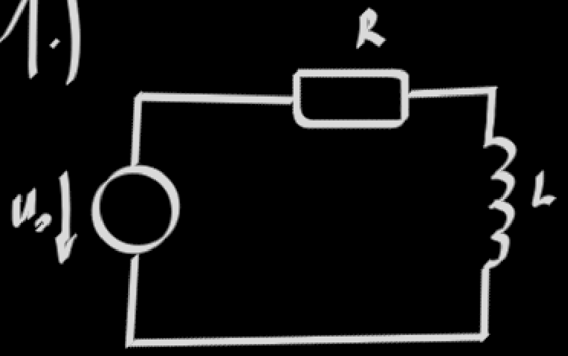
https://moodle.fel.cvut.cz/pluginfile.php/377413/mod_folder/intro/EOS_cv11_2011_prech_deje_1r.pdf

file:///C:/Users/jakub/Downloads/frek_charak.pdf

Havlík - Přechodové děje 1. řádu

1. video

1.)



$$iR + L\frac{di}{dt} = U_0$$

$$\frac{L}{R}\frac{di}{dt} + i = \frac{U_0}{R}$$

homogenní řešení:

$$\frac{L}{R}\lambda + 1 = 0$$

$$\lambda = -\frac{R}{L}$$

$$\lim_{t\to\infty} i_0(t) = 0$$

$$i_0(t) = k_1 e^{\lambda t} = k_1 e^{-\frac{R}{L}t} = k_1{}^{-t/\tau}, \quad \tau = \frac{L}{R}$$

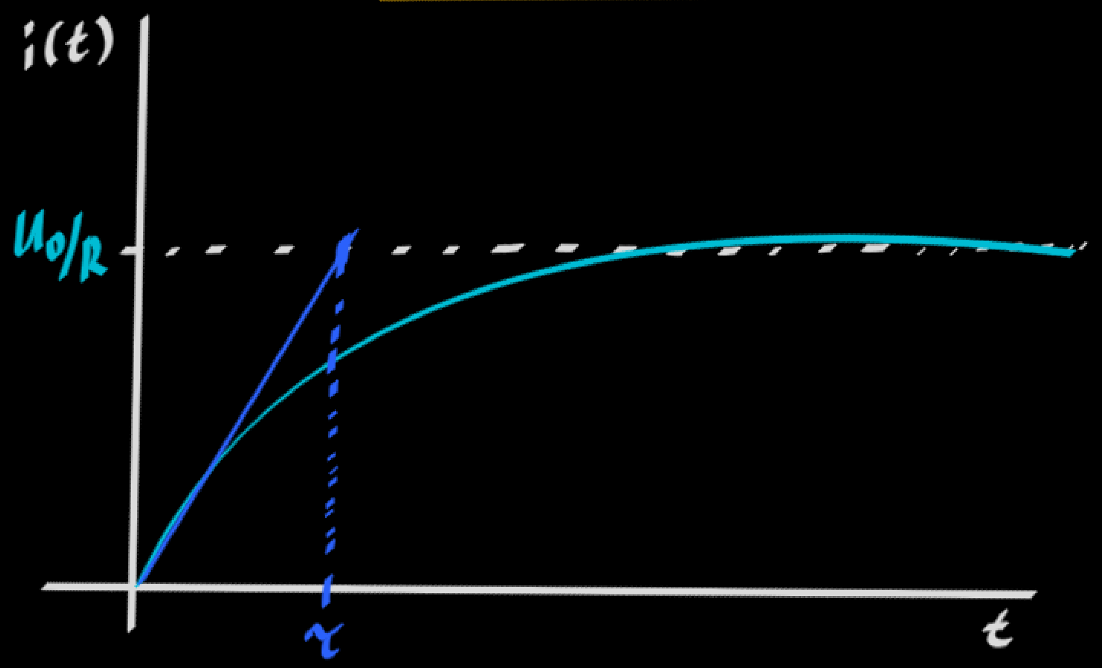
$$i(t) = i_0(t) + i_p(t) \rightarrow \lim_{t\to 0} i(t) = i_p(t) = \underline{SUS}$$

partikulární řešení: $i_p(t\to\infty) = \frac{U_0}{R}$

Průběh: $i(t) = K_1 e^{-t/\tau} + \frac{U_0}{R} \rightarrow i(t) = -\frac{U_0}{R}e^{-t/\tau} + \frac{U_0}{R} = \boxed{\frac{U_0}{R}\left(1 - e^{-t/\tau}\right)\ [A]}$

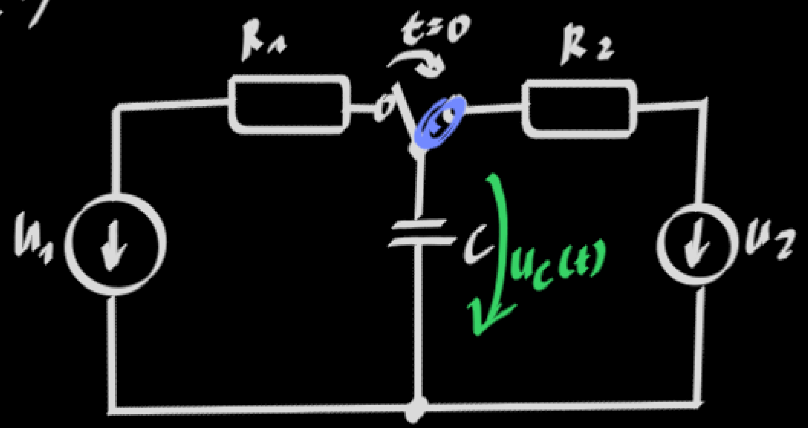
$$i(0) = 0\ A \rightarrow 0 = k_1 e^{-t/\tau} + \frac{U_0}{R}$$

$$-\frac{U_0}{R} = k_1$$



2.) $U_1 = 10V$, $U_2 = 5V$

$R_2 = 2k\Omega$, $C = 10\mu F$

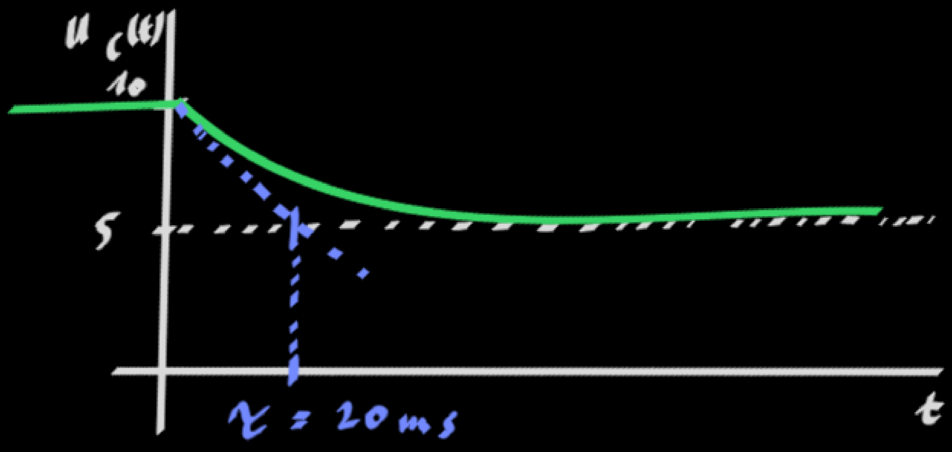


Rovnice pro uzel:

$$C\frac{du_C}{dt} + \frac{u_C - U_2}{R} = 0$$

$$C\frac{du_C}{dt} + \frac{u_C}{R_2} = \frac{U_2}{R_2}$$

$$R_2 C\frac{du_C}{dt} + u_C = U_2$$



$R_2 C \lambda + 1 = 0$

hom. řešení: $\lambda = -\frac{1}{R_2C}$

$u_0 = Ke^{\lambda t} = Ke^{-\frac{t}{R_2C}} = ke^{-t/\tau}$

$\tau = R_2C$

$u_C(t) = u_0(t) + u_p(t)$

$u_C(\infty) = u_p(t) = U_2$

Partikulární řešení

SUS → $u_p(t) = U_2$

$u_C(t) = ke^{-t/\tau} + U_2$

Pro t=0: ⊣⊢ se předtím nabil

$u_C(0) = k + U_2 \overset{\downarrow}{=} U_1$

$k = U_1 - U_2$

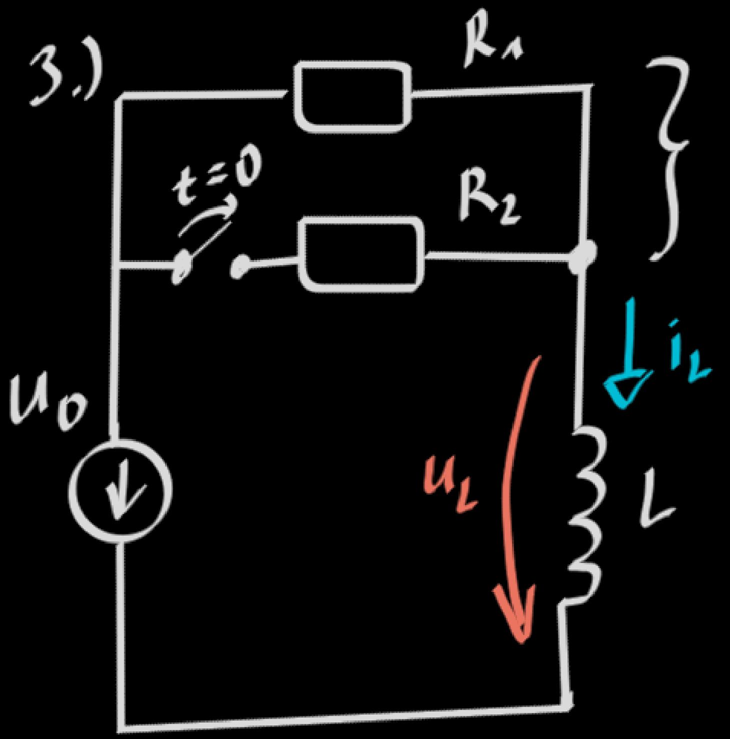
Průběh:

$u_C(t) = (U_1 - U_2)e^{-\frac{t}{\tau}} + U_2$, $\tau = R_2C$

dosazení: $u_C(t) = 5e^{-t/\tau} + 5$

$\tau = 2\cdot10^3 \cdot 10\cdot10^{-6} = 20\cdot10^{-3}s = \underline{20ms}$

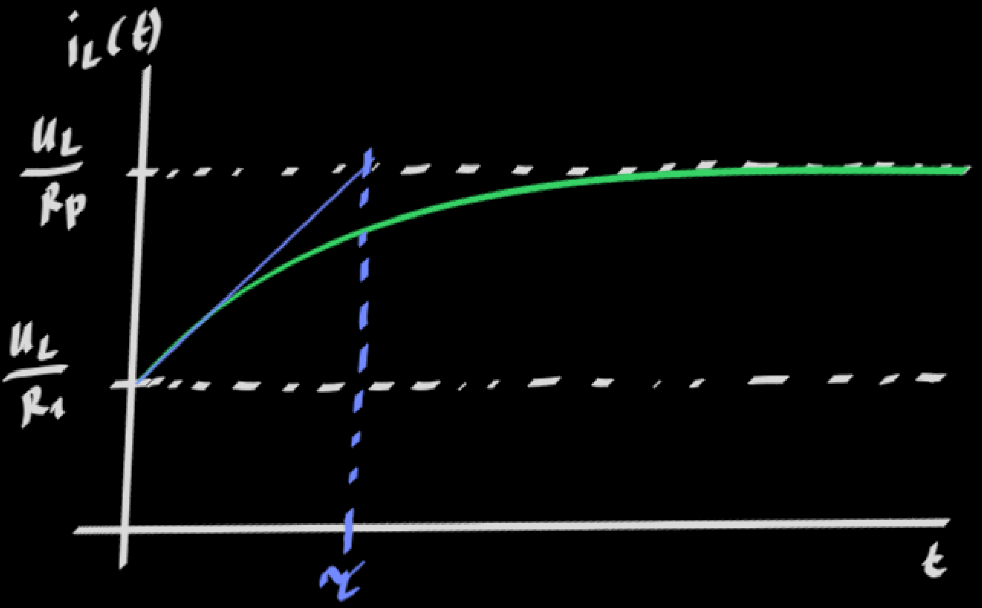
3.)



$$R_1 \parallel R_2 = \frac{R_1 R_2}{R_1 + R_2} = R_p$$

$$i\frac{R_1 R_2}{R_1 + R_2} + L\frac{di}{dt} = u_0$$

$$\frac{L}{R_p}\frac{di}{dt} + i = \frac{u_0}{R_p}$$



hom. řeš: $\frac{L}{R_p}\lambda + 1 = 0 \quad \Big| \quad \lambda = -\frac{R_p}{L}$

$$i_0 = ke^{\lambda t} = ke^{-\frac{R_p}{L}t} = ke^{-t/\tau}, \quad \tau = \frac{L}{R_p}$$

partikulární: $i_p = \frac{u_0}{R_p}$

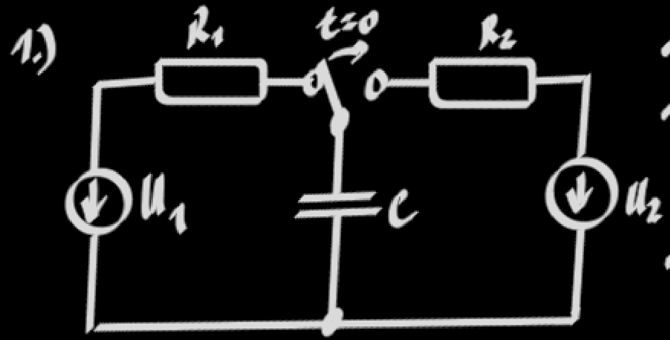
před sepnutím

Průběh: $i_L = ke^{-t/\tau} + \frac{u_0}{R_p}$, $\quad i(0) = k + \frac{u_0}{R_p} = \frac{u_0}{R_1}$

Závěr: $i_L = \left(\frac{u_0}{R_1} - \frac{u_0}{R_p}\right)e^{-t/\tau} + \frac{u_0}{R_p}$ $\qquad k = \frac{u_0}{R_1} - \frac{u_0}{R_p}$

Teď trochu jinak

1.)



Víme

- $u_C(t) = K_1 e^{-t/\tau} + k_2$
- $\tau = RC$

$t \to \infty$

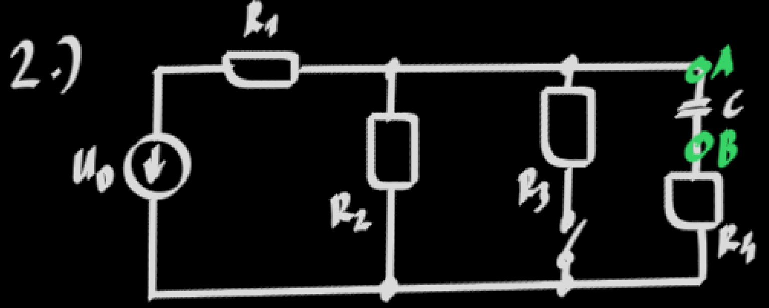
- $u_C(\infty) = k_2 \}$ SUS

Poč. podmínky

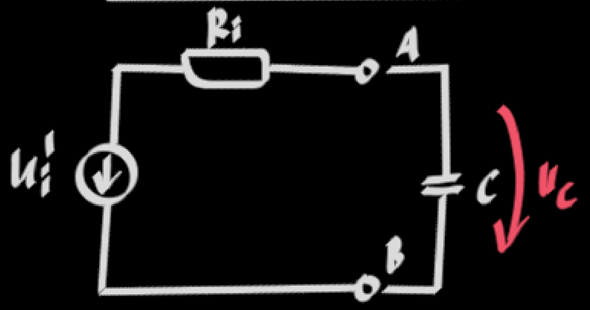
- $\underbrace{u_C(0) - u_C(\infty) = k_1}$

$$\boxed{u_C(t) = (U_1 - U_2)\, e^{-t/\tau} + U_2}$$

2.)



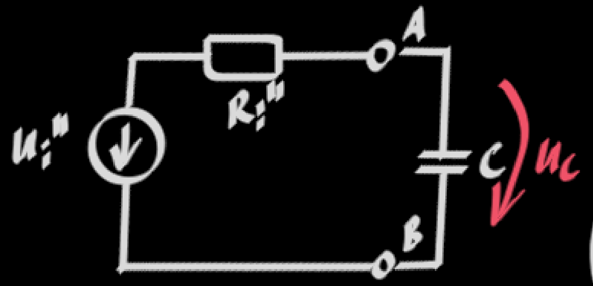
Thevenin před sepnutím



$$U_i' = U_0 \frac{R_2}{R_1 + R_2}$$

$$R_i' = R_4 + \frac{R_1 R_2}{R_1 + R_2}$$

po sepnutí



$$U_i'' = U_0 \frac{R_2 \| R_3}{R_1 + R_2 \| R_3}$$

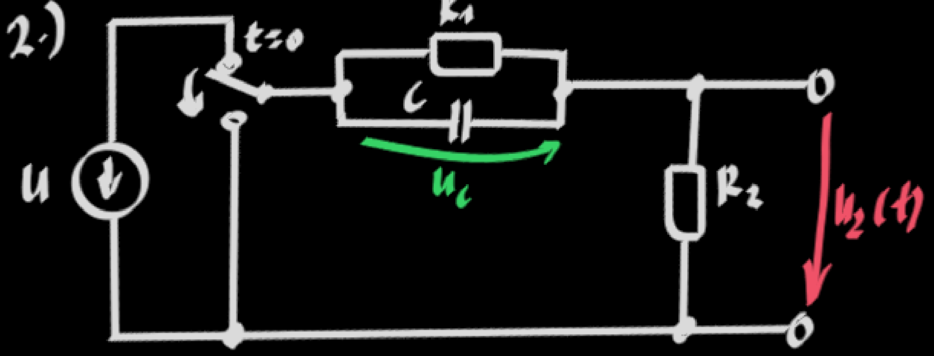
$$R_i'' = R_4 + R_1 \| R_2 \| R_3$$

$$\left.\begin{aligned} &u_C = k_1 e^{-t/\tau} + k_2 \\ &\tau = RC = R_i'' C \\ &u_C(\infty) = U_i'' \\ &u_C(0) \Rightarrow k_1 + U_i'' = U_i' \\ &\qquad k_1 = (U_i' - U_i'') \end{aligned}\right\}$$

Průběh

Video 2.2

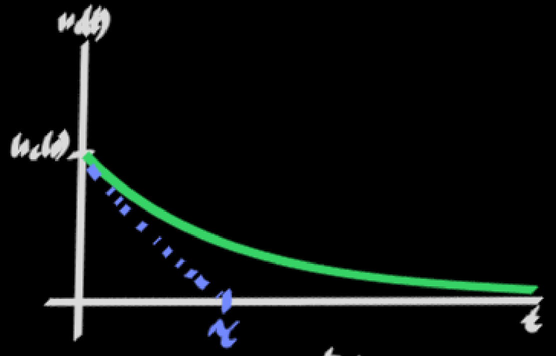
2.)



$$u_c(0) = U \frac{R_1}{R_1+R_2}$$

$$u_c(\infty) = 0$$

$$\tau = R_1 \| R_2 \cdot C$$

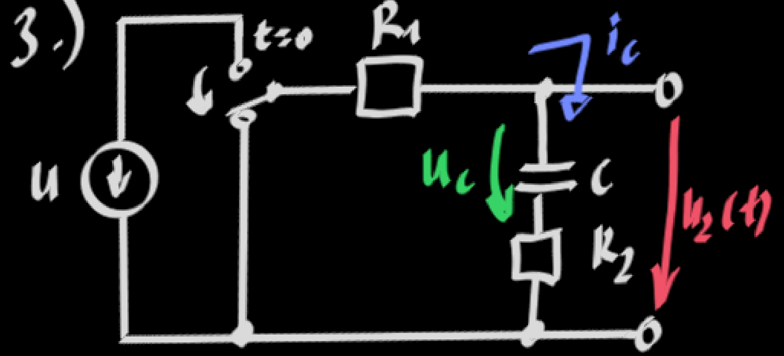


$$u_c(t) = K_1 e^{-t/\tau} + K_2$$

$$u_c(t) = U \frac{R_1}{R_1+R_2} e^{-t/\tau} \quad [V]$$

$$u_2(t) = -u_c(t)$$

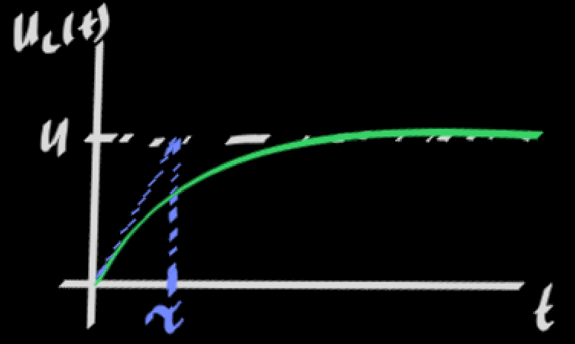
3.)



$$u_c(0) = 0$$

$$u_c(\infty) = U$$

$$\tau = (R_1+R_2) \cdot C$$



$$u_c(t) = k_1 e^{-t/\tau} + k_2$$

$$u_c(0) = k_2 = +U$$

$$u_c(0) - u_c(\infty) = k_1$$

$$k_1 = -U$$

$$u_c(t) = -U e^{-t/\tau} + U$$

$$\underline{u_c(t) = U(1-e^{-t/\tau})}$$

$$\tau = (R_1+R_2)C$$

$$i_c(t) = C\frac{du_c}{dt} = C\frac{(U(1-e^{-t/\tau}))}{dt} = C \cdot U \cdot (-1) \cdot \left(-\frac{1}{\tau}\right) \cdot e^{-\frac{t}{\tau}} =$$

$$= \cancel{C}\, U \frac{1}{(R_1+R_2)\cancel{C}} \cdot e^{-t/\tau} =$$

$$= \frac{U}{R_1+R_2} e^{-t/\tau}$$

$$u_2(t) = u_c(t) \cdot [R_2 \cdot i_c(t)] =$$

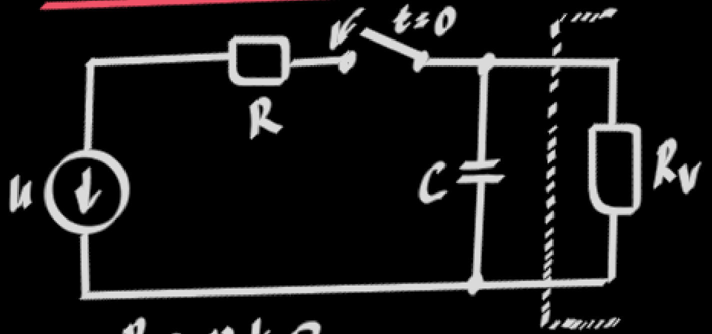
$$= U(1-e^{-t/\tau}) + R_2 \cdot \frac{U}{(R_1+R_2)} e^{-t/\tau} =$$

$$= U - Ue^{-t/\tau} + U\frac{R_2}{R_1+R_2} e^{-t/\tau} =$$

$$= U - \left[\left(U - U\frac{R_2}{R_1+R_2}\right)e^{-t/\tau}\right] =$$

$$= \ldots = U - U\frac{R_1}{R_1+R_2} e^{-t/\tau}$$

Výbojka blesku



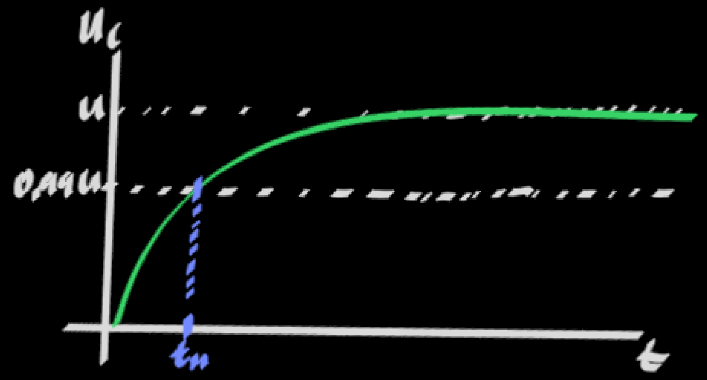
nabito při

$U_C = 0{,}99\,U$

$u_c(0) = 0$

$u_c(\infty) = u$

$u_c(t) = U(1 - e^{-t/\tau})$



$R = 12\,k\Omega$

$U = 330\,V$

$R_V = 12\,\Omega$

$C = 200\,\mu F$

- $u(1 - e^{-t_n/\tau}) = 0{,}99 \cdot u \quad |-u$

$$-u\,e^{-t_n/\tau} = -0{,}01 \cdot u \quad |:(-u)$$

$$e^{-t_n/\tau} = 0{,}01$$

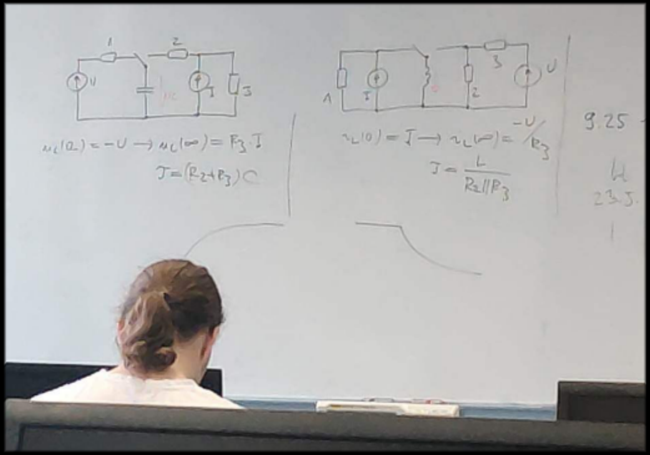
$$-\frac{t_n}{\tau} = \ln(0{,}01)$$

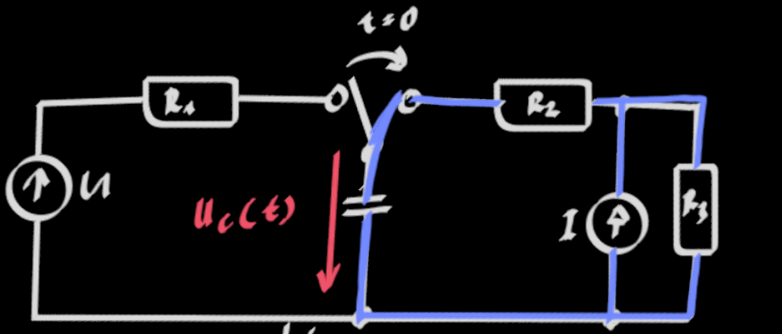
$$t_n = -\tau \cdot \ln(0{,}01)$$

$$t_n = -2{,}4 \cdot \ln(0{,}01) = \underline{11{,}05\,s}$$

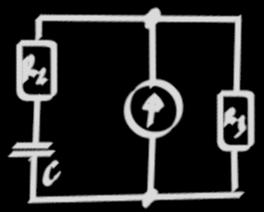
meh...

Zadání z discordu


1
2
U
I
3
$u_C(0) = -U \rightarrow u_C(\infty) = R_3 \cdot I$
$\tau = (R_2 + R_3)C$
1
I
2
3
U
$i_L(0) = I \rightarrow i_L(\infty) = -U / R_3$
$\tau = \frac{L}{R_2 \| R_3}$
9.25
23.5.



$u_C(\infty) = 3V$



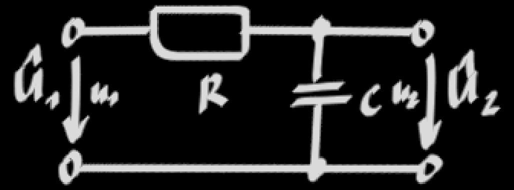
$u_C = k_1 e^{-t/\tau} + k_2$, $\tau = RC$

$\tau = (R_2 + R_3)C$

$u_C(0) = -U$ sus

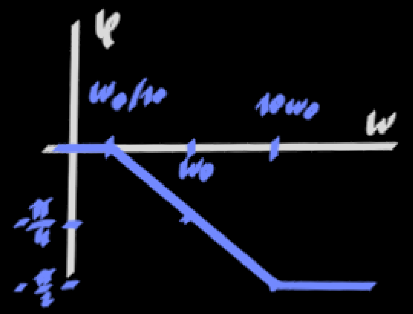
$u_C(\infty) = R_3 \cdot I$

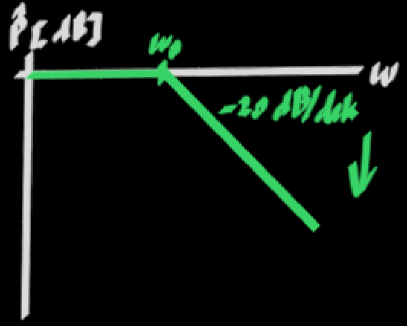
Frekvenční charakteristiky

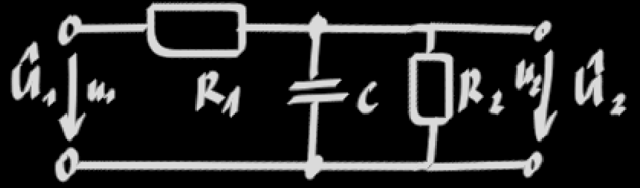


$$\hat{P}(j\omega) = \frac{\hat{U}_2}{\hat{U}_1} = \frac{\frac{1}{j\omega C}}{R+\frac{1}{j\omega C}} = \frac{1}{j\omega C}\cdot\left(\frac{1}{R}+\frac{j\omega C}{1}\right)$$

$$= \frac{1}{1+j\omega RC} = \frac{1}{1+j\frac{\omega}{\omega_0}}, \quad \omega_0 = \frac{1}{RC}$$







$$\frac{\cancel{R_2}}{j\omega C}\cdot\frac{1+j\omega CR_2}{\cancel{R_2}} = \frac{1+j\omega CR_2}{j\omega C}$$

$$\frac{1}{R_2} + \frac{j\omega C}{1} = \frac{1+j\omega CR_2}{R_2}$$

$$\hat{P}(j\omega) = \frac{\frac{R_2\frac{1}{j\omega C}}{R_2+\frac{1}{j\omega C}}}{R_1+\frac{R_2+\frac{1}{j\omega C}}{R_2+\frac{1}{j\omega C}}} =$$

$$\frac{R_2}{j\omega C}\left(\frac{1}{R_2}+j\omega C\right) \qquad \frac{R_2}{1+j\omega CR_2}$$

$$=$$