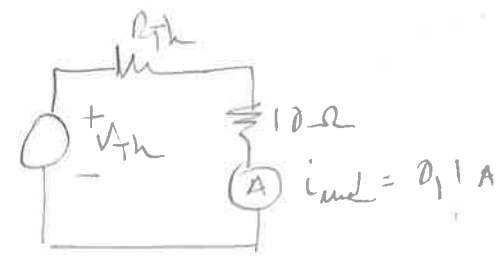
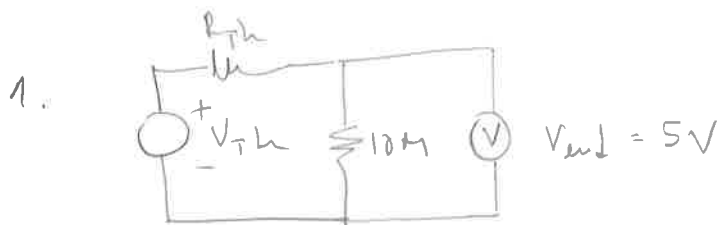


CALCULO DE TENSÃO

2015/16 - TEST 1



$$V_{Th} \frac{10M}{R_{Th} + 10M} = 5$$

$$(0,1R_{Th} + 1) \frac{10M}{R_{Th} + 10M} = 5$$

$$10^6 R_{Th} + 10^7 = 5(R_{Th} + 10^7)$$

$$10^6 R_{Th} - 5R_{Th} = 5 \times 10^7 - 10^7$$

$$R_{Th} (10^6 - 5) = 4 \times 10^7$$

$$R_{Th} = \frac{4 \times 10^7}{10^6 - 5} \approx 40 \Omega$$

$$\frac{V_{Th}}{R_{Th} + 10 \Omega} = 0,1 A$$

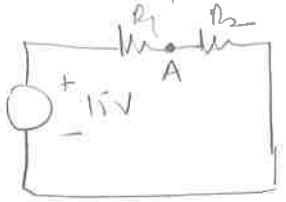
$$0,1(R_{Th} + 10 \Omega) = V_{Th}$$

$$0,1 R_{Th} + 1 = V_{Th}$$

$$V_{Th} = 0,1 R_{Th} + 1 = 4V + 1V = 5V$$

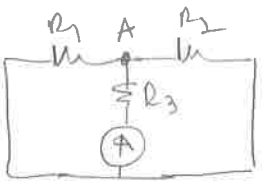
2. a)  $V_A = V_{A1} + V_{A2} + V_{A3}$

calculo  $V_{A1}$ :



$$V_{A1} = \frac{R_2}{R_1 + R_2} \times 15V = \frac{1}{2} 15V = 7,5V$$

calculo  $V_{A2}$ :



$$V_{A2} = i \times R_1 \parallel R_2 = 10 \times 10^{-3} \times \frac{1}{\frac{1}{0,15 \times 10^{-3}} + \frac{1}{500}} V = 5V$$

calculo  $V_{A3}$ :



$$V_{A3} = \frac{R_1}{R_1 + R_2} \times 5V = \frac{1}{2} 5V = 2,5V$$

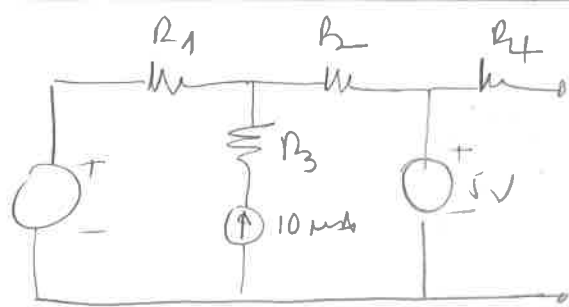
$$V_A = 7,5V + 5V + 2,5V = 15V$$

$$b) i_{R_1} = \frac{+15V - V_A}{1k\Omega} = 0$$

$$i_{R_2} = \frac{V_A - 5V}{1k\Omega} = \frac{10V}{1k\Omega} = 10 \mu A$$

$$i_{R_3} = 10 \mu A$$

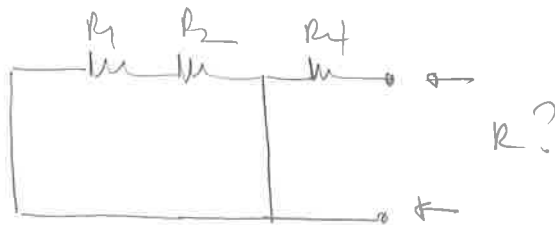
$$i_{R_4} = 0$$



$$c) V_{TC} = V_A + i_{R_3} \times R_3 = 15V + 10 \times 10^{-3} \times 1 \times 10^3 = 25V$$

$$d) V_{Th} = +5V$$

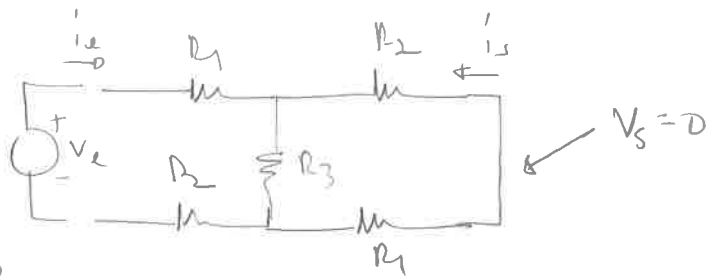
$$R_{Th} = R_4 = 1k\Omega$$



$$3. \begin{bmatrix} v_e \\ i_s \end{bmatrix} = \begin{bmatrix} h_{11} \\ h_{21} \end{bmatrix} \begin{bmatrix} i_e \\ v_s \end{bmatrix} \begin{cases} v_e = h_{11} i_e + h_{12} v_s \\ i_s = h_{21} i_e + h_{22} v_s \end{cases}$$

$$\text{SHORTCIRCUIT } v_s = 0$$

$$h_{11} = \frac{v_e}{i_e} \Big|_{v_s=0}$$



$$h_{11} = R_1 + R_3 \parallel (R_1 + R_2) + R_2$$

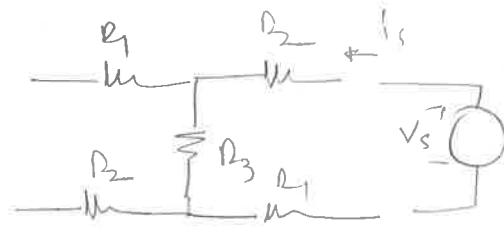
$$= R_1 + R_2 + \frac{R_3 (R_1 + R_2)}{R_3 + R_1 + R_2} = (R_1 + R_2) \left[ 1 + \frac{R_3}{R_1 + R_2 + R_3} \right]$$

$$h_{21} = \frac{i_s}{i_e} \Big|_{v_s=0}$$

$$i_s = -i_e \frac{R_3}{R_3 + (R_1 + R_2)} \Rightarrow h_{21} = - \frac{R_3}{R_1 + R_2 + R_3}$$

condition  $i_e = 0$

$$h_{12} = \frac{v_e}{v_s} \Big|_{i_e=0}$$



$$v_e = \frac{R_3}{R_1 + R_2 + R_3} v_s \Rightarrow h_{12} = \frac{R_3}{R_1 + R_2 + R_3}$$

$$h_{22} = \frac{i_s}{v_s} \Big|_{v_e=0}$$

$$h_{22} = \frac{1}{R_1 + R_2 + R_3}$$

4.  $v(t) - R i(t) - \frac{1}{C} \int i(t) dt = 0$

a)  $\frac{dv(t)}{dt} - R \frac{di(t)}{dt} - \frac{1}{C} i(t) = 0 \Rightarrow \frac{di(t)}{dt} = -\frac{1}{RC} i(t)$

$(t > 0)$

$$\begin{cases} i(t) = i_0 e^{-t/RC} \\ i_0 = \frac{V_0}{R} \end{cases}$$

now  $i(t) = \frac{V_0}{R} e^{-t/RC}$

$$i(t) = \frac{V_0}{R} e^{-t/RC}$$

$$v_R(t) = R \times i(t) = V_0 e^{-t/RC}$$

$$v_C(t) = V_0 - V_0 e^{-t/RC} = V_0 (1 - e^{-t/RC})$$

$$\frac{v_C(t)}{V_0} = (1 - e^{-t/RC}) \Rightarrow (1 - \frac{v_C(t)}{V_0}) = e^{-t/RC}$$

$$\ln(1 - \frac{v_C(t)}{V_0}) = -\frac{t}{RC} \Rightarrow t = -RC \ln(1 - \frac{v_C(t)}{V_0})$$

$$t = -10^3 \times 10^{-6} \ln(1 - \frac{7}{10}) = -10^{-3} \ln(0,3) = 1,2 \text{ ms}$$

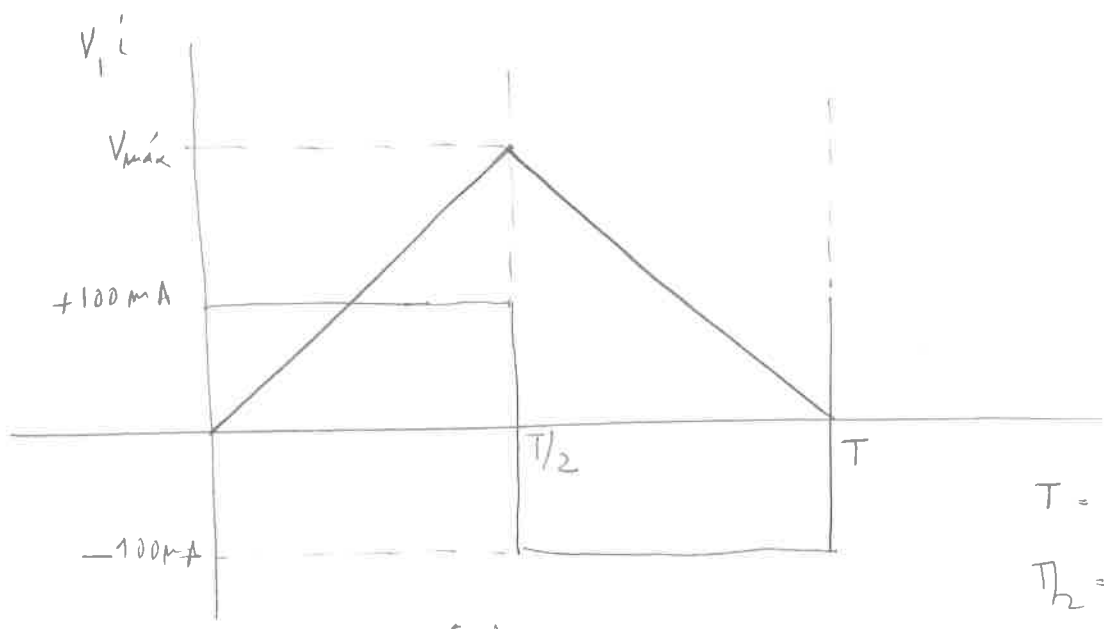
b)  $i(t) = \frac{V_0}{R} e^{-t/RC}$

$9 \times 10^{-3} = \frac{10}{10^3} e^{-t/RC}$

$9 \times 10^{-3} \times 10^3 \times 10^{-1} = e^{-t/RC} \Rightarrow \ln(0,9) = -t/RC \Rightarrow$

$\Rightarrow t = -RC \ln(0,9) = -10^3 \times 10^{-6} \times \ln(0,9) = 0,1 \text{ ms}$

c)



$T = \frac{1}{10 \times 10^3} = 0,1 \text{ ms}$

$T/2 = 0,05 \text{ ms}$

$V_{max} = \frac{1}{C} \int_0^{t=0,05 \text{ ms}} i(t) dt = \frac{1}{10^{-6}} = \frac{i_0}{C} [t]_0^{0,05 \text{ ms}} =$

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

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

$= 5 \checkmark$