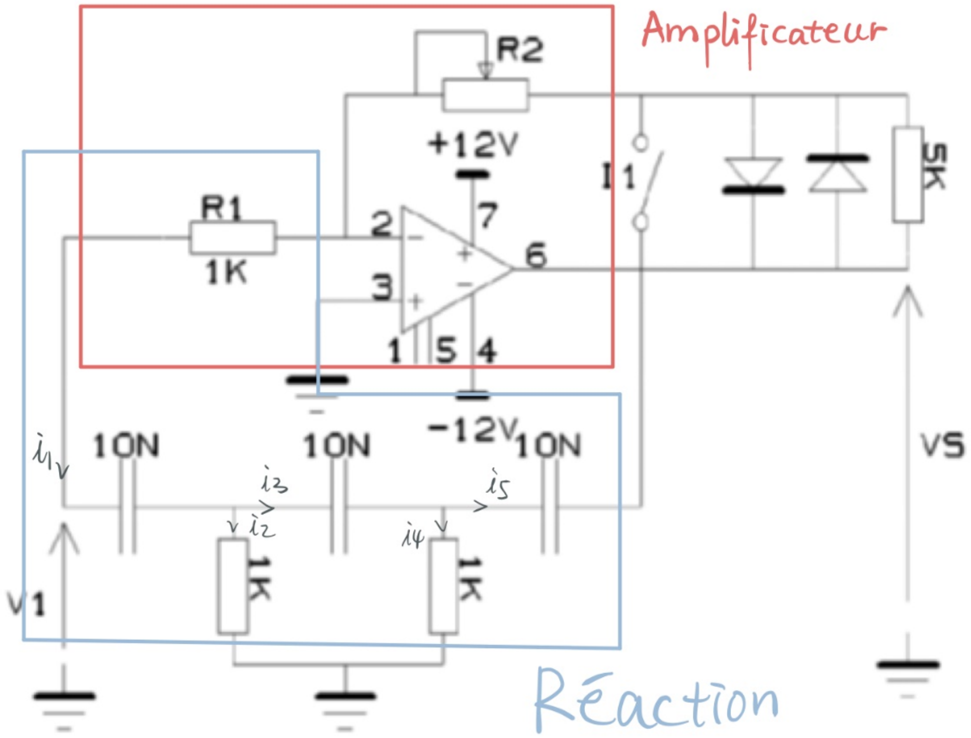
Devoir3 Génération de signaux

1 Étude théorique



1. On sait que $H(j\omega) = \frac{A}{1 - A\beta(j\omega)}$, ici $A = -\frac{R_2}{R_1}$, pour le $\beta(j\omega)$

   Posons que $R_1 = 1k\Omega = R, C = 10nF$

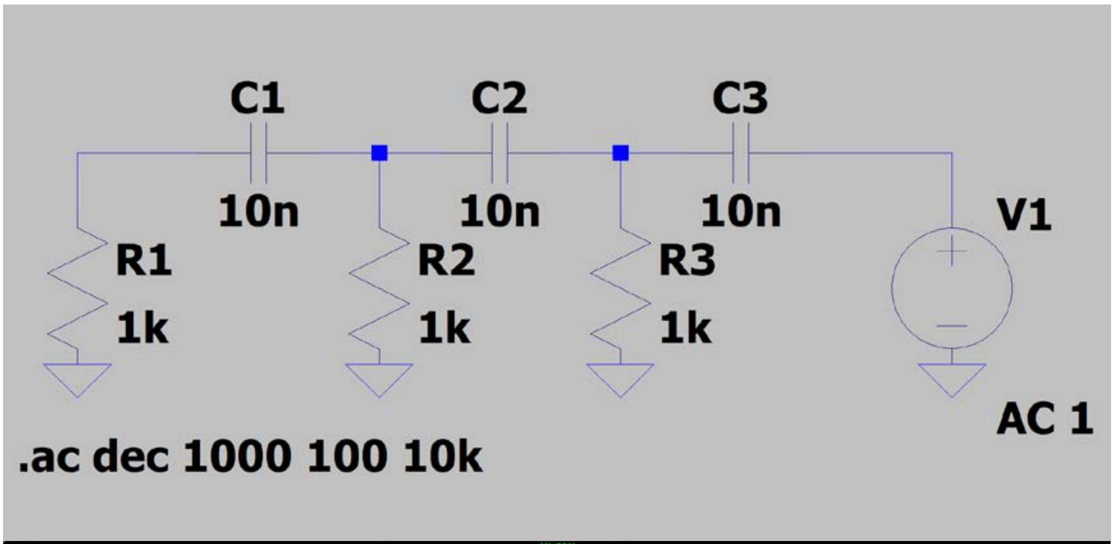
$$i_1 = -\frac{V_1}{R} = j\omega C(V_1 - U_1) \rightarrow U_1 = \left(1 + \frac{1}{j\omega C}\right)V_1$$

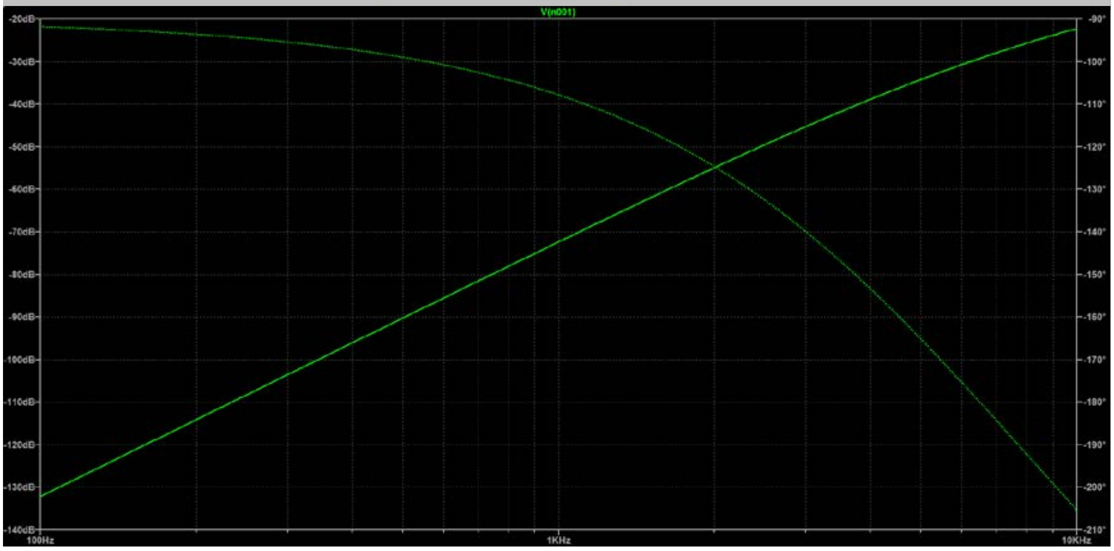
$$i_1 = i_2 + i_3, \qquad i_2 = \frac{U_1}{R}, \qquad i_3 = i_4 + i_5, \qquad i_4 = \frac{U_2}{R}, \qquad i_5 = j\omega C(U_2 - V_s)$$

   En résume, on peut avoir que $\beta(j\omega) = \frac{V_1}{V_s} = \frac{1}{1 - \frac{5}{(\omega RC)^2} - j\left(\frac{6}{\omega RC} - \frac{1}{(\omega RC)^3}\right)}$

2 Étude numérique

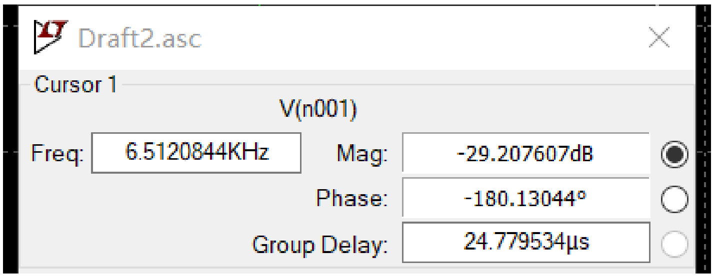
2.





3. On sait que $\omega_0 = \frac{1}{\sqrt{6}RC}, f_0 = \frac{1}{2\pi\sqrt{6}RC} \approx 6497.47Hz$

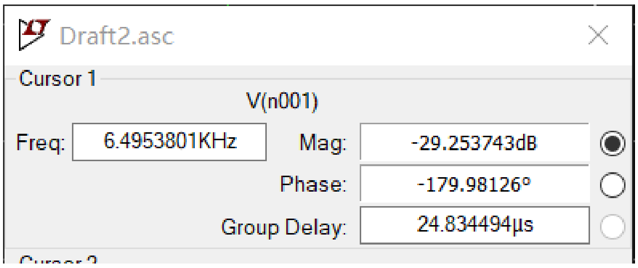
$$A = \frac{1}{|\beta(j\omega_0)|} = 1 - \frac{5}{(\omega_0 RC)^2} - j\left(\frac{6}{\omega_0 RC} - \frac{1}{(\omega_0 RC)^3}\right) = 29$$



Dans la simulation, $f_0 = 6.5kHz, A = -29.2$.

4. Théoriquement, la stabilité est $S(\omega_0) = \left|\frac{d\varphi(\beta(j\omega))}{d\left(\frac{\omega}{\omega_0}\right)}\right|_{\omega=\omega_0} = \frac{12}{29}\sqrt{6} \approx 1.01$

Dans la simulation, on calcule la pente

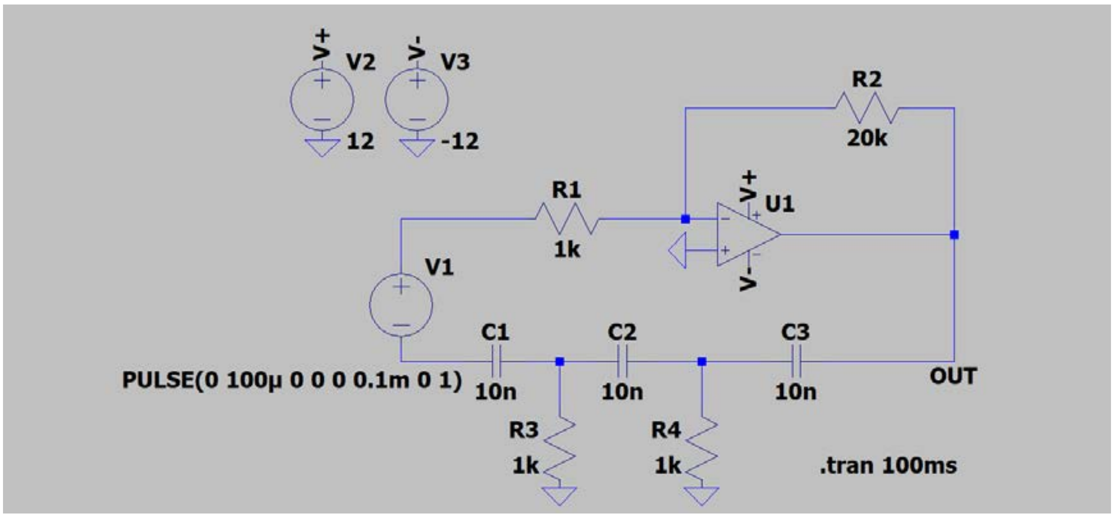


$$\left|\frac{d\varphi}{d\left(\frac{\omega}{\omega_0}\right)}\right|_{\omega=\omega_0} = \left|\frac{\frac{\omega_0}{2\pi} d\varphi}{df}\right|_{\omega=\omega_0}$$

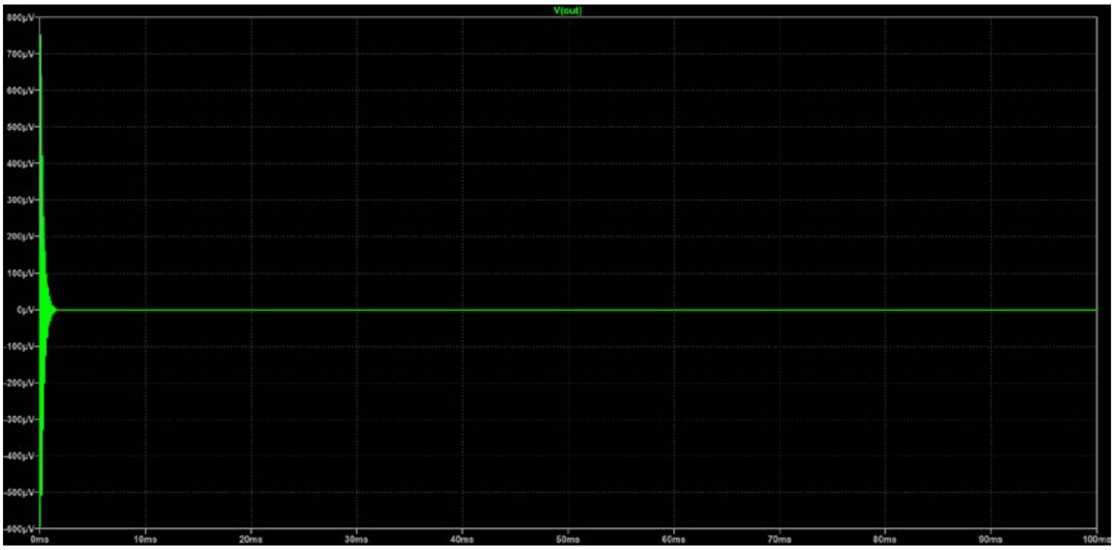
$$= \left|6500 \times \frac{-180.13044^{\circ} + 179.98126^{\circ}}{180^{\circ}} \times \frac{\pi}{6512.0844 - 6495.3801}\right|$$

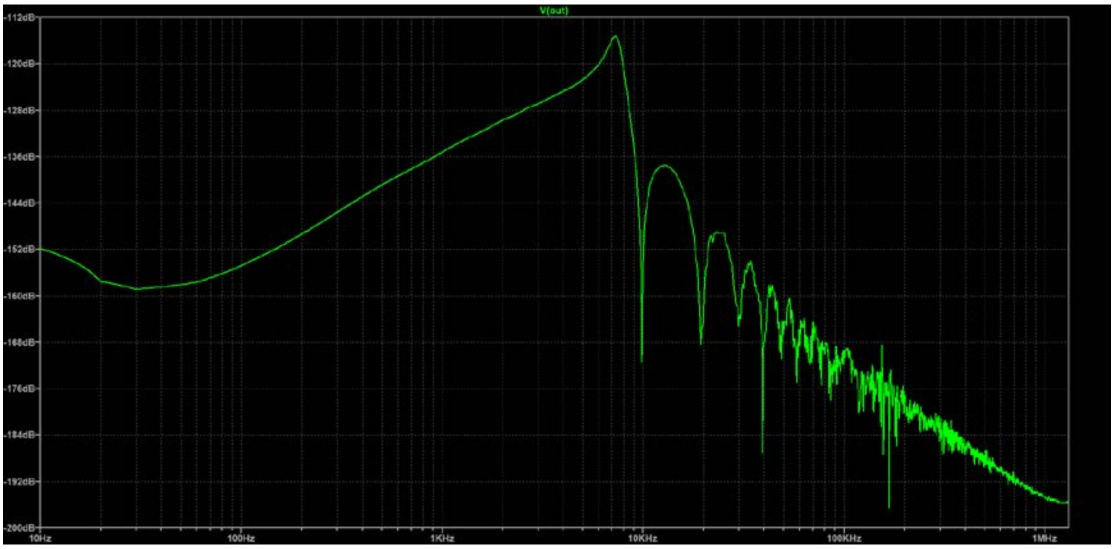
$$\approx 1.01314$$

5.

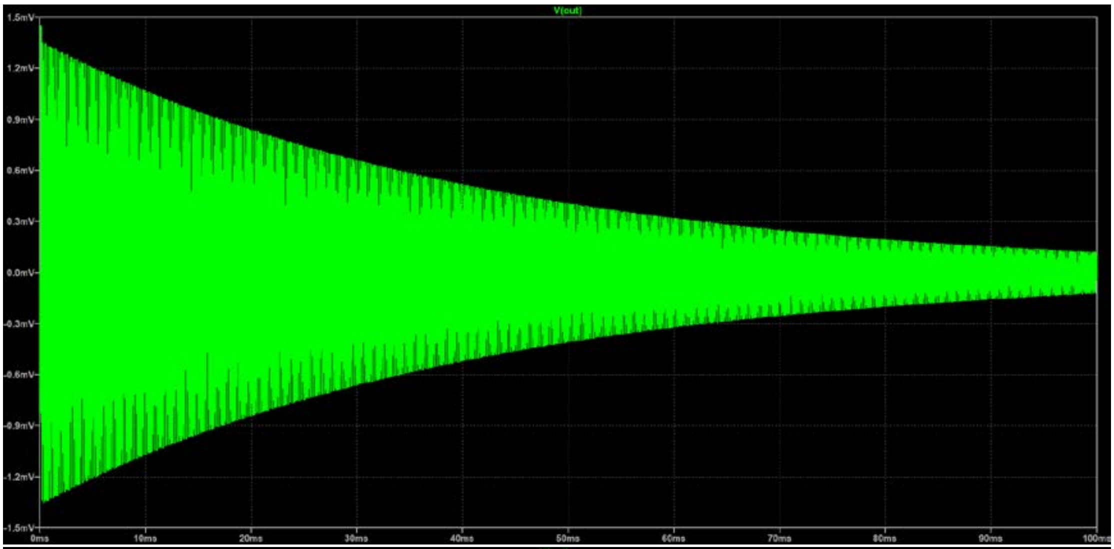


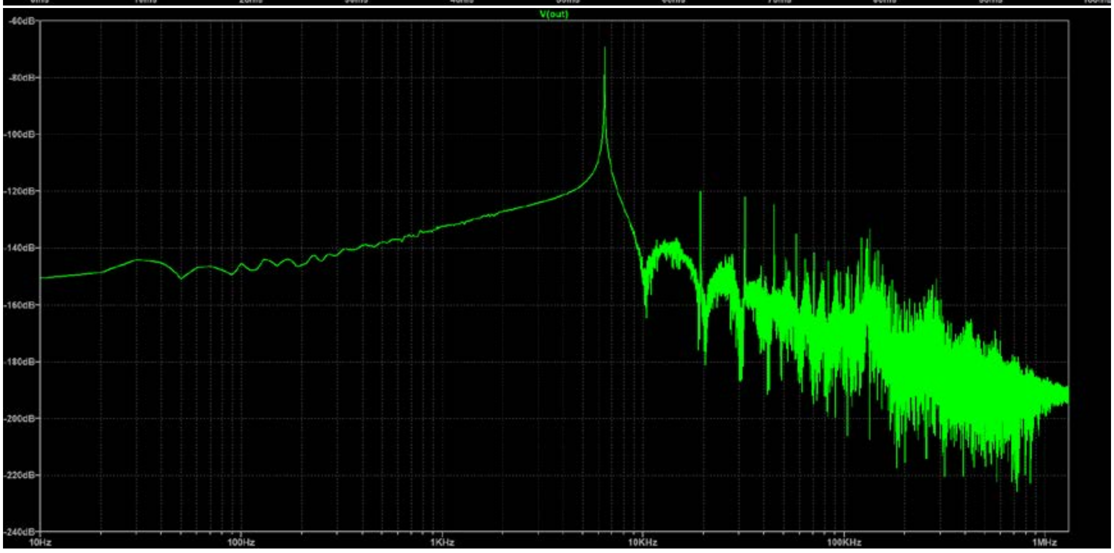
6. Le cas $R_2 = 20k\Omega, A\beta < 1$:





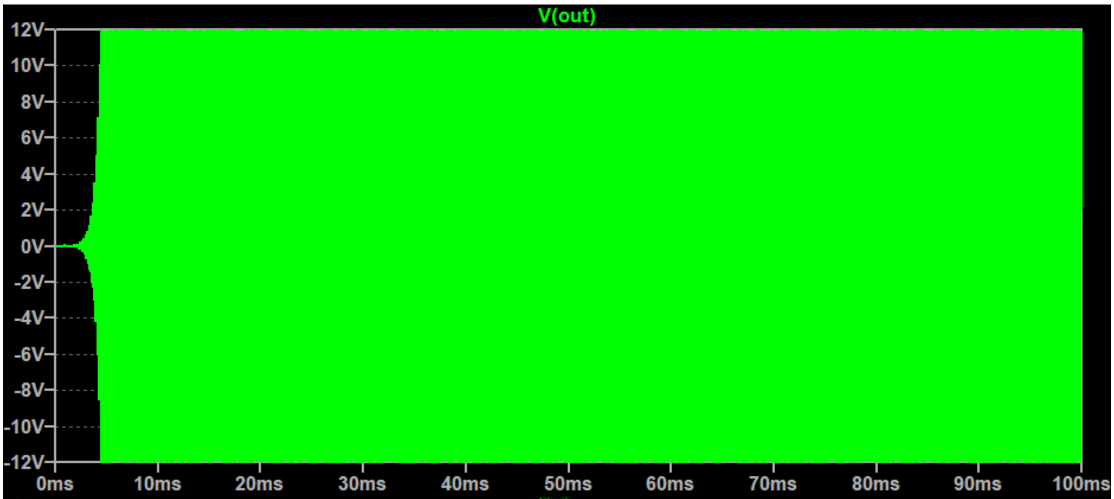
le cas $R_2 = 29k\Omega, A\beta = 1$:

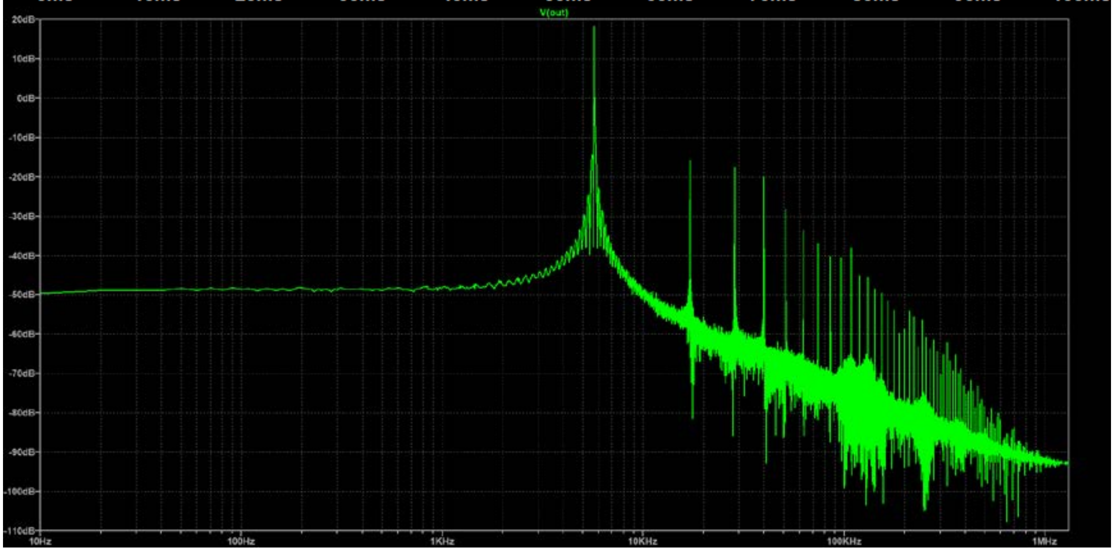




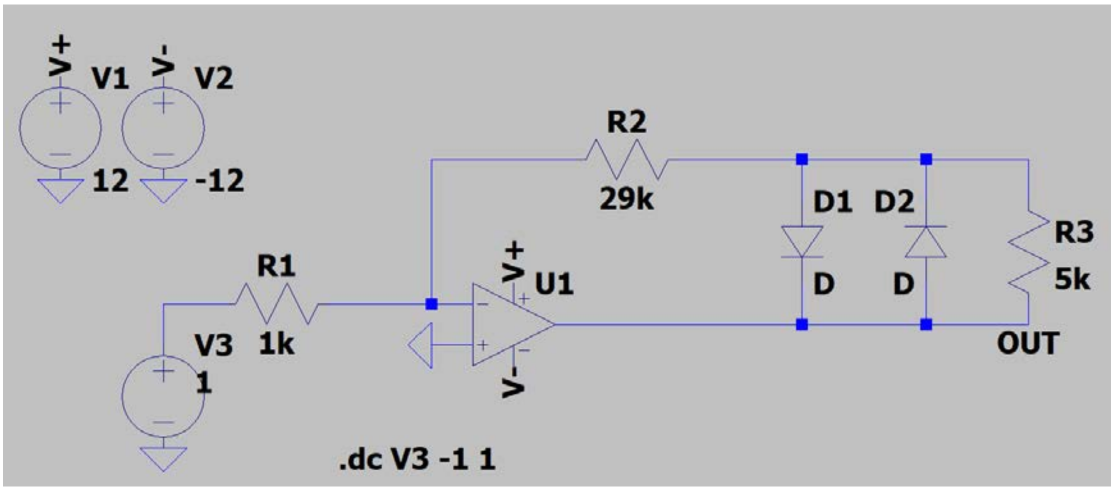
on peut voir que $f_0 = 6.4440661KHz \approx 6.5KHZ$

le cas $R_2 = 40k\Omega, A\beta > 1$:

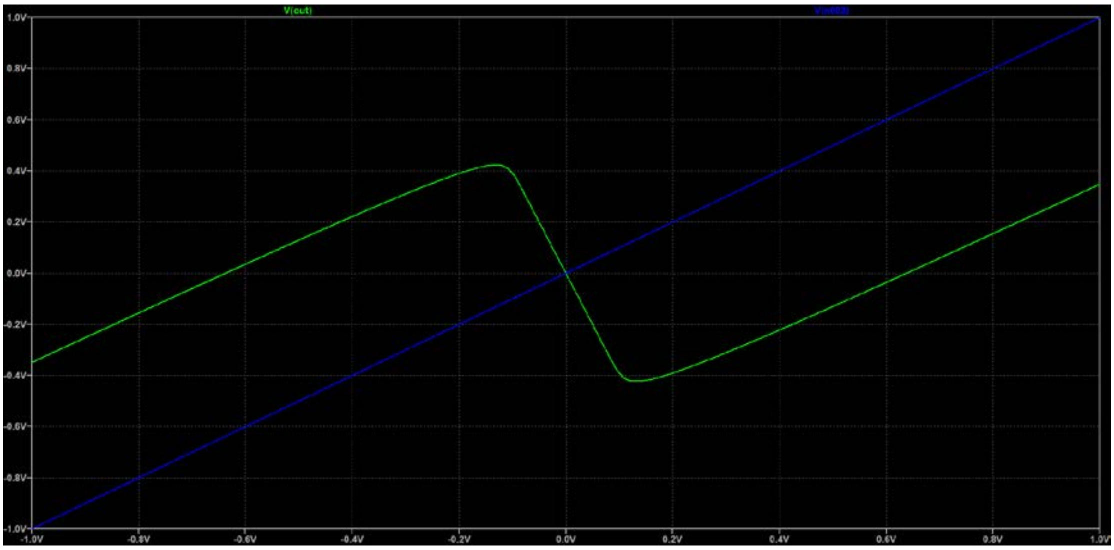

V(out)
12V
10V
8V
6V
4V
2V
0V
-2V
-4V
-6V
-8V
-10V
-12V
0ms
10ms
20ms
30ms
40ms
50ms
60ms
70ms
80ms
90ms
100ms


V(out)
20dB
10dB
0dB
-10dB
-20dB
-30dB
-40dB
-50dB
-60dB
-70dB
-80dB
-90dB
-100dB
-110dB
10Hz
100Hz
1KHz
10KHz
100KHz
1MHz

7.

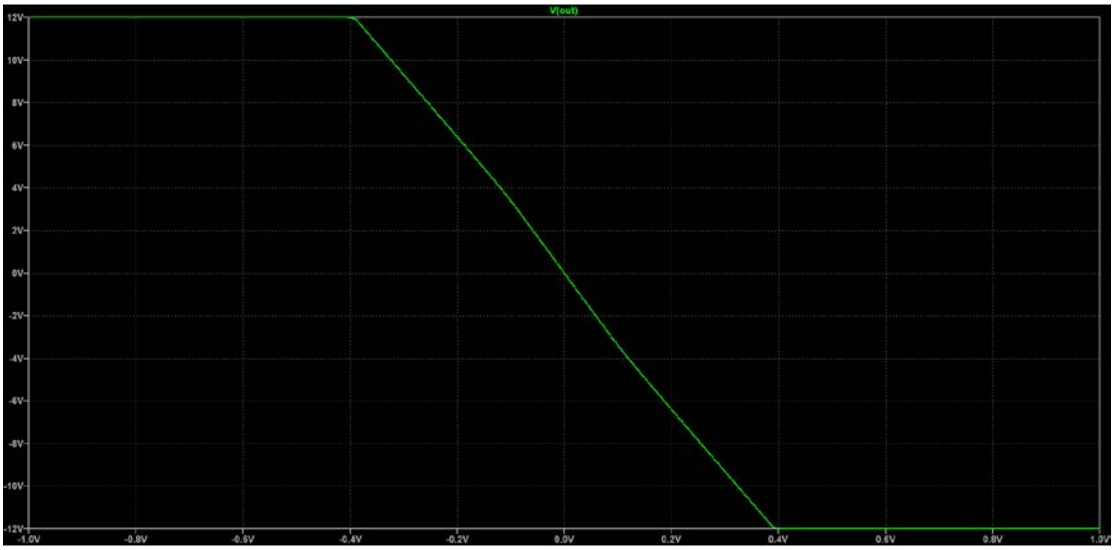

V+
V1
V-
V2
12
-12
R2
29k
D1
D2
R3
5k
R1
U1
D
D
1k
V3
1
OUT
.dc V3 -1 1

8. Si $R_2 = -1k\Omega$,



Si $R_2 = -2k\Omega$,

Si $R_2 = 29k\Omega$,



On peut observer la non-linéarité du gain introduit par les diodes.