4.1)

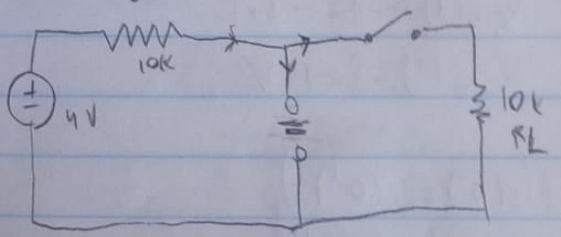
a) $\left(\frac{1}{\left(\frac{1}{4+4} + \frac{1}{6}\right)^{-1} + 2} + \frac{1}{6} \right)^{-1} = 2{,}85\ \mu F$

b) $\left(\frac{1}{\left(\frac{1}{4} + \frac{1}{12}\right)^{-1} + 3} + \frac{1}{4+2} \right)^{-1} + 1 + 2 = 6\ mH$

4.2)

a) $W = \frac{1}{2} C V^2 = \frac{1}{2} \cdot 100 \cdot 4^2 \times 10^{-6} = 0{,}0008\ J = 0{,}8\ mJ$

b)



$V_{R_H} = 4 \cdot \frac{10}{10+10} = 2V$

c)

$V_c(0) = K_1 + K_2$

$V_c(\infty) = K_1$

$\Leftrightarrow$

$V_c(0) = 4V \Leftrightarrow \begin{cases} K_1 = 2 \\ K_2 = 2 \end{cases}$

$V_c(\infty) = 2V = K_1$

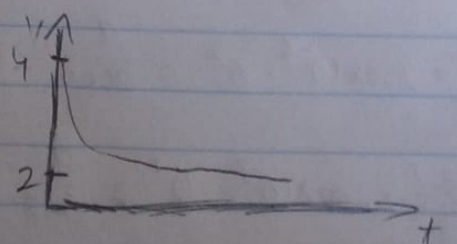
$\tau = R_H C$

$= 5 \times 10^{-3} \times 100 \times 10^{-6}$

$= 0{,}5$

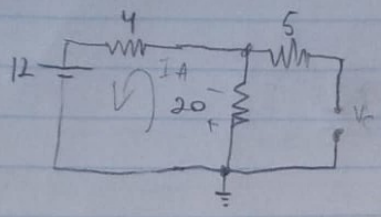
$V_c(t) = K_1 + K_2 e^{-t/\tau}$

$V_c(t) = 2 + 2 e^{-\frac{t}{0{,}5}}$



4.3) $V_c(0^-) = V_c(0^+) = 10\,V$

$t=0^-$

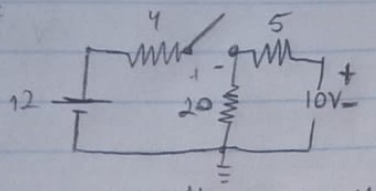


$I_A = -0{,}5\,A$

$20 \cdot 0{,}5 = 10\,V$

$\tau = R_{Th} \cdot C = 50_{om} \cdot 25 = 1250 \times 10^{-3}$

$t=0^+$

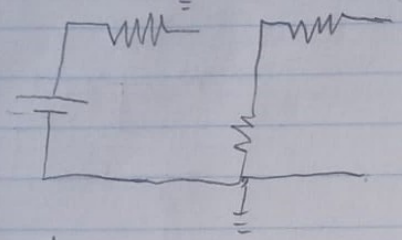


$V_c(0^+) = 10\,V$

$V_R(0^+) = 10 \cdot \frac{20}{5+20} = 8\,V$ $\rightarrow K_1 + K_2$

$V_{SW}(0^+) = 12 - 8 = 4$

$t=\infty$



$V_c(\infty) = 0V$

$V_R(\infty) = 0V$ $\rightarrow K_1$

$V_{SW}(\infty) = 12\,V$

$V_c(t) = 10\,e^{-\frac{t}{1250 \times 10^{-3}}}$ $V_R(t) = 8 \cdot e^{-\frac{t}{1250 \times 10^{-3}}}$ $V_{SW}(t) = 12 - 8 \cdot e^{-\frac{t}{1250 \times 10^{-3}}}$

$V_c(1) = 4{,}49\,V$ $V_R(1) = 3{,}59\,V$ $V_{SW}(1) = 8{,}41\,V$

4.4) $i_L(0^-) = \frac{10}{2} = 5A$ $V_L(0^-) = 0$ $(i_L(0^-) = i_L(0^+))$

$i_C(0^-) = 0$ $V_C(0^-) = \frac{12}{20} \cdot 10 = 6V$ $(V_c(0^-) = V_c(0^+))$

$i_L(\infty) = \frac{20}{2} = 10A$ $V_L(\infty) = 0$

$i_C(\infty) = 0$ $V_C(\infty) = \frac{12}{20} \cdot 20 = 12V$

$W_L(0) = \frac{1}{2} \cdot 3 \cdot 10^{-3} \cdot 5^2 = \frac{3}{80}\,J$ (37,5mJ) $W_C(0) = \frac{1}{2} \cdot 200 \times 10^{-6} \cdot 6^2 = \frac{9}{2600} = 3.6mJ$

$W_L(\infty) = \frac{1}{2} \cdot 3 \cdot 10^{-3} \cdot 10^2 = \frac{3}{20}\,J$ (150mJ) $W_L(0) = \frac{1}{2} \cdot 200 \times 10^{-6} \cdot 12^2 = \frac{9}{625} = 14{,}4mJ$

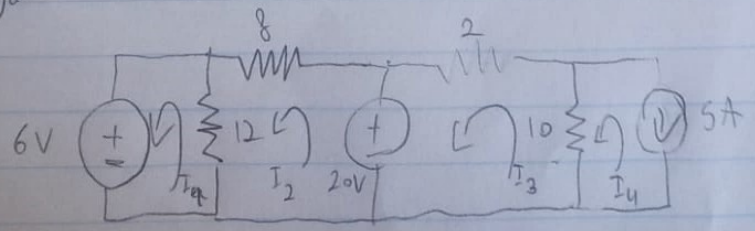
$0^+ \rightarrow$

$i_L(0^+) = 5A$ Logo

$V_C(0^+) = 6V$

$V_L(0^+) = 8.3V$

$i_C(0^+) = 1{,}25A$



$W_L(0^+) = W_L(0^-)$

$W_C(0^+) = W_C(0^-)$

I_3: $I_4 = 5A$

$10(I_3 - I_4) + 2(I_3) + 20V = 0$

I_2: $-20 + 8(I_2) + 12(I_2 - I_1) = 0$

I_1: $12(I_1 - I_2) + 6 = 0$

$\Leftrightarrow$

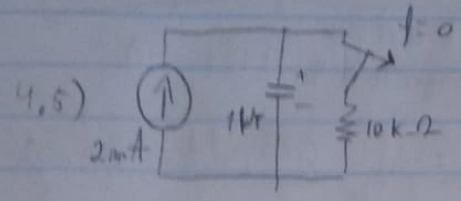
$I_4 = -5$

$I_3 = -5{,}8(3)$

$I_2 = 1{,}75$

$I_1 = 1{,}25$

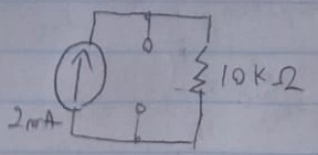
(4.6)



a) $W_C = \frac{1}{2} \cdot C \cdot V^2 =$

$= \frac{1}{2} \cdot 1 \cdot 10^{-6} \cdot 20^2 =$

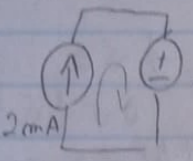
$= 2 \times 10^{-4} J$



$V = 2 \cdot 10^{-3} \cdot 10 \cdot 10^3 = 20V$

$P = 2 \cdot 10^{-3} \cdot -20 = -0.04 W$

b)



Tensão inicial

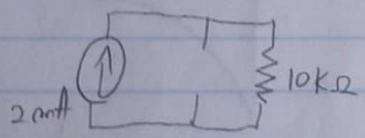
$2 \times 10^{-3} = 1 \times 10^{-6} \frac{dV}{dt} \Leftrightarrow \frac{dV}{dt} = 2000 \Leftrightarrow V = 2000t + k$

$\boxed{V = 2000t + 20}$

$t_1 = t = 15 ms$

$V_C(t_1) = 50V$

c) $V_C(t_1) = 50V$ $\quad V_C(\infty) = 20V$



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

$k_1 + k_2 = 50$

$k_1 = 20$

$\tau = 10 \cdot 10^3 \cdot 1 \cdot 10 \cdot 10^{-6} =$

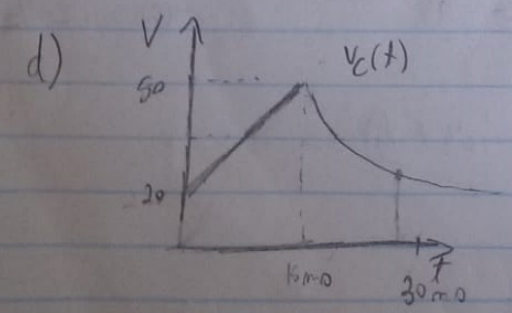
$= 10 \cdot 10^{-3}$

$V(t) = 20 + 30 e^{-\frac{t - 15ms}{10 \cdot 10^{-3}}}$

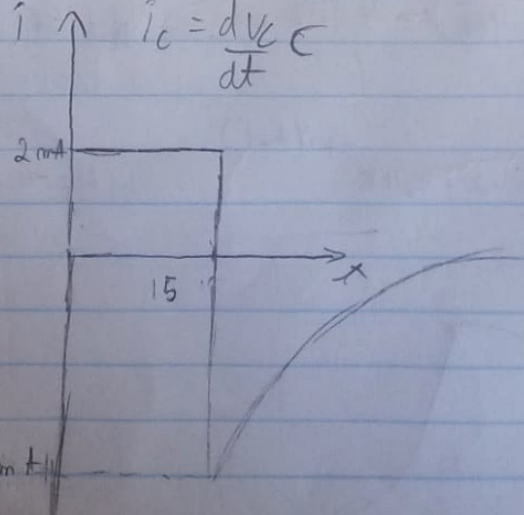
$t = t_2 = 30 ms$

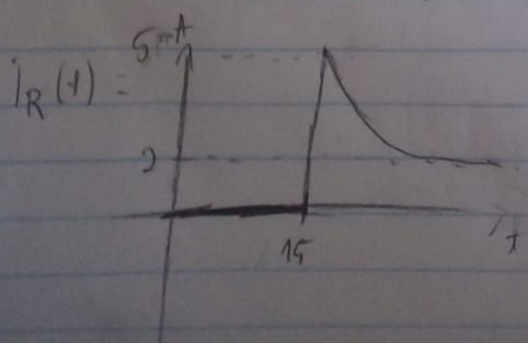
$V(t_2) = 20 + 30 e^{-\frac{15ms}{10 \cdot 10^{-3}}} \approx 26.69$

d)



$i_C = \frac{dV_C}{dt} C$





2) $P_F = i(t) \cdot v(t) = 2\times10^{-3} \cdot V_c(t) = -2\times10^{-3} \cdot \begin{cases} 2000t+20 & 0<t<15\,ms \\ 20+30e^{-\frac{t-15ms}{10}} & 15<t<30 \end{cases}$

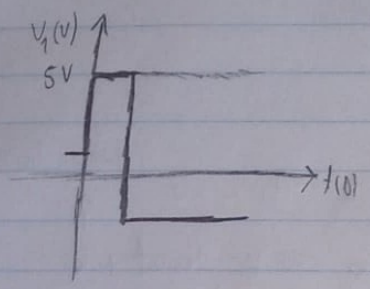
$W_F = \int_0^{30} P_F = \int_0^{15} -2\times10^{-3}(2000t+20) + \int_{15}^{30} -2\times10^{-3}\,20+30e^{-\frac{t-15}{10}} =$

$W_F = -\frac{21}{2000e} - \frac{e^{-\frac{3}{2}}\left(6e^{\frac{3}{2}}-3\right)}{6000} = -2,116\,mJ$

$P_R = \begin{matrix} 0 \text{ a } 15 = 0 \\ 15 \text{ a } 30 = V_c(t) \end{matrix}$

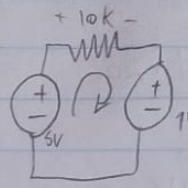
$W_R = \int_{15}^{30} P_R = \int_{15}^{30} \frac{V_c^2(t)\cdot dt}{R} = 1,96\,mJ$

4.6)



$V_c(t)\begin{cases} 1 & t<0 \\ 5-4e^{-10^4 t} & 0<t<150\mu s \\ -2+4.11e^{-10^4(t-t_1)} & t>150\mu s \end{cases}$

$V_R(t)\begin{cases} 0 & t<0 \\ 4e^{-10^4 t} & 0<t<150\mu s \\ -6.11e^{-10^4(t-t_1)} & t>150\mu s \end{cases}$



de 1 para 5:

$V_c(0^-) = V_c(0^+)$

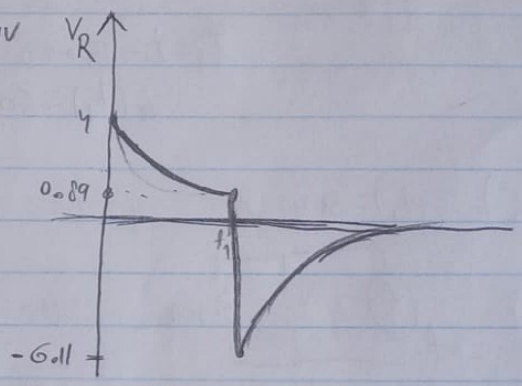
$V_c(0^-) = 1V$

$V_c(0^+) = 1V$

$V_R(0^+) = 4V$

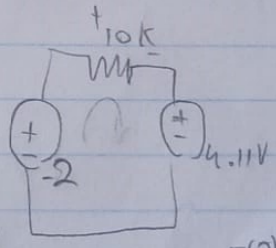
$V_c(\infty) = 5V = k_1$

$V_R(\infty) = 0$



$k_1 = 5V$ e $k_2 = -4V$ e $\tau = 10\cdot10^3 \cdot 10\cdot10^{-9} = 10^{-4}$

$V_c(t) = 5-4e^{-10^4 t}$ $\quad V_R(t) = 4e^{-10^4 t}$



de 5 para 2:

$V_c(150\mu s^+) = V_c(150\mu s^-) = 4,11V$

$V_c(\infty) = -2$

$k_1 = -2$ $\quad V_c(t) = -2+4,11e^{-10^4(t-t_1)}$

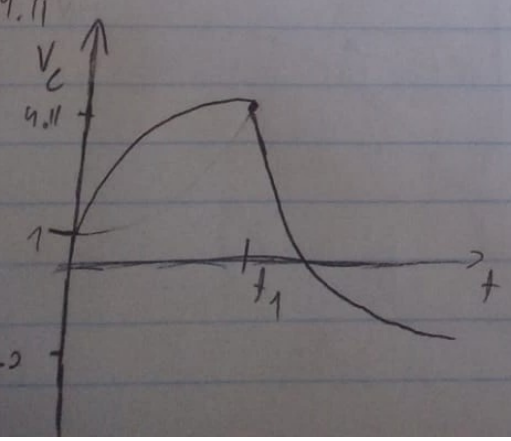
$k_2 = 4,11$

$V_R(150\mu s^+) = -6.11V$

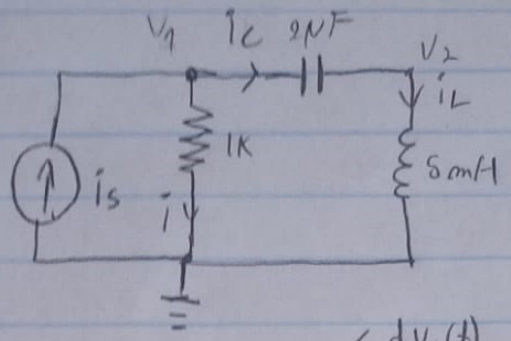
$V_R(\infty) = 0$

$V_R(t) = -6.11e^{-10^4(t-t_1)}$

$-(-2)+4.11 = -V_R$



4.7



a)

$$\begin{cases} i_S = i_C + i \\ i_2 = i_C \end{cases} \Leftrightarrow \begin{cases} i_S = \frac{v_1(t)}{R} + C\left(\frac{dv_1(t)}{dt} - \frac{dv_2(t)}{dt}\right) \\ C\left(\frac{dv_2(t)}{dt} - \frac{dv_1(t)}{dt}\right) = \frac{1}{L}\int_0^t v_2(x)dx + i_L(0) \end{cases}$$

b) $$\frac{1}{C}\int_0^t i_C(x)dx + R\left(i_C(t) - i_S(t)\right) + L\frac{di_C(t)}{dt} + v_C(0) = 0$$