Elektrotehnika

Vežbe 7

Konturne struje, transfiguracije otpornika vežbanje

Visoka škola elektrotehnike i računarstva
strukovnih studija, Beograd 2020

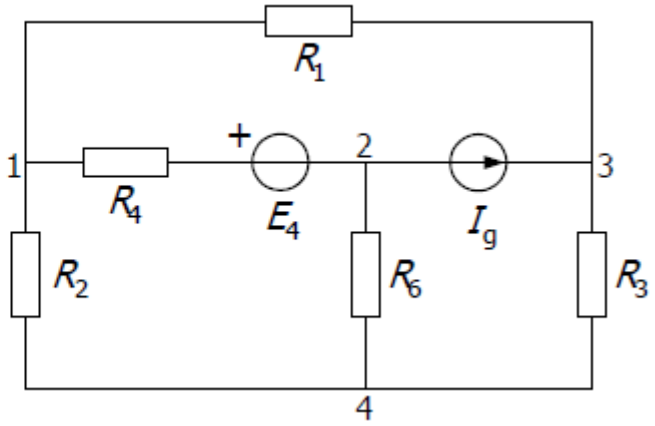
Konturne struje

II.8.2.6 Odrediti struje svih grana kola primenom metode konturnih struja, kao i snage svih elemenata u kolu. Poznato je:

$E_4 = 138$ V, $I_g = 34$ mA,

$R_1 = 2$ kΩ, $R_2 = 2$ kΩ, $R_3 = 3$ kΩ,

$R_4 = 500$ Ω, $R_6 = 6$ kΩ.



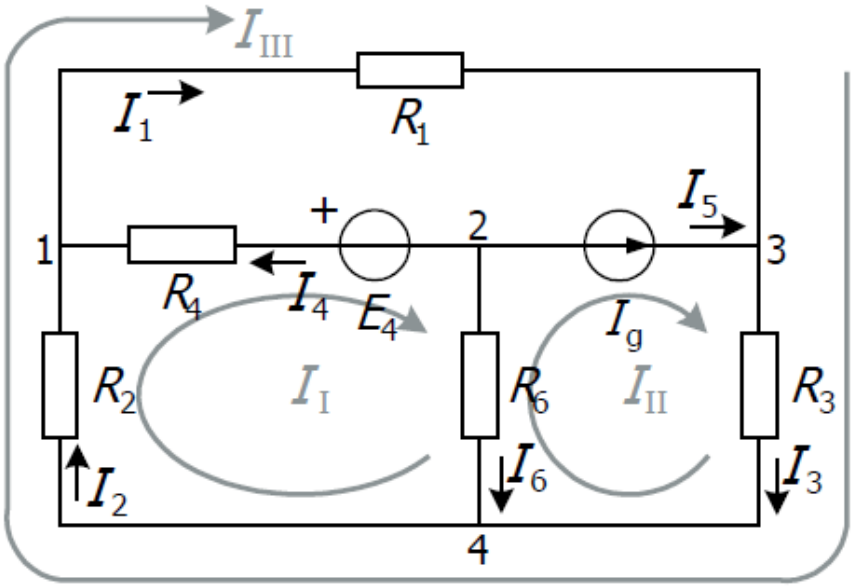
Konturne struje

Zadatak II.8.2.6

Rešenje:

$$n_g - (n_č - 1) = 3$$

$$n_g - (n_č - 1) - n_{Ig} = 2$$



$$(R_2 + R_4 + R_6)I_I - R_6 I_{II} + R_2 I_{III} = -E_4$$

$$I_{II} = I_g$$

$$R_2 I_I + R_3 I_{II} + (R_1 + R_2 + R_3)I_{III} = 0$$

Konturne struje

Zadatak II.8.2.6

$$8{,}5I_{\mathrm{I}} + 2I_{\mathrm{III}} = 66$$

$$2I_{\mathrm{I}} + 7I_{\mathrm{III}} = -102$$

$$\Delta = \begin{vmatrix} 8{,}5 & 2 \\ 2 & 7 \end{vmatrix} = 8{,}5 \cdot 7 - 2 \cdot 2 = 55{,}5\,,$$

$$\Delta_{\mathrm{I}} = \begin{vmatrix} 66 & 2 \\ -102 & 7 \end{vmatrix} = 66 \cdot 7 - (-102) \cdot 2 = 666\,,$$

$$\Delta_{\mathrm{III}} = \begin{vmatrix} 8{,}5 & 66 \\ 2 & -102 \end{vmatrix} = 8{,}5 \cdot (-102) - 2 \cdot 66 = -999\,.$$

Konturne struje

Zadatak II.8.2.6

$$I_{\mathrm{I}} = \frac{\Delta_{\mathrm{I}}}{\Delta} = \frac{666}{55{,}5}\ \mathrm{mA} = 12\ \mathrm{mA}\,, \qquad I_{\mathrm{III}} = \frac{\Delta_{\mathrm{III}}}{\Delta} = \frac{-999}{55{,}5}\ \mathrm{mA} = -18\ \mathrm{mA}\,.$$

$$I_1 = I_{\mathrm{III}} = -18\ \mathrm{mA}\,,$$

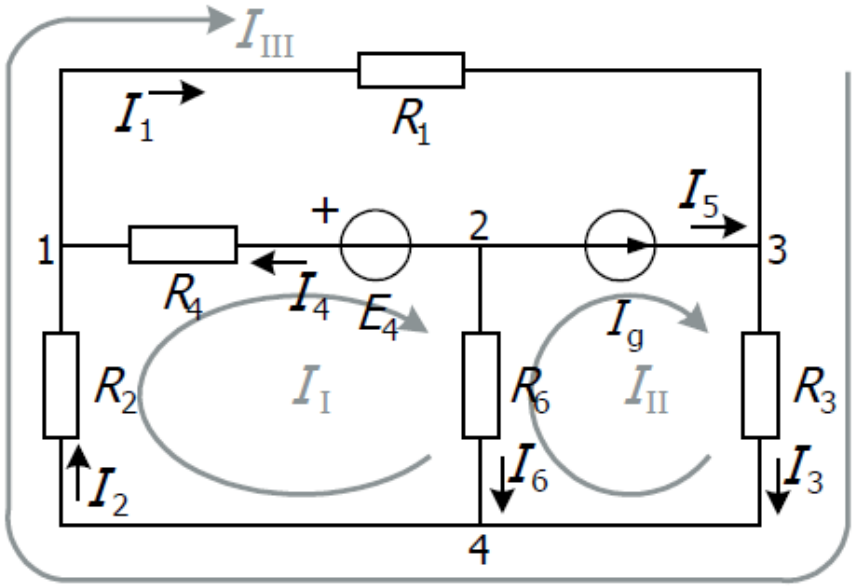
$$I_2 = I_{\mathrm{I}} + I_{\mathrm{III}} = -6\ \mathrm{mA}\,,$$

$$I_3 = I_{\mathrm{II}} + I_{\mathrm{III}} = 16\ \mathrm{mA}$$

$$I_4 = -I_{\mathrm{I}} = -12\ \mathrm{mA}\,,$$

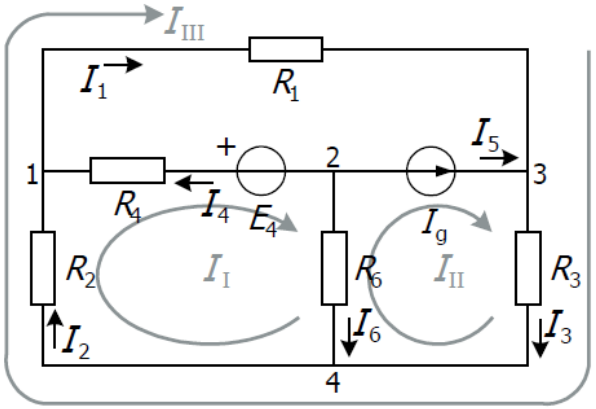
$$I_5 = I_{\mathrm{II}} = 34\ \mathrm{mA}\,,$$

$$I_6 = I_{\mathrm{I}} - I_{\mathrm{II}} = -22\ \mathrm{mA}\,.$$



Konturne struje

Zadatak II.8.2.6 Određivanje snaga



$$U_{32} = -R_6 I_6 + R_3 I_3 = 180\ \text{V}$$

$$P_{I_g} = U_{32} \cdot I_g = 180\ \text{V} \cdot 0{,}034\ \text{A} = 6{,}12\ \text{W}$$

$$P_{E_4} = E_4 I_4 = 138\ \text{V} \cdot (-0{,}012\ \text{A}) = -1{,}656\ \text{W}$$

$$P_{R_1} = R_1 I_1^{\,2} = 2000\ \Omega \cdot \left(-18 \cdot 10^{-3}\,\text{A}\right)^2 = 0{,}648\ \text{W},$$

$$P_{R_2} = R_2 I_2^{\,2} = 2000\ \Omega \cdot \left(-6 \cdot 10^{-3}\,\text{A}\right)^2 = 0{,}072\ \text{W},$$

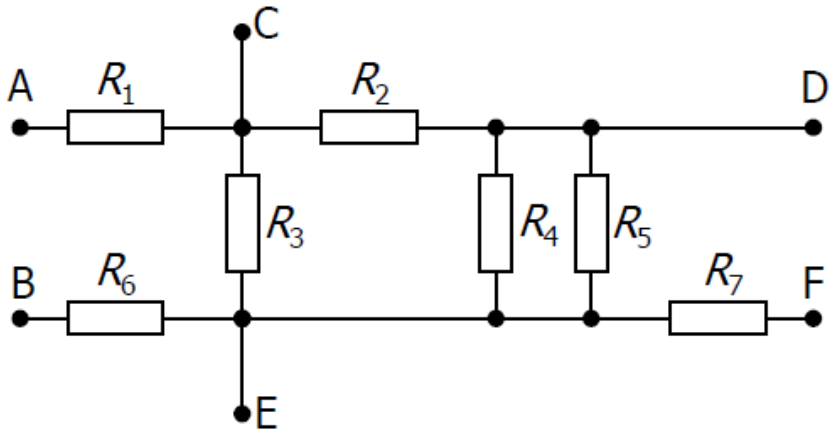
$$P_{R_3} = R_3 I_3^{\,2} = 3000\ \Omega \cdot \left(-16 \cdot 10^{-3}\,\text{A}\right)^2 = 0{,}768\ \text{W},$$

$$P_{R_4} = R_4 I_4^{\,2} = 500\ \Omega \cdot \left(-12 \cdot 10^{-3}\,\text{A}\right)^2 = 0{,}072\ \text{W}.$$

$$P_{R_6} = R_6 I_6^{\,2} = 6000\ \Omega \cdot \left(-22 \cdot 10^{-3}\,\text{A}\right)^2 = 2{,}904\ \text{W}.$$

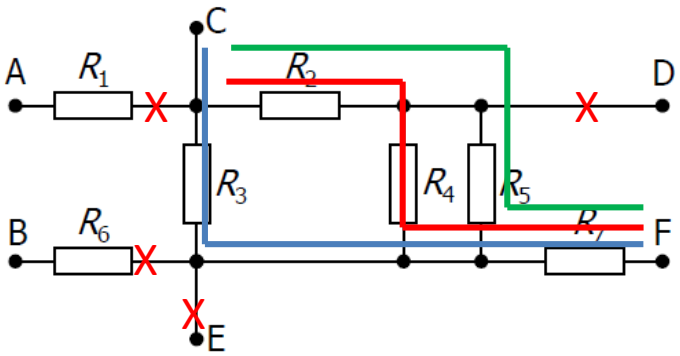
Transfiguracije otpornika

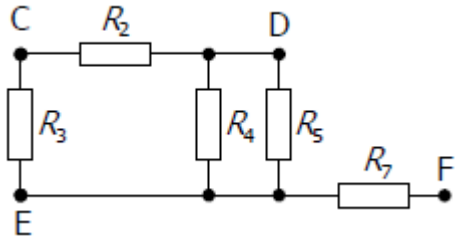
II.8.3.1.3 Za grupu otpornika na slici odrediti ekvivalentnu otpornost između tačaka C i F

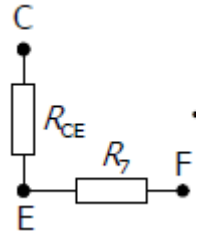


Transfiguracije otpornika

II.8.3.1.3 Rešenje



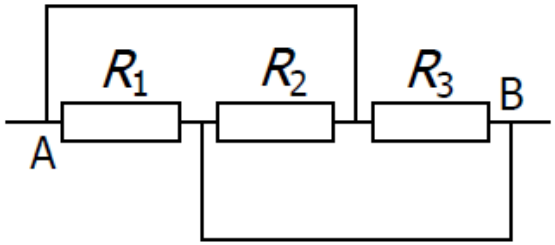




$$R_{CF} = R_{CE} + R_7 = R_3 \,||\, (R_2 + R_4 \,||\, R_5) + R_7 = \frac{R_3\left(R_2 + \frac{R_4 R_5}{R_4 + R_5}\right)}{R_3 + R_2 + \frac{R_4 R_5}{R_4 + R_5}} + R_7$$

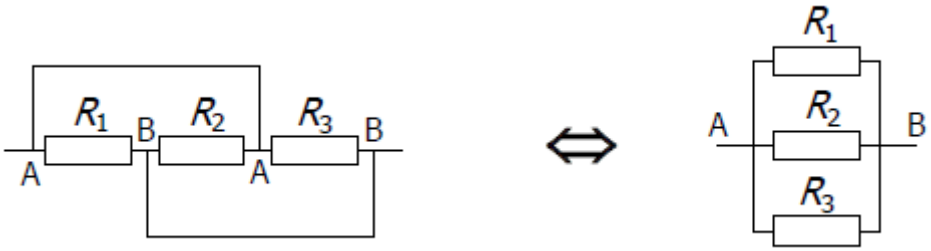
Transfiguracije otpornika

II.8.3.1.4 Izračunati ekvivalentnu otpornost između tačaka A i B, ako je $R_1 = 10\ \text{k}\Omega$, $R_2 = 20\ \text{k}\Omega$, $R_3 = 60\ \text{k}\Omega$.



Transfiguracije otpornika

Zadatak II.8.3.1.4



$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{10\ \text{k}\Omega} + \frac{1}{20\ \text{k}\Omega} + \frac{1}{60\ \text{k}\Omega} = 0{,}167\,\frac{1}{\text{k}\Omega}$$

$$R_e = R_1 \,||\, R_2 \,||\, R_3 = \frac{1}{0{,}167}\ \text{k}\Omega = 6\ \text{k}\Omega$$

Transfiguracije otpornika

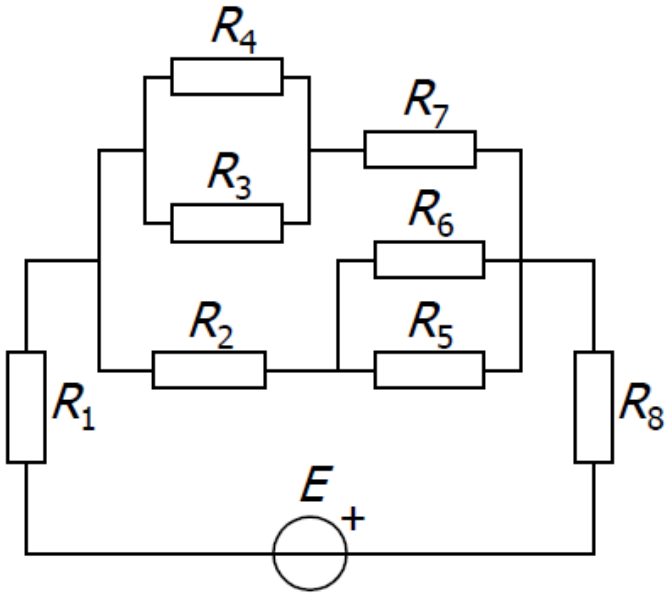
II.8.3.1.5 Izračunati struje u granama kola sa slike, kao i snagu naponskog generatora.

Dato je:

$R_1 = 7\ \text{k}\Omega$, $R_2 = 8\ \text{k}\Omega$, $R_3 = 10\ \text{k}\Omega$, $R_4 = 30\ \text{k}\Omega$,

$R_5 = 3\ \text{k}\Omega$, $R_6 = 6\ \text{k}\Omega$, $R_7 = 2{,}5\ \text{k}\Omega$, $R_8 = 8\ \text{k}\Omega$,

$E = 40\ \text{V}$



Transfiguracije otpornika

Zadatak II.8.3.1.5

$$\frac{1}{R_{34}} = \frac{1}{R_3} + \frac{1}{R_4}$$

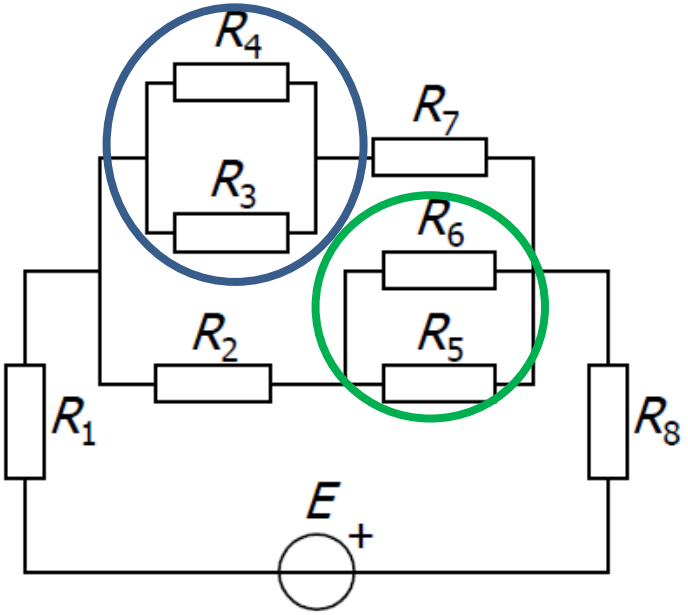
$$R_{34} = R_3 \,||\, R_4 = \frac{R_3 R_4}{R_3 + R_4} = \frac{10\ \text{k}\Omega \cdot 30\ \text{k}\Omega}{10\ \text{k}\Omega + 30\ \text{k}\Omega} = 7{,}5\ \text{k}\Omega$$

$$R_{347} = R_7 + R_{34} = 2{,}5\ \text{k}\Omega + 7{,}5\ \text{k}\Omega = 10\ \text{k}\Omega$$

$$\frac{1}{R_{56}} = \frac{1}{R_5} + \frac{1}{R_6}$$

$$R_{56} = R_5 \,||\, R_6 = \frac{R_5 R_6}{R_5 + R_6} = \frac{3\ \text{k}\Omega \cdot 6\ \text{k}\Omega}{3\ \text{k}\Omega + 6\ \text{k}\Omega} = 2\ \text{k}\Omega$$

$$R_{562} = R_2 + R_{56} = 8\ \text{k}\Omega + 2\ \text{k}\Omega = 10\ \text{k}\Omega$$

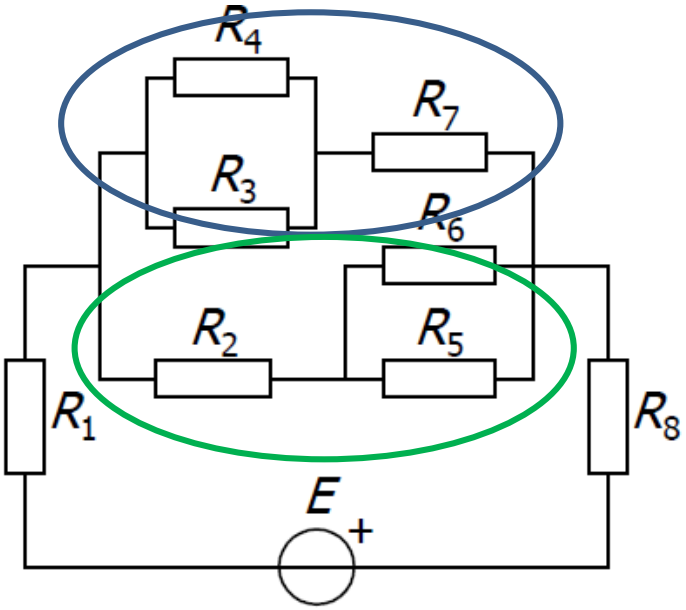


Transfiguracije otpornika

Zadatak II.8.3.1.5

$$\frac{1}{R_{234567}} = \frac{1}{R_{347}} + \frac{1}{R_{562}}$$

$$R_{234567} = R_{347} \,||\, R_{562} = \frac{R_{347}R_{562}}{R_{347} + R_{562}} = \frac{10\ \text{k}\Omega \cdot 10\ \text{k}\Omega}{10\ \text{k}\Omega + 10\ \text{k}\Omega} = 5\ \text{k}\Omega$$



$$R_e = R_1 + R_8 + R_{234567} = 7\ \text{k}\Omega + 8\ \text{k}\Omega + 5\ \text{k}\Omega = 20\ \text{k}\Omega$$

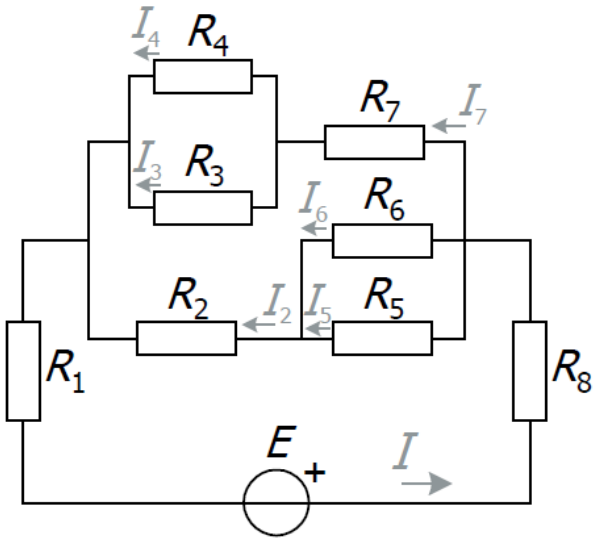
Transfiguracije otpornika

Zadatak II.8.3.1.5

$$I = \frac{E}{R_e} = \frac{40\ \text{V}}{20\ \text{k}\Omega} = 2\ \text{mA}$$

$$I_7 = \frac{R_{562}}{R_{347} + R_{562}} I = \frac{10\ \text{k}\Omega}{10\ \text{k}\Omega + 10\ \text{k}\Omega} \cdot 2\ \text{mA} = 1\ \text{mA}$$

$$I_2 = \frac{R_{347}}{R_{347} + R_{562}} I = \frac{10\ \text{k}\Omega}{10\ \text{k}\Omega + 10\ \text{k}\Omega} \cdot 2\ \text{mA} = 1\ \text{mA}$$



Transfiguracije otpornika

Zadatak II.8.3.1.5

$$I_3 = \frac{R_4}{R_3 + R_4} I_7 = \frac{30\ \text{k}\Omega}{10\ \text{k}\Omega + 30\ \text{k}\Omega} \cdot 1\ \text{mA} = 0{,}75\ \text{mA}$$

$$I_4 = \frac{R_3}{R_3 + R_4} I_7 = \frac{10\ \text{k}\Omega}{10\ \text{k}\Omega + 30\ \text{k}\Omega} \cdot 1\ \text{mA} = 0{,}25\ \text{mA}$$

$$I_5 = \frac{R_6}{R_5 + R_6} I_2 = \frac{6\ \text{k}\Omega}{3\ \text{k}\Omega + 6\ \text{k}\Omega} \cdot 1\ \text{mA} = 0{,}67\ \text{mA}$$

$$I_6 = \frac{R_5}{R_5 + R_6} I_2 = \frac{3\ \text{k}\Omega}{3\ \text{k}\Omega + 6\ \text{k}\Omega} \cdot 1\ \text{mA} = 0{,}33\ \text{mA}$$