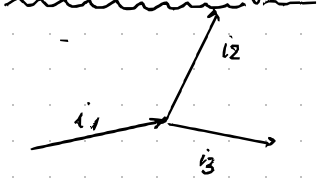
3. Kirchoffovi zakoni

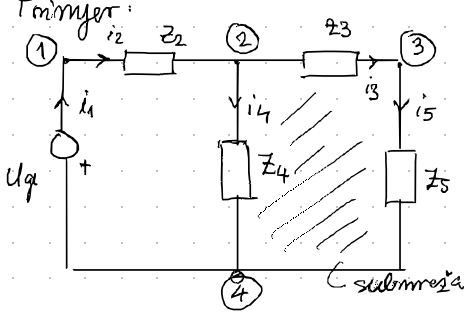
KZS (za struje)



- od čvorišta = +
- prema čvorištu = −

$i_1 = i_2 + i_3$

Primjer:



1) $i_1 = i_2$
2) $i_2 = i_3 + i_4$
3) $i_3 = i_5$
4) $i_1 = i_4 + i_5$

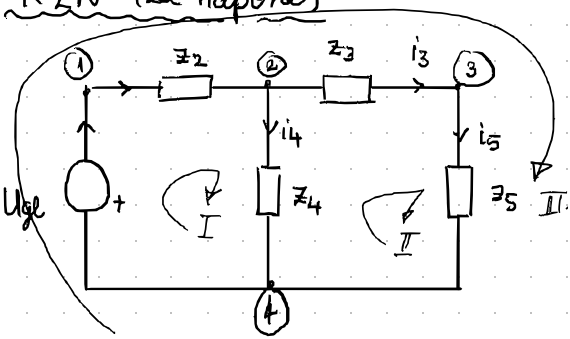
*ali to već znamo
→ najmanje jednu jed. moguće je izraziti kao linearnu kombinaciju ostalih
↳ ako nije moguće
↳ linearno neovisan je

$i_1 = i_3 + i_4$

→ za submrežu neke mreže → alg. suma svih struja koje ulaze u submrežu

▸ broj lin. nez. jed. KZS: $N_v - 1$ — v - vertex (čvorište)

KZN (za napone)



I) $-U_1 + U_2 + U_4 = 0$

II) $-U_4 + U_3 + U_5 = 0$

III) $-U_1 + U_2 + U_3 + U_5 = 0$

- ako su poznate dvije jednadžbe, poznata je također i treća → jedna je suvišna

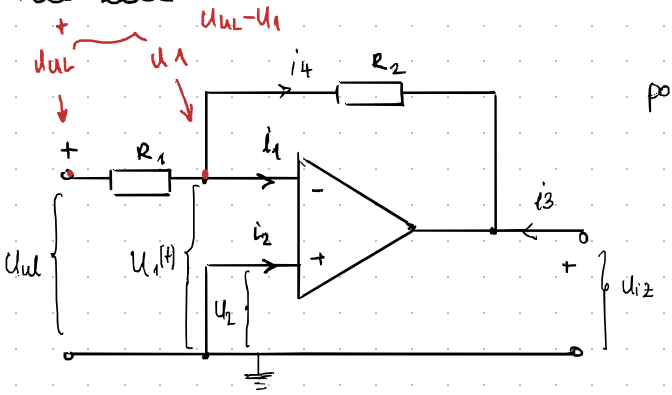
Općenito: broj linearno neovisnih jednadžbi KZN je: $N_b - (N_v - 1) = N_b - N_v + 1$

b - branch (grana)

N_b (KZN + KZS), N_b - zakoni elemenata

PRIMJENA KIRCHOFFOVH ZAKONA

Primjer 1:



po def: $u_{iz} = A(u_2 - u_1)$ $(A \to \infty)$

$i_1 = i_2 = 0$

$u_2 = 0$ (uzemljeno)

KZS: $-i_3 + i_1 + i_4 = 0 \longrightarrow i_3 = i_4 = i$ $\qquad u_{iz} = -u_1 \cdot A \longrightarrow u_1 = \frac{-u_{iz}}{A}$

$$i = \frac{u_{ul} - u_1}{R_1} = \frac{u_1 - u_{iz}}{R_2} \qquad \frac{u_{ul} + \frac{u_{iz}}{A}}{R_1} = \frac{-\frac{u_{iz}}{A} - u_{iz}}{R_2}$$

$$\frac{u_{ul}}{R_1} + \frac{u_{iz}}{AR_1} = \frac{-u_{iz}}{AR_2} - \frac{u_{iz}}{R_2}$$

$$u_{iz}\left(\frac{1}{AR_1} + \frac{1}{AR_2} + \frac{1}{R_2}\right) = -\frac{u_{ul}}{R_1} \longrightarrow u_{iz} = \frac{-\frac{1}{R_1}u_{ul}}{\frac{1}{AR_1} + \frac{1}{AR_2} + \frac{1}{R_2}} \qquad A \to \infty$$

$\frac{1}{AR_1} \to 0$ $\qquad \frac{1}{AR_2} \to 0$

$$u_{iz} = \frac{-\frac{1}{R_1}u_{ul}}{\frac{1}{R_2}} \longrightarrow \boxed{u_{iz} = -\frac{R_2}{R_1}u_{ul}}$$

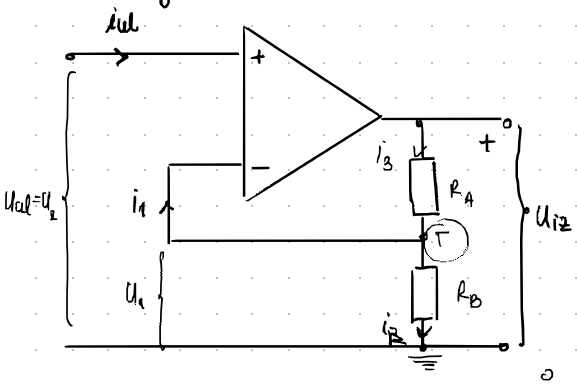
II. način

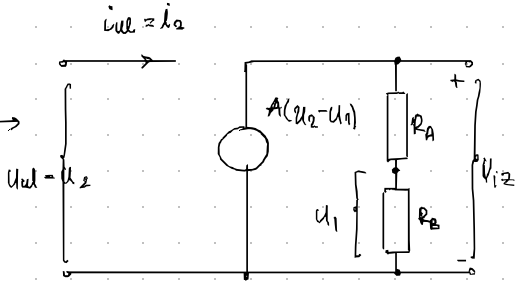
Def: $i_1 = i_2 = 0$ $\qquad u_2$ je spojen na $0 \to u_1 = u_2 = 0$

PVKS: $u_1 = u_2$

$$i = \frac{u_{UL} - 0}{R_1} = \frac{0 - u_{iz}}{R_2} \longrightarrow \frac{u_L}{R_1} = \frac{-u_{iz}}{R_2} \Rightarrow \boxed{u_{iz} = \frac{-R_2}{R_1}u_{ul}}$$

Primjer 2)





Uizlazni = ?

$i_1 = i_2 = 0$

$U_+ = U_- \rightarrow U_{ul} = U_1$

(T) $-i_1 + i_3 - i_R = 0 \rightarrow i_3 = i_R$

$$i = \frac{U_2 - U_1}{R_A} = \frac{U_{ul} - 0}{R_B} \Rightarrow \frac{U_2 - U_{ul}}{R_A} = \frac{U_{ul}}{R_B}$$

$$\boxed{U_{iz} = U_{ul}\left(1 + \frac{R_A}{R_B}\right)}$$

uvijek pojačava ili propušta točno

vs $U_{iz} = \frac{-R_2}{R_1} U_{ul}$

ovaj je invertirajući

$R_1 > R_2 \rightarrow$ invertira