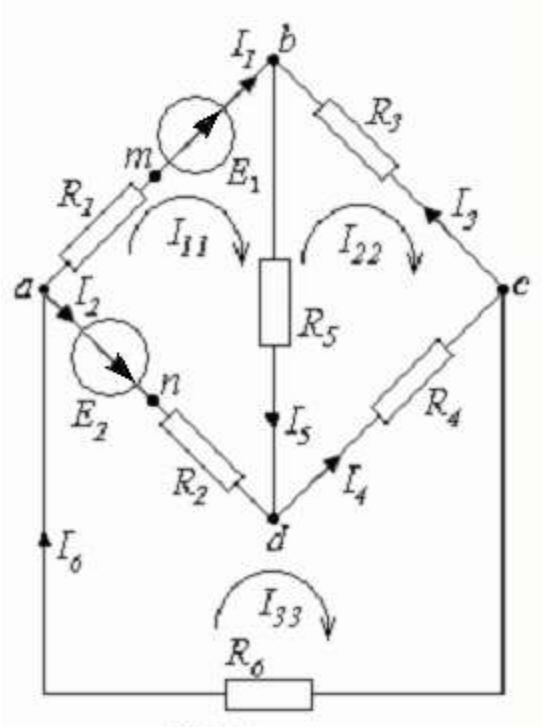
$$K = (Sh - Sh_{TM}) - (T - 1) = Sh - Sh_{TM} - T + 1.$$

According to Kirchhoff's 2nd law, it is necessary to create equations for independent (independent) contours. An unrelated contour is a contour that differs from previous contours by at least one new branch.

A system of linear algebraic equations is a mathematical model of constant current circuits.

There are two types of problems in the theory of electrical circuits. In the first type of problems, it is necessary to calculate the currents in the branches and the voltages and powers in some parts of the circuit, the scheme and elements of which are known. These types of problems are called chain analysis problems. In the second type of problems, the current and voltage in some sections of the inverse problem-chain are given, and it is necessary to determine the circuit scheme and its elements. Such problems are called synthesis problems of electric circuits. To solve both types of problems, a mathematical model of the chain is often created.

Below, we will consider the mathematical model of circuits commonly found in theoretical electrical engineering based on Kirchhoff's laws, using the example of the circuit in Fig. 1.24



1.24 – rasm

1. The direction of the currents in each branch is chosen arbitrarily.

2. We make equations based on Kirchhoff's first law.

Their number is one less than chain nodes:

$I_6 - I_1 - I_2 = 0$ *a* for the node

, $I_1 + I_3 - I_5 = 0$ *b* for the node,

$-I_3 + I_4 - I_6 = 0$ *c* for the node.

3. The direction of rotation of chain contours is selected. In this case, the equations created according to the chosen direction should not be related to each other. According to Kirchhoff's second law, the equations for independent contours are formulated:

$R_1 I_1 + R_5 I_5 - R_2 I_2 = E_1 - E_2$ for abda outline

,

$-R_5 I_5 - R_3 I_3 - R_4 I_4 = 0$ for dbcd outline

,

$R_2 I_2 + R_4 I_4 + R_6 I_6 = E_2$ for adca outline

In these equations, the sign of ЕУК and currents corresponding to the direction of rotation of the contours is written with a positive sign, and the sign of ЕУК and currents opposite to the direction of rotation is written with a negative sign. As can be seen from this example, the number of equations is equal to the number of unknown currents or branches in the circuit whose currents are to be determined. A system of six equations with six unknown currents is a mathematical model of the circuit shown above. If, as a result of the calculation, the sign of some current turns out to be negative, then the actual direction of this current is opposite to the initially selected direction.

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