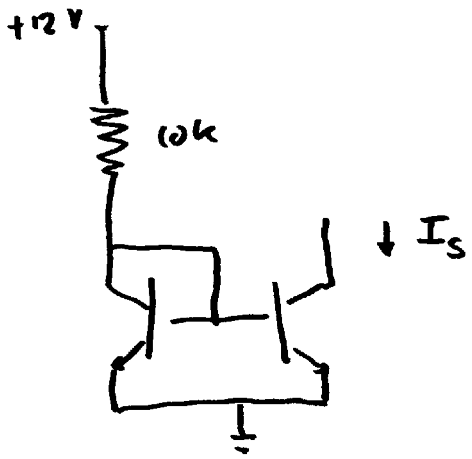
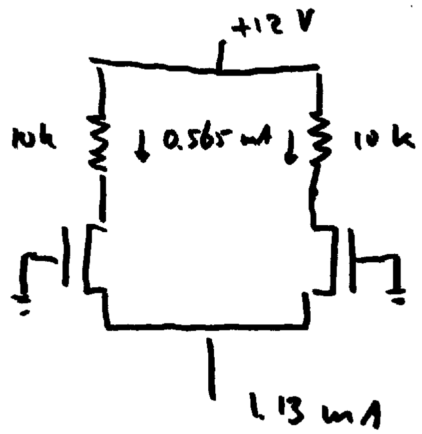
Electrónica II Exame Época Especial

5/12/2006



Fonte de corrente, I_S:

$$\frac{(12-0.7)\,V}{10\,k\Omega} = 1.13\ mA$$



$I_{M1} = I_{M2} = 1.13\ mA / 2 = 0.565\ mA$

$V_o = 12\ V - 0.565\ mA \cdot 10\ k\Omega$

$= 6.35\ V = V_D$

$V_G = 0$

SAT or LIN ?

SAT : $I_D = \frac{k}{2}(V_{GS} - V_T)^2$

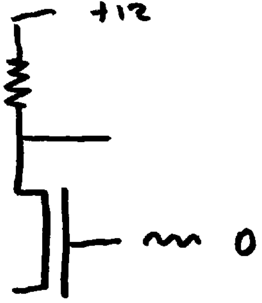
$565\ \mu A = 100\ \frac{\mu A}{V^2} \cdot (V_{GS} - 1)^2 \Rightarrow V_{GS} = 3.38\ V$

$\Rightarrow V_S = -3.38\ V \quad (V_G = 0)$

$V_D = 6.35\ V$

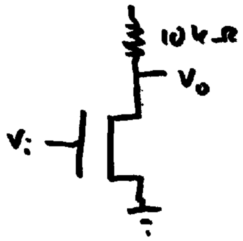
$V_G = 0$

$$\left.\begin{array}{l} V_{DS} = 6.35 - (-3.38) = 9.73\ V \\ V_{GS} = 3.38\ V \end{array}\right\} V_{DS} > V_{GS} \Rightarrow SAT$$



Esta bem polarizado. 6.35 fica mais ou menos no meio de 0 (V_G) e +12 V (V_{cc})

b)



O ganho de um source comum é

$$-g_m \cdot R_D$$

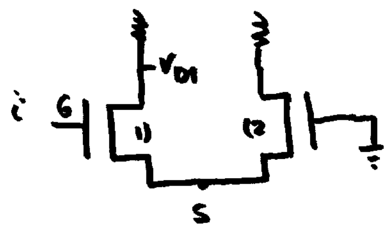
$$g_m = \frac{dI_D}{dV_{GS}} = \frac{d\,\frac{K}{2}(V_{GS}-V_T)^2}{dV_{GS}} = K(V_{GS}-V_T)$$

$$= 200\,\frac{\mu A}{V^2} \cdot (3.38\,V - 1\,V) = 476\,\frac{\mu A}{V}$$

$$\frac{V_D}{V_G} = -g_m R_D = -476\,\frac{\mu A}{V} \cdot 10\,k\Omega$$

$$= -4.76\,\frac{V}{V}$$

no par diferencial



$$\frac{dV_{GS1}}{dV_i} = \frac{1}{2}$$

(subida de V_i é dividida sobre os dois transistores)

O ganho do p.d.

$$A_{v1} = \frac{dV_{D1}}{dV_{i1}} = -R_D \cdot \frac{dI_{D1}}{dV_{i1}} = -R_D\,\frac{dI_{D1}}{dV_{GS1}} \cdot \frac{dV_{GS1}}{dV_{i1}}$$

$$= -R_D \cdot 476\,\frac{\mu A}{V} \cdot \frac{1}{2} = -2.38\,\frac{V}{V}$$

pela simetria: $A_{v2} = +2.38\,\frac{V}{V}$ $\left(= \frac{dV_{D2}}{dV_{i1}}\right)$

$$A_{dm} = |A_{v1} - A_{v2}| = 4.76\ \frac{V}{V}$$

modo comum: $A_{cm} = 0$. Desde não há corrente do gate, para qualquer tensão de entrada igual as duas entradas

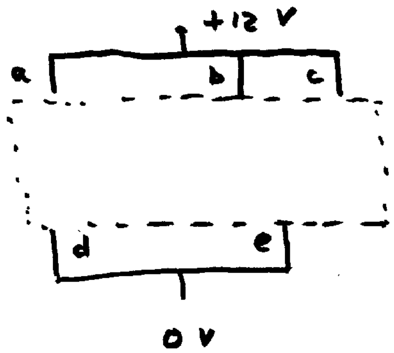
$$I_{D1} = I_{D2} = 565\ \mu A$$

$$\frac{dI_{D1}}{dv_i} = \frac{dI_{D2}}{dv_i} = 0$$

$$A_v = -R_D \cdot \frac{dI_{D1}}{dv_i} = 0$$

$$CMRR = \infty$$

c)

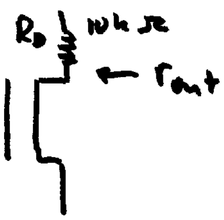


a = 1.13 mA
b = 0.565 mA
c = 0.565 mA
d = 1.13 mA
e = 1.13 mA

$$P = I \cdot V = 12 \cdot (I_a + I_b + I_c) + 0 \cdot (I_d + I_e)$$

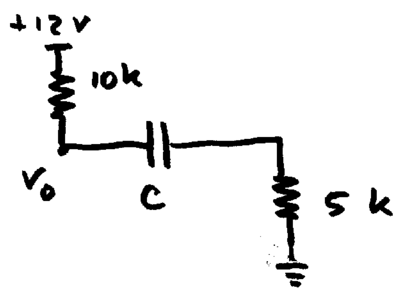
$$= 27\ mW$$

d) $r_{in} = \infty \quad (I_G = 0)$



$$r_o = 1 \Big/ \frac{\partial I_D}{\partial V_D} = 1 \Big/ \frac{d\ \frac{K}{2}(V_{GS} - V_T)}{\partial V_{DS}} = 1/0 = \infty$$

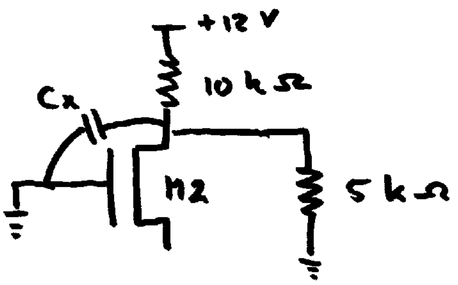
e) baixas frequências



$$f_{cL} = \frac{1}{2\pi RC} = 10 \text{ Hz}$$

$$C = \frac{1}{2\pi\,(10\,k\Omega \,/\!/\, 5\,k\Omega)\cdot 10 \text{ Hz}} = 4.8\ \mu F$$

altas frequências

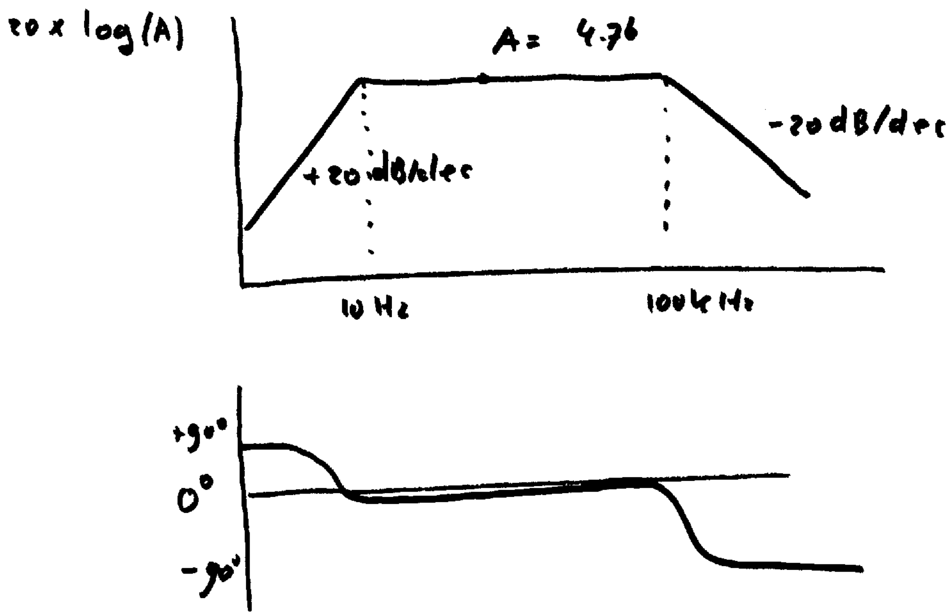


$$C_M = (1-A)\,C_x = (1-0)\,C_x = C_x$$

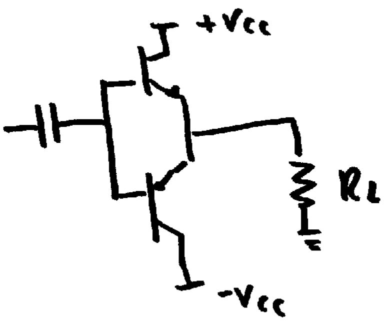
$$f_{cH} = \frac{1}{2\pi RC} = 100 \text{ kHz}$$

$$\Rightarrow C = 48 \text{ mF}$$

f)



g)



$$P_L = \frac{1}{2}\frac{V_{cc}^2}{R_L} = 1 \text{ W}$$

$$\Rightarrow V_{cc} = \sqrt{2\cdot 8\Omega\cdot 1W} = 4 \text{ V}$$

h) $$P_S = \frac{1}{T}\int_0^T V\cdot I\,dt = \frac{1}{T}\int_0^T V_{cc}^2\cdot\frac{|\sin \omega t|}{R_L} = \frac{4}{\pi}\frac{V_{cc}^2}{R_L} = 2.5 \text{ W}$$

nos transistores

$$P_T = P_S - P_L = 1.5\ W$$

por transistor

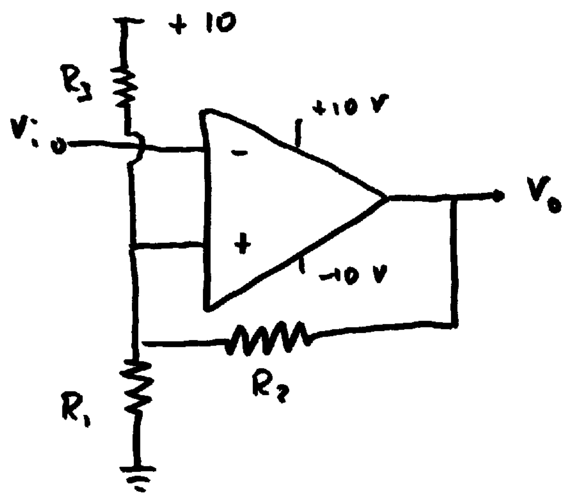
$$P_{T1} = P_{T2} = \tfrac{1}{2} P_T = 0.75\ W$$

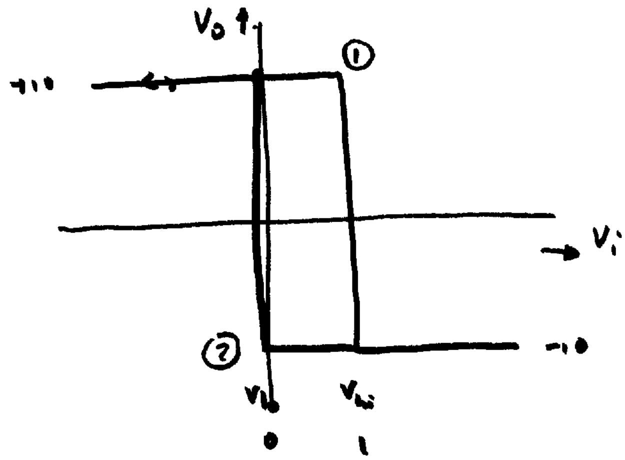
$$T_J = T_A + P \cdot R_T$$

$$= 25^\circ + 0.75\ W \cdot 100^\circ C/W = 100^\circ C$$

não há problema

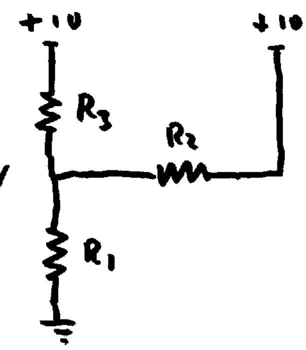
$\boxed{2}$





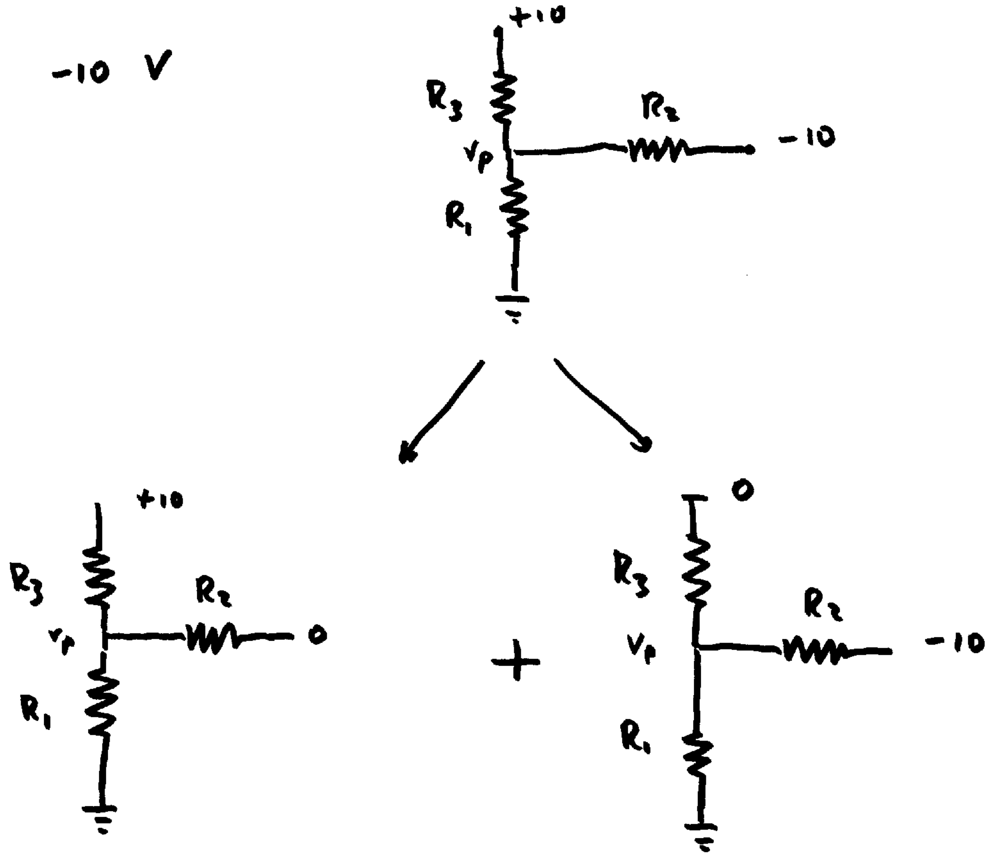
① $V_o = +10V$

$$V_p = \frac{R_1}{R_1 + R_2 /\!/ R_3} \cdot 10V$$



no $V_i = V_{hi}$, $V_p = V_n$ $\Rightarrow$ $10 \cdot \dfrac{R_1}{R_1 + R_2/\!/R_3} = 1$ (I)

(3) $V_0 = -10\ V$



$$V_p = \frac{R_1 /\!/ R_2}{R_1 /\!/ R_2 + R_3} \cdot 10 + \frac{R_1 /\!/ R_3}{R_1 /\!/ R_3 + R_2} (-10) = \underset{\substack{\uparrow \\ V_{10}}}{0} \quad (\mathrm{II})$$

Escolhe : $R_1 = 1\,k\Omega$

(Ia) : $$\frac{1\,k\Omega}{1k + R_2 /\!/ R_3} = 1/10 \Rightarrow \underbrace{R_2 /\!/ R_3 = 9\,k\Omega}$$

(IIa) $$\frac{\frac{R_2}{1+R_2}}{\frac{R_2}{1+R_2} + R_3} = \frac{\frac{R_3}{1+R_3}}{\frac{R_3}{1+R_3} + R_2}$$

$$\frac{R_2}{R_2 + R_3 + R_2 R_3} = \frac{R_3}{R_2 + R_3 + R_2 R_3}$$

$$R_2 = R_3$$

$$\boxed{R_2 = R_3 = 18\,k\Omega}$$