Correction du 10/5/2016

1) a) à $-45° \Rightarrow p_1 = 1\,kHz$

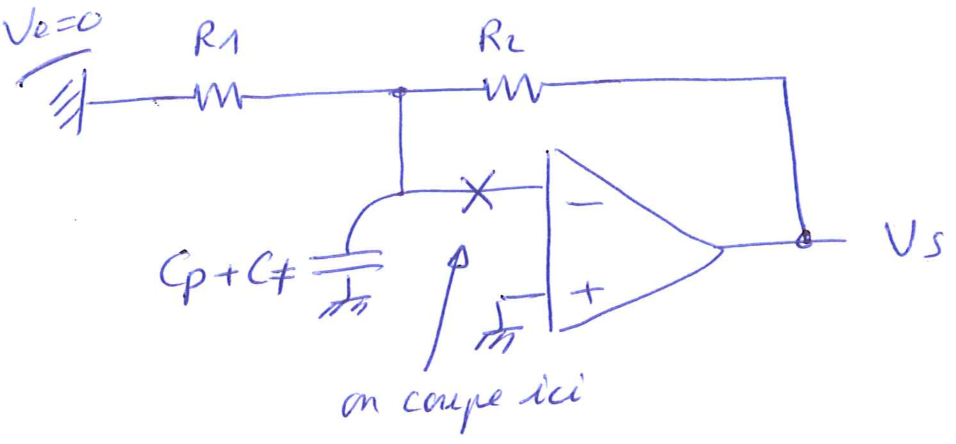
$-135° \Rightarrow p_2 = 200\,MHz$

gain $A_0 = 100\,dB \rightarrow 10^5\,V/V$

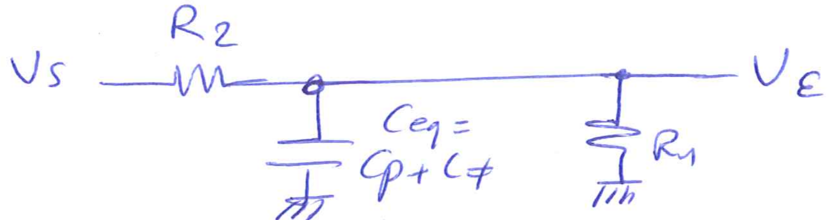
$GBW = A_0\, p_1 = 100\,MHz$

$p_2 = 2\, A_0\, p_1 \Rightarrow$ marge de phase $= 60°$ pour $F = 1 \rightarrow$ inconditionnellement stable

b)



F = ?

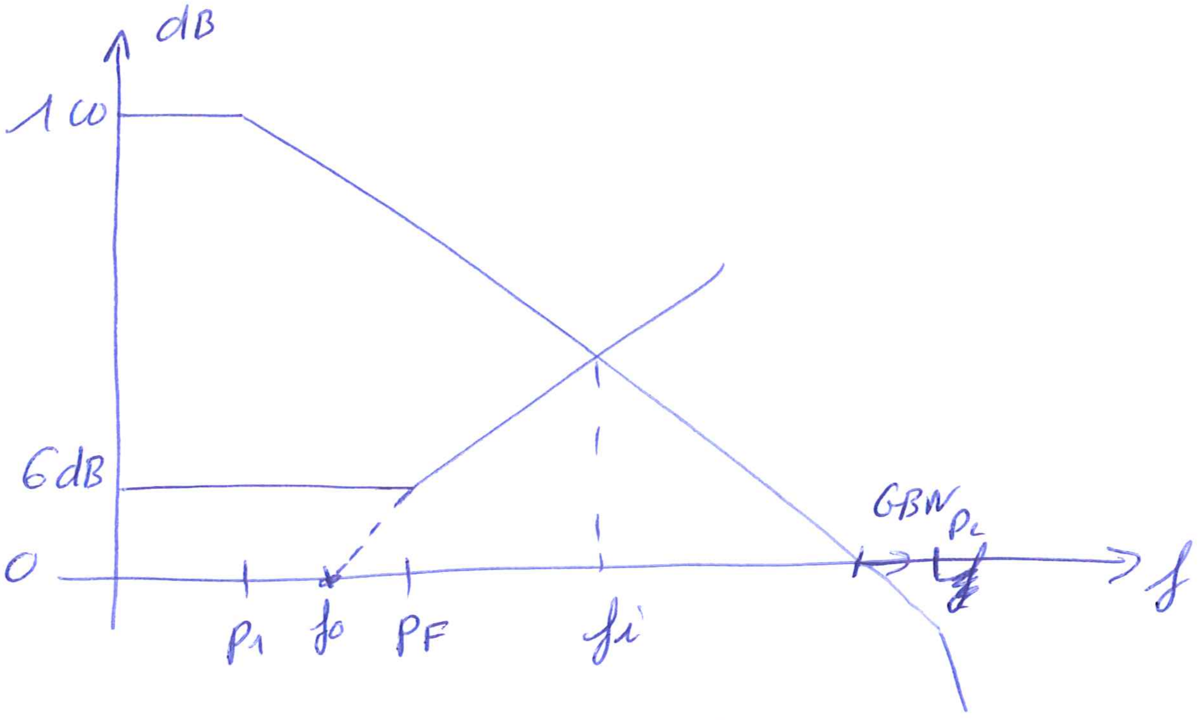


$$F = \frac{V_E}{V_s} = \frac{R_1 /\!/ \frac{1}{C_{eq} s}}{R_2 + \left(R_1 /\!/ \frac{1}{C_{eq} s}\right)} \qquad C_{eq} = 2\,pF$$

$$= \frac{R_1}{R_1 + R_2} \; \frac{1}{1 + (R_1 /\!/ R_2)\, C_{eq}\, s}$$

pôle $$p_F = \frac{1}{2\pi (R_1 /\!/ R_2)\, C_{eq}} = 1{,}59\,MHz$$

c)



$$f_0 = \frac{p_F}{2} \qquad f_i = \sqrt{\frac{p_F \, GBW}{2}} = 8{,}9\,MHz$$

d)

$$\varphi_A = \underbrace{-90°}_{\text{car } p_1 \ll f_i} - \arctg \frac{f_i}{p_2} = -92{,}5°$$

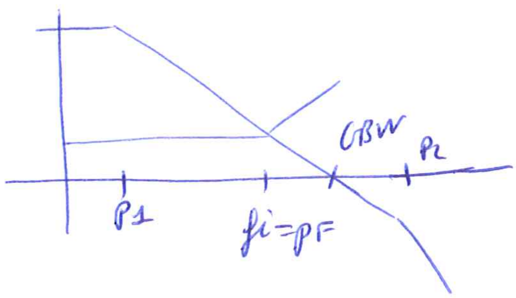
$$\varphi_F = -\arctg \frac{f_i}{p_F} = -79{,}9°$$

$$\varphi_T = \varphi_A + \varphi_F = -172{,}4° \Longrightarrow \varphi_M \simeq 8°$$

φ_M beaucoup trop faible pour être considéré comme étant stable (même si on n'atteint pas la condition d'oscillation)

e) il faut augmenter f_i, donc p_F

si $p_F = f_i \rightarrow f_i = p_F = \frac{GBW}{2} = 50MHz \rightarrow R_1 = R_2 = 1{,}6k\Omega$



$$\varphi_A = -90 - \arctg \frac{f_i}{p_2} = -104°$$

$$\varphi_F = -45°$$

$$\varphi_M \simeq 30°$$

si $p_F > f_i$, φ_A reste constant $= -104°$

il faut $\varphi_F = -150°$ pour $\varphi_M = 60°$

$$p_F = \frac{f_i}{\tan(|\varphi_F|)} \simeq 168\ MHz$$

soit $R_1 = R_2 \approx 950\,\Omega$ ~~au maximum~~

2) a) $V_s = -\frac{Z_b}{R_a} V_e \qquad Z_b = R_b \,//\, \frac{1}{Cs} = \frac{R_b}{1 + R_b C s}$

$$\frac{V_s}{V_e} = -\frac{R_b}{R_a} \frac{1}{1 + R_b C s}$$

$$K = -\frac{R_b}{R_a} \qquad p = \frac{1}{2\pi R_b C}\ (Hz)$$

ou $\frac{1}{R_b C}$ (rd/s)

b) $$\frac{V_s}{V_e} = \left(-\frac{R_2}{R_1} \frac{1}{1 + R_2 C_2 s}\right)\left(-\frac{R_3}{R_4} \frac{1}{1 + R_3 C_3 s}\right)$$

$$p_1 = \frac{1}{R_2 C_2} \qquad p_2 = \frac{1}{R_3 C_3}$$

$$\frac{V_s}{V_e} = \frac{R_2 R_3}{R_1 R_4} \frac{1}{(1 + s/p_1)} \frac{1}{(1 + s/p_2)}$$

$$= \frac{R_2 R_3}{R_1 R_4} \frac{p_1 p_2}{s^2 + (p_1 + p_2)s + p_1 p_2}$$

$$= \frac{K \omega_p^2}{s^2 + \frac{\omega_p}{Q} s + \omega_p^2}$$

$$K = \frac{R_2 R_3}{R_1 R_4} \qquad \omega_p = \sqrt{p_1 p_2} \qquad Q = \frac{\sqrt{p_1 p_2}}{p_1 + p_2}$$

c) gain = 0 dB à $f = 0 \Rightarrow K = 1$

$R_2 R_3 = R_1 R_4$ solution simple

$R_1 = R_2 = R_3 = R_4$

$$p_1 = \alpha p_2 \Rightarrow Q = \frac{\sqrt{\alpha}\, p_2}{p_2(1+\alpha)} = \frac{\sqrt{\alpha}}{1+\alpha}$$

$\omega_p = 1 \rightarrow Q = \frac{1}{2}$

$$\frac{\sqrt{\alpha}}{1+\alpha} = \frac{1}{2} \Rightarrow \alpha = 1$$

puisque $R_2 = R_3 \rightarrow C_2 = C_3$

$\omega_p = 1$ pour $\omega_c = 1$ (filtre normalisé)

pour $\omega_c = 2\pi f_c = 62{,}8\,10^3$ rd/s (filtre réel)

$$\omega_c = \frac{1}{R_2 C_2} = \frac{1}{R_3 C_3} \Rightarrow RC \simeq 15{,}9\,10^{-6}\ \text{sec}$$

R en kΩ pour $\neq$ valeurs de C

1,59E-06

	1,00E-11 x 10 pF	1,00E-10 x 100 pF	1,00E-09 x 1 nF
1	159,00	15,90	1,59
1,5	106,00	10,60	1,06
2,2	72,27	7,23	0,72
3,3	48,18	4,82	0,48
4,7	33,83	3,38	0,34
6,8	23,38	2,34	0,23