Vysoké Učení Technické v Brně
Fakulta informačních technologií

Elektronika pro informační technologie

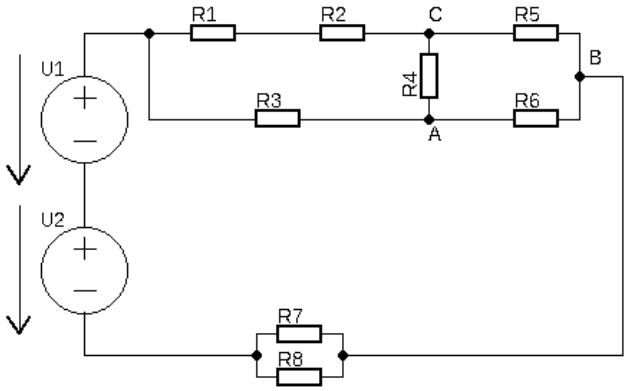
2018/2019

Semestrální projekt

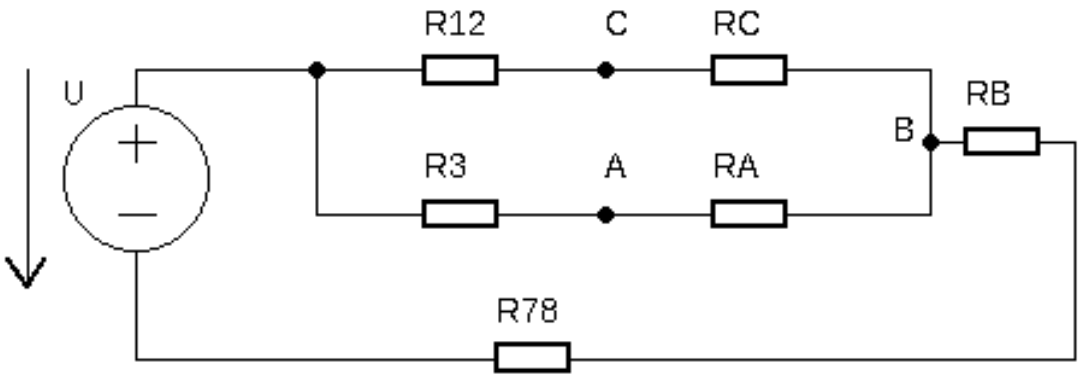
Ondřej Dohnal (xdohna45) Brno, 20. prosince 2018

1 Příklad (B)

Zadání:
$U_1 = 95\text{V}$ $U_2 = 115\text{V}$
$R_1 = 650\Omega$ $R_2 = 730\Omega$ $R_3 = 340\Omega$ $R_4 = 330\Omega$ $R_5 = 410\Omega$ $R_6 = 830\Omega$
$R_7 = 340\Omega$ $R_8 = 220\Omega$
$U_{R_3} = \ ?$
$I_{R_3} = \ ?$



Řešení (metoda postupného zjednodušování):



Transfigurace - trojúhelník $\rightarrow$ hvězda

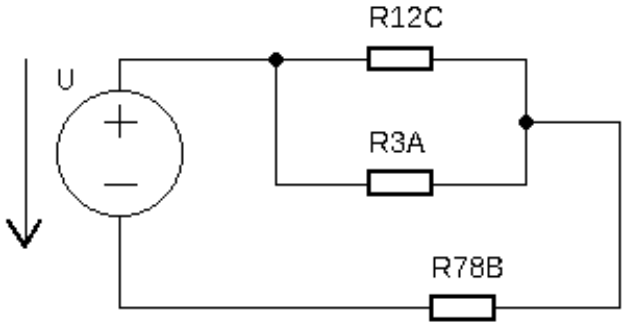
$$U = U_1 + U_2 = 95 + 115 = 210\text{V}$$

$$R_A = \frac{R_4 R_6}{R_4 + R_5 + R_6} = \frac{330 \cdot 830}{330 + 410 + 830} = \frac{27390}{157} \doteq 174.4586\Omega$$

$$R_B = \frac{R_5 R_6}{R_4 + R_5 + R_6} = \frac{410 \cdot 830}{330 + 410 + 830} = \frac{34030}{157} \doteq 216.7516\Omega$$

$$R_C = \frac{R_4 R_5}{R_4 + R_5 + R_6} = \frac{330 \cdot 410}{330 + 410 + 830} = \frac{13530}{157} \doteq 86.1783\Omega$$

$$R_{78} = \frac{R_7 R_8}{R_7 + R_8} = \frac{340 \cdot 220}{340 + 220} = \frac{935}{7} \doteq 133.7514\Omega$$

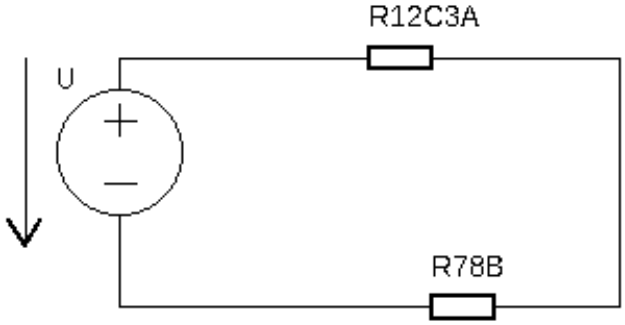


R_{12} a R_C jsou zapojeny sériově stejně jako R_3 a R_A a stejně R_{78} a R_B

$$R_{12C} = R_{12} + R_C = 1380 + \frac{13530}{157} = \frac{230190}{157} \doteq 1460.1783\Omega$$

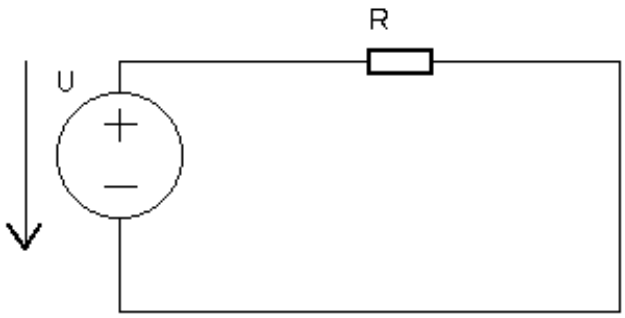
$$R_{3A} = R_3 + R_A = 340 + \frac{27390}{157} = \frac{80770}{157} \doteq 514.4586\Omega$$

$$R_{78B} = R_{78} + R_B = \frac{935}{7} + \frac{34030}{157} = \frac{385005}{1099} \doteq 350.3230\Omega$$



R_{12C} a R_{3A} jsou zapojeny paralelně

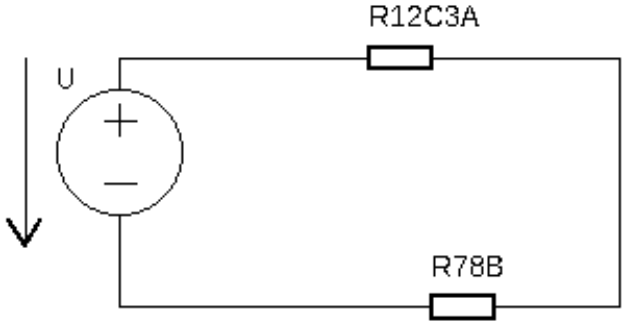
$$R_{123C3A} = \frac{R_{12C}R_{3A}}{R_{12C} + R_{3A}} = \frac{\frac{230190}{157} \cdot \frac{80770}{157}}{\frac{230190}{157} + \frac{80770}{157}} = \frac{929622315}{2441036} \doteq 380.8311\Omega$$



R_{12C3A} a R_{78B} jsou zapojeny sériově

$$R = R_{12C3A} + R_{78B} = \frac{929622315}{2441036} + \frac{385005}{1099} = \frac{79575885}{108836} \doteq 731.1541\Omega$$

$$I = \frac{U}{R} = \frac{210}{\frac{70247085}{2441030}} = \frac{1523704}{5305059} \doteq 0.2872172\text{A}$$

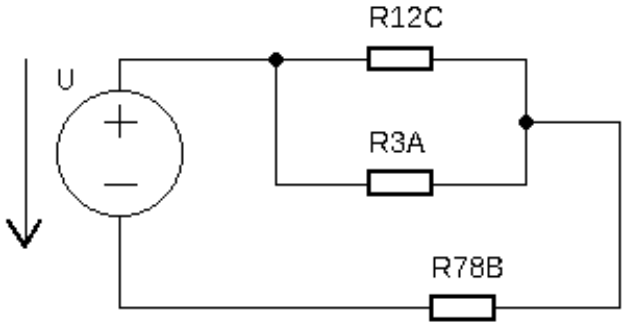


R_{12C3A} a R_{78B} jsou zapojeny sériově

Z I. Kirchhoffova zákona:

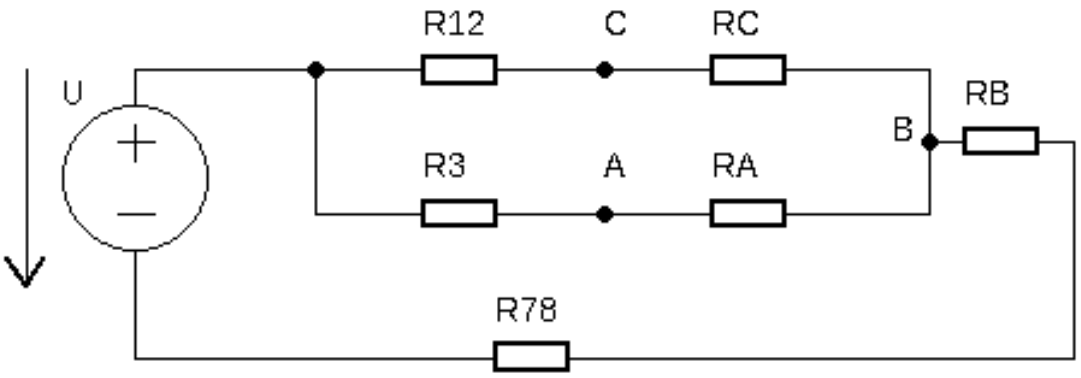
$$I_{R_{78B}} = I_{R_{12C3A}} = I$$

$$U_{R_{12C3A}} = R_{12C3A} \cdot I = \frac{1523704}{5305059} \cdot \frac{929622315}{2441036} = \frac{30367662290}{277631421} \doteq 109.3812\text{V}$$



R_{12C} a R_{3A} jsou zapojeny paralelně

$$I_{R_{3A}} = \frac{U_{R_{12C3A}}}{R_{3A}} = \frac{\frac{30367662290}{277631421}}{\frac{80770}{157}} = \frac{375977}{1768353} \doteq 0.2126142\text{A}$$



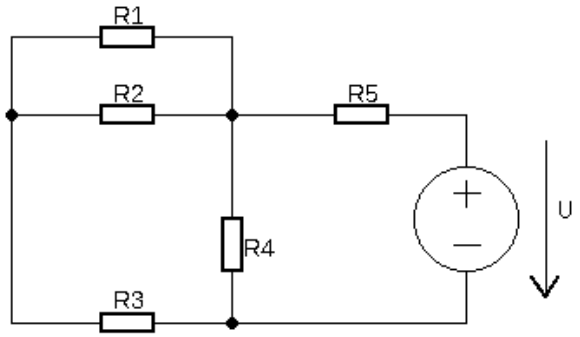
R_3 a R_A jsou zapojeny sériově

$$I_3 = I_{R_3} = \frac{375977}{1768353} \doteq 0.2126142\text{A}$$

$$U_{R_3} = R_3 \cdot I_{R_3} = 340 \cdot \frac{375977}{1768353} = \frac{127832180}{1768353} \doteq 72.288836\text{V}$$

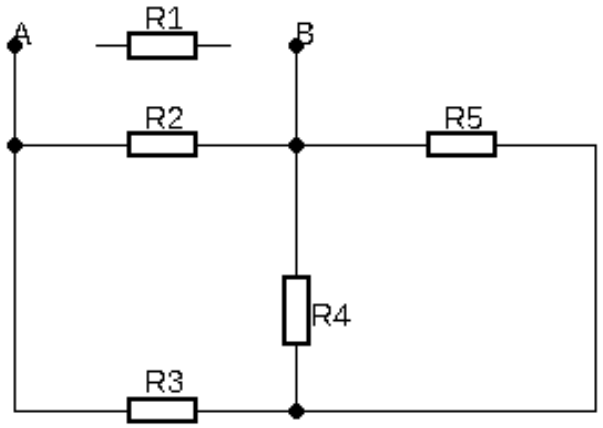
2 Příklad (E)

Zadání:
$U = 250\text{V}$
$R_1 = 150\Omega$ $R_2 = 335\Omega$ $R_3 = 625\Omega$ $R_4 = 245\Omega$
$R_5 = 600\Omega$
$U_{R_1} = \ ?$
$I_{R_1} = \ ?$



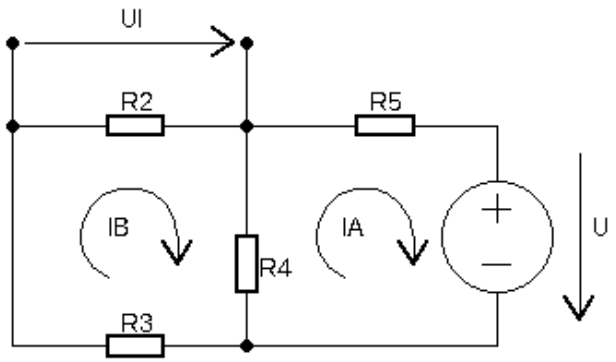
Řešení (Metoda Théveninovy věty):

Vypočítáme $\boldsymbol{R_i}$:



Odpojíme R_1 a zkratujeme napěťový zdroj

$$R_i = \frac{R_2(R_3 + \frac{R_4 R_5}{R_4+R_5})}{R_2 + (R_3 + \frac{R_4 R_5}{R_4+R_5})} = \frac{335 \cdot (625 + \frac{245 \cdot 600}{245+600})}{335 + (625 + \frac{245 \cdot 600}{245+600})} \doteq 236.03306\Omega$$



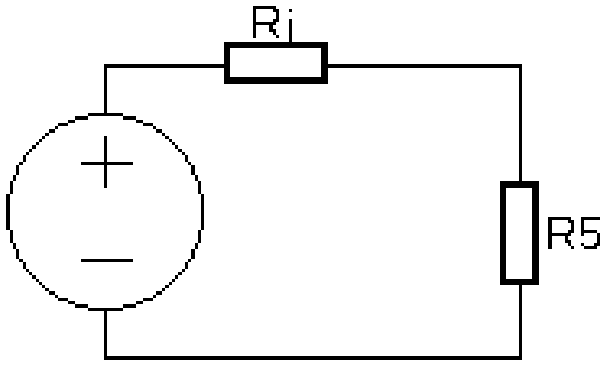
Vypočítáme I_B metodou smyčkových proudů

$$\begin{aligned} I_A R_4 + I_A R_5 - I_B R_4 + U &= 0 \\ I_B R_3 + I_B R_2 + I_B R_4 - I_A R_4 &= 0 \end{aligned}$$

$$\begin{aligned} 245 I_A + 600 I_A - 245 I_B &= 0 \\ 625 I_B + 335 I_B + 245 I_B - 245 I_A &= 0 \end{aligned}$$

$$\begin{aligned} 1205 I_B - 245 I_A &= 0 \\ I_A &= -\frac{50 + 49 I_B}{169} \end{aligned}$$

$$\begin{aligned} 1205 I_B - 245 \left(-\frac{50 + 49 I_B}{169} \right) &= 0 \\ I_B &= -\frac{1225}{19164} \end{aligned}$$



Vypočítáme U_i a I_i

$$|I_B| = \frac{1225}{19164} \doteq 0.0639219\text{A}$$

$$U_i = R_2 I_B = 335 \cdot \frac{1225}{19164} = \frac{410375}{19164} \doteq 21.4139\text{V}$$

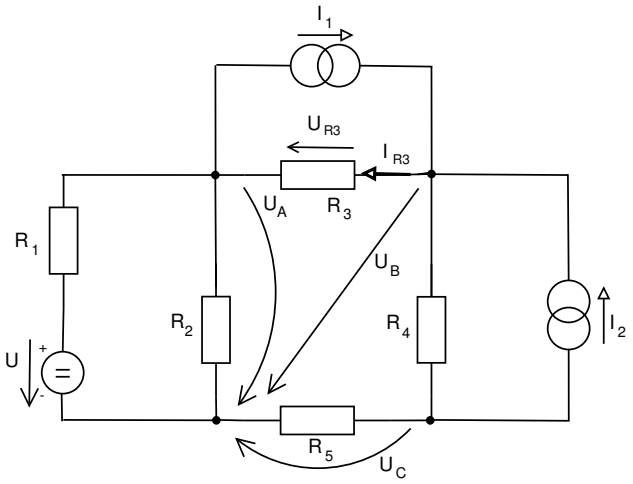
$$I_i = \frac{U_i}{R_i + R_1} = \frac{21.4138}{236.0331 + 150} \doteq 0.0554714\text{A}$$

$$I_{R_1} = I_i \doteq 0.0554714\text{A}$$

$$U_{R_1} = I_{R_1} R_1 = 0.0554714 \cdot 150 \doteq 8.32071\text{V}$$

3 Příklad (B)

Zadání:
$U = 150\text{V}$
$I_1 = 0.7\text{A}$ $I_2 = 0.8\text{A}$
$R_1 = 49\Omega$ $R_2 = 45\Omega$ $R_3 = 61\Omega$ $R_4 = 34\Omega$
$R_5 = 34\Omega$
$U_{R_3} = \ ?$
$I_{R_3} = \ ?$



Přepočítáme napěťový zdroj U na proudový zdroj I_3

Řešení (Metoda uzlových napětí):

$$I_3 = \frac{U}{R_1} = \frac{150}{49} \doteq 3.0612\text{A}$$

Sestavíme rovnice pro jednotlivé uzly:

$$\begin{aligned} -I_1 + I_3 - \frac{U_A}{R_1} - \frac{U_A}{R_2} - \frac{U_A - U_B}{R_3} &= 0 \\ I_1 + I_2 + \frac{U_A - U_B}{R_3} - \frac{U_B - U_C}{R4} &= 0 \\ -I_2 + \frac{U_B - U_C}{R_4} - \frac{U_C}{R_5} &= 0 \end{aligned}$$

Dosadíme do rovnic:

$$\begin{aligned} -0.7 + 3.0612 - \frac{U_A}{49} - \frac{U_A}{45} - \frac{U_A - U_B}{61} &= 0 \\ 0.7 + 0.8 + \frac{U_A - U_B}{61} - \frac{U_B - U_C}{34} &= 0 \\ -0.8 + \frac{U_B - U_C}{34} - \frac{U_C}{34} &= 0 \end{aligned}$$

Upravíme:

$$\begin{aligned} -3969500U_A + 1102500U_B &= -158796603 \\ 34U_A - 95U_B + 61U_C &= -3111 \\ 5U_B - 10U_C &= 136 \end{aligned}$$

Vypočítáme:

$$U_A = \frac{158796603}{3969500} + \frac{2205}{7939}U_B$$

$$
\begin{aligned}
34(\frac{158796603}{3969500} + \frac{2205}{7939}U_B) - 95U_B + 61U_C &= -3111 \\
5U_B - 10U_C &= 136
\end{aligned}
$$

$$
\begin{aligned}
-9988750U_B + 7121750U_C &= -522005853 \\
5U_B - 10U_C &= 136
\end{aligned}
$$

$$
\begin{aligned}
-9988750U_B + 7121750U_C &= -522005853 \\
9988750U_B - 19977500U_C &= 271964000
\end{aligned}
$$

$$
-12855750U_C = -250311853
$$

$$
U_C = \frac{4103473}{210750}
$$

$$
\begin{aligned}
5U_B - 10\frac{4103473}{210750} &= 136 \\
U_B &= \frac{6969673}{105375}
\end{aligned}
$$

$$
U_A = \frac{158796603}{3969500} + \frac{2205}{7939} \cdot \frac{6969673}{105375}
$$

$$
U_A = \frac{139427589}{2388500}
$$

$$
\begin{aligned}
U_A &\doteq 58.3745\text{V} \\
U_B &\doteq 66.1416\text{V} \\
U_C &\doteq 19.4708\text{V}
\end{aligned}
$$

Pomocí U_A a U_B vypočítáme napětí na U_{R_3}:

$$U_{R_3} = U_B - U_A = \frac{6969673}{105375} - \frac{139427589}{2388500} = \frac{55654997}{7165500} \doteq 7.76708\text{V}$$

$$I_{R_3} = \frac{U_{R_3}}{R_3} = \frac{\frac{55654997}{7165500}}{61} = \frac{912377}{7165500} \doteq 0.127329\text{A}$$

Tabulka výsledků

Příklad	Varianta	Výsledek
1	B	$I_{R_3} = 0.2126\text{A} = 212.6\text{mA}$ $U_{R_3} = 72.288836\text{V}$
2	E	$I_{R_1} = 0.0554714\text{A} = 55.4714\text{mA}$ $U_{R_1} = 8.32071\text{V}$
3	B	$I_{R_3} = 0.127329\text{A} = 127.329\text{mA}$ $U_{R_3} = 7.76708\text{V}$