Vysoké učení technické v Brně, Fakulta informačních technologií

Semestrální projekt pro předmět Elektrotechnika pro informační technologie (IEL)

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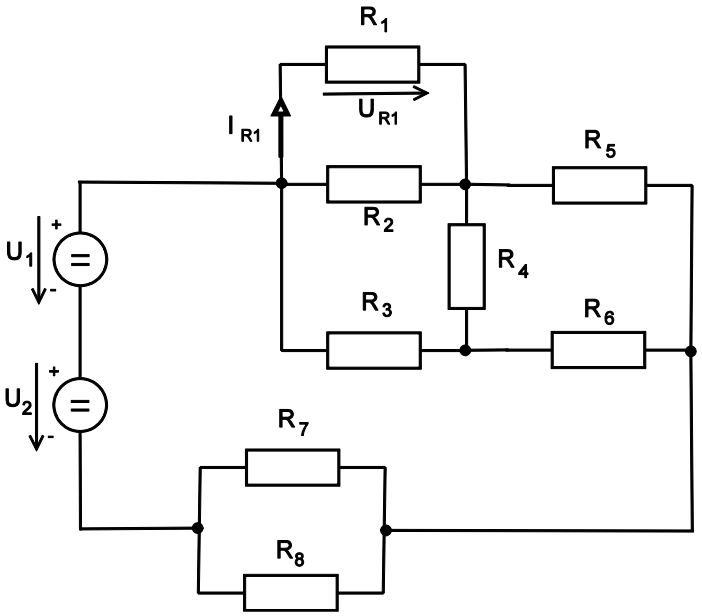
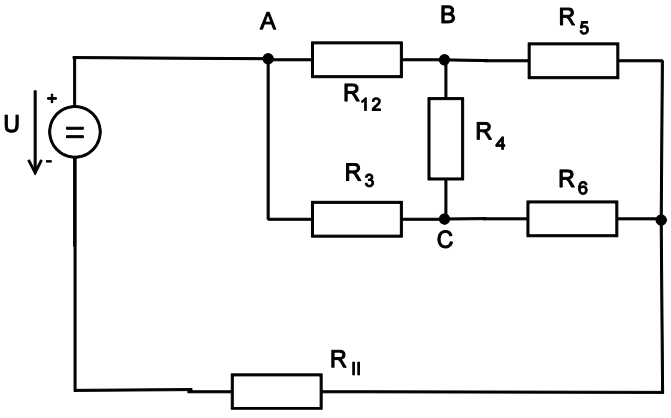
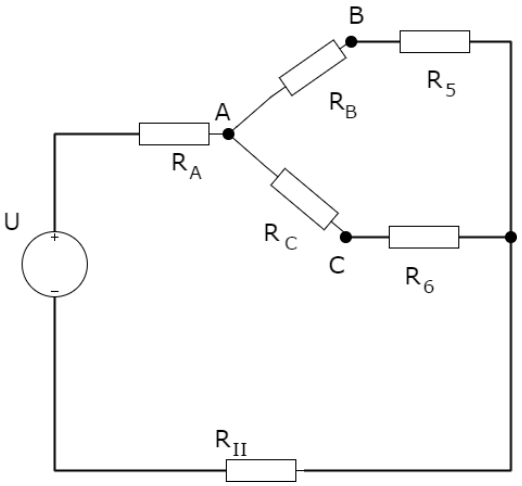
Úloha č. 1:

Stanovte napětí U_{R1} a proud I_{R1}. Použijte metodu postupného zjednodušování obvodu.

sk.	U_1 [V]	U_2 [V]	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	R_4 [Ω]	R_5 [Ω]	R_6 [Ω]	R_7 [Ω]	R_8 [Ω]
F	125	65	510	500	550	250	300	800	330	250







Nákres: V našem obvodu budeme využívat metodu zjednodušování trojúhelník → hvězda

$U = U_1 + U_2$

$U = 125 + 65$

$U = 190\,V$

$$R_{12} = \frac{R_1 * R_2}{R_1 + R_2}$$

$$R_{12} = \frac{510 * 500}{510 + 500}$$

$R_{12} = 252{,}4752\,\Omega$

$$R_B = \frac{R_4 * R_{12}}{R_{12} + R_3 + R_4}$$

$$R_B = \frac{250 * 252{,}4752}{252{,}4752 + 550 + 250}$$

$$R_B = 59{,}9718\ \Omega$$

$$R_A = \frac{R_{12} * R_3}{R_{12} + R_3 + R_4}$$

$$R_A = \frac{252{,}4752 * 550}{252{,}4752 + 550 + 250}$$

$$R_A = 131{,}9379\ \Omega$$

$$R_C = \frac{R_4 * R_3}{R_{12} + R_3 + R_4}$$

$$R_C = \frac{250 * 550}{252{,}4752 + 550 + 250}$$

$$R_C = 130{,}6444\ \Omega$$

$$R_B + R_5 = R_{B5}$$

$$R_{B5} = 59{,}9718 + 300$$

$$R_{B5} = 359{,}9718\ \Omega$$

$$R_C + R_6 = R_{C6}$$

$$R_{C6} = 130{,}6444 + 800$$

$$R_{C6} = 930{,}6444\ \Omega$$

$$R_{B5C6} = \frac{R_{B5} * R_{C6}}{R_{B5} + R_{C6}}$$

$$R_{B5C6} = \frac{359{,}9718 * 930{,}6444}{359{,}9718 + 930{,}6444}$$

$$R_{B5C6} = 259{,}5704\ \Omega$$

$$R_A + R_{B5C6} = R_I$$

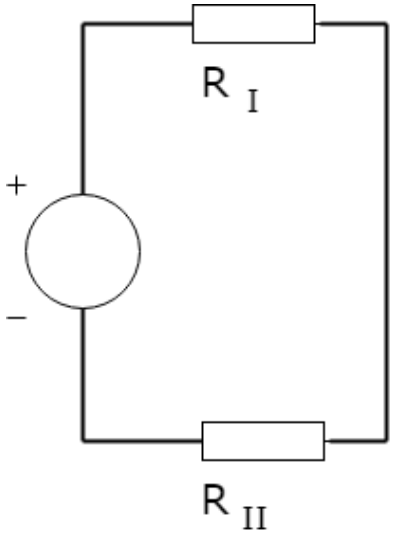
$$R_I = 131{,}9379 + 259{,}5704$$

$$R_I = 391{,}5083\ \Omega$$

$$R_{II} = \frac{R_7 * R_8}{R_7 + R_8}$$

$$R_{II} = \frac{330 * 250}{330 + 250}$$

$$R_{II} = 142{,}2414\ \Omega$$



$$R_I + R_{II} = R_{EKV}$$

$$R_{EKV} = 391{,}5083 + 142{,}2414$$

$$R_{EKV} = 533{,}7497\ \Omega$$

$$I = \frac{U}{R_{EKV}}$$

$$I = \frac{190}{533{,}7497}$$

$$I = 0{,}3560\ A$$

Zpětně poskládáme obvod a postupně počítáme napětí a proudy:

3.

$$U_{RI} = I * R_I$$

$$U_{RI} = 0{,}3560 * 391{,}5083$$

$$U_{RI} = 139{,}3770\ V$$

2.

$$U_{RA} = I * R_A$$

$$U_{RA} = 0{,}3560 * 131{,}9379$$

$$U_{RA} = 46{,}9699\ V$$

$$U_{B5C6} = I * R_{B5C6}$$

$$U_{B5C6} = 0{,}3560 * 259{,}5704$$

$$U_{B5C6} = 92{,}4071\ V$$

1.

$$I_{RB5} = \frac{U_{B5C6}}{R_{B5}}$$

$$I_{RB5} = \frac{92{,}4071}{359{,}9718}$$

$$I_{RB5} = 0{,}2567\ A$$

$$I_{RC6} = \frac{U_{B5C6}}{R_{C6}}$$

$$I_{RC6} = \frac{92{,}4071}{930{,}6444}$$

$$I_{RC6} = 0{,}0993\ A$$

$U_{RB} = I_{RB5} * R_B$

$U_{RB} = 0{,}2567 * 59{,}9718$

$U_{RB} = 15{,}3948\, V$

$U_{RC} = I_{RC6} * R_C$

$U_{RC} = 0{,}0993 * 130{,}6444$

$U_{RC} = \ 12{,}9730\, V$

$U_{R5} = I_{RB5} * R_5$

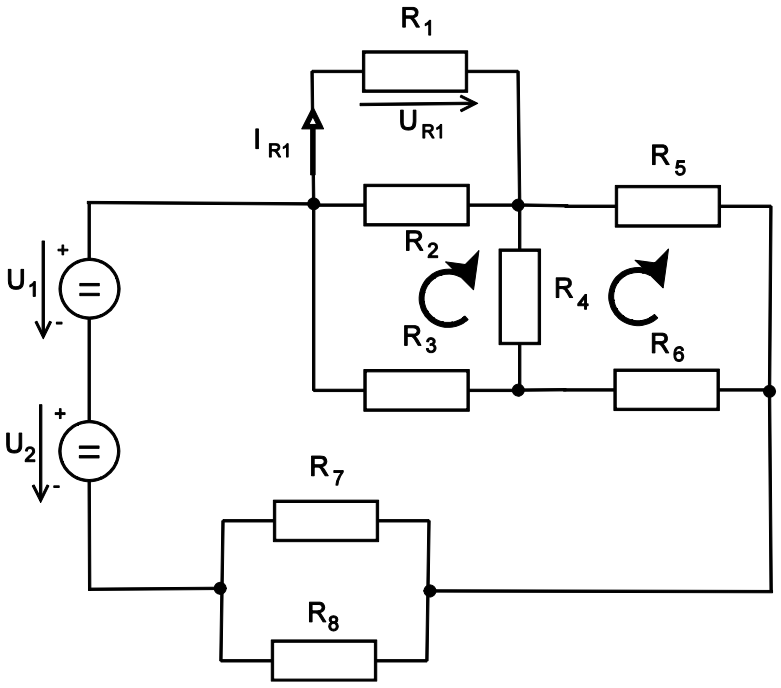
$U_{R5} = 0{,}2567 * 300$

$U_{R5} = 77{,}0100\, V$

$U_{R6} = I_{RC6} * R_6$

$U_{R6} = 0{,}0993 * 800$

$U_{R6} = 79{,}4400\, V$



1. II. k. z.

$U_{R5} - U_{R4} - U_{R6} = 0$

$-U_{R4} = U_{R6} - U_{R5}$

$U_{R4} = U_{R5} - U_{R6}$

$U_{R4} = 77{,}0100 - 79{,}4400$

$U_{R4} = -2{,}4300\, V$

$I_{R4} = \dfrac{U_{R4}}{R_4}$

$I_{R4} = \dfrac{2{,}4300}{250}$

$I_{R4} = 0{,}0097\, A$

2. I. k. z.

$I_{R3} + I_{R4} - I_{R6} = 0$

$I_{R3} = I_{R6} - I_{R4}$

$I_{R3} = 0{,}0993 - 0{,}0097$

$I_{R3} = 0{,}0896\, A$

3.

$U_{R3} = R_3 * I_3$

$U_{R3} = 550 * 0{,}0896$

$U_{R3} = 49{,}2800\, V$

4.

$U_{R12} + U_{R4} - U_{R3} = 0$

$$U_{R12} = U_{R3} - U_{R4}$$

$$U_{R12} = 49{,}2800 + 2{,}4300$$

$$U_{R12} = 51{,}7100\ V$$

$$\boldsymbol{U_{R1} = 57{,}71\ V}$$

$$I_{R1} = \frac{U_{R12}}{R_1}$$

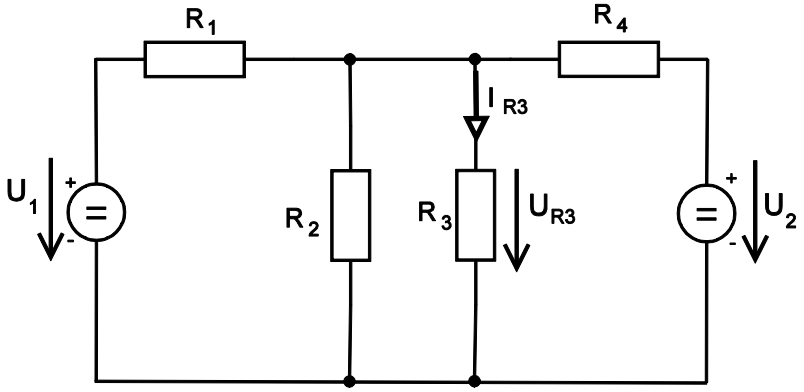
$$I_{R1} = \frac{51{,}7100}{510}$$

$$\boldsymbol{I_{R1} = 0{,}10\ A}$$

Úloha č. 2:

Stanovte napětí U_{R3} a proud I_{R3}. Použijte metodu Théveninovy věty.

sk.	U_1 [V]	U_2 [V]	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	R_4 [Ω]
H	220	190	360	580	205	560



$$R_{23} = \frac{R_1 * R_2}{R_1 + R_2}$$

$$R_{23} = \frac{360 * 580}{360 + 580}$$

$$R_{23} = 222{,}1277\ \Omega$$

$$I_{R23} = \frac{U_i}{R_i + R_{23}}$$

$U_i, R_i = ?$

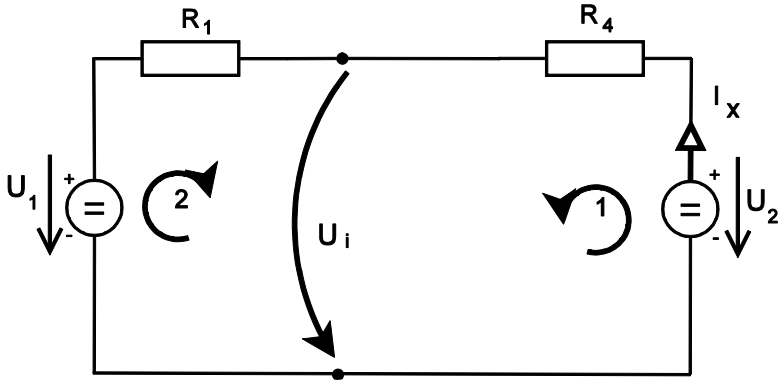
Náhradní napěťové zdroje zkratujeme:

$$R_{EKV} = R_i$$

$$R_i = \frac{R_1 * R_4}{R_1 + R_4}$$

$$R_i = \frac{360 * 560}{360 + 560}$$

$$R_i = 219{,}1304\ \Omega \doteq 219{,}13\ \Omega$$



Určíme I_x například z 2. k. z.:

1.

$$R_1 * I_x + R_4 * I_x + U_1 - U_2 = 0$$

$$I_x = \frac{U_2 - U_1}{R_1 + R_4}$$

$$I_x = \frac{190 - 220}{360 + 560}$$

$$I_x = -0{,}0326\ A$$

2. Smyčka s U_i:

$$-R_1 * I_x + U_i - U_1 = 0$$

$$U_i = U_1 + R_1 * I_x$$

$$U_i = 220 + 360 * (-0{,}0326)$$

$$U_i = 208{,}2640\ V$$

$$I_{R23} = \frac{U_i}{R_i + R_{23}}$$

$$I_{R23} = \frac{208{,}2640}{219{,}1304 + 222{,}1277}$$

$$I_{R23} = 0{,}4720\ A$$

$$U_{R23} = R_{23} * I_{R23}$$

$$U_{R23} = 222{,}1277 * 0{,}4720$$

$$U_{R23} = 104{,}8443\ V$$

$$\boldsymbol{U_{R3} = 104{,}8443\ V\ \doteq 104{,}84\ \mathrm{V}}$$

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

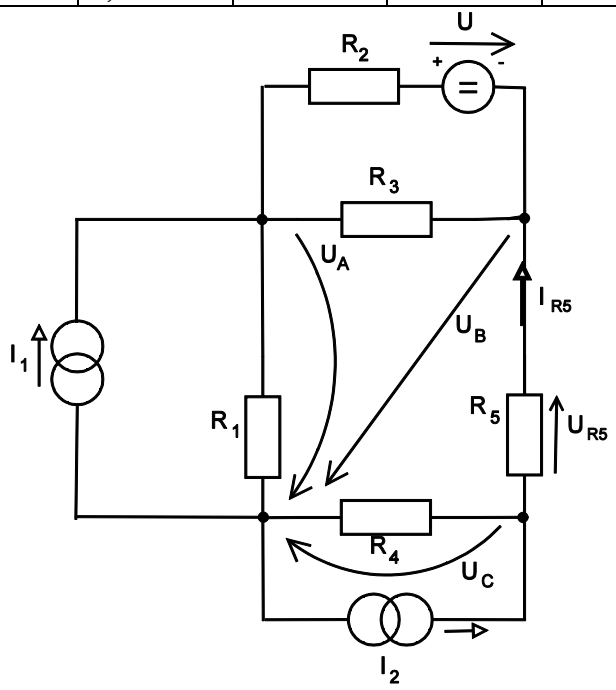
$$I_{R3} = \frac{104{,}8443}{205}$$

$$\boldsymbol{I_{R3} = 0{,}5114\ A\ \doteq 0{,}51\ A}$$

Úloha č. 3:

Stanovte napětí U_{R5} a proud I_{R5}. Použijte metodu uzlových napětí (U_A, U_B, U_C).

sk.	U [V]	I_1 [A]	I_2 [A]	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	R_4 [Ω]	R_5 [Ω]
B	150	0,7	0,8	49	45	61	34	34



A:

$I_1 + I_{R2} - I_{R1} - I_{R3} = 0$

B:

$I_{R3} + I_{R5} - I_{R2} = 0$

C:

$I_2 - I_{R4} - I_{R5} = 0$

$$I_{R1} = \frac{U_A}{R_1}$$

$$I_{R2} = \frac{U + U_B - U_A}{R_2}$$

$$I_{R3} = \frac{U_A - U_B}{R_3}$$

$$I_{R4} = \frac{U_C}{R_4}$$

$$I_{R5} = \frac{U_C - U_B}{R_5}$$

A:

$$I_1 + \frac{U + U_B - U_A}{R_2} - \frac{U_A}{R_1} - \left(\frac{U_A - U_B}{R_3}\right) = 0$$

B:

$$\frac{U_A - U_B}{R_3} + \frac{U_C - U_B}{R_5} - \left(\frac{U + U_B - U_A}{R_2}\right) = 0$$

C:

$$I_2 - \frac{U_C}{R_4} - \left(\frac{U_C - U_B}{R_5}\right) = 0$$

Číselně:

A:

$$0{,}7 + \frac{150 + U_B - U_A}{45} - \frac{U_A}{49} - \left(\frac{U_A - U_B}{61}\right) = 0$$

$$94153{,}5 + 2989 * (150 + U_B - U_A) - 2745 * U_A - 2205 * (U_A - U_B) = 0$$

$$94153{,}5 + 448350 + 2989 * U_B - 2989 * U_A - 2745 * U_A - 2205 * U_A + 2205 * U_B = 0$$

$$-7939 * U_A + 5194 * U_B = -542503{,}5$$

B:

$$\frac{U_A - U_B}{61} + \frac{U_C - U_B}{34} - \left(\frac{U + U_B - U_A}{45}\right) = 0$$

$$1530 * (U_A - U_B) + 2745 * (U_C - U_B) - 2074 * (150 + U_B - U_A) = 0$$

$$1530 * U_A - 1530 * U_B + 2745 * U_C - 2745 * U_B - 311100 - 2074 * U_B + 2074 * U_A = 0$$

$$3604 * U_A - 6349 * U_B + 2745 * U_C = 311100$$

C:

$$0{,}8 - \frac{U_C}{34} - \left(\frac{U_C - U_B}{34}\right) = 0$$

$$27{,}2 - U_C - U_C + U_B = 0$$

$$U_B - 2 * U_C = -27{,}2$$

Sestavíme si matici a řešíme úlohu pomocí Cramerova pravidla:

$$\left(\begin{array}{ccc|c} -7939 & 5194 & 0 & -542503{,}5 \\ 3604 & -6349 & 2745 & 311100 \\ 0 & 1 & -2 & -27{,}2 \end{array}\right)$$

$$D_V = \begin{vmatrix} -7939 & 5194 & 0 \\ 3604 & -6349 & 2745 \\ 0 & 1 & -2 \end{vmatrix}$$
$$= (-7939 * (-6349) * (-2)) + (3604 * 1 * 0) + (0 * 5194 * 2745) - \left(3604 * 5194 * (-2)\right)$$
$$- (-7939 * 1 * 2745) - (0 * (-6349) * 0) = -41578514{,}99999999 \doteq -41578515{,}0000$$

$$D_{U_A} = \begin{vmatrix} -542503{,}5 & 5194 & 0 \\ 311100 & -6349 & 2745 \\ -27{,}2 & 1 & -2 \end{vmatrix} = -2555635351{,}4999995 \doteq -2555635351{,}5000$$

$$D_{U_B} = \begin{vmatrix} -7939 & -542503{,}5 & 0 \\ 3604 & 311100 & 2745 \\ 0 & -27{,}2 & -2 \end{vmatrix} = 436523075{,}9999997 \doteq 436523076{,}0000$$

$$D_{U_C} = \begin{vmatrix} -7939 & 5194 & -542503{,}5 \\ 3604 & -6349 & 311100 \\ 0 & 1 & -27{,}2 \end{vmatrix} = -347206266{,}00000006 \doteq -347206266{,}0000$$

$$U_A = \frac{D_{U_A}}{D_V} = \frac{-2555635351{,}5000}{-41578515{,}0000} = 61{,}4653\ V$$

$$U_B = \frac{D_{U_B}}{D_V} = \frac{436523076{,}0000}{-41578515{,}0000} = -10{,}4988\ V$$

$$U_C = \frac{D_{U_C}}{D_V} = \frac{-347206266{,}0000}{-41578515{,}0000} = 8{,}3506\ V$$

$$U_{R5} = U_C - U_B$$

$$U_{R5} = 8{,}3506 - (-10{,}4988)$$

$$\boldsymbol{U_{R5} = 18{,}8494 \doteq 18{,}85\ V}$$

$$I_{R5} = \frac{U_{R5}}{R_5}$$

$$I_{R5} = \frac{18{,}8494}{34}$$

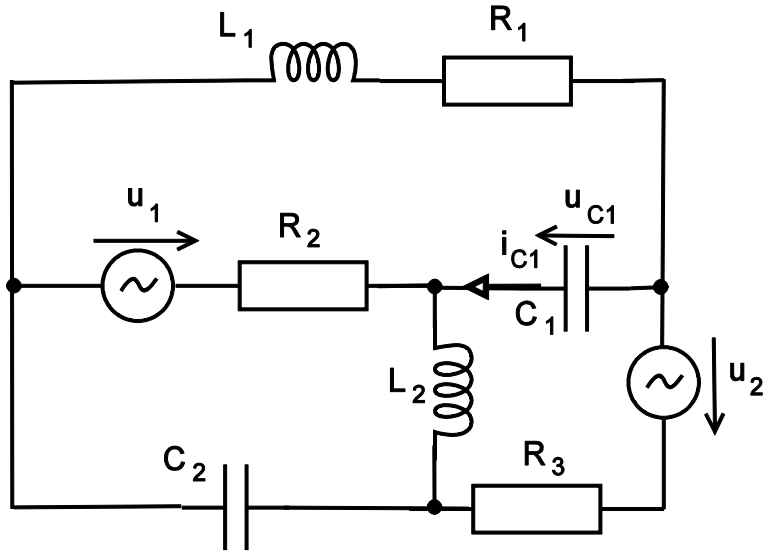
$$\boldsymbol{I_{R5} = 0{,}5544 \doteq 0{,}55\ A}$$

Úloha č. 4:

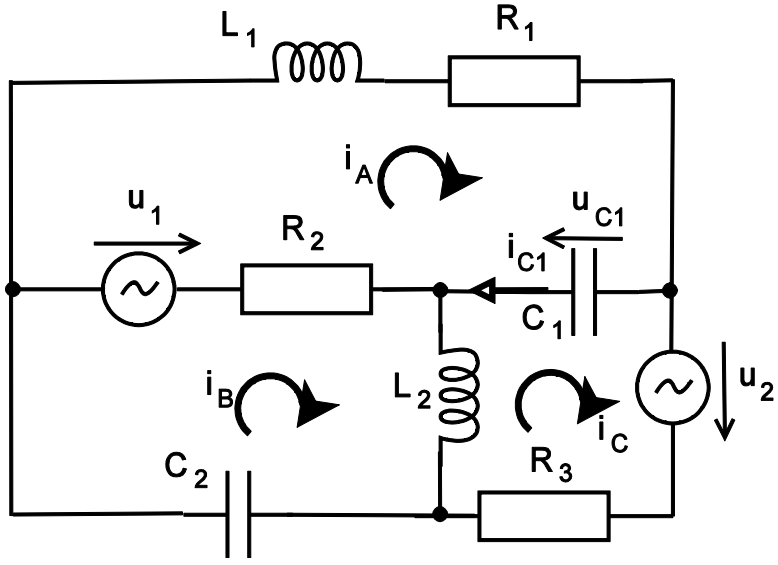
Pro napájecí napětí platí: $u_1 = U_1 * \sin(2\pi ft)$, $u_2 = U_2 * \sin(2\pi ft)$. Ve vztahu pro napětí $u_{C_1} = U_{C_1} * \sin(2\pi ft + \varphi_{C_1})$ určete $|U_{C_1}|$ a φ_{C_1}. Použijte metodu smyčkových proudů.

Pozn: Pomocné „směry šipek napájecích zdrojů platí pro speciální časový úsek ($t = \frac{\pi}{2\omega}$).“

sk.	U_1 [V]	U_2 [V]	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	L_1[mH]	L_2[mH]	C_1 [µF]	C_2 [µF]	f [Hz]
F	20	35	12	10	15	170	80	150	90	65



Zvolíme si směry smyčkových proudů:



Sestavíme a upravíme rovnice:

i_A: $Z_{L_1} * I_A + R_1 * I_A + Z_{C_1} * (I_A - I_C) + R_2 * (I_A - I_B) - U_1 = 0$

$Z_{L_1} * I_A + R_1 * I_A + Z_{C_1} * I_A - Z_{C_1} * I_C + R_2 * I_A - R_2 * I_B - U_1 = 0$

$I_A * (Z_{L_1} + R_1 + Z_{C_1} + R_2) + I_B * (-R_2) + I_C * (-Z_{C_1}) = U_1$

i_B: $R_2 * (I_B - I_A) + Z_{L_2} * (I_B - I_C) + Z_{C_2} * I_B + U_1 = 0$

$$R_2 * I_B - R_2 * I_A + Z_{L_2} * I_B - Z_{L_2} * I_C + Z_{C_2} * I_B + U_1 = 0$$

$$I_A * (-R_2) + I_B * \left(R_2 + Z_{L_2} + Z_{C_2}\right) + I_C * \left(-Z_{L_2}\right) = -U_1$$

$$i_C: Z_{C_1} * (I_C - I_A) + R_3 * I_C + Z_{L_2} * (I_C - I_B) + U_2 = 0$$

$$Z_{C_1} * I_C - Z_{C_1} * I_A + R_3 * I_C + Z_{L_2} * I_C - Z_{L_2} * I_B + U_2 = 0$$

$$I_A * \left(-Z_{C_1}\right) + I_B * \left(-Z_{L_2}\right) + I_C * \left(Z_{C_1} + R_3 + Z_{L_2}\right) = -U_2$$

sestavíme matici:

$$\begin{pmatrix} Z_{L_1} + R_1 + Z_{C_1} + R_2 & -R_2 & -Z_{C_1} \\ -R_2 & R_2 + Z_{L_2} + Z_{C_2} & -Z_{L_2} \\ -Z_{C_1} & -Z_{L_2} & Z_{C_1} + R_3 + Z_{L_2} \end{pmatrix} * \begin{pmatrix} I_A \\ I_B \\ I_C \end{pmatrix} = \begin{pmatrix} U_1 \\ -U_1 \\ -U_2 \end{pmatrix}$$

$$Z_{C_1} = -\frac{j}{\omega * C_1}$$

$$Z_{C_1} = -\frac{j}{2 * \pi * f * C_1}$$

$$Z_{C_1} = -\frac{j}{2 * \pi * 65 * 150 * 10^{-6}}$$

$$Z_{C_1} = -16{,}3236 * j\ \Omega$$

$$Z_{C_2} = -\frac{j}{\omega * C_2}$$

$$Z_{C_2} = -\frac{j}{2 * \pi * f * C_2}$$

$$Z_{C_2} = -\frac{j}{2 * \pi * 65 * 90 * 10^{-6}}$$

$$Z_{C_2} = -27{,}2060 * j\ \Omega$$

$$Z_{L_1} = j * \omega * L_1$$

$$Z_{L_1} = j * 2 * \pi * f * L_1$$

$$Z_{L_1} = j * 2 * \pi * 65 * 170 * 10^{-3}$$

$$Z_{L_1} = 69{,}4292 * j\ \Omega$$

$$Z_{L_2} = j * \omega * L_2$$

$$Z_{L_2} = j * 2 * \pi * f * L_2$$

$$Z_{L_2} = j * 2 * \pi * 65 * 80 * 10^{-3}$$

$$Z_{L_2} = 32{,}6726 * j\ \Omega$$

číselně dosadíme do matice a řešíme pomocí Cramerova pravidla:

$$\begin{pmatrix} 69{,}4292j + 12 - 16{,}3236j + 10 & -10 & 16{,}3236j \\ -10 & 10 + 32{,}6726j - 27{,}2060j & -32{,}6726j \\ 16{,}3236j & -32{,}6726j & -16{,}3236j + 15 + 32{,}6726j \end{pmatrix} * \begin{pmatrix} I_A \\ I_B \\ I_C \end{pmatrix} = \begin{pmatrix} 20 \\ -20 \\ -35 \end{pmatrix}$$

$$\begin{pmatrix} 22 + 53{,}1056j & -10 & 16{,}3236j \\ -10 & 10 + 5{,}4666j & -32{,}6726j \\ 16{,}3236j & -32{,}6726j & 15 + 16{,}3490j \end{pmatrix} * \begin{pmatrix} I_A \\ I_B \\ I_C \end{pmatrix} = \begin{pmatrix} 20 \\ -20 \\ -35 \end{pmatrix}$$

$$\left(\begin{array}{ccc|c} 22 + 53{,}1056j & -10 & 16{,}3236j & 20 \\ -10 & 10 + 5{,}4666j & -32{,}6726j & -20 \\ 16{,}3236j & -32{,}6726j & 15 + 16{,}3490j & -35 \end{array}\right)$$

$$D_V = \begin{vmatrix} 22 + 53{,}1056j & -10 & 16{,}3236j \\ -10 & 10 + 5{,}4666j & -32{,}6726j \\ 16{,}3236j & -32{,}6726j & 15 + 16{,}3490j \end{vmatrix} = 2279{,}8271 + 65132{,}2612j$$

$$D_{I_A} = \begin{vmatrix} 20 & -10 & 16{,}3236j \\ -20 & 10 + 5{,}4666j & -32{,}6726j \\ -35 & -32{,}6726j & 15 + 16{,}3490j \end{vmatrix} = 5772{,}6072 - 4082{,}1700j$$

$$D_{I_B} = \begin{vmatrix} 22 + 53{,}1056j & 20 & 16{,}3236j \\ -10 & -20 & -32{,}6726j \\ 16{,}3236j & -35 & 15 + 16{,}3490j \end{vmatrix} = 79830{,}3907 - 39300{,}0820j$$

$$D_{I_C} = \begin{vmatrix} 22 + 53{,}1056j & -10 & 20 \\ -10 & 10 + 5{,}4666j & -20 \\ 16{,}3236j & -32{,}6726j & -35 \end{vmatrix} = 42447{,}3999 - 30637{,}6660j$$

$$I_A = \frac{D_{I_A}}{D_V} = \frac{5772{,}6072 - 4082{,}1700j}{2279{,}8271 + 65132{,}2612j} = \frac{5772{,}6072 - 4082{,}1700j}{2279{,}8271 + 65132{,}2612j} * \frac{2279{,}8271 - 65132{,}2612j}{2279{,}8271 - 65132{,}2612j}$$

$$= \frac{5772{,}6072 * 2279{,}8271 - 5772{,}6072 * 65132{,}2612j - 4082{,}1700j * 2279{,}8271 - 4082{,}1700j * (-65132{,}2612j)}{2279{,}8271^2 + 65132{,}2612^2}$$

$$= -0{,}0595 - 0{,}0907j\ A$$

$$I_B = \frac{D_{I_B}}{D_V} = \frac{79830{,}3907 - 39300{,}0820j}{2279{,}8271 + 65132{,}2612j} = -0{,}5598 - 1{,}2453j\ A$$

$$I_C = \frac{D_{I_C}}{D_V} = \frac{42447{,}3999 - 30637{,}6660j}{2279{,}8271 + 65132{,}2612j} = -0{,}4470 - 0{,}6674j\ A$$

$$i_{C_1} = I_A - I_B$$

$$i_{C_1} = -0{,}0595 - 0{,}0907j - (-0{,}5598 - 1{,}2453j)$$

$$i_{C_1} = 0{,}5003 + 1{,}1546j\ A$$

$$U_{C_1} = i_{C_1} * Z_{C_1}$$

$$U_{C_1} = (0{,}5003 + 1{,}1546j) * (-16{,}3236j)$$

$$U_{C_1} = (0{,}5003 + 1{,}1546j) * (-16{,}3236j)$$

$U_{C_1} = 18{,}8472 - 8{,}1667j\ V$

$\left|U_{C_1}\right| = \sqrt[2]{18{,}8472^2 + (-8{,}1667)^2}$

$\boldsymbol{\left|U_{C_1}\right| = 20{,}5405 \doteq 20{,}54\ V}$

$\varphi_{C_1} = \arctan\frac{Im}{Re}$

$\varphi_{C_1} = \arctan\frac{-8{,}1667}{18{,}8472}$

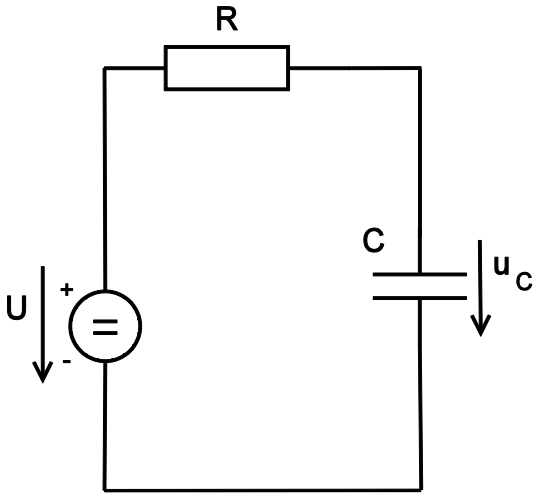
$\varphi_{C_1} = \arctan(-0{,}433311048)$

$\boldsymbol{\varphi_{C_1} = -23{,}4276178° \doteq\ -23{,}43°}$

Úloha č. 5:

Sestavte diferenciální rovnici popisující chování obvodu na obrázku, dále ji upravte dosazením hodnot parametrů. Vypočítejte analytické řešení $u_C = f(t)$. Proveďte kontrolu výpočtu dosazením do sestavené diferenciální rovnice.

sk.	U [V]	C [F]	R [Ω]	$u_c(0)$ [V]
H	5	50	40	2



hledáme:

$u_c = f(t)$??

POPIS ROVNICEMI:

1) Ohmův zakon

$$i = \frac{u_R}{R}$$

2) II. kirch. zákon

$$u_R + u_c - U = 0$$

3)

$$u_c' = \frac{i}{C}$$

$$u_c(0) = 2\ V$$

---

dosazení 1) do 3)

$$u_c' = \frac{\frac{u_R}{R}}{C} = \frac{u_R}{R * C}$$

dosazení u_R z druhé rovnice:

$$u_R = U - u_c$$

$$u_c' = \frac{U - u_c}{R * C}$$

dif. rovnice 1. řádu:

$$u_c' + \frac{u_c}{R * C} = \frac{U}{R * C}$$

dosazení hodnot:

$$u_c' + \frac{u_c}{40 * 50} = \frac{5}{40 * 50}$$

$$u_c' + \frac{u_c}{2000} = \frac{5}{2000}$$

$$u_c' + \frac{u_c}{2000} = \frac{1}{400}$$

očekávané řešení rovnice:

$$u_c(t) = K(t) * e^{\lambda t}$$

$$u_c(t) = K(t) * e^{-\frac{t}{RC}}$$

řešení charakteristické rovnice:

$$\lambda + \frac{1}{R * C} = 0$$

$$\lambda = -\frac{1}{R * C}$$

$$\lambda = -\frac{1}{40 * 50}$$

$$\lambda = -\frac{1}{2000}$$

dosazení do očekávaného řešení rovnice:

$$u_c(t) = K(t) * e^{-\frac{1}{2000} * t}$$

derivace u_c:

$$u_c' = K'(t) * e^{-\frac{t}{2000}} + K(t)\left(-\frac{1}{2000}\right) * e^{-\frac{t}{2000}}$$

dosazení u_c a u_c' do diferenciální rovnice:

$$u_c' + \frac{u_c}{R * C} = \frac{U}{R * C}$$

$$u_c' + \frac{u_c}{2000} = \frac{1}{400}$$

$$K'(t) * e^{-\frac{t}{2000}} + K(t)\left(-\frac{1}{2000}\right) * e^{-\frac{t}{2000}} + \frac{K(t) * e^{-\frac{1}{2000} * t}}{2000} = \frac{1}{400}$$

$$K'(t) * e^{-\frac{t}{2000}} = \frac{1}{400}$$

$$K'(t) = \frac{1}{400} * e^{\frac{t}{2000}}$$

zintegrujeme:

$$K(t) = \frac{1}{400}\int e^{\frac{t}{2000}}\, dt$$

$$K(t) = \frac{\frac{1}{400}}{\frac{1}{2000}} * e^{\frac{1}{2000} * t} + k$$

$K(t) = 5 * e^{\frac{1}{2000}*t} + k$

dosazení do očekávaného řešeni:

$u_c(t) = (5 * e^{\frac{1}{2000}*t} + k) * e^{-\frac{1}{2000}*t}$

$u_c(t) = (5 * e^{\frac{1}{2000}*t} + k) * e^{-\frac{1}{2000}*t}$

$u_c(t) = (5 * e^{\frac{1}{2000}*t} * e^{-\frac{1}{2000}*t}) + k * e^{-\frac{1}{2000}*t}$

$u_c(t) = 5 + k * e^{-\frac{1}{2000}*t}$

dosazení počáteční podmínky:

$u_c(0) = 2\ V$

$2 = 5 + k * e^{-\frac{1}{2000}*0}$

$u_c(0) = U + k$

$2 = 5 + k$

$k = -3$

$\boldsymbol{u_c(t) = 5 - 3 * k * e^{-\frac{1}{2000}*t}}$

Kontrola pro $t = 0$

$u_c(0) = 5 - 3 * k * e^{-\frac{1}{2000}*0}$

$u_c(0) = 2\ V$

Kontrola pro $t \to +\infty$

$u_c(+\infty) = 5 - 3 * k * e^{-\infty}$

$5\ V = 5\ V$

Závěr

Úloha č. 1:

sk.	U_1 [V]	U_2 [V]	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	R_4 [Ω]	R_5 [Ω]	R_6 [Ω]	R_7 [Ω]	R_8 [Ω]
F	125	65	510	500	550	250	300	800	330	250

$$\boldsymbol{U_{R1} = 57,71\ V}$$

$$\boldsymbol{I_{R1} = 0,10\ A}$$

Úloha č. 2:

sk.	U_1 [V]	U_2 [V]	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	R_4 [Ω]
H	220	190	360	580	205	560

$$\boldsymbol{U_{R3} = 104,84\ V}$$

$$\boldsymbol{I_{R3} = 0,51\ A}$$

Úloha č. 3:

sk.	U [V]	I_1 [A]	I_2 [A]	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	R_4 [Ω]	R_5 [Ω]
B	150	0,7	0,8	49	45	61	34	34

$$\boldsymbol{U_{R5} = 18,85\ V}$$

$$\boldsymbol{I_{R5} = 0,55\ A}$$

Úloha č. 4:

sk.	U_1 [V]	U_2 [V]	R_1 [Ω]	R_2 [Ω]	R_3 [Ω]	L_1[mH]	L_2[mH]	C_1 [µF]	C_2 [µF]	f [Hz]
F	20	35	12	10	15	170	80	150	90	65

$$\boldsymbol{|U_{C_1}| = 20,54\ V}$$

$$\boldsymbol{\varphi_{C_1} = -23,43°}$$

Úloha č. 5:

sk.	U [V]	C [F]	R [Ω]	$u_c(0)$ [V]
H	5	50	40	2

$$\boldsymbol{u_c(t) = 5 - 3 * k * e^{-\frac{1}{2000} * t}}$$