1 a) $I_x = \dfrac{V_1}{R_1+R_2} \Rightarrow \boxed{I_x = 2{,}70\,mA}$

$V_x = I_x R_2 = \dfrac{R_2}{R_1+R_2} V_1 \Rightarrow \boxed{V_x = 5{,}95V}$

b) $I_x = \dfrac{V_{cc}}{R_1+R_2+R_3} \Rightarrow \boxed{I_x = 49{,}5\,mA}$

$V_x = I_x R_3 = \dfrac{R_3}{R_1+R_2+R_3} V_{cc} \Rightarrow \boxed{V_x = 1{,}34V}$

c) $I_x = I_1 \Rightarrow \boxed{I_x = 10\,mA}$

$V_x = I_x R_2 \Rightarrow \boxed{V_x = 1{,}8V}$

d) $I_x = \dfrac{R_1}{R_1+R_2} I_1 \Rightarrow \boxed{I_x = 43{,}7\,mA}$

$V_x = I_x R_2 \Rightarrow \boxed{V_x = 3{,}59V}$

e) $v' = I_1 R_1 \Rightarrow \boxed{v' = 660\,mV}$

$I_2 = k v' \Rightarrow \boxed{I_2 = 99{,}0\,mA}$

$I_1 = I_x + I_2 \Rightarrow \boxed{I_x = -69\,mA}$

$V_x = I_x R_3$

$\therefore \boxed{V_x = -2{,}28V}$

$\boxed{A}$

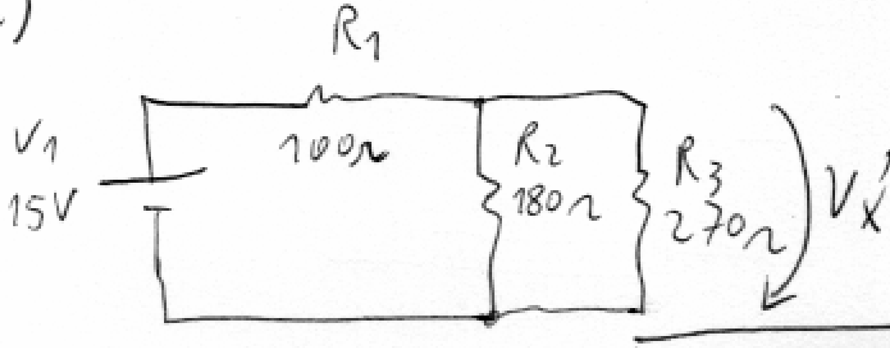
f) $i' = \frac{V_1}{R_{11} + R_{15}} \Rightarrow \boxed{i' = 0{,}4\,mA}$

$V_2 = \delta\, i' \Rightarrow \boxed{V_2 = 6V}$

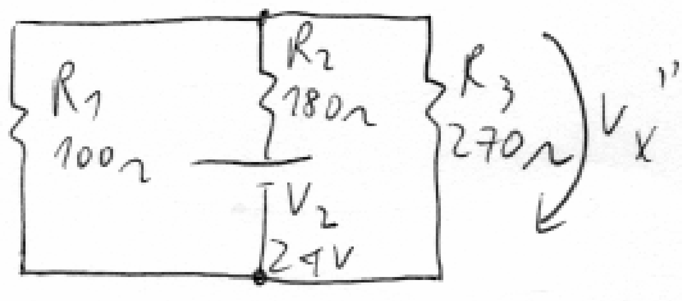
$V_x = V_1 + V_2 \Rightarrow \boxed{V_x = 18V}$

$I_x = \frac{V_x}{R_{14}} \Rightarrow \boxed{I_x = 3{,}27\,mA}$

② a)



$V_x' = \frac{-R_2 // R_3}{R_2 // R_3 + R_1} \cdot V_1 \Rightarrow \boxed{V_x' = -7{,}79V}$

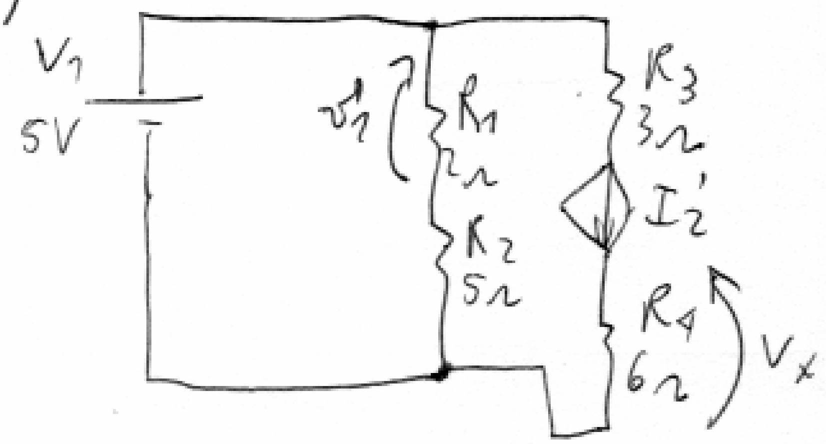


$V_x'' = -\frac{R_1 // R_3}{R_1 // R_3 + R_2} V_2 \Rightarrow \boxed{V_x'' = -6{,}92V}$

$\therefore V_x = V_x' + V_x'' \Rightarrow \boxed{V_x = -14{,}71V}$

B

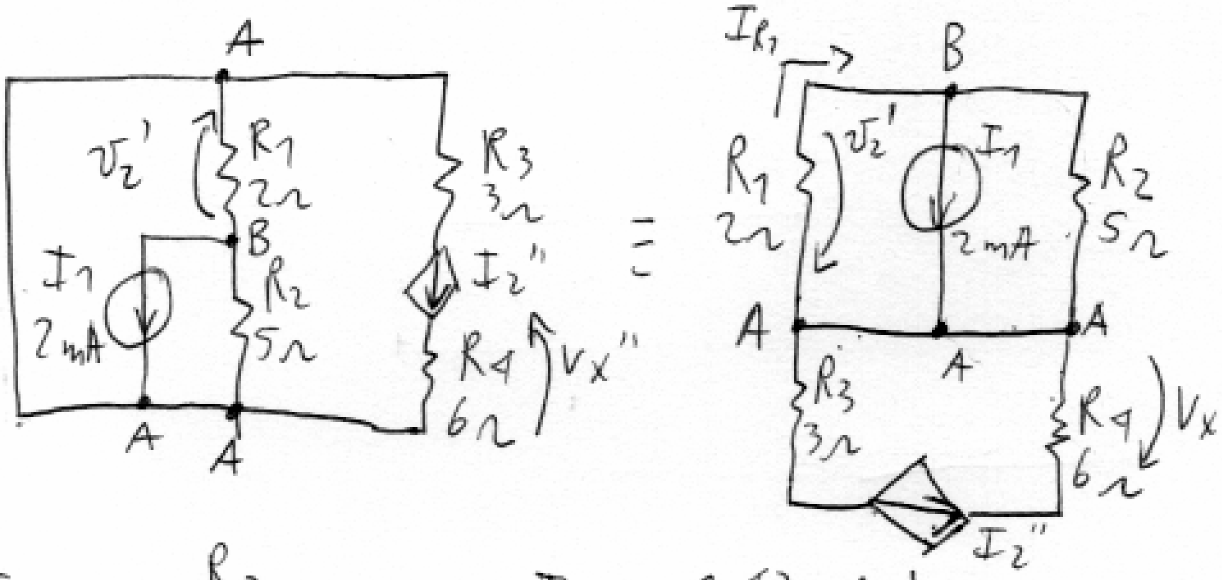
b)



$$v_1' = \frac{R_1}{R_1+R_2} V_1 \Rightarrow \boxed{v_1' = 1{,}43V}$$

$$I_2' = K v_1' \Rightarrow \boxed{I_2' = 0{,}714A}$$

$$V_x' = R_4 I_2' \Rightarrow \boxed{V_x' = 4{,}29V}$$



$$I_{R_1} = \frac{R_2}{R_1+R_2} I_1 \Rightarrow \boxed{I_{R_1} = 1{,}43mA}$$

$$v_2' = I_{R_1} \cdot R_1 \Rightarrow \boxed{v_2' = 2{,}86mV}$$

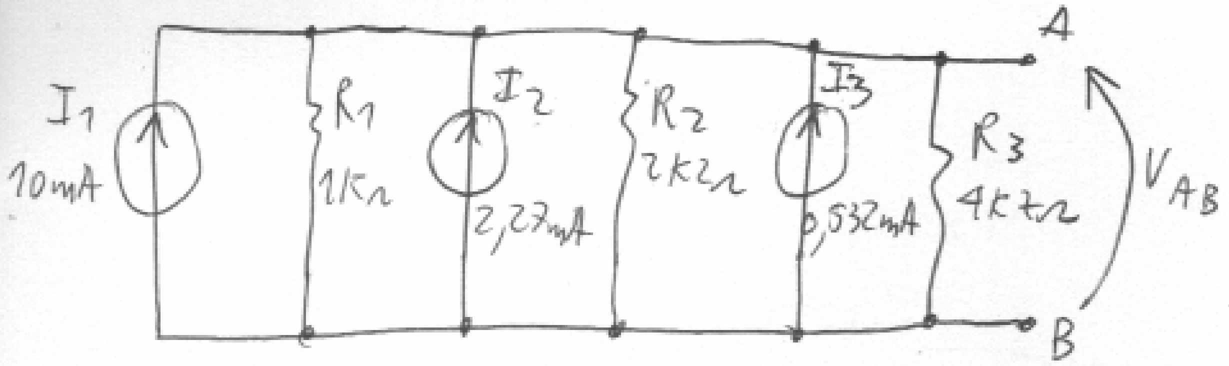
$$I_2'' = K v_2' \Rightarrow \boxed{I_2'' = 1{,}43mA}$$

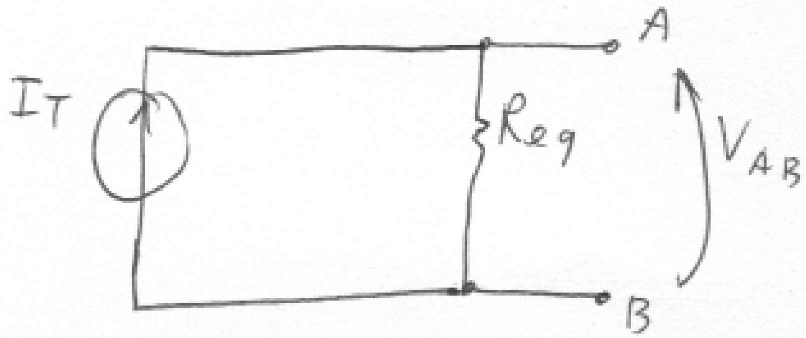
$$V_x'' = I_2'' \cdot R_4 \Rightarrow \boxed{V_x'' = 8{,}57mV}$$

$$\therefore V_x = V_x' + V_x'' \Rightarrow \boxed{V_x = 4{,}29V} \quad (V_x = 4{,}30V)$$

C

3

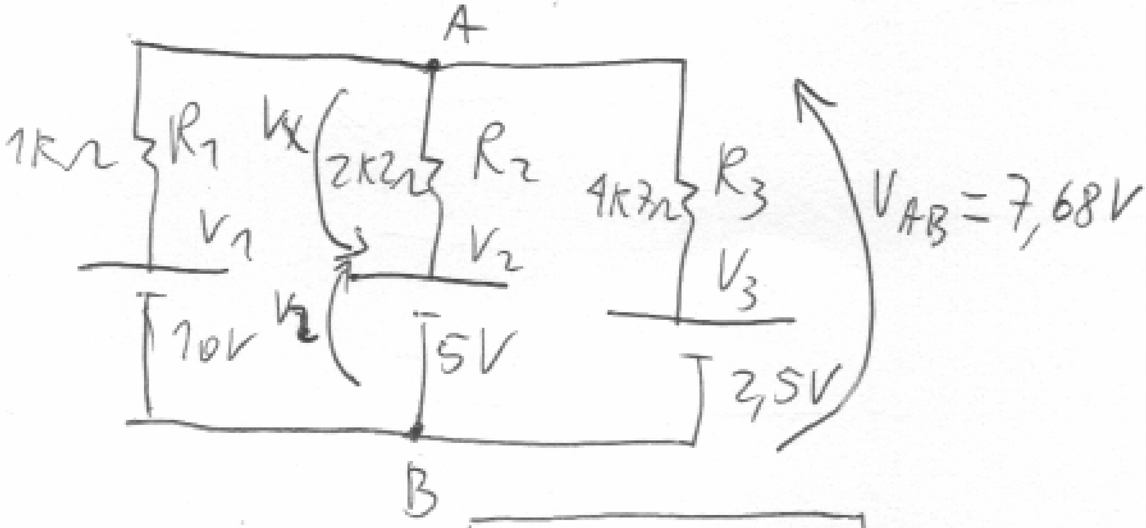




$I_T = I_1 + I_2 + I_3 \Rightarrow \boxed{I_T = 12,8\,mA}$

$R_{eq} = R_1 // R_2 // R_3 \Rightarrow \boxed{R_{eq} \cong 600\,\Omega}$

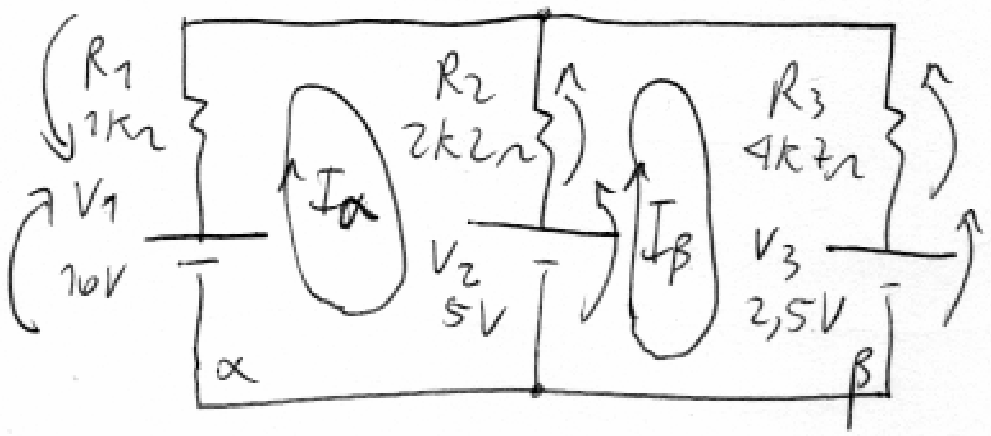
$V_{AB} = I_T R_{eq} \Rightarrow \boxed{V_{AB} = 7,68\,V}$



$V_X = V_2 - V_{AB} \Rightarrow \boxed{V_X = -2,68\,V}$

D

④



a)

$\alpha : V_1 - R_1 I_\alpha - (I_\alpha - I_\beta) R_2 - V_2 = 0$

$$(-R_1 - R_2) I_\alpha + R_2 I_\beta = V_2 - V_1$$

$\beta : V_2 + (I_\alpha - I_\beta) R_2 - R_3 I_\beta - V_3 = 0$

$$R_2 I_\alpha + (-R_2 - R_3) I_\beta = V_3 - V_2$$

$$\therefore \boxed{\begin{cases} (R_1 + R_2) I_\alpha - R_2 I_\beta = V_1 - V_2 \\ -R_2 I_\alpha + (R_2 + R_3) I_\beta = V_2 - V_3 \end{cases}}$$

b)

$$\begin{cases} 3,2 \cdot 10^3 I_\alpha - 2,2 \cdot 10^3 I_\beta = 5 \\ -2,2 \cdot 10^3 I_\alpha + 6,9 \cdot 10^3 I_\beta = 2,5 \end{cases}$$

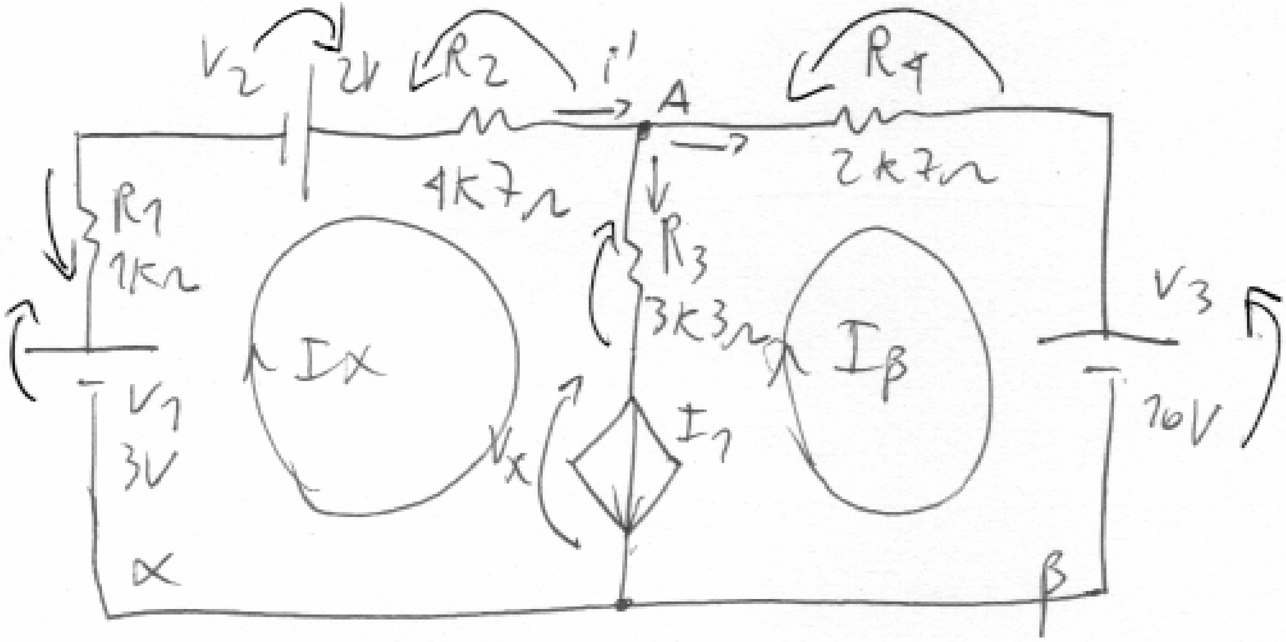
$\therefore \boxed{I_\alpha = 2,32\ mA}$ $\boxed{I_\beta = 1,10\ mA}$

E

c) $V_{R_2} = (I_\alpha - I_\beta) R_2 \Rightarrow \boxed{V_{R_2} = 3{,}68V}$

$$V_x = -V_{R_2} \Rightarrow \boxed{V_x = -2{,}68V}$$

⑤



$\underline{\alpha+\beta}$: $V_1 - R_1 I_\alpha + V_2 - R_2 I_\alpha - R_4 I_\beta - V_3 = 0$

$\underline{A}$: $I_\alpha = I_1 + I_\beta$

$\therefore I_\beta = I_\alpha - I_1 = I_\alpha - \alpha i' = I_\alpha - \alpha I_\alpha =$
$= I_\alpha(1-\alpha)$

$\therefore V_1 - R_1 I_\alpha + V_2 - R_2 I_\alpha - R_4[I_\alpha(1-\alpha)] - V_3 = 0$

$[-R_1 - R_2 - R_4(1-\alpha)] I_\alpha = V_3 - V_2 - V_1$

$$\boxed{I_\alpha = \frac{-V_3 + V_2 + V_1}{R_1 + R_2 + R_4(1-\alpha)}}$$

F

Alternativamente:

$$\boxed{\begin{cases} (-R_1 - R_2) I_\alpha - R_4 I_\beta = V_3 - V_1 - V_2 \\ (1-\alpha) I_\alpha - I_\beta = 0 \end{cases}}$$

b) $\begin{cases} -5{,}7 \cdot 10^3 I_\alpha - 2{,}7 \cdot 10^3 I_\beta = 5 \\ 0{,}5 I_\alpha - I_\beta = 0 \end{cases}$

$\therefore \boxed{I_\alpha = -709\,\mu A}$ $\boxed{I_\beta = -355\,\mu A}$

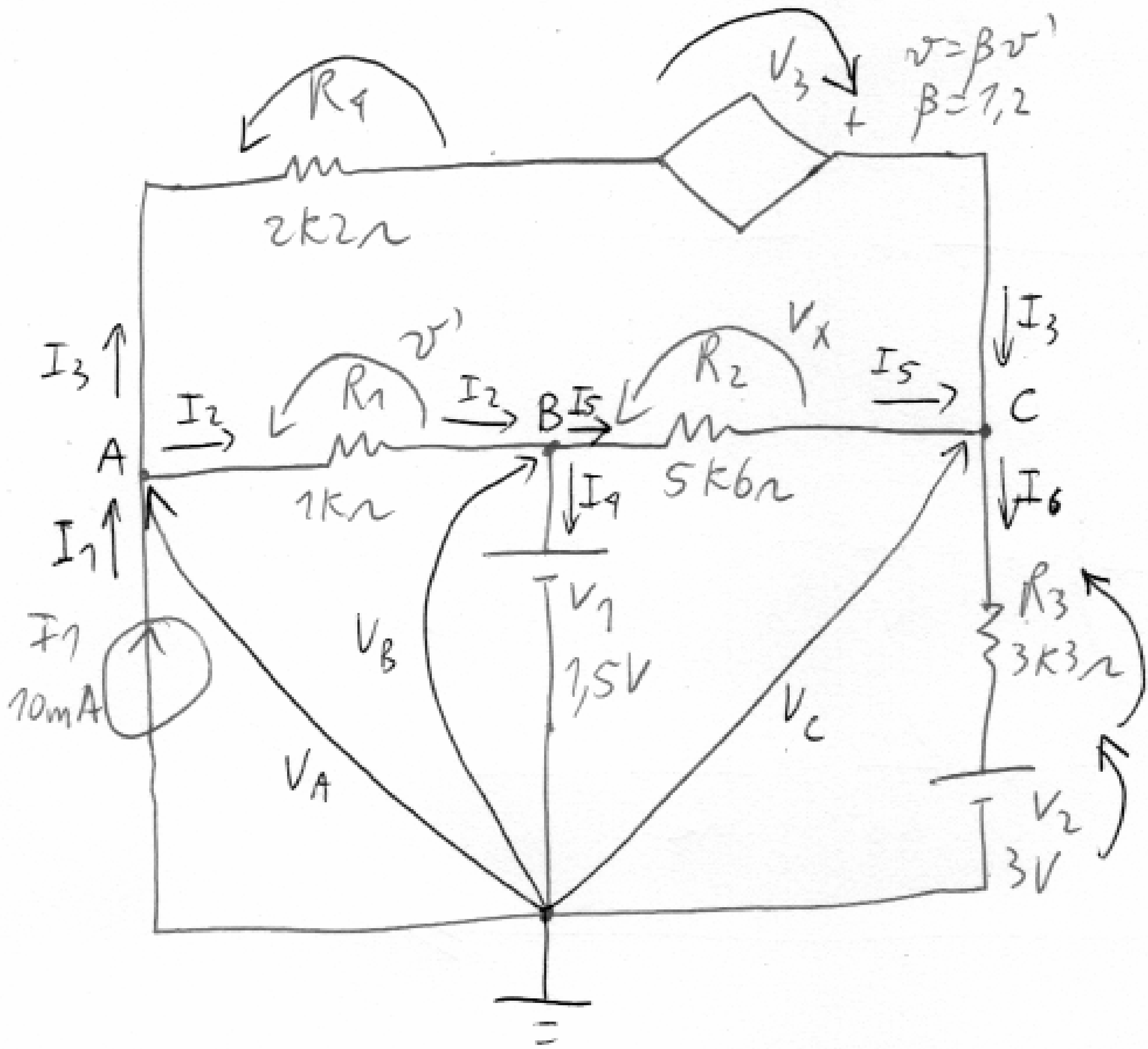
c) $\underline{\beta}$: $V_x + R_3 I_1 - R_4 I_\beta - V_3 = 0$

$I_1 = 0{,}5 I_\alpha = \alpha I_\alpha$

$\cancel{\boxed{V_x = 10{,}2\,V}}$ $\cancel{\boxed{V_x = 9{,}79\,V}}$

$\therefore \boxed{V_x = 10{,}2\,V}$

6



a) $I_1 = I_2 + I_3$

$$I_1 = \frac{V_A - V_B}{R_1} + \frac{V_3 - V_C + V_A}{R_4}$$

$$V_B = V_1$$

$$V_3 = \beta v' = \beta (V_A - V_B) = \beta (V_A - V_1)$$

$$\frac{-V_1 + V_A}{R_1} + \frac{\beta (V_A - V_1) - V_C + V_A}{R_4} = I_1$$

$$\left(\frac{1}{R_1} + \frac{\beta + 1}{R_4}\right) V_A - \frac{1}{R_4} V_C = I_1 + \frac{V_1}{R_1} + \frac{\beta V_1}{R_4}$$

H

$\underline{C}$: $I_5 + I_3 - I_6 = 0$

$$\frac{-V_C + V_B}{R_2} + \frac{\beta(V_A - V_1) - V_C + V_A}{R_4} - \frac{V_C - V_2}{R_3} = 0$$

$$V_B = V_1$$

$$\left(\frac{\beta+1}{R_4}\right)V_A + \left(-\frac{1}{R_2} - \frac{1}{R_3} - \frac{1}{R_4}\right)V_C =$$

$$= -\frac{V_1}{R_2} + \frac{\beta V_1}{R_4} - \frac{V_2}{R_3}$$

b) $$\begin{cases} 2 \cdot 10^{-3} V_A - 455 \cdot 10^{-6} V_C = 12{,}3 \cdot 10^{-3} \\ 1 \cdot 10^{-3} V_A - 936 \cdot 10^{-6} V_C = -359 \cdot 10^{-6} \end{cases}$$

$\therefore$ $\boxed{V_A = 8{,}25\,V}$ $\boxed{V_B = 1{,}5\,V}$ $\boxed{V_C = 9{,}19\,V}$

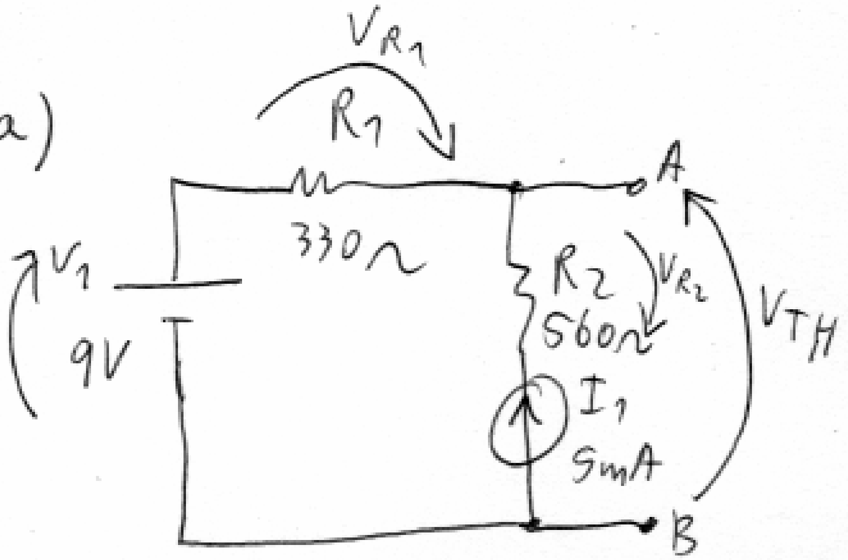
c) $V_X = -V_C + V_B$

$\therefore$ $\boxed{V_X = -7{,}69\,V}$

I

7

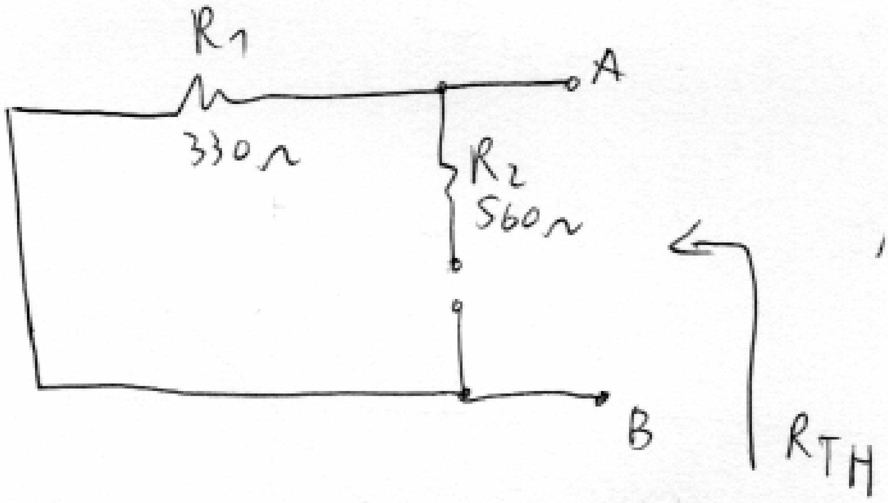
a)



$V_{R_1} = I_1 R_1 \Rightarrow \underline{V_{R_1} = 1{,}65V}$

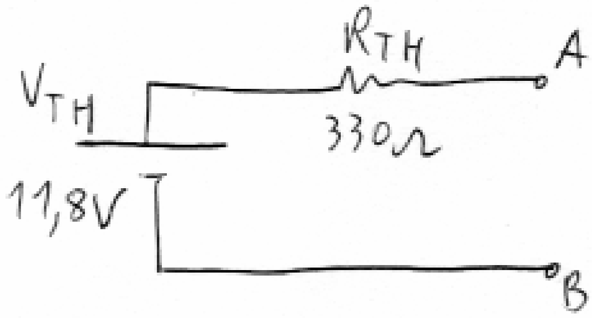
$V_{R_2} = I_1 R_2 \Rightarrow \underline{V_{R_2} = 2{,}8V}$

$V_{TH} = V_1 + V_{R_1} \Rightarrow \boxed{V_{TH} = 10{,}7V}$



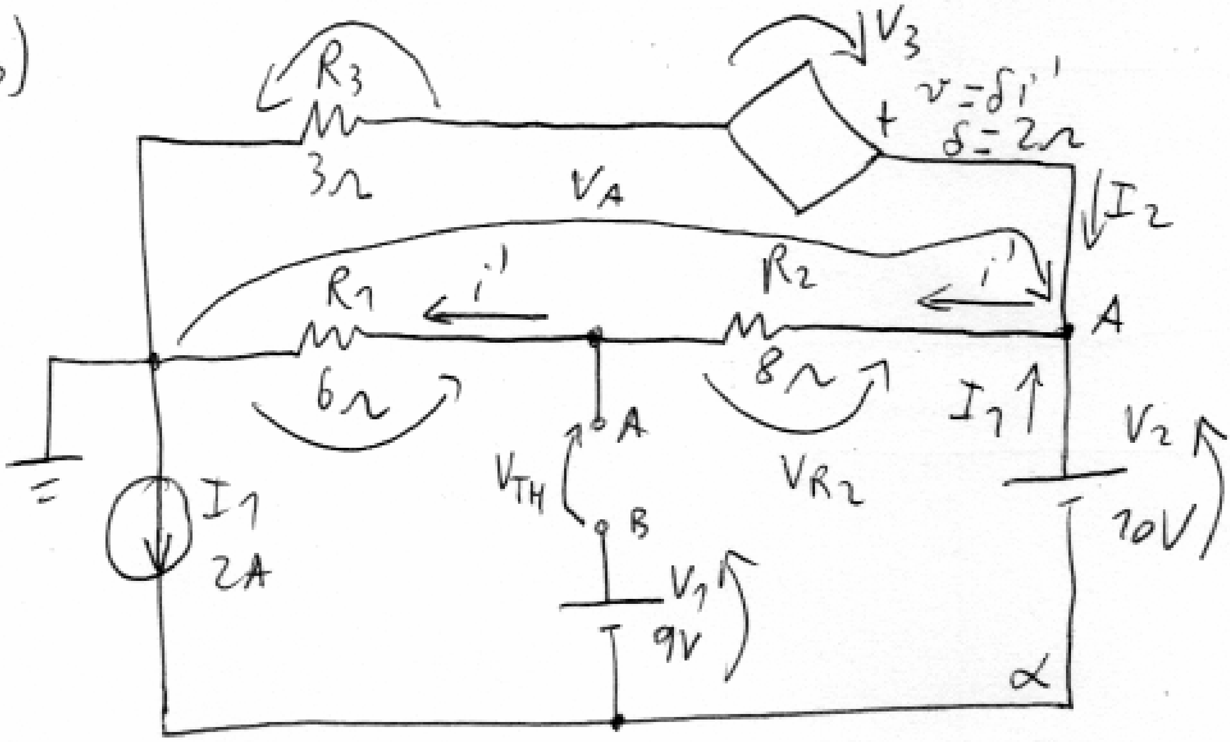
$\therefore \boxed{R_{TH} = 330\Omega}$

Circuito Equivalente:



J

b)



$\underline{A}$: $I_1 + I_2 - i' = 0$

$$I_1 + \frac{V_3 - V_A}{R_3} - \frac{V_A}{R_1+R_2} = 0$$

$$V_3 = \delta i' = \delta \frac{V_A}{R_1+R_2}$$

$$\therefore I_1 + \frac{\left(\frac{\delta}{R_1+R_2} - 1\right)V_A}{R_3} - \frac{V_A}{R_1+R_2} = 0$$

$$\boxed{V_A = \frac{I_1}{\frac{1}{R_1+R_2} - \frac{\frac{\delta}{R_1+R_2} - 1}{R_3}}}$$

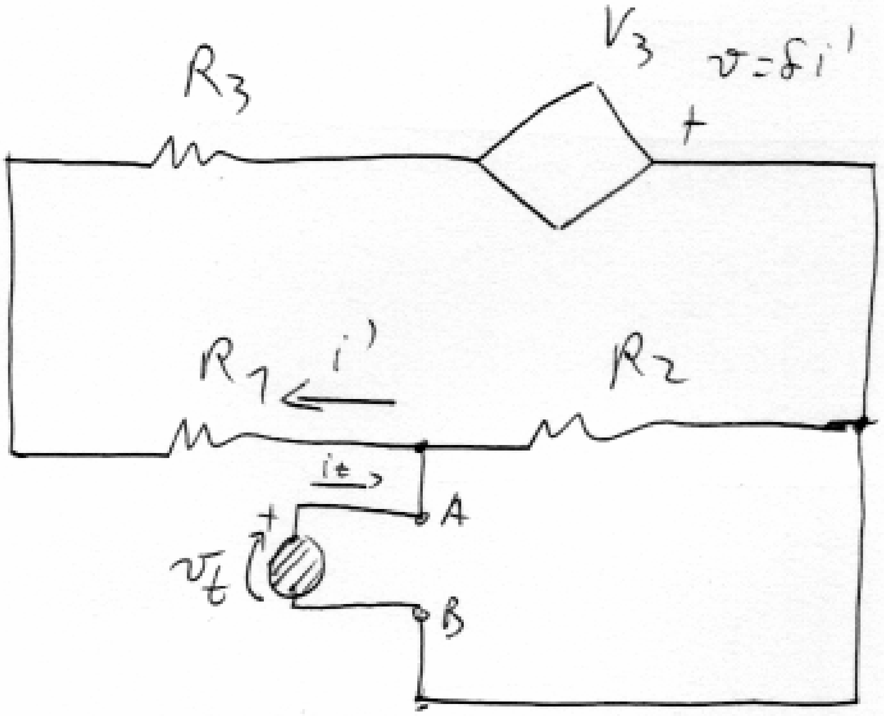
$$\boxed{V_A = 237 mV}$$

$\boxed{K}$

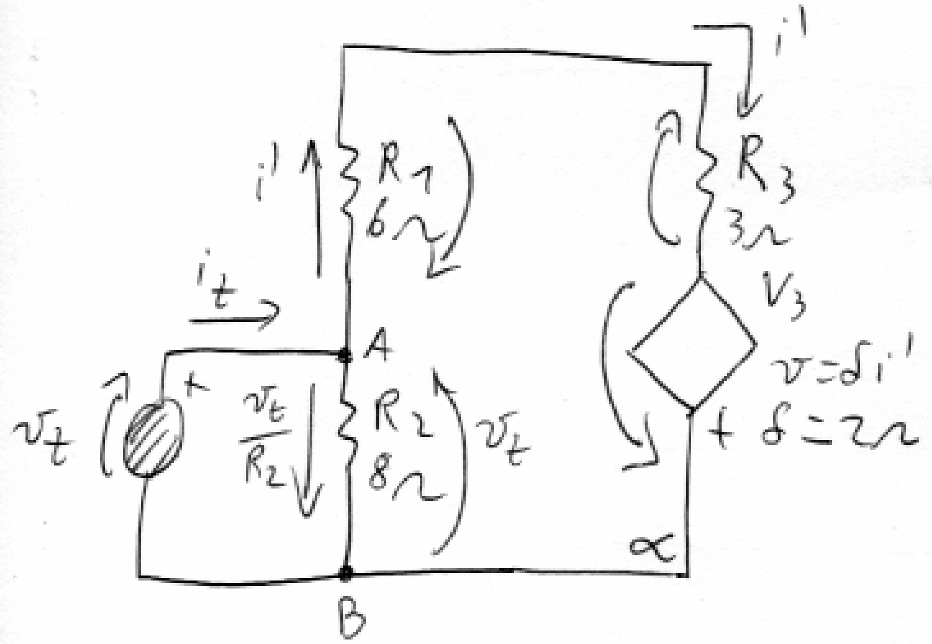
$$V_{R_2} = \frac{R_2}{R_1 + R_2} V_A \Rightarrow \boxed{V_{R_2} = 135\,mV}$$

$\underline{\alpha}$: $V_1 + V_{TH} + V_{R_2} - V_2 = 0$

$\therefore \boxed{V_{TH} = 865\,mV}$ //



$\Downarrow$



$$i' = i_t - \frac{v_t}{R_2}$$

(Continua...)

$\underline{\alpha}$: $v_t - V_{R_1} - V_{R_3} + V_3 = 0$

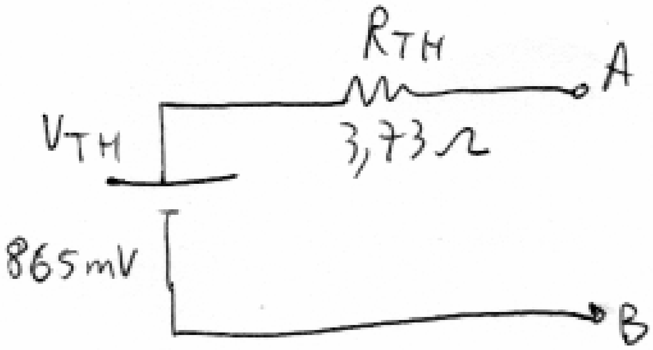
$$v_t - \left(i_t - \frac{v_t}{R_2}\right)(R_1 + R_3) + \delta\left(i_t - \frac{v_t}{R_2}\right) = 0$$

$$v_t\left[1 + \frac{R_1 + R_3}{R_2} - \frac{\delta}{R_2}\right] = i_t\left[(R_1 + R_3) - \delta\right]$$

$$\boxed{\frac{v_t}{i_t} = \frac{R_1 + R_3 - \delta}{1 + \frac{R_1 + R_3}{R_2} - \frac{\delta}{R_2}}}$$

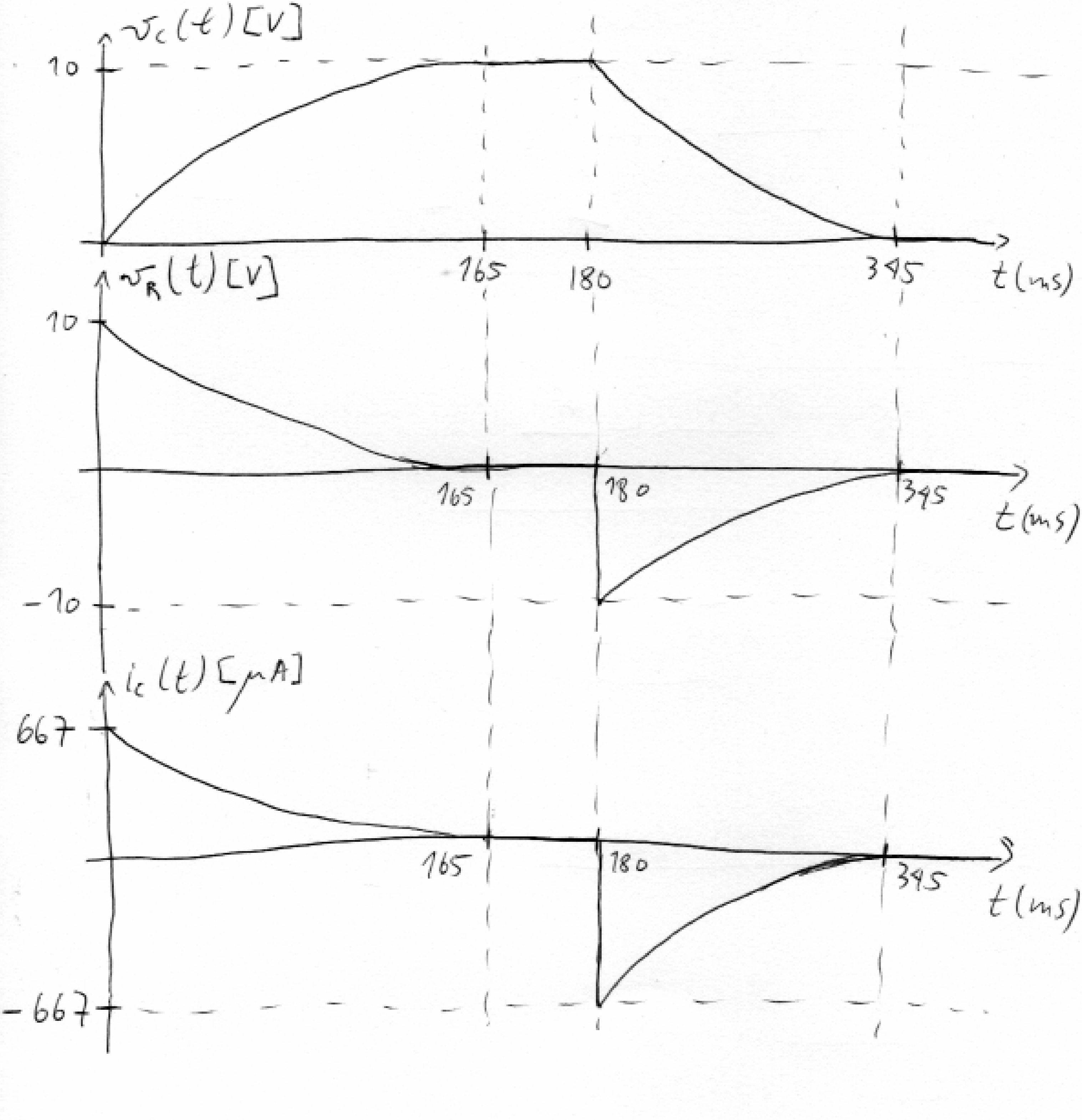
$$R_{TH} = \frac{v_t}{i_t} \Rightarrow \boxed{R_{TH} = 3{,}73\,\Omega}$$

<u>Circuito Equivalente:</u>



⑧

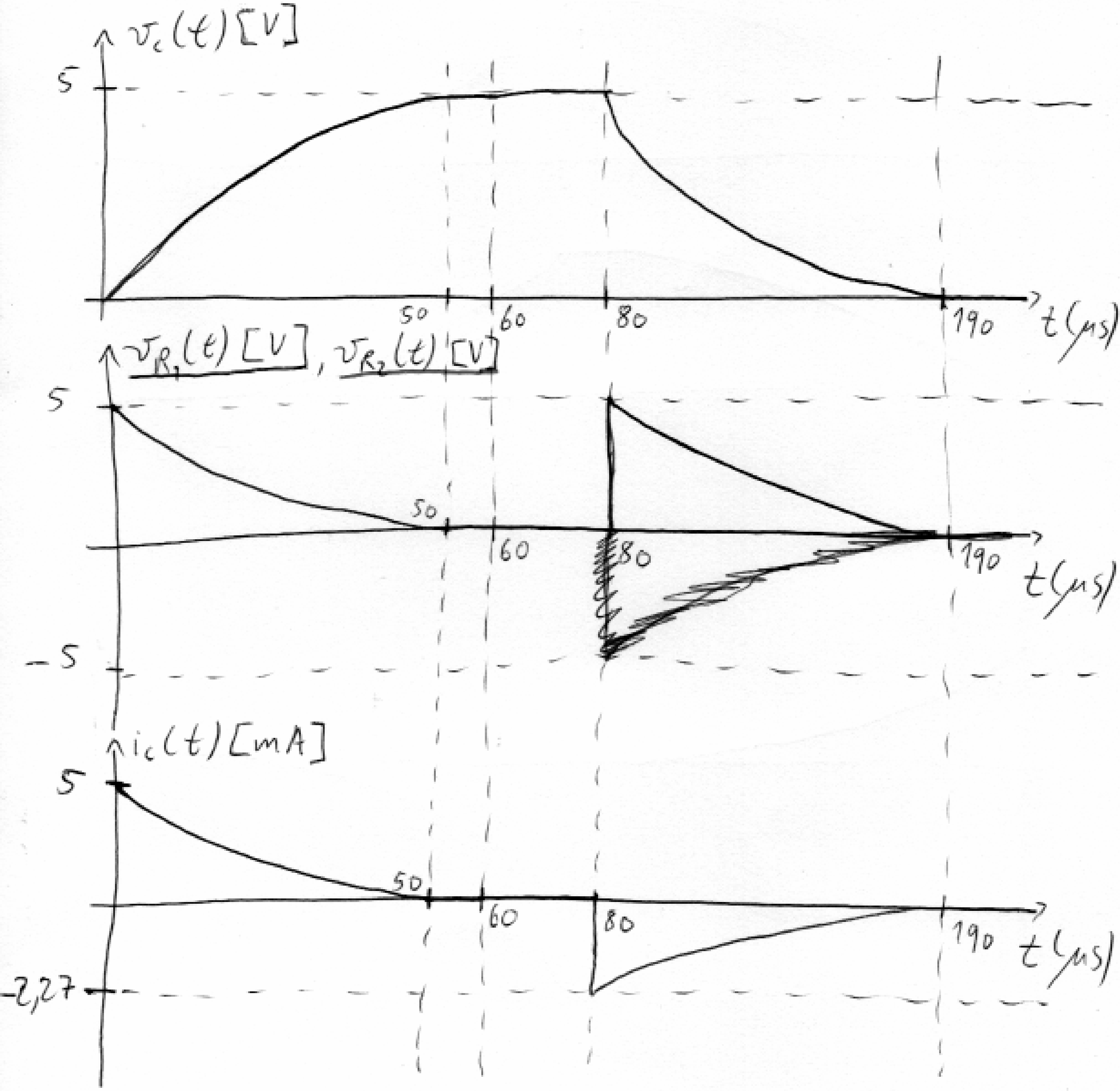
a) $\tau = R_1 C_1 \Rightarrow \boxed{\tau = 33\,ms}$ $\boxed{5\tau = 165\,ms}$



N

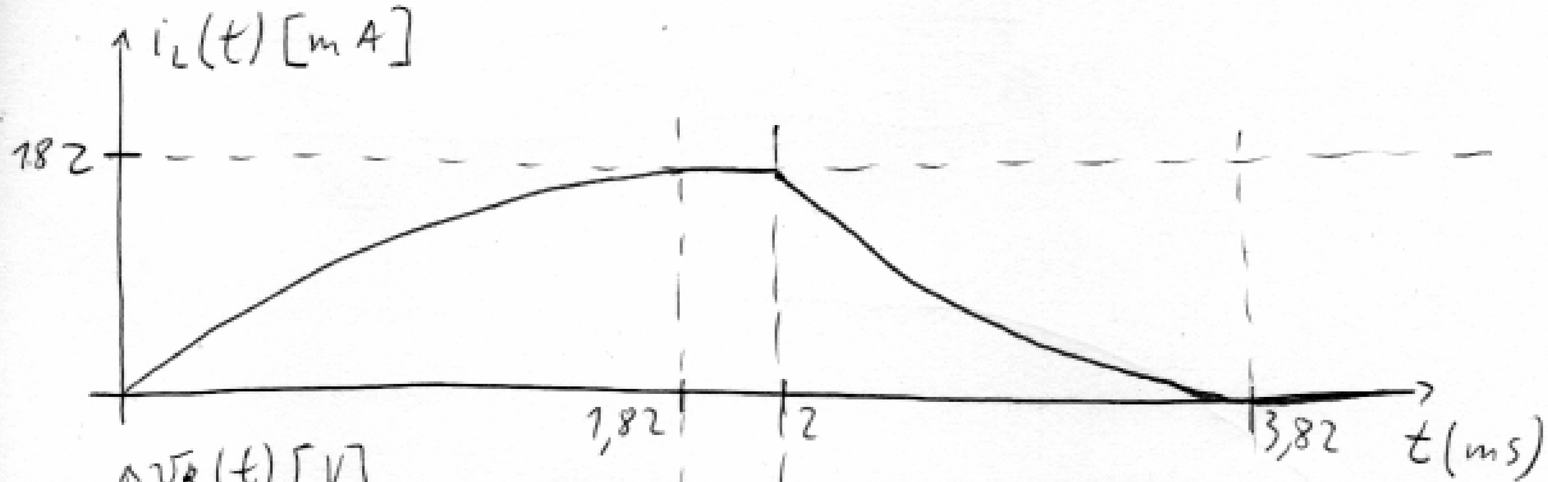
b) $\tau_1 = R_1 C_1 \Rightarrow \boxed{\tau_1 = 10\,\mu s}$ $\boxed{5\tau_1 = 50\,\mu s}$

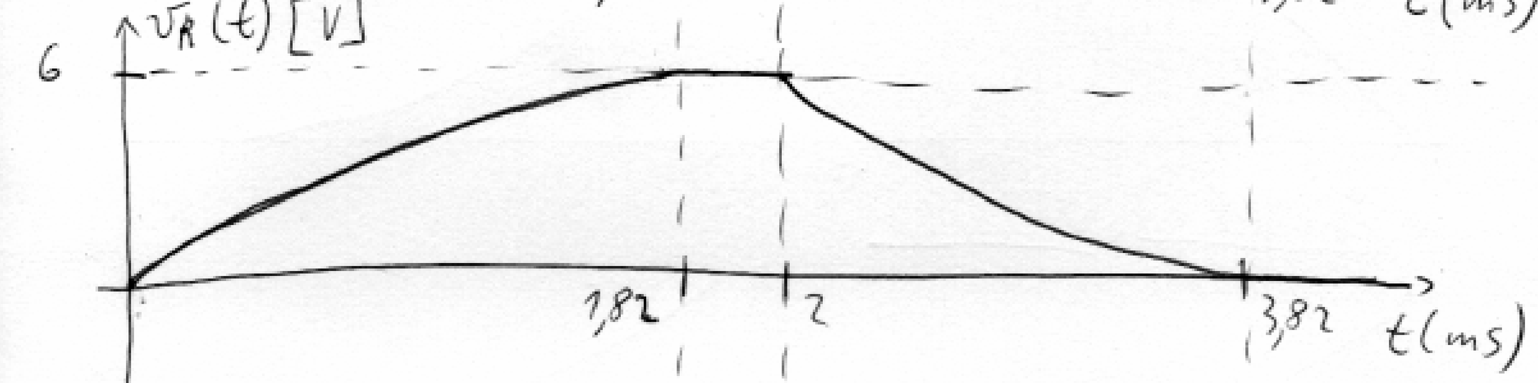
$\tau_2 = R_2 C_1 \Rightarrow \boxed{\tau_2 = 22\,\mu s}$ $\boxed{5\tau_2 = 110\,\mu s}$

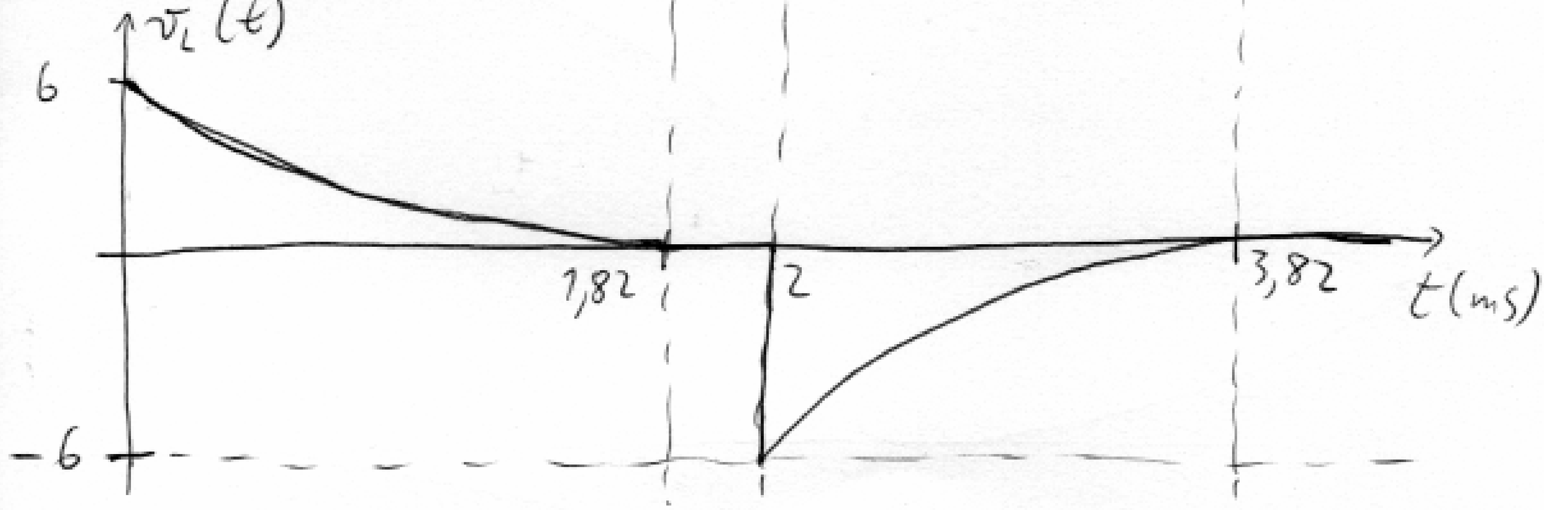


$\boxed{0}$

9) a) $\tau = \frac{L}{R} \Rightarrow \boxed{\tau = 363\,\mu s}$ $\boxed{5\tau = 1{,}82\,ms}$



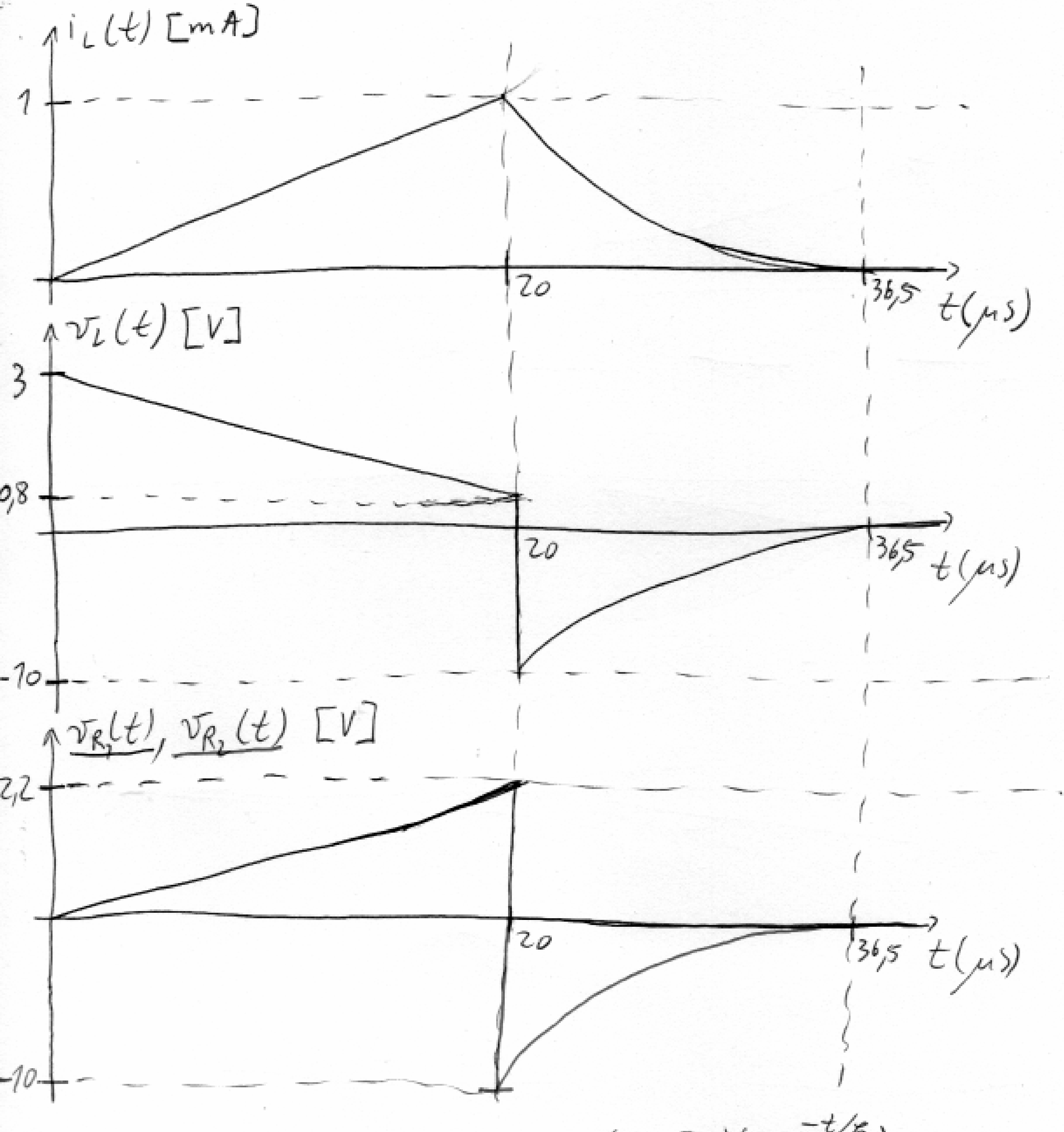




$\boxed{p}$

b) $\tau_1 = R_1^{-1} L_1 \Rightarrow \boxed{\tau_1 = 15\,\mu s}$ $\boxed{5\tau_1 = 75\,\mu s}$

$\tau_2 = L_1 / R_2 \Rightarrow \boxed{\tau_2 = 3{,}3\,\mu s}$ $\boxed{5\tau_2 = 16{,}5\,\mu s}$



P/ $0\,\mu s \le t \le 20\,\mu s$: $i_L(t) = I_i + (I_f - I_i)(1 - e^{-t/\tau_1})$

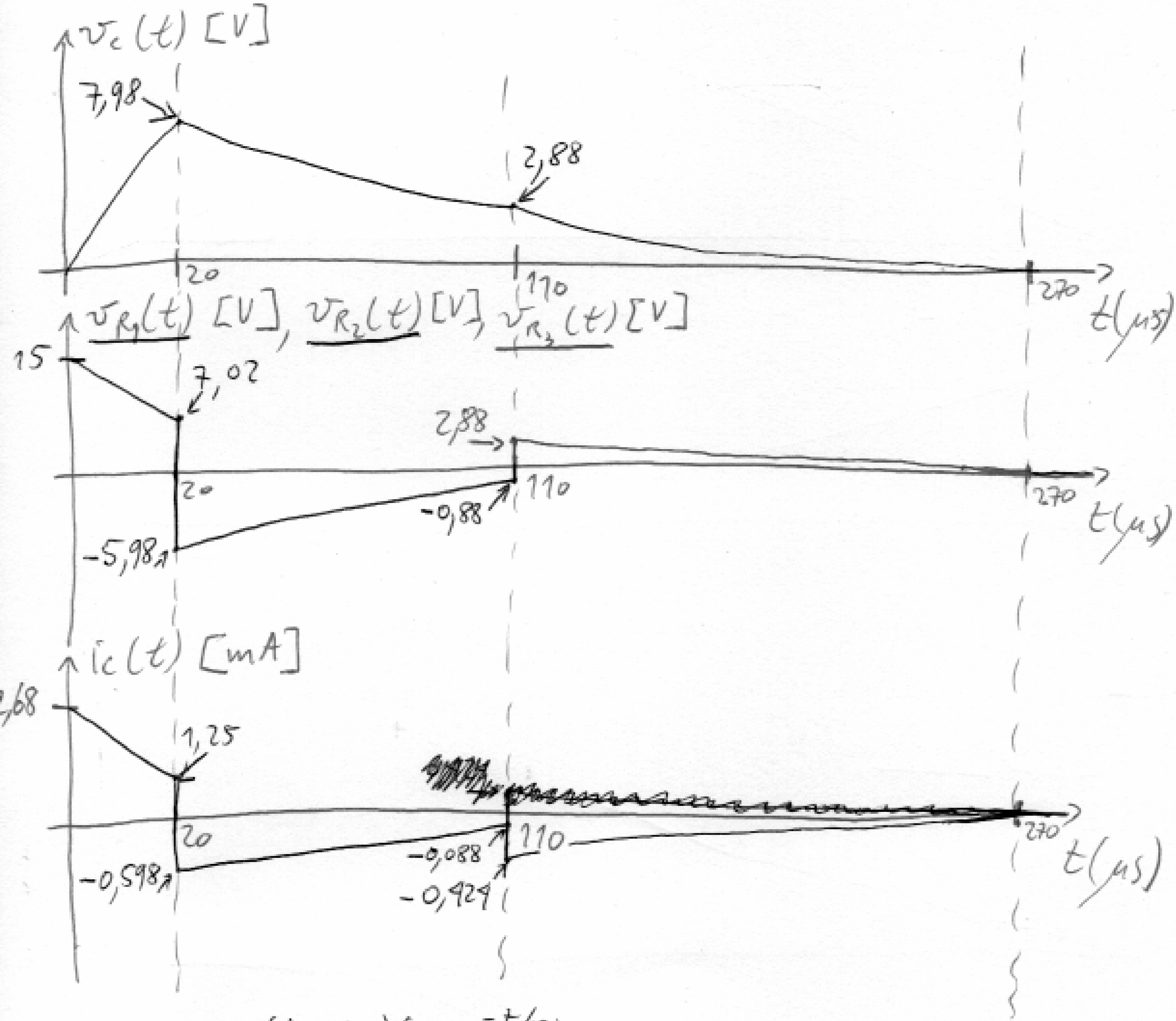
$I_i = 0\,mA$; $I_f = 1{,}36\,mA$; $\boxed{i_L(20 \cdot 10^{-6}) = 1{,}00\,mA}$

$\boxed{9}$

(10) $\tau_1 = R_1 C_1 \Rightarrow \tau_1 = 26{,}32\,\mu s$ $\quad 5\tau_1 = 131{,}6\,\mu s$

$\tau_2 = R_2 C_1 \Rightarrow \tau_2 = 47{,}00\,\mu s$ $\quad 5\tau_2 = 235{,}0\,\mu s$

$\tau_3 = R_3 C_1 \Rightarrow \tau_3 = 31{,}96\,\mu s$ $\quad 5\tau_3 = 159{,}8\,\mu s$



$v_c(t) = V_i + (V_f - V_i)(1 - e^{-t/\tau})$

p/ $0\,\mu s \le t \le 20\,\mu s$:

$V_i = 0V$ $\quad \Delta t = 20\,\mu s$

$V_f = 15V$

$v_c(20 \cdot 10^{-6}) = 7{,}98V$

p/ $20\,\mu s \le t \le 110\,\mu s$:

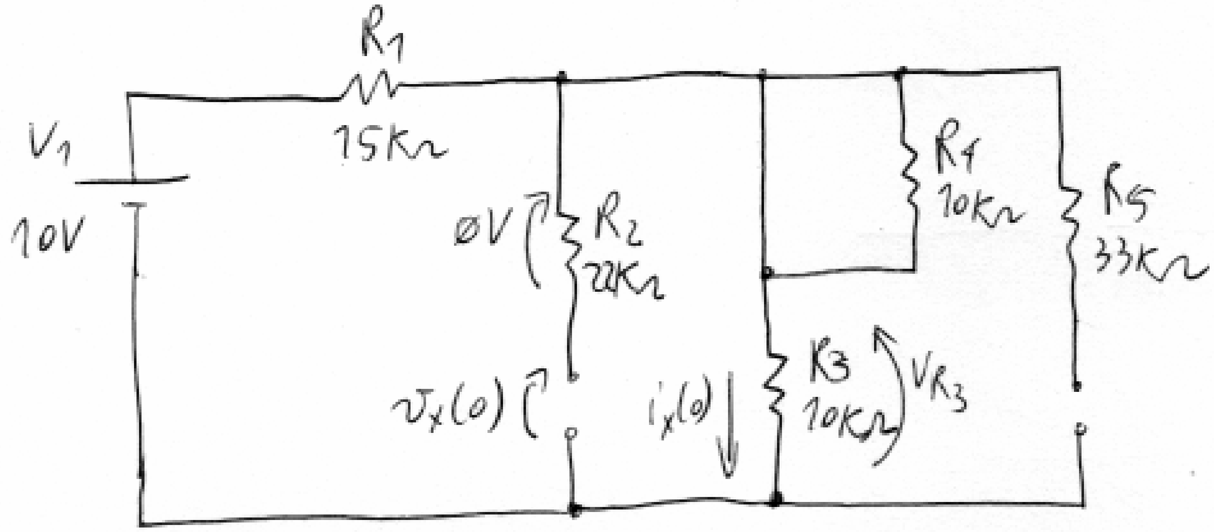
$V_i = 7{,}98V$ $\quad V_f = 2V$

$\Delta t = 90\,\mu s$

$v_c(90 \cdot 10^{-6}) = 2{,}88V$

R

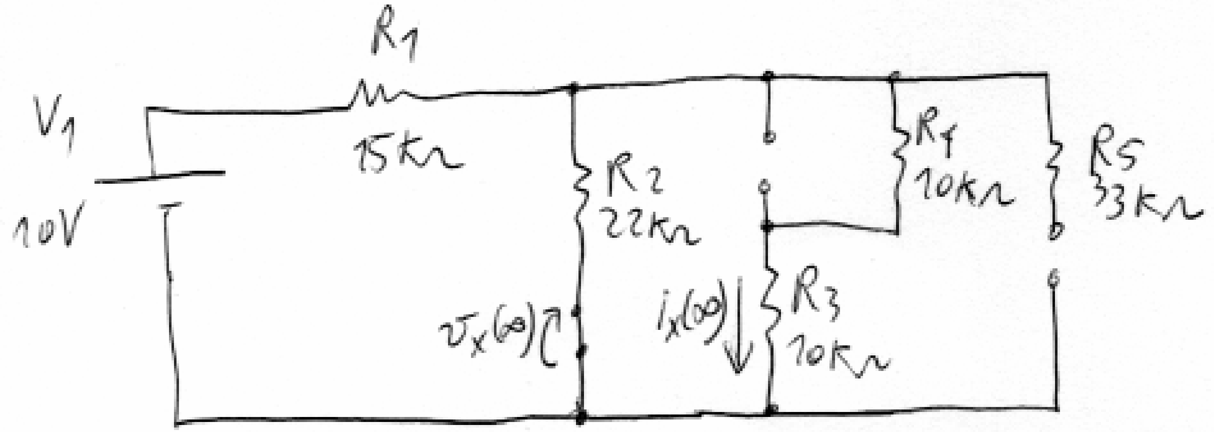
(11) P/ t = 0s :



$$i_x(0) = \frac{V_1}{R_1 + R_3} \Rightarrow \boxed{i_x(0) = 400\mu A}$$

$$v_x(0) = V_{R_3} = R_3 \cdot i_x(0) \Rightarrow \boxed{v_x(0) = 4V}$$

P/ t → ∞ :



$$i_x(\infty) = \frac{(R_3 + R_4) // R_2}{(R_3 + R_4) // R_2 + R_1} \cdot V_1 \cdot \frac{1}{R_3 + R_4} \Rightarrow \boxed{i_x(\infty) = 206\mu A}$$

$$\boxed{v_x(\infty) = 0V}$$

12

$$C = \frac{dq}{dv} = \frac{i\,dt}{dv}$$

$$[R][C] = \frac{\cancel{V}}{\cancel{A}} \cdot \frac{\cancel{A}s}{\cancel{V}} = s$$

$$L = \frac{d\phi}{di} = \frac{v\,dt}{di}$$

$$\frac{[L]}{[R]} = \frac{\cancel{V}s/\cancel{A}}{\cancel{V}/\cancel{A}} = s$$

T