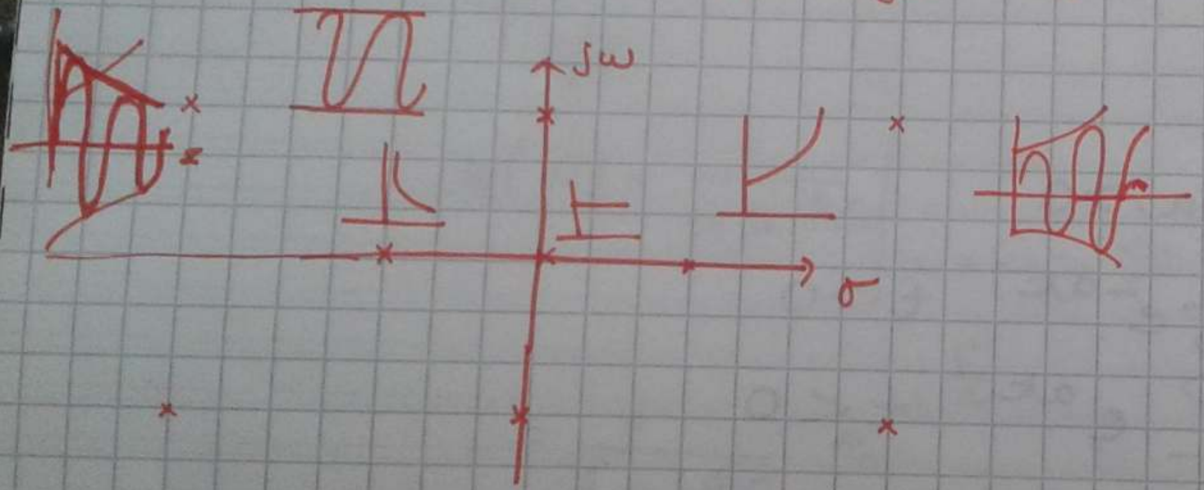
nov. 14. Egyoldalas Laplace transzformáció

$$\mathcal{L}\{f(t)\} = F(s)\Big|_{s=\sigma+j\omega} = \int_0^{\infty} f(t)e^{-st}\,dt$$



ha a bal félsíkra esik $\sigma < 0$:

stabil a rendszer

Fourier

csak $j\omega$
$\sigma = 0$

$$\int_{-\infty}^{\infty} f(t)e^{-j\omega t}\,dt$$

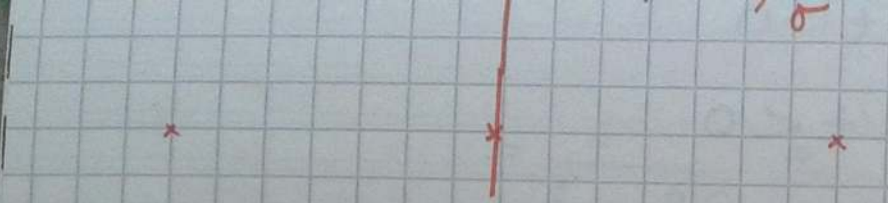
állandósult áll.
kezdeti felt. nincs

Laplace

$s = \sigma + j\omega$

$$\int_{0+}^{\infty} f(t)e^{-st}\,dt$$

kezdeti feltételre is jó



Fourier

csak $j\omega$
$\sigma = 0$

$$\int_{-\infty}^{\infty} f(t)\, e^{-j\omega t}\, dt$$

állandósult áll.
kezdeti felt. NINCS

Laplace

$s = \sigma + j\omega$

$$\int_{0+}^{\infty} f(t)\, e^{-st}\, dt$$

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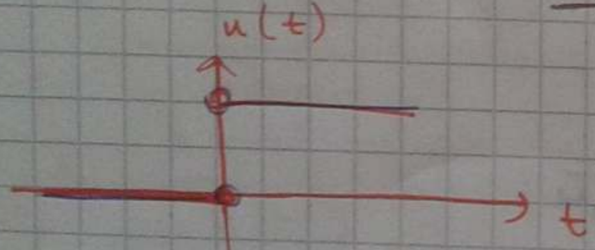
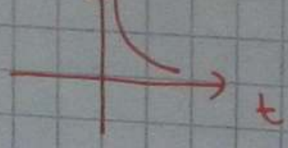


$$\mathcal{L}\{u(t)\} = \int_{0+}^{\infty} 1 e^{-st}\, dt = -\frac{1}{s} e^{-st} \Big|_{0+}^{\infty} = -\frac{1}{s}\cdot 0 + \frac{1}{s}\cdot 1 = \underline{\underline{\frac{1}{s}}}$$

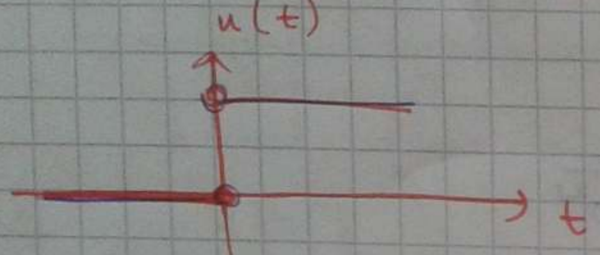
e^{-at}



$$\mathcal{L}\{e^{-at}\} = \int_{0+}^{\infty} e^{-at} e^{-st}\, dt = \int_{0+}^{\infty} e^{-(s+a)t}\, dt = \underline{\underline{\frac{1}{s+a}}}$$

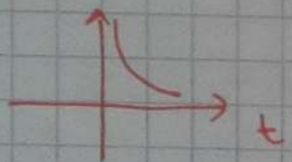
állandósult áll.
kezdeti felt. NINCS

kezdeti feltételre is jó



$$\mathcal{L}\{u(t)\} = \int_{0+}^{\infty} 1 e^{-st}\,dt = -\frac{1}{s} e^{-st} \Big|_{0+}^{\infty} = -\frac{1}{s}\cdot 0 + \frac{1}{s}\cdot 1 = \underline{\underline{\frac{1}{s}}}$$

e^{-at}



$$\mathcal{L}\{e^{-at}\} = \int_{0+}^{\infty} e^{-at} e^{-st}\,dt = \int_{0+}^{\infty} e^{-(s+a)t}\,dt = \underline{\underline{\frac{1}{s+a}}}$$

$$\mathcal{L}\{\sin(\omega t)\} = \int_{0+}^{\infty} \sin(\omega t) e^{-st}\,dt = \int_{0+}^{\infty} \frac{e^{j\omega t} - e^{-j\omega t}}{2j} e^{-st}\,dt =$$

$$= \frac{1}{2j}\int_{0+}^{\infty} \left[e^{-(s-j\omega)t} - e^{-(s+j\omega)t}\right] dt = \frac{1}{2j}\left(\frac{1}{s-j\omega} - \frac{1}{s+j\omega}\right) =$$

$$= \underline{\underline{\frac{\omega}{s^2+\omega^2}}}$$

$$\mathcal{L}\{\delta(t)+2u(t)-3e^{-2t}\} = \mathcal{L}\{\delta(t)\}+\mathcal{L}\{2u(t)\}-\mathcal{L}\{3e^{-2t}\}=$$

$$= 1 + \frac{2}{s} - 3\cdot\frac{1}{s+2} = \underline{\underline{\frac{s^2+s+4}{s(s+2)}}}$$

Inverz Laplace transzformáció

$$F(s) = \frac{3}{s} - \frac{5}{s+1} + \frac{6}{s^2+4} \leftrightarrow \mathcal{L}^{-1}\{F(s)\} = 3u(t) - 5e^{-t} +$$

$$+ 3\sin(2t)$$

$$F(s) = \frac{s^2+12}{s(s+2)(s+3)} = \frac{A}{s} + \frac{B}{s+2} + \frac{C}{s+3} = \frac{A(s+2)(s+3)+Bs(s+3)+Cs(s+2)}{s(s+2)(s+3)} = \dots$$

$$s^2+12 = A(s^2+5s+6)+B(s^2+3s)+$$

$$+C(s^2+2s)$$

$$12 = 6A \Rightarrow A=2$$

$$0s = 5A+3B+2C \Rightarrow 3B+2C=-10$$

$$1s^2 = A+B+C \Rightarrow B+C=-1$$

$$\underline{B=-8}$$

$$\underline{C=7}$$

$$= \frac{2}{s} - \frac{8}{s+2} + \frac{7}{s+3}$$

$$\updownarrow$$

$$\boxed{2u(t) - 8e^{-2t} + 7e^{-3t}}$$

$$= \frac{2}{s} - \frac{8}{s+2} + \frac{7}{s+3}$$

$$\boxed{2u(t) - 8e^{-2t} + 7e^{-3t}}$$

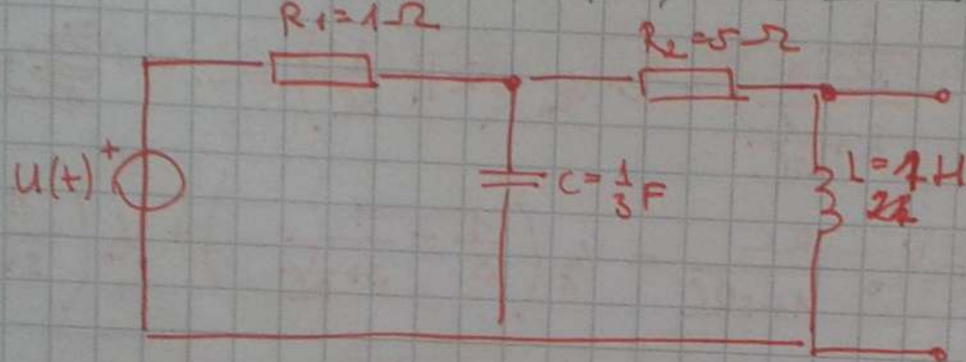
$12 = 6A \Rightarrow A = 2$

$0s = 5A + 3B + 2C \Rightarrow 3B + 2C = -10$

$1s^2 = A + B + C \Rightarrow B + C = -1$

$B = -8$

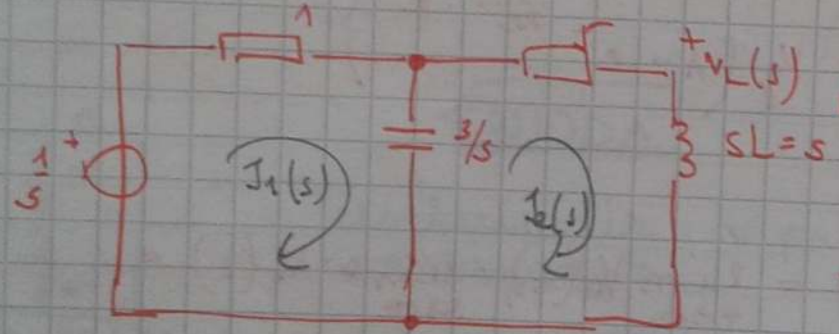
$C = 7$



$V_C(0) = 0$

$i_L(0) = 0$

$V_L(t) = ?$



$u(t) \leftrightarrow \frac{1}{s}$

$Z_C(s) = \frac{1}{sC}$

$Z_L(s) = sL$

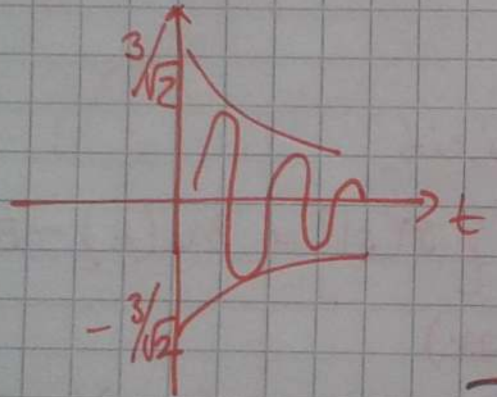
Hurokegyenlet:

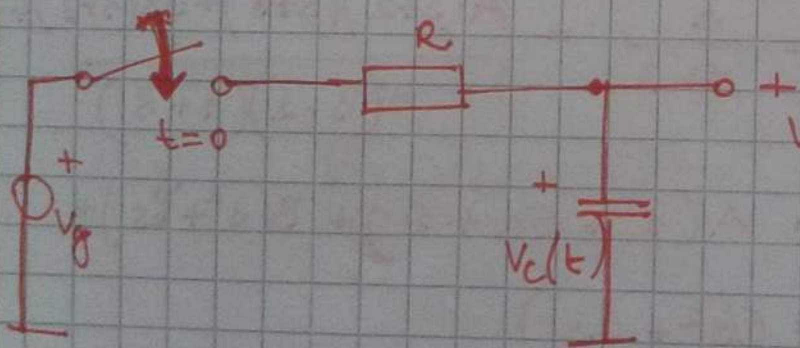
$$\left.\begin{aligned} 0 &= -\frac{1}{s} + \left(1 + \frac{3}{s}\right) J_1 - \frac{3}{s} J_2 \\ 0 &= -\frac{3}{s} J_1 + \left(s + 5 + \frac{3}{s}\right) J_2 \end{aligned}\right\} \Rightarrow$$

$$\Rightarrow J_2 = \frac{3}{s^3 + 8s^2 + 18s}$$

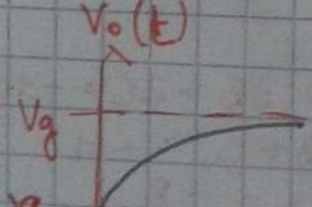
$$V_L(s) = sL J_2(s) = s \cdot \frac{3}{s^3 + 8s^2 + 18s} = \frac{3}{s^2 + 8s + 18} =$$

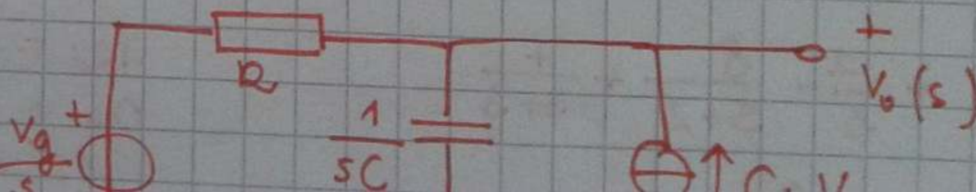
$$= \frac{3}{(s+4)^2+2} = \frac{3\sqrt{2}}{\sqrt{2}\left((s+4)^2+(\sqrt{2})^2\right)} \rightarrow \frac{3}{\sqrt{2}} e^{-4t} \sin(\sqrt{2}\,t) = V_L(t)$$

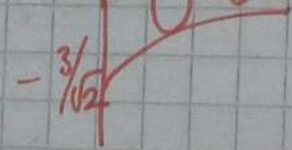


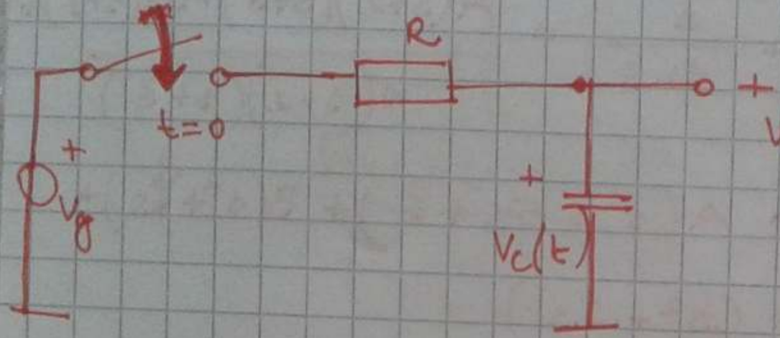


$V_o(t)$, ha $V_c(0) = V_{C_0}$

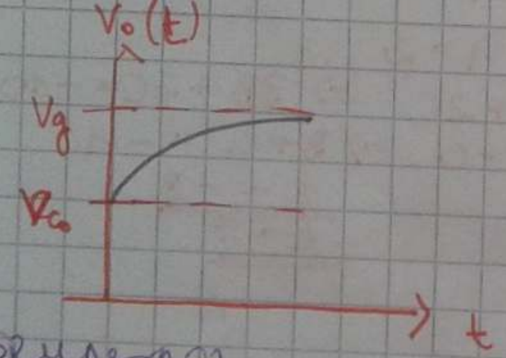


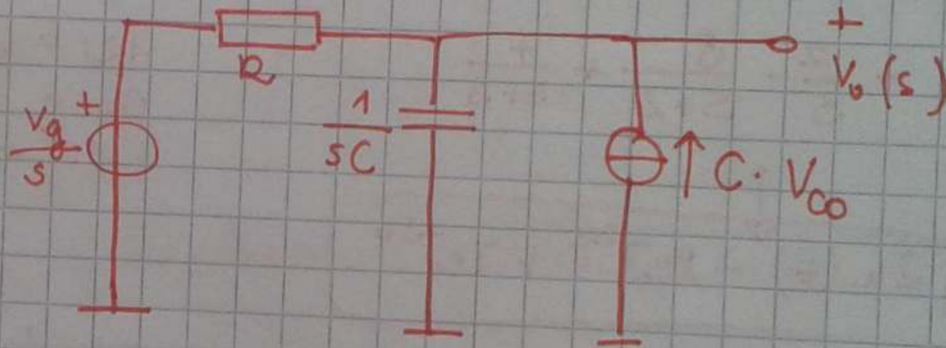






$V_o(t)$, ha $V_C(0) = V_{C_0}$





szuperpoz.

$$V_o(s) = \frac{V_g}{s}\cdot\frac{\frac{1}{sC}}{R+\frac{1}{sC}} + C\cdot V_{C_0}\cdot\left(R \,\|\, \frac{1}{sC}\right) = \dots = \cancel{\frac{V_g}{s}} +$$

$$= \frac{V_g}{s(1+sRC)} + V_{C_0}\frac{RC}{1+sRC} = V_g\left(\frac{1}{s} - \frac{1}{s+\frac{1}{RC}}\right) + V_{C_0}\left(\frac{1}{s+RC}\right)$$

$$\longleftrightarrow V_{C_0}\cdot e^{-\frac{1}{RC}\cdot t} + V_g\left(1 - e^{-\frac{1}{RC}\cdot t}\right)$$

<u>Végérték tétel</u>

$t \to 0$ $\qquad V_o(0+) = \lim V(\dots)$

szuperpoz.

$$V_o(s) = \frac{V_g}{s}\cdot\frac{\frac{1}{sC}}{R+\frac{1}{sC}} + C\cdot V_{C_0}\cdot\left(R \parallel \frac{1}{sC}\right) = \dots = \quad +$$

$$= \frac{V_g}{s(1+sRC)} + V_{C_0}\frac{RC}{1+sRC} = V_g\left(\frac{1}{s} - \frac{1}{s+\frac{1}{RC}}\right) + V_{C_0}\left(\frac{1}{s+RC}\right)$$

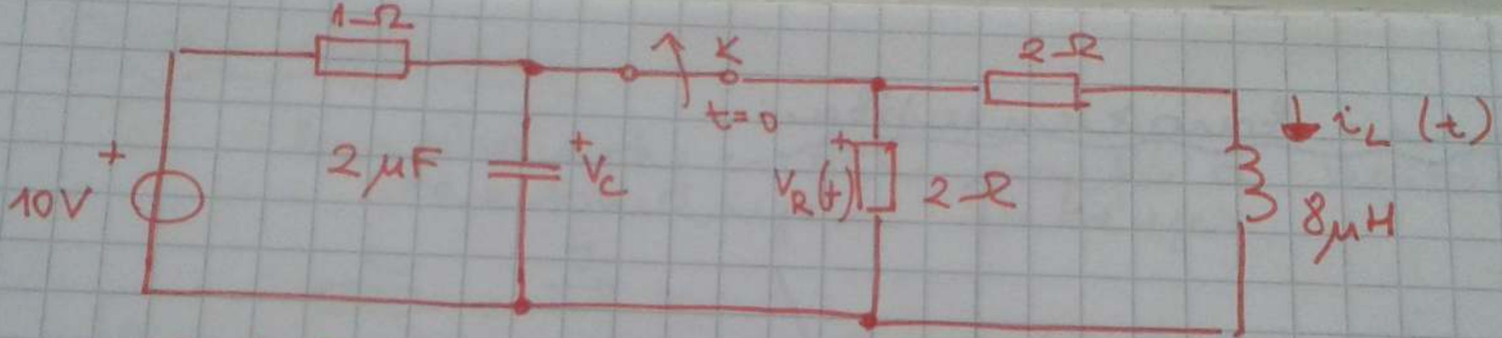
$$\longleftrightarrow \quad V_{C_0}\cdot e^{-\frac{1}{RC}\cdot t} + V_g\left(1-e^{-\frac{1}{RC}\cdot t}\right)$$

Végérték tétel

$t\to 0$ $\quad V_o(0+) = \lim_{t\to 0} V_o(t) = \lim_{s\to\infty} s\cdot V_o(s) =$

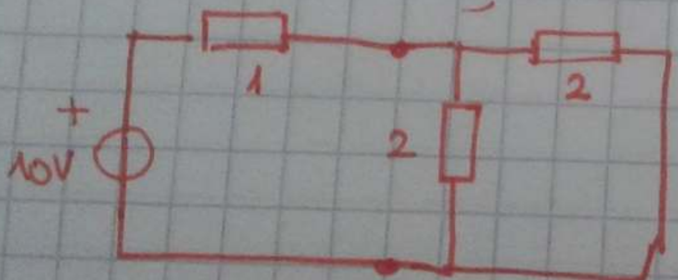
$$= \left(s\cdot\frac{V_g}{s(1+sRC)} + s\cdot\frac{V_{C_0}\cdot RC}{1+sRC}\right)\Bigg|_{s\to\infty} = 0 + V_{C_0}$$

$t\to\infty$ $\quad V_o(\infty) = \lim_{t\to\infty} V_o(t) = \lim_{s\to 0} s\cdot V_o(s) = V_g + 0$



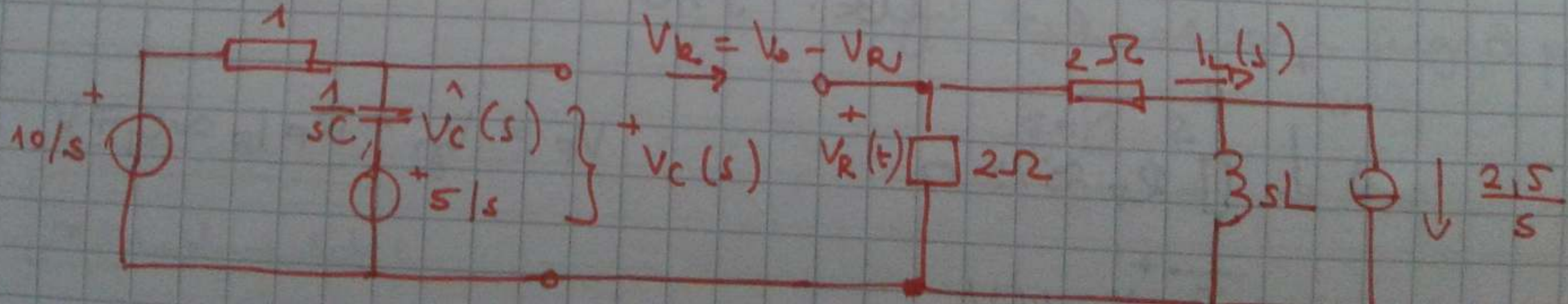
$V(t) = ?$ abr. $V_c(t)$, $V_R(t)$ $-\infty < t < \infty$

$V_c(0) = ?$

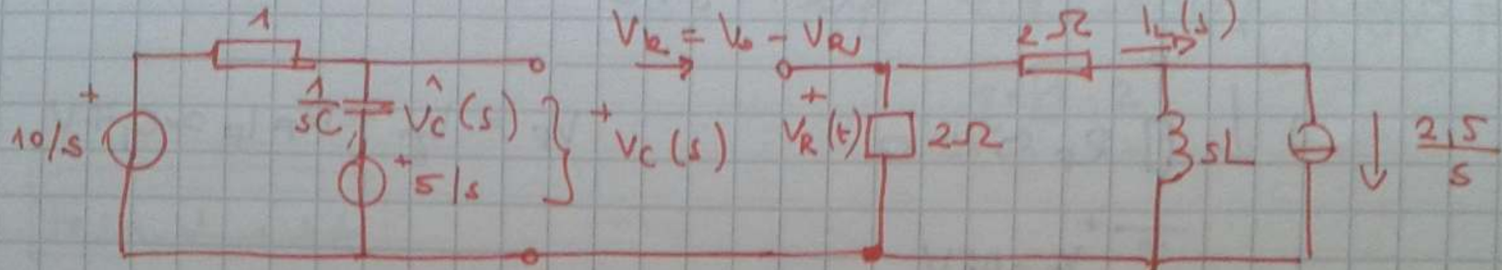


$V_c(0) = 5\,V$

$i_L(0) = 2{,}5\,A$



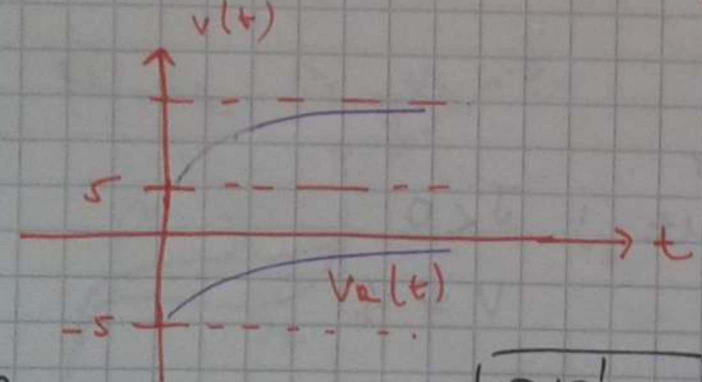
$i_L(0) = 2,5$ A

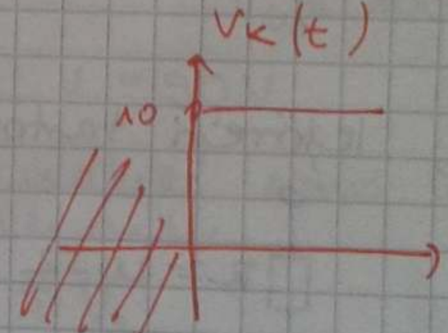


$$V_C(s) = \frac{5}{s} + \hat{V}_C(s) = \frac{5}{s} + \left(\frac{10}{s} - \frac{5}{s}\right) \cdot \frac{\frac{1}{sC}}{1 + \frac{1}{sC}} \qquad \tau_1$$

$$V_R(s) = -\frac{2,5}{s} \cdot \frac{sL}{sL + (2+2)} \cdot 2 \qquad \tau_2$$

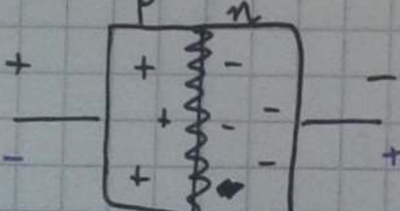
$$V_K(s) = V_C(s) - V_R(s) = \frac{10}{s} \longleftrightarrow 10\,u(t)$$





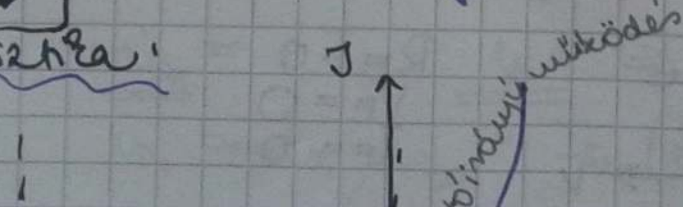
DIÓDA

nov. 21.



elvékonyodik a p-n -átmenet
vastagodik

karakterisztika:



áramköri kép: