

VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ

FAKULTA INFORMAČNÍCH TECHNOLOGIÍ

**Semestrální projekt do IEL  
2016/2017**

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# 1 Úloha 1

## 1.1 Zadání

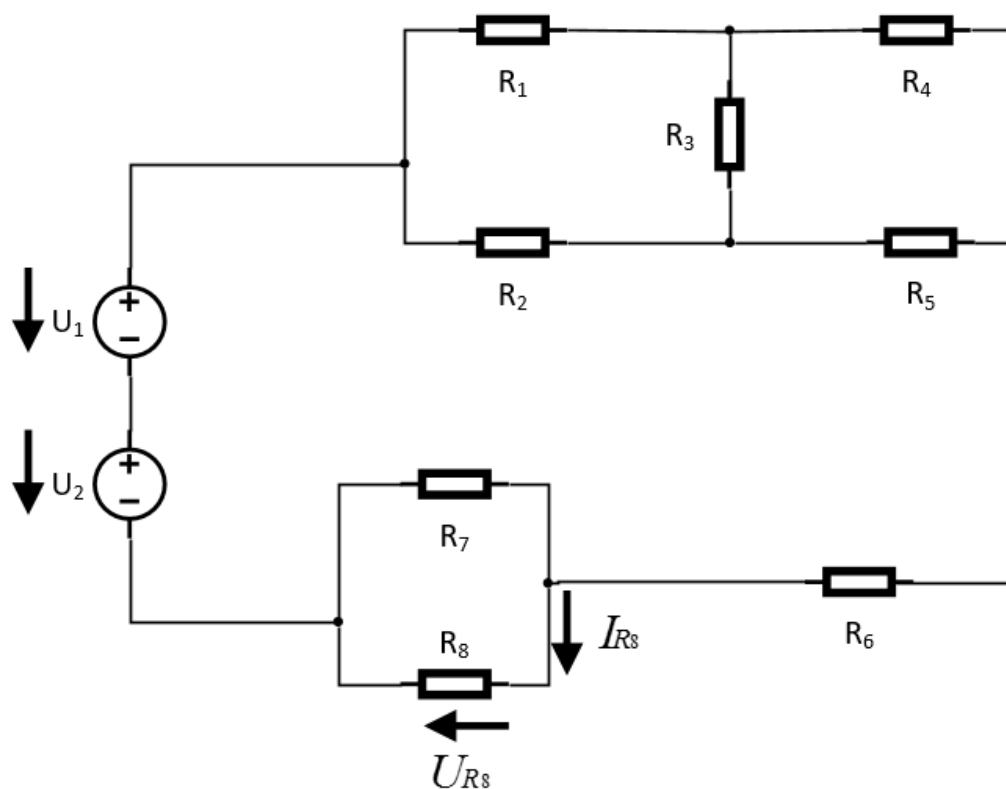
Stanovte napětí  $U_{R_8}$  a proud  $I_{R_8}$ . Použijte metodu postupného zjednodušování obvodu.

## 1.2 Tabulka hodnot

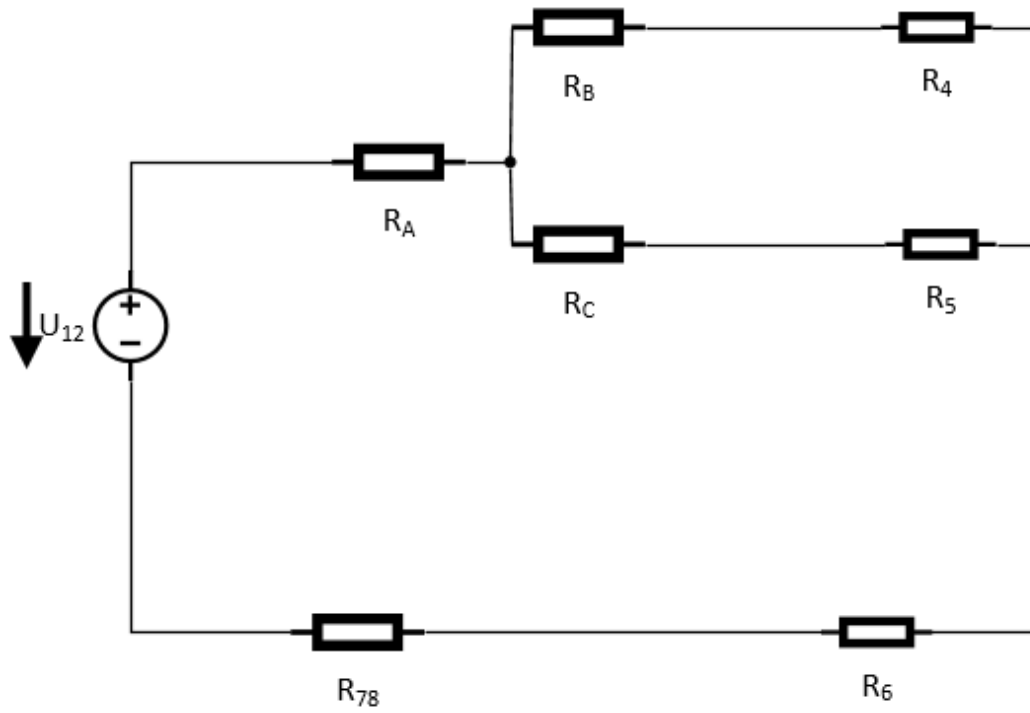
sk.	$U_1[V]$	$U_2[V]$	$R_1[\Omega]$	$R_2[\Omega]$	$R_3[\Omega]$	$R_4[\Omega]$	$R_5[\Omega]$	$R_6[\Omega]$	$R_7[\Omega]$	$R_8[\Omega]$
H	135	80	680	600	260	310	575	870	355	265

## 1.3 Postup

### 1.3.1



### 1.3.2



$$U_{12} = U_1 + U_2 = 215 \text{ [V]}$$

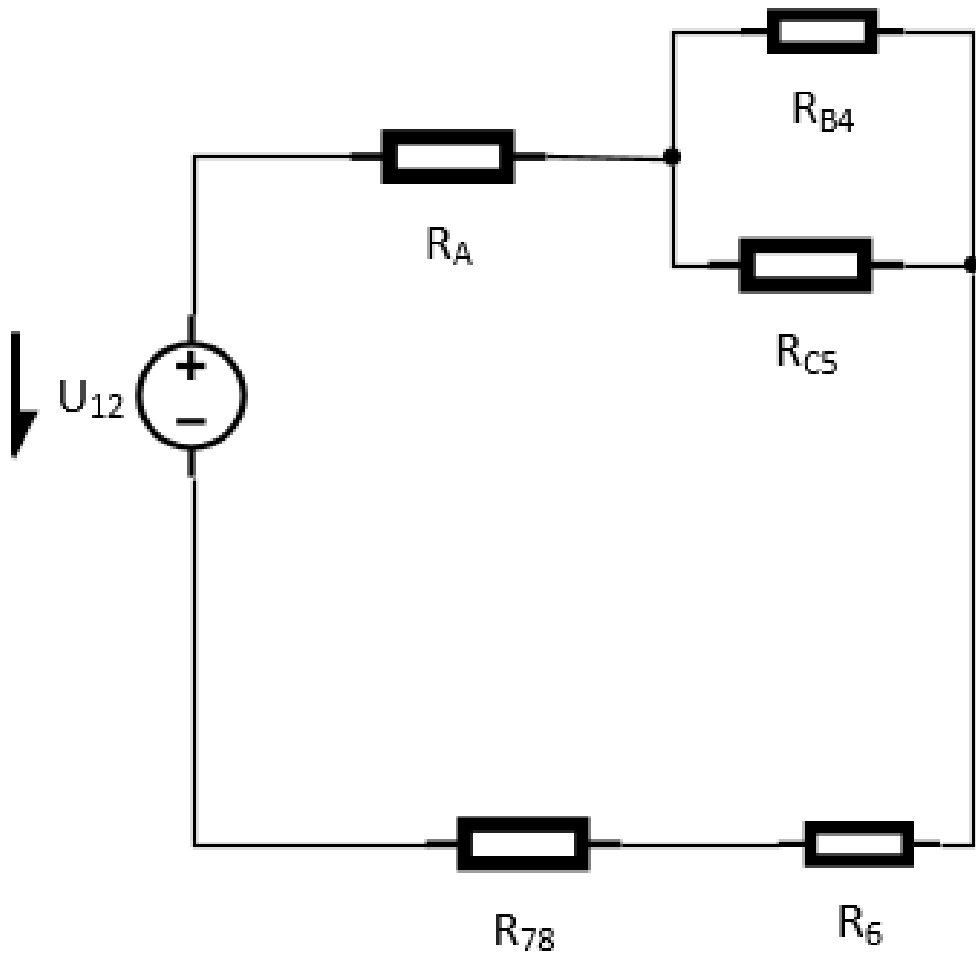
$$R_A = \frac{R_1 \times R_2}{R_1 + R_2 + R_3} = 264,9351 \text{ } [\Omega]$$

$$R_B = \frac{R_1 \times R_3}{R_1 + R_2 + R_3} = 114,8052 \text{ } [\Omega]$$

$$R_C = \frac{R_2 \times R_3}{R_1 + R_2 + R_3} = 101,2987 \text{ } [\Omega]$$

$$R_{78} = \frac{R_7 \times R_8}{R_7 + R_8} = 151,7339 \text{ } [\Omega]$$

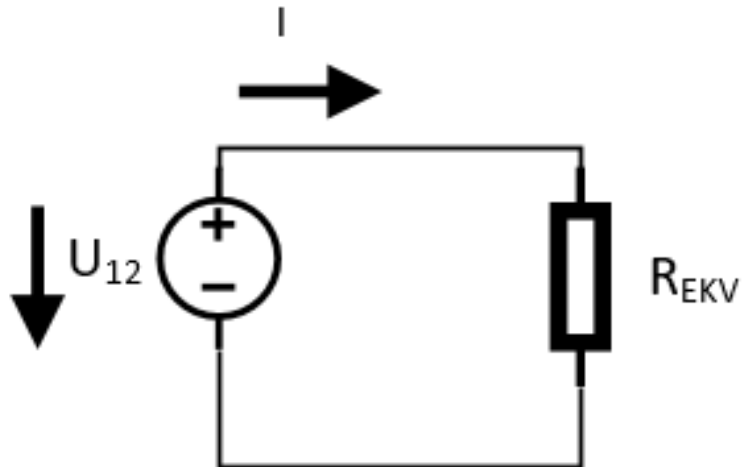
### 1.3.3



$$R_{B4} = R_B + R_4 = 4524,8052 \, [\Omega]$$

$$R_{C5} = R_C + R_5 = 676,2987 \, [\Omega]$$

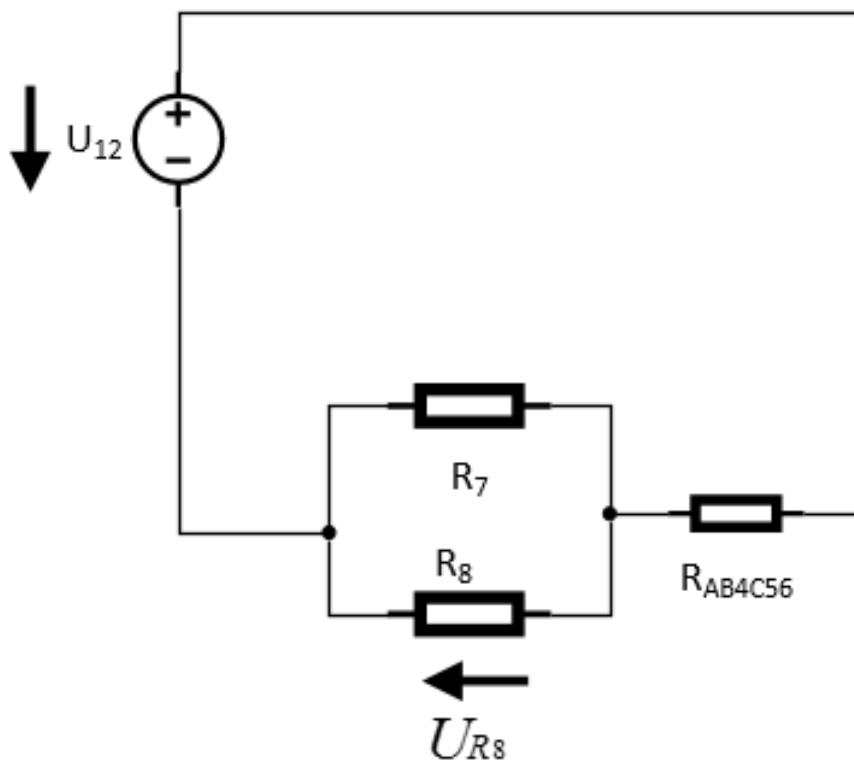
### 1.3.4



$$R_{EKV} = R_A + \frac{R_{B4} \times R_{C5}}{R_{B4} + R_{C5}} + R_6 + R_{78} = 1547,5846 \text{ } [\Omega]$$

$$I = \frac{U_{12}}{R_{EKV}} = 0,1389 \text{ } [A]$$

### 1.3.5



$$U_{78} = I \times R_{78} = 21,0758 \text{ } [V]$$

$$U_{78} = U_{R_7} = U_{R_8}$$

$$I_{R_8} = \frac{U_{R_8}}{R_8} = 0.0795 \text{ [A]}$$

## 2 Úloha 2

### 2.1 Zadání

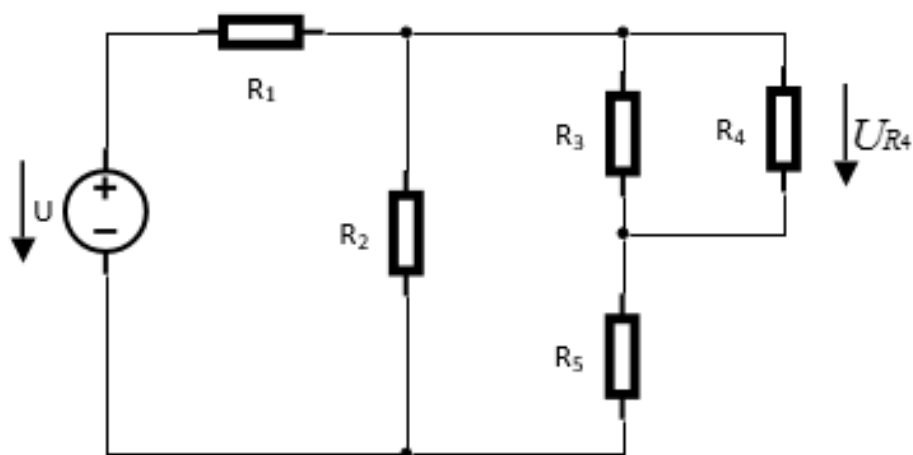
Stanovte napětí  $U_{R_4}$  a proud  $I_{R_4}$ . Použijte metodu Théveninovy věty.

### 2.2 Tabulka hodnot

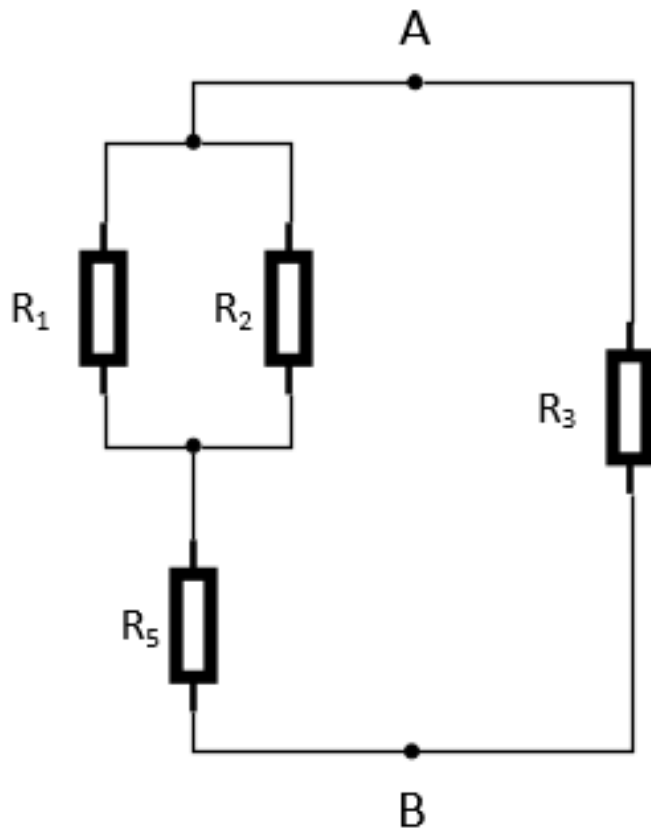
sk.	$U[V]$	$R_1[\Omega]$	$R_2[\Omega]$	$R_3[\Omega]$	$R_4[\Omega]$	$R_5[\Omega]$
D	150	200	660	200	550	330

### 2.3 Postup

#### 2.3.1

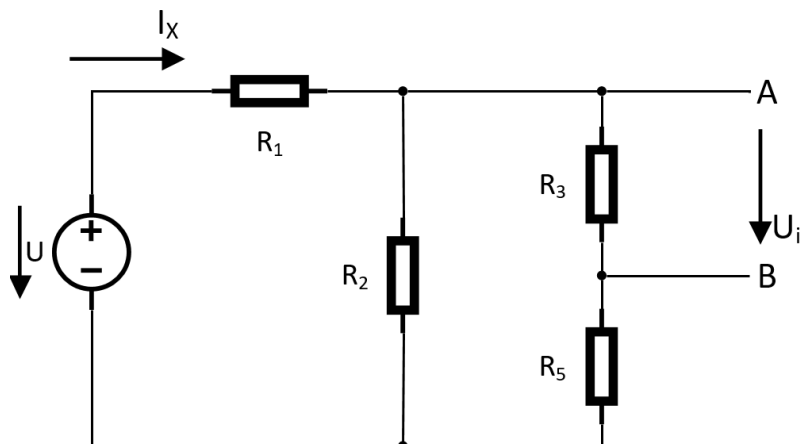


### 2.3.2



$$R_i = \frac{\left(\frac{R_1 \times R_2}{R_1 + R_2} + R_5\right) \times R_3}{\left(\frac{R_1 \times R_2}{R_1 + R_2} + R_5\right) + R_3} = 141,4767 \text{ } [\Omega]$$

### 2.3.3



$$R_{EKV} = R_1 + \frac{R_2 \times (R_3 + R_5)}{R_2 + R_3 + R_5} = 493,9496 \text{ } [\Omega]$$

$$I_X = \frac{U}{R_{EKV}} = 0,3037 \text{ } [A]$$

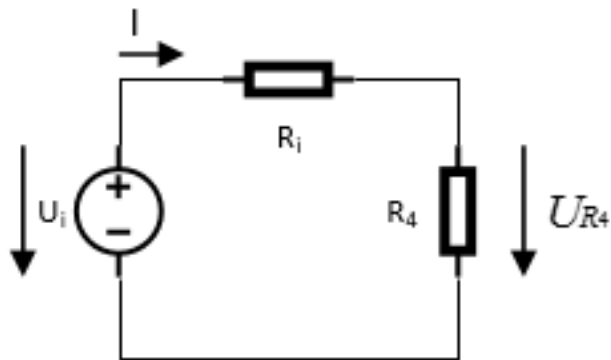


$$I_{R_2} = \frac{U - (I_X \times R_1)}{R_2} = 0,1488 \text{ [A]}$$

$$I_{R_{35}} = I_X - I_{R_2} = 0,1549 \text{ [A]}$$

$$U_i = U_{R_3} = I_{R_{35}} \times R_3 = 30,98 \text{ [V]}$$

#### 2.3.4



$$I = \frac{U_i}{R_i + R_4} = 0,0448 \text{ [A]}$$

$$U_{R_4} = I \times R_4 = 24,64 \text{ [V]}$$

$$I_{R_4} = \frac{U_{R_4}}{R_4} = 0,0448 \text{ [A]}$$

## 3 Úloha 3

### 3.1 Zadání

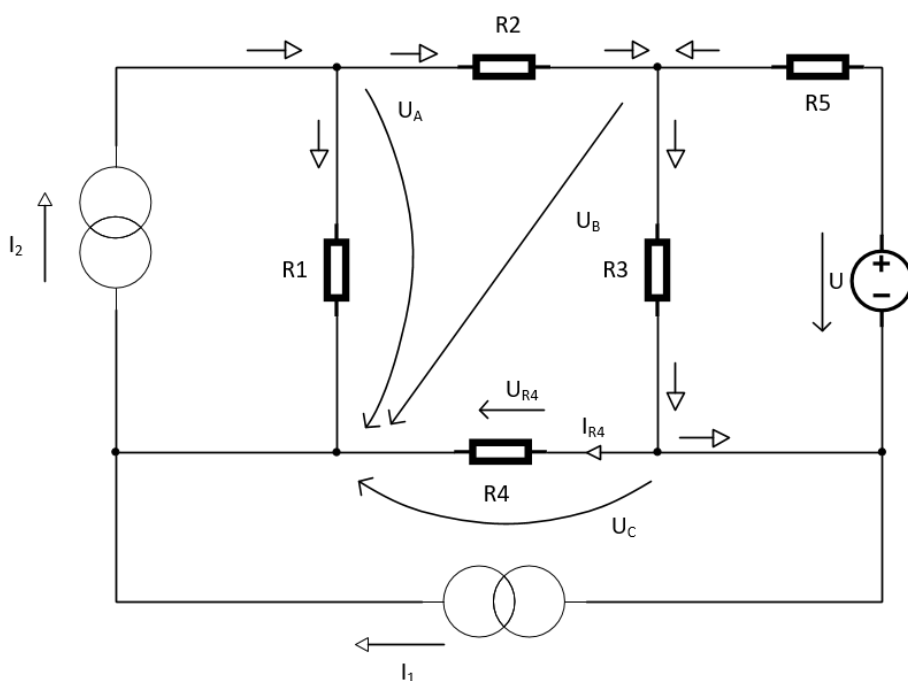
Stanovte napětí  $U_{R_4}$  a proud  $I_{R_4}$ . Použijte metodu uzlových napětí ( $U_A$ ,  $U_B$ ,  $U_C$ ).

### 3.2 Tabulka hodnot

sk.	$U[V]$	$I_1[A]$	$I_2[A]$	$R_1[\Omega]$	$R_2[\Omega]$	$R_3[\Omega]$	$R_4[\Omega]$	$R_5[\Omega]$
A	120	0,9	0,7	53	49	65	39	32

### 3.3 Postup

#### 3.3.1



$$\mathbf{A} : I_2 - \frac{U_A}{R_1} - \frac{U_A - U_B}{R_2} = 0$$

$$\mathbf{B} : \frac{U_A - U_B}{R_2} + \frac{U - U_B + U_C}{R_5} - \frac{U_B - U_C}{R_3} = 0$$

$$\mathbf{C} : -\frac{U_C}{R_4} + \frac{U_B - U_C}{R_3} - \frac{U - U_B + U_C}{R_5} - I_1 = 0$$

### 3.3.2

$$\mathbf{A} : I_2 \times R_1 \times R_2 - U_A \times R_2 - U_A \times R_1 + U_B \times R_1 = 0$$

$$\mathbf{B} : U_A \times R_5 \times R_3 - U_B \times R_5 \times R_3 - U \times R_2 \times R_3 - U_B \times R_2 \times R_3 + U_C \times R_2 \times R_3 - U_B \times R_2 \times R_5 + U_C \times R_2 \times R_5 + 1 + 2 + 3 + 4 + 5 = 0$$

$$\mathbf{C} : -U_C \times R_3 \times R_5 + U_B \times R_4 \times R_5 - U_C \times R_5 \times R_4 - U \times R_4 \times R_3 - U_C \times R_4 \times R_3 - I_1 \times R_4 \times R_3 \times R_5 = 0$$

$$\mathbf{A} : U_A \times (-R_2 - R_1) + U_B \times R_1 + 0 \times U_C = -I_2 \times R_1 \times R_2$$

$$\mathbf{B} : U_A \times (R_5 \times R_3) + U_B \times (-R_5 \times R_3 - R_2 \times R_3 - R_2 \times R_5) + U_C \times (R_2 \times R_3 + R_2 \times R_5) = -U \times R_2 \times R_3$$

$$\mathbf{C} : 0 \times R_A + U_B \times (R_4 \times R_5 + R_4 \times R_3) + U_C \times (-R_3 \times R_5 - R_4 \times R_5 - R_4 \times R_3) = U \times R_4 \times R_3 + I_1 \times R_4 \times R_3 \times R_5$$

$$M_0 = \begin{pmatrix} -102 & 53 & 0 \\ 2080 & -6833 & 4753 \\ 0 & 3783 & -5863 \end{pmatrix}$$

$$M_0 = [(-102) \times (-6833) \times (-5863) + 2080 \times 3783 \times 0 + 0 \times 53 \times 4753] - [(-6833) \times 0 \times 0 + 4753 \times 3783 \times (-102) + (-5863) \times 53 \times 2080] = -\mathbf{1605953440}$$

$$M_1 = \begin{pmatrix} -102 & 53 & -1817, 9 \\ 2080 & -6833 & -382200 \\ 0 & 3783 & 377208 \end{pmatrix}$$

$$M_1 = [(-102) \times (-6833) \times 377208 + 2080 \times 3783 \times (-1817, 9) + 0 \times 53 \times (-382200)] - [(-6833) \times 0 \times (-1817, 9) + (-382200) \times 3783 \times (-102) + 377208 \times 53 \times 2080] = \mathbf{59535355152}$$

$$U_{R_4} = U_C = \frac{\det(M_1)}{\det(M_0)} = -37,0717 \text{ [V]}$$

$$I_{R_4} = \frac{U_{R_4}}{R_4} = -0,9506 \text{ [A]}$$

## 4 Úloha 4

### 4.1 Zadání

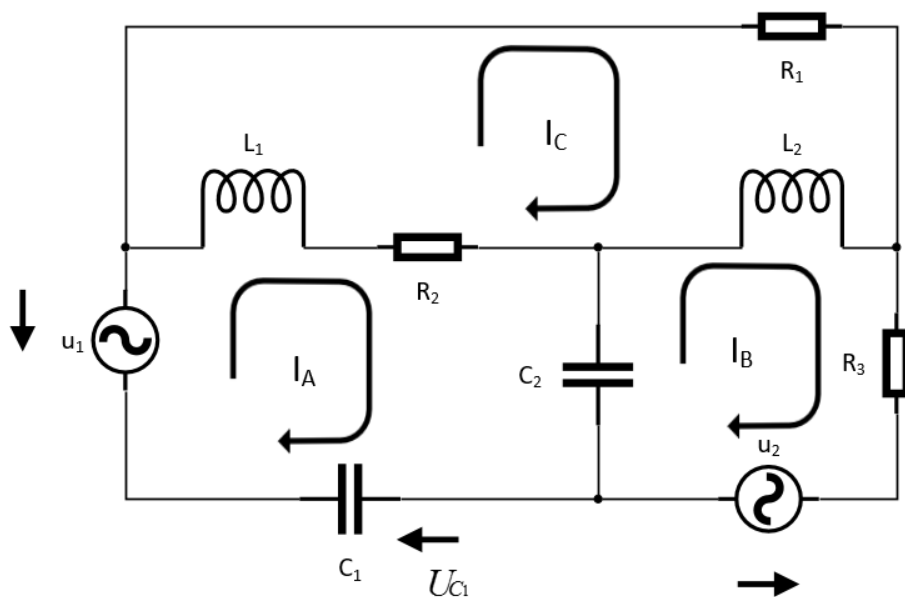
Pro napájecí napětí platí:  $u_1 = U_1 \times \sin(2\pi ft)$ ,  $u_2 = U_2 \times \sin(2\pi ft)$ . Ve vztahu pro napětí  $u_{C_1} = U_{C_1} \times \sin(2\pi ft)$  určete  $|U_{C_1}|$  a  $\varphi_{C_1}$ . Použijte metodu smyčkových proudů.

### 4.2 Tabulka hodnot

sk.	$U_1$ [V]	$U_2$ [V]	$R_1$ [ $\Omega$ ]	$R_2$ [ $\Omega$ ]	$R_3$ [ $\Omega$ ]	$L_1$ [mH]	$L_2$ [mH]	$C_1$ [ $\mu$ F]	$C_2$ [ $\mu$ F]	$f$ [Hz]
H	65	60	10	10	12	160	75	155	70	95

### 4.3 Postup

#### 4.3.1



$$X_{R_1} = R_1 = 10 \text{ } [\Omega]$$

$$X_{R_2} = R_2 = 10 \text{ } [\Omega]$$

$$X_{R_3} = R_3 = 12 \text{ } [\Omega]$$

$$\omega = 2\pi f = 596,9026 \text{ } \left[\frac{\text{rad}}{\text{s}}\right]$$

$$X_{L_1} = j\omega L_1 = j95,504 \text{ } [\Omega]$$

$$X_{L_2} = j\omega L_2 = j44,7677 \text{ } [\Omega]$$

$$X_{C_1} = \frac{1}{j\omega C_1} = -j12,8351 \text{ } [\Omega]$$

$$X_{C_2} = \frac{1}{j\omega C_2} = -j28,4205 \text{ } [\Omega]$$

$$\begin{aligned}
\mathbf{I_A} : X_{L_1} \times (I_A - I_C) + X_{R_2} \times (I_A - I_C) + X_{C_2} \times (I_A - I_B) + X_{C_1} \times I_A - U_1 &= 0 \\
\mathbf{I_B} : X_{L_2} \times (I_B - I_C) + X_{R_3} \times I_B - U_2 + X_{C_2} \times (I_B - I_A) &= 0 \\
\mathbf{I_C} : X_{R_1} \times I_C + X_{L_2} \times (I_C - I_B) + X_{R_2} \times (I_C - I_A) + X_{L_1} \times (I_C - I_A) &= 0 \\
\mathbf{I_A} : I_A \times (X_{L_1} + X_{R_2} + X_{C_2} + X_{C_1}) - I_B \times X_{C_2} + I_C \times (-X_{L_1} - X_{R_2}) &= U_1 \\
\mathbf{I_B} : -I_A \times X_{C_2} + I_B \times (X_{L_2} + X_{R_3} + X_{C_2}) - I_C \times X_{L_2} &= U_2 \\
\mathbf{I_C} : I_A \times (-X_{R_2} - X_{L_1}) - I_B \times X_{L_2} + I_C \times (X_{R_1} + X_{L_2} + X_{R_2} + X_{L_1}) &= 0 \\
\mathbf{I_A} : I_A \times (10 + j54, 2484) + I_B \times (j28, 4205) + I_C \times (-10 - j95, 504) &= 65 \\
\mathbf{I_B} : I_A \times (j28, 4205) + I_B \times (12 + j16, 3472) + I_C \times (-j44, 7677) &= 60 \\
\mathbf{I_C} : I_A \times (-10 - j95, 504) + I_B \times (-j44, 7677) + I_C \times (20 + j140, 2717) &= 0
\end{aligned}$$

$$M_0 = \begin{pmatrix} 10 + j54, 2484 & j28, 4205 & -10 - j95, 504 \\ j28, 4205 & 12 + j16, 3472 & -j44, 7677 \\ -10 - j95, 504 & -j44, 7677 & 20 + j140, 2717 \end{pmatrix}$$

$$M_0 = \begin{pmatrix} 65 & j28, 4205 & -10 - j95, 504 \\ 60 & 12 + j16, 3472 & -j44, 7677 \\ 0 & -j44, 7677 & 20 + j140, 2717 \end{pmatrix}$$

$$I_A = \frac{\det(M_1)}{\det(M_0)} = 137.936 - j53.7687 [A]$$

$$U_{C_1} = I_A \times X_{C_1} = 148, 045 [V]$$

$$\varphi_{C_1} = -21, 2963 [^\circ C]$$

## 5 Úloha 5

### 5.1 Zadání

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

### 5.2 Tabulka hodnot

sk.	$U[V]$	$L[H]$	$R[\Omega]$	$i_L(0)[A]$
D	5	50	40	2

### 5.3 Postup

#### 5.3.1

TODO

#### 5.3.2

TODO

#### 5.3.3

TODO

## 6 Výsledná tabulka

Úloha	Výsledek
1	$U_{R8} = 21,0758 [V]$ $I_{R8} = 0,0795 [A]$
2	$U_{R4} = 24,64 [V]$ $I_{R4} = 0,0448 [A]$
3	$U_{R4} = -37,0717 [V]$ $I_{R4} = -0,9506 [A]$
4	$ U_{C1}  = 148,045 [V]$ $\varphi_{C1} = -21,2963 [^\circ C]$
5	TODO