VINNITSA NATIONAL AGRARIAN UNIVERSITY

Department of Electric Power Engineering, Electrical Engineering and Electromechanics

CALCULATION OF ELECTRICAL CIRCUITS WITH SEVERAL POWER SOURCES. KIRCHHOFF'S RULES

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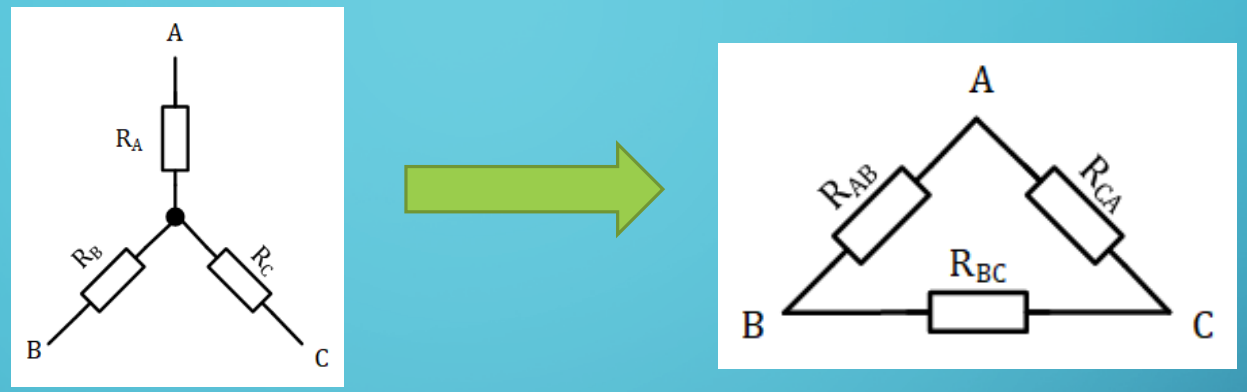
CALCULATION OF ELECTRICAL CIRCUITS WITH SEVERAL POWER SOURCES

The principle of superposition

If an electric circuit contains two or more power sources, then the total current induced in the line by all sources will be equal to the sum of the currents from each of the sources separately!!!

CONVERTING A "STAR" TO A "TRIANGLE"

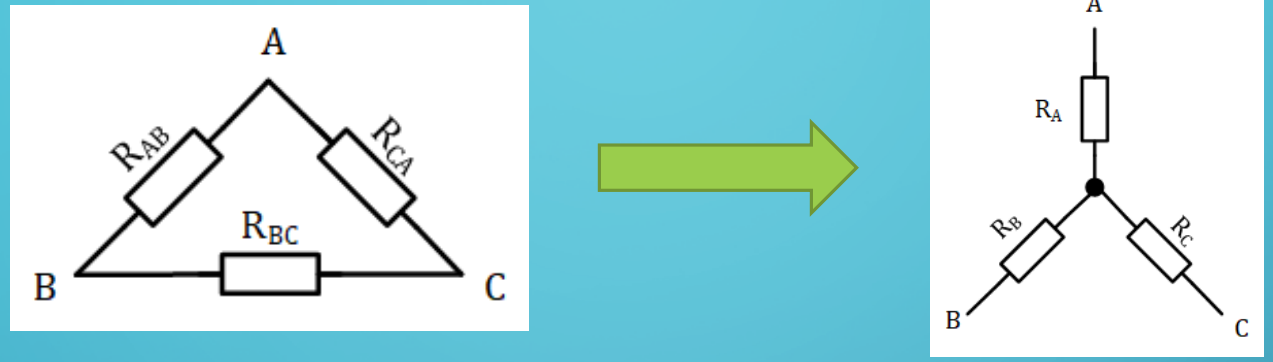


$$R_{AB} = R_A + R_B + \frac{R_A \cdot R_B}{R_C}$$

$$R_{BC} = R_B + R_C + \frac{R_B \cdot R_C}{R_A}$$

$$R_{CA} = R_C + R_A + \frac{R_C \cdot R_A}{R_B}$$

CONVERTING A "TRIANGLE" TO A "STAR"



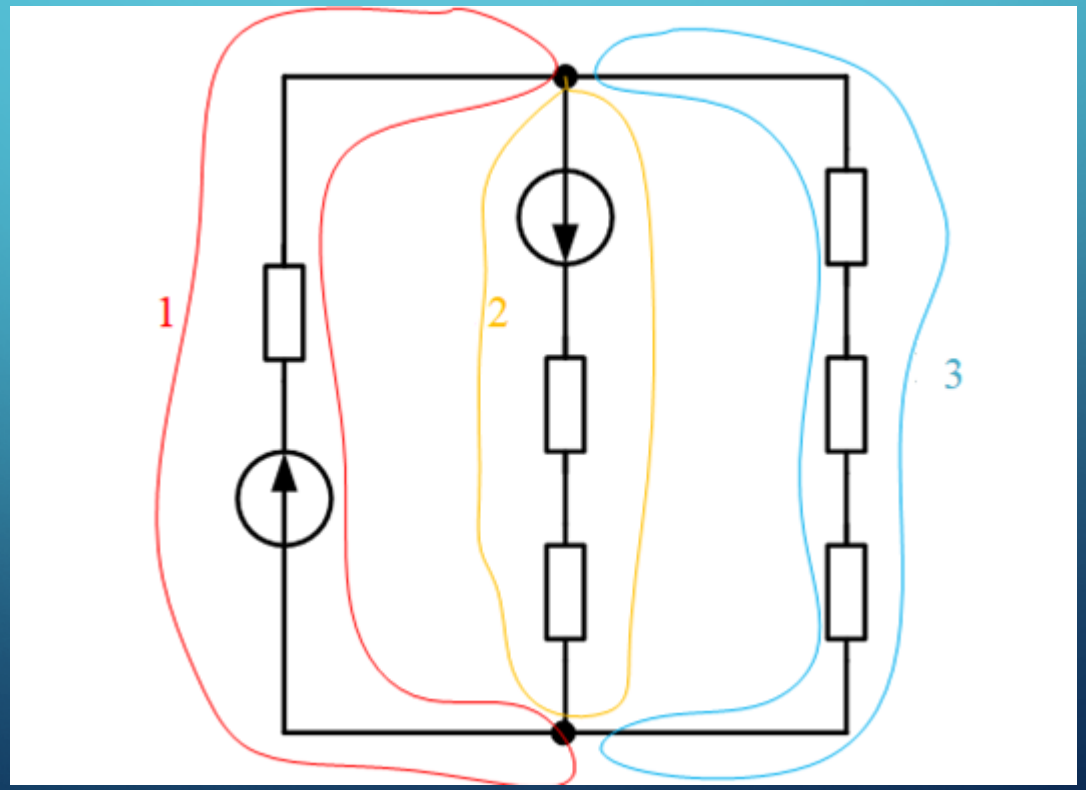
$$R_A = \frac{R_{AB} \cdot R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$$

$$R_B = \frac{R_{AB} \cdot R_{BC}}{R_{AB} + R_{BC} + R_{CA}}$$

$$R_C = \frac{R_{BC} \cdot R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$$

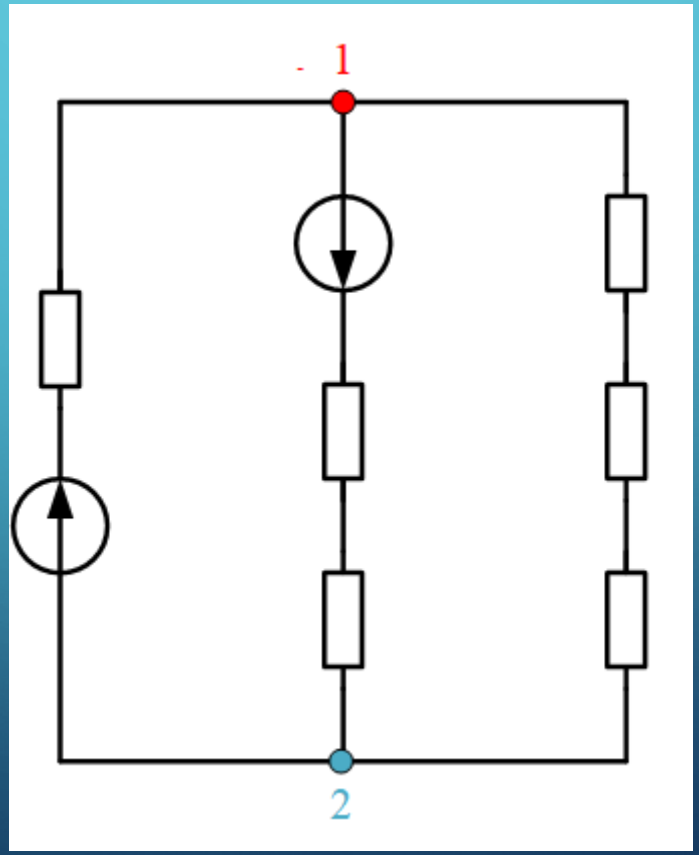
BASIC TOPOLOGICAL CONCEPTS OF AN ELECTRIC CIRCUIT

A branch is a set of elements of an electric circuit connected in series and through which the same current flows



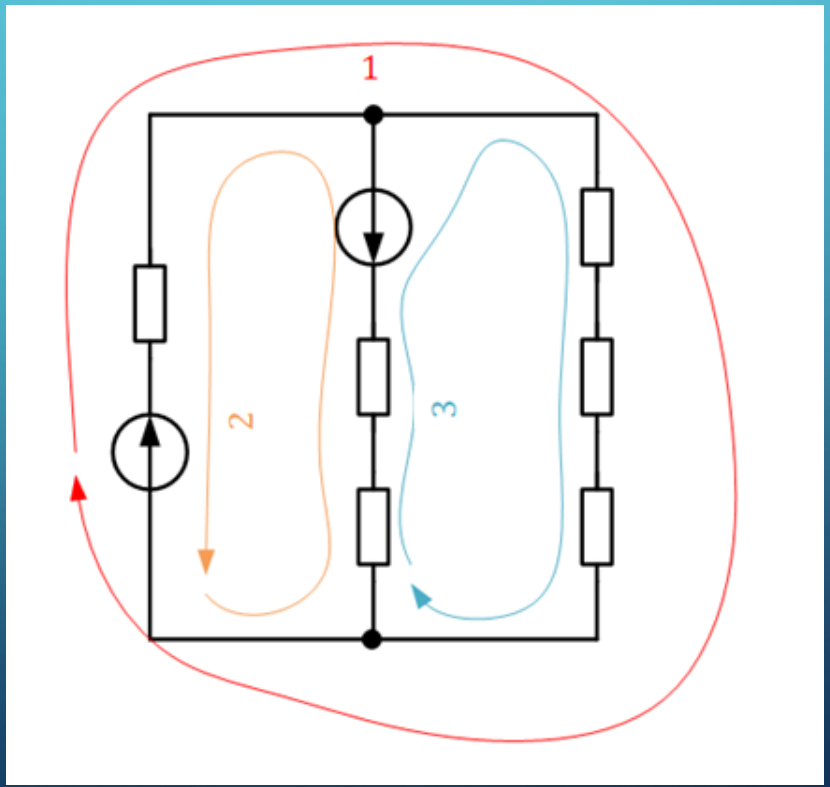
BASIC TOPOLOGICAL CONCEPTS OF AN ELECTRIC CIRCUIT

A node is a point of connection of three or more branches



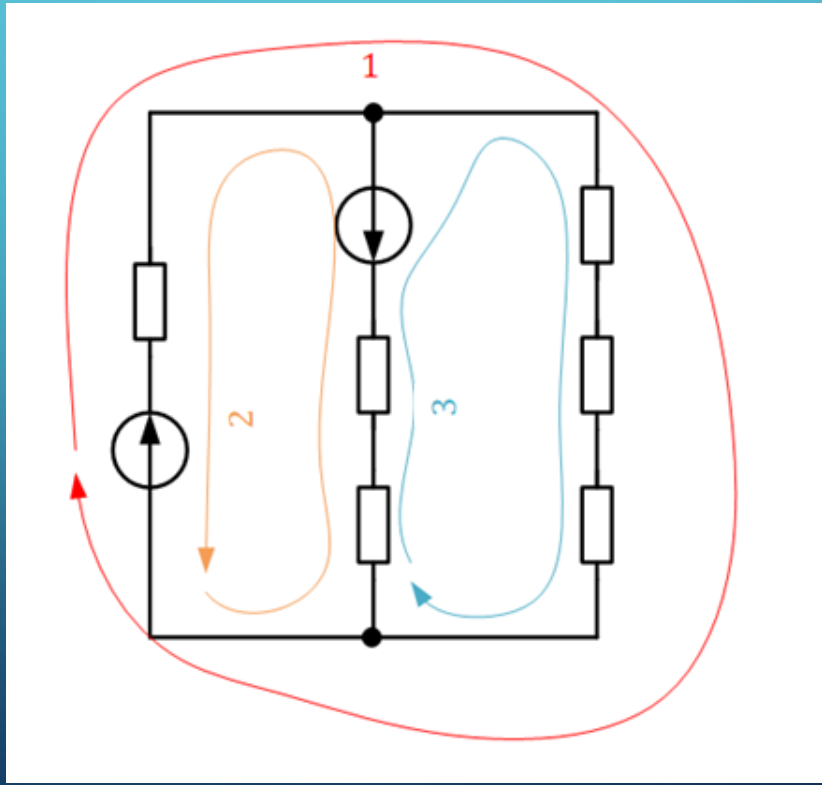
BASIC TOPOLOGICAL CONCEPTS OF AN ELECTRIC CIRCUIT

A loop is any closed path along a circuit that does not encounter the same node more than once.



BASIC TOPOLOGICAL CONCEPTS OF AN ELECTRIC CIRCUIT

An independent loop is a loop in the selected system of loops, which has at least one branch in its composition, which is not part of any other loop of this system of loop.

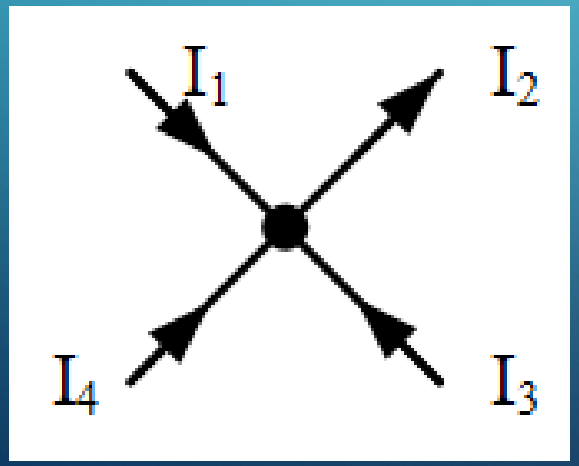


FIRST KIRCHHOFF'S RULE

The algebraic sum of the currents in any circuit node is ZERO

in other words

The sum of the currents entering the node is equal to the sum of the currents leaving it



$$I_1 + I_3 + I_4 = I_2$$

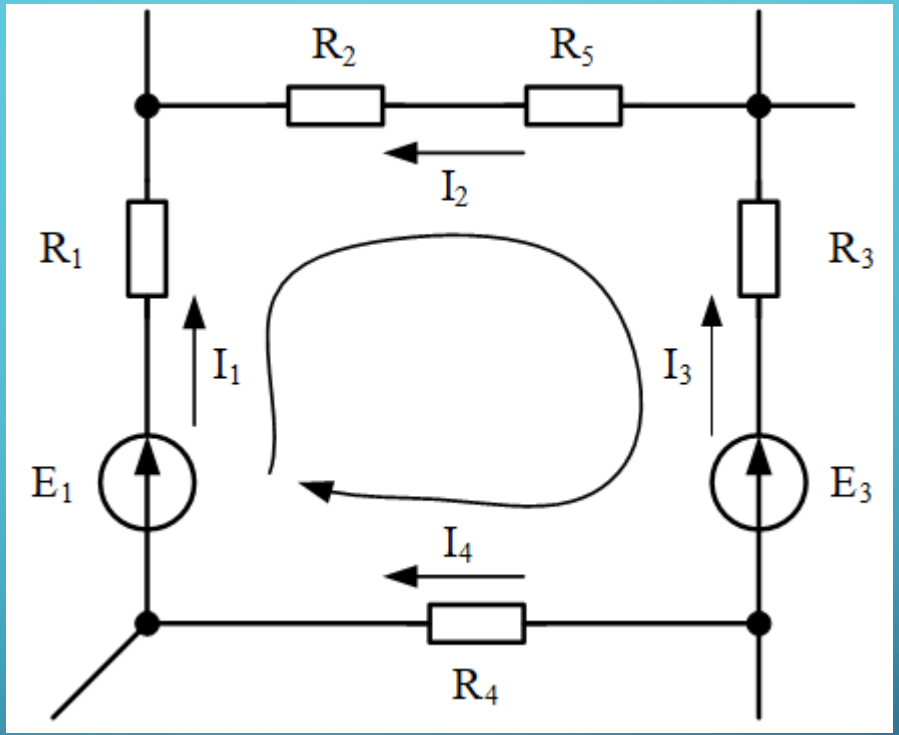
SECOND KIRCHHOFF'S RULE

The algebraic sum of EMF (electromotive force) in a closed loop is equal to the algebraic sum of the voltage drops on the resistances of this loop.

in other words

The sum of EMF taking into account the sign (if the direction of EMF coincides with the selected direction of the current, then "+", if it is opposite to it, then "-") is equal to the sum of products R*I, taking into account the sign (if the direction of EMF coincides with the selected direction of current, then "+" , if opposite to it, then "-")

SECOND KIRCHHOFF'S RULE (EXAMPLE)



$$E_1 - E_3 = I_1 \cdot R_1 - I_2 \cdot R_2 - I_2 \cdot R_5 - I_3 \cdot R_3 + I_4 \cdot R_4$$

CALCULATION OF AN ELECTRIC CIRCUIT USING KIRCHHOFF'S RULES

The method of the system of equations according to Kirchhoff's rules is considered the main and most universal method of calculating electric circuits, which can be used for an electric circuit of any configuration for any mode of its operation.

Before compiling the system of equations in all branches of the circuit, the directions of the currents must be specified (arbitrarily, but along the conductor). If the direction of the current is "missed", the result of the calculation will be a negative value.

PECULIARITIES OF COMPILING A SYSTEM OF EQUATIONS ACCORDING TO KIRCHHOFF'S RULES

1. The number of system equations is equal to the number of unknown currents.
2. According to first Kirchhoff's rule, the number of equations that is "1" less than the number of nodes in the circle is formed.
3. The rest of the equations are formed according to second Kirchhoff's rule for a system of independent loops formed in a circle.