

## EXERCÍCIO 9 CAPÍTULO 13 RAZAVI 2ª ED

a) PARA GARANTIR  $Q_1$  OPERANDO:

$$\cdot V_{out} \approx V_{in} - V_{BE(Q1)} = -800 \text{ mV.}$$

$$\cdot I_{C1} = I_1 + \frac{V_{out}}{R_L}, \text{ considerando } Q_2 \text{ desligado.}$$

$$\cdot I_{C1} \geq 0 \Rightarrow I_1 + \frac{V_{out}}{R_L} \geq 0 \Rightarrow \boxed{I_1 R_L \geq 800 \text{ mV}}$$

b) Quando  $Q_2$  está operando:

$$\cdot \frac{V_{out}}{R_L} - I_1 = I_{C2} \Rightarrow \frac{V_{out}}{R_L} - \frac{800 \cdot 10^{-3}}{R_L} = I_{S2} \exp\left(\frac{V_{BE2}}{V_T}\right)$$

$$\Rightarrow V_{out} = -0,81 \text{ V.}$$

$$\therefore V_{in} = V_{out} - |V_{BE(Q2)}| = -0,81 - 0,8 = \boxed{-1,61 \text{ V}}$$

Exercício 17.

•  $V_{out} = 0$ :

$$\Rightarrow I_{C1} = I_{C2} = I_{B1} \cdot \beta$$

$$\Rightarrow I_{S1} \exp\left(\frac{V_{in} + V_B - V_{out}}{V_T}\right) = I_{S2} \exp\left(\frac{V_{out} - V_{in}}{V_T}\right)$$

$$\ln\left(\frac{I_{S1}}{I_{S2}}\right) + \frac{V_{in} + V_B - V_{out}}{V_T} = \frac{V_{out} - V_{in}}{V_T}$$

• Para  $V_{out} = 0$ ,  $V_T = 0,026 \text{ V}$ :

$$\ln\left(\frac{5}{8}\right) + \frac{V_{in} + V_B}{0,026} = \frac{V_{in}}{0,026}$$

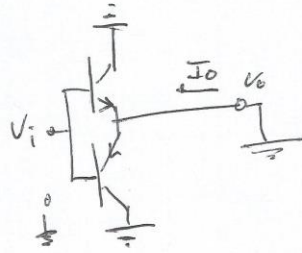
• Com  $I_{C2} = 5 \text{ mA} \Rightarrow I_{S2} \exp\left(\frac{-V_{in}}{0,026}\right) = 5 \text{ mA} \Rightarrow V_{in} = -0,83 \text{ V}$ .

$$I_{C1} = I_{S1} \exp\left(\frac{V_{in} + V_B - V_{out}}{V_T}\right) = (5 \cdot 10^{-7}) \exp\left(\frac{-0,83 + V_B}{V_T}\right)$$

$$\Rightarrow V_B = 0,83 + 0,026 \ln\left(\frac{5 \cdot 10^{-3}}{5 \cdot 10^{-7}}\right) \Rightarrow \boxed{V_B = 1,67 \text{ V}}$$

Exercício 18.

a) modelo de pequenos sinais :



$$I_o = -g_{m1} V_i + (-V_i) g_{m2} = -(g_{m1} + g_{m2}) V_i \rightarrow g_m = \frac{I_o}{V_i} = -(g_{m1} + g_{m2})$$

$$\therefore A_v = \frac{V_o}{V_i} = \frac{I_o \cdot R_L}{V_i} \Rightarrow \boxed{A_v = -(g_{m1} + g_{m2}) R_L}$$

$$b) A_v = - \left( \frac{I_{C1}}{V_T} + \frac{I_{C2}}{V_T} \right) R_L = - \left( \frac{5 \cdot 10^{-3}}{0,026} + \frac{5 \cdot 10^{-3}}{0,026} \right) \cdot 8 \Omega = -3,08$$

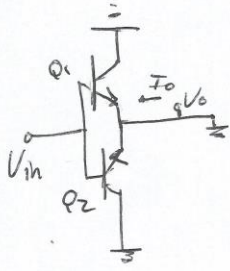
$$|V_o|_p = |V_i \cdot A_v|_p = |2 \cdot -3,08| = \boxed{6,16 V}$$

$$c) I_{C1} = I_{C2} = \frac{V_{out}}{R_L}$$

$$I_{C1, pico} = I_{C2} + \frac{V_p}{R_L} \Rightarrow I_{C1, pico} = 8 \cdot 10^{-3} + \frac{6,16}{8}$$

$$\boxed{I_{C1, pico} = 775 \text{ mA}}$$

26. modelo de pequenos sinais:



$$g_m = \frac{I_o}{v_{in}} = -(g_{m1} + g_{m2})$$

$$\rightarrow A_v = \frac{v_o}{v_{in}} = \frac{I_o R_L}{v_{in}} = \boxed{+(g_{m1} + g_{m2}) R_L}$$