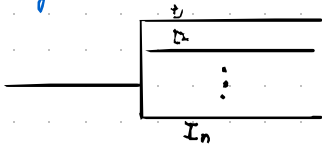


3.6. KIRCHHOFFOVI ZAKONI

I. KIRCHHOFFOV zakon

Zbroj svih struja koje ulaze u čvor jednak je zbroju struja koje izlaze iz čvora.



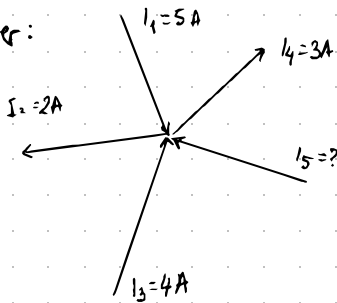
$$\sum_{j=1}^n I_j = 0$$

Struja koje ulaze u čvor = +
- - - - - izlaze iz ... = -

n - broj grananja

$$\rightarrow \sum_{j=1}^{n_{ul}} I_{ul} = \sum_{k=1}^{n_{iz}} I_{iz}$$

Primjer:



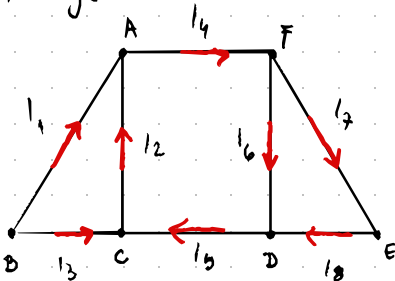
$$I_1 + I_3 + I_5 - I_2 - I_4 = 0$$

$$- I_5 = 5 + 4 - 2 - 3$$

$$I_5 = \underline{\underline{-4A}}$$

smjer suprotan od ref;
tj struja IZLAZI

Primjer:



$$A: I_4 = I_1 + I_2$$

$$B: I_1 + I_3 = 0 \rightarrow I_1 = -I_3$$

$$C: I_2 = I_3 + I_5$$

$$I_4 = -I_3 + I_3 + I_5$$

$$\underline{\underline{I_4 = I_5}}$$

II) KIRCHHOFFOV ZAKON

u zatvorenoj petlji algebarska suma svih unutarnjih napona izvora jednaka je algebarskoj sumi svih napona na pasivnim elementima.

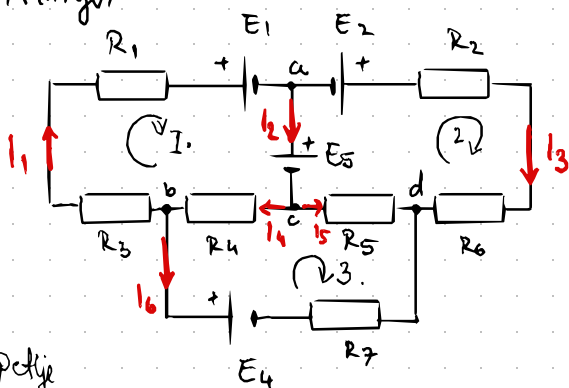
- ako je u zatvorenoj konturi n_E naponskih izvora napona U_{izv} i pasivnih elemenata n_{pas} na kojima su naponi U_{pas} :

$$\sum_{j=1}^{n_E} U_{izv}(t) = \sum_{k=1}^{n_{pas}} U_{pas}(t)$$

za zatvorenu konturu u istosmjernoj otporničkoj mreži vrijedi:

$$\sum_{j=1}^{n_E} U_{izv} = \sum_{k=1}^{n_R} U_R = \sum_{k=1}^{n_R} I_k \cdot R_k$$

Primjer:



$$R_1 = 4 \Omega$$

$$R_2 = 3 \Omega$$

$$R_3 = 5 \Omega$$

$$E_1 = 12 V$$

$$R_4 = 1 \Omega$$

$$E_2 = 4 V$$

$$R_5 = 2 \Omega$$

$$E_3 = 12 V$$

$$R_6 = 10 \Omega$$

$$E_5 = 10 V$$

Petlje

$$(1) I_1 \cdot R_1 + I_4 \cdot R_4 + I_3 \cdot R_3 + E_1 + E_5 = 0$$

$$(2) I_3 \cdot R_2 + I_3 \cdot R_6 - I_5 \cdot R_5 - E_5 - E_2 = 0 \rightarrow I_5 \text{ ide u kontra smjeru} \\ \rightarrow \text{ulaz na } E \text{ je u } \ominus$$

$$(3) -I_6 \cdot R_7 - R_4 \cdot I_4 + I_5 \cdot R_5 - E_4 = 0$$

čvorovi:

$$I_1 = I_2 + I_3 \Rightarrow I_1 - I_2 - I_3 = 0$$

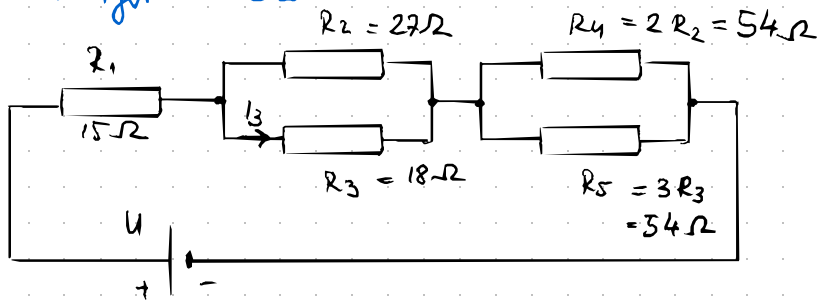
$$I_4 = I_1 + I_6 \Rightarrow -I_1 + I_4 - I_6 = 0$$

$$I_2 = I_4 + I_5 \Rightarrow I_2 - I_4 - I_5 = 0$$

$$\begin{matrix} * & I_1 & I_2 & I_3 & I_4 & I_5 & I_6 \end{matrix}$$

$$\begin{bmatrix} 1 & -1 & -1 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 & 0 & -1 \\ 0 & 1 & 0 & -1 & -1 & 0 \\ R_1 + R_3 & 0 & 0 & R_4 & 0 & 0 \\ 0 & 0 & R_2 + R_6 & 0 & -R_5 & 0 \\ 0 & 0 & 0 & -R_4 & R_5 & -R_7 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ -E_1 - E_5 \\ E_5 + E_2 \\ E_4 \end{bmatrix}$$

Primer iz DZ



$$I_1 = I_2 + I_3$$

$$R_1 + R_{23} + R_{45} = R_{\text{ukl}} \longrightarrow R_{\text{ukl}} = 52.8 \Omega$$

$$\frac{1}{R_{23}} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{5}{54} \rightarrow R_{23} = 10.8 \Omega$$

$$\frac{1}{R_{45}} = \frac{1}{54} + \frac{1}{54} = \frac{2}{54} = \frac{1}{27} \rightarrow R_{45} = 27 \Omega$$

$$U_1 + U_{23} + U_{45} = U_{\text{ukl}}$$

$$U_{23} = U_2 = U_3$$

$$U_{45} = U_4 = U_5$$

$$U_1 = I_1 \cdot R_1 = \underline{\underline{1.375 \text{ V}}}$$

$$U_2 = R_3 \cdot I_3 = \underline{\underline{0.99 \text{ V}}}$$

$$I_2 = \frac{0.99}{27} = \underline{\underline{36.67 \text{ mA}}}$$

$$U = U_1 + U_2 + U_3 = \underline{\underline{4.84 \text{ V}}}$$

$$I_1 = I_2 + I_3 = \underline{\underline{91.67 \text{ mA}}}$$

$$P_4 = U_4 \cdot I_4 = 2.475 \times 45.83 \text{ mA}$$

$$P_4 = 0.1134 \text{ W}$$

$$R_4 = R_5 \text{ i } U_4 = U_5 \rightarrow I_4 = I_5$$

$$I_1 = I_4 + I_5 \rightarrow I_1 = 2 I_4$$

$$\frac{I_1}{2} = I_4 \rightarrow \underline{\underline{I_4 = I_5 = 45.83 \text{ mA}}}$$

$$U_4 = I_4 \cdot R_4 = \underline{\underline{2.475 \text{ V}}}$$