Elektrotehnika

Vežbe 6

Teorema superpozicije

Vežbanje

Visoka škola elektrotehnike i računarstva
strukovnih studija, Beograd 2020

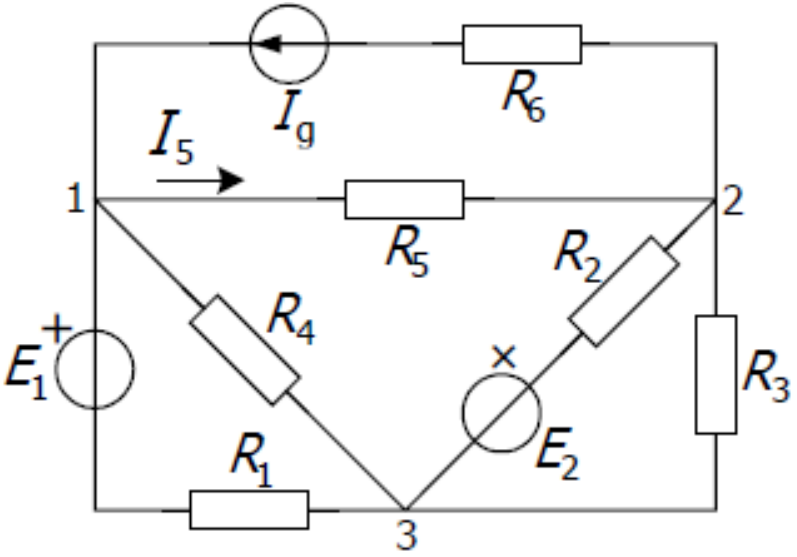
Teorema superpozicije

Zadatak II.8.5.1

Primenom teoreme superpozicije odrediti struju I_5

$E_1 = 10V$, $E_2 = 30V$, $I_g = 80mA$,

$R_1 = 200\Omega$, $R_2 = 2k\Omega$, $R_3 = 1k\Omega$, $R_4 = 2k\Omega$, $R_5 = 2{,}5k\Omega$.



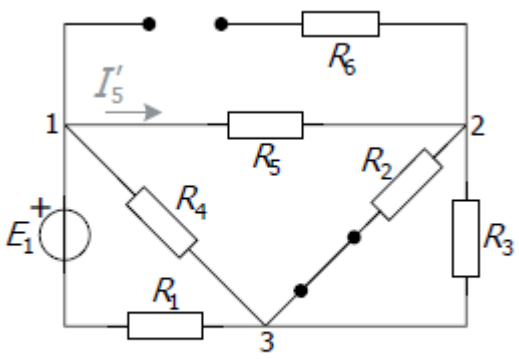
Teorema superpozicije

Zadatak II.8.5.1

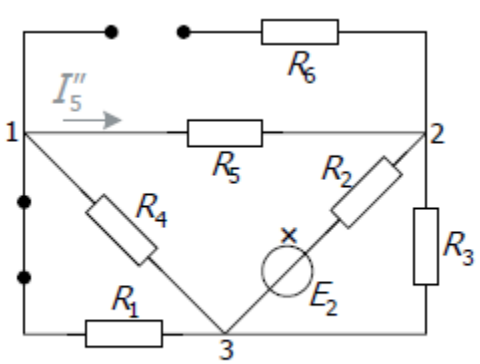
Rešenje:

Teorema superpozicije-električno kolo se može prestaviti kao superpozicija stanja koja postoje u kolu kada se uključe pojedini generatori ili grupe generatora.

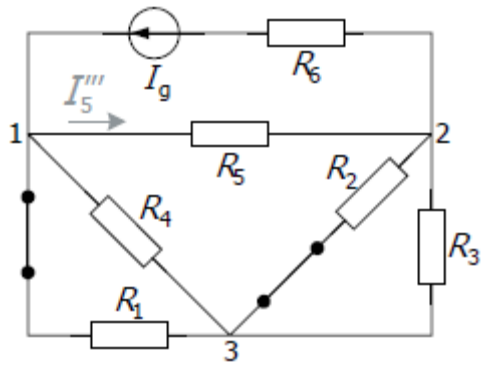
Ostali generatori se isključuju tako što se naponski predstave kratkim spojem, a strujni otvorenom vezom.



a)



b)



c)

Teorema superpozicije

Zadatak II.8.5.1

Rešenje: Rešavamo kolo a) i tražimo komponentu struje I_5 koja potiče dejstvom samo generatora E_1

$$I_5' = \frac{R_4}{R_4 + R_{523}} I_1 = 2{,}7 \text{ mA}$$

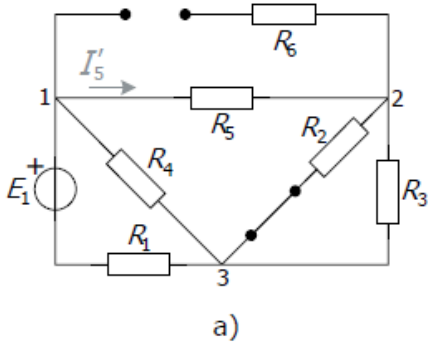
$$I_1 = \frac{E_1}{R_{E_1}} = \frac{10 \text{ V}}{1{,}43 \text{ k}\Omega} = 7 \text{ mA}$$

$$R_{E_1} = R_1 + R_{4523} = 1{,}43 \text{ k}\Omega$$

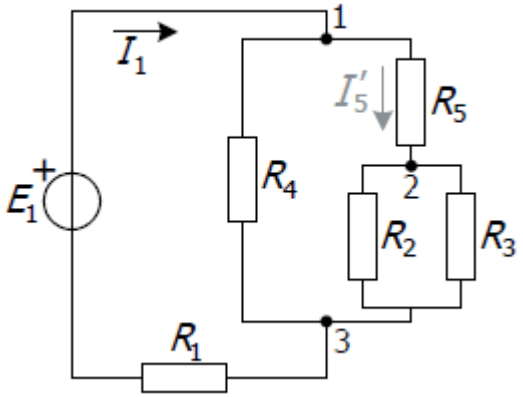
$$R_{4523} = R_4 \,||\, R_{523} = \frac{R_4 R_{523}}{R_4 + R_{523}} = 1{,}23 \text{ k}\Omega$$

$$R_{523} = R_5 + R_{23} = 3{,}17 \text{ k}\Omega$$

$$R_{23} = R_2 || R_3 = \frac{R_2 R_3}{R_2 + R_3} = 0.67 k\Omega$$



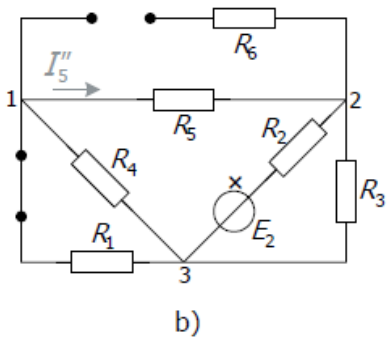
a)



Teorema superpozicije

Zadatak II.8.5.1

Rešenje: Rešavamo kolo b) i tražimo komponentu struje I_5 koja potiče dejstvom samo generatora E_2



b)

$$I_5'' = -\frac{R_3}{R_3 + R_{514}} I_2 = -3\ \text{mA}$$

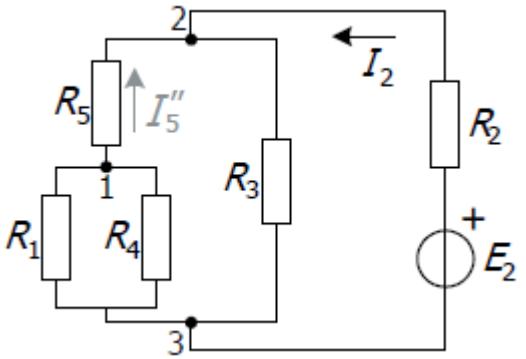
$$I_2 = \frac{E_2}{R_{E_2}} = \frac{30\text{V}}{2{,}73\text{k}\Omega} = 11\ \text{mA}$$

$$R_{E_2} = R_2 + R_{3514} = 2{,}73\ \text{k}\Omega$$

$$R_{3514} = R_3 \,||\, R_{514} = \frac{R_3 R_{514}}{R_3 + R_{514}} = 0{,}73\ \text{k}\Omega$$

$$R_{514} = R_5 + R_{14} = 2{,}68\ \text{k}\Omega$$

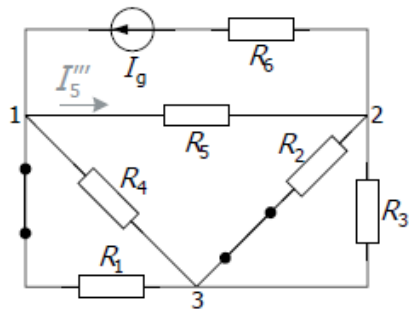
$$R_{14} = R_1 || R_4 = \frac{R_1 R_4}{R_1 + R_4} = 0.18k\Omega$$



Teorema superpozicije

Zadatak II.8.5.1

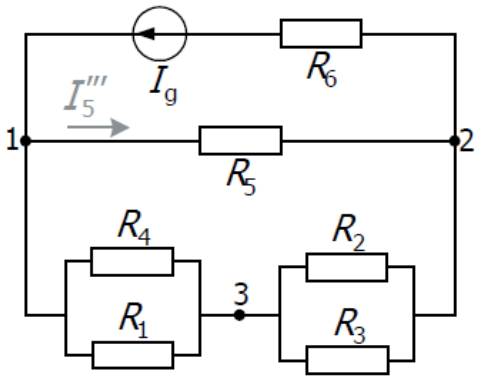
Rešenje: Rešavamo kolo c) i tražimo komponentu struje I_5 koja potiče dejstvom samo generatora I_g



$$I_5''' = \frac{R_{1423}}{R_5 + R_{1423}} I_g = 20{,}3 \text{ mA}$$

$$R_{1234} = R_{14} + R_{23} = R_1 || R_4 + R_2 || R_3 =$$

$$= 0.18k\Omega + 0.67k\Omega = 0.85k\Omega$$



Prema teoremi superpozicije:

$$I_5 = I_5' + I_5'' + I_5''' = 2.7mA - 3mA + 20.3mA = 20mA$$

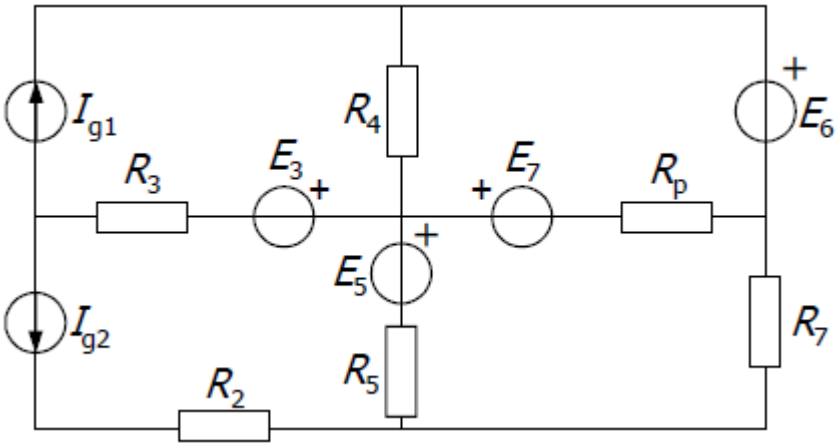
Vežbanje

Zadatak II.8.4.1.3

U kolu prikazanom na slici odrediti otpornost potrošača R_p tako da se na njemu razvije maksimalna snaga. Odrediti tu snagu.

$E_3 = 1{,}5V$, $E_5 = 1{,}2V$, $E_6 = 0{,}9V$, $E_7 = 0{,}4V$, $I_{g1} = 60mA$, $I_{g2} = 100mA$,

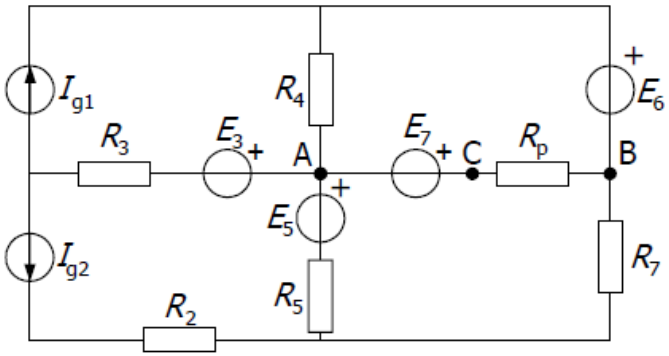
$R_2 = 20\Omega$, $R_3 = 10\Omega$, $R_4 = 20\Omega$, $R_5 = 20\Omega$, $R_7 = 10\Omega$

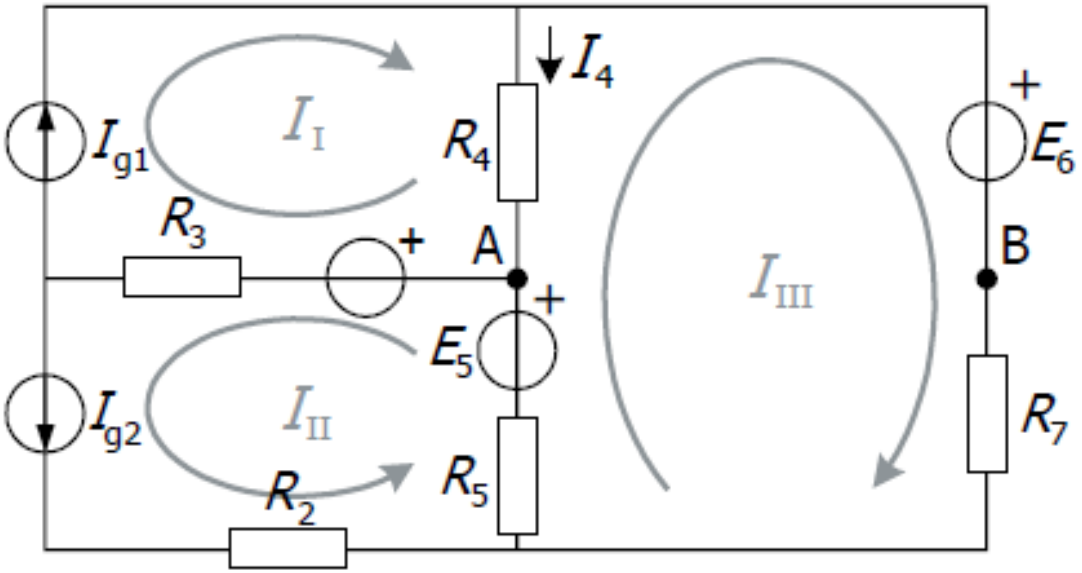


Vežbanje

Zadatak II.8.4.1.3

Za određivanje Tevenenovog generatora otkačićemo iz kola celu granu u kojoj se nalazi potrošač i ekvivalentiraćemo kolo između tačaka A i B.



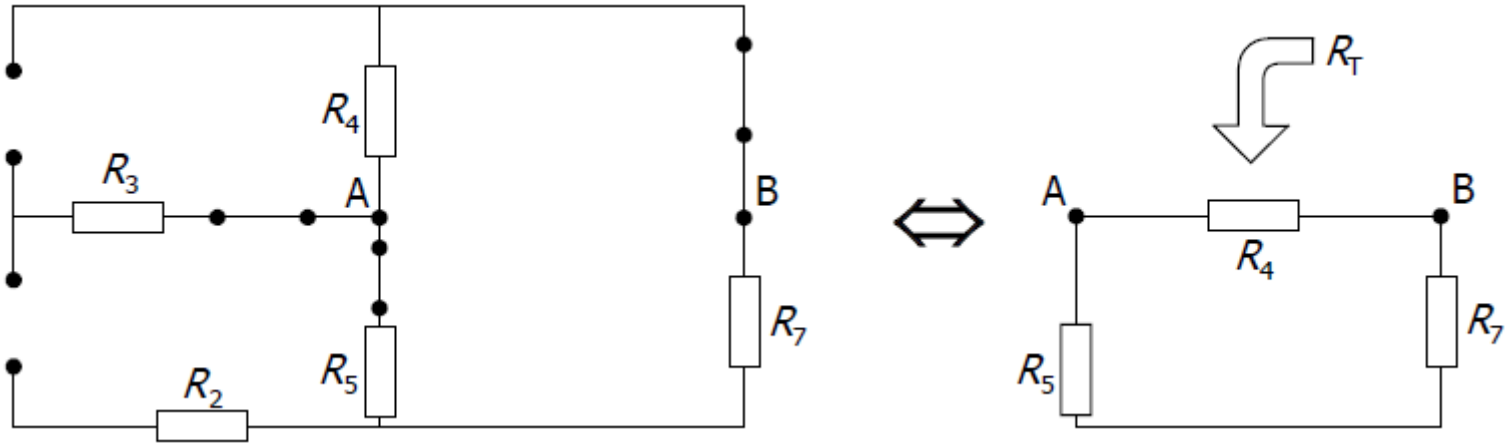


Vežbanje

Zadatak II.8.4.1.3

Otpornost Tevenenovog generatora određujemo kao:

$$R_T = R_4||(R_5 + R_7) = \frac{R_4 \cdot (R_5 + R_7)}{R_4 + R_5 + R_7} = 12\Omega$$



Uslov prilagođenja prijemnika po snazi je: $R_P = R_T = 12\Omega$

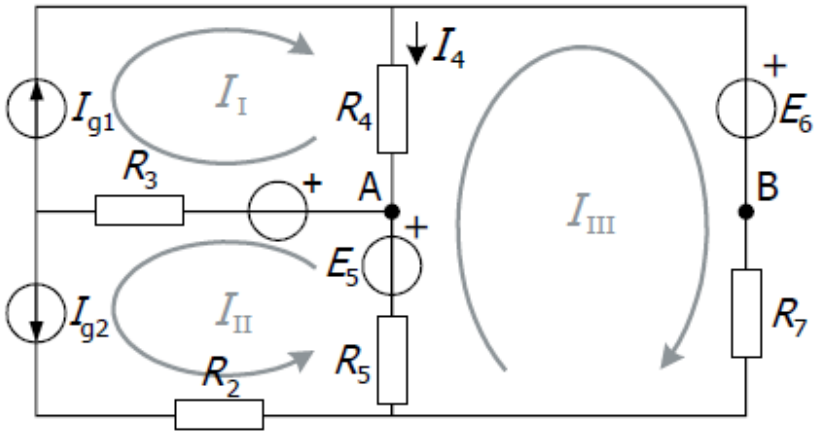
Vežbanje

Zadatak II.8.4.1.3

Elektromotornu silu Teveneneovog generatora određujemo metodom konturnih struja. $n_g = 6$ $n_č = 4$

n_g-($n_č$–1)=3 br. nezavisnih kontura

n_g-($n_č$–1) – n_{Ig}=1 br. jednačina



$$I_I = I_{g1}$$

$$I_{II} = I_{g2}$$

$$-R_4 I_I + R_5 I_{II} + (R_4 + R_5 + R_7) I_{III} = E_5 - E_6$$

zamenom dobijamo:

$$-R_4 I_{g1} + R_5 I_{g2} + (R_4 + R_5 + R_7) I_{III} = E_5 - E_6$$

$$I_{III} = -10mA$$

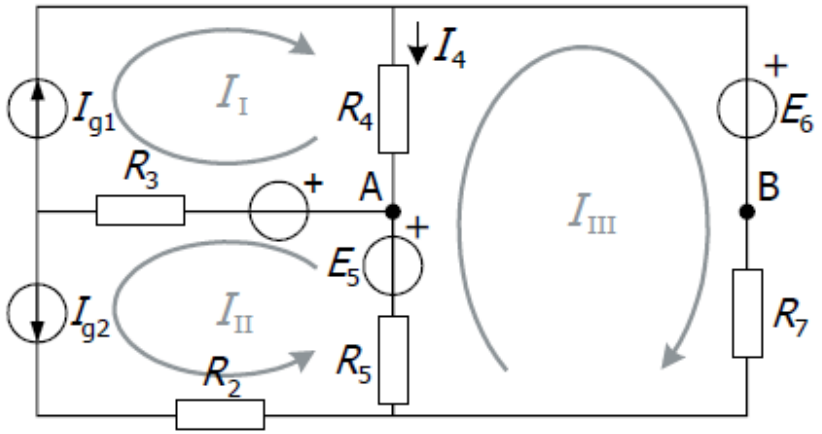
Vežbanje

Zadatak II.8.4.1.3

Zatim računamo napon između tačaka A i B

$$I_4 = I_I - I_{III} = 70mA$$

$$E_T = U_{AB}\Big|_{OK} = E_6 - R_4 I_4 = -0{,}5V$$



Vežbanje

Zadatak II.8.4.1.3

Sada ćemo Tevenenov generator i generator E_7 predstaviti jednim generatorom

$$E' = U_{CD} = E_T - E_7 = -0.9V$$

pa dalje imamo

$$I_P = \frac{E'}{R_T + R_P} = 37.5mA$$

$$P_{R_p} = I_P^2 R_P = 16.875mW$$