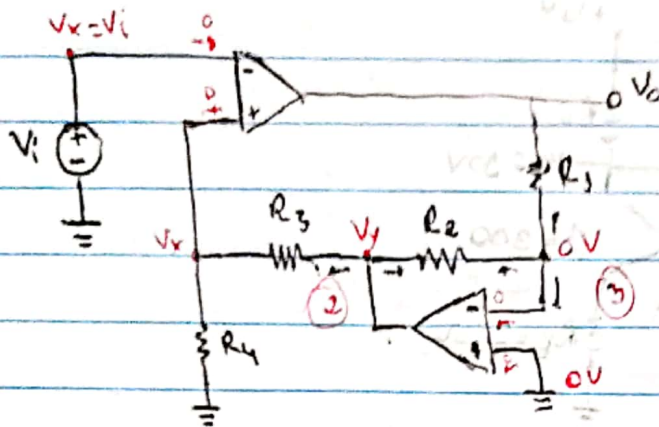


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Questão 1.



$$\therefore V_o = -\frac{R_1}{R_2} \left[V_i \left(\frac{R_3 + R_4}{R_4} \right) \right]$$

$$V_x = V_i$$

$$\textcircled{2} \quad \frac{V_x - 0}{R_4} + 0 + \frac{V_x - V_y}{R_3} = 0$$

$$\frac{V_x}{R_4} + \frac{V_x}{R_3} - \frac{V_y}{R_3} = 0$$

$$\frac{V_y}{R_3} = \frac{V_x}{R_3} + \frac{V_x}{R_4}$$

$$V_y = \left[V_x \left(\frac{1}{R_3} + \frac{1}{R_4} \right) \right] R_3$$

$$\textcircled{3} \quad \frac{0 - V_y}{R_2} + 0 + \frac{0 - V_o}{R_3} = 0$$

$$-\frac{V_y}{R_2} - \frac{V_o}{R_3} = 0$$

$$V_o = -\frac{R_3}{R_2} V_y$$

$$V_o = -\frac{R_3}{R_2} \left[V_x \left(\frac{1}{R_3} + \frac{1}{R_4} \right) \right] R_3$$

$$V_o = -\frac{R_3}{R_2} \left(V_x \left(\frac{R_3 + R_4}{R_3 \cdot R_4} \right) R_3 \right)$$

$$V_o = -\frac{R_3}{R_2} \left(R_3 V_x \left[\frac{R_3 + R_4}{R_3 \cdot R_4} \right] \right)$$

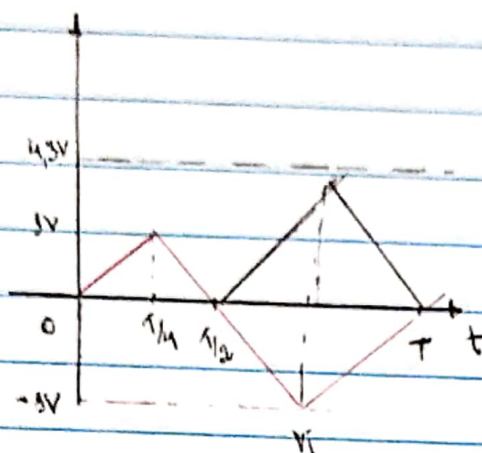
$$\therefore V_o = -\frac{R_3}{R_2} \left(V_i \left[\frac{R_3 + R_4}{R_3 \cdot R_4} \right] R_3 \right)$$

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Questão 2

a)



b)

$$V_x = - \frac{R_2}{R_3} \cdot V_i \Rightarrow V_x = -5(1)$$

$$\cancel{V_x = -5}$$

$$\frac{R_2}{R_3} = \frac{100k}{20k} = 5$$

$$\boxed{V_x = -5V}$$

$$V_x = - \frac{R_2}{R_3} \cdot V_i \Rightarrow V_x = -5 \cdot (-1) \Rightarrow V_x$$

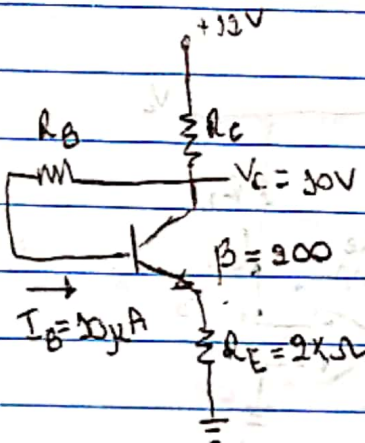
$$\boxed{V_x = 5V}$$

$$V_o = 5 - 0,7 = 4,3V$$

$$\boxed{V_o = 4,3V}$$

Carlos Luisquen Pineda Santos (20350465)

Questão 3



a)

$$I_C = \beta I_B$$

$$I_C = 200(30 \mu A)$$

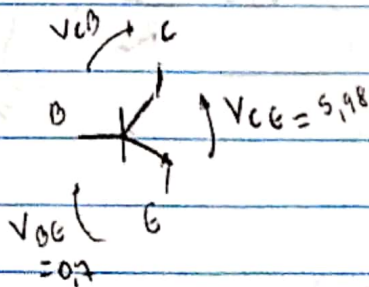
$$I_C = 2 \text{ mA}$$

$$I_E = (1 + \beta) I_B$$

$$I_E = (1 + 200)(30 \mu A)$$

$$I_E = 2,03 \text{ mA}$$

d)



$$V_E = 2 \text{ k} \cdot I_E$$

$$V_E = 2 \text{ k} \cdot (2,03 \text{ mA})$$

$$V_E = 4,03 \text{ V}$$

$$V_{CE} = V_{CC} - V_{CE}$$

$$V_{CE} = V_{CC} - V_{CE}$$

$$V_{CE} = 5,98$$

$$V_B = V_E + 0,7$$

$$V_B = 4,73 \text{ V}$$

$$V_B = 10 - R_B I_B$$

$$4,73 = 10 - R_B (30 \mu A)$$

$$R_B = 2,656 \text{ k} \Omega$$

$$R_B = 528 \text{ k} \Omega$$

$$V_C = 12 - R_C I_C$$

$$10 = 12 - R_C [(2 \times 10^{-3}) + (30 \times 10^{-6})]$$

$$R_C = 333 \Omega$$

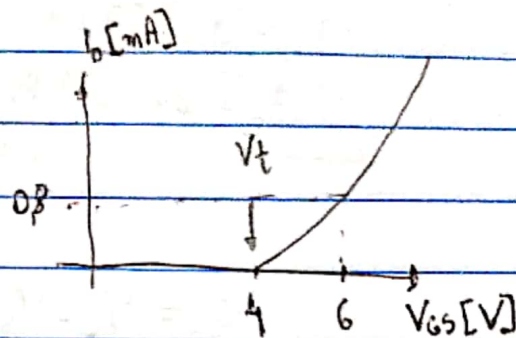
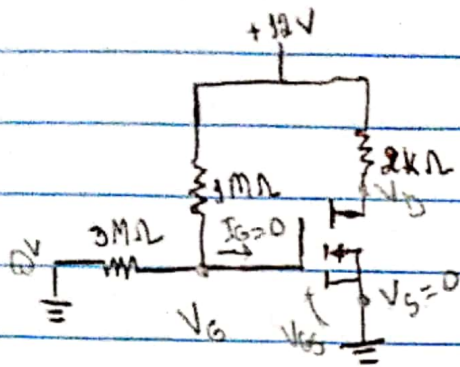
$$R_C \approx 995 \Omega$$

$$V_{CE} = V_C - V_E$$

$$= 10 - 4,03$$

$$= 5,98 \text{ V} \approx 6 \text{ V}$$

Questão 4



a) Solução

para gráfico:

$$V_t = 4V$$

$$I_D (\text{ligado}) = 0,8mA$$

$$V_{GS} (\text{ligado}) = 6V$$

$$I_D = K (V_{GS} - V_t)^2$$

$$K = \frac{I_D (\text{ligado})}{(V_{GS} (\text{ligado}) - V_t)^2}$$

$$K = \frac{0,8mA}{(6 - 4)^2} = 2 \times 10^{-4} A/V^2$$

$$K_m = 0,2 \times 10^{-3} A/V^2$$

b)

$$I_D = 0$$

$$I_D = I_S$$

$$V_{GS} = V_G - V_S$$

$$I_D = K_m (V_{GS} - V_t)^2$$

$$0,8mA = 0,2mA (V_{GS} - 4)^2$$

$$4 = V_{GS}^2 - 8V_{GS} + 16$$

$$V_{GS}^2 - 8V_{GS} + 12 = 0$$

$$V_{GS} = 4$$

$$\Rightarrow V_{GS} = 6V$$

$4 < V_t \rightarrow \text{erro}$

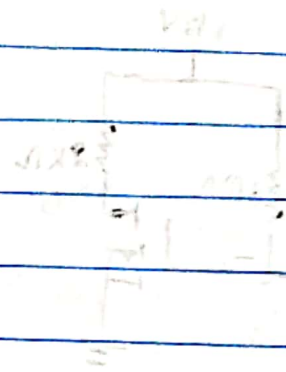
2)

$$I_D = K_m (V_{GS} - V_t)^2$$

$$I_D = 0,2m (6-4)^2$$

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

$$I_D = 8 \times 10^{-4} A$$



$$V_{GS} = V_G - V_S$$

$$V_{GS} = V_G - 0$$

$$V_G = 6V$$

$$V_D = 12 - R_D I_D$$

$$V_D = 12 - (2k)(0,8m)$$

$$V_D = 10,4V$$

$$V_{DS} = V_D - V_S$$

$$V_{DS} = 10,4$$

$$V_{DS} > V_{GS} - V_t$$

$$10,4 > 6 - 4 \rightarrow \text{Região de Saturação}$$