Electronique PC 2015 Cours N°12

Titre de la note 29/11/2015

Plan :

- Montage intégrateur | approche analytique (p40)
  | approche fct de transfert
- Redresseur sans seuil (p44)
- Oscillateur pont de Wien + Analyse Simetrix (page 56)
  + ajout LED en TP
- Ex 8 variante Sallen-Key
  → tracé du $G_{dB} = 20 \log G(\omega)$
- Ex 9 Filtre à multiples rétroactions

Classe inversée : Mesures de l'amplificateur à Tx

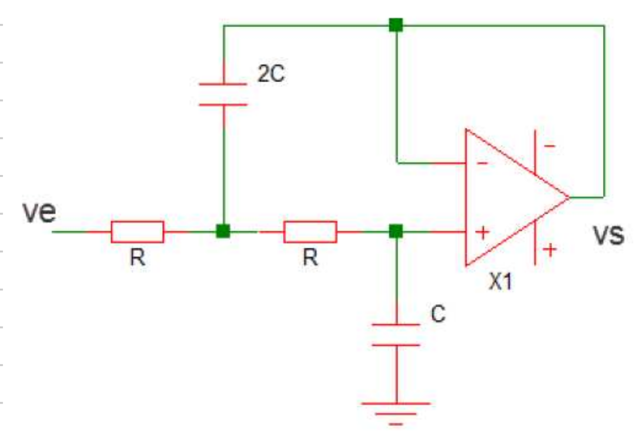
- Notes de cours Mesures amplificateur à Tx
- Vidéo cours Mesures amplificateur Tx
- Circuit Simetrix : Polarisation de Tx, mesure en CC
- Circuit Simetrix : Amplificateur à Tx, mesure en AC
- Circuit Simetrix : Mesure impédance d'entrée par signal moitié
- Tutoriel des mesures sous Simetrix
- Tableau des mesures à réaliser (Simetrix et TP) en PDF
- Tableau des mesures à réaliser (Simetrix et TP) format Excel
- Texte de TP Partie 2 : Amplificateur à Tx

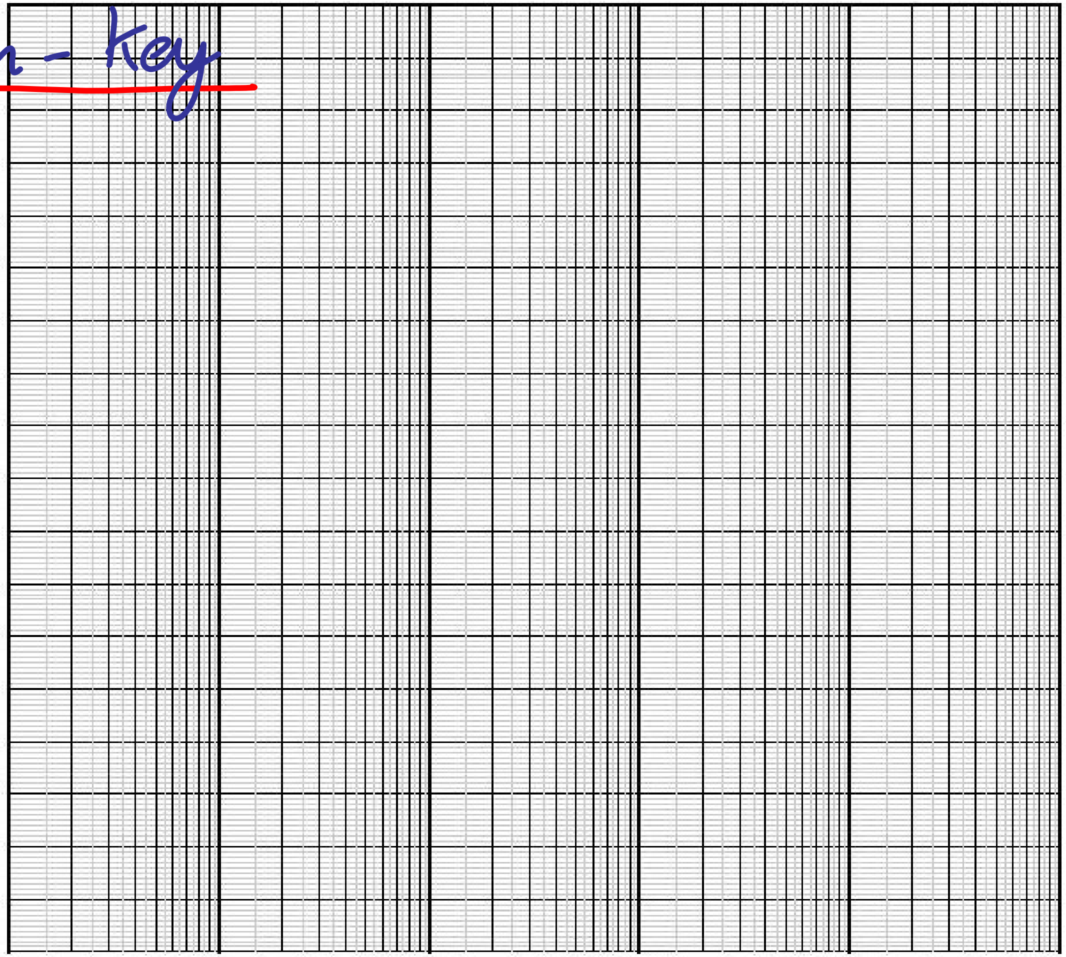
Simulations SIMETRIX

- Téléchargement Simetrix pour Windows
- Installation Simetrix
- Simetrix : Montage à Diode
- Initiation Simetrix en vidéo (EAD)
- Circuits Simetrix
- Ajustement caractéristique diode sous Regressi
- Regressi (version stable)
- Notice simplifiée Regressi

- AOP
  - ampliDifference.sxsch
  - dephaseur.sxsch
  - Ex1AmpliNonInverseur.sxsch
  - Ex2AmpliInverseur.sxsch
  - Ex3Ampli2entrees.sxsch
  - Ex4ApplicationThMillman.sxsch
  - filtreBiquadCversionTD.sxsch
  - filtrePH.sxsch
  - PasseBande_RC_Wien.sxsch
  - polarisationAOP.sxsch
  - polarisationAOPbis.sxsch
  - wien.sxsch
- Diode
  - redresseur.sxsch

Ex. Supplémentaire Sallen-Key

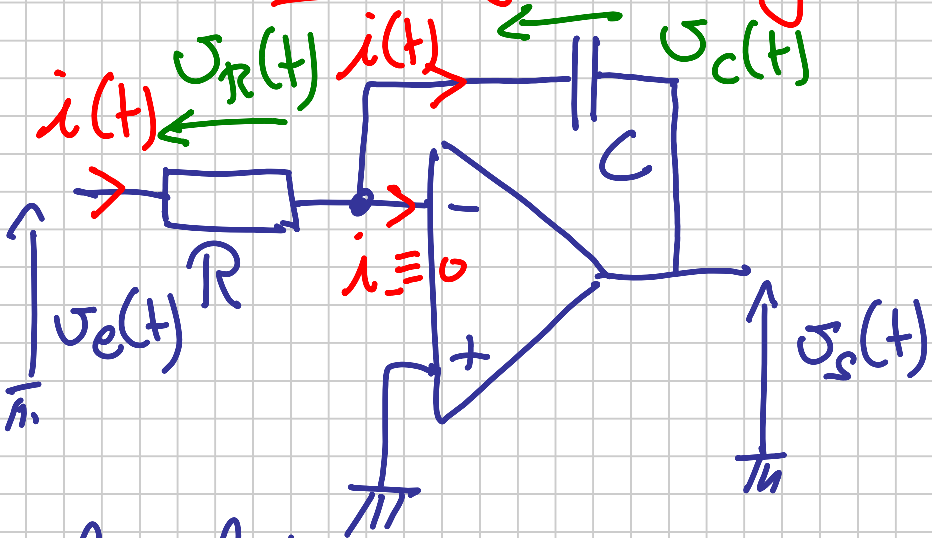




200	500	700	1000	1125	2000	5000	7000	10000	20000	50000	70000	100000
1257	3142	4398	6283	7069	12566	31416	43982	62832	125664	314159	439823	628319
0.1256637	0.3141593	0.439823	0.6283185	0.7068583	1.2566371	3.1415927	4.3982297	6.2831853	12.566371	31.415927	43.982297	62.831853
0.0002494	0.0097409	0.0374207	0.1558545	0.2496488	2.4936727	97.409091	374.20676	1558.5455	24936.727	974090.91	3742067.6	15585455
1.0009975	1.0389636	1.1496827	1.6234182	1.9985954	10.974691	390.63636	1497.8271	6235.1818	99747.909	3896364.6	14968272	62341819
0.000433	0.0166003	0.060578	0.2104304	0.3007249	1.0403923	2.5917727	3.1754617	3.7948491	4.9989038	6.5906596	7.1751717	7.7947795
0.0	-0.2	-0.6	-2.1	-3.0	-10.4	-25.9	-31.8	-37.9	-50.0	-65.9	-71.8	-77.9

Montage Intégrateur

AOP Parfait



CRN ⇒ Régime linéaire

$0 \equiv V_+ = V_- \Leftarrow \varepsilon = 0$

Reponse temporelle

$v_s(t) = f(v_e(t))$

Loi électrocinétique

$i(t) = \frac{dq}{dt} = C\frac{dv_c}{dt}$

d.d.p

$v_c(t) = V_- - v_s(t) = -v_s(t)$

$$i(t) = -C\frac{dv_s(t)}{dt}$$

d.d.p

$v_R(t) = v_e(t) - V_- = v_e(t)$

Ohm $= R\,i(t)$

$$\Rightarrow \quad i(t) = \frac{v_e(t)}{R}$$

$$-C\,\frac{dv_s}{dt} = \frac{v_e}{R}$$

$$\frac{dv_s}{dt} = -\frac{v_e}{RC}$$

$$dv_s = -\frac{1}{RC}\,v_e(t)\,dt$$

$$\int_{v_s(0)}^{v_s(t)} dv_s = -\frac{1}{RC}\int_{t=0}^{t} v_e(t)\,dt$$

$$v_s(t) - v_s(0) = -\frac{1}{RC}\int_{t=0}^{t} v_e(t)\,dt$$

$$v_s(t) = v_s(0) - \frac{1}{RC}\int_{t=0}^{t} v_e(t)\,dt$$

Fct Intégrateur

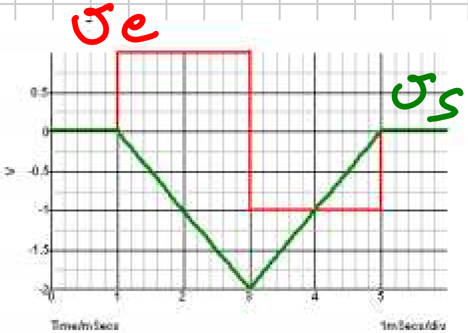
int1.sch

$R = 1k\Omega, C = 1\mu F$

$v_e(t) = 1V, t \in [1,3]ms$

$v_e(t) = -1V, t \in [3,5]ms$

$v_e(t) = 0V, t \notin [1,5]ms$



int2.sch

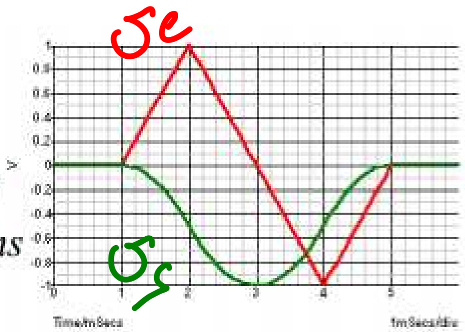
$R = 1k\Omega, C = 1\mu F$

$v_e(t) = (t-1)V, t \in [1,2]ms$

$v_e(t) = (3-t)V, t \in [2,4]ms$

$v_e(t) = (-5+t)V, t \in [4,5]ms$

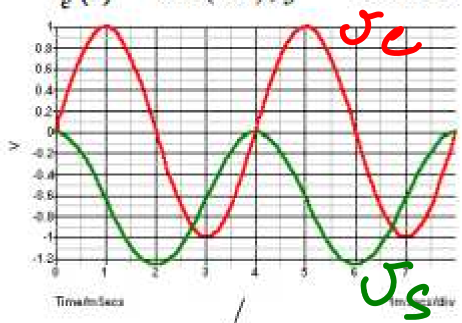
$v_e(t) = 0V, t \notin [1,5]ms$



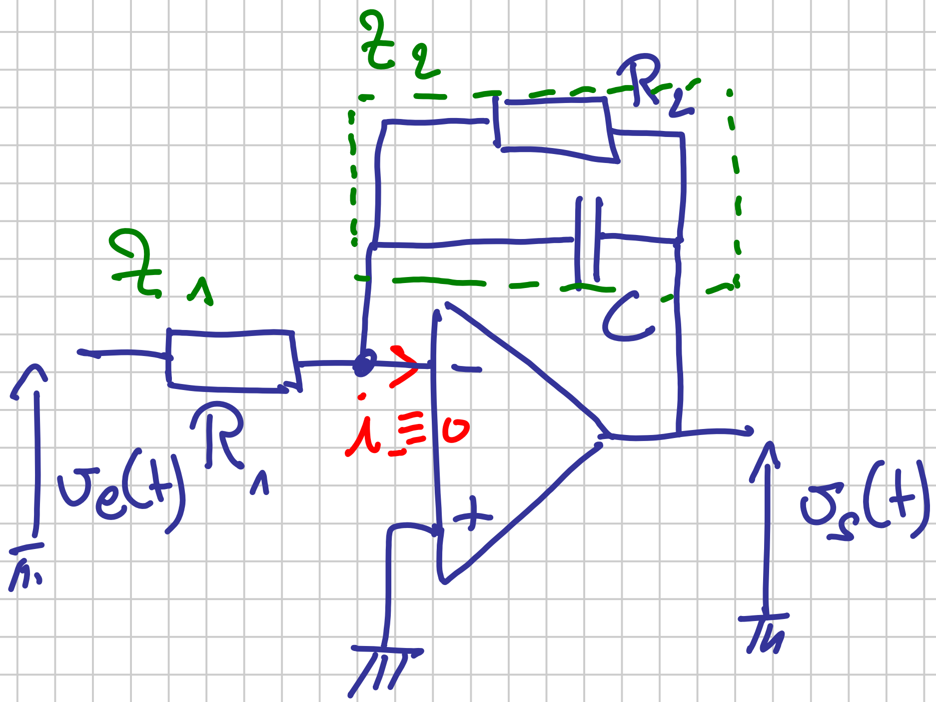
int3.sch

$R = 1k\Omega, C = 1\mu F$

$v_e(t) = \sin(\omega t), f = 250Hz$



Remarque



$$\mathcal{H}(j\omega) = \frac{v_s}{v_e} = -\frac{Z_2}{Z_1}$$

car amplification inverseur

Etude du 'Filtre'

via la fct de transfert

$$Z_1 = R_1$$

$$Z_2 = (R_2 // C) \quad \text{et} \quad Z_C = \frac{1}{jC\omega}$$

$$\frac{1}{Z_2} = \frac{1}{Z_{R_2}} + \frac{1}{Z_C} = \frac{1}{R_2} + jC\omega$$

$$\frac{1}{Z_2} = \frac{1 + jR_2C\omega}{R_2}$$

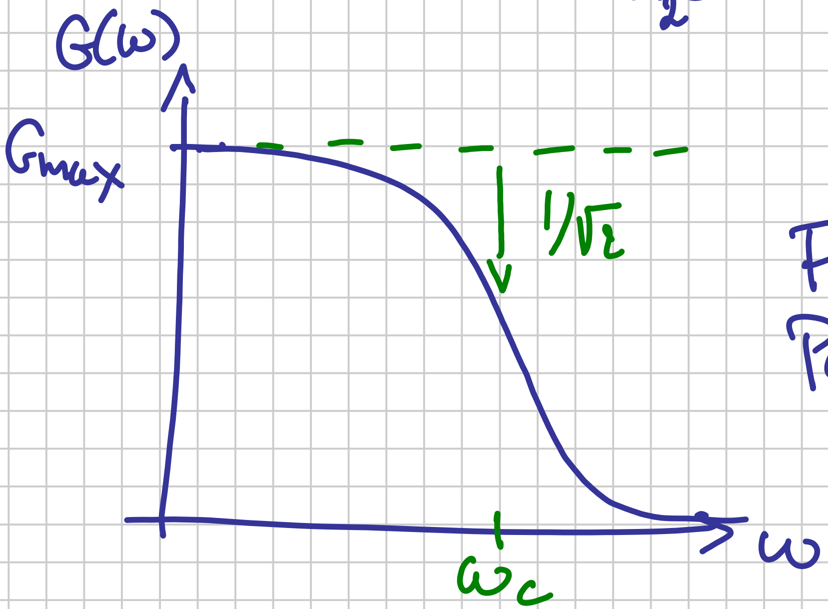
$$\Rightarrow \boxed{Z_2 = \frac{R_2}{1 + jR_2C\omega}}$$

$$\mathcal{H}(j\omega) = -\frac{R_2}{R_1}\frac{1}{1+jR_2C\omega} = -\frac{R_2}{R_1}\frac{1}{1+j\,\omega/\omega_0}$$

Gain $G(\omega) = \|\mathcal{H}(j\omega)\| = \frac{R_2}{R_1}\frac{1}{\sqrt{1+R_2^2C^2\omega^2}}$

posons $\omega_0 = \frac{1}{R_2C}$

$$G(\omega) = \frac{R_2}{R_1}\frac{1}{\sqrt{1+\left(\frac{\omega}{\omega_0}\right)^2}}$$



Filtre Passe Bas

$\lim_{\omega \to 0}$ $G(0) = \frac{R_2}{R_1}\frac{1}{\sqrt{1+0}} = \frac{R_2}{R_1}$

$\lim_{\omega \to \infty}$ $G(\infty) = \frac{R_2}{R_1}\frac{1}{\sqrt{1+\infty}} \simeq 0$

ω_c pulsation de coupure $\quad G(\omega_c) = \dfrac{G_{max}}{\sqrt{2}}$

$$G(\omega_c) = \frac{R_2}{R_1} \frac{1}{\sqrt{1+\left(\frac{\omega_c}{\omega_0}\right)^2}} = \frac{R_2}{R_1} \frac{1}{\sqrt{2}}$$

$$\Rightarrow \quad 1+\left(\frac{\omega_c}{\omega_0}\right)^2 = 2$$

$$\left(\frac{\omega_c}{\omega_0}\right)^2 = 1$$

$$\Rightarrow \quad \boxed{\omega_c = \omega_0 = \frac{1}{R_2 C}} = 2\pi f_c$$

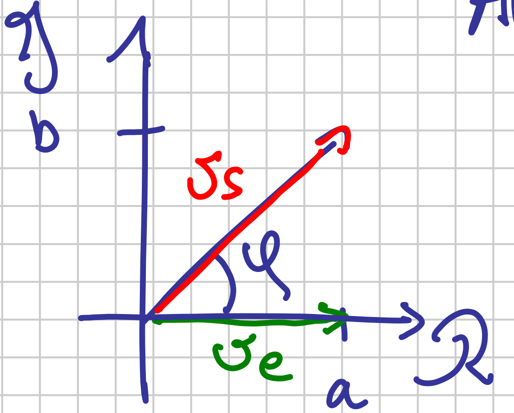
$$\boxed{f_c = \frac{1}{2\pi R_2 C}}$$

Etude de la phase

$$\mathcal{H}(j\omega) = -\frac{R_2}{R_1}\,\frac{1}{1+jR_2C\omega}$$

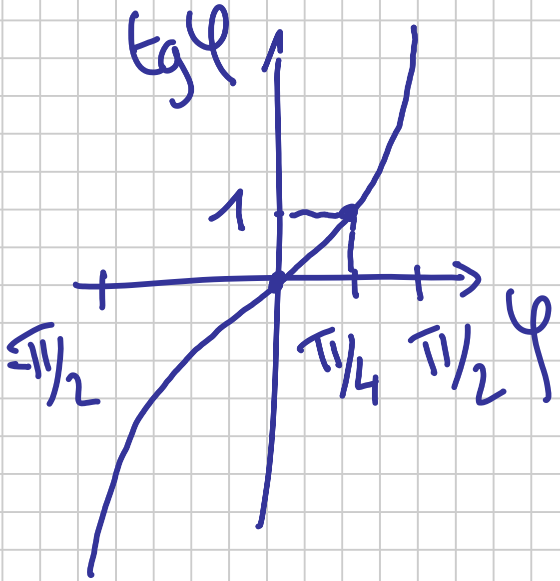
$$\text{Arg}\left(\mathcal{H}(j\omega)\right) = \frac{\text{Arg}\,N}{\text{Arg}\,D} = \text{Arg}\,N - \text{Arg}\,D$$

$$= 0 - \text{arctg}\,R_2C\omega$$



$$\text{tg}\,\varphi = \frac{b}{a}$$

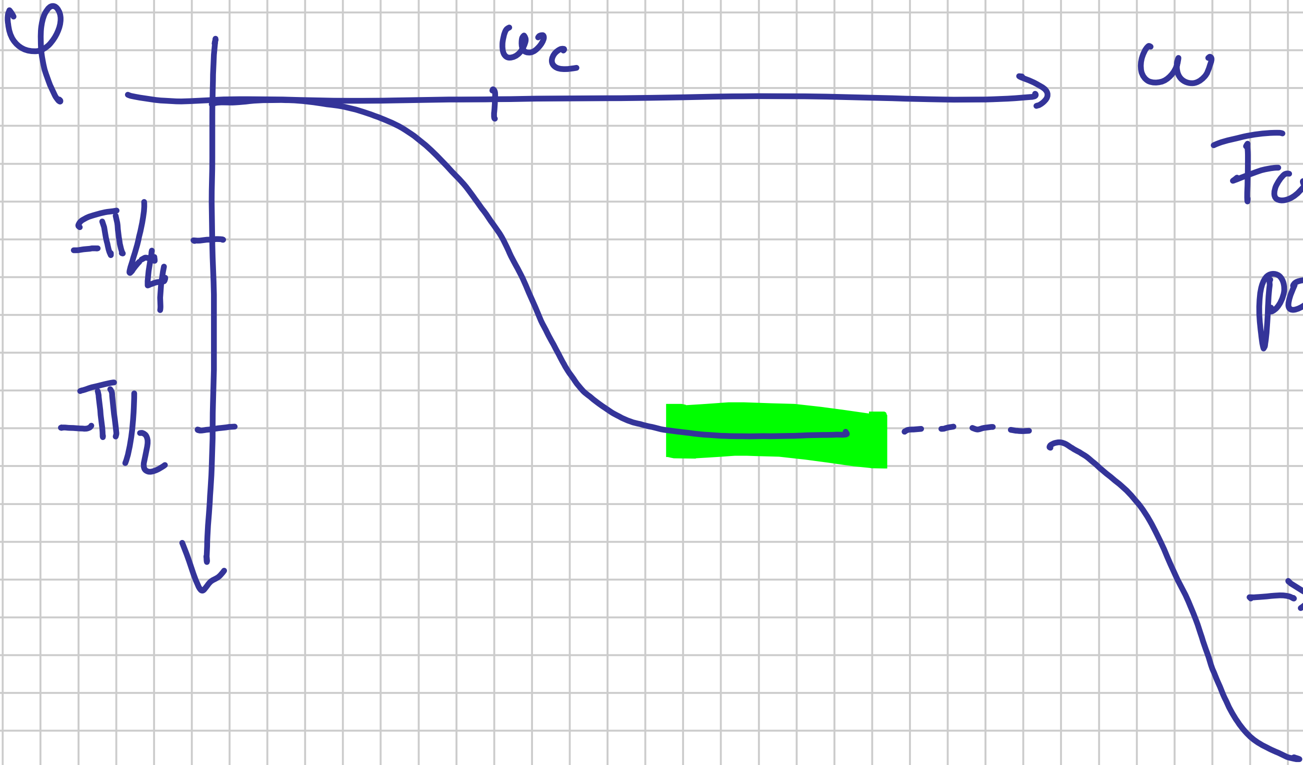
$$\boxed{\varphi(\omega) = -\text{arctg}\,R_2C\omega}$$



$$\lim_{\omega\to 0} \varphi(0) = 0$$

$$\lim_{\omega\to\infty} \varphi(\infty) = -\pi/2$$

$$\lim_{\omega=\omega_c} \varphi(\omega_c) = -\pi/4$$

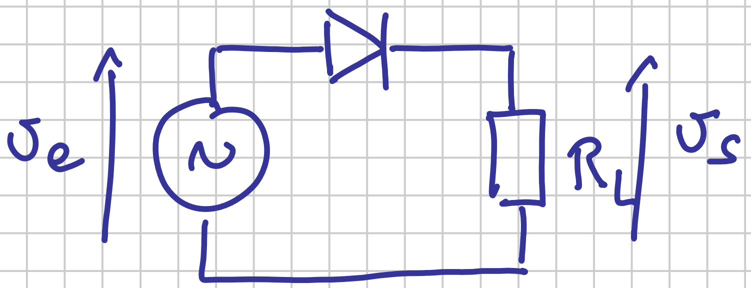


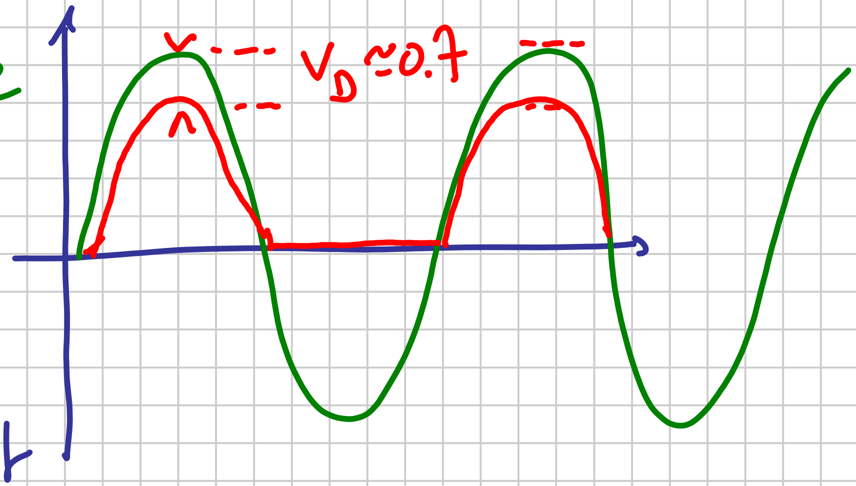
Question :

Fct Intégrateur pour quel domaine de fréquence ?

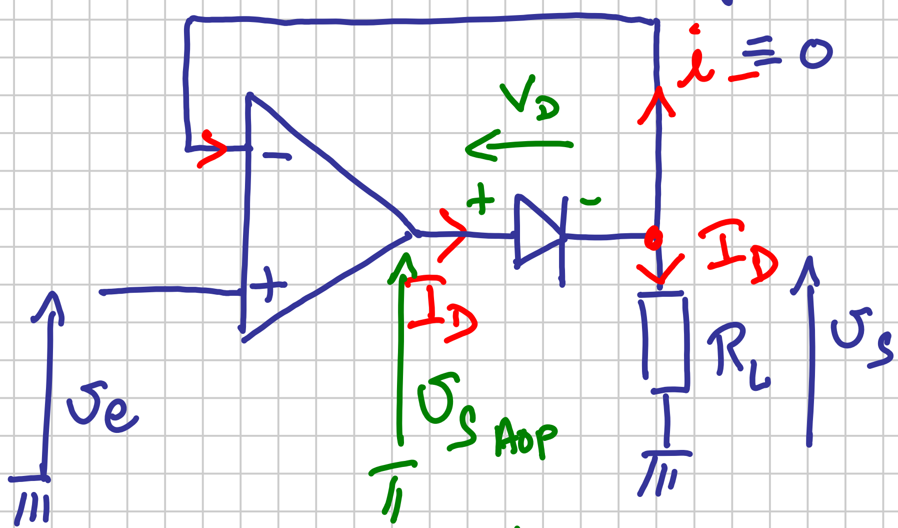
→ nouveau déphasage dû à l'AOP !

Redresseur sans seuil





AOP Parfait



$v_{s\,AOP} = v_s + V_D = v_e + V_D$

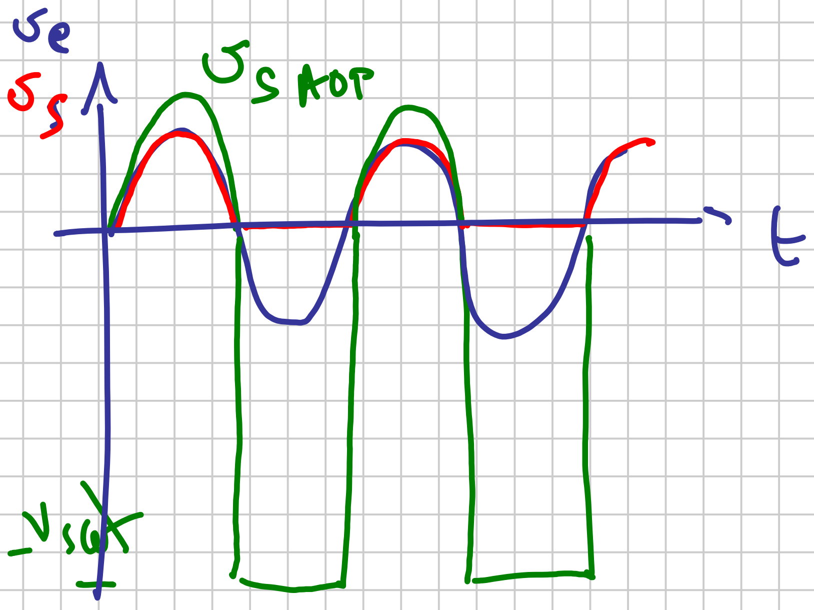
1) Alternance positive

$v_e > 0$

Hyp : Diode passante

d'où CRN $\Rightarrow \varepsilon \equiv 0$

$\Rightarrow V_+ = V_-$ or $V_+ = v_e$



donc $V_- = v_e \equiv v_S = R_L I_D$

$\Rightarrow$ $\boxed{v_S = v_e}$

$I_D = \dfrac{v_e}{R} > 0$

Hyp diode passante vérifiée $\Leftarrow$ car $v_e > 0$

2) Alternance négative

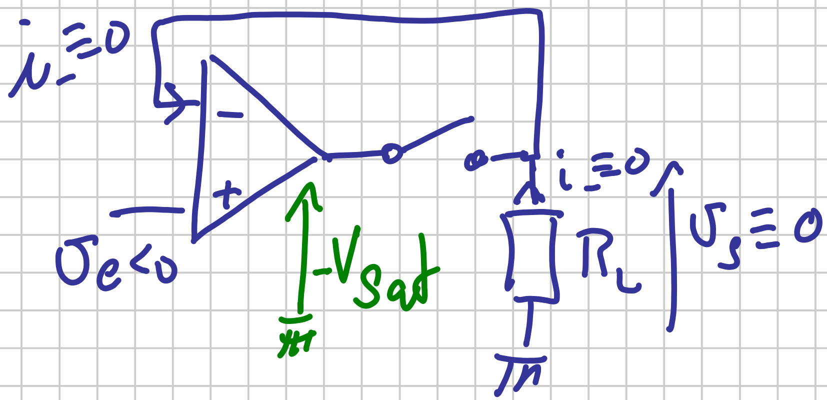
$v_e < 0$, Hyp. Diode passante

$\hat{m}$ calculs

Mais $I_D = \dfrac{v_e}{R} < 0$!

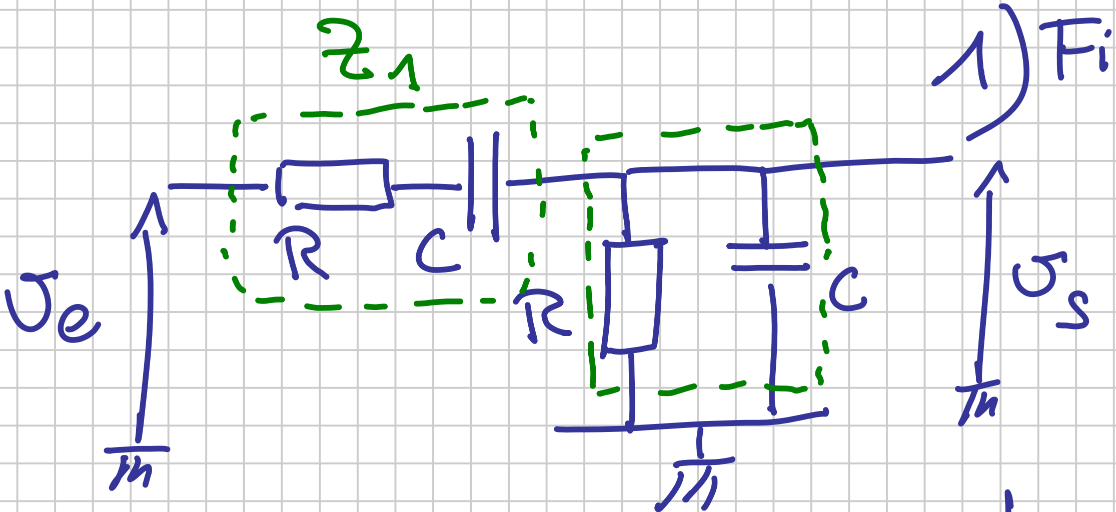
car $v_e < 0$ $\Rightarrow$ Diode Bloquée

Alternance positive



$V_s = A\varepsilon = A v_e < 0$

Oscillateur à Pont de Wien



1) Filtre

Fct transfert

$$\mathcal{H}(j\omega) = \frac{v_s}{v_e}$$

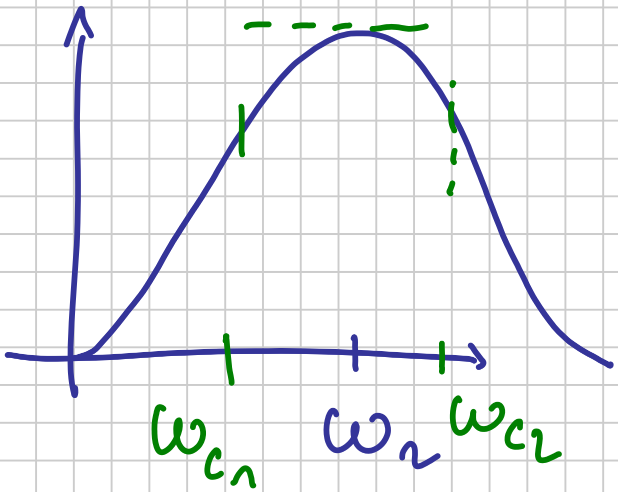
Div. tension $\mathcal{H}(j\omega) = \frac{Z_2}{Z_1+Z_2}$

$$Z_1 = R + \frac{1}{jC\omega}$$

$$Z_2 = (R // C)$$

$$G(\omega) = \|\mathcal{H}(j\omega)\|$$

lim $\omega \to 0$, $\omega \to \infty$



Passe Bande

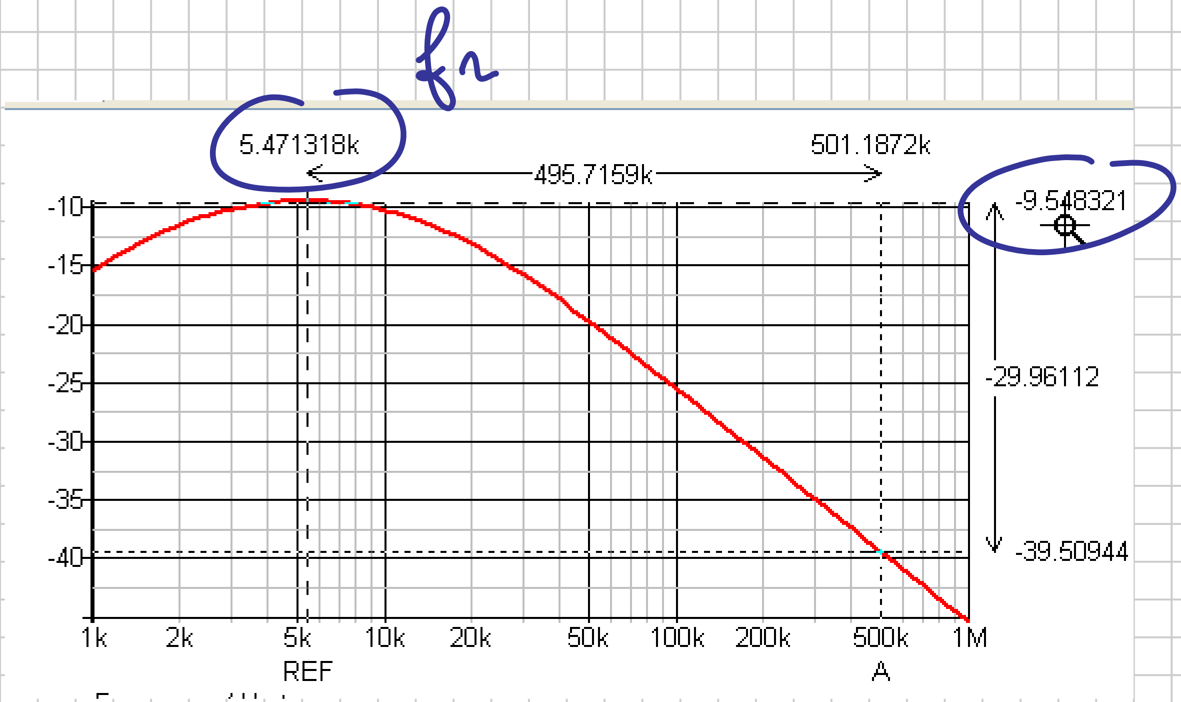
pulsation de résonance ω_r

$\Rightarrow \mathcal{H}(j\omega) \in \mathbb{R}$

et G_{max} ? $= \frac{1}{3}$ à ω_r, $f_r \simeq 5\,kHz$

pour $R = 3\,k\Omega$

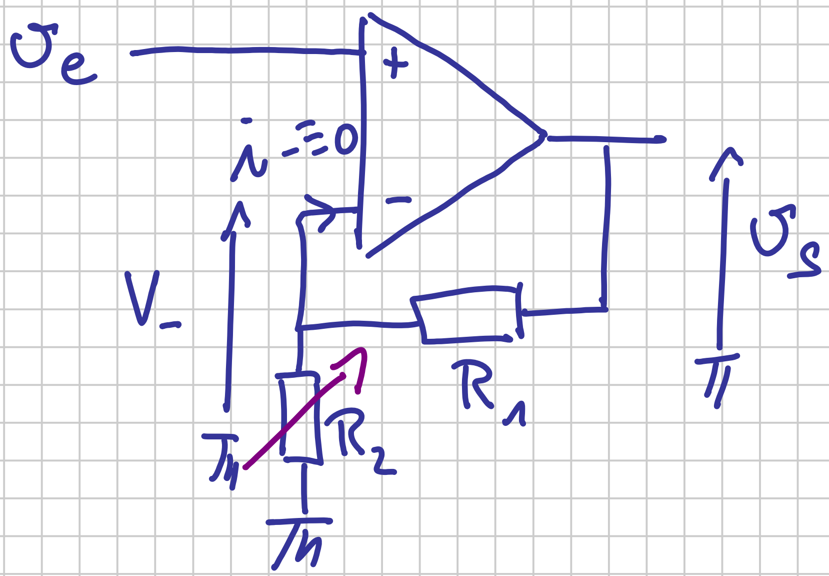
$C = 10\,nF$



$$G_{dB} = 20 \log_{10} G(\omega)$$

si $G_{max} = \frac{1}{3} \Rightarrow G_{dB} \simeq -9.54$

2) Amplificateur non inverseur



CRN ⇒ $\varepsilon = 0$

$V_+ = V_-$

$v_e = \frac{R_2}{R_1+R_2} v_s$

$v_s = \frac{R_1+R_2}{R_2} v_e$

$$v_s = \left(\frac{R_1}{R_2} + 1\right) v_e$$

choix de R_1, R_2 ⇒ Gain = 3

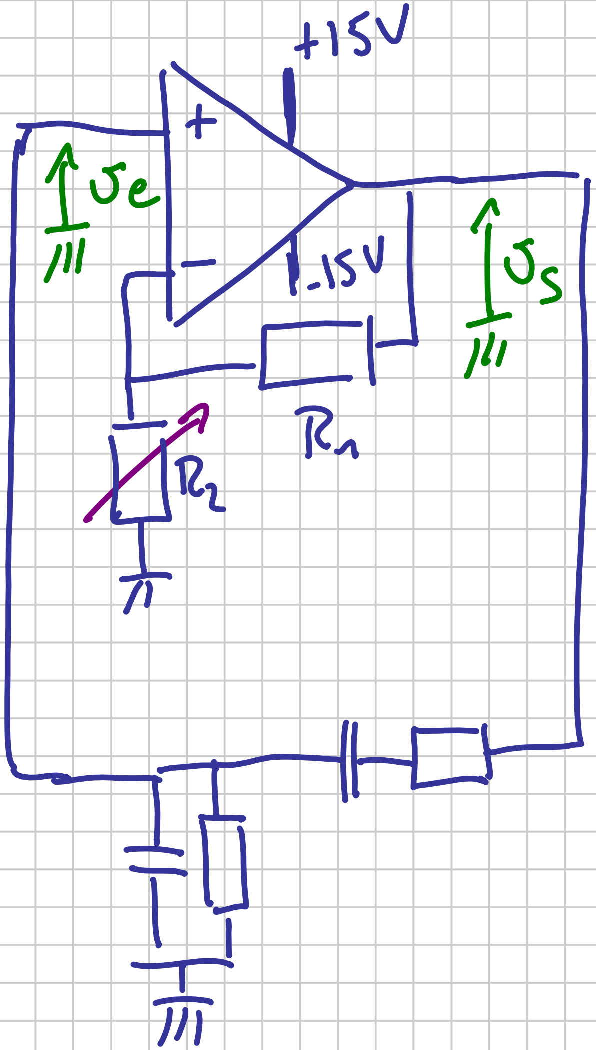
$R_1 = 1\,k\Omega$

$R_2 \simeq 500\,\Omega \in [0, 1\,k\Omega]$

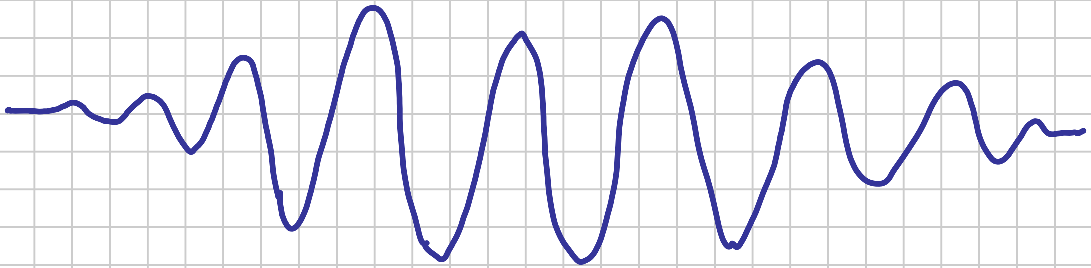
alors $v_s = 3 v_e$

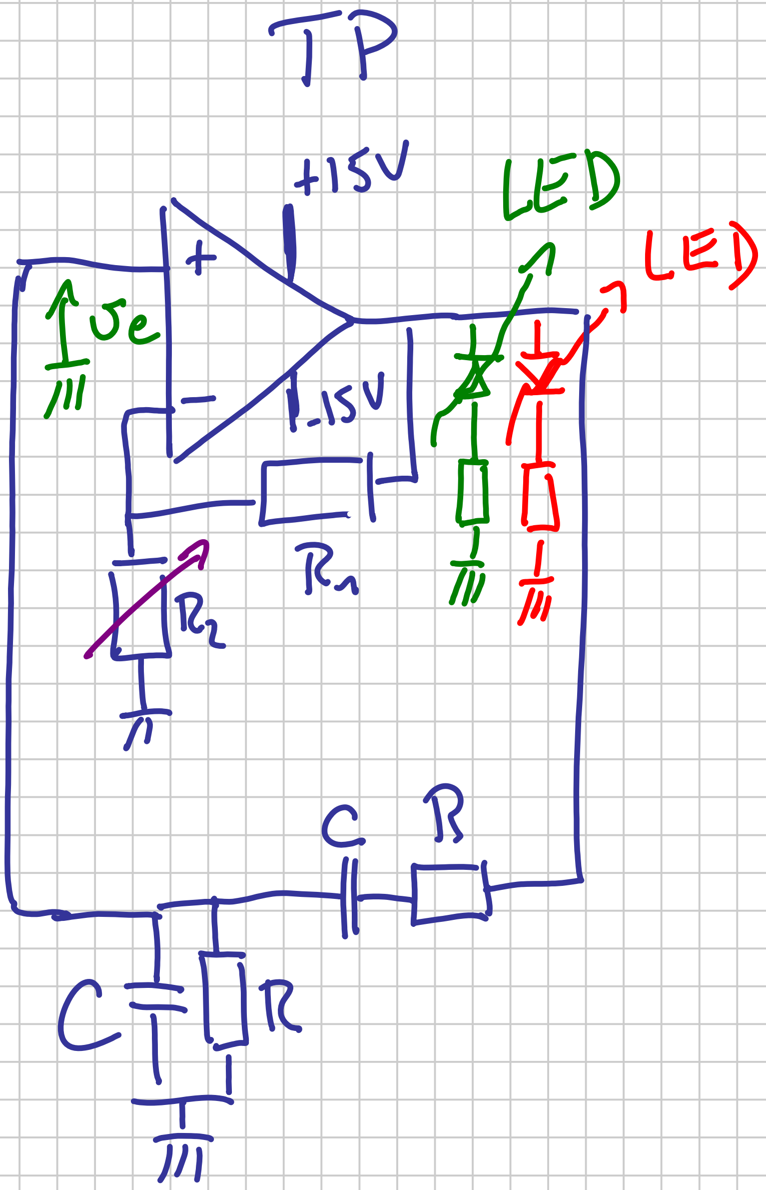
3) Oscillateur

$G = G_{PB} \times G_{AOP}$

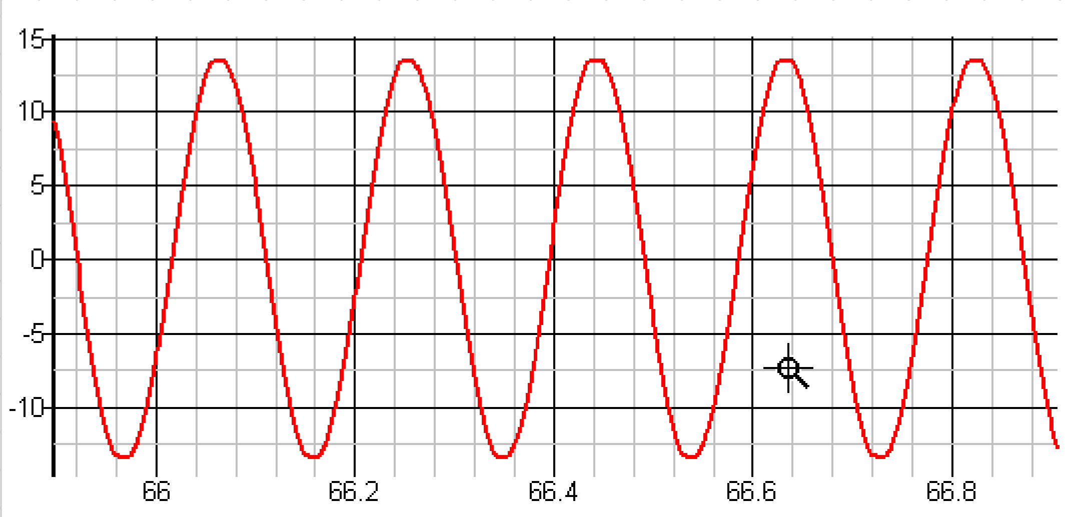


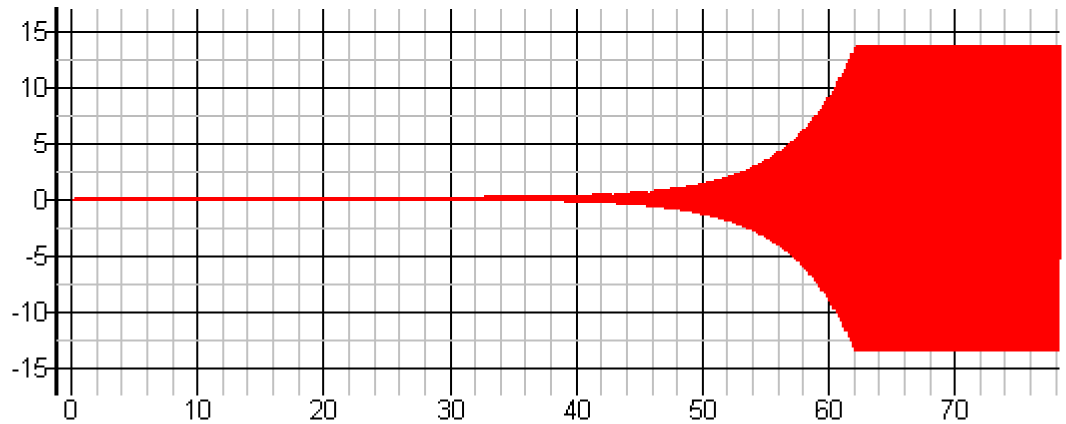
$G > 1$ $\quad$ $G \simeq 1$ $\quad$ $G < 1$



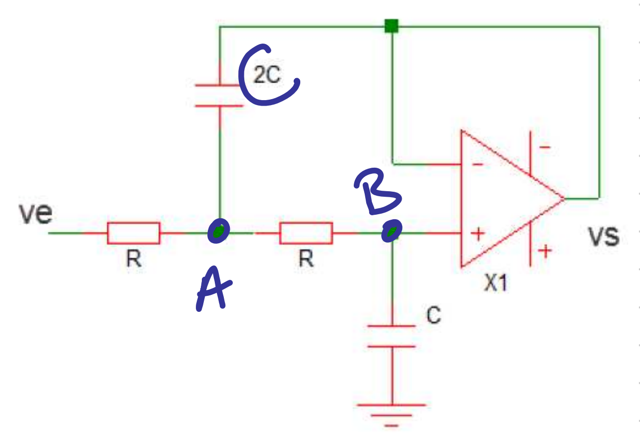


R, C $\Rightarrow f_r \approx 1\,Hz$


15
10
5
0
-5
-10
66
66.2
66.4
66.6
66.8


15
10
5
0
-5
-10
-15
0
10
20
30
40
50
60
70

Ex 8 Variante de Sallen - Key



CRN → $\varepsilon \equiv 0$

1) Millman en B

2) Millman en A

3) $\underline{H}(j\omega) = \frac{\underline{v}_s}{\underline{v}_e}$

4) $G(\omega)$, limites, Allure Filtre, ⇒ Passe Bas

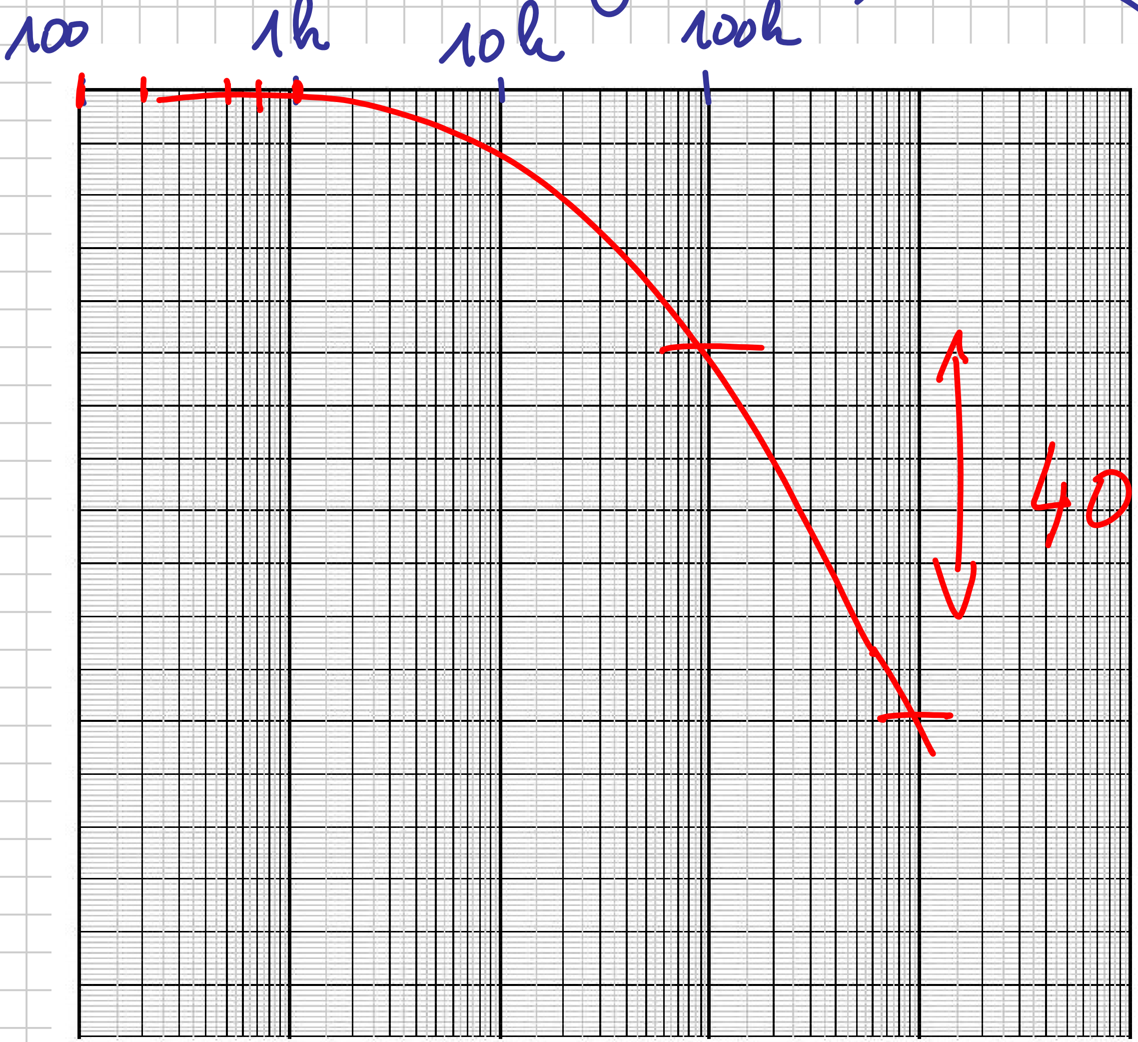
ω_c, f_c

$$\underline{H}(j\omega) = \frac{1}{(1 - 2R^2C^2\omega^2) + 2jRC\omega}$$

$G_{dB} = 20 \log_{10} G(\omega)$

$G(\omega) = \dfrac{1}{\sqrt{1 + 4R^4C^4\omega^4}}$

Excel



1, 2, 5, 7

40 dB / décade

$G(\omega_2) - G(\omega_1)$

avec $\omega_2 = 10\,\omega_1$

lim $\omega_2 \to \infty$

$= -40$