Oscillations électriques forcées

Outils

*** Déphasage :** fonction sinusoïdale synchrone (isochrone et en même temps)

$u_1(t) = 4\sin(100\pi t)$

$u_2(t) = 3\sin\left(100\pi t + \frac{\pi}{2}\right)$

$\Delta\varphi$ entre u_1 et u_2 : $\Delta\varphi = \varphi_1 - \varphi_2$

$\Delta\varphi$ entre u_2 et u_1 : $\Delta\varphi = \varphi_2 - \varphi_1$

$\longrightarrow \Delta\varphi = \varphi_2 - \varphi_1 = \frac{\pi}{2}$ rad > 0

u_2 est en avance sur u_1

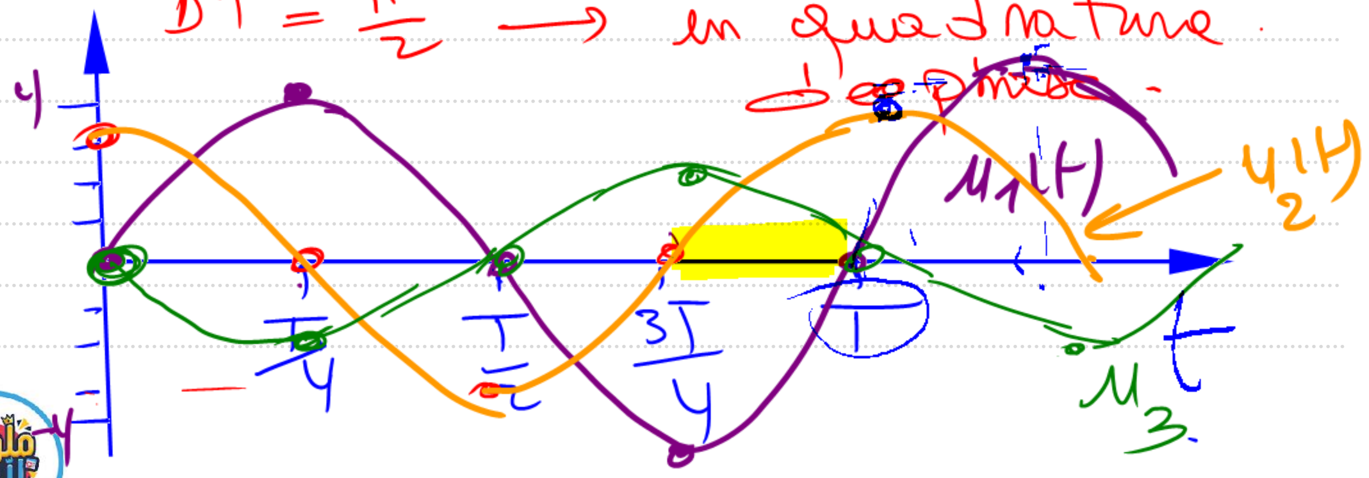
si $\varphi_2 - \varphi_1 > 0 \longrightarrow u_2$ en avance sur u_1

si $\varphi_2 - \varphi_1 < 0 \longrightarrow u_2$ en retard sur u_1

$\Delta\varphi = 0 \longrightarrow$ en phase

$\Delta\varphi = \pi \longrightarrow$ en opposition de phase

$\Delta\varphi = \frac{\pi}{2} \longrightarrow$ en quadrature de phase.



soit $u_B(t) = 2\sin(\omega t + \pi)$

* Decalage Δt

Eap entre u_2 et u_1 $\Delta t = T/4$

soit $w.\Delta t = \frac{2\pi}{\cancel{T}} \cdot \frac{\cancel{T}}{4} = \frac{\pi}{2}$ rad

$= \varphi_2 - \varphi_1$

Generale

$|\varphi_2 - \varphi_1| = \frac{2\pi}{T} \cdot \Delta t \longrightarrow$

$\longrightarrow$ signe.

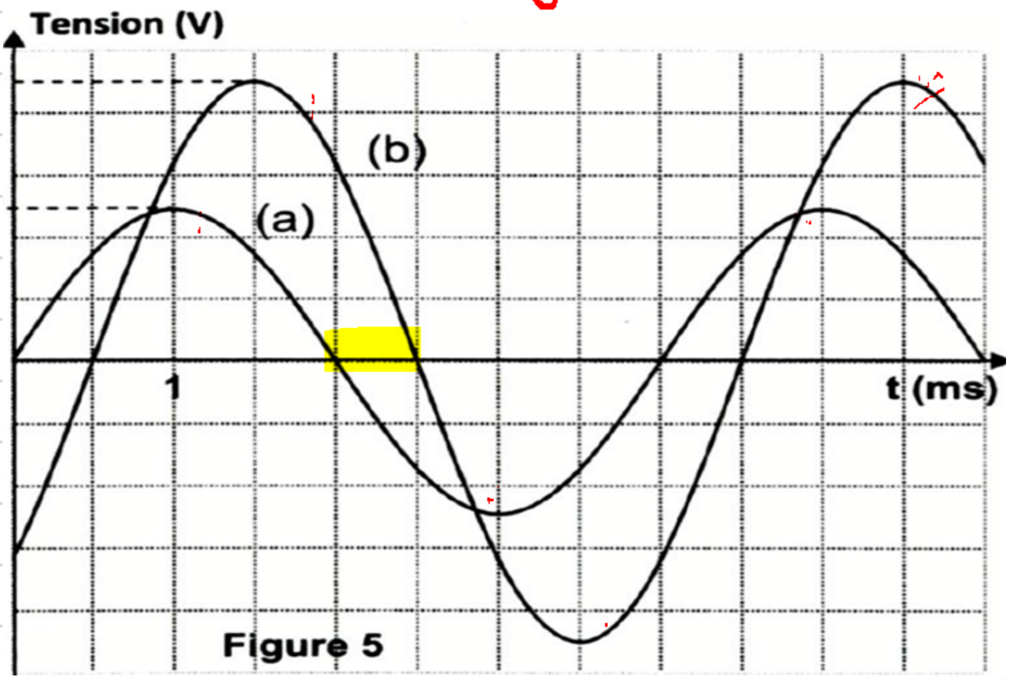


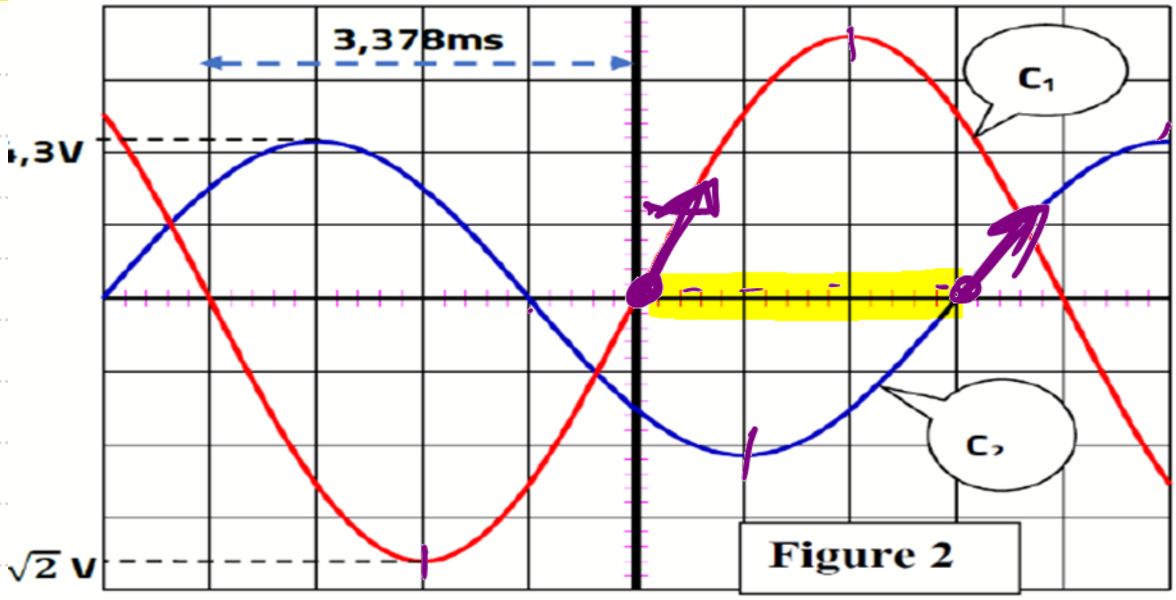
Figure 5

$\Delta t \to 1$ Div

$T \to 8$ Div

$|\varphi_b - \varphi_a| = \frac{2\pi}{T} \times \Delta t = \frac{2\pi}{T} \times \frac{T}{8} = \frac{\pi}{4}$ rad

Or b en retard. $\longrightarrow$ $\boxed{\varphi_b - \varphi_a = -\frac{\pi}{4} \text{ rad}}$



$\varphi_1 - \varphi_2$? $|\varphi_1 - \varphi_2| = \frac{2\pi}{T} \times \frac{3T}{8} = \frac{3\pi}{4}$

or C_1 en avance sur C_2

$\Rightarrow \boxed{\varphi_1 - \varphi_2 = \frac{3\pi}{4} \text{ rad}}$

Construction de Fresnel

Problématique : Math

$u_1 = U_{1m} \sin(\omega t + \varphi_1)$ $u_2 = U_{2m} \sin(\omega t + \varphi_2)$

⊙ si $U_{1m} = U_{2m}$

$u(t) = u_1(t) + u_2(t) = U_m[\sin(a) + \sin(b)]$

th $\sin a + \sin b = 2\cos\left(\frac{a-b}{2}\right) \cdot \sin\left(\frac{a+b}{2}\right)$

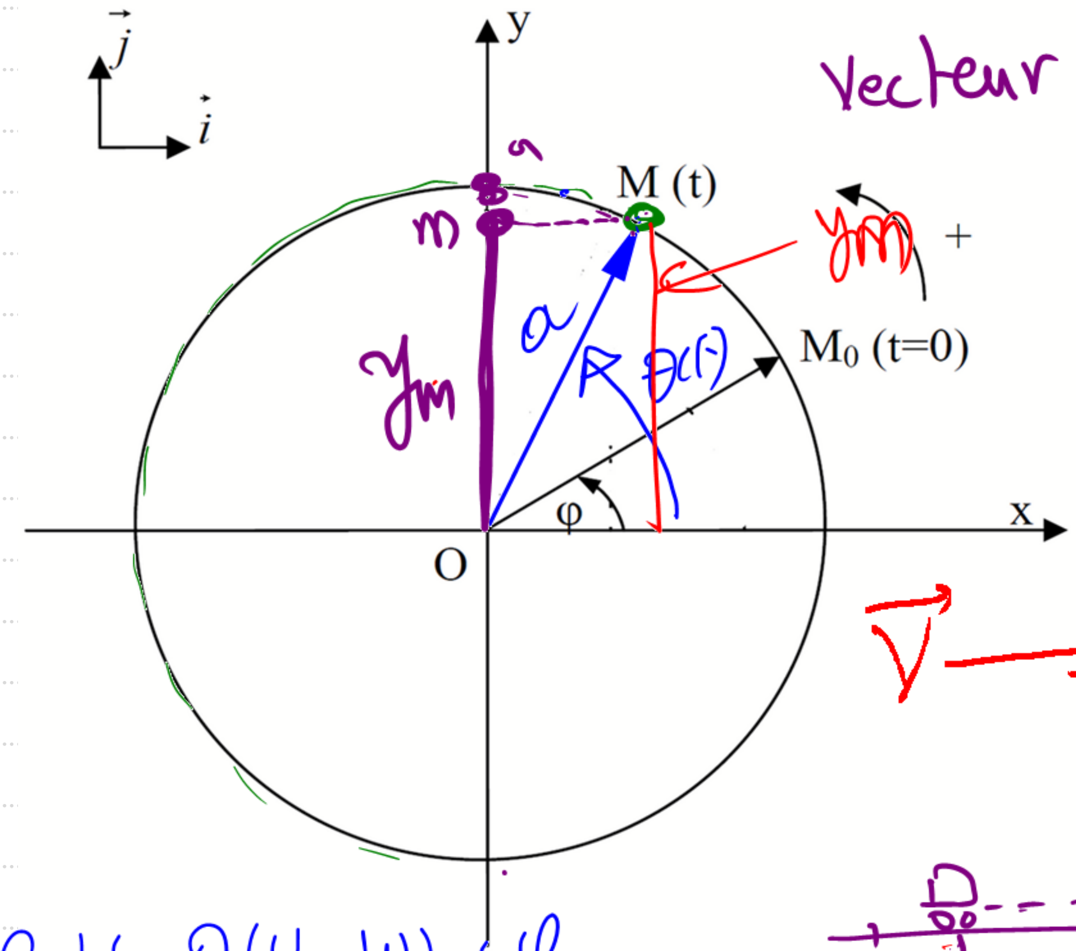
$u(t) = \underbrace{2\cos\left(\frac{\varphi_1 - \varphi_2}{2}\right) U_m}\sin\left(\omega t + \frac{\varphi_1 + \varphi_2}{2}\right)$

$\boxed{u(t) = U_m \sin(\omega t + \varphi)}$

⊙ si $U_{1m} \neq U_{2m}$

$u(t) = u_1(t) + u_2(t) = U_m \sin(\omega t + \varphi)$

Vecteur tournant



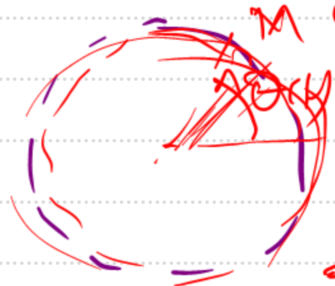
$\vec{V} \longrightarrow f^{e}N$

M.R.U.
$v = c^{te} = v_0$

$x(t) = v_0 t + x_0$

C.U: $\theta(t) = \omega t + \varphi$.

M.C.U
$\dot{\theta} = c^{te}$



$\dfrac{y_m}{a} = \sin(\theta(t))$

$$\boxed{y_m = a \sin(\omega t + \varphi)}$$

$\theta(t) = \dot{\theta} t + \theta_0$

$\theta(t) = \omega t + \varphi$

$\vec{V} \begin{pmatrix} a \\ \varphi \end{pmatrix}$

$u_1(t) \longrightarrow \vec{V}_1 \quad \begin{cases} U_{1m} = 4\ V \\ \varphi_1 = \frac{\pi}{4} \end{cases}$

$u_2(t) \longrightarrow \vec{V}_2 \quad \begin{cases} U_{2m} = 5\ V \\ \varphi_2 = \frac{3\pi}{4} \end{cases}$

$u(t) \longrightarrow \vec{V} \quad \begin{cases} U_m\ ? \\ \varphi\ ? \end{cases}$

$\vec{V} = \vec{V}_1 + \vec{V}_2$

$u(t) = 6,4 \sin(100\pi t + 1,69)$

$180° \longrightarrow \pi$

$97 \longrightarrow ? \qquad \frac{97\pi}{180}$

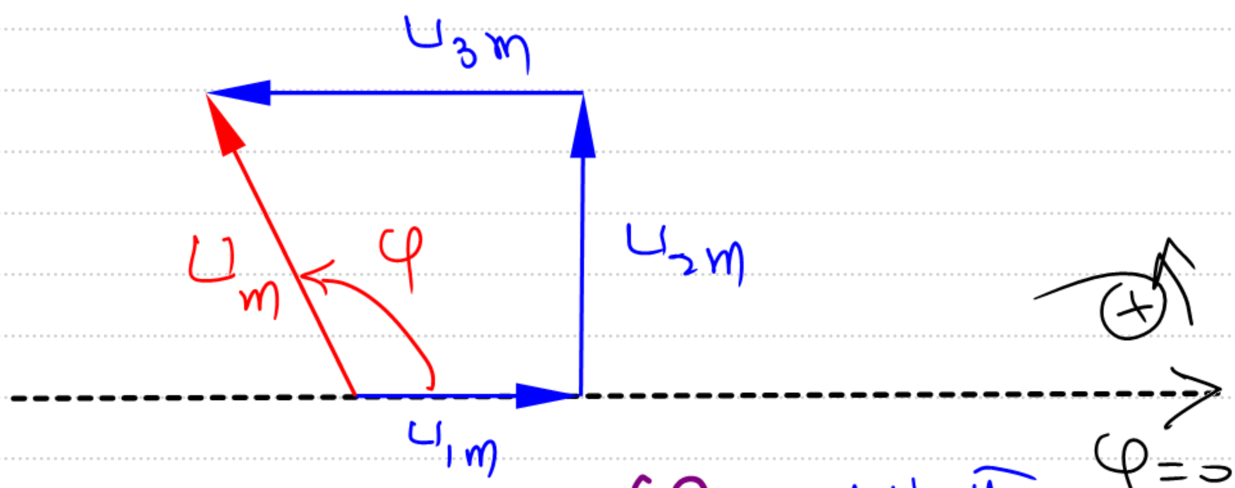
Application

$u_1(t) = 3\sin(50\pi t) \rightarrow \begin{cases} U_{1m} = 3\,V \\ \varphi = 0 \end{cases}$

$u_2(t) = 4\sin(50\pi t + \frac{\pi}{2}) \rightarrow \begin{cases} U_{2m} = 4\,V \\ \varphi_2 = \frac{\pi}{2} \end{cases}$

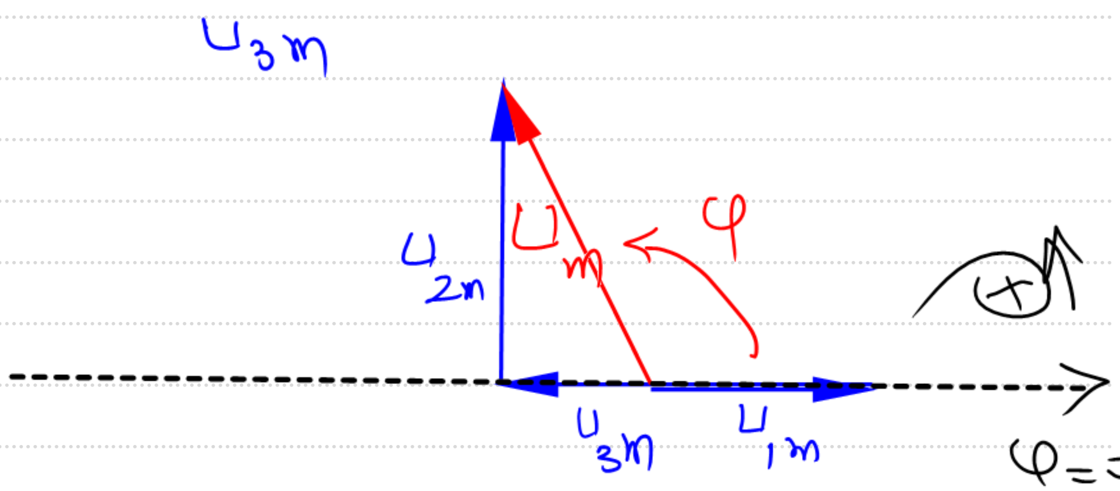
$u_3(t) = 5\sin(50\pi t + \pi) \rightarrow \begin{cases} U = 5\,V \\ \pi \end{cases}$

? $u(t) = u_1(t) + u_2(t) + u_3(t) = U_m \sin(50\pi t + \varphi)$



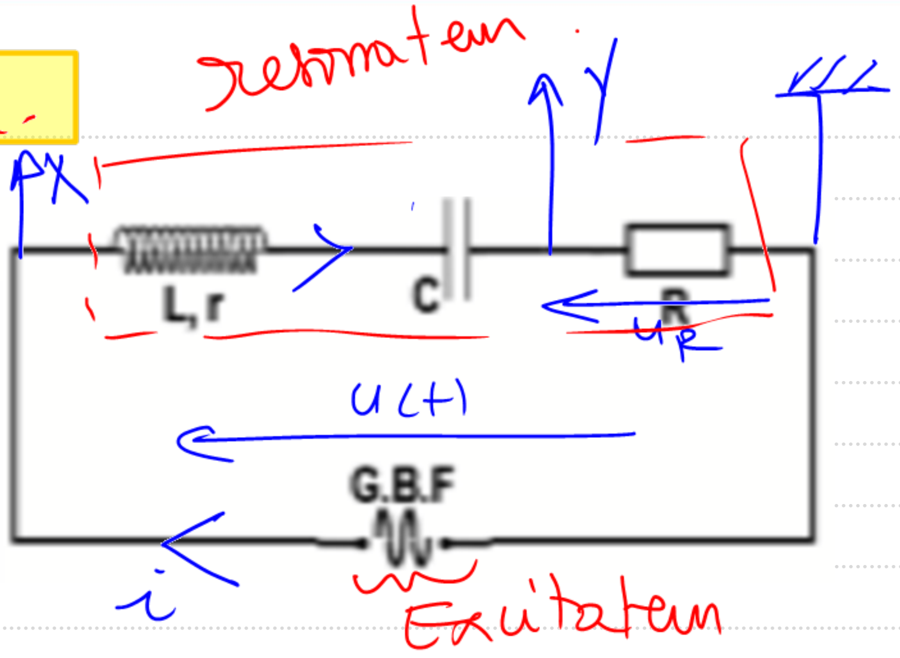
$U_m = 4{,}5\,V \quad , \quad \varphi_u = \frac{116\,\pi}{180}\ rad.$

$$\boxed{u(t) = 4{,}5\sin(50\pi t + 2{,}02)}$$



Exercice.

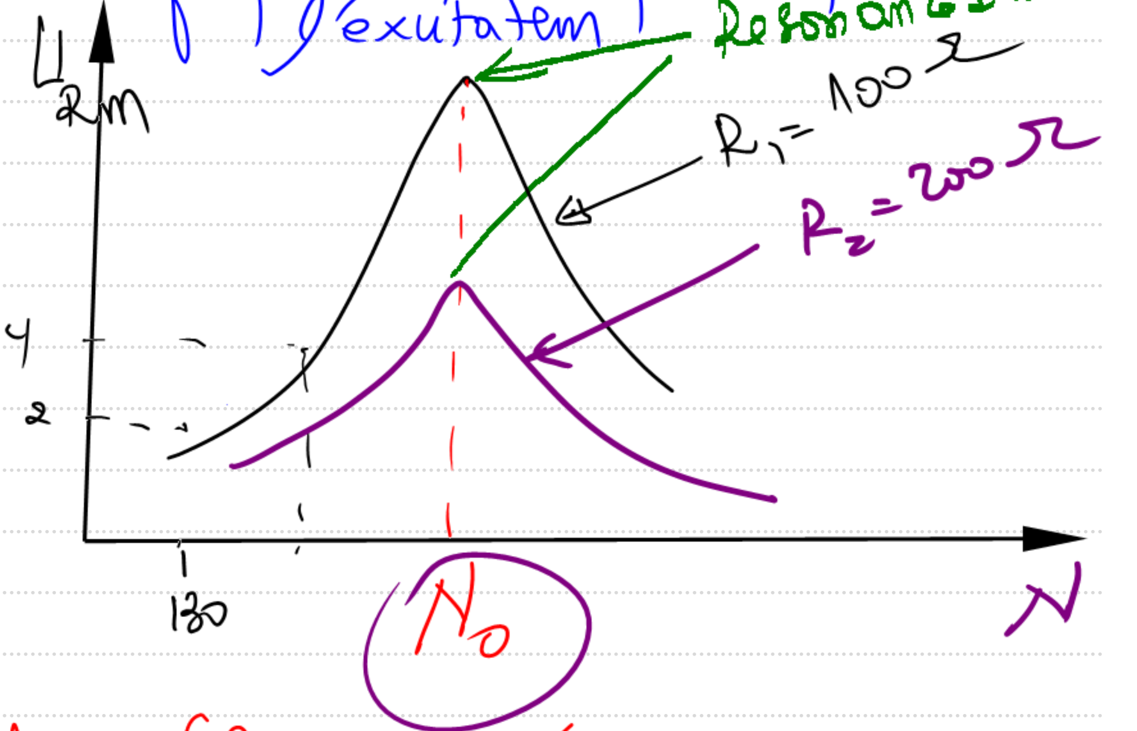
1°)



2) Excitateur ⟶ GBF
Résonateur ⟶ dipôle R, L, C

3°) Car la fréquence est imposée par l'excitateur

Cours

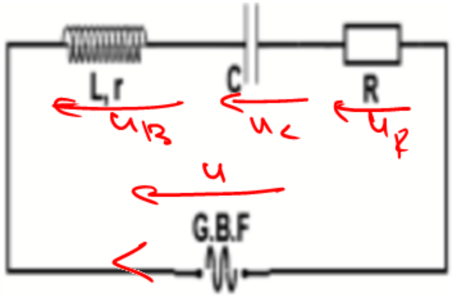


Si $N < N_0$ $\varphi_u - \varphi_i < 0$

Si $N = N_0$ $\varphi_u - \varphi_i = 0$

Si $N > N_0$ $\varphi_u - \varphi_i > 0$

4°/



Loi des mailles

$u_R(t)+u_B(t)+u_C(t)-u(t)=0$

$(R+r)i(t)+L\frac{di}{dt}+\frac{1}{C}q(t)=u(t)$

$i=\frac{dq}{dt} \Rightarrow q=\int i\,dt$

$$\boxed{(R+r)i(t)+L\frac{di(t)}{dt}+\frac{1}{C}\int i(t)\,dt=u(t)}$$

$i(t)=I_m\sin(\omega t+\varphi_i)$

$(\sin(at+b))'=a\cos(at+b)=a\sin(at+b+\frac{\pi}{2})$

$\int\sin(at+b)=-\frac{1}{a}\cos(at+b)=\frac{1}{a}\sin(at+b-\frac{\pi}{2})$

5°/ a) $(R+r)i(t)=(R+r)I_m\sin(\omega t+\varphi_i)\rightarrow\vec{V}_1\begin{vmatrix}(R+r)I_m\ (V)\\ \varphi_i\end{vmatrix}$

$L\frac{di}{dt}=L\omega I_m\sin(\omega t+\varphi_i+\frac{\pi}{2})\rightarrow\vec{V}_2\begin{vmatrix}L\omega I_m\\ \varphi_i+\frac{\pi}{2}\end{vmatrix}$

$\frac{1}{C}\int i(t)=\frac{1}{C}(-\frac{I_m}{\omega}\cos(\omega t+\varphi_i))$

$=\frac{I_m}{C\omega}\sin(\omega t+\varphi_i-\frac{\pi}{2})\rightarrow\vec{V}_3\begin{vmatrix}\frac{I_m}{C\omega}\ (V)\\ \varphi_i-\frac{\pi}{2}\end{vmatrix}$

U_{Cm}

$u(t)=U_m\sin(\omega t)\rightarrow\begin{pmatrix}U_m\\ 0\end{pmatrix}$

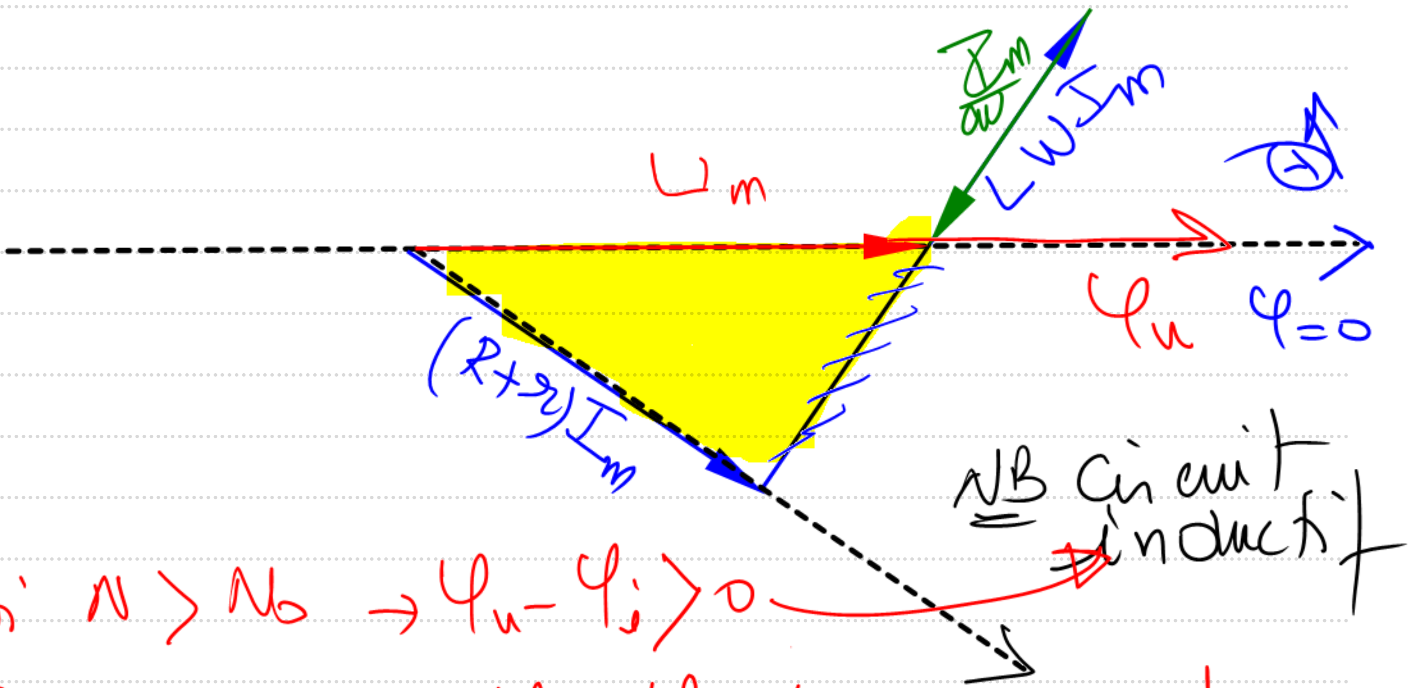
$\boxed{N > N_0} \Rightarrow \omega > \omega_0 \longrightarrow \omega^2 > \frac{1}{LC}$

$L\omega > \frac{1}{C\omega}$

$\varphi_u - \varphi_i > 0$

$\varphi_u > \varphi_i \rightarrow \varphi$.

0



NB Circuit inductif

si $N > N_0 \rightarrow \varphi_u - \varphi_i > 0$

si $N < N_0 \longrightarrow \varphi_u - \varphi_i < 0 \longrightarrow$ Circuit capacitif

si $N = N_0 \longrightarrow \varphi_u - \varphi_i = 0 \longrightarrow$ Circuit résistif

b) Pythagor $(R+r)^2 I_m^2 + \left(L\omega I_m - \frac{I_m}{C\omega}\right)^2 = U_m^2$

$I_m^2 \left[(R+r)^2 + \left(L\omega - \frac{1}{C\omega}\right)^2\right] = U_m^2$

$$\boxed{I_m = \frac{U_m}{\sqrt{(R+r)^2 + \left(L\omega - \frac{1}{C\omega}\right)^2}}}$$

Voltmetre → $U_{(\text{efficace})} = \dfrac{U_m}{\sqrt{2}}$ ← Courbe

Amperemetre → $I_{(\text{efficace})} = \dfrac{I_m}{\sqrt{2}}$ ← Courbe

c) L'impedance Z :

$$(\Omega)\quad Z = \frac{U\,(V)}{I\,(A)} = \frac{U_m}{I_m}$$

$$\boxed{Z = \sqrt{(R+r)^2 + \left(L\omega - \frac{1}{C\omega}\right)^2}}$$

Impedance du dipole R,L,C

AB

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

$$Z_R = \underbrace{R}_{\Omega}$$

$$Z_C = \underbrace{\frac{1}{C\omega}}_{\Omega} = \frac{U_{Cm}}{I_m}$$

$$Z_B = \sqrt{r^2 + (L\omega)^2} = \frac{U_{Bm}}{I_m}$$

$$Z_{B-C} = \sqrt{r^2 + \left(L\omega - \frac{1}{C\omega}\right)^2} = \frac{U_{BCm}}{I_m}$$

$$tg(\varphi_u-\varphi_i)=\frac{L\omega-\frac{1}{C\omega}}{R+r}$$

HN