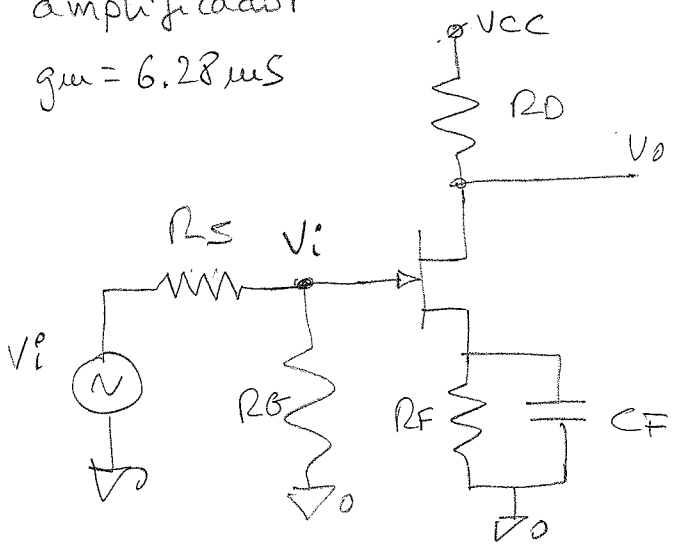
① Calcular la respuesta en frecuencia del siguiente amplificador

$g_m = 6.28\,mS$

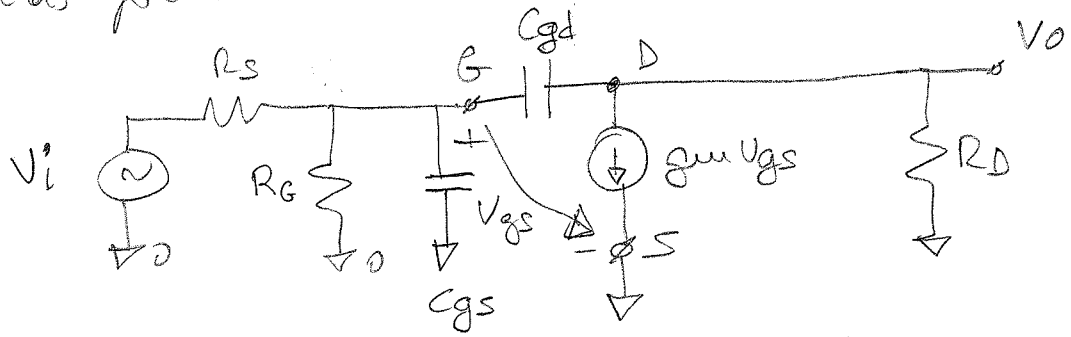


$R_D = 5\,k\Omega$
$C_{gd} = 4.57\,pF$
$C_{gs} = 4.06\,pF$
$R_F = 1000\,\Omega$

$C_G = C_{gs} + C_{gd}(1-K)$
$C_G = 4.06 + 4.57(1-(-31.4))$
$C_G = 152.128\,pF$

$C_O = C_{gd}\cdot\left(1-\frac{1}{K}\right) = 4.71\,pF$

altas frecuencias:



Av (frecuencias medias) $\Rightarrow$ $V_g = V_i' \frac{R_G}{R_G+R_S} = V_{GS}$

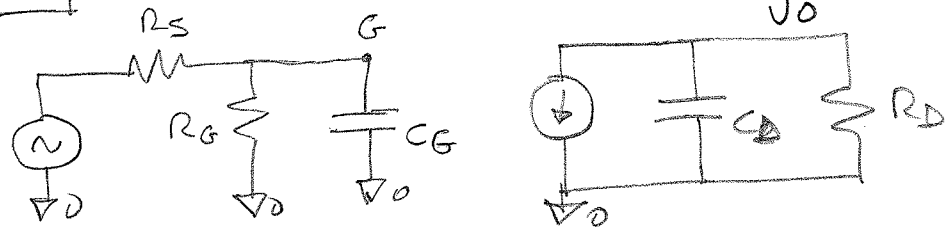
$V_o = -g_m \frac{R_G}{R_G+R_S}\cdot R_D \cdot V_i'$

$A_V = -6.28\cdot10^{-3}\cdot\frac{2\cdot10^6}{2\cdot10^6+50}\cdot5\cdot10^3$

$A_V = -31.4$ $\Rightarrow$ $20\log A_V = 29.93\,dB$

$\Rightarrow$ Miller

$K = -R_D\cdot g_m = \frac{V_o}{V_G} = -31.4$



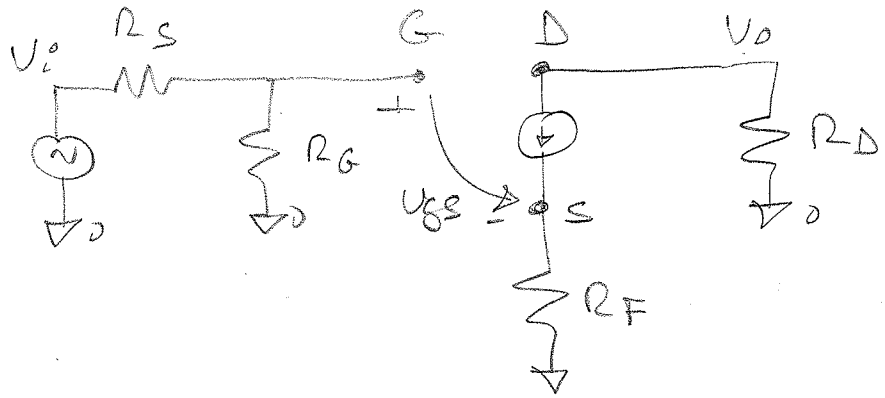
P1 $\Rightarrow$ $f_{P1} = \frac{1}{2\pi\,(R_S//R_G)\cdot C_G} = \frac{1}{2\pi\cdot49.98\cdot152.128\cdot10^{-12}}$

$f_{P1} = 20.93\,MHz$

P2 $\Rightarrow$ $f_{P2} = \frac{1}{2\pi R_D C_O} = \frac{1}{2\pi\cdot5.000\cdot4.71\cdot10^{-12}} = 6,75\,MHz$

$f_{P2} = 7.2\,MHz$

A frecuencia cero



$$V_s = g_m \cdot V_{gs} \cdot R_F \qquad V_{gs} = V_i \frac{R_G}{R_S+R_G} - g_m V_{gs} R_F$$

$$V_s = V_i \cdot \frac{R_G}{R_S+R_G} \qquad V_{gs}(1 + g_m R_F) = V_i \frac{R_G}{R_S+R_G}$$

$$V_o = -g_m \cdot R_D \cdot V_i \cdot \frac{R_G}{(R_S+R_G)(1+g_m R_F)}$$

$$A_{V(f=0)} = \frac{-g_m \cdot R_D \cdot R_G}{(R_S+R_G)(1+g_m R_F)} =$$

$$A_V(f=0) = \frac{-6.28 \cdot 10^{-3} \cdot 5000 \cdot 2 \cdot 10^6}{(50+2\cdot 10^6)(1+6.28\cdot 10^{-3}\cdot 1000)} = -4.31$$

$$\Downarrow$$

12.69 dB

A baja frecuencia

$$R_F // C_F = \frac{R_F \cdot \frac{-j^\circ}{\omega C_F}}{R_F - \frac{j^\circ}{\omega C_F}} =$$

$$= \frac{-j^\circ R_F}{\omega C_F R_F - j^\circ} = \frac{R_F}{j^\circ \omega C_F R_F + 1} \Rightarrow Z_F = \frac{R_F}{s \cdot C_F R_F + 1}$$

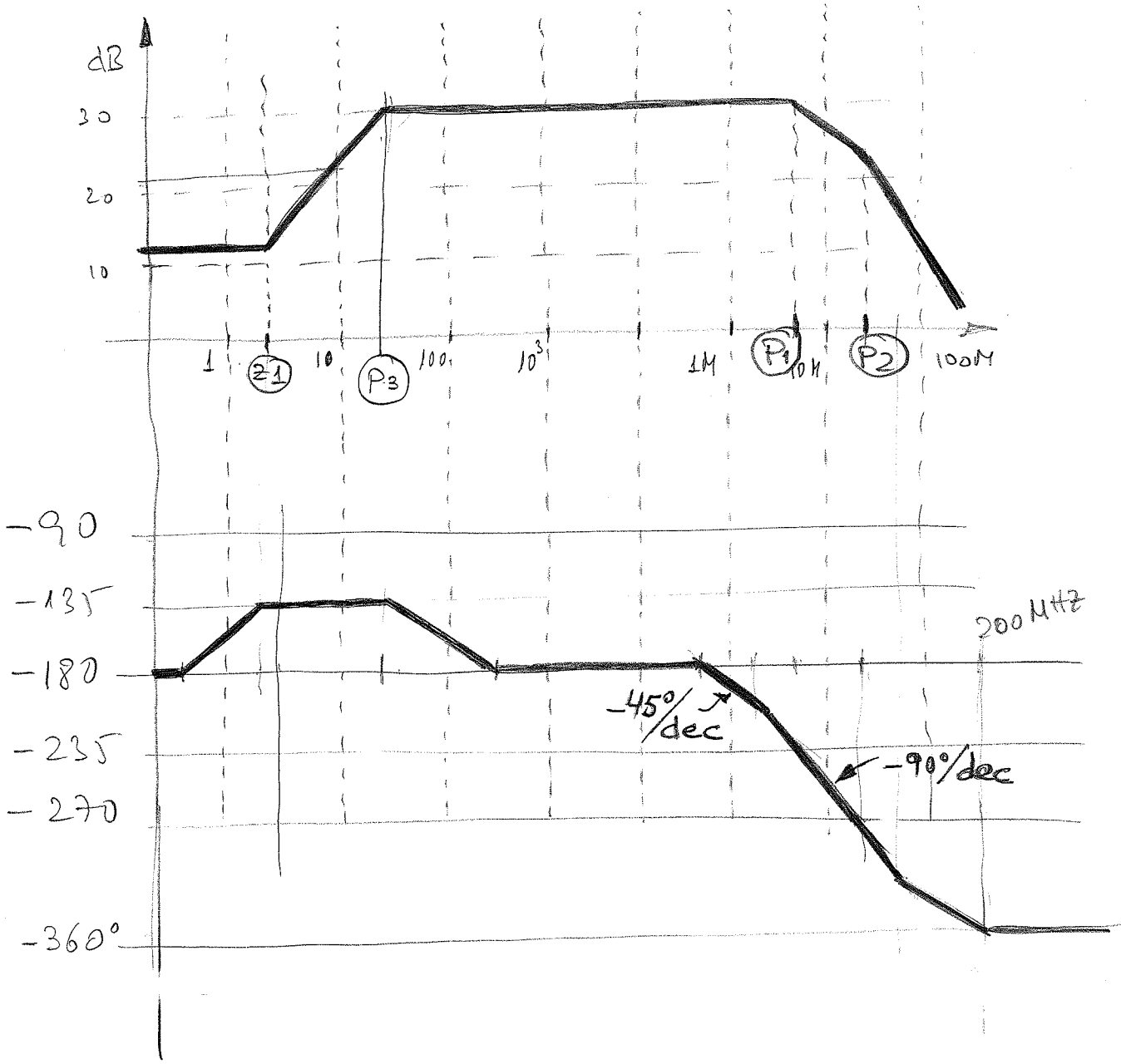
$$\Rightarrow 1 + g_m \cdot Z_F = 1 + g_m \cdot \frac{R_F}{s C_F R_F + 1} = \frac{s \cdot C_F R_F + 1 + g_m R_F}{s C_F R_F + 1}$$

$$\Rightarrow A_V(\text{baja } f) = \frac{-g_m \cdot R_D \cdot R_G}{(R_S+R_G)\cdot(1+g_m R_F)} \cdot \frac{s(C_F R_F)+1}{s \frac{C_F R_F}{1+g_m R_F} + 1}$$

zero en $z_1 = \frac{1}{2\pi R_F C_F} = \frac{1}{2\pi \cdot 1000 \cdot 50 \cdot 10^{-6}} =$ **3.18 Hz = z_1**

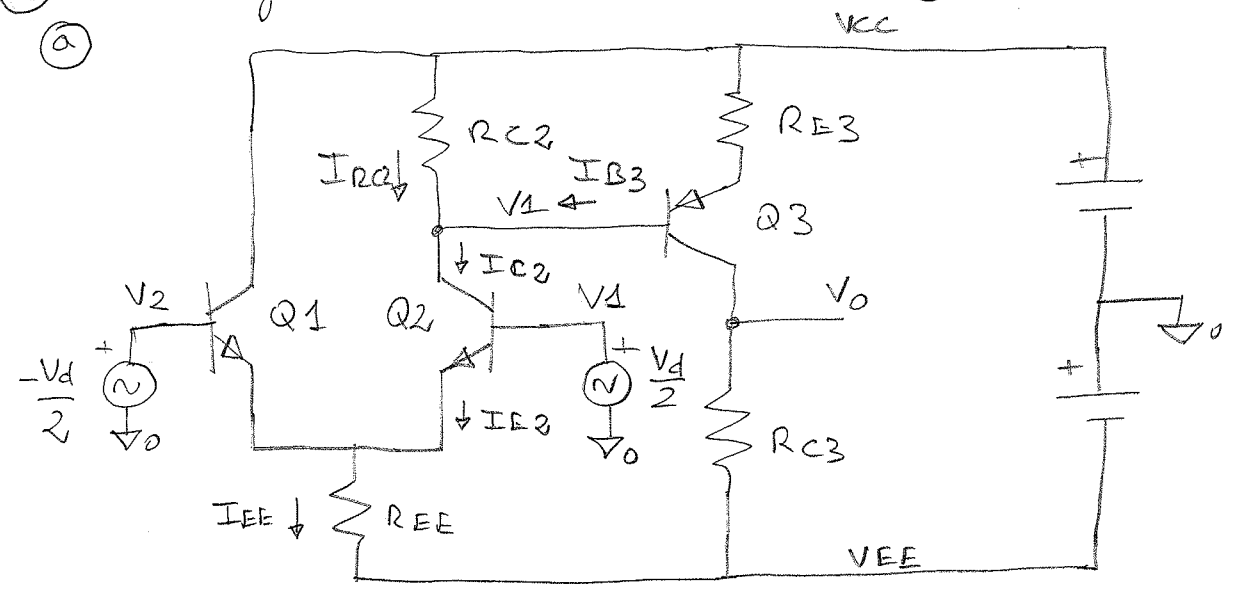
polo en $p_3 = \frac{1+g_m \cdot R_F}{2\pi C_F R_F} =$ **22.92 Hz = p3**

Diagrama de Bode



(2) En el siguiente circuito calcular R_{C2} y R_{E3}.

(a)



$\beta = 100$, $R_{EE} = 10\,k\Omega$, $R_{C3} = 2\,k$

$V_{CC} = 12\,V$, $V_{EE} = -12\,V$, $V_o = 0\,V$, $V_1 = 9\,V$

$V_{BE\,Q_3} = 0.76\,V$, $V_{BE\,Q_3} = 0.82\,V$

(1) $$I_{E2} = \frac{1}{2} I_{EE} = \frac{1}{2} \frac{|V_{EE}| - V_{BE\,Q2}}{R_{EE}} = \frac{1}{2} \frac{12 - 0.76}{10\,k\Omega} = 562\,\mu A$$

(2) $$I_{C2} = I_{E2} \cdot \frac{\beta}{1+\beta} = 556{,}4\,\mu A$$

(3) $$\frac{V_o - V_{EE}}{R_{C3}} = I_{C3} = \frac{0 - (-12)}{2\,k\Omega} = 6\,mA$$

$$I_{B3} = \frac{I_{C3}}{\beta} = 0{,}06\,mA = 60\,\mu A$$

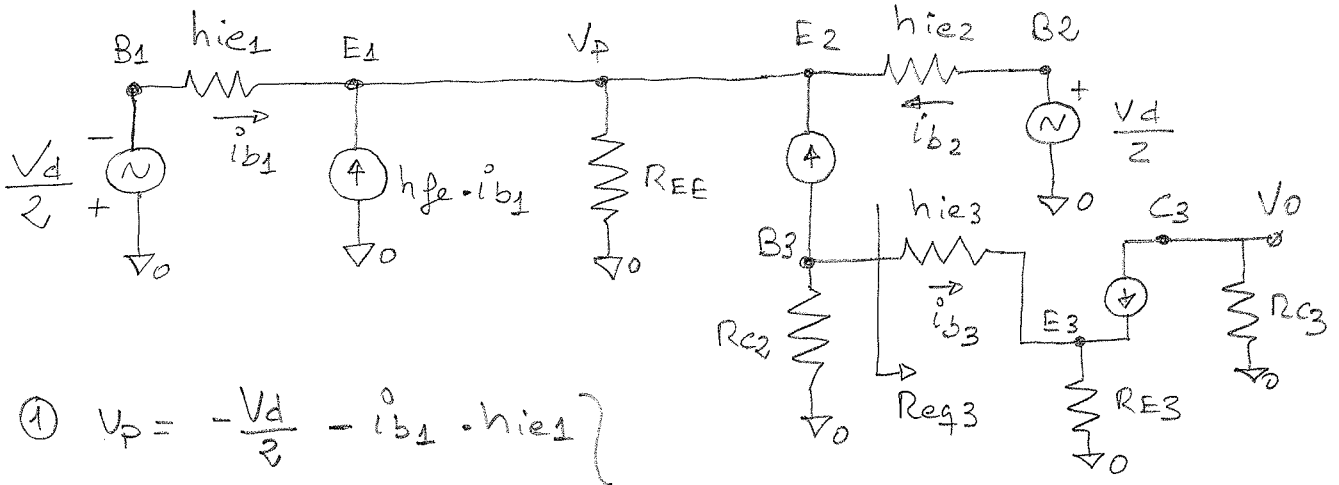
(4) $$\frac{V_{CC} - V_{BE\,Q3} - V_1}{R_{E3}} = I_{E3} = I_{B3} + I_{C3} = 6{,}06\,mA$$

$$R_{E3} = \frac{12 - 0.82 - 9}{6{,}06\,mA} = 360\,\Omega$$

(5) $$I_{RC2} = I_{C2} - I_{B3} = 556{,}4\,\mu A - 60\,\mu A = 496{,}4\,\mu A$$

$$R_{C2} = \frac{V_{CC} - V_1}{I_{RC2}} = 6043\,\Omega$$

(2) (b) Calcular la ganancia: $A_V = \frac{V_o}{V_1 - V_2} = \frac{V_o}{V_d}$



(1) $V_p = -\frac{V_d}{2} - i_{b_1} \cdot hie_1$

(2) $V_p = \frac{V_d}{2} - i_{b_2} \cdot hie_2$ $\Rightarrow 2V_p = -(i_{b_1} + i_{b_2}) \cdot hie$ (3)

(4) $(i_{b_1} + i_{b_2}) \cdot (1 + hfe) = \frac{V_p}{REE}$ $\overset{(3)}{\Rightarrow} 2V_p = \frac{-V_p}{(1+hfe)REE} \cdot hie \Leftrightarrow \boxed{V_p = \emptyset}$

(5) como $V_p = \emptyset \Rightarrow i_{b_2} = \frac{V_d}{2hie_2}$

(6) $i_{C_2} = i_{b_2} \cdot hfe = \frac{V_d}{2hie_2} \cdot hfe$

(7) $V_{B3} = -i_{C_2} \cdot (Rc2 // Req_3) \overset{(6)}{=} -\frac{V_d \cdot hfe}{2hie_2} \cdot \frac{Rc_2 \cdot [hie_3 + RE_3(1+hfe)]}{Rc_2 + hie_3 + RE_3(1+hfe)}$

(8) $A_{V_1} = \frac{V_{B3}}{V_d} = -\frac{100}{2 \cdot 4607} \cdot \frac{6043 \cdot [430 + 360 \cdot 101]}{6043 + 430 + 360 \cdot 101} = -56.3$

$hie_2 = \frac{hfe \cdot V_T}{I_{C_2 Q}} = \frac{100 \cdot 25.8}{0.56} = 4607\,\Omega$

$hie_3 = \frac{hfe \cdot V_T}{I_{C_3 Q}} = \frac{100 \cdot 25.8}{6} = 430\,\Omega$

(9) $A_{V_2} = \frac{V_o}{V_{B3}} = \frac{-Rc_3 \cdot hfe \cdot i_{b_3}}{i_{b_3} \cdot hie_3 + i_{b_3}(1+hfe) \cdot RE_3} = \frac{-2000 \cdot 100}{430 + 101 \cdot 360}$

$A_{V_2} = -5.44$ $\Rightarrow \boxed{A_d = A_{V_1} \cdot A_{V_2} = 306.27}$