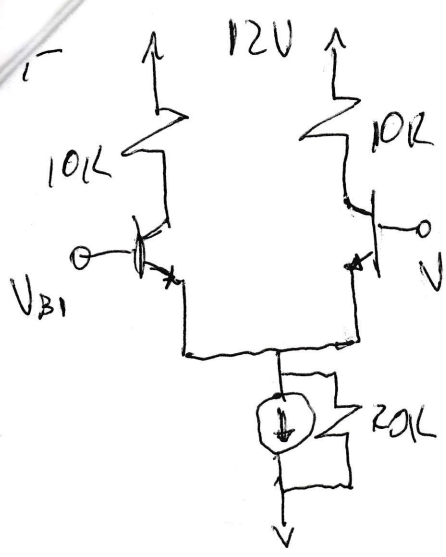
1-



$\beta = 150$

$V_T = 26\,mV$

$I = 0.25\,mA$

a) $v_{id} = 10\,mV$

$i_{C_1} = ?$ $i_{C_2} = ?$

$$i_{E_1} = \frac{I}{1 + e^{-v_{id}/V_T}}$$

$$i_{E_1} = \frac{0.25\,m}{1 + e^{-10/26}} = 0.1487\,mA$$

$$i_{E_2} = \frac{I}{1 + e^{v_{id}/V_T}} = \frac{0.25\,m}{1 + e^{10/26}} = 0.1013\,mA$$

$$i_{C_1} = \alpha i_{E_1} = \frac{\beta}{\beta+1} i_{E_1} = \frac{150}{151} 0.149 = 0.148\,mA$$

$$i_{C_2} = \alpha i_{E_2} = \frac{150}{151} 0.101 = 0.100\,mA$$

b) a) $I_{C_1} = I_{C_2} = I_C$ $\quad I_C = \alpha I_E$

$$I_E = \frac{I}{2} = 0.125\,mA$$

$$I_C = \frac{150}{151} \times 0.125\,m = 0.124\,mA$$

$$g_m = \frac{I_C}{V_T} = \frac{0.124\,m}{26\,m} = 4.78\,mA/V$$

Ganancia Salida Dif.

$A_d = g_m R_C$

$A_d = 4.78m \times 10k$

$A_d = 47.8\,V/V$

Ganancia Salida Dif.

$A_c = 0$

$$RRMC = \frac{47.8}{0}$$

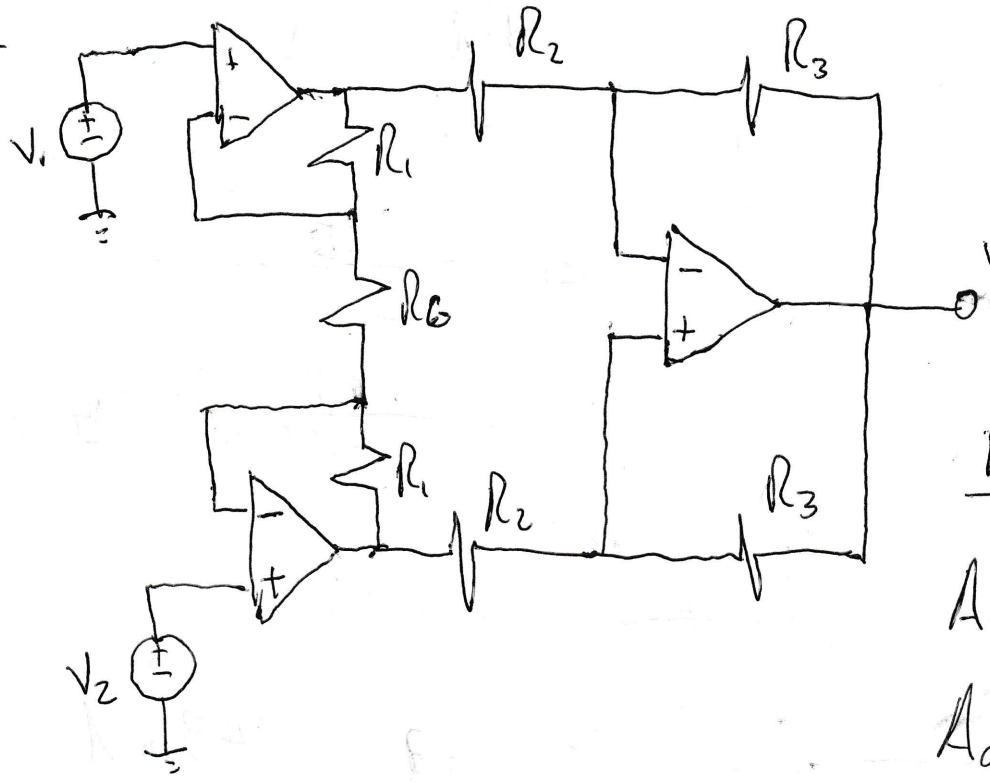
$RRMC = \infty$

c) $v_{B_1} = 30\,mV$ y $v_{B_2} = 10\,mV$

$v_d = 30 - 10 = 20\,mV$

$v_{sd} = A_d \times v_d = 20\,m \times 47.8 = 0.956\,V$

2.-



$R_1 = R_2 = R_3 = 20K$

RESPUESTA:

$$A_d = \frac{R_3}{R_2}\left(1 + \frac{2R_1}{R_G}\right)$$

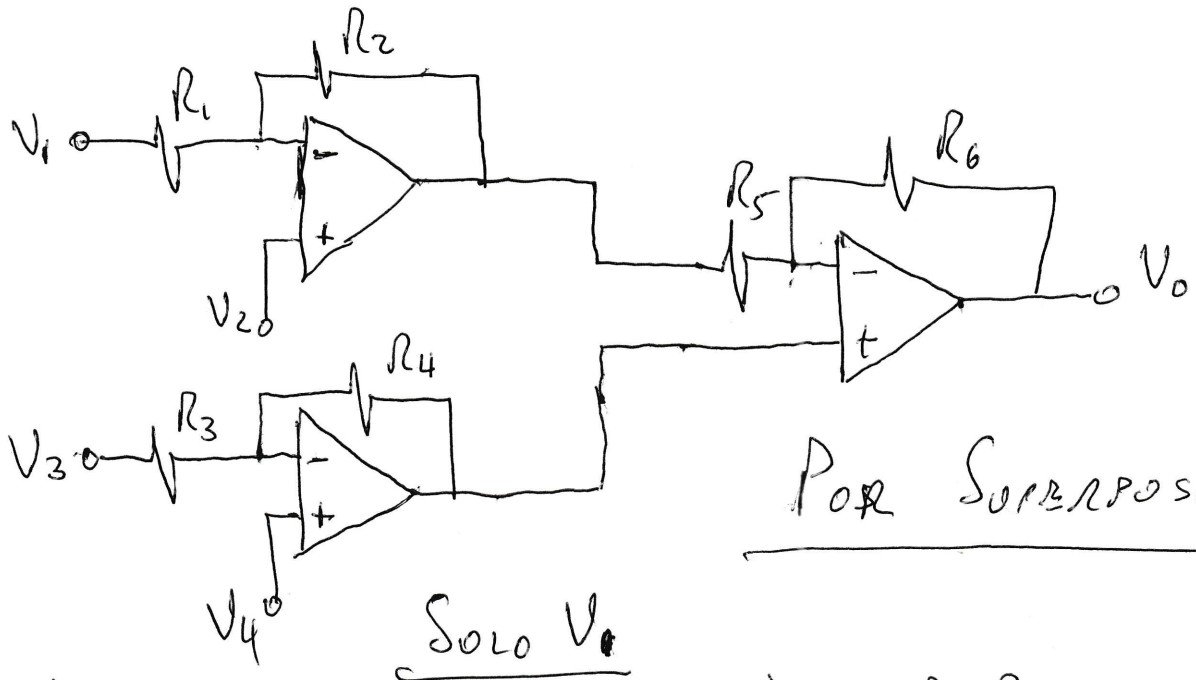
$$A_d = \frac{20K}{20K}\left(1 + \frac{2(20K)}{R_G}\right)$$

$$A_d = 1 + \frac{40K}{R_G}$$

SE UTILIZARÁ R_G PARA AJUSTAR LA GANANCIA.

A_V	10	20	50	100
R_G	4.44K	2015	816	404

3.-



Por Superposición

Solo V_1

$$\frac{V_{o_1}}{V_1} = -\frac{R_2}{R_1}\left(-\frac{R_6}{R_5}\right) = \frac{R_2 R_6}{R_1 R_5}$$

Solo V_2

$$\frac{V_{o_2}}{V_2} = \left(1+\frac{R_2}{R_1}\right)\left(-\frac{R_6}{R_5}\right)$$

$$\frac{V_{o_2}}{V_2} = -\frac{R_6}{R_5}\left(1+\frac{R_2}{R_1}\right)$$

Solo V_3

$$\frac{V_{o_3}}{V_3} = -\frac{R_4}{R_3}\left(1+\frac{R_6}{R_5}\right) = \frac{-R_4}{R_3}\left(1+\frac{R_6}{R_5}\right)$$

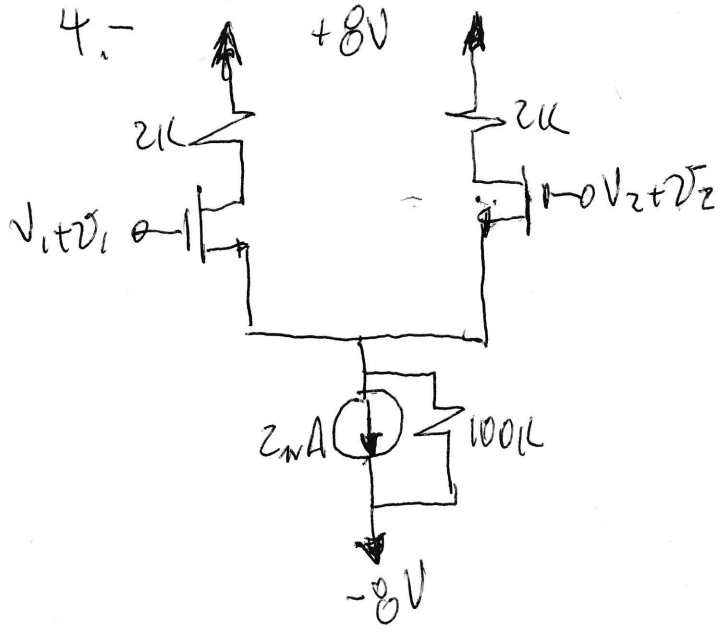
Solo V_4

$$\frac{V_{o_4}}{V_4} = \left(1+\frac{R_4}{R_3}\right)\left(1+\frac{R_6}{R_5}\right)$$

$$V_o = V_{o_1} + V_{o_2} + V_{o_3} + V_{o_4}$$

$$V_o = \frac{R_2 R_6}{R_1 R_5} V_1 - \frac{R_6}{R_5}\left(1+\frac{R_2}{R_1}\right)V_2 - \frac{R_4}{R_3}\left(1+\frac{R_6}{R_5}\right) + \left(1+\frac{R_4}{R_3}\right)\left(1+\frac{R_6}{R_5}\right)$$

4.-



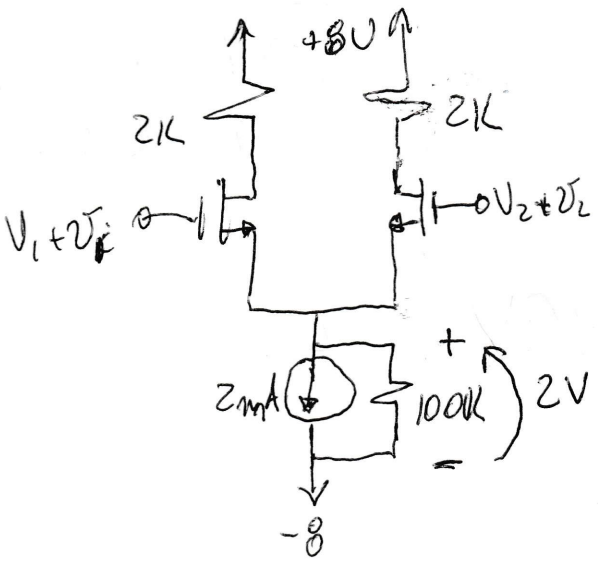
$K_n = 2\,mA/V^2$ $\quad V_t = 1\,V$

2V A TRAVÉS DE LA FUENTE PARA QUE OPERE ADECUADAMENTE.

4.- Continuación

a) ¿Rango de voltajes en MC?

Para trabajo adecuado



Valor mínimo

$V_{S_{min}} = V_{SS} + V_I$

$V_{S_{min}} = -8 + 2 = -6\,V$

$V_{GS} = ?$

$2I_D = \frac{2}{100K} + 2mA = 2.02\,mA$

$I_D = 1.01\,mA$

$I_D = \frac{1}{2}K_n (V_{GS} - V_t)^2 \Rightarrow 1.01 = \frac{1}{2}2(V_{GS} - 1)^2$

$V_{GS} = 2.005\,V$

$V_{G_{min}} = V_{S_{min}} + V_{GS} = -6 + 2.005 = -3.995\,V \cong -4V$

$V_{G_{min}} = V_{MC_{min}} = \underline{-4V}$

Valor máximo

$V_{GD} \leq V_t$

$V_D = 8 - 2KI_D$

$V_S = (2I_D - 2_m)100K - 8$

$V_{GD} = V_G - V_D = V_G - [8 - 2KI_D]$

$1 \geq V_G - 8 + 2KI_D$

$1 = V_G - 8 + 2KI_D$

$V_G = 1 + 8 - 2KI_D$

$V_G = 9 - 2KI_D$

$I_D = \frac{1}{2}K_n (V_{GS} - V_t)^2$

$I_D = \frac{1}{2}2_m (V_G - V_S - 1)^2$

$I_D = 1_m \{9 - 2KI_D - [(2I_D - 2_m)100K - 8]\}^2$

$$I_D = 1m \left\{ 9 - 2K I_D - 200K I_D + 200 + 8 \right\}^2$$

$$I_D = 1m \left\{ 216 - 202K I_D \right\}^2$$

$$1K I_D = (216 - 202K I_D)^2$$

$I_{D1} = 1.08\,mA$

$I_{D2} = 1.06\,mA$ ✓

$V_G \leq 9 - 2K I_D$

$V_{G_{max}} \leq 9 - 2K \times 1.06m = 6.88V$

$-4V \leq V_{MC} \leq 6.88V$

Aprox

$I_D \cong 1mA$

$V_G = 9 - 2K\,1m$

$V_G = 7V$

$-4 \leq V_{MC} \leq 7V$

b) $I_D \cong 1mA$

$I \cong 2I_D = 2mA$

$V_{OV} = V_{GS} - V_t$

$V_{OV} = 2 - 1 = 1$

$g_m = \frac{I}{V_{OV}} = \frac{2m}{1} = 2m\,A/V$

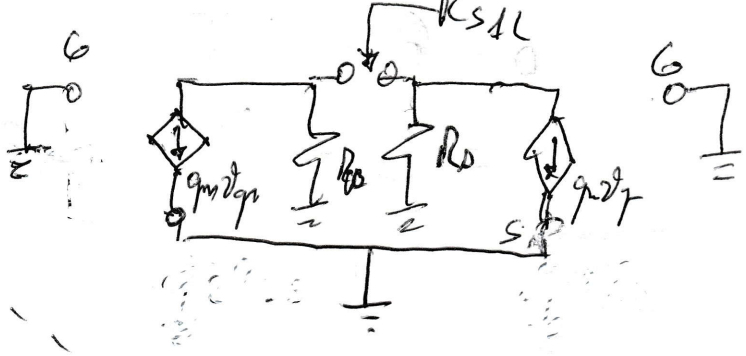
$A_d = g_m R_D = 2m \times 2K = 4\,V/V$

$v_G = 0 \Rightarrow v_{GS} = -v_S$

$v_d = g_m v_{gs} 2R_{SS} \Rightarrow v_d = -g_m v_S \times 2R_{SS} \Rightarrow v_S = 0$

c) $R_{ext} = \infty$

$R_{SS} = 2R_D = 2 \times 2K = 4K$



d) $A_{MC} = \frac{-R_D}{2R_{SS}} = \frac{2K}{2 \times 100K}$

$A_{MC} = -0.01$ ⇐ Una sola salida sin diferencial

Tomando salida diferencial

$A_{MC} = 0$

e) $RRMC = \infty$