Vysoké učení technické v Brně
Fakulta informačních technologií

Elektronika pro informační technologie

2018/2019

Semestrální projekt

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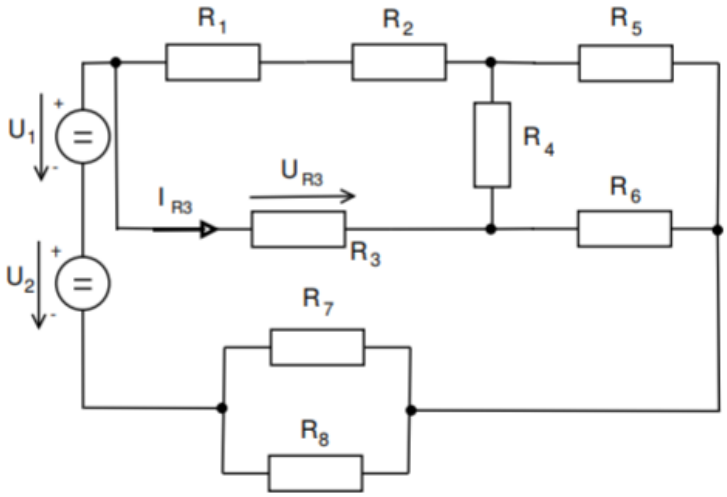
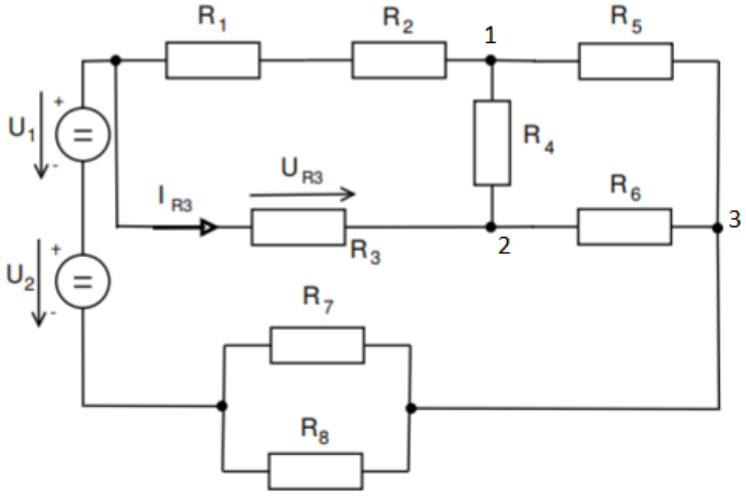
1.C

Zadání:
$U_1 = 100V$ $U_2 = 80V$
$R_1 = 450\Omega$ $R_2 = 810\Omega$ $R_3 = 190\Omega$ $R_4 = 220\Omega$ $R_5 = 220\Omega$ $R_6 = 720\Omega$
$R_7 = 260\Omega$ $R_8 = 180\Omega$
$U_{r3} =?$ $I_{r3} =?$



Řešení metodou postupného zjednodušování

Označení uzlů pro transfiguraci (trojuhelník ⇒ hvězda):



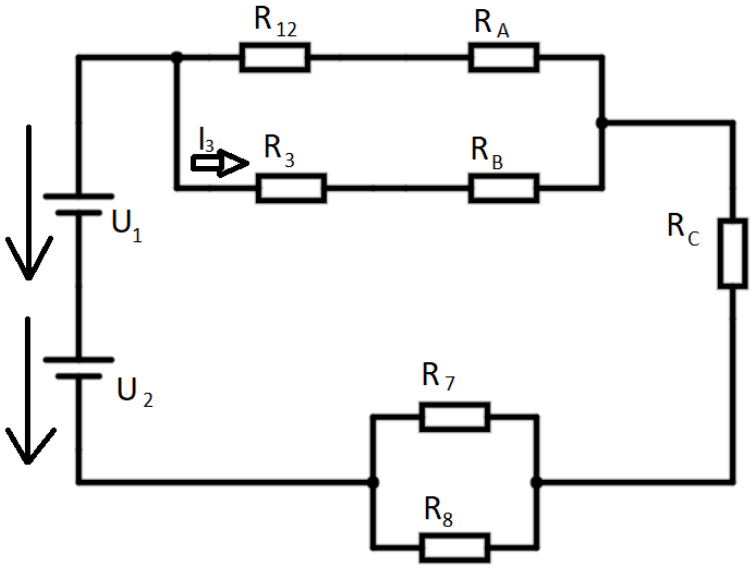
Provedení transfigurace a spojení R_1 a R_2:

$$R_{12} = R_1 + R_2 = 450 + 810 = 1260$$

$$R_A = \frac{R_4 * R_5}{R_4 + R_6 + R_5} = \frac{220 * 220}{220 + 220 + 720} = 41.7241\Omega$$

$$R_B = \frac{R_4 * R_6}{R_4 + R_6 + R_5} = \frac{220 * 720}{220 + 220 + 720} = 136.5517\Omega$$

$$R_C = \frac{R_6 * R_5}{R_4 + R_6 + R_5} = \frac{220 * 720}{220 + 220 + 720} = 136.5517\Omega$$

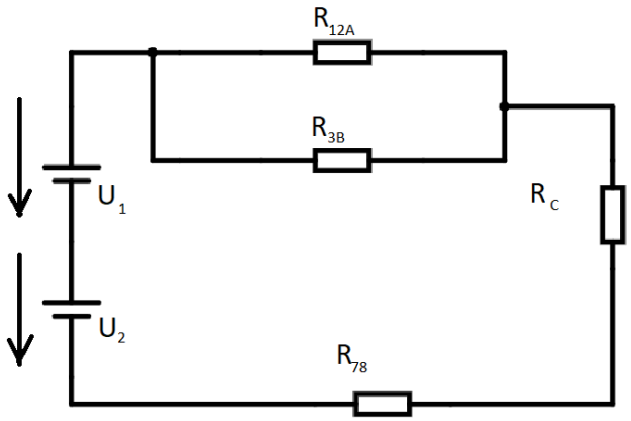


Sériové spojení R_{12} s R_A a R_3 s R_B a Paralelní spojení R_7 s R_8

$$R_{12A} = R_{12} + R_A = 1260 + 41.7241 = 1300.7241\Omega$$

$$R_{3B} = R_3 + R_A = 190 + 136.5517 = 326.5517\Omega$$

$$R_{78} = \frac{R_7 * R_8}{R_7 + R_8} = \frac{260 * 180}{260 + 180} = 106.3636\Omega$$

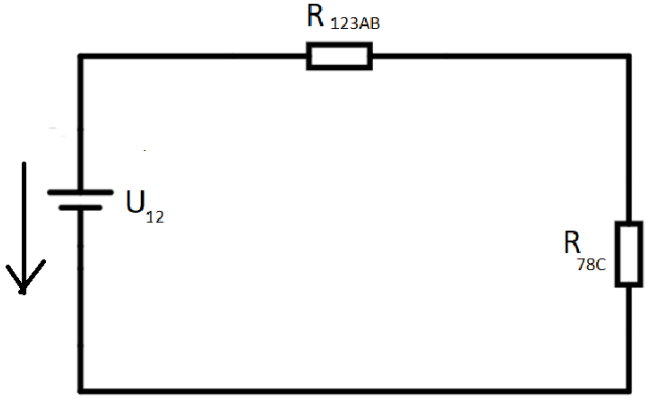


Sériové spojení R_{78} s R_C, Paralelní spojení R_12A s R_3B a spojení zdrojů napětí

$$R_{78C} = R_{78} + R_C = 106.3636 + 136.5517 = 242.9153$$

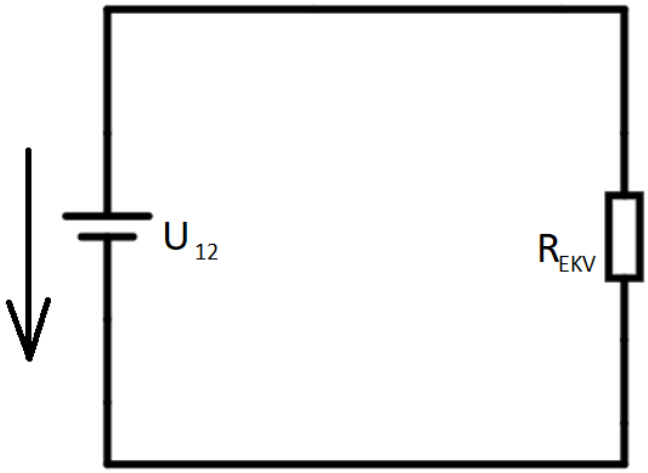
$$R_{123AB} = \frac{R_{12A} * R_{3B}}{R_{12A} + R_{3B}} = \frac{1300.7241 * 326.5517}{1300.7241 + 326.5517} = 261.0184\Omega$$

$$U_{12} = U_1 + U_2 = 100 + 800 = 180V$$



Sériové spojení R_{123AB} s R_{78C}

$$R_{EKV} = R_{123AB} + R_{78C} = 261.0184 + 242.9153 = 503.9337$$



Celkový proud I:

$$I = \frac{U}{R_{EKV}} = \frac{180}{503.9337} = 0.3571A$$

Nyní můžeme zpětně dopočítat napětí a proud na rezistoru R_3

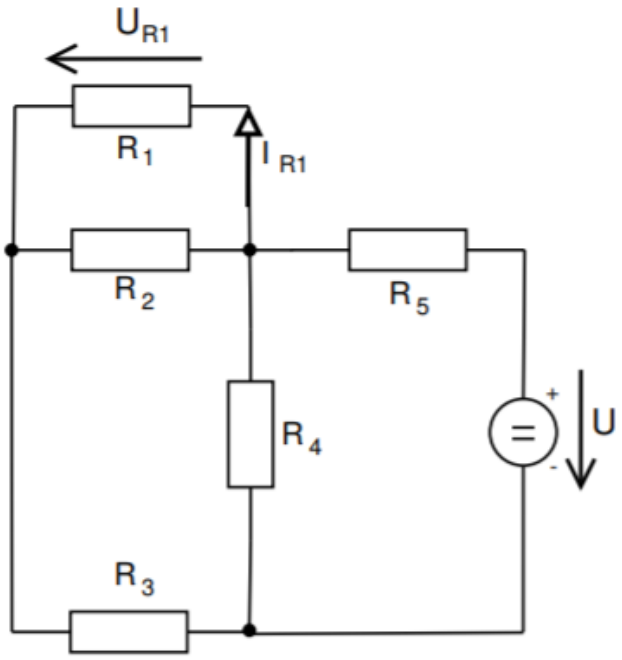
$$U_{123AB} = I * R_{123AB} = 0.3571 * 261.0184 = 93.2096$$

$$I_3 \equiv I_{3B} = \frac{U_{123AB}}{R_{3B}} = \frac{93.2096}{326.5551} = 0.2854$$

$$U_3 = I * R_3 = 0.2854 * 190 = 54.226$$

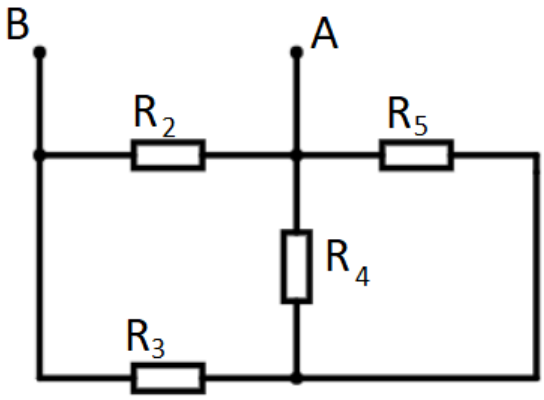
2.B

Zadání:
$U = 100V$
$R_1 = 50\Omega$ $R_2 = 310\Omega$ $R_3 = 610\Omega$ $R_4 = 220\Omega$ $R_5 = 570\Omega$



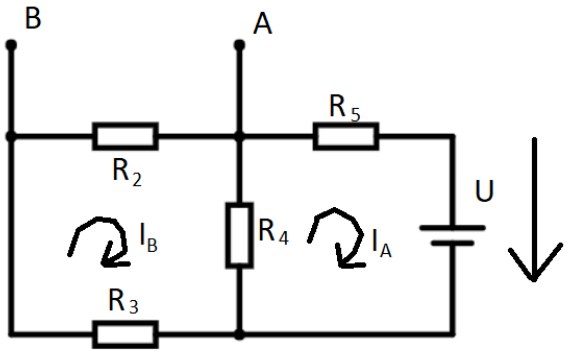
Řešení pomocí Théveninovy věty

Výpočet R_i:



$$R_i = \frac{(\frac{R_5 * R_4}{R_5 + R_4} + R_3) * R_2}{(\frac{R_5 * R_4}{R_5 + R_4} + R_3) + R_2} = \frac{(\frac{570*220}{570+220} + 610) * 310}{(\frac{570*220}{570+220} + 610) + 310} = 220.9141$$

Výpočet U_i:



Vypočítáme I_B metodou smyčkových proudů:

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

$$\begin{cases} 100 + 220I_A - 220I_B + 570I_A = 0 \\ 310I_B + 610I_B + 220I_B - 220I_B = 0 \end{cases}$$

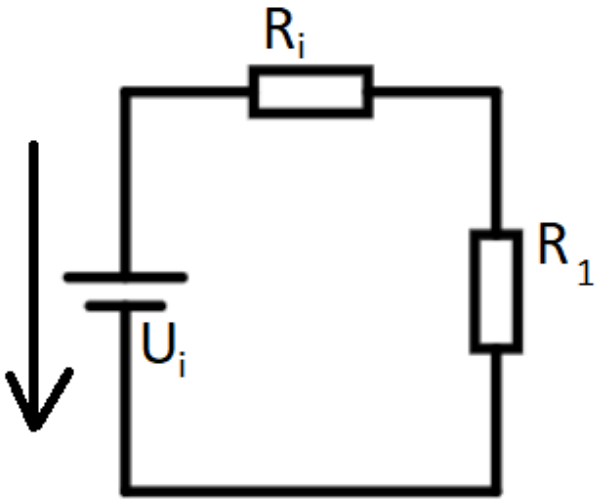
$$\begin{cases} 790I_A - 220I_B = -100 \\ -220I_A + 1140I_B = 0 / * 3.590909091 \end{cases}$$

$$\begin{cases} 790I_A - 220I_B = -100 \\ -790I_A + 4093.6363I_B = 0 \end{cases}$$

$$3873.6363I_B = -100$$

$$I_B = 0.02581A$$

$$U_i = U_2 = R_2 * I_B = 310 * 0.02581 = 8.00281V$$



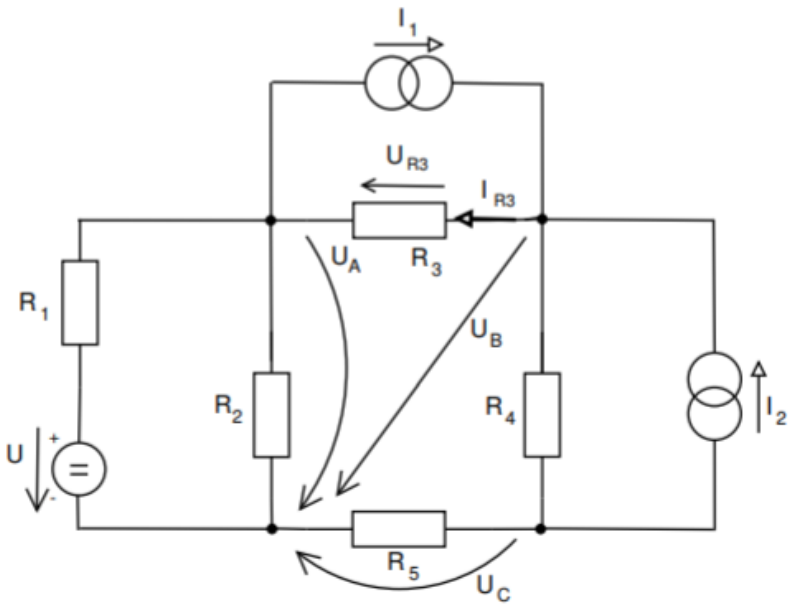
$$I_i = \frac{U_i}{R_i + R_1} = \frac{8.00281}{220.9141 + 50} = 0.02964A$$

$$U_1 = R_1 * I_i = 1.48200V$$

$$I_1 = \frac{U_1}{R_1} = \frac{1.48200}{50} = 0.02964A$$

3.B

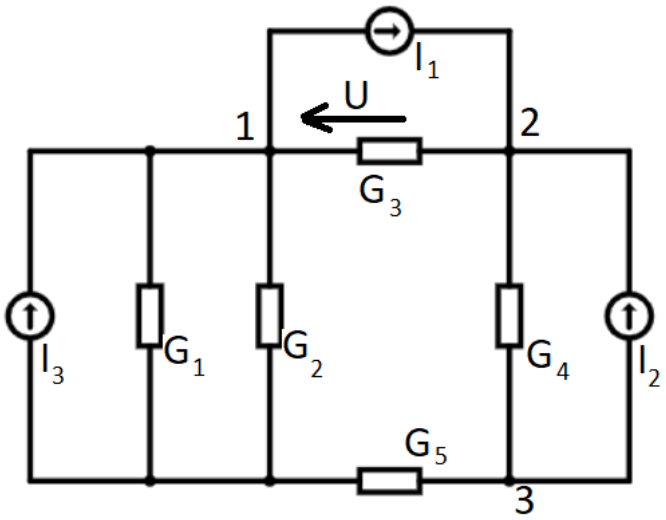
Zadání:
$U = 150V$
$I_1 = 0.7A$ $I_2 = 0.8A$
$R_1 = 49\Omega$ $R_2 = 45\Omega$ $R_3 = 61\Omega$ $R_4 = 34\Omega$ $R_5 = 34\Omega$



Řešení metodu uzlových napětí

Označíme nezávislé uzly a převedeme zdroj napětí na proudový zdroj a odpory převedeme na vodivost:

$G_1 = \frac{1}{49}S$, $G_2 = \frac{1}{45}S$, $G_3 = \frac{1}{61}S$, $G_4 = \frac{1}{34}S$, $G_5 = \frac{1}{34}S$,



$$I_3 = \frac{U}{R_1} = \frac{150}{49}$$

Dále sestavíme rovnice pro jednotlivé uzly:

$$\begin{cases} 1: -I_1 + I_3 - G_1 * U_A - G_2 * U_A - G_3 * (U_A - U_B) = 0 \\ 2: +I_1 + I_2 + G_3 * (+U_A - U_B) - G_4 * (+U_B - U_C) = 0 \\ 3: -I_2 + G_4 * (+U_B - U_C) - G_5 * U_C = 0 \end{cases}$$

$$\begin{cases} 1: -G_1 * U_A - G_2 * U_A - G_3 * U_A + G_3 * U_B = +I_1 - I_3 \\ 2: +G_3 * U_A - G_3 * U_B - G_4 * U_B + G_4 * U_C = -I_1 - I_2 \\ 3: G_4 * +U_B - G_4 * U_C - G_5 * U_C = +I_2 \end{cases}$$

$$\begin{cases} 1: U_A * (-G_1 - G_2 - G_3) + U_B * (G_3) + 0 = I_1 - I_3 \\ 2: U_A * (G_3) + U_B * (-G_3 - G_4) + U_C * (G_4) = -I_1 - I_2 \\ 3: 0 + U_B * (G_4) + U_C * (-G_4 - G_5) = +I_2 \end{cases}$$

Dosadíme proudy a vodivosti:

$$\begin{cases} 1 : U_A * (-\frac{1}{49} - \frac{1}{45} - \frac{1}{61}) + U_B * (\frac{1}{61}) + 0 = 0.7 - \frac{150}{49} \\ 2 : U_A * (\frac{1}{61}) + U_B * (-\frac{1}{34} - \frac{1}{61}) + U_C * (\frac{1}{34}) = -0.7 - 0.8 \\ 3 : 0 + U_B * (\frac{1}{34}) + U_C * (-\frac{1}{34} - \frac{1}{34}) = +0.8 \end{cases}$$

$$\begin{cases} 1 : -\frac{4939}{134505} * U_A + \frac{1}{61} * U_B = -\frac{1157}{490} \\ 2 : \frac{1}{61} * U_A - \frac{95}{2074} * U_B + \frac{1}{34} * U_C = -\frac{15}{10} \\ 3 : \frac{1}{34} * U_B - \frac{1}{17} * U_C = \frac{8}{10} \end{cases}$$

Máme tři rovnice o třech neznámých. Třetí rovnici vydělíme dvěma a přičteme k druhé rovnici:

$$\begin{cases} 2 : \frac{1}{61} * U_A - \frac{95}{2074} * U_B + \frac{1}{34} * U_C = -\frac{15}{10} \\ 3 : \frac{1}{68} * U_B - \frac{1}{34} * U_C = \frac{2}{5} \end{cases}$$

$$\{ \frac{1}{61} * U_A - \frac{129}{4148} * U_B = -\frac{11}{10}$$

Osamostatníme z rovnice U_A

$$U_A = -\frac{129}{68} * U_B = -\frac{671}{10}$$

U_A Nyní dosadíme do první rovnice abychom zjistili hodnotu U_B

$$-\frac{7939}{134505} * (\frac{129}{68} * U_B - \frac{671}{10}) + \frac{1}{61} = -\frac{1157}{490}$$

$$-0.1119716 * U_B + 3.960498866 + \frac{1}{61} U_B = -\frac{1157}{490}$$

$$-\frac{281}{2940} U_B = -6.321723356$$

$$U_B = 66.14187426V$$

Když známe U_B tak můžeme zjistit U_A dosazení U_B do první rovnice:

$$-\frac{7939}{134505} * U_A + \frac{1}{61} * U_B = -\frac{1157}{490}$$

$$-\frac{7939}{134505} * U_A + \frac{1}{61} * 66.1418657 = -\frac{1157}{490}$$

$$-\frac{7939}{134505} * U_A + 1.08429288 = -\frac{1157}{490}$$

$$-\frac{7939}{134505} * U_A = -1.276931609$$

$$U_A = 58.37502617$$

Když známe U_A a U_B můžeme zjistit napětí na U_{R3}

$$U_{R3} = U_A - U_B$$

$$U_{R3} = 58.37501 - 66.141874426$$

$$U_{R3} = 7.76684809V$$

$$I_{R3} = \frac{U_{R3}}{R_3}$$

$$I_{R3} = \frac{7.76684809}{61}$$

$$I_{R3} = 0.1273253786A$$