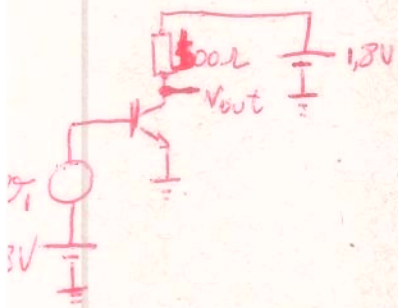


AULA 07



$$\begin{cases} V_{Tpp} = 1 \text{ mV} \\ I_S = 3 \cdot 10^{-16} \\ \beta = 100 \end{cases}$$

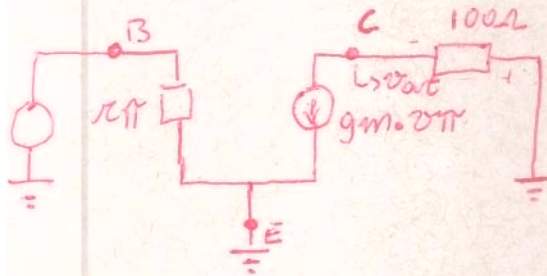
* $V_{BE} = 0$

$$I_C = I_S \cdot \exp\left(\frac{V_{BE}}{V_T}\right) = \frac{6,92}{26} \text{ mA}$$

$$V_{out} = 1,8 - 100 \cdot 6,91 \cdot 10^{-3} = 1,108 \text{ V}$$

$\Rightarrow V_{out} > 0,8 \text{ V} \Rightarrow V_{CE} > 0 \Rightarrow$ ~~Região Ativa~~ **Modo Ativo**

• Modelo de pequenos sinais (fontes de tensão = 0V)



$$g_m = \frac{I_C}{V_T} = 0,2661 \text{ S}$$

$$r_{\pi} = \frac{\beta}{g_m} = 375,7898 \Omega$$

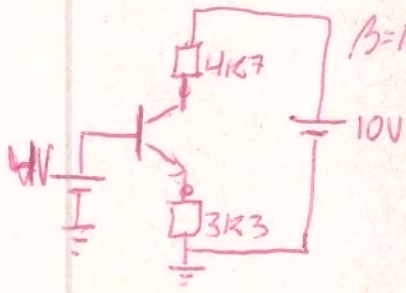
$$i_C = g_m \cdot v_{\pi} = g_m \cdot v_i = 0,2661 \text{ mA}$$

$$v_{out} = -100 \cdot i_C = -26,6106 \text{ mV}$$

$$\text{Ganho} = \frac{v_{out}}{v_i} = -26,6106$$

$$V_{out} = 1,1081 - 26,6106 \text{ mV}$$

AULAD7



$$V_B = 4V$$

$$V_E = 4 - 0,7 = 3,3V$$

$$I_E = \frac{V_E}{3,3 \cdot 10^3} = 1mA$$

$$\alpha = \frac{\beta}{\beta + 1} = \frac{100}{101} = 0,9901$$

$$I_C = \alpha \cdot I_E = 0,9901mA$$

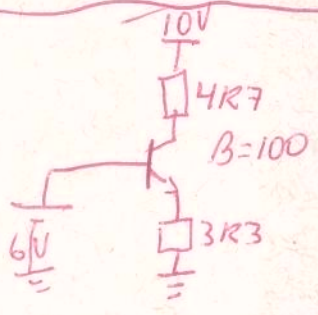
$$I_B = \frac{I_C}{\beta} = 0,9901 \cdot 10^{-5} A$$

$$V_C = 3,8V$$

$$V_C = 10 - R_C \cdot I_C = 10 - 4,7 \cdot 10^3 \cdot 0,9901 \cdot 10^{-3}$$

$$V_C = 5,34V$$

$V_C > V_B \Rightarrow$ modo ativo \Rightarrow OK



$$V_E = 6 - 0,7 \Rightarrow V_E = 5,3V$$

$$I_E = \frac{5,3}{3,3} \Rightarrow I_E = 1,6061$$

$$I_C = \alpha \cdot I_E = 0,99 \cdot 1,6061 \Rightarrow I_C = 1,5902 mA$$

$$V_C = 10 - 4,7 \cdot 10^3 \cdot 1,59 \cdot 10^{-3} \Rightarrow V_C = 2,52V$$

$\Rightarrow V_B > V_C \Rightarrow$ modo saturação \Rightarrow contas acima estão erradas
 $\left\{ \begin{array}{l} V_B > V_E \\ V_B > V_C \end{array} \right.$
 $V_{BE} = 0,8V$
 $V_{CEsat} = 0,2V$

$$V_B = 6V$$

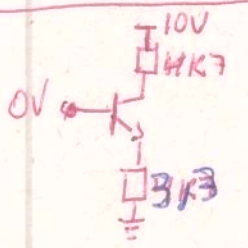
$$\Rightarrow V_E = 6 - 0,8 = 5,2V$$

$$I_E = \frac{5,2}{3,3} = 1,5758 mA$$

$$\Rightarrow V_C = V_E + 0,2 = 5,4V$$

$$I_C = \frac{10 - V_C}{4,7} \Rightarrow I_C = 0,9787 mA$$

$$\Rightarrow I_B = I_E - I_C \Rightarrow I_B = 0,5971 mA$$

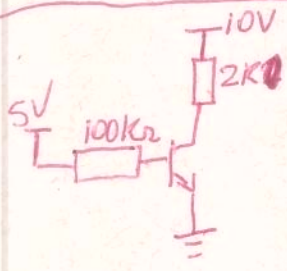


$$V_B = 0 \Rightarrow I_E = 0 \Rightarrow I_C = 0 \Rightarrow I_B = 0$$

$$V_E = 0$$

$$V_C = 10V$$

modo corte
 $V_{BE} = 0$
 $V_{BC} < 0 (V_B < V_C)$



$$V_B = V_{BE} = 0,7$$

$$I_B = \frac{5 - 0,7}{100K} = 4,3 \cdot 10^{-5} A$$

$$I_C = \beta \cdot I_B = 4,3 \cdot 10^{-3} A$$

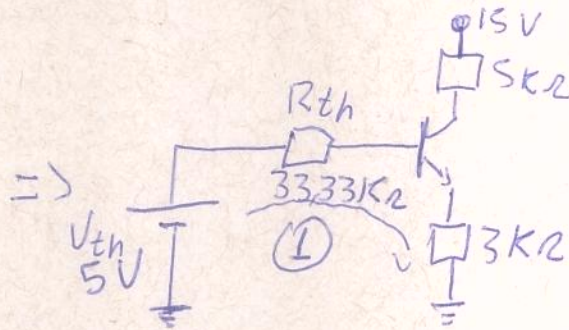
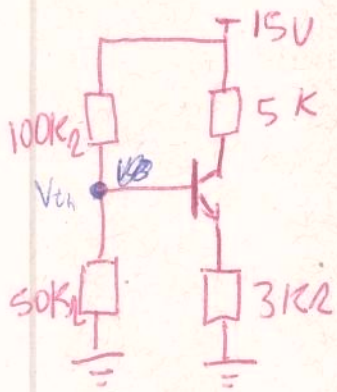
$$V_C = 10 - 2,2 \cdot 10^3 \cdot 4,3 \cdot 10^{-3}$$

$$V_C = 1,4V$$

$$V_E = 0$$

$$I_E = I_C + I_B = 4,343 mA$$

dependente de β , mais que os exc. anteriores.
 Se β for muito alto, sai do modo ativo ($V_C > V_B$; $V_B > V_E$)



$$V_{th} = \frac{15 \cdot 50}{100 + 50}$$

$$V_{th} = 5V$$

$$R_{th} = 100 // 50 \Rightarrow R_{th} = 33,333k\Omega$$

$$\textcircled{1} \quad 5 - 33,33 \cdot 10^3 I_B - 0,7 - 3 \cdot 10^3 I_E = 0$$

$$\Rightarrow 33,33 \cdot 10^3 I_B + 3 \cdot 10^3 \cdot \frac{I_B}{100} (\beta + 1) = 0$$

$$I_B = \frac{4,3}{(33,33 \cdot 10^3 + 3 \cdot 10^3 \cdot 101)} \Rightarrow I_B = 1,2785 \cdot 10^{-5} A$$

$$V_B = 5 - 33,33 \cdot 10^3 \cdot 1,2785 \cdot 10^{-5} = V_B = 4,5738V$$

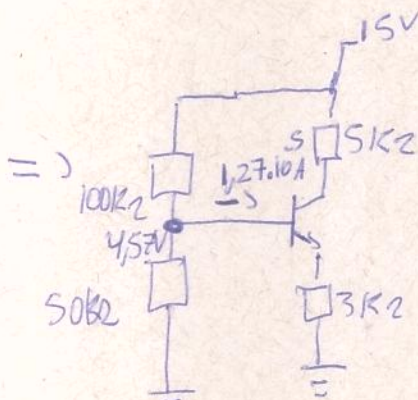
$$V_E = 4,5738 - 0,7 \Rightarrow V_E = 3,8738V$$

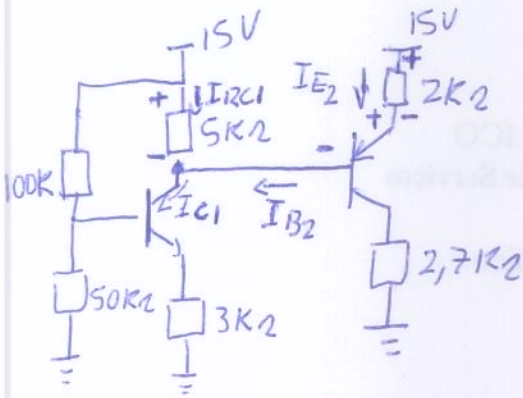
$$I_E = \frac{3,8738}{3 \cdot 10^3} \Rightarrow I_E = 1,2913 \cdot 10^{-3} A$$

$$I_C = \beta I_B = 1,2785 \cdot 10^{-3} A$$

$$V_C = 15 - 5 \cdot 10^3 \cdot 1,27 \cdot 10^{-3}$$

$$V_C = 8,6075 \Rightarrow V_C > V_B \Rightarrow \text{modo Ativo OK}$$





• De exercício anterior

• $V_{B1} = 4,57V$

• $V_{E1} = 3,87V$

• $I_{B1} = 1,27 \cdot 10^{-5}A$

• $I_{C1} = 1,2785 \cdot 10^{-3}A$

$I_{E1} = 1,29 \cdot 10^{-3}A$

$$2 \cdot 10^3 \cdot I_{E2} + 0,7 - 5 \cdot 10^3 \cdot I_{RC1} = 0$$

$$2 \cdot 10^3 \cdot (\beta + 1) I_{B2} - 5 \cdot 10^3 I_{RC1} = -0,7$$

~~$$I_{B2} = \frac{5 \cdot 10^3 \cdot I_{RC1} - 0,7}{2 \cdot 10^3 (\beta + 1)}$$~~

$$2 \cdot 10^3 (\beta + 1) I_{B2} - 5 \cdot 10^3 (I_{C1} - I_{B2}) = -0,7$$

$$2 \cdot 10^3 (\beta + 1) I_{B2} - 5 \cdot 10^3 I_{C1} + 5 \cdot 10^3 I_{B2} = -0,7$$

$$I_{B2} \cdot [2 \cdot 10^3 (\beta + 1) + 5 \cdot 10^3] = 5 \cdot 10^3 I_{C1} - 0,7$$

$$I_{B2} = 2,75 \cdot 10^{-5} A$$

$$I_{C2} = \beta I_{B2} = 2,75 \cdot 10^{-3} A$$

$$I_{E2} = I_{C2} + I_{B2} = 2,7775 \cdot 10^{-3} A$$

$$V_{C2} = 2,7 \cdot 10^3 \cdot I_{C2} = 7,4250V$$

$$V_{E2} = 15 - 2 \cdot 10^3 \cdot I_{E2} \Rightarrow V_{E2} = 9,4450V$$

$$V_{B2} = V_{C1} = 15 - 5 \cdot 10^3 \cdot I_{RC1} = 15 - 5 \cdot 10^3 (I_{C1} - I_{B2}) = V_{B2} = V_{C1} = 8,74V$$