Projekt IEL

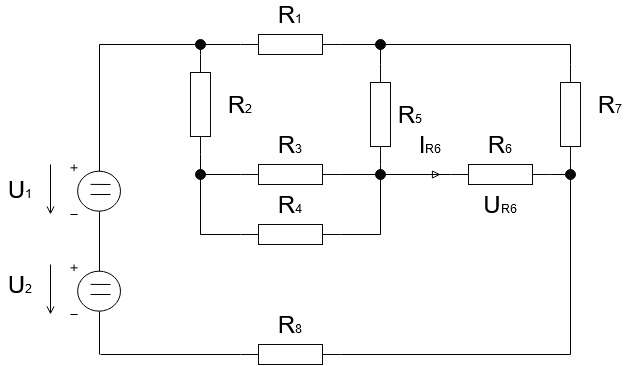
Vojtěch Hájek

xhajek51

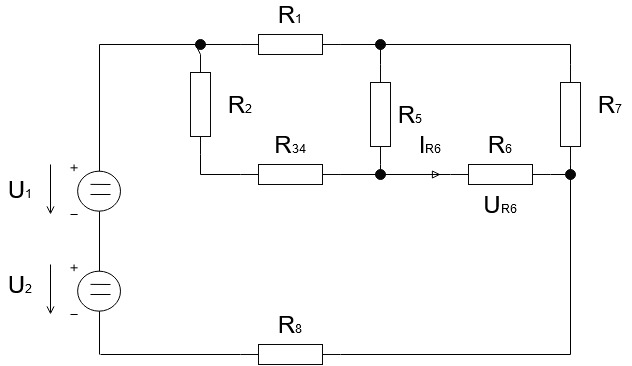
Příklad 1

Stanovte napětí UR6 a proud IR6. Použijte metodu postupného zjednodušování obvodu.

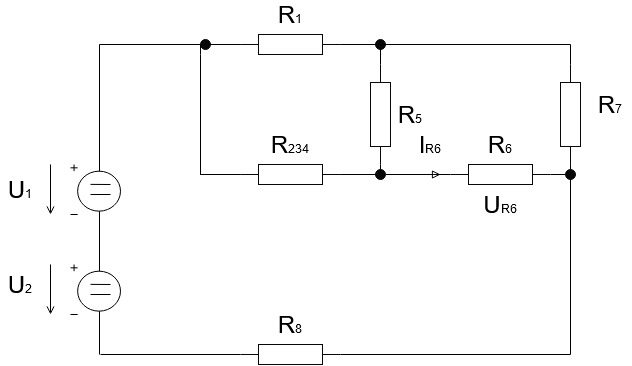
|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| sk. | U1 [V] | U2 [V] | R1 [Ω] | R2 [Ω] | R3 [Ω] | R4 [Ω] | R5 [Ω] | R6 [Ω] | R7 [Ω] | R8 [Ω] |
| G | 130 | 60 | 380 | 420 | 330 | 440 | 450 | 650 | 410 | 275 |

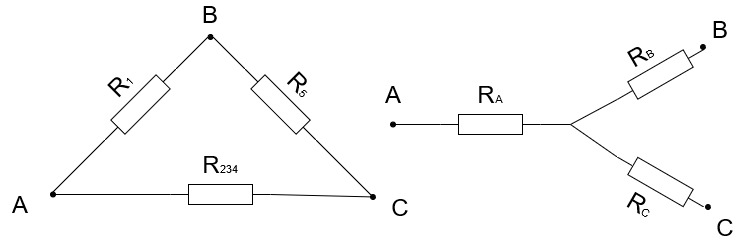


R34 = = 330 \* + 440 = 188.5714 Ω



R234 = R2 + R34 = 420 + 188.5714 = 608.5714 Ω

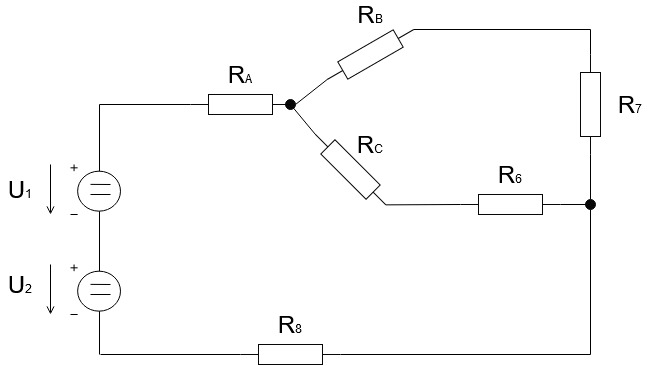




RA = = 380 \* 608.5714 / 380 + 450 + 608.5714 = 160.7547 Ω

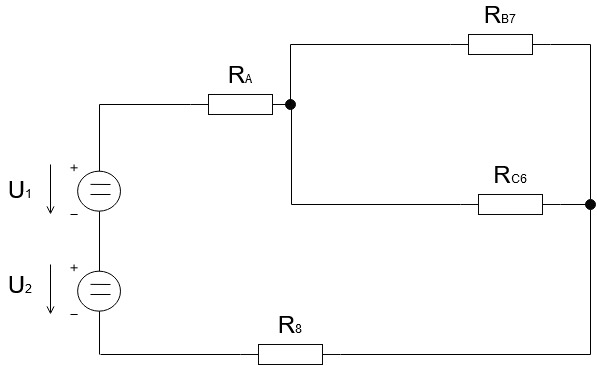
RB = = 380 \* 450 / 380 + 450 + 608.5714 = 118.8679 Ω

RC = = 450 \* 608.5714 / 380 + 450 + 608.5714 = 190.3674 Ω

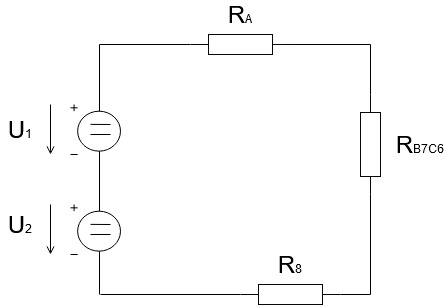


RB7 = RB + R7 = 118.8679 + 410 = 528.8679 Ω

RC6 = RC + R6 = 190.3674 + 650 = 840.3674 Ω



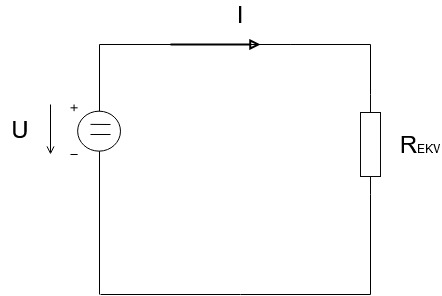
RB7C6 = = 528.8679 \* 840.3674 / 528.8679 + 840.3674 = 324.5923 Ω



REKV = RA + RBC76 + R8 = 160.7547 + 324.5923 + 275 = 760.3471 Ω

U = U1 + U2 = 130 + 60 = 190 V

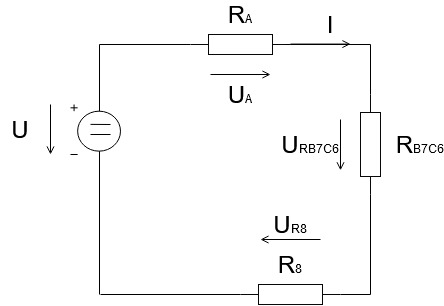
I = = 190 / 760.3471 = 0.2498 A



URA = RA \* I = 160.7547 \* 0.2498 = 40.1703 V

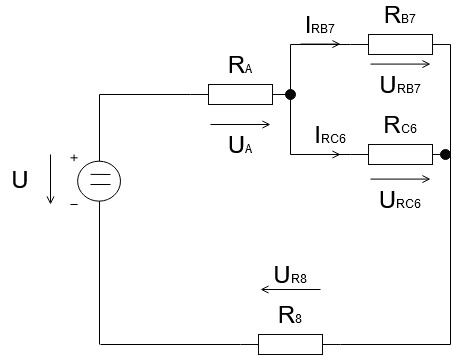
UR8 = R8 \* I = 275 \* 0.2498 = 68.7186 V

URB7C6 = RB7C6 \* I = 324.5923 \* 0.2498 = 81.1110 V



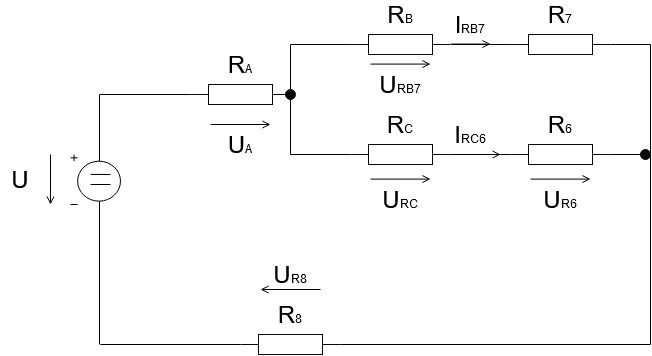
IRB7 = = 81.1110 / 528.8679 = 0.1533 A

IRC6 = = 81.1110 / 840.3674 = 0.0965 A



**UR6 = R6 \* IRC6 = 650 \* 0.0965 = 62.7370 V**

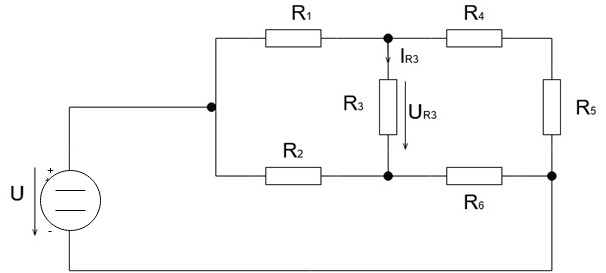
**IR6 = IRC6 = 0.0965 A**



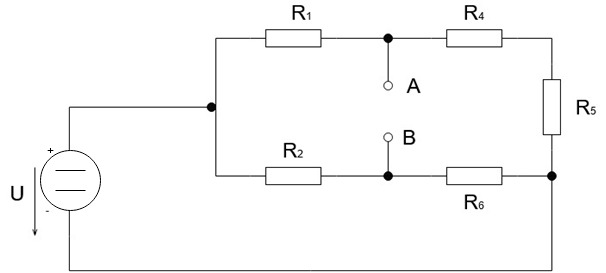
Příklad 2

Stanovte napětí UR3 a proud IR3. Použijte metodu Théveninovy věty.

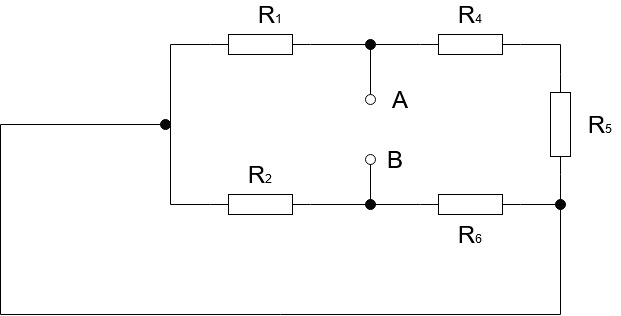
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| sk. | U [V] | R1 [Ω] | R2 [Ω] | R3 [Ω] | R4 [Ω] | R5 [Ω] | R6 [Ω] |
| H | 220 | 190 | 360 | 580 | 205 | 560 | 180 |

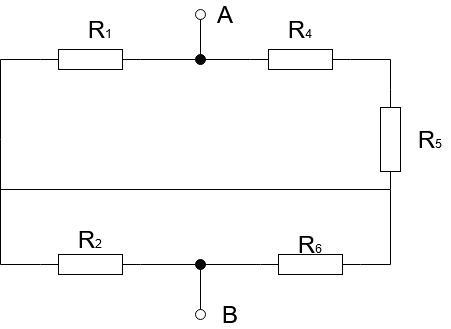


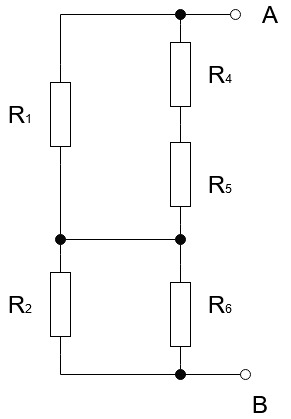
Obvod bez R3



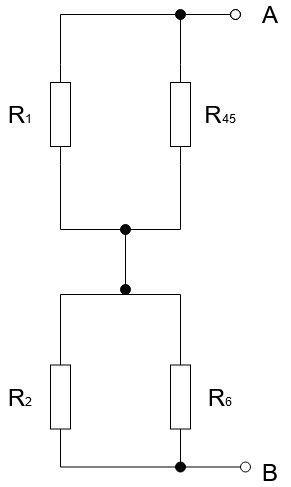
Zkratujeme napěťové zdroje





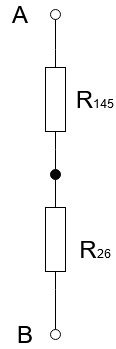
¨

R45 = R4 + R5 = 205 + 560 = 765 Ω

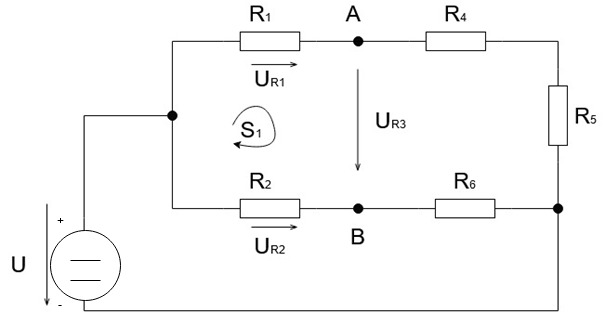


R145 = = 190 \* 765 / 190 + 765 = 152.1989 Ω

R26 = = 360 \* 160 / 360 + 160 = 110.7692 Ω



Ri= R145 + R26 = 152.1989 + 110.7692 = 262.9681 Ω



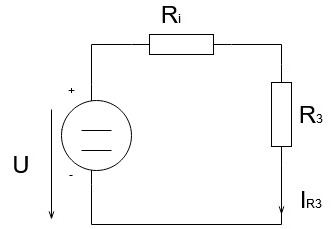
UR1 = U \* () = 220 \* (190/ 190 + 205 + 560) = 43.7696 V

UR2 = U \* () = 220 \* (360 / 360 + 180) = 146.6666 V

S1:

UR1 + UR3 – UR2 = 0

**UR3** = UR2 – UR1 = 146.6666 - 43.7696 = **102.8970 V**

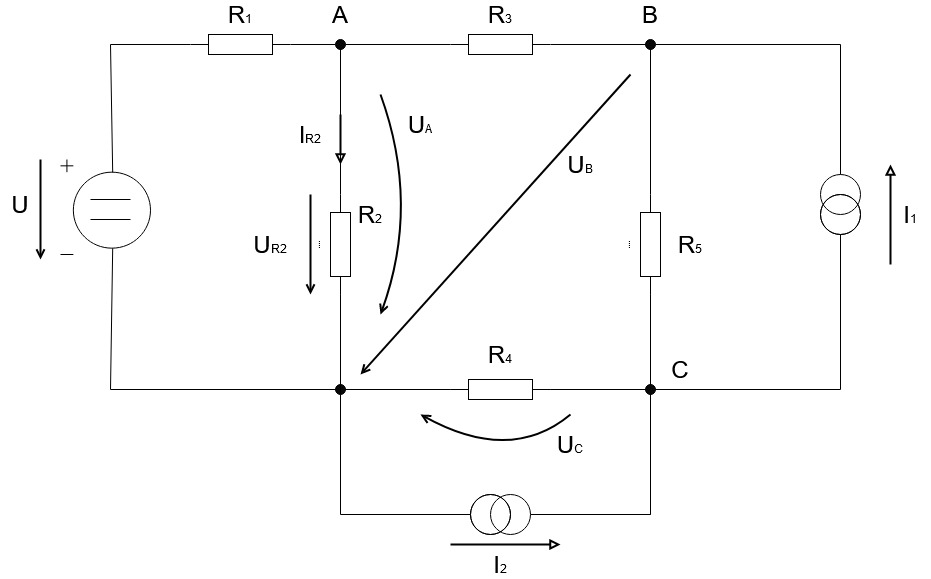


**IR3** = = 102.8970 / 262.9681 + 580 = **0.1220 A**

Příklad 3

Stanovte napětí UR2 a proud IR2. Použijte metodu uzlových napětí (UA, UB, UC).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| sk. | U [V] | I1 [A] | I2 [A] | R1 [Ω] | R2 [Ω] | R3 [Ω] | R4 [Ω] | R5 [5] |
| C | 110 | 0.85 | 0.75 | 44 | 31 | 56 | 20 | 30 |



Uzel

A: IR1 – IR3 – IR2 = 0

B: IR3 + I1 – IR5 = 0

C: I2 – I1 + IR5 – IR4 = 0

Ohmův zákon

IR1 =

IR2 =

IR3 =

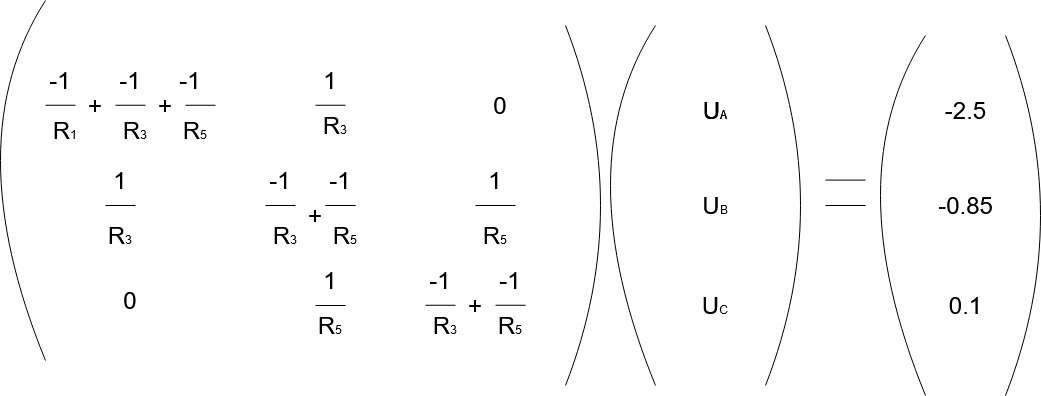
IR4 =

IR5 =

I.KZ

– – = 0

+ 0.85 – = 0

(0.75 – 0.85) + – = 0

UA = 44.7393 V

UB = 42.4997 V

UC = 15.7999 V

IR1 = = 1.4832 A

IR2 = = 1.4432 A

**IR3** = = **0.0399 A**

IR4 = = 0.7899 A

IR5 = = 0.8899 A

Zkouška:

A: 1.4832 - 0.0399 - 1.4432 = 0

B: 0.0399 + 0.85 - 0.8899 = 0

C: 0.75 – 0.85 + 0.8899 - 0.7899 = 0

**UR3** = UA = **44.7393 V**

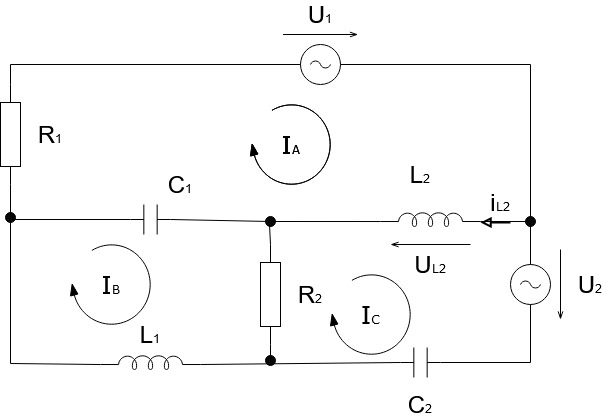
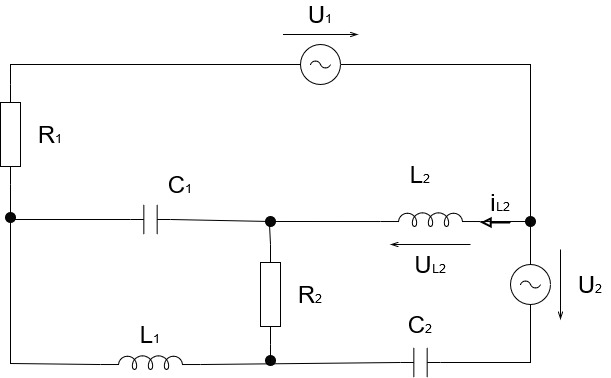
Příklad 4

Pro napájecí napětí platí: u1 = U1·sin(2πf t), u2 = U2·sin(2πf t).

Ve vztahu pro napětí uL2 = UL2 ·sin(2πf t + ϕL2 ) určete |UL2 | a ϕL2 . Použijte metodu smyčkových proudů.

Pozn: Pomocné směry šipek napájecích zdrojů platí pro speciální časový okamžik (t = π / 2ω).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| sk. | U1 [V] | U2 [V] | R1 [Ω] | R2 [Ω] | L1 [mH] | L2 [mH] | C1 [µF] | C2 [µF] | f [Hz] |
| G | 55 | 50 | 13 | 12 | 140 | 60 | 160 | 80 | 60 |



ω = 2πf = 376.98 [rad/s]

ZL1 = j \* ω \* L1 = j \* 52.7772

ZL2 = j \* ω \* L2 = j \* 22.6188

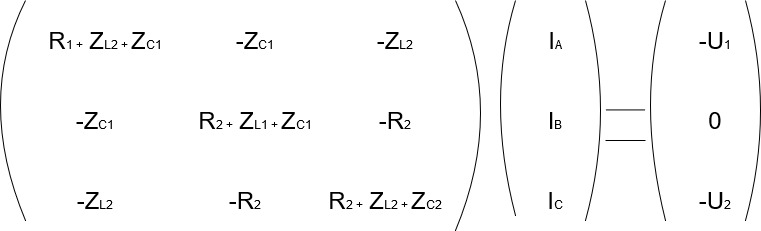
ZC1 = -j \* = -j \* 1.6579

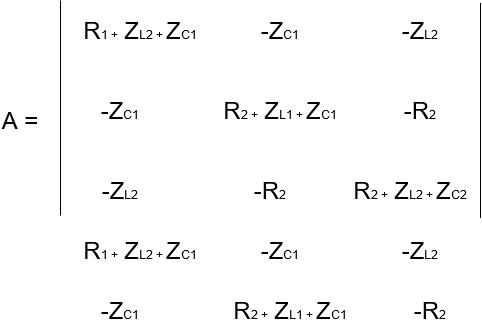
ZC2 = -j \* = -j \* 3.3158

IA: R1 \* IA + ZL2 \* (IA – IC) + ZC1 \* (IA – IB) + U1 = 0

IB: ZC1 \* (IB – IA) + R2 \* (IB – IC) + ZL1 \* IB = 0

IC: ZL2 \* (IC – IA) + ZC2 \* IC + R2 \* (IC – IB) + U2 = 0





|A| = ((13+20,9609j)\*( 12+20,9609j) \* (12+19,303j))+((1,6579j)\*(-12)\*(- 22,6188j))+   
((-22,6188j)\* (1,6579j)\*(-12))-((-22,6188j)\*(12+20,9609j)\*(-22,6188j))-((-12)\*12\* (13+20,9609j))-((12+19,303j)\* (1,6579j)\*(1,6579j))

|A| = -6371,2063+14613,8197j

|IA| = ((-55)\*( 12+20,9609j)\*(12+19,303j))+(0\*(-12)\*(-22,6188j))+((-50)\*( 1,6579j)\*(-12))-   
((-22,6188j)\*( 12+20,9609j)\*(-50))-((-12)\*(-12)\*(-55))-((12+19,303j)\*(1,6579j)\*0)

|IA|= 45958,9741-39150,714j

IA = = -3,4032-1,6611j A

|IB| = ((13+20,9609j)\*0\*( 12+19,303j)) + ((1,6579j)\*(-50)\*(-22,6188j))+((-22,6188j)\*(-55)\*(-12))-((-22,6188j)\*0\*(-22,6188j))-((-12)\*(-50)\*(13+20,9609j))-((12+19,303j)\*(-55)\*(1,6579j))

|IB|= -11435,1198-26410,734j

IB = = -1,2319+1,3195j A

|IC| = ((13+20,9609j)\*(12+20,9609j)\*(-50))+((1,6579j)\*(-12)\*(-55))+((22,6188j)\*(1,6579j)\* 0)-((-55)\*( 12+20,9609j)\*(-22,6188j))-(0\*(-12)\*(13+20,9609j))-((-50)\*(1,6579j)\*(1,6579j))

|IC| = 40106,6070-40035,319j

IC = = -3,3074-1,3024j A

IL2 = IA – IC = (-3,4032-1,6611j) - (-3,3074-1,3024j) = -0,0958-0,3587j A

UL2 = IL2 \* ZL2 = (-0,0958-0,3587j) \* (22,6188j) = 8,1133-2,1668j V

|UL2|, ϕL2

**|UL2|** = √((8,1133)2-(2,1668j)2) = **8,3976**

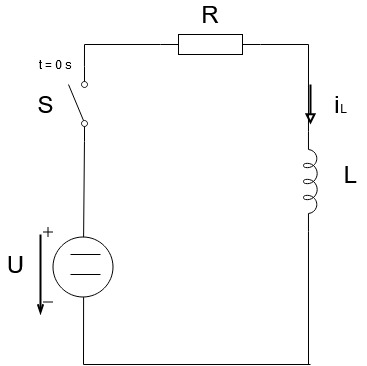
ϕ= tan-1 = 14,95°

**UL2** = **8,3976 ∠ 14,95°**

Příklad 5

V obvodu na obrázku níže v čase t = 0 [s] sepne spínače S. Sestavte diferenciální rovnici popisující chování obvodu na obrázku, dále ji upravte dosazením hodnot parametrů. Vypočítejte analytické řešení iL = f (t). Proveďte kontrolu výpočtu dosazením do sestavené diferenciální rovnice.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| sk. | U [V] | L [H] | R [Ω] | iL (0) [A] |
| H | 18 | 50 | 40 | 5 |



1. iL =
2. uR + uL – U = 0
3. iL‘ = , iL(0) = iLP

L \* iL‘ + R \* iL = U

**Očekáváné řešení:**

iL (t) = K(t) \* eλt

**λ..?**

Lλ + R = 0 -> λ = -

iL(t) = K(t) \*e- t

iL(t) = K´(t) \* e- t + K(t) \* (- ) \* e- t

dosazení rovnice

L \* (K´(t) \* e- t + K(t) \* (- ) \* e- t ) + R \* K(t) \*e- t = U

L \* K´(t) \* e- t - L \* K(t) \* ( ) \* e- t + R \* K(t) \* e- t = U

L \* K´(t) \* e- t – R \* K(t) \* e- t + R \* K(t) e- t = U

L \* K´(t) \* e- t = U

K´(t) = \* e t

K(t) = \* e t + k

K(t) = \* e t + k

Dosazení rovnice

iL = K(t) \* e- t

iL = ( \* e t + k) \* e- t

iL = + k \* e- t

určení integrační konstanty z počáteční podmínky

iL(0)=iLP t=0s

iLP = + k \* e0

k = iLP –

Analytické řešení

iL = f(t)

**iL** = **+ (iLP – ) \* e- t**

zkouška:

iL = + (iLP – ) \* e- t

5 = + (5 – ) \* e0

5 = 5

iL(0) = iLP

**TABULKA VÝSLEDKŮ**

|  |  |  |
| --- | --- | --- |
| ÚLOHA | VARIANTA | VÝSLEDKY |
| 1. | G | UR6 = 62.7370 V IR6 = 0.0965 A |
| 2. | H | UR3 = 102.8970 V IR3 = 0.1220 A |
| 3. | C | UR3 = 44.7393 V IR2 = 0.0399 A |
| 4. | G | |UL2|= 8,3976 ϕ=14,95° UL2 = 8,3976 ∠ 14,95° |
| 5. | H | iL = + (iLP – ) \* e- t |