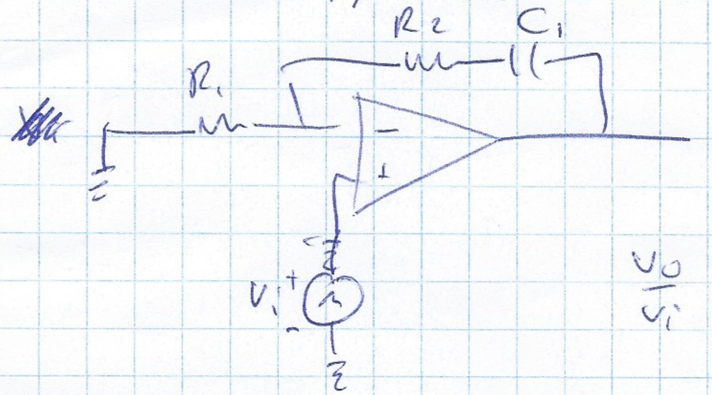
Examen partiel - hiver 2014

1. Questions à courts développements

a)



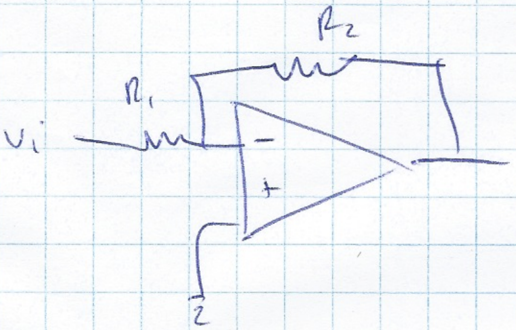
$$\frac{V_o}{V_i} = \frac{-Z_2}{Z_1}$$

$$\frac{V_o}{V_i} = 1 + \frac{\left(R_2 + \frac{1}{sC_1}\right)}{R_1}$$

$$= 1 + \frac{R_2}{R_1} + \frac{1}{sR_1C_1}$$

ou $$1 + \frac{(sR_2C_1 + 1)}{sC_1R_1}$$

b)



$$\frac{R_2}{R_1} = 100$$

$\omega_{-3dB} = \beta\omega_t$ où $\beta \approx \frac{1}{A_{BF}}$

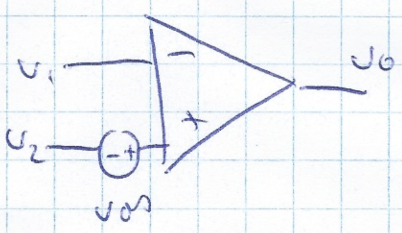
$$f_{-3dB} = f_t/(1 + R_2/R_1)$$

$$= 10^6/(1+100)$$

$$= 9900\ Hz$$

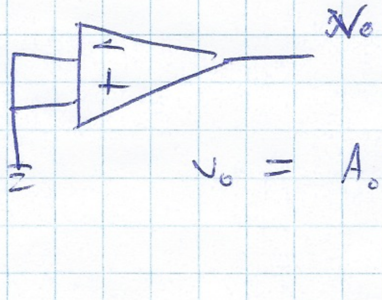
$\approx$ 10 kHz

c)

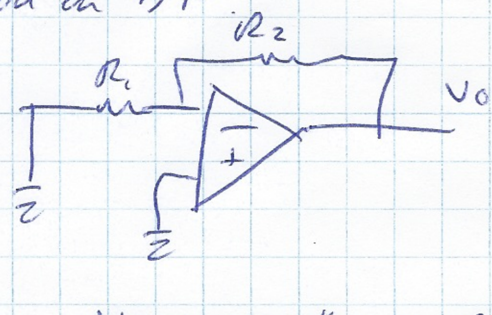


V_o c'est une tension de sortie non nulle quand $v_1 = v_2 = 0$

on peut la mesurer soit en BO ou en BF

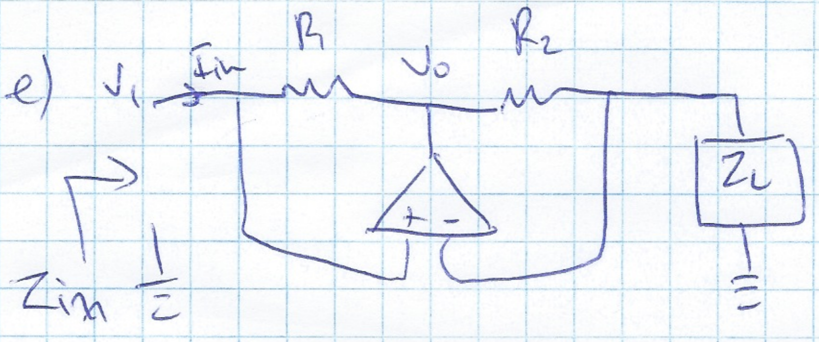


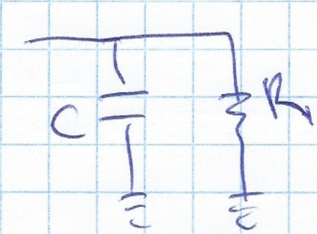
$$V_o = A_o V_{os}$$



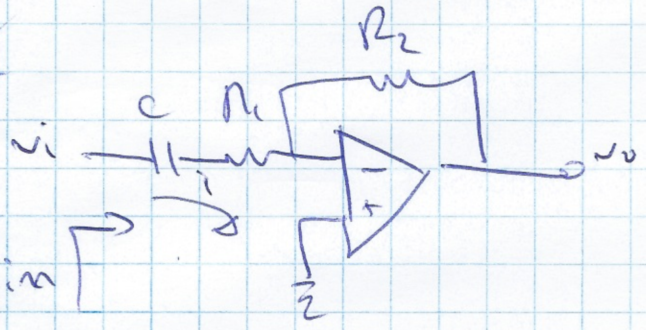
$$V_o = V_{os}\left(1 + \frac{R_2}{R_1}\right)$$

d) $f_M \leq \frac{SR}{2\pi V_{omax}} = \frac{10\ V/\mu s}{2\pi \cdot 5V} = \frac{10^6}{2\pi 5} = 31830\ Hz$

e) 

$Z_L \equiv$ 

avec $R_1 = R_2$

F) 

$$\begin{cases} Z_{in} = \frac{1}{sC} + R_1 \\ v_o = V_{o.s.} \end{cases}$$

$$i = \frac{V_i - 0}{\frac{1}{sC} + R_1}$$

$$Z_{in} = \frac{V_i - 0}{i} = \frac{1}{sC} + R_1$$

Question 2

a) $R_1 = R_4$ et $R_2 = R_3$ → on veut $V_{out} = A_d(V_{in2} - V_{in1})$

$$V_{out} = V_{in1}\left(1 + \frac{R_2}{R_1}\right)\left(-\frac{R_4}{R_3}\right) + V_{in2}\left(1 + \frac{R_4}{R_3}\right)$$

$$= V_{in1}\left(1 + \frac{R_2}{R_1}\right)\left(-\frac{R_1}{R_2}\right) + V_{in2}\left(1 + \frac{R_1}{R_2}\right)$$

$$= V_{in1}\left(\frac{R_1 + R_2}{\cancel{R_1}}\right)\left(-\frac{\cancel{R_1}}{R_2}\right) + V_{in2}\left(\frac{R_2 + R_1}{R_2}\right)$$

$$= \left(V_{in2} - V_{in1}\right)\left(1 + \frac{R_1}{R_2}\right) \Rightarrow \text{forme } A_d(V_{in2} - V_{in1})$$

b) si $V_{in2} = V_{in1} = V_{cm}$, $A_d = 10 \frac{V}{V}$

$$1 + \frac{R_1}{R_2} = 10\,V/V$$

$$R_1 = 9R_2$$

$$V_{out} = V_{cm} \frac{\left(1 + \frac{R_2}{R_1}\right)}{1 + \left(1 + \frac{R_2}{R_1}\right)/A_1} \left(\frac{-\frac{R_1}{R_2}}{1 + \left(1 + \frac{R_1}{R_2}\right)/A_2}\right) + V_{cm} \frac{1 + \frac{R_1}{R_2}}{1 + \left(1 + \frac{R_1}{R_2}\right)/A_2}$$

$$A_{cm} = \frac{V_{out}}{V_{cm}} = -\frac{\left(\frac{R_1 + R_2}{R_2}\right)}{\left(1 + \left(1 + \frac{R_2}{R_1}\right)/A_1\right)\left(1 + \left(1 + \frac{R_1}{R_2}\right)/A_2\right)} + \frac{\frac{R_2 + R_1}{R_2}}{1 + \left(1 + \frac{R_1}{R_2}\right)/A_2}$$

$$= \frac{\overset{10}{\cancel{\frac{R_1 + R_2}{R_2}}}}{1 + \overset{10}{\cancel{\left(1 + \frac{R_1}{R_2}\right)}}/A_2} \left(\frac{-1}{1 + \left(1 + \frac{R_2}{R_1}\right)/A_1} + 1\right)$$

$R_1 = 49,9\,k\Omega$

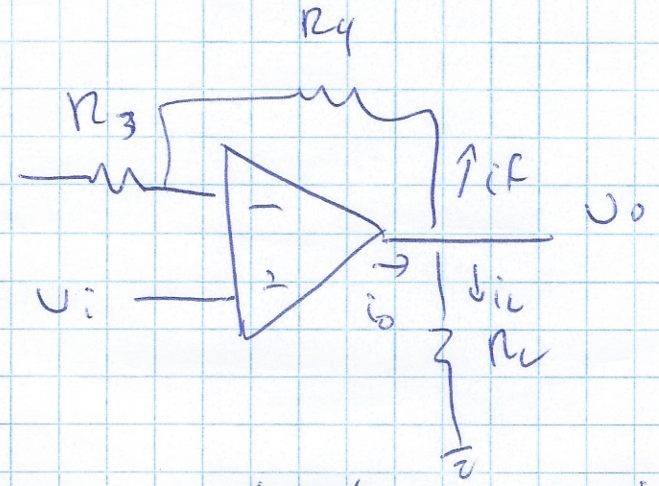
$R_2 = 449,1\,k\Omega$

$$= \frac{10}{1 + 10/10^4} \left(\frac{-1}{1 + (1 + 9)/10^5} + 1\right)$$

$$= 9,99\,(9,999 \times 10^{-5}) = 0,00099989$$

$TRMC = 20 \log \frac{A_d}{A_{cm}} = 80\,dB$

c)



$V_{o\,max} = \pm 9V$ $\qquad i_{o\,max}$?

$R_3 = R_2 = 499{,}1K\Omega$

$R_1 = R_4 = 49{,}9K\Omega$

$i_{o\,max} = i_{f\,max} + i_{L\,max}$.

$$i_o = \frac{V_{o\,max}}{R_4 + R_3} + \frac{V_{o\,max}}{R_L} = \frac{9V}{499K\Omega} + \frac{9V}{10K\Omega}$$

$$= 18\mu A + 0{,}9\,mA.$$

$$= \underline{0{,}000918\,A}.$$

$0{,}918\,mA$.

d) l'impédance d'entrée de ce circuit est

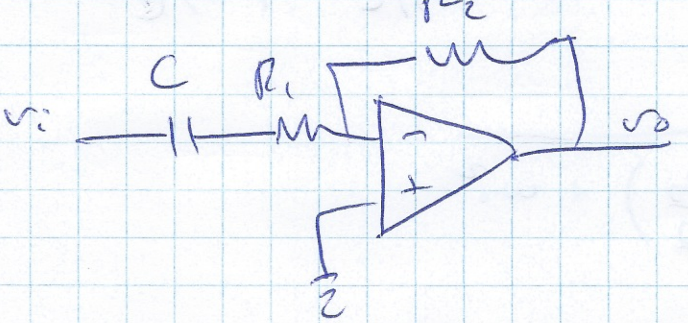
$Z_{in} = \infty$.

$\underline{i_i = 0}$.

$$Z_{in} = \frac{V_i}{i_i} = \infty$$

3- $\omega_{0hp} = 2\pi \cdot 10\,Hz$ $\quad A = -10\,V/V$

a)



$$\frac{v_o}{v_i} = -\frac{R_2}{\frac{1}{sC}+R_1}$$

$$= -\frac{sR_2C}{sCR_1+1}$$

$$\omega_{0hp} = \frac{1}{CR_1}$$

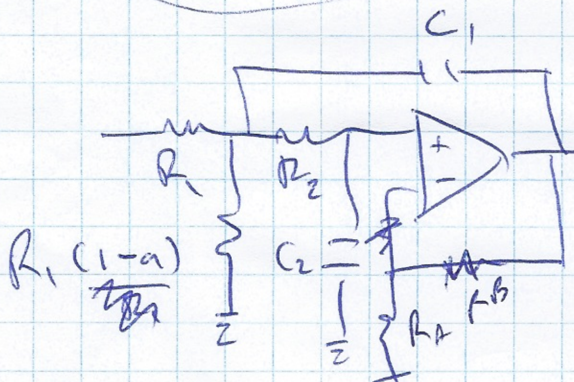
$$R_1 = \frac{1}{100nf \cdot 2\pi \cdot 10Hz} = \underline{\underline{159\,K\Omega}}$$

$$R_2 = 10 \cdot R_1 = \underline{1,59\,M\Omega}$$

A_{HF} in $s \to \infty$

$$= -\frac{R_2}{R_1}$$

b)



$C_1 = C_2 = 100nf$

$Q = 1/0,765$

$\omega_B = 2\pi \cdot 10KHz$

normaliser $\quad \frac{\cancel{K}\, a_0 \cancel{\omega_0}^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$

$= R_A$.

$\times \; a_0 = aK\omega_0^2$

$$= \frac{1}{s^2 + \frac{1}{0,765}s + 1}$$

$R_1 = R_2 = R$ (dénormaliser)

$R = 1/\omega_B C = 1,59\,M\Omega$.

$R_B = (2 - 1/Q)R_A = (2 - 0,765)\,1,59M\Omega = \underline{1,964\,M\Omega}$

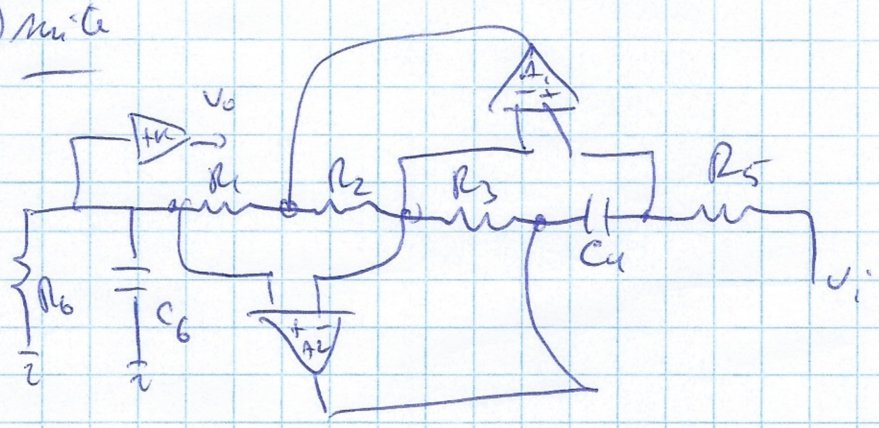
$K = 1 + R_B/R_A = \cancel{1,63}\ \underline{2,24}$

$a = 1/K = 0,447 \quad \cancel{0,591} \rightarrow (1-a) \times R1 = 0,88\,M\Omega$

$$H_1(s) = \frac{aK\, G_1G_2/C^2}{s^2 + s\left(G_1 + G_2(2-K)\right)/C + G_1G_2/C^2}$$

$$= \frac{aK\,\omega_0^2}{s^2 + s\left(\frac{\omega_0}{Q}\right) + \omega_0^2}$$

b) mita



$$\frac{K_2}{s^2 + 1{,}618\,s + 1}$$

$R = R_1 = R_2 = R_3 = R_5$ $\qquad$ $\omega_{0lp} = 2\pi \cdot 10\,kHz$

$C_6 = C_4 = 100\,nf$ $\qquad$ $Q = 1/1{,}618$

$$\frac{a_0}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2} \equiv \frac{K \frac{1}{R^2C^2}}{s^2 + \frac{1}{R_6C_6} + \frac{1}{R^2C^2}}$$

$a_0 = K\omega_0^2$

ω_{0lp}^2

$R = 1/(\omega_{0lp}C) = \underline{159\,\Omega}$

$C_6 = 100\,nf$

$$R_6 = \frac{1}{\frac{\omega_0}{Q}C_6} = \underline{98\,\Omega} \Big\} \quad \frac{\omega_0}{Q} = \frac{1}{R_6C_6}$$

$$a_0 = K_2 = K\frac{1}{R^2C^2} \rightarrow \underline{K = 1}$$

$$\frac{a_0}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2} = \frac{K_2}{s^2 + 1{,}618\,s + 1} = 1$$

c) $A_{max} = 0{,}3 \text{ dB}$.

$\omega_s = 2\pi \cdot 20 \text{ kHz}$

$\varepsilon = \sqrt{10^{A_{max}/10} - 1} = 0{,}2674$

calculer à ω_s.

$A(j\omega_s) = 10 \log\left(1 + \varepsilon^2 (\omega_s/\omega_p)^{2N}\right)$

$= 10 \log\left(1 + (0{,}2674)^2 \left(\cancel{2\pi} \cdot 20\text{kHz} / \cancel{2\pi} \cdot 10\text{kHz}\right)^{2 \cdot 4}\right)$

2^8

$= 12{,}86 \text{ dB}$.

d)

passe bas $\begin{cases} \text{4 pôles passe-bas.} \\ \text{4 zéros à l'infini.} \end{cases}$

passe haut $\begin{cases} \text{1 pôle} \\ \text{1 zéro à l'origine.} \end{cases}$