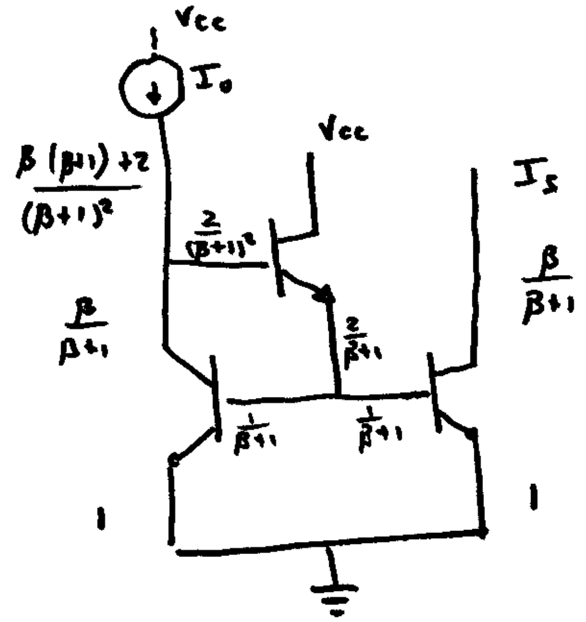
Electrónica II 30.01.2006

Exame de Recurso ESI

1a



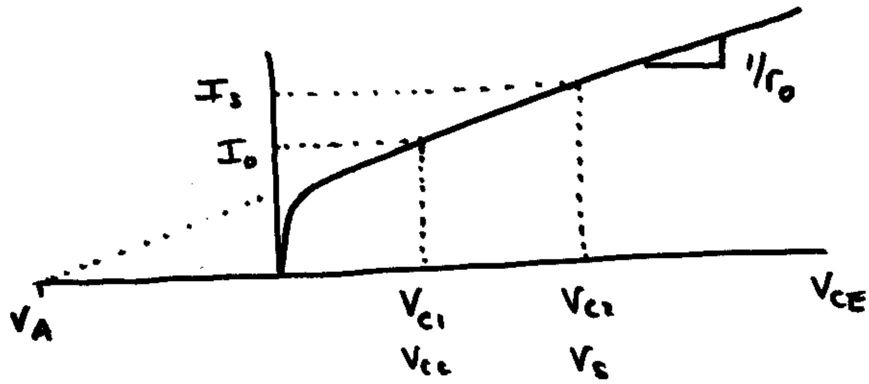
$$I_s = \frac{\beta}{\beta+1}$$

$$= \frac{\beta}{\beta+1} \cdot I_o \cdot \frac{(\beta+1)^2}{\beta(\beta+1)+2}$$

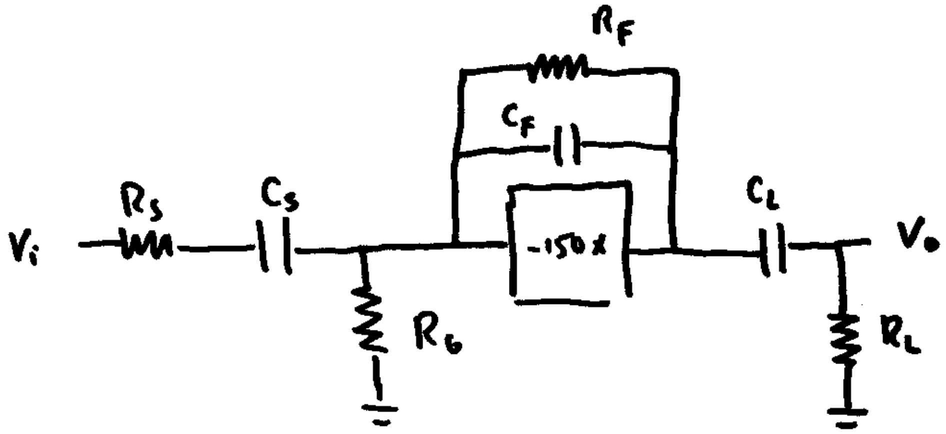
$$= I_o \, \frac{\beta(\beta+1)}{\beta(\beta+1)+2}$$

$$= I_o \, \frac{1}{1 + 2/\beta(\beta+1)}$$

1b



$$I_s = I_o + (V_s - V_{cc})/r_o$$



2a) $\dfrac{V_x}{V_i} = \dfrac{r_i /\!/ R_G}{r_i /\!/ R_G + R_s} = \dfrac{10\,k /\!/ 5k}{10k /\!/ 5k + 500} = 0.8696$

$\dfrac{V_o}{V_x} = -150 \cdot \dfrac{R_L}{R_L + r_o} = -150 \cdot \dfrac{1500}{1500 + 10k} = -19.565$

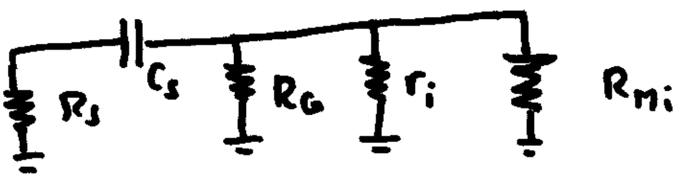
$\dfrac{V_o}{V_i} = \dfrac{V_o}{V_x} \cdot \dfrac{V_x}{V_i} = -19.565 \times 0.8696 = -17.014$

2b) $C_s \rightarrow$ HPF 

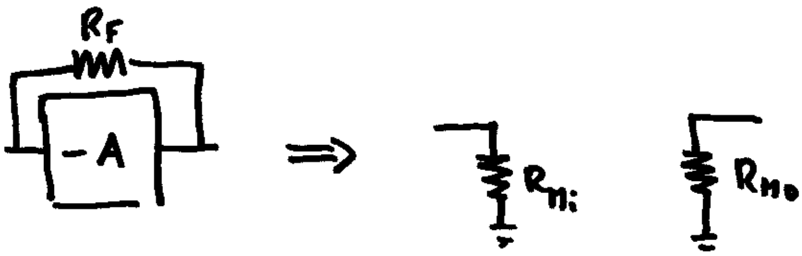
$C_L \rightarrow$ HPF 

$C_F \rightarrow$ LPF 

C_s : os C's dos LPF's : circuito aberto



efeito Miller :



$A = -19.565$, $R_{Mi} = \dfrac{R_F}{1-A} = 10\,k\Omega / 20.565 = 486.3\,\Omega$

$$R_{Mo} = \frac{R_F}{1 - 1/A} = 10\,k\Omega / (1 + 1/19.565) = 9514\,\Omega$$

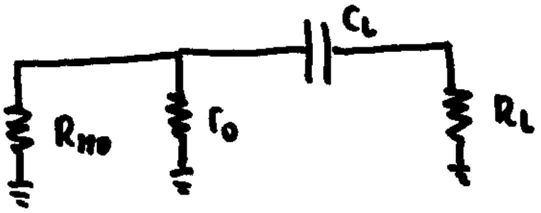
$$\tau_S = C_S (R_S + R_b // r_i // R_{Mi})$$

$$= 5\mu F \; (1500\,\Omega + 5k\Omega // 10\,k\Omega // 486.3\,\Omega)$$

$$= 4.62 \text{ ms}$$

$$f_{1S} = \frac{1}{2\pi\tau_S} = 34.4 \text{ Hz}$$

C_L : os c's do LPF (C_F) : circuito aberto



$$\tau_L = C_L (R_{Mo} // r_o + R_L)$$

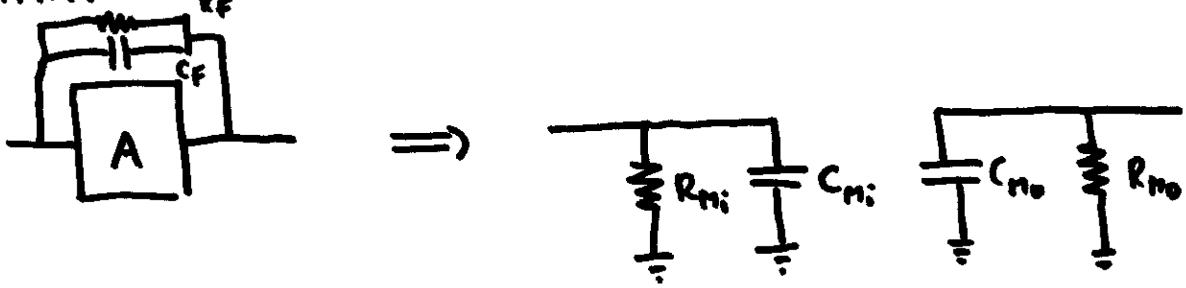
$$= 5\mu F \; (9514\,\Omega // 10\,k\Omega + 1500\,\Omega)$$

$$= 31.9 \text{ ms}$$

$$f_{1L} = \frac{1}{2\pi\tau_L} = 4.99 \text{ Hz}$$

C_F : todos os C's do HPF's : curto circuito

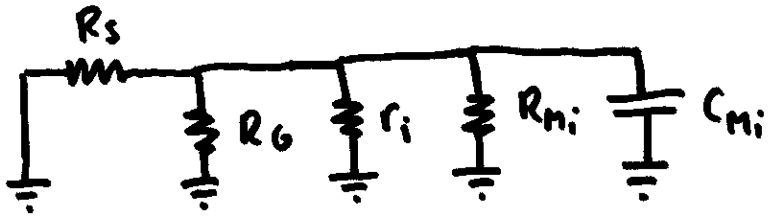
efeito Miller



$$C_{Mi} = C_F (1-A) = 50 \text{ pF} \cdot 20.565 = 1.028 \text{ nF}$$

$$C_{Mo} = C_F (1 - 1/A) = 50 \text{ pF} \cdot (1 + 1/19.565) = 52.556 \text{ pF}$$

in :



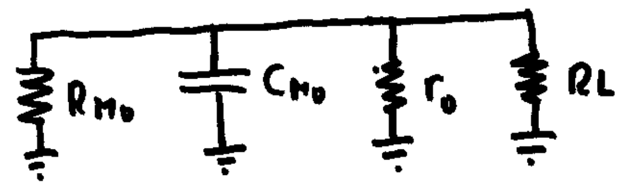
$$\tau_i = C_{Mi} \left(R_S \,/\!/\, R_G \,/\!/\, r_i \,/\!/\, R_{Mi} \right)$$

$$= 1.026 \text{ nF} \left(500\,\Omega \,/\!/\, 5\text{k}\Omega \,/\!/\, 10\text{ k}\Omega \,/\!/\, 481.3\,\Omega \right)$$

$$= 236 \text{ ns}$$

$$f_{2i} = \frac{1}{2\pi \tau_i} = 674.45 \text{ kHz}$$

out :



$$\tau_o = C_{Mo} \left(R_{Mo} \,/\!/\, r_o \,/\!/\, R_L \right)$$

$$= 52.556 \text{ pF} \left(9514\,\Omega \,/\!/\, 10\text{k}\Omega \,/\!/\, 1500\,\Omega \right)$$

$$= 60.29 \text{ ns}$$

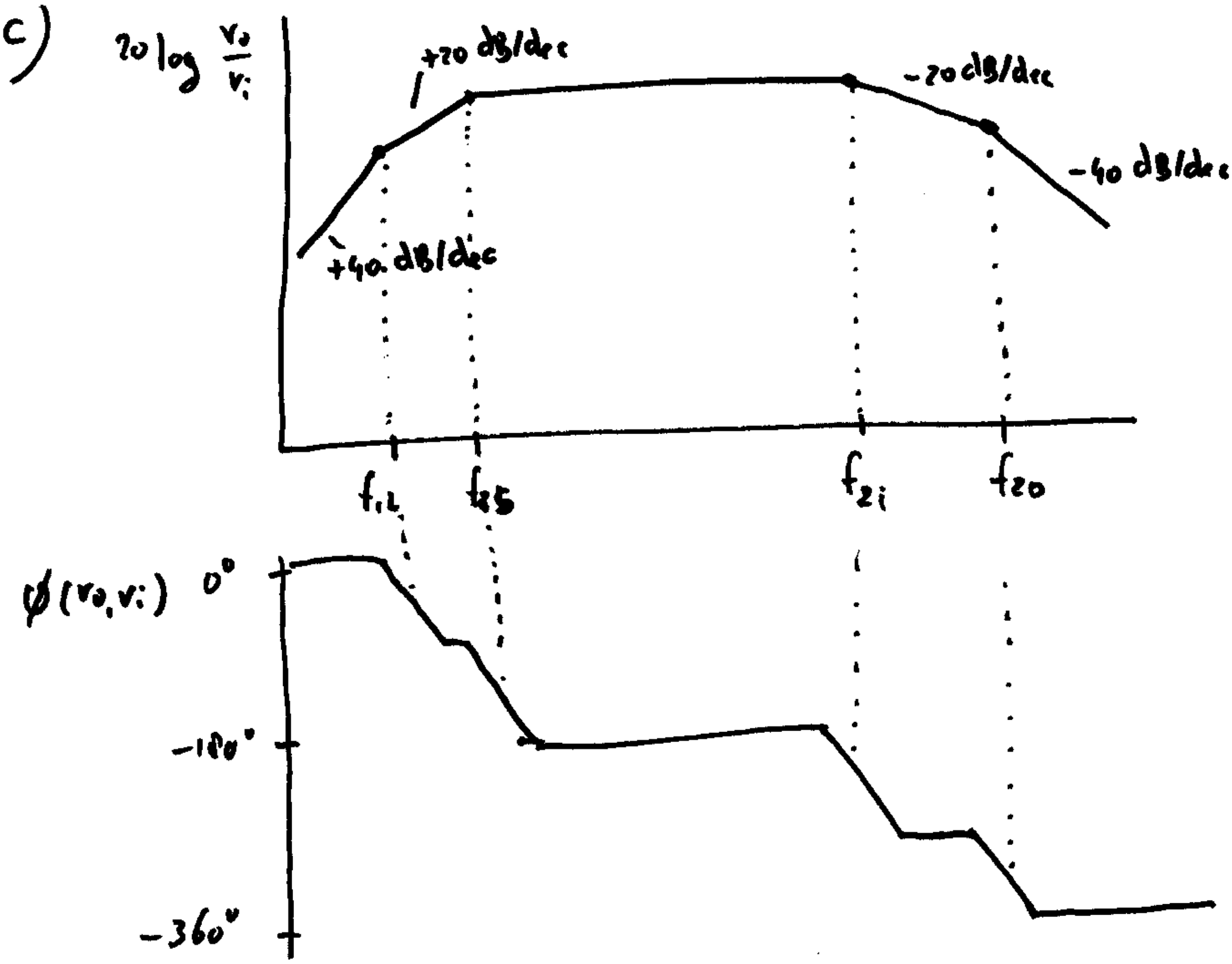
$$f_{2o} = \frac{1}{2\pi \tau_o} = 2.640 \text{ MHz}$$

$$f_L = f_{1S} + f_{1L} = 34.4 \text{ Hz} + 4.99 \text{ Hz} = 39.4 \text{ Hz}$$

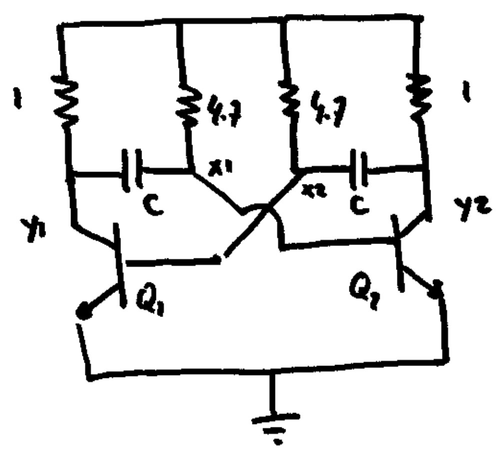
$$\tau_H = \tau_i + \tau_o = 236 \text{ ns} + 60.29 \text{ ns} = 296 \text{ ns}$$

$$f_H = \frac{1}{2\pi \tau_H} = 538 \text{ kHz}$$

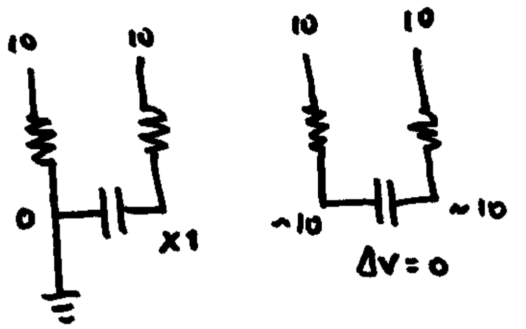
2c)


20 log $\frac{v_o}{v_i}$
+20 dB/dec
-20 dB/dec
-40 dB/dec
+40 dB/dec
f_{1L}
f_{1S}
f_{2i}
f_{2o}
$\phi(v_o, v_i)$
0°
-180°
-360°

3)



Q_1 aberto (curto circuito) e Q_2 fechado (circuito aberto)

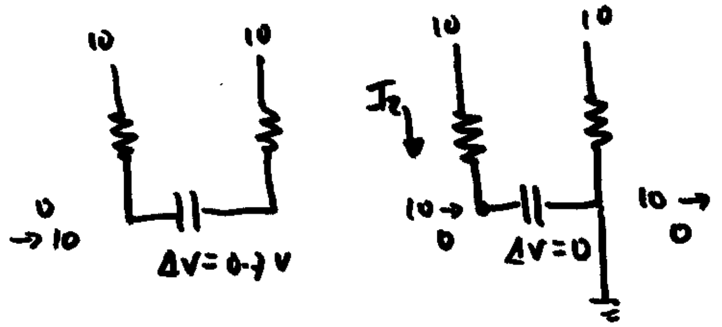


X1 começa por uma tensão < 0.7

e vai subir $\tau = R \cdot C$ ($R = 4.7\ k$)

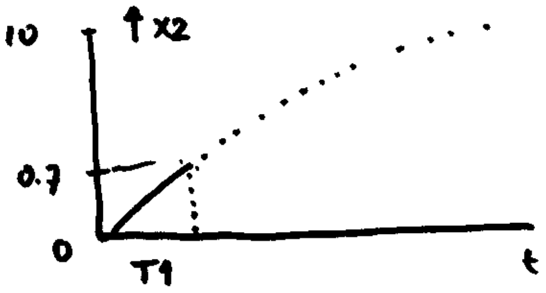
com tendência $V_{cc} = +10\ V$

chega a $V_{x1} = 0.7\ V$

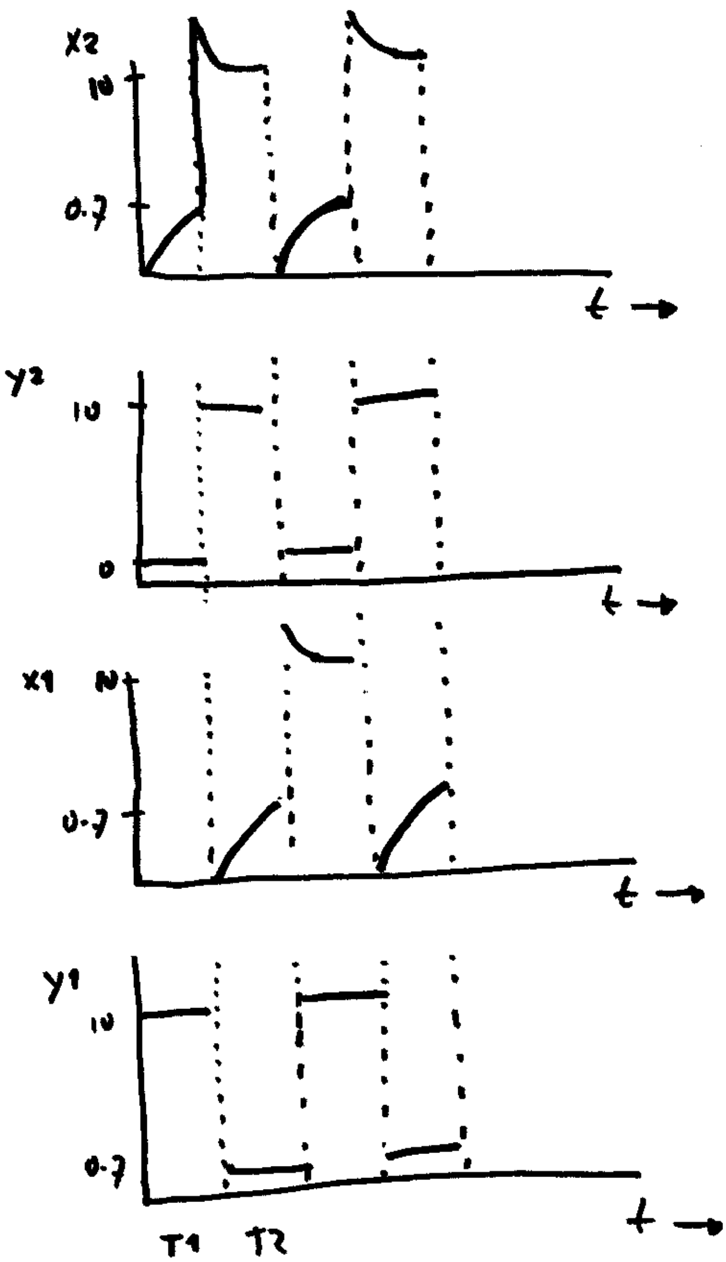


Agora tem uma corrente $I_2 = \frac{10}{4.7k}$ que vai

carregar C2



a)



b) T1 : $V_{x2} = 10\left(1 - \exp(-t/\tau)\right) = 0.7$

$$\rightarrow \quad \exp\left(-\frac{t}{\tau}\right) = \frac{9.3}{10}$$

$$t = -\tau \ln\left(\frac{9.3}{10}\right)$$

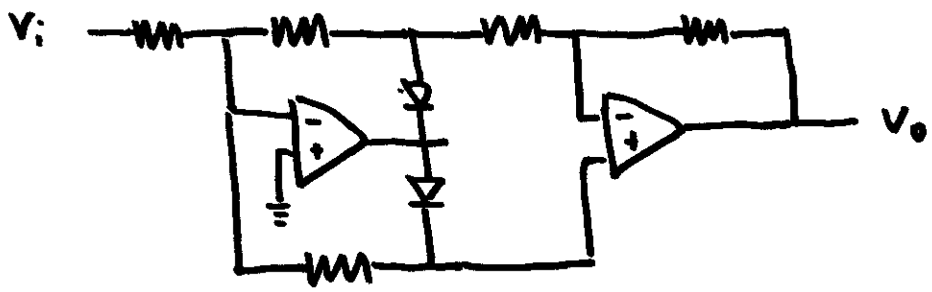
$\tau = RC$ $\qquad t = RC \ln\left(10/9.3\right)$ $\qquad R = 4.7\,k\Omega$

$T2 = T1$ $\qquad T_{tot} = T_1 + T_2 = 2RC \ln\left(\frac{10}{10-0.7}\right)$

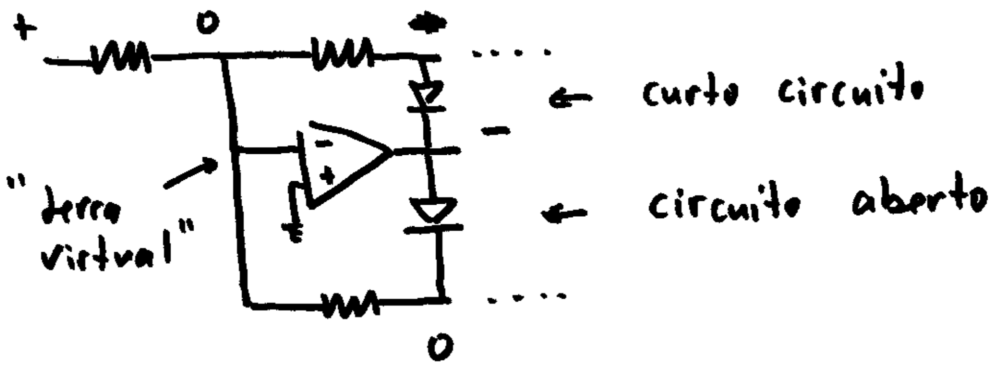
c) 10 kHz $\Rightarrow T_{tot} = 1\,ms$

$$R = 1\,ms \,/\, 2 \cdot 4.7\,k\Omega \cdot \ln\left(\frac{10}{10-0.7}\right) = 1.5\,\mu F$$

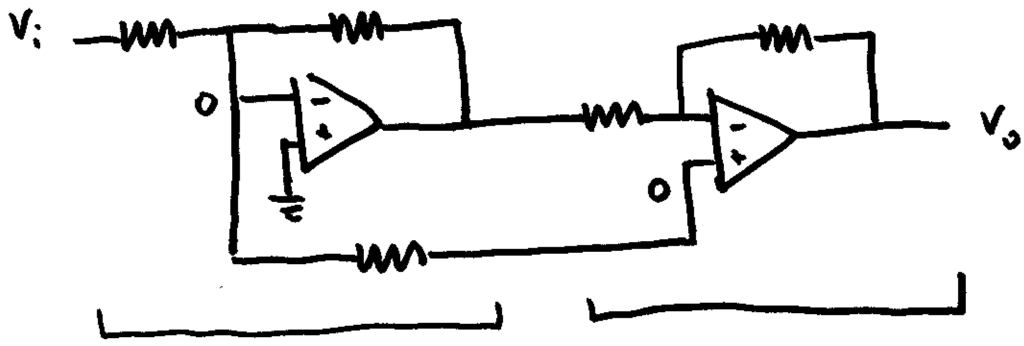
4)



para $V_i > 0$ (+)



$\Downarrow$



ampop 1

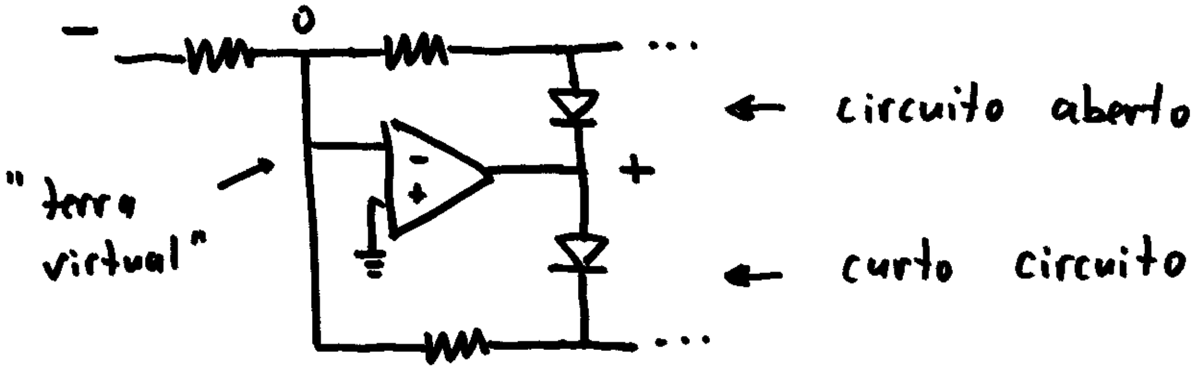
ganho $\frac{v_o}{v_i} = -\frac{R}{R} = -1$

ampop 2

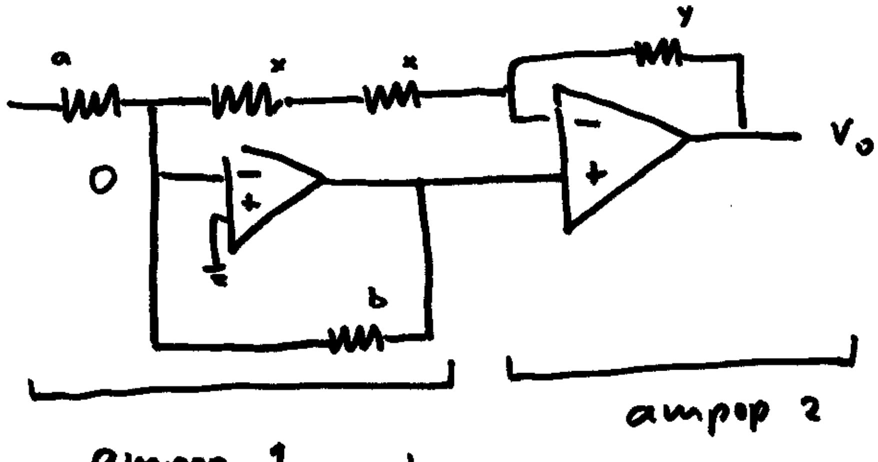
ganho $= \frac{V_o}{V_i} = -\frac{R}{R} = -1$

ganho $= +1$

para $V_i < 0$



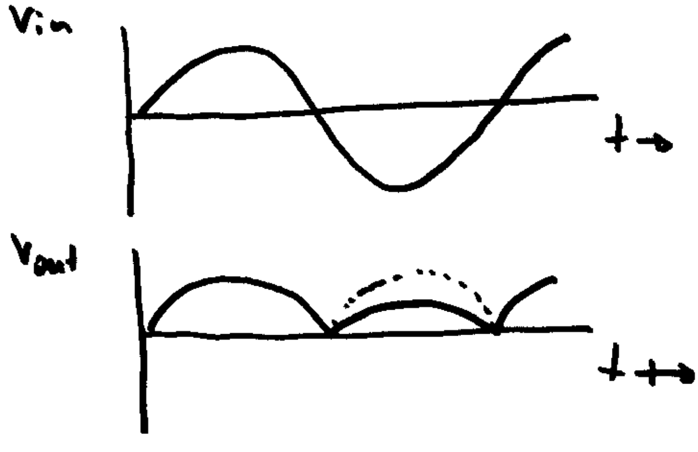
$\Downarrow$



ganho $= -\frac{R \to b}{R \to a} = -1$

ganho $= +\frac{R \to y}{R + R \to x} = +\frac{1}{2}$

ganho total : $-1/2$



a notar : com escolha diferente para R_x, R_y é possível melhorar