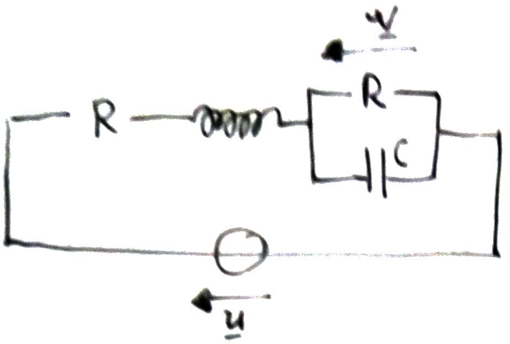
EX P RSF2

$\boxed{1}$



$u(t) =$

$$\underline{v} = \frac{\underline{Z_1}}{R + jL\omega + \underline{Z_1}}\,\underline{u} \qquad \underline{Z_1} = \frac{R}{1 + jRC\omega}$$

$$= \frac{1}{1 + \frac{1}{\underline{Z_1}}(R + jL\omega)}\,\underline{u} \qquad \frac{1}{\underline{Z_1}} = \frac{1}{R} + jC\omega$$

$$= \frac{1}{1 + \left(\frac{1}{R} + jC\omega\right)(R + jL\omega)}$$

$$= \frac{1}{1 + 1 + \frac{jL\omega}{R} + jRC\omega - LC\omega^2}$$

$$= \frac{1}{2 - \tau^2\omega^2 + 2j\tau}\,\underline{u} \qquad \frac{L}{R} = RC = \tau \Rightarrow LC = \tau^2$$

$$\Leftrightarrow \underline{V} = \frac{1}{2 - \tau^2\omega^2 + 2j\tau}\,\underline{U}$$

$$\underline{V} = Ve^{j\varphi} \Rightarrow \begin{cases} |\underline{V}| = V = \dfrac{U}{\sqrt{(2-\tau^2\omega^2)^2 + 4\tau^2\omega^2}} = \dfrac{U}{\sqrt{4 + \tau^4\omega^4}} \\ \varphi = \arg \underline{V} = \arg \underline{U} - \arg(2 - \tau^2\omega^2 + 2j\tau\omega) \end{cases}$$

$$\sin\varphi = -\frac{2\tau\omega}{\sqrt{4+\tau^4\omega^4}} \quad < 0$$

$$\tan\varphi = -\frac{2\tau\omega}{2-\tau^2\omega^2}$$

$$\varphi = -\arctan\frac{2\tau\omega}{2-\tau^2\omega^2} \qquad (\text{si dénom}>0 \iff 2 > \tau^2\omega^2)$$

$$= \pi - \arctan\frac{2\tau\omega}{2-\tau^2\omega^2} \qquad \text{si } 2 < \tau^2\omega^2$$

$\boxed{2/1}$

$$\underline{Z}_1 = R + jL\omega + \frac{\frac{jL_1\omega}{jC_1\omega}}{jL_1\omega + \frac{1}{jC_1\omega}}$$

$$= R + jL\omega + \frac{jL_1\omega}{1-L_1C_1\omega^2} = R + jL\omega\left(1 + \frac{\frac{L_1}{L}}{1-L_1C_1\omega^2}\right)$$

$$= R + jL\omega\left(1 + \frac{L_1}{L - LL_1C_1\omega^2}\right)$$

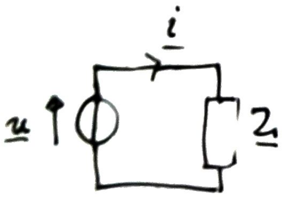
$$= R + jL\omega\left(\frac{L+L_1-L_1LC_1\omega^2}{L-L_1LC_1\omega^2}\right)$$

$$= R + jL\omega\left(\frac{\frac{L+L_1}{LL_1C_1} - \omega^2}{\frac{L}{LL_1C_1} - \omega^2}\right)$$

On pose
$$\begin{cases} \omega_1^2 := \dfrac{L+L_1}{LL_1C_1} \\ \omega_2^2 := \dfrac{L}{LL_1C_1} = \dfrac{1}{L_1C_1} \end{cases}$$

$$= R + jL\omega\left(\frac{\omega_1^2-\omega^2}{\omega_2^2-\omega^2}\right)$$

$\boxed{2/2}$



$$\underline{u} = U_m e^{j\omega t}$$

$$\underline{i} = I_m e^{j(\omega t+\varphi)}$$

$$\underline{u} = \underline{Z}_1 \underline{i}$$

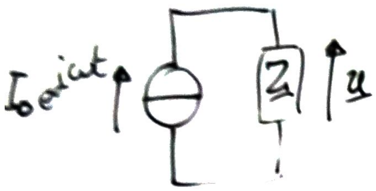
- Module : $U_m = |\underline{Z}_1| I_m \Rightarrow I_m = \dfrac{U_m}{\sqrt{R^2+X^2}}$
- Argument : $0 = \arg\underline{Z} + \varphi$, $\varphi = -\arg\underline{Z}_1 = -\arg(R+jX)$

$$= -\arctan\frac{X}{R} \quad \text{car } R > 0$$

$\boxed{3/1}$

$$\frac{1}{\underline{Z}} = \frac{1}{R} + \frac{1}{jL\omega} + jC\omega$$

$\boxed{3/2}$



$$\underline{u} = \underline{Z}\, I_0 e^{j\omega t}$$

$$\underline{U} = \underline{Z}\, I_0 = \frac{1}{\frac{1}{R} + \frac{1}{jL\omega} + jC\omega} I_0$$

$\boxed{3/3}$

$$U = |\underline{U}| = \frac{I_0}{\sqrt{\frac{1}{R^2} + \left(C\omega - \frac{1}{L\omega}\right)^2}}$$

sera max qd le dénominateur est minimum ie

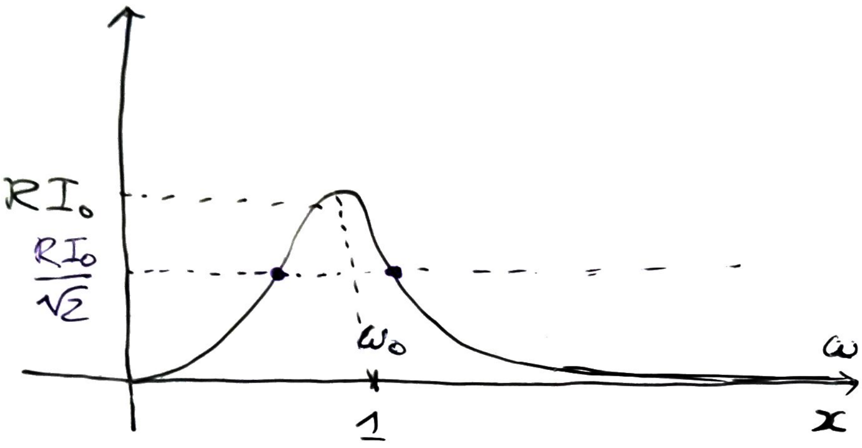
$$\frac{1}{R^2} + \left(C\omega - \frac{1}{L\omega}\right)^2 = 0$$

$$\Leftrightarrow C\omega - \frac{1}{L\omega} = 0$$

$$\Leftrightarrow \omega = \omega_0 = \frac{1}{\sqrt{LC}}$$

$$\Rightarrow U_{max} = R \cdot I_0$$

3/4



3/5

3/6

$$\varphi = \arg \underline{U} - \arg \underline{I}$$

$$= \arg \frac{I_0}{\frac{1}{R} + j\left(C\omega + \frac{1}{L\omega}\right)} - \arg \underline{I}$$

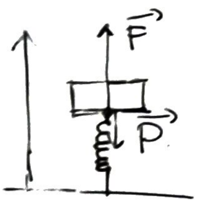
$$= \arg \frac{\underline{U}}{\underline{I}}$$

$$= \arg \frac{1}{\frac{1}{R} + j\left(C\omega - \frac{1}{L\omega}\right)}$$

$$= \arctan\left(\tan\left(-\arg\left(\frac{1}{R} + j\left(C\omega - \frac{1}{L\omega}\right)\right)\right)\right)$$

$$= -\arctan\left(R\left(C\omega - \frac{1}{L\omega}\right)\right)$$

4/1



On projette : $\vec{P} + \vec{F_r} = \vec{0}$ $/Oz$

$$\Leftrightarrow -mg - k(l_{eq} - l_0) = 0$$

$$\Leftrightarrow l_{eq} = l_0 - \frac{mg}{k}$$

4/2

hors équilibre:

$$m\vec{a} = \vec{P} + \vec{F_r} + \vec{f} + \vec{F} \; ; \qquad \vec{F_r} = -k(l - l_0)\vec{u_z}$$

$/Oz$

$$m\ddot{z} = -\cancel{mg} - k\left(l(t) \overset{+\cancel{l_{eq}} - l_{eq}}{-\cancel{l_0}}\right) - \alpha\dot{z} + F_0 \cos \omega t$$

On pose $z = l - l_{eq}$

$$m\ddot{z} = -\alpha\dot{z} - kz + F_0 \cos \omega t$$

$$m\ddot{z} + \alpha\dot{z} + kz = F_0 \cos \omega t$$

$$m\ddot{\underline{z}} + \alpha\dot{\underline{z}} + k\underline{z} = F_0 e^{j\omega t}$$

4/3 | $\underline{v} = \dot{\underline{x}}$

$$m\dot{\underline{v}} + \alpha\underline{v} + \frac{k}{j\omega}\underline{v} = F_0 e^{j\omega t}$$

$$\underline{v}\left(jm\omega + \alpha + \frac{k}{j\omega}\right) = F_0 e^{j\omega t}$$

$$\underline{V} = \frac{F_0}{\alpha + j\left(m\omega - \frac{k}{\omega}\right)} \qquad \left(\underline{v} = \underline{V}e^{j\omega t}\right)$$

$$\underline{V} = \frac{V_m}{1 + jQ\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)} = \frac{F_0/\alpha}{1 + j\left(\frac{m\omega}{\alpha} - \frac{k}{\alpha\omega}\right)}$$

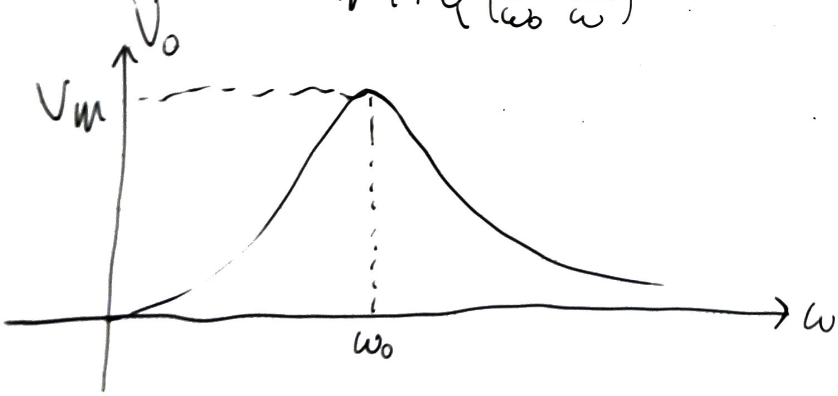
On a
$$\begin{cases} \frac{Q}{\omega_0} = \frac{m}{\alpha} \\ Q\omega_0 = \frac{k}{\alpha} \\ V_m = \frac{F_0}{\alpha} \end{cases}$$

$$\times \rightarrow Q^2 = \frac{mk}{\alpha^2} \Rightarrow Q = \frac{\sqrt{mk}}{\alpha}$$

$$\div \rightarrow \frac{Q\omega_0}{\frac{Q}{\omega_0}} = \frac{k/\alpha}{m/\alpha} \Rightarrow \omega_0^2 = \frac{k}{m} \Rightarrow \omega_0 = \sqrt{\frac{k}{m}}$$

4/4

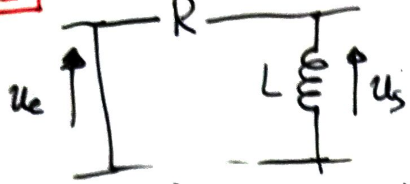
$$V_0 = |\underline{V}| = \frac{V_m}{\sqrt{1 + Q^2\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)^2}}$$



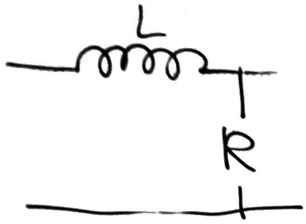
|4/5|

On fait en sorte d'avoir $|\omega - \omega_0|$ ~~le~~ plus grand.

$\boxed{1}$



$$\underline{H} = \frac{jL\omega}{R+jL\omega} = \frac{j\frac{L}{R}\omega}{1+j\frac{L\omega}{R}} = \frac{j\frac{\omega}{\omega_0}}{1+j\frac{\omega}{\omega_0}} \quad \text{avec } \omega_0 := \frac{R}{L}$$

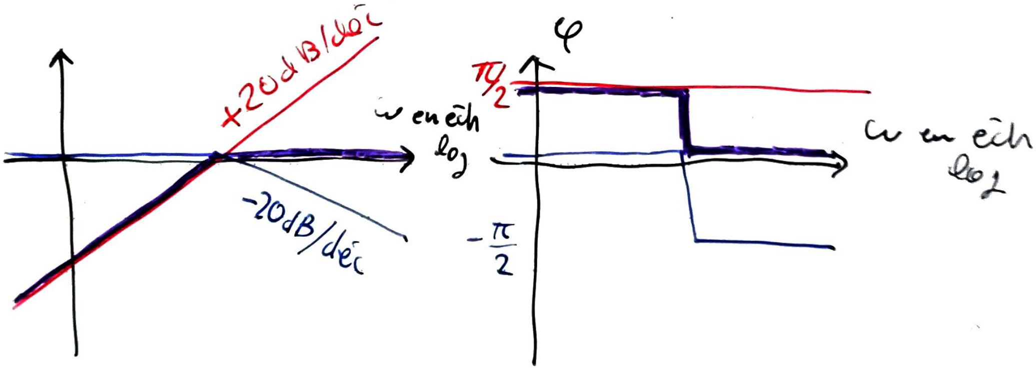


RL $\Longleftrightarrow$ CR

LR $\Longleftrightarrow$ RC

$$\underline{H} = \frac{1}{1+j\frac{\omega}{\omega_0}} \quad \text{avec } \omega_0 := \frac{R}{L}$$

$$\boxed{\underline{H}} = \underbrace{\underline{H}_0}_{j\frac{\omega}{\omega_0}} \cdot \underbrace{\underline{H}_1}_{\frac{1}{1+j\frac{\omega}{\omega_0}}}$$



$\forall \omega, \quad G_{dB} = 20 \log \frac{\omega}{\omega_0}$

$\forall \omega, \quad \varphi = \frac{\pi}{2}$

7 [poly!] $\qquad G_{dB} = 20 \iff G =$

$$e_1(t) = 5\cos(2\pi\, 1000\, t)$$

$$\Rightarrow s_1(t) = \underbrace{10^{20/20}}_{G = 10^{G_{dB}/20}}\, 5\cos(2\pi\, 1000\, t \underbrace{-0{,}1}_{\varphi})$$

$$= 20\cos(2\pi\, 100 t - 0{,}1)$$

$$e_2(t) = 5\cos(2\pi\, 1000 t) \;:\; G_{dB} = 17$$

(pas approx : $\underset{\uparrow \text{ max}}{20} - 3$ dB

car on est au max, à $f_c = f_0$

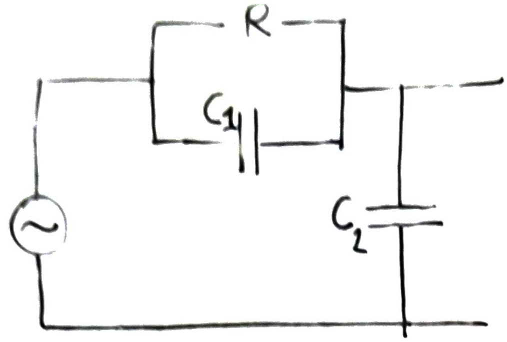
$$\Rightarrow S_2(t) = \underbrace{10^{17/20}}_{G} \cdot 5\cos(2\pi\, 1000 t \underbrace{-0{,}8}_{\varphi})$$

$$= \underbrace{35}_{\approx}\cos(2\pi\, 1000 t - 0{,}8)$$

$$e_3(t) = 5\cos(2\pi\, 10^5 t) \;:\; G_{dB} = 0 ; \quad \varphi \approx -1{,}35$$

$$\Rightarrow S_3(t) = \underbrace{10^0}_{G}\, 5\cos(2\pi\, 10^5 t \underbrace{-1{,}35}_{\varphi})$$

$\boxed{6}$



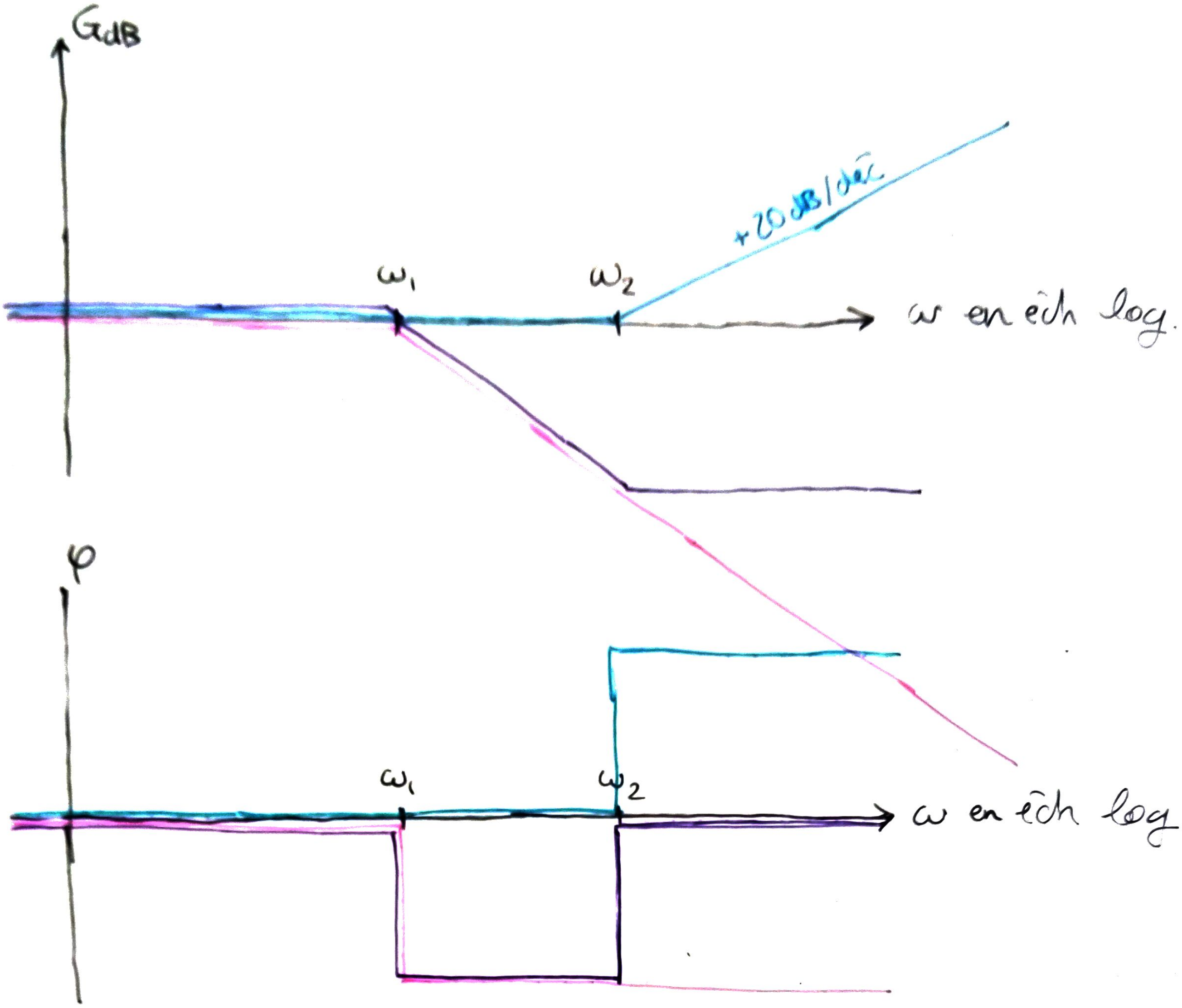
$$\underline{H} = \frac{\underline{U_s}}{\underline{U_e}} = \frac{\frac{1}{jC1\omega}}{}$$

$$= \frac{1}{1 + j\frac{RC_2\omega}{1+jRC_1\omega}}$$

$$= \frac{1+jRC_1\omega}{1+jRC_1\omega+jRC_2\omega}$$

$$= \frac{1+jRC_1\omega}{1+jR(C_1+C_2)\omega}$$

On a $\omega_1 = \frac{1}{RC_1}$; $\omega_2 = \frac{1}{R(C_1+C_2)}$



$$\omega \gg \omega_1 : \underline{H}_1 \sim j\frac{\omega}{\omega_1}$$

$$\underline{H} = \frac{1 \left(1 + j\frac{\omega}{\omega_1}\right)}{1 + j\frac{\omega}{\omega_2}}$$

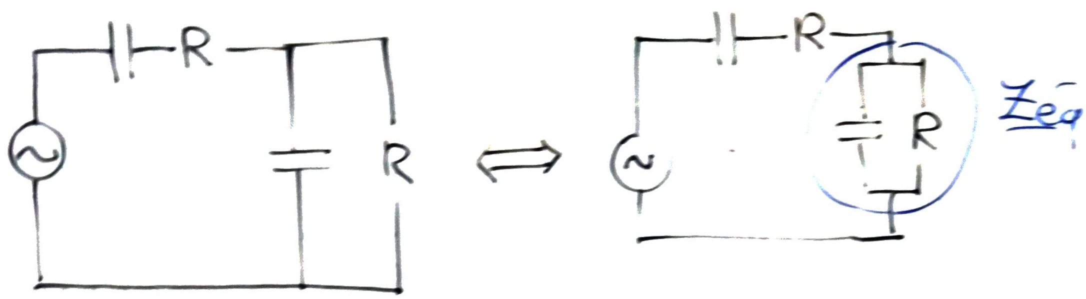
H_2 H_1

$$\underline{H} \underset{\infty}{\sim} \frac{jRC_1\omega}{jR(C_1+C_2)\omega} = \frac{C_1}{C_1+C_2}$$

$$G_{dB\infty} = 20 \log \frac{C_1}{C_1+C_2}$$

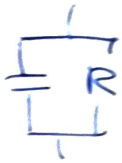
$\longrightarrow$ LPF avec atténuation constante en HF

$\boxed{4}$



$$\underline{H} = \frac{\underline{Z}_{eq}}{\underline{Z}_{eq} + R + \frac{1}{jC\omega}} = \frac{1}{1 + \frac{1}{\underline{Z}_{eq}}\left(R + \frac{1}{jC\omega}\right)}$$

$\frac{1}{\underline{Z}_{eq}} = \frac{1}{R} + jC\omega$ car



(//)

$$= \frac{1}{1 + \left(\frac{1}{R} + jC\omega\right)\left(R + \frac{1}{jC\omega}\right)}$$

$$= \frac{1}{1 + 1 + \frac{1}{jRC\omega} + 1 + jRC\omega}$$

$$= \frac{1}{3 + \frac{1}{jRC\omega} + jRC\omega}$$

$$= \frac{1}{3 + j\left(RC\omega - \frac{1}{RC\omega}\right)}$$

$$\omega_0 := \frac{1}{RC}$$

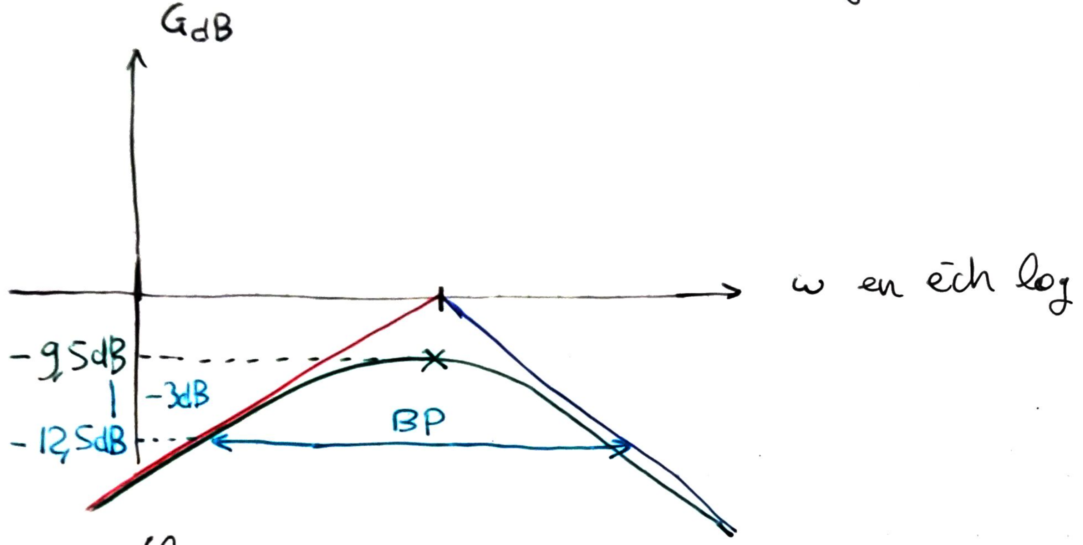
$$\underline{H} = \frac{1}{3 + j\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)}$$

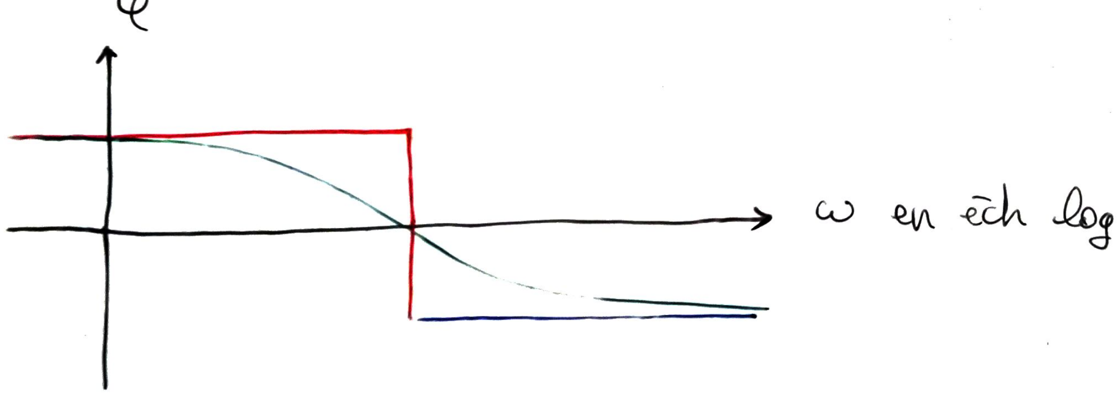
$\omega \gg \omega_0$: $\underline{H} \sim \dfrac{1}{-j\frac{\omega_0}{\omega}} \Rightarrow \begin{cases} \varphi = \frac{\pi}{2} \\ |\underline{H}| = \dfrac{1}{\frac{\omega_0}{\omega}} ; \; G_{dB} = -20 \log \frac{\omega_0}{\omega} \end{cases}$

$= 20 \log \frac{\omega}{\omega_0}$

$\omega \ll \omega_0$: $\underline{H} \sim \dfrac{1}{j\frac{\omega}{\omega_0}} \Rightarrow \begin{cases} \varphi = \frac{-\pi}{2} \\ G_{dB} = -20 \log \frac{\omega}{\omega_0} \end{cases}$

$\omega = \omega_0$: $\underline{H} = \frac{1}{3} \Rightarrow \begin{cases} \varphi = 0 \\ G_{dB} = -20 \log 3 = -9{,}5\,dB \end{cases}$





→ passe-bande

On cherche la BP : les solutions :

$$\frac{1}{\sqrt{9 + (\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega})^2}} = \frac{1/3}{\sqrt{2}}$$

$1/3$ → quand $(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega})^2 = 0$ on est au max (à $-9{,}5\,dB$)

$$\Leftrightarrow \frac{1}{9+\left(\frac{\omega}{\omega_0}-\frac{\omega_0}{\omega}\right)^2} = \frac{1/9}{2}$$

$$\Leftrightarrow \left(\frac{\omega}{\omega_0}-\frac{\omega_0}{\omega}\right)^2 = \frac{2}{\frac{1}{9}} - 9$$

$$\Leftarrow \frac{\omega}{\omega_0}-\frac{\omega_0}{\omega} = \sqrt{\quad 9 \quad} = \pm 3$$

$$\Leftrightarrow \omega^2 - \omega_0^2 = \pm 3\omega\omega_0$$

$$\Leftrightarrow \omega^2 \pm 3\omega_0\omega - \omega_0^2 = 0$$

$$\Delta = 9\omega_0^2 + 4\omega_0^2 = 13\omega_0^2$$

$$\frac{\mp 3\omega_0 \pm \sqrt{13}\,\omega_0}{2}$$

Les solutions sont :

$$(+,+)\quad \omega_{c_2} = \frac{3+\sqrt{13}}{2}\omega_0$$

$$(-,+)\quad \omega_{c_1} = \frac{\sqrt{13}-3}{2}\omega_0$$

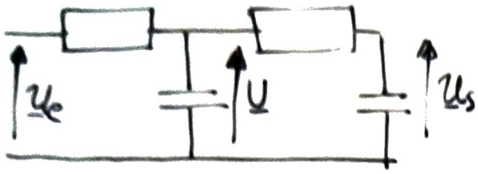
$$\Delta\omega = \omega_{c_2} - \omega_{c_1} = \omega_0\left(\frac{3+\sqrt{13}-\sqrt{13}+3}{2}\right) = \frac{6}{2}\omega_0 = 3\omega_0$$

$$Q = \frac{\omega_0}{\Delta\omega} = \frac{1}{3}$$

rem

C'est de la forme $\frac{\alpha}{1+jQ\left(\frac{\omega}{\omega_0}-\frac{\omega_0}{\omega}\right)}$: $\underline{H} = \frac{\frac{1}{3}}{1+j\underbrace{\frac{1}{3}}_{Q}\left(\frac{\omega}{\omega_0}-\frac{\omega_0}{\omega}\right)}$

Sigal - Chireux

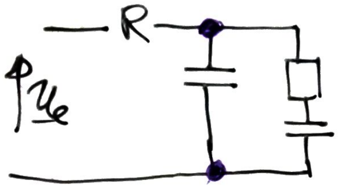


Meth 1

$$\underline{H} = \frac{\underline{u_e}}{\underline{U}} \cdot \frac{\underline{U}}{\underline{u_s}}$$

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

⚠ $\neq \dfrac{1}{1+jRC\omega}$



$R + \dfrac{1}{jC\omega}$

$$\frac{\underline{U}}{\underline{u_e}} = \frac{\underline{Z_{éq}}}{R + \underline{Z_{éq}}}$$

$$\text{où } \underline{Z_{éq}} = \frac{\left(R + \frac{1}{jC\omega}\right)\frac{1}{jC\omega}}{R + \frac{2}{jC\omega}} = \frac{R + \frac{1}{jC\omega}}{2 + jRC\omega}$$

$$\frac{\underline{U}}{\underline{u_e}} = \frac{\frac{R + \frac{1}{jC\omega}}{2+jRC\omega}}{R + \frac{R + \frac{1}{jC\omega}}{2+jRC\omega}}$$

$$= \frac{R + \frac{1}{jC\omega}}{R(2+jRC\omega) + R + \frac{1}{jC\omega}}$$

$$= \frac{R + \frac{1}{jC\omega}}{3R + jR^2C\omega + \frac{1}{jC\omega}} = \frac{1 + jRC\omega}{1 + 3jRC\omega - R^2C^2\omega^2}$$

d'où $\underline{H} = \frac{1}{\cancel{1+jRC\omega}} \cdot \frac{\cancel{1+jRC\omega}}{1+3jRC\omega - R^2C^2\omega^2}$

$= \frac{1}{1+3jRC\omega - R^2C^2\omega^2}$

posons $\begin{cases} \omega_0 = \frac{1}{RC} \\ x = \frac{\omega}{\omega_0} \end{cases}$

$\underline{H} = \frac{1}{1+3jx-x^2}$

$x \gg 1 \Rightarrow \underline{H} \sim -\frac{1}{x^2}$

$\Rightarrow \begin{cases} G_{dB} = -20\log x^2 = -40\log x \\ \varphi = \pm\pi \text{ car } -\frac{1}{x^2} \in \mathbb{R}_- \end{cases}$

$\sin\varphi = \frac{-3x}{\sqrt{\cdots}} < 0$

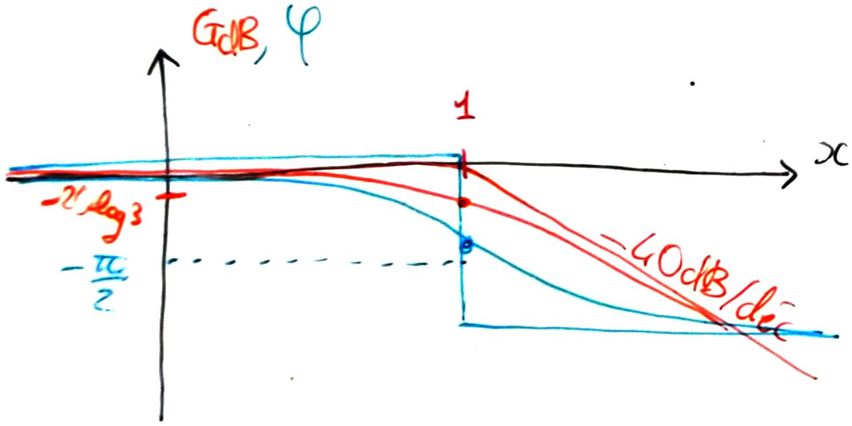
ou : avec $x=1$

$x \ll 1 \Rightarrow \underline{H} \sim 1$

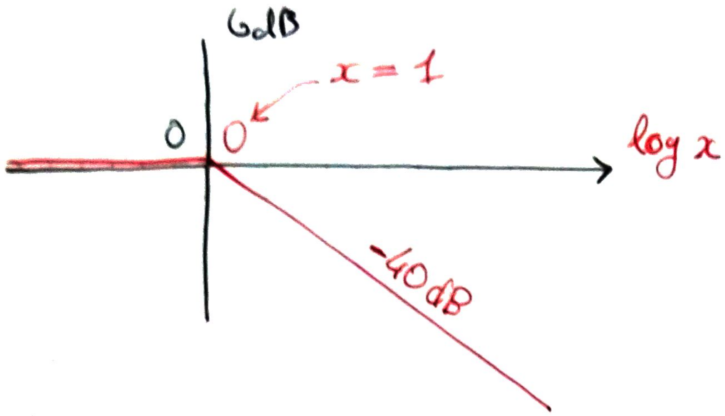
$\Rightarrow \begin{cases} G_{dB} = 0 \\ \varphi = 0 \end{cases}$

$x = 1 \Rightarrow \underline{H} = \frac{1}{\cancel{1}+3j\cancel{-1}} = \frac{1}{3j}$

$\Rightarrow \begin{cases} G_{dB} = -20\log 3 \\ \varphi = -\frac{\pi}{2} \end{cases}$



variante



$$\underline{H} = \frac{1}{1-x^2+3jx} \quad \text{de la forme} \quad \frac{1}{1-x^2+j\frac{x}{Q}} \quad \text{ici } Q = \frac{1}{3}$$

$|\underline{H}|$ admet un max si $Q > \frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2}$

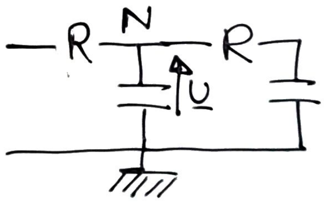
ici, $Q < \frac{\sqrt{2}}{2} \Rightarrow$ pas de max pour $\underline{H}$

pulsation réduite de coupure à -3dB :

$x_c \; / \; |\underline{H}| = \frac{|\underline{H}|_{max}}{\sqrt{2}}$

$$\frac{1}{\sqrt{(1-x^2)^2+9x^2}} = \frac{1}{\sqrt{2}}$$

Meth 2



Meth 2 Théorème de Millmann. (ou $\Leftrightarrow$ances successives)

$$V_N = \underline{U} = \frac{\frac{\underline{U}_e}{R} + 0 \cdot jC\omega + \frac{\underline{U}_s}{R}}{\frac{1}{R} + jC\omega + \frac{1}{R}} \xrightarrow{\cdot R} = \frac{\underline{U}_e + \underline{U}_s}{2+jRC\omega}$$

or $\underline{U_s} = \dfrac{\frac{1}{jC\omega}}{R + \frac{1}{jC\omega}} \underline{U}$

$$\underline{U_s} = \frac{1}{1 + jRC\omega} \underline{U}$$

$$\underline{U_s} = \frac{1}{1+jRC\omega} \cdot \frac{\underline{U_e} + \underline{U_s}}{2 + jRC\omega}$$

$$\underline{U_s}\left(1 - \frac{1}{(1+jRC\omega)(2+jRC\omega)}\right) = \frac{\underline{U_e}}{(1+jRC)(2+jRC\omega)}$$

$$\underline{U_s}\left(\frac{1+3jRC\omega - R^2C^2\omega^2}{\cancel{(1+jRC\omega)(2+jRC\omega)}}\right) = \frac{\underline{U_e}}{\cancel{(1+jRC)(2+jRC\omega)}}$$