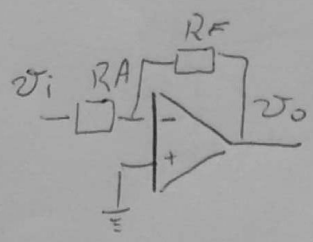
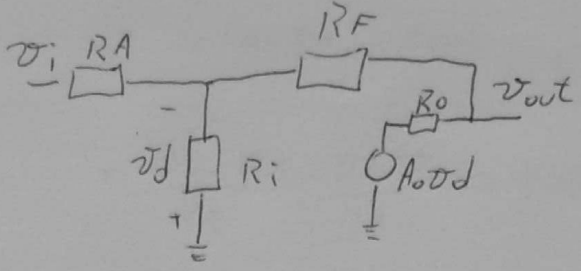
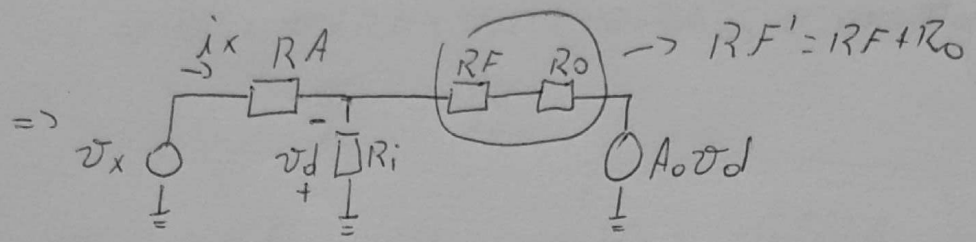
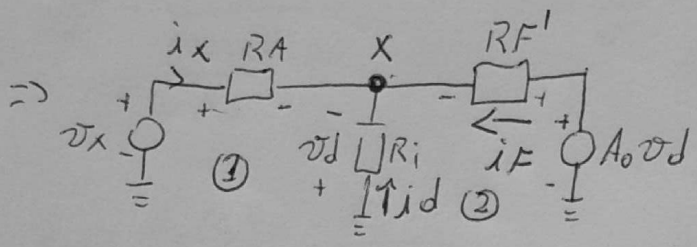
(1)







$\rightarrow R_F' = R_F + R_o$



Malha 2

$\Rightarrow v_d - R_F' I_F + A_o v_d = 0 \Rightarrow I_F = \frac{v_d \cdot (A_o + 1)}{R_F'}$

Nó x

$\Rightarrow i_x + i_d + i_A = 0 \Rightarrow i_x + \frac{v_d}{R_i} + \frac{(A_o+1)v_d}{R_F'} = 0 \Rightarrow \boxed{i_x = -\frac{v_d[R_F' + R_i(A_o+1)]}{R_i R_F'}}$

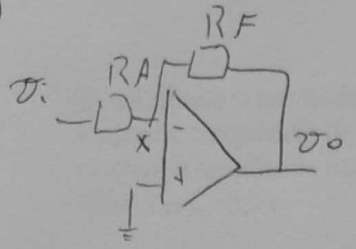
Malha 1

$v_x - R_A \dot{I}_x + v_d = 0 \Rightarrow v_x = R_A i_x - v_d \Rightarrow v_x = R_A \cdot \frac{-v_d[R_F + R_i(A_o+1)}{R_i \cdot R_F'} - v_d$

$R_{in} = \frac{v_x}{i_x} = R_A \cdot 1 + \left(\frac{R_F' + R_i(A_o+1)}{R_i \cdot R_F'}\right)^{-1} \Rightarrow \boxed{R_{in} = R_A + \frac{R_i \cdot R_F'}{R_F' + R_i(A_o+1)}}$ 12"

(2)

a)



- $A_o(0 - v_x) = v_{out} \Rightarrow \boxed{v_x = -\frac{v_o}{A_o}}$

- $\frac{v_i - v_x}{RA} = \frac{v_x - v_o}{RF} \Rightarrow v_i RF - v_x RF = v_x RA - v_o RA$

$\Rightarrow v_i RF = v_x RF + v_x RA - v_o RA \Rightarrow v_i RF = -v_o\left(\frac{RF}{A_o} + \frac{RA}{A_o} + RA\right)$

($v_x \downarrow -\frac{v_o}{A_o}$, $v_x \downarrow -\frac{v_o}{A_o}$)

$$\frac{v_o}{v_i} = \frac{-RF}{\frac{(RF+RA)}{A_o} + RA} \cdot RA^{-1} \cdot RA^{-1} \Rightarrow \boxed{\frac{v_o}{v_i} = \frac{-RF/RA}{\frac{1+RF/RA}{A_o} + 1}}$$

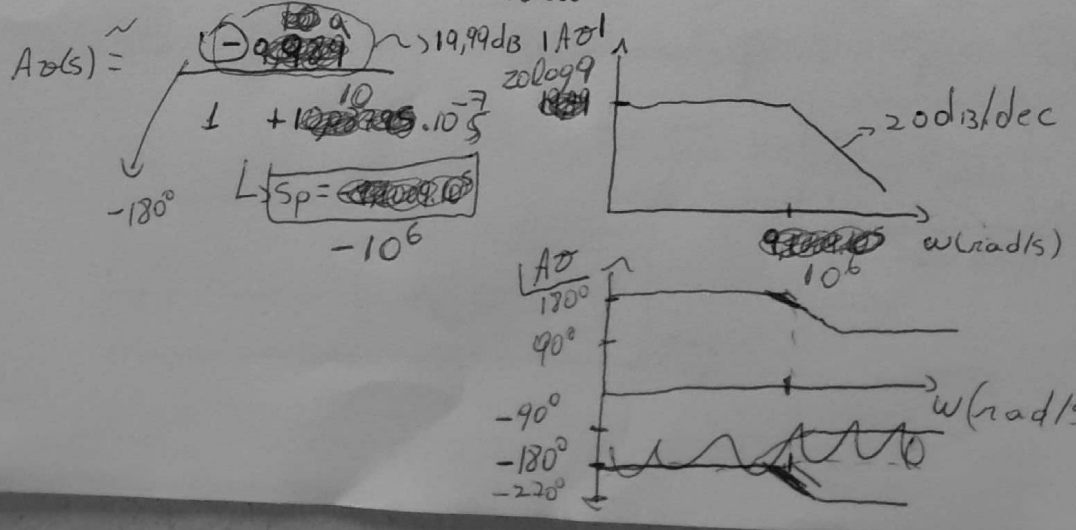
$$A_o = A_o(s) = \frac{A_{occ}}{s/w_o + 1}$$

$$\frac{V_o(s)}{V_i(s)} = \frac{-RF/RA}{\frac{1+RF/RA}{\frac{A_{occ}}{s/w_o+1}} + 1} = \frac{-RF/RA}{\frac{(1+RF/RA)\cdot\left(\frac{s}{w_o}+1\right)}{A_{occ}} + 1} = \frac{-RF/RA}{\frac{1+RF/RA}{A_{occ}} + \frac{1+RF/RA}{A_{occ}}\cdot\frac{s}{w_o} + 1}$$

$$\therefore \boxed{A_v(s) = \frac{-RF/RA}{\frac{1+RF/RA}{A_{occ}} + 1 + \frac{1+RF/RA}{A_{occ}}\cdot\frac{s}{w_o}}}$$

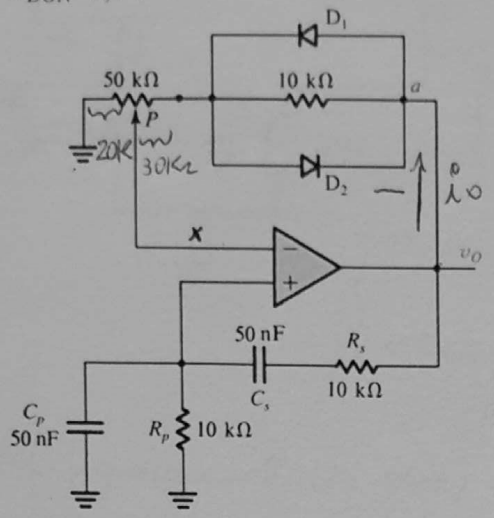
b) $A_v(s) = \frac{-9}{\frac{10}{10.000} + 1 + \frac{10}{10.000}\cdot\frac{s}{1000}} = \frac{-9}{1,0009 + 10.10^{-7}s} = \frac{-9}{1,0009 + 10.10^{-7}s} \cdot 1,0009^{-1} \cdot 1,0009^{-1}$

$A_v(s) \approx$



18''

3) a)Calcule o ponto de ajuste do potenciômetro em que se inicia as oscilações.
b)Qual a frequência de oscilação
c) Qual a amplitude de vo?
Obs: V_{DON}=0,7V



$$\omega = \omega_0 = \frac{1}{RC} \qquad \frac{R_F}{R_A} = 2$$

a) $R_p = R_1 + R_2 = 50K\Omega$ (2RA)

$$\begin{cases} R_F = 10K\Omega + R_2 \\ R_A = 50K\Omega - R_2 \\ R_F = 2 \cdot R_A \end{cases} \Rightarrow$$

$2RA = 10K\Omega + R_2 \Rightarrow R_2 = 2 \cdot RA - 10K\Omega$

$RA = 50K\Omega - (2RA - 10K\Omega) \Rightarrow RA + 2RA = 60K\Omega$

$\Rightarrow$ **$RA = 20K\Omega$**
$R_F = 40K\Omega$
$R_2 = 30K\Omega$
$R_1 = 20K\Omega$

b) $\omega_0 = \frac{1}{10.10^3 . 50.10^{-9}} \Rightarrow \omega_0 = \frac{1}{5.10^5 . 10^{-9}} \Rightarrow$

$\omega_0 = 2.10^3$ rad/s

c) $\frac{v_o}{10K + 50K} = i_o \Rightarrow v_{10K} = 10K \cdot \frac{v_o'}{60K} \Rightarrow v_{10K} = \frac{v_o}{6} \Rightarrow$

$60K\Omega$

$v_o = v_p \cdot \operatorname{sen} \omega_0 t$ ($\operatorname{sen}\omega_0 t = \phi$) $\Rightarrow v_o = v_p \Rightarrow v_{10K\Omega} = V_{DON} = 0,7V$

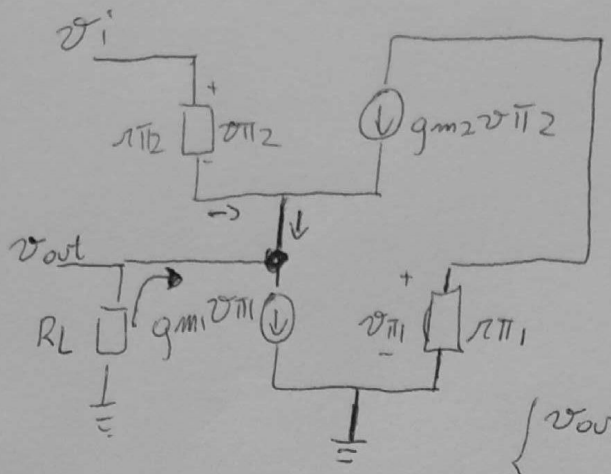
$\Rightarrow 0,7 = \frac{v_p}{6} \Rightarrow$ **$v_p = 4,2V$**

tensão de pico

Amplitude = 8,4V

15"

④



$$-\frac{v_{out}}{R_L}+g_{m2}v_{\pi 2}+\frac{v_{\pi 2}}{r_{\pi 2}}=g_{m1}v_{\pi 1}$$

$$\begin{cases} v_{out}=-R_L\left(g_{m1}v_{\pi 1}-g_{m2}v_{\pi 2}-\dfrac{v_{\pi 2}}{r_{\pi 2}}\right) \\ v_{\pi 2}=v_i-v_{out} \end{cases} \qquad -v_{\pi 2}\left(g_{m2}+\frac{1}{r_{\pi 2}}\right)$$

$$\begin{cases} v_{out}=-R_L\left[g_{m1}v_{\pi 1}-(v_i-v_{out})\cdot\left(g_{m2}+\dfrac{1}{r_{\pi 2}}\right)\right] \\ v_{\pi 1}=-g_{m2}v_{\pi 2}\cdot r_{\pi 1} \end{cases}$$

v_i-v_{out}

$$v_{out}=-R_L\cdot\left[-g_{m1}g_{m2}r_{\pi 1}\cdot(v_i-v_{out})-v_i\left(g_{m2}+\frac{1}{r_{\pi 2}}\right)+v_{out}\left(g_{m2}+\frac{1}{r_{\pi 2}}\right)\right]$$

$$v_{out}=-R_L\left[-v_i\underbrace{g_{m1}g_{m2}r_{\pi 1}}_{\beta_2}+v_{out}\cdot\underbrace{g_{m1}g_{m2}r_{\pi 1}}_{\beta_1}-v_i\underbrace{\left(g_{m2}+\frac{1}{r_{\pi 2}}\right)}_{(\beta_2+1)/r_{\pi 2}}+v_{out}\underbrace{\left(g_{m2}+\frac{1}{r_{\pi 2}}\right)}_{(\beta_2+1)/r_{\pi 2}}\right]$$

$$v_{out}=-R_L\left[-v_i\left(\beta_1 g_{m2}+\frac{\beta_2+1}{r_{\pi 2}}\right)+v_{out}\cdot\left(\beta_1 g_{m2}+\frac{\beta_2+1}{r_{\pi 2}}\right)\right]$$

$$v_{out}\cdot\left(1+R_L\left(\beta_1 g_{m2}+\frac{\beta_2+1}{r_{\pi 2}}\right)\right)=R_L\cdot\left(\beta_1 g_{m2}+\frac{\beta_2+1}{r_{\pi 2}}\right)\cdot v_i$$

$$A_v=\frac{R_L\left(\beta_1 g_{m2}+(\beta_2+1)/r_{\pi 2}\right)}{1+R_L\left(\beta_1 g_{m2}+\dfrac{\beta_2+1}{r_{\pi 2}}\right)} \Rightarrow \boxed{A_v=\frac{R_L}{\dfrac{1}{\beta_1 g_{m2}+\dfrac{\beta_2+1}{r_{\pi 2}}}+R_L}}$$

15"

$$A_v=\frac{R_L}{\left(\dfrac{\beta_1\beta_2+\beta_2+1}{r_{\pi 2}}\right)^{-1}+R_L}=\frac{R_L}{\dfrac{r_{\pi 2}}{1+\beta_2(1+\beta_1)}+R_L}$$

↳ X