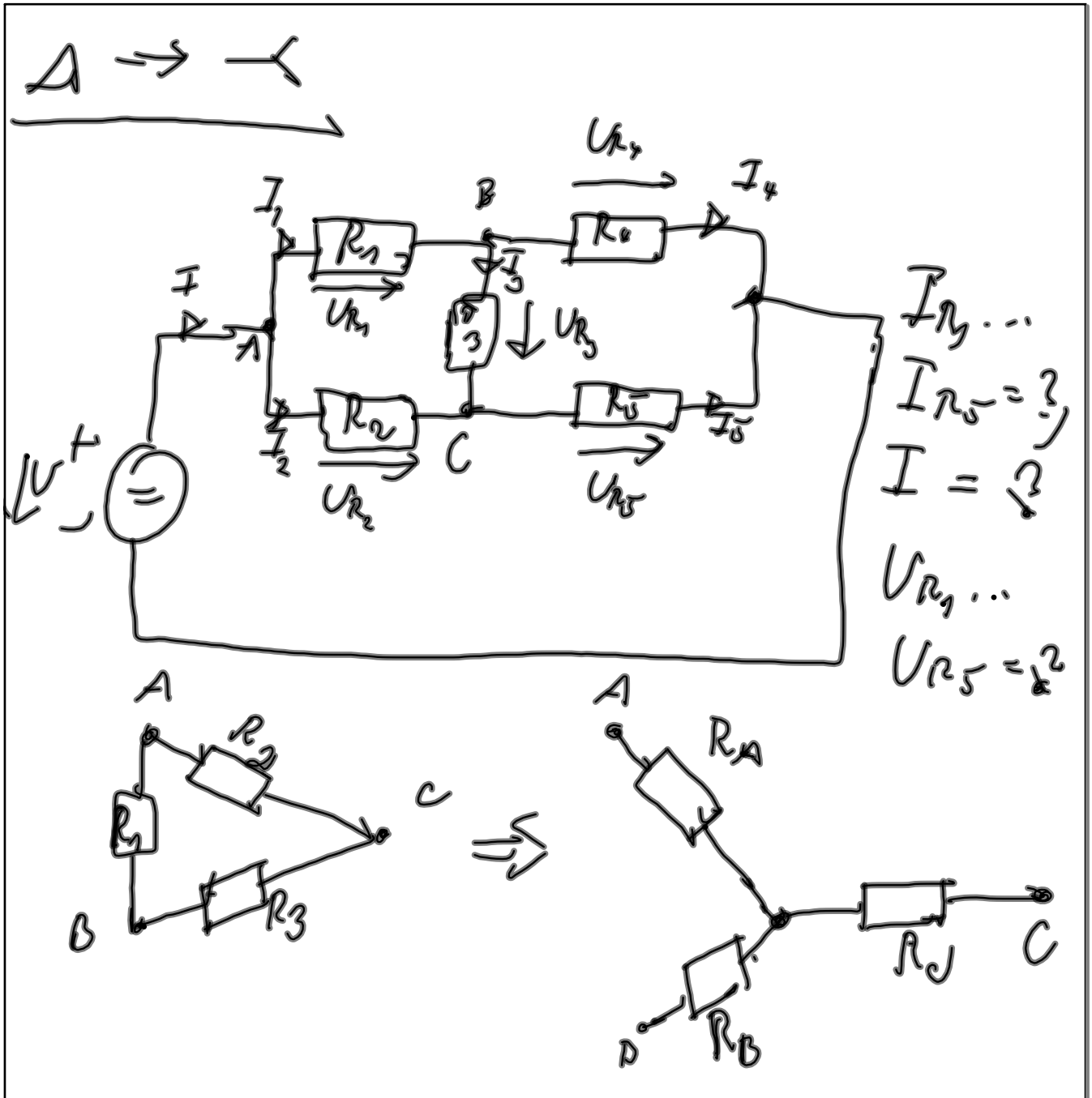


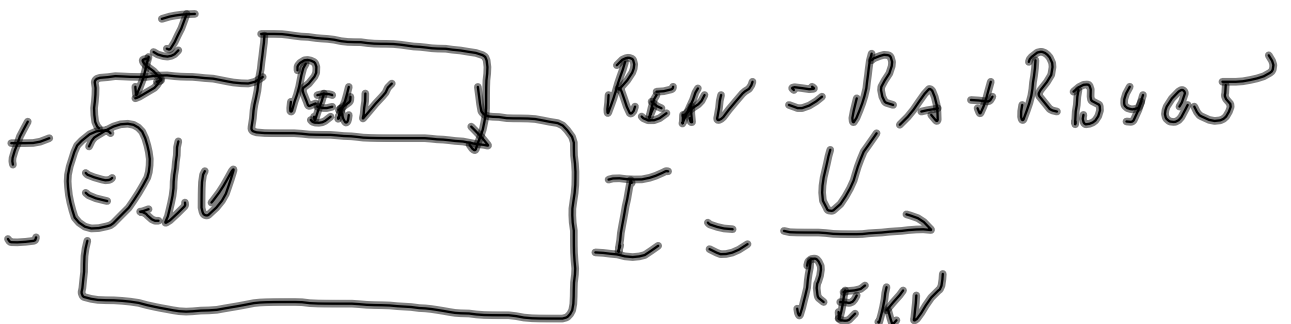
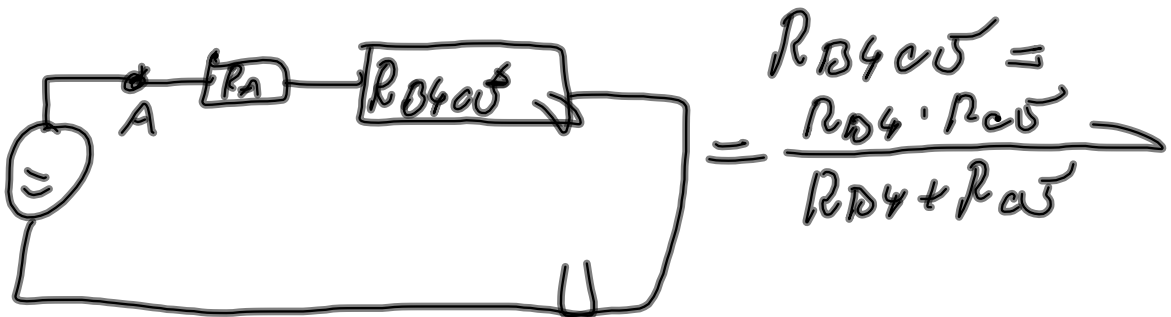
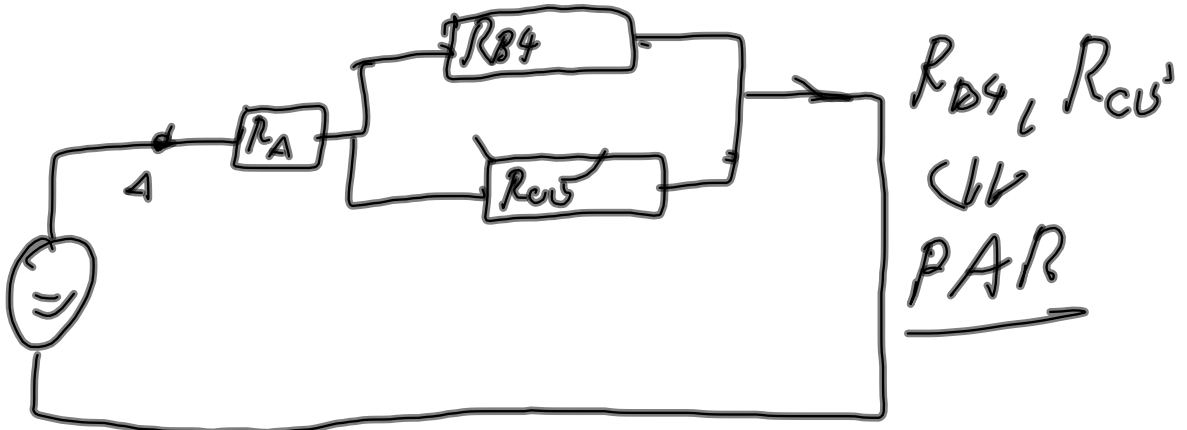
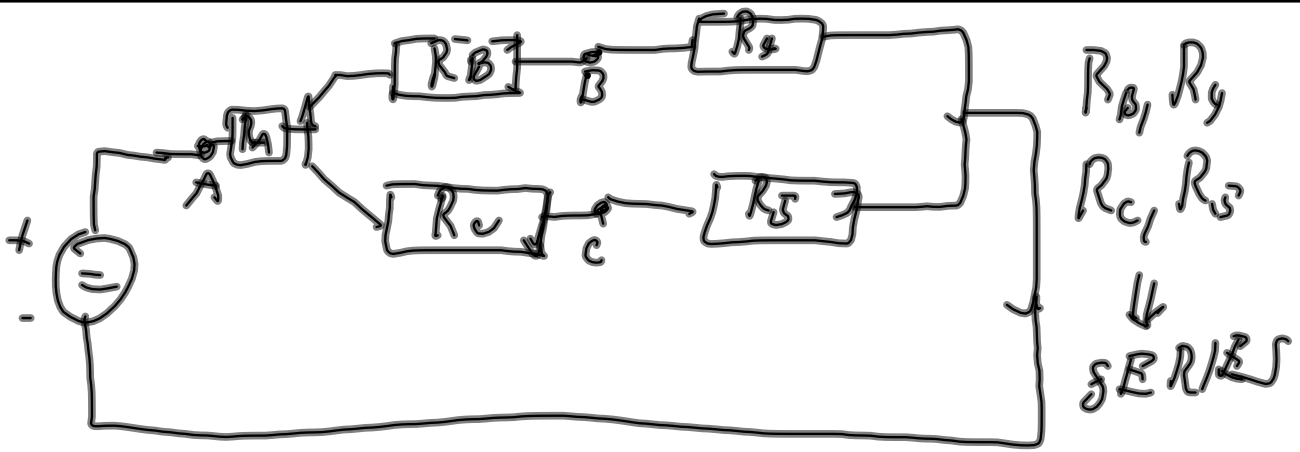
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TO CALCULATE THE REST,  
 WORK BACKWARDS\*

The image contains three circuit diagrams and their corresponding equations:

- Top Diagram:** A series circuit with a voltage source  $U$  and two resistors  $R_A$  and  $R_{B+C}$ . The current is  $I$ . The voltage across  $R_A$  is  $U_{R_A}$  and across  $R_{B+C}$  is  $U_{R_{B+C}}$ .
 
$$U_{R_A} = I \cdot R_A$$

$$U_{R_{B+C}} = I \cdot R_{B+C}$$
- Middle Diagram:** A circuit with a voltage source  $U$  and resistor  $R_A$  in series with a parallel combination of  $R_D$  and  $R_C$ . The current through  $R_A$  is  $I_{D+C}$ . The voltage across the parallel branch is  $U_{R_{D+C}}$ .
 
$$I_{D+C} = \frac{U_{R_{D+C}}}{R_{D+C}}$$

$$I_{D+C} = \frac{U_{R_{B+C}}}{R_{D+C}}$$
- Bottom Diagram:** A circuit with a voltage source  $U$  and resistor  $R_A$  in series with a parallel network. The parallel network consists of two branches: one with  $R_D$  and  $R_4$  in series, and another with  $R_C$  and  $R_5$  in series.
 
$$U_{R_4} = I_{D+C} \cdot R_4$$

$$U_{R_D} = I_{D+C} \cdot R_D$$

$$U_{R_C} = I_{C5} \cdot R_C$$

$$U_{R_5} = I_{C5} \cdot R_5$$

$$R_A = \frac{R_1 \cdot R_2}{R_1 + R_2 + R_3}$$

$$R_B = \frac{R_1 \cdot R_3}{R_1 + R_2 + R_3}$$

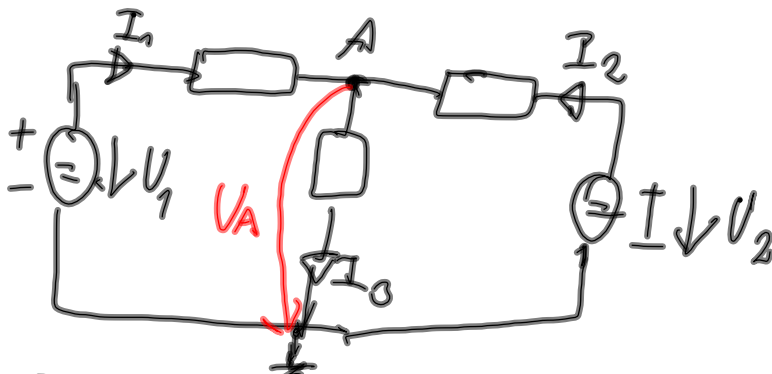
$$R_C = \frac{R_2 \cdot R_3}{R_1 + R_2 + R_3}$$

1.  $V_{R_2} + V_{R_5} - U = 0 \Rightarrow V_{R_2} = \dots$   
 2.  $V_{R_1} + V_{R_4} - U = 0 \Rightarrow V_{R_1} = \dots$   
 3.  $V_{R_1} + V_{R_3} - V_{R_2} = 0 \Rightarrow V_{R_3} = \dots$

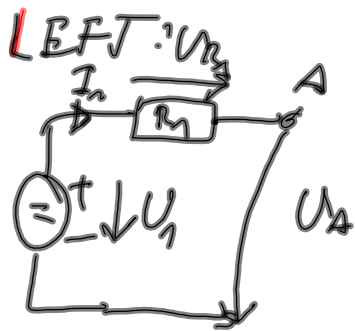
# CIRCUITS WITH MULT. SOURCES

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## NODE METHOD

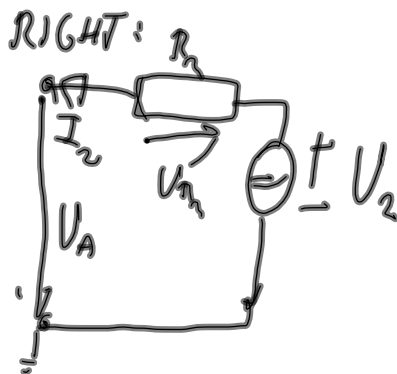


$$I_1 + I_2 - I_3 = 0$$



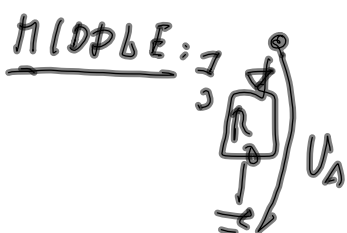
$$U_1 = R_1 \cdot I_1 + U_A$$

$$I_1 = \frac{U_1 - U_A}{R_1}$$



$$U_2 = R_2 \cdot I_2 + U_A$$

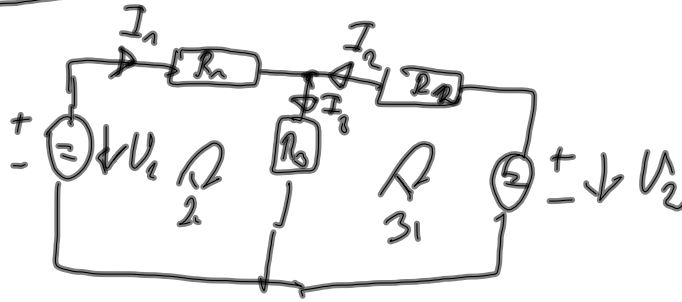
$$I_2 = \frac{U_2 - U_A}{R_2}$$



$$I_3 = \frac{U_A}{R_3}$$

$$I_1 + I_2 - I_3 = 0$$

## ALGEBRAIC EQUATIONS



$$1. I_1 + I_2 - I_0 = 0$$

$$2. R_1 \cdot I_1 + R_3 \cdot I_0 - U_1 = 0$$

$$3. -R_2 \cdot I_2 + U_2 - R_3 \cdot I_0 = 0 \quad | \cdot (-1)$$

$$\downarrow R_2 I_2 + R_3 I_0 - U_2 = 0$$

MAT. REPR

$$\begin{pmatrix} 1 & 1 & -1 \\ R_1 & 0 & R_3 \\ 0 & R_2 & R_3 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \\ I_0 \end{pmatrix} = \begin{pmatrix} 0 \\ U_1 \\ U_2 \end{pmatrix}$$

$$A \begin{pmatrix} 1 & 1 \\ 4 & 5 \end{pmatrix} \quad \det(A) = 1 \cdot 5 - 4 \cdot 2$$

$$D_5 = \begin{vmatrix} 1 & 1 & -1 & 1 & 1 \\ 1 & R_1 & 0 & R_3 & R_1 & 0 \\ 0 & R_2 & R_3 & 0 & R_2 \end{vmatrix} =$$

$$1 \cdot 0 \cdot R_3 + 1 \cdot R_2 \cdot 0 - 1 \cdot R_1 \cdot R_2$$

$$- [(0 \cdot 0 \cdot -1) + (R_2 \cdot R_3 \cdot 1) + (R_3 \cdot R_1 \cdot 1)]$$

$$I_1 \left( \begin{array}{cccc|c} 0 & 1 & -1 & 0 & 1 \\ U_1 & 0 & 0 & U_2 & 0 \end{array} \right) \quad I_1 = \frac{D_1}{D_5}$$