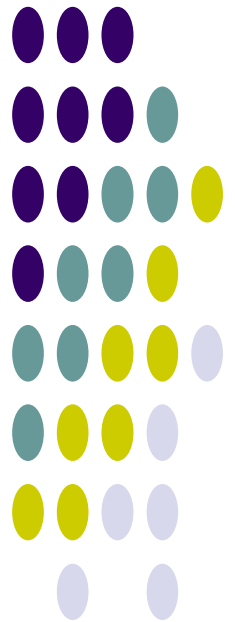


Istosmjerna struja 2

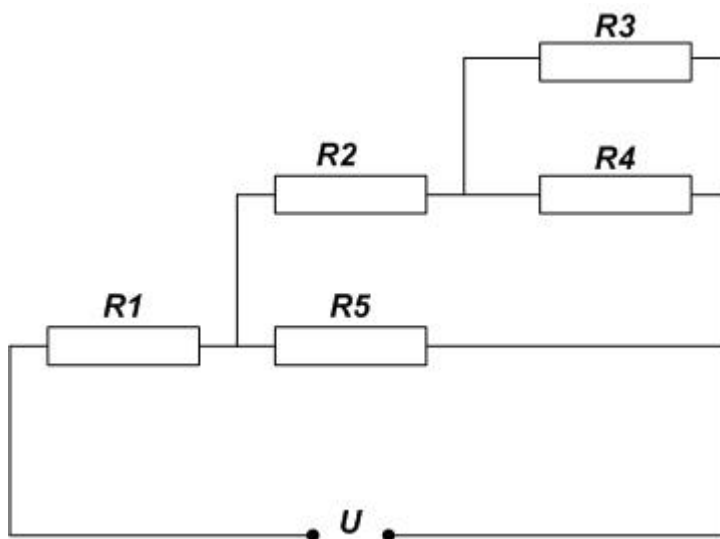
- Ohmov zakon
- Spajanje otpornika
- Strujni i naponski izvori
- II. Kirchhoffov zakon





1. zadatak

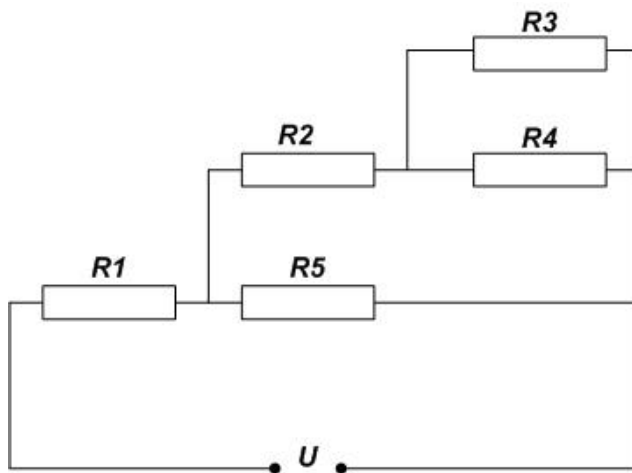
Zadana je mreža prema slici. Vrijednosti su sljedeće $R_1=2\Omega$, $R_2=3\Omega$, $R_3=9\Omega$, $R_4=18\Omega$ i $R_5=3\Omega$, te pad napona na otporniku R_3 , $U_3=39\text{V}$. Odredite napon U .





Rješenje zadatka

$R1=2\Omega$
 $R2=3\Omega$
 $R3=9\Omega$
 $R4=18\Omega$
 $R5=3\Omega$
 $U3=39V$
 $U=?$



Paralelni spoj – $U_3=U_4=39V$

$$I_3 = \frac{U_3}{R_3} = \frac{39V}{9\Omega} = 4.33[A]$$

$$I_4 = \frac{U_4}{R_4} = \frac{39V}{18\Omega} = 2.16[A]$$

$$U_2 = I_2 \cdot R_2 = 19.47V$$

$$I_2 = I_3 + I_4 = 4.33 + 2.16 = 6.49A \quad U_2 + U_{34} = U_5 = 19.47 + 39 = 58.47V$$

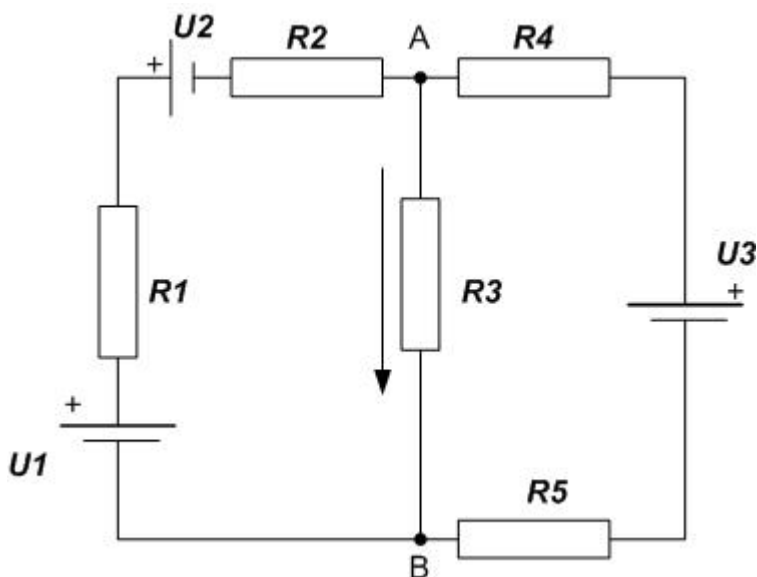
$$I_1 = I_2 + I_5 = 6.49 + 19.49 = 25.98A \quad I_5 = U_5 / R_5 = 19.49A$$

$$U_1 = I_1 \cdot R_1 = 51.96V$$

$$\underline{\underline{U = U_1 + U_5 = 110.43V}}$$

2. zadatak

Zdana je mreža prema slici. Odredite struju kroz R_3 ako su vrijednosti $U_1=64V$, $U_2=24V$, $U_3=30V$, $R_1=2\Omega$, $R_2=3\Omega$, $R_3=4\Omega$, $R_4=7\Omega$ i $R_5=3\Omega$. Potrebno je naći struju I .

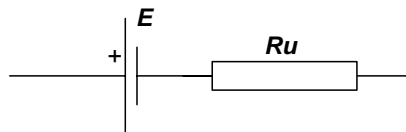


Uvodni pojmovi



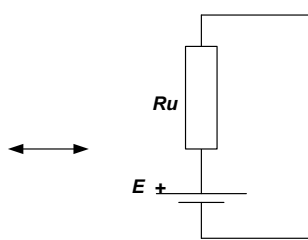
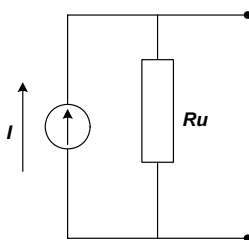
Naponski izvor

Realni naponski izvor ima unutarnji otpor R_u



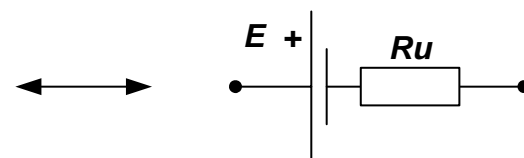
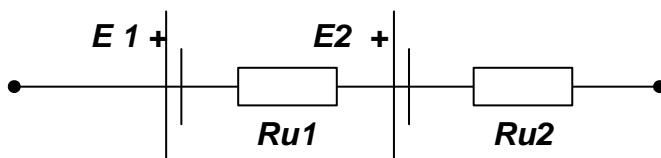
Strujni izvor

Strujni izvor daje struju određene jakosti:



$$E = I \cdot R_u$$

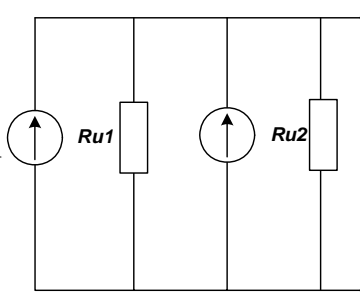
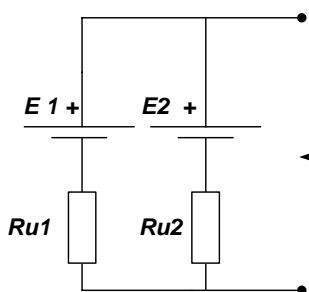
Serijski spoj izvora



$$E = E_1 + E_2$$

$$R_u = R_{u1} + R_{u2}$$

Paralelni spoj izvora

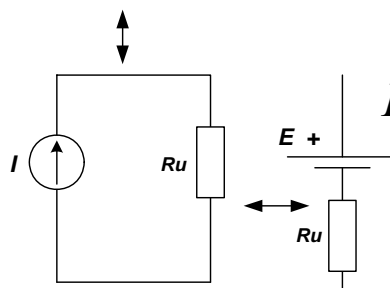


$$I_1 = U_1 / R_{u1}$$

$$I_2 = U_2 / R_{u2}$$

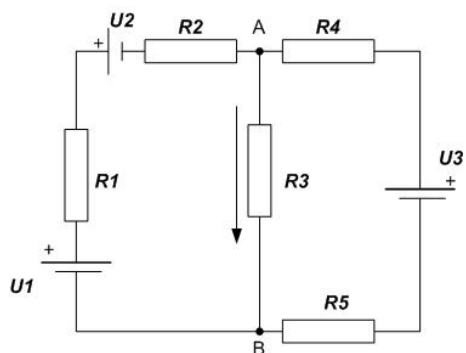
$$I = I_1 + I_2$$

$$1/R_u = 1/R_{u1} + 1/R_{u2}$$



$$E = I \cdot R_u$$

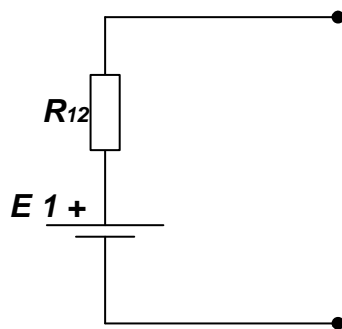
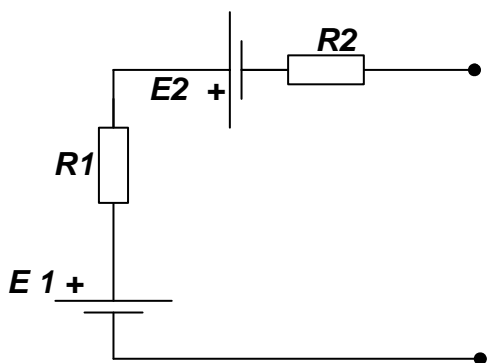
Rješenje zadatka



$$I = U_{AB} / R_3$$

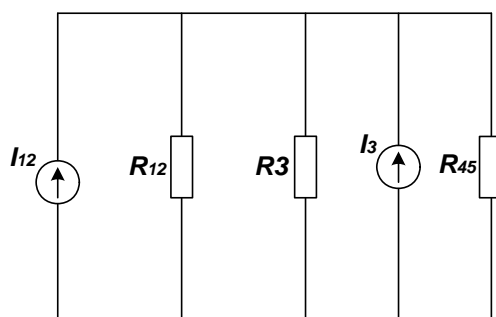
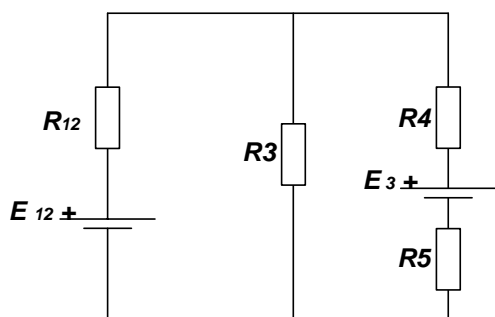


Serijski spoj izvora

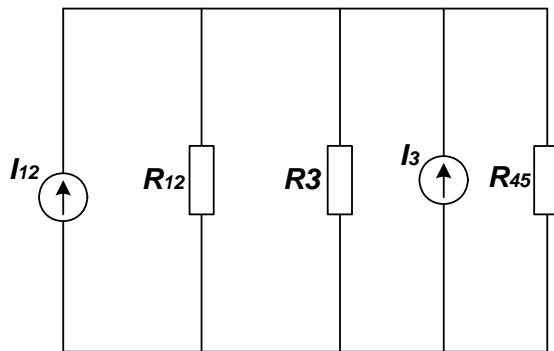
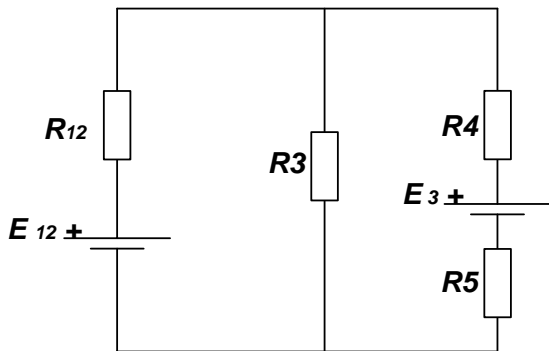


$$U_{12} = U_1 - U_2 = 64 - 24 = 40\text{V}$$

$$R_{12} = R_1 + R_2 = 2 + 3 = 5.2\Omega$$



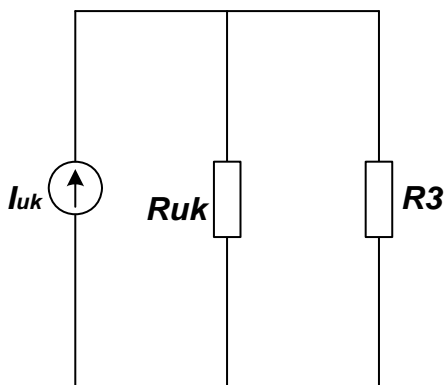
$$R_{45} = R_4 + R_5 = 7 + 3 = 10\Omega$$



$$I_{12} = U_{12} / R_{12} = 40 / 5 = 8 \text{ A}$$

$$I_3 = U_3 / R_{45} = 3 \text{ A}$$

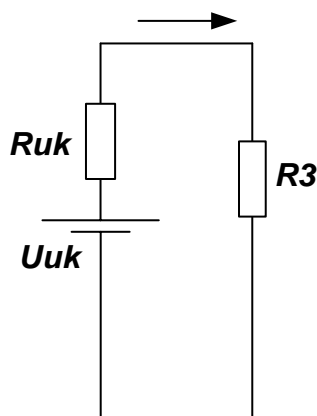
Nadomjesni strujni izvor:



$$I_{uk} = I_{12} + I_3 = 11 \text{ A}$$

$$1/R_{uk} = 1/R_{12} + 1/R_{45}$$

$$R_{uk} = 3.33 \Omega$$



$$U_{uk} = I_{uk} \cdot R_{uk} = 36.63 \text{ V}$$

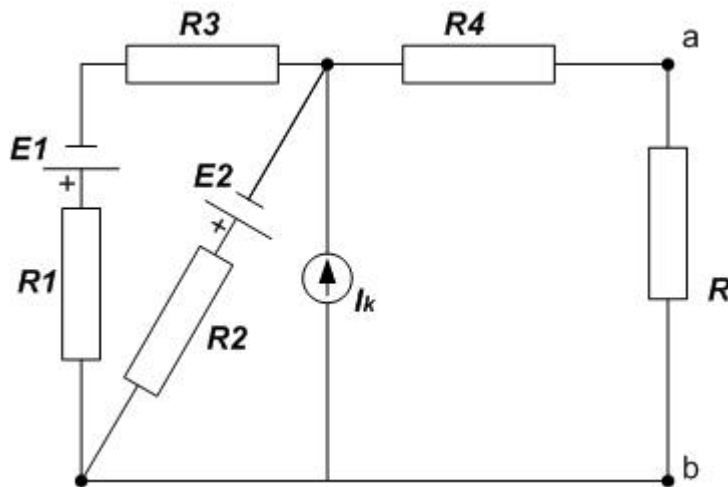
$$U - I \cdot R_{uk} - I \cdot R_3 = 0$$

$$I(R_{uk} + R_3) = U$$

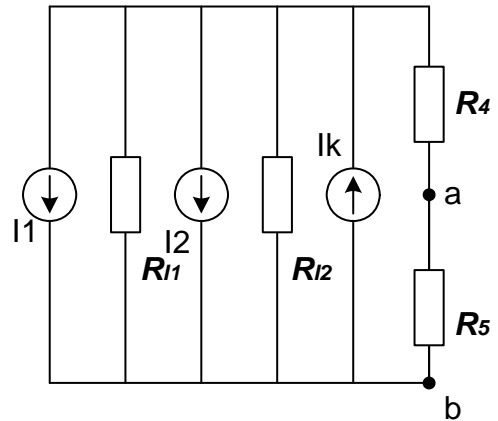
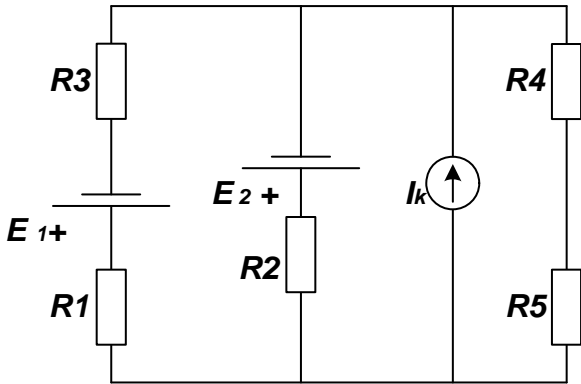
$$I = 5 \text{ A}$$

3. zadatak

U mreži prema slici odredite struju kroz otpornik R i snagu koja se na njemu troši. Zadani su elementi u mreži $R1=5\Omega$, $R2=4\Omega$, $R3=1\Omega$, $R4=2\Omega$, $R=10\Omega$, $E1=12V$, $E2=12V$, $I_k=14A$.



Rješenje zadatka

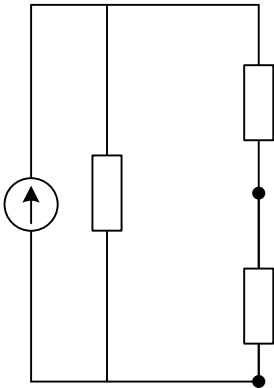


$$I_1 = E_1 / R_1 + R_3 = 2A$$

$$R_{i1} = R_1 + R_3 = 6\Omega$$

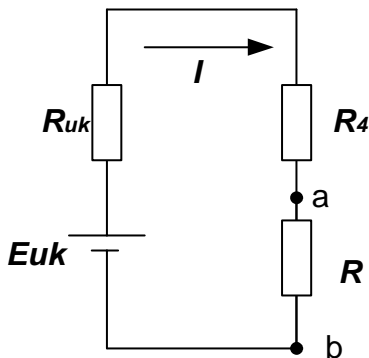
$$I_2 = E_2 / R_2 = 12/4 = 3A$$

$$R_{i2} = R_2 = 4\Omega$$



$$I_{uk} = I_k - I_1 - I_2 = 14 - 2 - 3 = 9A$$

$$1/R_{uk} = 1/R_{i1} + 1/R_{i2} = R_{uk} = 2,4\Omega$$



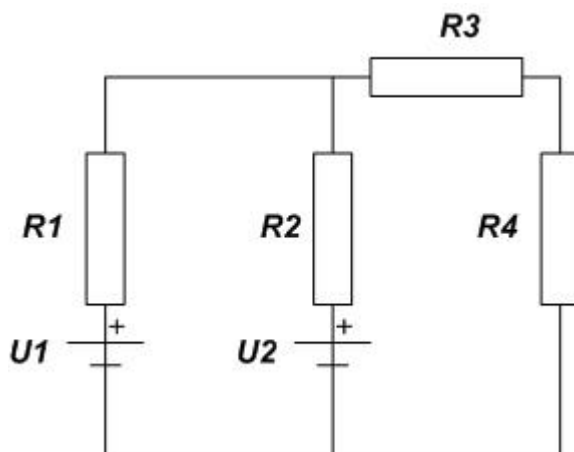
$$E_{uk} = I_{uk} \cdot R_{uk} = 9 \cdot 2,4 = 21,6V$$

$$I_r = E_{uk} / R_{uk} + R_4 + R = 1,5A$$

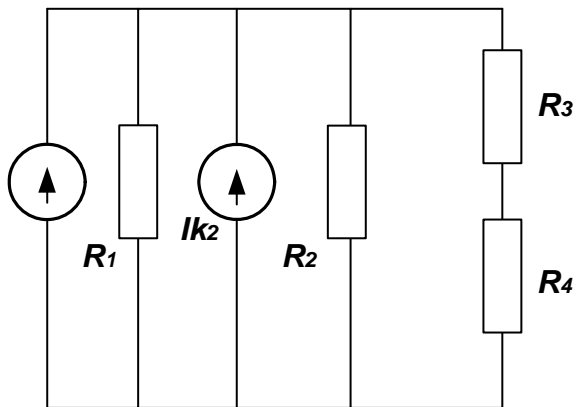
$$P_R = I_R^2 \cdot R = 22,5W$$

4. zadatak

Odredi kolika se snaga troši na otporu $R4$ ako su zadani elementi mreže spojeni prema slici: $U1=U2=12V$, $R1=0,2\Omega$, $R2=0,3\Omega$, $R3=0,1\Omega$, $R4=0,2\Omega$.



Rješenje zadatka



$$I_1 = U_1 / R_1 = 12 / 0,2 = 60 A$$

$$I_2 = U_2 / R_2 = 12 / 0,3 = 40 A$$

$$1/R_{uk} = 1/R_1 + 1/R_2 = R_{uk} = 0,12 \Omega$$

$$I_{uk} = I_1 + I_2 = 100 A$$

$$U_{uk} = I_{uk} \cdot R_{uk} = 100 \cdot 0,12 = 12 V$$

$$R_{34} = R_3 + R_4 = 0,3 \Omega$$

$$I_4 = U_{uk} / R_{uk} + R_3 + R_4 = 28,57 A$$

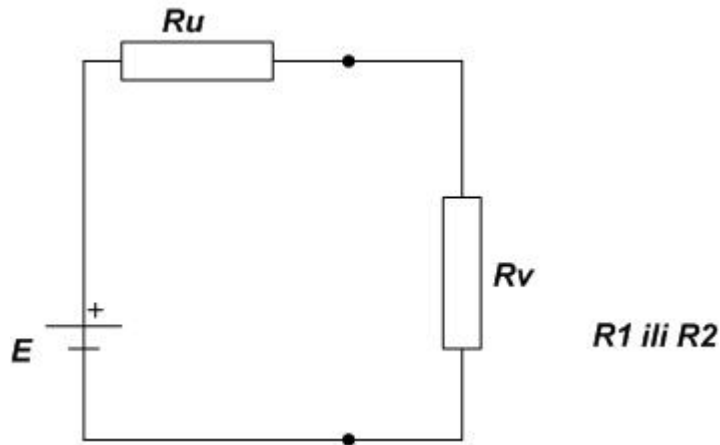
$$P_4 = I_4^2 \cdot R_4 = 163,26 W$$



5. zadatak



Akumulator praznimo prvo sa otpornikom $0,1\Omega$, a zatim s otpornikom od $0,9\Omega$. Koliki je unutrašnji otpor akumulatora ako je snaga razvijena na vanjskom otporniku jednaka u oba slučaja?



Rješenje zadatka

$$P_{v1} = I_1^2 \cdot R_1 = (E/R_1 + Ru)^2 \cdot R_1 \quad I_1 = E/R_1 + Ru$$

$$P_{v2} = I_2^2 \cdot R_2 = (E/R_2 + Ru)^2 \cdot R_2 \quad I_2 = E/R_2 + Ru$$

$$P_{v1} = P_{v2}$$

$$(E/R_1 + Ru)^2 \cdot R_1 = (E/R_2 + Ru)^2 \cdot R_2$$

$$R_1/R_2 = (R_1 + Ru)^2 / (R_2 + Ru)^2$$

$$Ru = \frac{\sqrt{R_1 \cdot R_2} - R_1}{1 - \sqrt{\frac{R_1}{R_2}}}$$

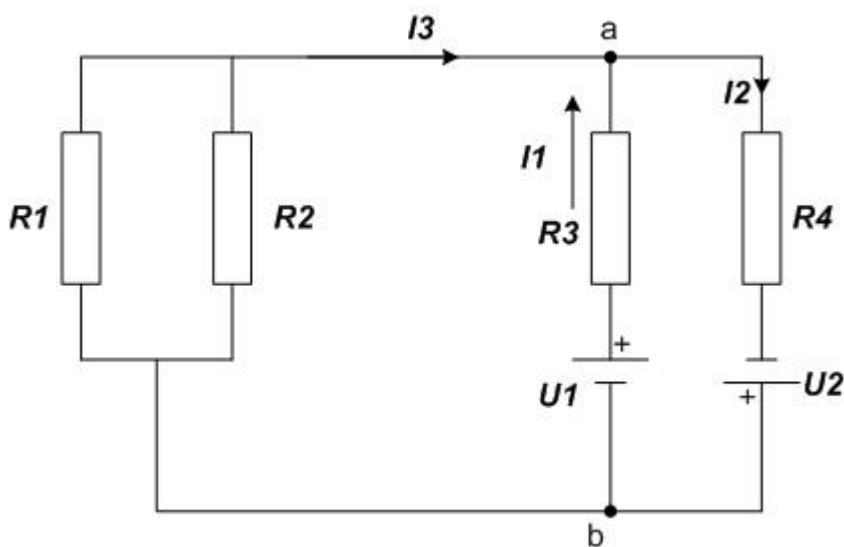
$$\underline{\underline{Ru = 0,3\Omega}}$$



6. zadatak

Zadane su vrijednosti za napone izvora i otpore spojene prema shemi na slici. Treba odrediti:

- struje grane (I_1, I_2, I_3) i
- razvijene snage na radnim otporima.



$$U_1 = 150\text{V}$$

$$U_2 = 120\text{V}$$

$$R_1 = 4\Omega$$

$$R_2 = 12\Omega$$

$$R_3 = 6\Omega$$

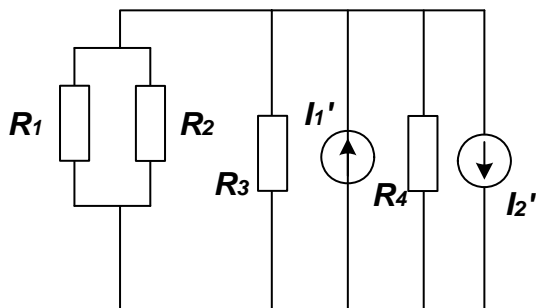
$$R_4 = 3\Omega$$



Rješenje zadatka

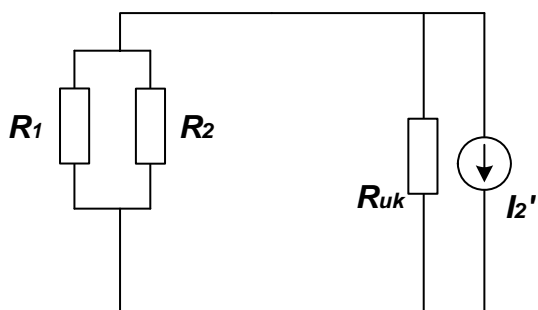
Kako bi odredili struje grana, treba naći napon između a i b.

Nadomjesna shema za paralelni spoj izvora:



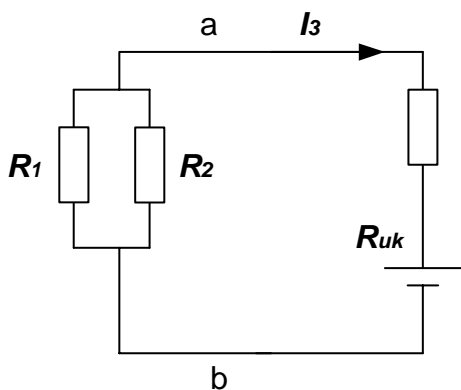
$$I_1' = U_1 / R_3 = 25A$$

$$I_2' = U_2 / R_4 = 40A$$

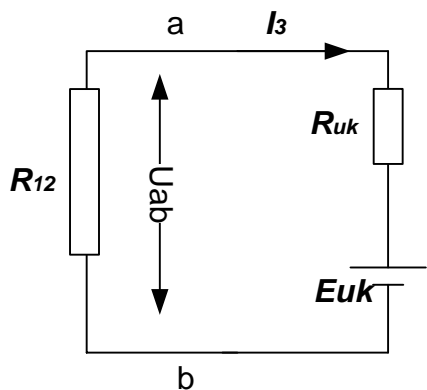


$$1/R_{uk} = 1/R_3 + 1/R_4 = R_{uk} = 2\Omega$$

$$I_{uk} = -I_1' + I_2' = 15A$$



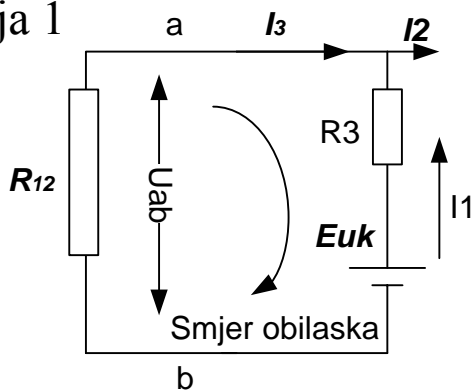
$$U_{uk} = I_{uk} \cdot R_{uk} = 30V$$



$$1/R_{12} = 1/R_1 + 1/R_2 = R_{12} = 3\Omega$$

$$I_3 = E_{uk}/R_{12} + R_{uk} = 6A$$

Petlja 1



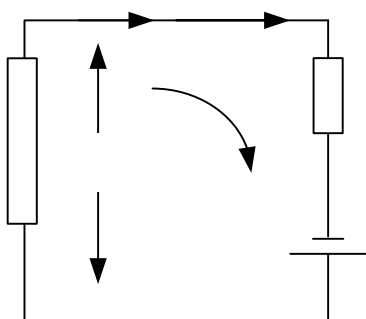
II. Kirchoffov zakon

$$-U_1 + I_1 \cdot R_3 - I_3 \cdot R_{12} = 0$$

$$I_1 \cdot R_3 = U_1 + I_3 \cdot R_{12}$$

$$I_1 = 28A$$

Petlja 2



$$U_2 - I_2 \cdot R_4 - I_3 \cdot R_{12} = 0$$

$$I_2 \cdot R_4 = U_2 - I_3 \cdot R_4$$

$$I_2 = 34A$$

$$P_{R1} = U_{ab}^2/R_1 \text{ --- } P_{R2} = U_{ab}^2/R_2$$

$$P_{R3} = I_1^2 \cdot R_3 \text{ --- } P_{R4} = I_2^2 \cdot R_4$$