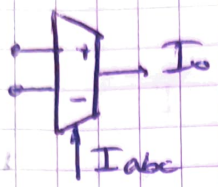
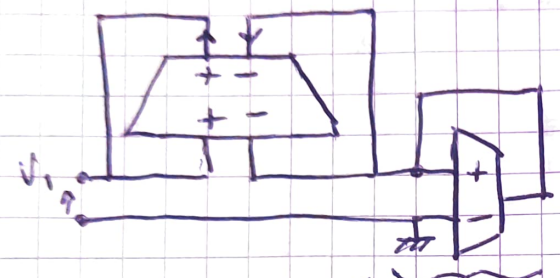
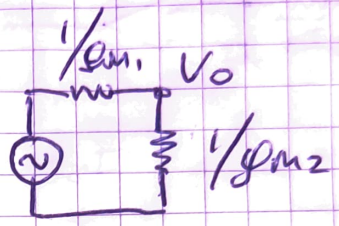
④





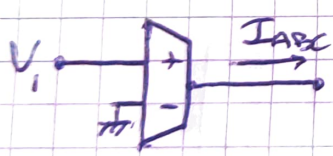
≡



$g_{m1} = g_{m2} = g_m = \frac{1}{5k}$

$\boxed{g_m = 0{,}2\ mS}$

Por gráfico: $I_{ABC}\Big|_{g_m = 0{,}2\,mS} = 11\,\mu A$

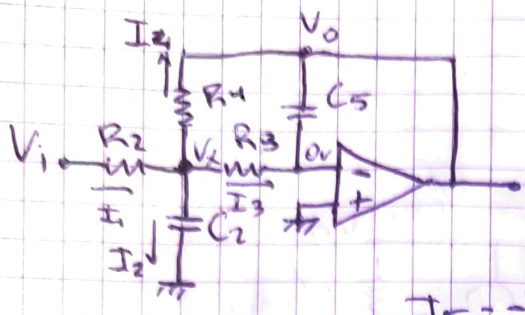


Si utilizamos $g_m = 0{,}2\ mS$:

$I_{ABC} = V_1 \cdot g_m \Rightarrow \boxed{V_1 = 55\ mV}$

⑨ MFB

a-



$$I_1 = \frac{V_i - V_x}{R_1}, \quad I_2 = V_x s C_2$$

$$I_3 = \frac{V_x}{R_3}, \quad I_4 = \frac{V_x - V_0}{R_4}$$

$$I_5 = -V_0 s C_5, \quad I_3 = m I_5$$

$$I_1 = I_2 + I_3 + I_4$$

$$\frac{V_x}{R_3} = -V_0 s C_5$$

$$\frac{V_i}{R_1} + \frac{V_0 s C_5 R_3}{R_1} = I_1$$

$$V_x = -V_0 s R_3 C_5 \quad (1)$$

$$\frac{V_i}{R_1} + \frac{V_0 s C_5 R_3}{R_1} = -V_0 s^2 C_2 C_5 R_3 - V_0 s C_5 \frac{R_3}{R_3} - \frac{V_0 s C_5 R_3 + V_0}{R_4}$$

$$\frac{V_i}{R_1} = -V_0 \left[s^2 C_5 R_3 + s\left(\frac{C_5 R_3}{R_1} + C_5 + \frac{C_5 R_3}{R_4} \right) + \frac{1}{R_4} \right]$$

$$\frac{V_i}{R_1 R_3 C_2 C_5} = -V_0 \left[s^2 + s\left(\frac{1}{C_2 R_1} + \frac{1}{C_2 R_3} + \frac{1}{C_2 R_4} \right) + \frac{1}{C_2 C_5 R_3 R_4} \right]$$

$$\boxed{\frac{V_0}{V_i} = -\frac{R_4}{R_1} \cdot \frac{\frac{1}{R_3 R_4 C_2 C_5}}{s^2 + s\frac{1}{C_2}\left(\frac{1}{R_1} + \frac{1}{R_3} + \frac{1}{R_4}\right) + \frac{1}{R_3 R_4 C_2 C_5}}}$$

Con $R_1 = R_3 = R_4 = 1\,\Omega$, $C_2 = 1\,f$, $C_2 = 0{,}01\,f$

$$\frac{V_0}{V_i} = -100\,\frac{1}{seg} \cdot \frac{1}{s^2 + 3s + 100} = -\frac{\omega_0^2}{s^2 + \frac{\omega_0}{Q} s + \omega_0^2}, \quad \omega_0 = 100\,\frac{1}{seg}$$

b-

Si $\omega_0 = 1000\,\frac{1}{seg}$; $C_2 = 47\,pf$, $C_5 = 4700\,pf$.

$$\frac{\omega_0}{Q} = 3$$

$$\omega_0^2 = 1000000\,\frac{1}{seg^2} = \frac{1}{R_3 R_4 C_2 C_5} \Rightarrow \frac{1}{R_3} = 2{,}209 \cdot 10^{-10}$$

$R_1 = R_4 = 1\,k$

$$\Rightarrow \boxed{R_3 = 4{,}527 \quad k\Omega}$$