Diamatos

1- a)

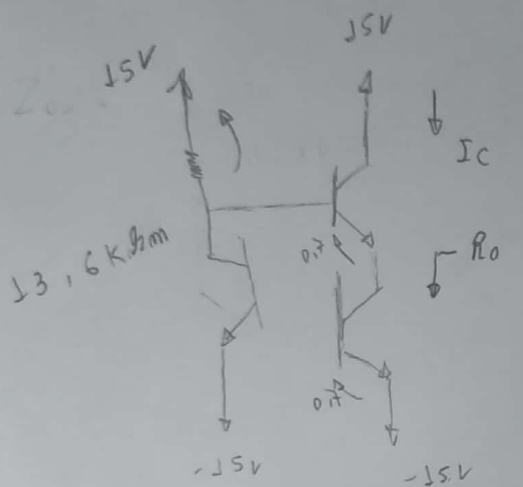
Dados : { Transistores NPN: $\beta = 200$, $V_A = 100V$ — Transistores PNP: $\beta = 100$, $V_A = 50$

$\to ro = 4M$

$\to rop = 5M$

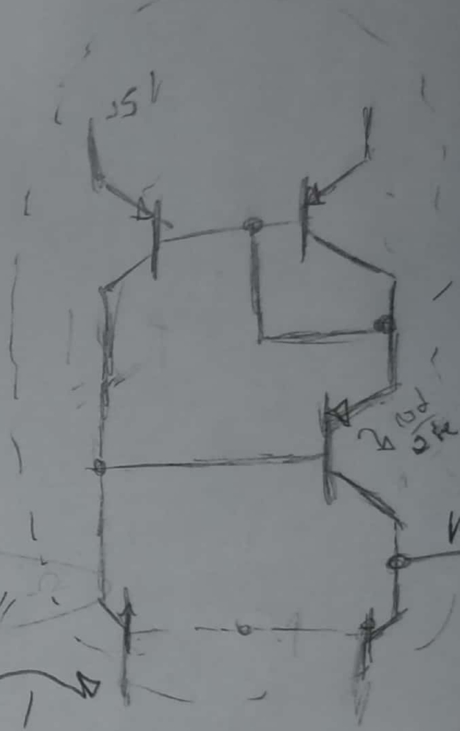
$\to rom = 20M$

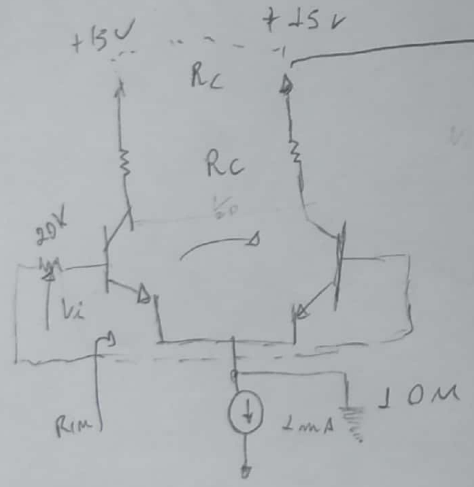
a) Resistência de saída



$$I_0 = \frac{15-1,4}{13,6K}$$

$$I_0 = 1\,mA$$





$$rop = \frac{V_{Ap}}{0,5mA} \quad 50$$

$$\frac{\beta_p}{2} = \frac{100}{2} = 50$$

$\beta + 1 = 201$

$$re = \frac{25\,mV}{0,5\,mA} = 50\,\Omega$$

$$Rim = 201 \cdot 2 \cdot re$$

$$= 201 \cdot 2 \cdot 50$$

$$= 20100 \rightsquigarrow \boxed{Rim = 20100}$$

$$rop = \frac{\beta p}{2} \cdot \frac{V_{Ap}}{0,5m}$$

$$rop = \frac{100}{2} \cdot \frac{50}{0.5m}$$

$$rop = 5M \to rop = 5M$$

$$rom = \frac{\beta m}{2} \cdot \frac{V_m}{0.5m}$$

$$rom = \frac{200}{100} \cdot \frac{100}{0.5m}$$

$$\boxed{rom = 20M}$$

... continuando

$v_d = v_s$

$A_o = \frac{v_d}{v_s}$

$R_N // R_p = R_o$

$r_e = \frac{V_T}{0,5m} = \frac{25\,mV}{0,5\,mV} = 50\,\Omega$

$\frac{\lambda . v_d}{r_e} = v_o \rightsquigarrow \frac{v_o}{v_d} = \frac{R_o}{r_e} = \frac{4M}{50\Omega} = 80K\ [V/V]$

$R_N // R_p = R_o \rightarrow \frac{20M . 5M}{20M + 5M} = 4M\,\Omega$

$R_s = R_{in}$

$A_o = \frac{v_d}{v_s} = \frac{2 r_e (\beta + 1)}{2 r_e (\beta + 1) + R_s} = \frac{20.100}{20100 + 20100} = 0.5$

b)

\# Ganho de Tensão

$A_v = \frac{V_o}{V_s}$

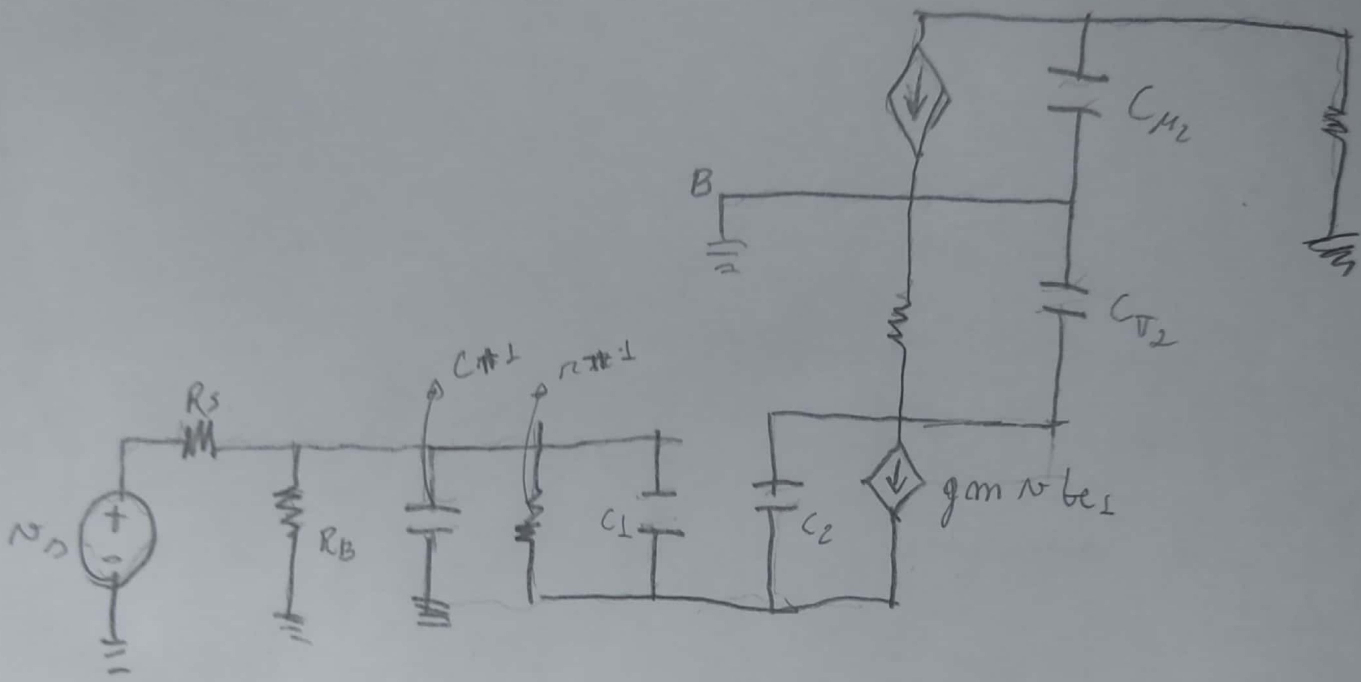
$A_v = \frac{V_o}{V_s} = \frac{V_o}{V_d} . A_o$

$A_o . v_o : 80K . 0.5 = A_v = \frac{V_o}{V_d}$

$\boxed{A_v = 40K}$

2.

Fazendo o modelo de pequenos sinais



Equações

$$\begin{cases} R_B = R_{B3} // R_{B2} \\ \end{cases}$$

$$\begin{cases} C_1 = C_{\mu 1}\left(1 + \overset{\sim 1}{g_m r_e}\right) = 2\, C_{\mu 1} \\ C_2 = C_{\mu 2}\left(1 + \dfrac{1}{g_m r_e}\right) = 2C_{\mu 1} \end{cases}$$

$$\begin{cases} \tau_1 = (C_1 + C_{\pi 1}) \cdot R_S // R_B // r_{\pi 1} \\ \tau_2 = (C_2 + C_{\pi 2}) \cdot r_e \\ \tau_3 = (C_{\mu 2} // R_L') \end{cases}$$

Iniciando

P/ wL deve alterar para CE

$$w_L = \frac{1}{R_{CE} \cdot C_E}$$

P/ RCE

$$R_{CE} = \left(\frac{R_B // R_S}{\beta} + r_e\right) \cdot R_E = 44{,}562\,\Omega$$

$$w_L = \frac{1}{44{,}562 \cdot 220\mu}$$

$$\boxed{w_L = 102 \text{ rad/s}}$$

P/A

$$v_o = r_e \cdot g_m \cdot v_{be1}$$

$$A \Rightarrow \frac{v_o}{v_{be1}} = r_e \cdot g_m$$

$$A = -1$$

p/

$$RCE = \left(\frac{R_B // R_S}{\beta} + r_e \right) \cdot R_E = 44{,}562\,\Omega$$

P/A

$$v_o = r_e \cdot g_m \cdot v_{be1}$$

$$A \Rightarrow \frac{v_o}{v_{be1}} = r_e \cdot g_m$$

$$A = -1$$

P/ ω_h → deve olhar para as equações τ_1, τ_2, τ_3

$$\tau_1 = 1{,}286 \cdot 10^{-7}$$
$$\tau_2 = 4{,}37 \cdot 10^{-10}$$
$$\tau_3 = 1{,}458 \cdot 10^{-8}$$

$$\omega_h = \frac{1}{\tau_1 + \tau_2 + \tau_3} \Rightarrow \boxed{\omega_h = 963\,K\ rad/s}$$

P/ Am

$$Am = \frac{v_b}{v_s} \cdot \frac{v_o}{v_b} = 0.3815 \cdot (-112)$$

$$\boxed{Am = -42.729}$$

P/ A(s)

$$A(s) = Am \cdot \frac{\frac{s}{wL}}{1 + \frac{s}{wL}} \cdot \frac{1}{1 + \frac{s}{wh}}$$

$$\boxed{A(s) = -42729 \cdot \frac{\frac{s}{102}}{1 + \frac{s}{102}} \cdot \frac{1}{1 + \frac{s}{963k}}}$$

3

Dados:

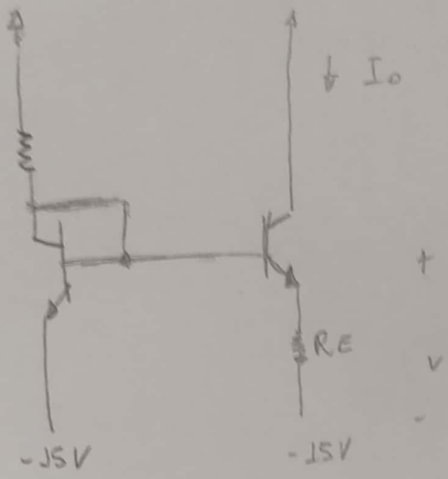
$\beta \to \infty$

$I_C = 1mA$

$V_{BE} = 0.7V$

$I_o = 20\mu A$

R_C



$$R_E = \frac{0{,}7 - V_{BE_2}}{20\mu A} \qquad ①\ 0{,}7 = V_T \cdot Ln\left(\frac{1m}{I_S}\right) \qquad ②\ V_{BE_2} = V_T \cdot Ln\left(\frac{20\mu}{I_S}\right)$$

$$V_{BE_2} - 0{,}7 = V_T \cdot Ln\left(\frac{20\mu}{1m}\right)$$

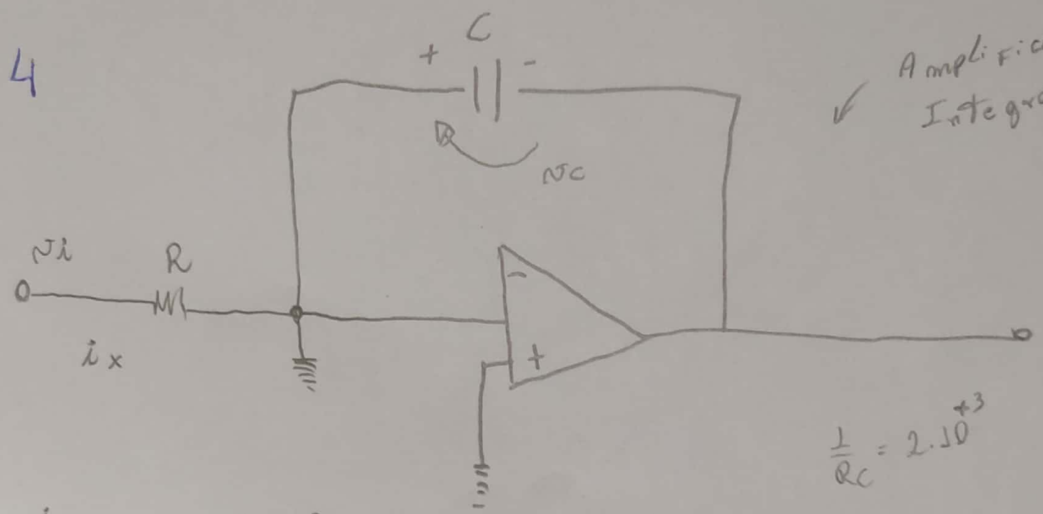
$$V_{BE_2} = 0.7 + 25.10^{-3} \cdot Ln\left(20.\right.$$

$$\boxed{V_{BE_2} = 0{,}60220}$$

$$R_E = \frac{0{,}7 - V_{BE2}}{20\mu} = \frac{0.7 - 0{,}60220}{20\mu}\ \}\ 0{,}097801$$

$$\boxed{R_E = 4890\,\Omega}$$

4



Amplificador Integrador

$$\left.\begin{aligned} v_+ &= 0 \\ v_- &= 0 \\ v_+ &= v_- \\ v_0 &= -v_c \end{aligned}\right\}$$

$$\frac{1}{RC} = 2.10^{+3}$$

$$\left. i_x = \frac{v_i}{R} = i_c \right\} \text{ Integrar}$$

$$\int v_0 = \frac{1}{C} \cdot i_c \Rightarrow v_o(t) = \frac{1}{RC} \int v_i(t)\,dt - \cancel{v(0)}$$

é zero

$$\int \frac{1}{C} \cdot \frac{v}{R}$$

$$v_0(t) = -\frac{1}{RC} \int v_i(t)\,dt$$

$$\boxed{v_0(t) = -2.10^{+3} \int v_i(t)\,dt}$$

$$\tau = \cancel{10}^3 \cdot 0{,}5 \cdot 10^{-\cancel{6}\,3}$$

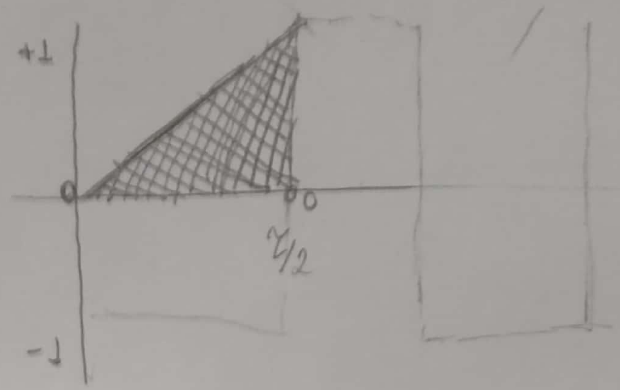
$$\tau = 0.5.10^{-3}$$

$$v_{out} = -2.10^3 \int_0^t -1\,dt \quad e \quad v_{out} = -2.10^{+3} \int_0^t -1\,dt + 1$$

P/ $v_{out} = -2.10^{3} \int_{0}^{t} -1 \, dt$ ↗ gráfica

1

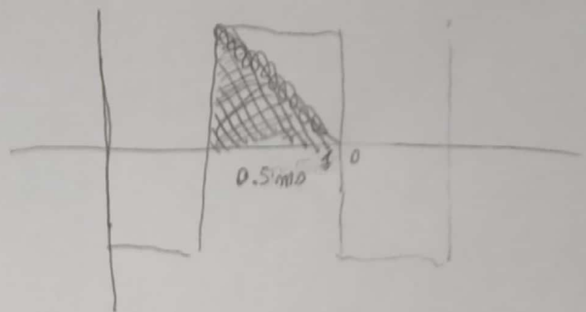
$v_{out} = -2.10^{3}$



P/ $v_{out} = -2.10^{3} \int_{0}^{t} -1 \, dt + 1$ $\Big\}$ com $t = 0{,}5\ ms$

$v_{out} = -2.10^{-3} t + 1$

2



Juntando