VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ
Fakulta informačních technologií

ITO- TEORIA OBVODOV
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Skupiny

1A 2E 3H 4A 5E 6H

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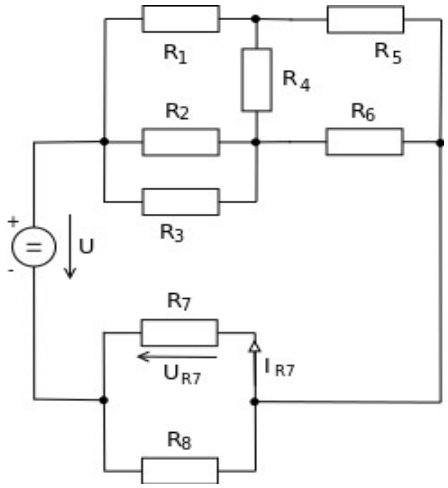
Úloha č.1

U [V]	R1 [Ω]	R2 [Ω]	R3 [Ω]	R4 [Ω]	R5 [Ω]	R6 [Ω]	R7 [Ω]	R8 [Ω]
80	350	650	410	130	360	750	310	190

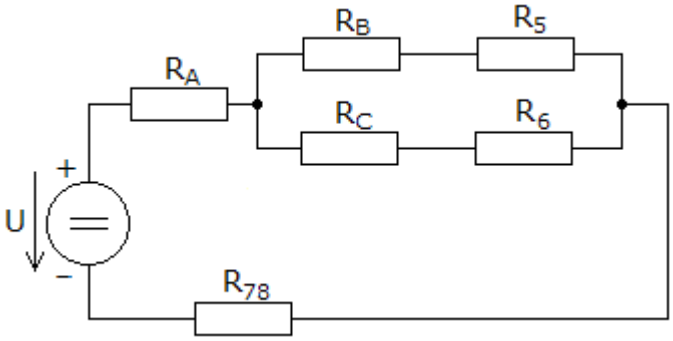
$$R_{23}=\frac{R_2.R_3}{R_2+R_3}$$



$$R_A=\frac{R_1.\frac{R_2.R_3}{R_2+R_3}}{R_1+R_4+\frac{R_2.R_3}{R_2+R_3}}$$

$$R_B=\frac{R_1.R_4}{R_1+R_4+\frac{R_2.R_3}{R_2+R_3}}$$

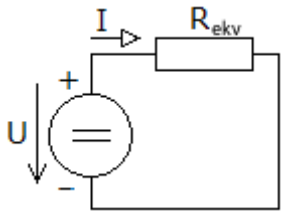
$$R_C=\frac{R_4.\frac{R_2.R_3}{R_2+R_3}}{R_1+R_4+\frac{R_2.R_3}{R_2+R_3}}$$



$$R_{AB5C6}=R_A+\frac{(R_B+R_5).(R_C+R_6)}{(R_B+R_5)+(R_C+R_6)}$$

$$R_{ekv}=R_{AB5C6}+\frac{R_7.R_8}{R_7+R_8}$$

$R_{ekv} = 513.8290\ \Omega$



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

$I = 0.1557$ A

$$I_{R7}=I.\frac{R_7.R_8}{R_7+R_8}$$

$I_{R7} = 0.0592$ A

$$U_{R7}=R_7.I_{R7}$$

$U_{R7} = 18.352$ V

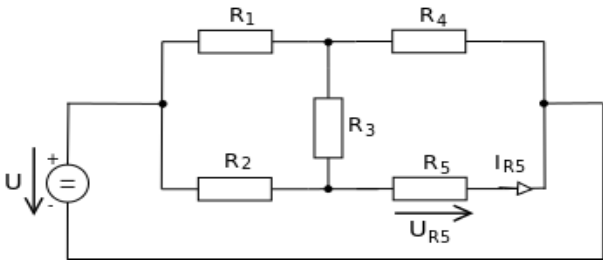
Úloha č.2

U [V]	R1 [Ω]	R2 [Ω]	R3 [Ω]	R4 [Ω]	R5 [Ω]
250	335	625	245	250	180

$$I_{R5}=\frac{U_i}{R_i+R_5}$$

$$R_A=\frac{R_2.R_3}{R_1+R_2+R_3} \qquad R_B=\frac{R_2.R_1}{R_1+R_2+R_3} \qquad R_C=\frac{R_1.R_3}{R_1+R_2+R_3}$$

$$R_{ekv}=R_A+\frac{R_B.(R_C+R_4)}{R_B+(R_C+R_4)}$$



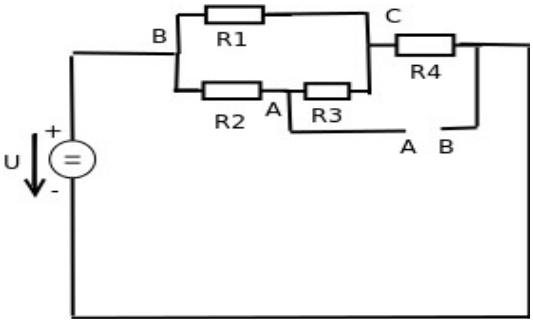
$R_{ekv} = R_i = 239.4498\ \Omega$

Prechod na hviezdu

$$R_A=\frac{R_2.R_3}{R_1+R_2+R_3} \qquad R_B=\frac{R_1.R_3}{R_1+R_2+R_3} \qquad R_C=\frac{R_2.R_1}{R_1+R_2+R_3}$$

$$U_i=\frac{U.(R_B+R_4)}{R_B+R_C+R_4}$$

$U_i = 161.6859$ V

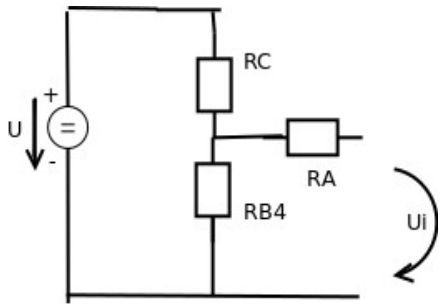


$$I_{R5}=\frac{U_i}{R_i+R_5}$$

$I_{R5} = 0.3855$ A

$$U_{R5}=R_5.I_{R5}$$

$U_{R5} = 69.39$ V



Úloha č.3

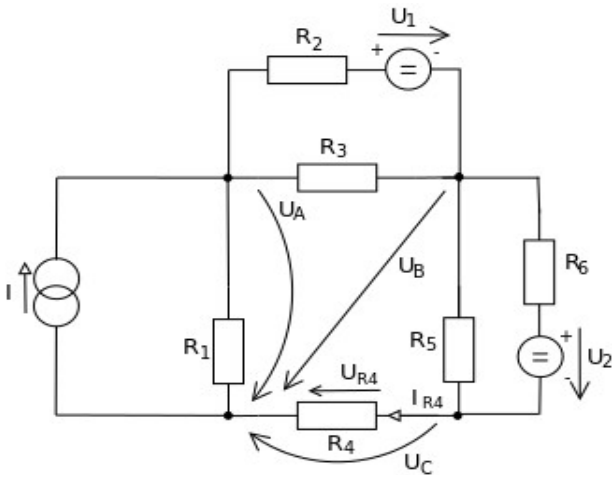
U1 [V]	U2 [V]	I [A]	R1 [Ω]	R2 [Ω]	R3 [Ω]	R4 [Ω]	R5 [Ω]	R6 [Ω]
130	95	0.5	470	390	580	280	205	350

Uzly:

$$A: I - I_{R1} + I_{R2} - I_{R3} = 0$$

$$B: I_{R3} - I_{R5} + I_{R6} - I_{R2} = 0$$

$$C: I_{R5} - I_{R6} - I_{R4} = 0$$



Jednotlivé prúdy:

I_{R1}: $R_1 . I_{R1} - U_A = 0 \quad => \quad I_{R1} = \frac{U_A}{R_1}$

I_{R2}: $R_2 . I_{R2} - U_1 + U_A - U_B = O \quad => \quad I_{R2} = \frac{U_1 + U_B - U_A}{R_2}$

I_{R3}: $R_3 . I_{R3} - U_A + U_B = 0 \quad => \quad I_{R3} = \frac{U_A - U_B}{R_3}$

I_{R4}: $R_4 . I_{R4} - U_C = 0 \quad => \quad I_{R4} = \frac{U_C}{R_4}$

I_{R5}: $R_5 . I_{R5} - U_B + U_C = 0 \quad => \quad I_{R5} = \frac{U_B - U_C}{R_5}$

I_{R6}: $R_6 . I_{R6} - U_2 + U_B - U_C = 0 \quad => \quad I_{R6} = \frac{U_2 + U_C - U_B}{R_6}$

Rovnice pre jednotlivé uzly - sústava troch rovníc s troma neznámymi: U_A, U_B, U_C:

A: $I - \frac{U_A}{R_1} + \frac{U_1 + U_B - U_A}{R_2} - \frac{U_A - U_B}{R_3} = 0$

B: $\frac{U_A-U_B}{R_3}-\frac{U_B-U_C}{R_5}+\frac{U_2+U_C-U_B}{R_6}-\frac{U_1+U_B-U_A}{R_2}=0$

C: $\frac{U_B-U_C}{R_5}-\frac{U_2+U_C-U_B}{R_6}-\frac{U_C}{R_4}=0$

$U_A = 183.382$ V
$U_B = 80.0393$ V
$U_C = U_{R4} = 30.7511$ V

$U_{R4}=I_{R4}.R_4 \Rightarrow I_{R4}=\frac{U_{R4}}{R_4}$

$I_{R4}=0.1098$ A

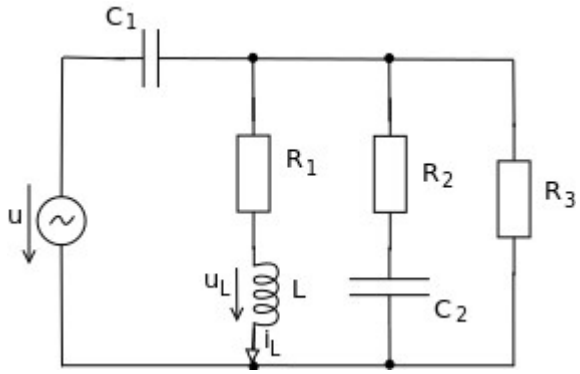
Úloha č. 4

U [V]	R1 [Ω]	R2 [Ω]	R3 [Ω]	L [mH]	C1 [μF]	C2 [μF]	F [Hz]
45	140	210	340	470	210	150	70

$u=U.sin(2\pi ft)$

$u_L=U_{L.sin}(2\pi ft+\varphi_L)$

$\omega=2\pi f=439.8230$ rad.s^{-1}



$X_{C1}=j\frac{-1}{\omega.C_1}=-10.8269\text{j}\Omega$

$X_{C2}=\frac{-1}{\omega.C_2}=-15.1576\text{j}\Omega$

$X_L=\omega.Lj=206.7169\text{j}\Omega$

$Z_1=R_1+X_L=140+206.7169\text{j}\Omega$

$Z_2=R_2+X_{C2}=210-15.1576\text{j}\Omega$

$Z_3=\frac{Z_1.Z_2}{Z_1+Z_2}$

$Z_4=\frac{Z_3.R_3}{Z_3+R_3}$

$Z=Z_4+X_{C1}=92.4563+16.8833\text{j}$

$$I=\frac{U}{Z}=0.47101-0.0860104\text{j}$$

$$U_L=I.Z_4=29.1206+24.8217\text{j}$$

$$|U_L|=38.2639\,V$$

$$\varphi=arctg\left(\frac{\Im(U_L)}{\Re(U_L)}\right)=0.705871\,rad.s^{-1}=40\,°\,26\,'\,36\,''$$

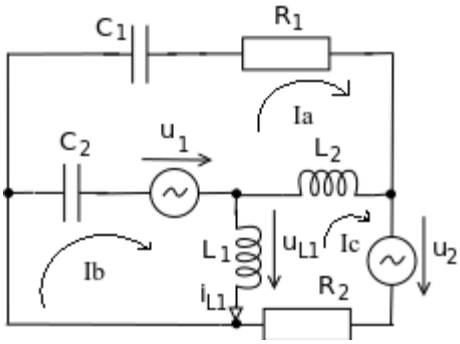
Úloha č. 5

U1 [V]	U2 [V]	R1 [Ω]	R2 [Ω]	L1 [mH]	L2 [mH]	C1 [μF]	C2 [μF]	F [Hz]
50	30	145	135	130	60	100	65	90

$$u_1=U_1.\sin(2\pi\text{ft})$$

$$u_2=U_2.\sin(2\pi\text{ft})$$

$$\omega=2\pi\text{f}=565.4867\,rad.s^{-1}$$



Použitá metoda smyčkových prúdov.Pozn.:Pomocné „smery šípok“ napájacích zdrojov platia pre špeciálny časový okamih (t= π/2ω).

Rovnice pre jednotlivé smyčky:

$$I_A.\frac{-1}{j.\omega.C_1}+I_1.R_1+(I_A-I_C).j.\omega.L_2-U_1+(I_A-I_B).\frac{-1}{j.\omega.C_2}+U_1=0$$

$$(I_B-I_C).j.\omega.L_1+(I_B-I_A).\frac{-1}{j.\omega.C_2}+U_1=0$$

$$(I_C-I_B).j.\omega.L_1+I_C.R_2+U_2+(I_C-I_A).j.\omega.L_2=0$$

Dosadíme,upravíme, a vypočítame Ia,Ib,Ic:

$$I_A.(-17.6839\text{j})+I_A.145+(I_A-I_C).33.9292\text{j}-50+(I_A-I_B).(-27.2060\text{j})=0$$

$$(I_B-I_C).73.5133\,j+(I_B-I_A).(-27.2060\text{j})+50=0$$

$$(I_C - I_B).73.5133j + I_C.135 + 30 + (I_C - I_A).33.9292j = 0$$

I_A=0.4861 – 0.0846j
I_B=-0.9973 + 0.8695j
I_C= -0.6121 + 0.1016j

$$X_{L1} = j.\omega.L_1 = 73.5133j$$

$$U_L = (I_B - I_C).X_{L1} = -56.4509 - 28.3173j$$

$$|U_L| = \sqrt{-28.3173^2 - 56.4509^2} = 63.1551\,V$$

$$\varphi = arctg\left(\frac{\Im(U_L)}{\Re(U_L)}\right) = 0.4649\,rad.s^{-1} = 26\,°\,38\,'\,12\,''$$

Úloha č. 6

U [V]	R [Ω]	C [F]	Uc(0)
18	40	50	9

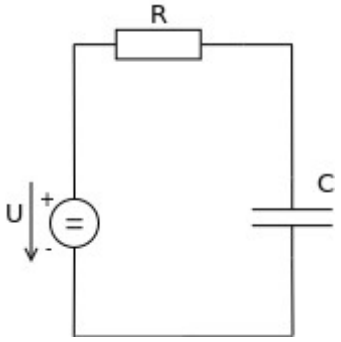
$$U_C' = \frac{1}{C}.i \qquad i = i_C = i_R$$

Pre celkové napatie platí:

$$U_R + U_C - U = 0$$

$$U = R.I + U_C$$

$$I = \frac{U - U_C}{R}$$



Dosadíme:

$$U_C' = \frac{1}{C}.\frac{U - U_C}{R} \quad => \quad \frac{18 - U_C}{2000}$$

Charakteristická rovnica:

2000 Uc'+Uc=18 Uc(0)=9
2000λ+1=0
λ= -1/2000 = -0.0005

Očakávané riešenie:

$$U_C(t)=k(t).e^{\lambda t}=k(t).e^{-0.0005t}$$

$$U_C'(t)=k'(t).e^{\lambda t}+k(t).\lambda.e^{\lambda t}$$

Dosadením do charakteristickej rovnice:

$$2000\left(k'(t)e^{-0.0005t}-0.0005.k(t).e^{0.0005t}\right)-k(t).e^{-0.0005t}=18$$

$$k'(t).e^{\lambda t}=0.009 \quad => \quad k'(t)=0.009.e^{0.0005t}$$

Integrácia:

$$k(t)=0.009.\frac{1}{0.005}.e^{0.0005t} \quad => \quad 18.e^{0.0005t}+q$$

Dosadenie do očakávaného riešenia:

$$U_C(t)=(18.e^{0.0005t}+q).e^{-0.0005t}=18+q.e^{-0.0005t}$$

Hladám q:

Uc(0)=9
$9=18+q.e^{0}$
q= -9

$$U_C=18-9.e^{-0.0005t}$$

Skúška:

2000.Uc' + Uc=6
$0+9.e^{-0.0005t} + 18 - 9.e^{-0.0005t} = 18$
<u>18=18</u>

Tabulka výsledkov:

1	A	U_{R7}	18.352 V
		I_{R7}	0.0592 A
2	E	U_{R5}	69.39 V
		I_{R5}	0.3855 A
3	H	U_{R4}	30.7511 V
		I_{R4}	0.1098 A
4	A	$\|U_L\|$	38.2639 V
		φ_L	0.705871 $rad.s^{-1}$
5	E	$\|U_{L1}\|$	63.1551 V
		φ_{L1}	0.4649 $rad.s^{-1}$
6	H		