Classe : 4ème Math (Gr standard)

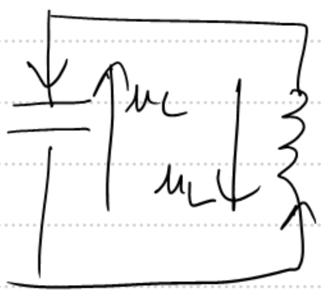
Série 16 oscillations électriques libre

Non amorti

Prof : Karmous Med

Exercice 1

1)



loi des mailles

$u_C + u_L = 0$

$u_C + L\frac{di}{dt} = 0$ or $i = C\frac{du_C}{dt}$

$\frac{di}{dt} = C\frac{d^2u_C}{dt^2}$

$u_C + LC\frac{d^2u_C}{dt^2} = 0$

$\frac{d^2u_C}{dt^2} + \frac{1}{LC}u_C = 0$ or $N_0 = \frac{1}{2\pi\sqrt{LC}}$

$N_0^2 = \frac{1}{4\pi^2 LC}$

$\frac{1}{LC} = 4\pi^2 N_0^2$

$$\frac{d^2u_C}{dt^2} + 4\pi^2 N_0^2 u_C = 0$$

②

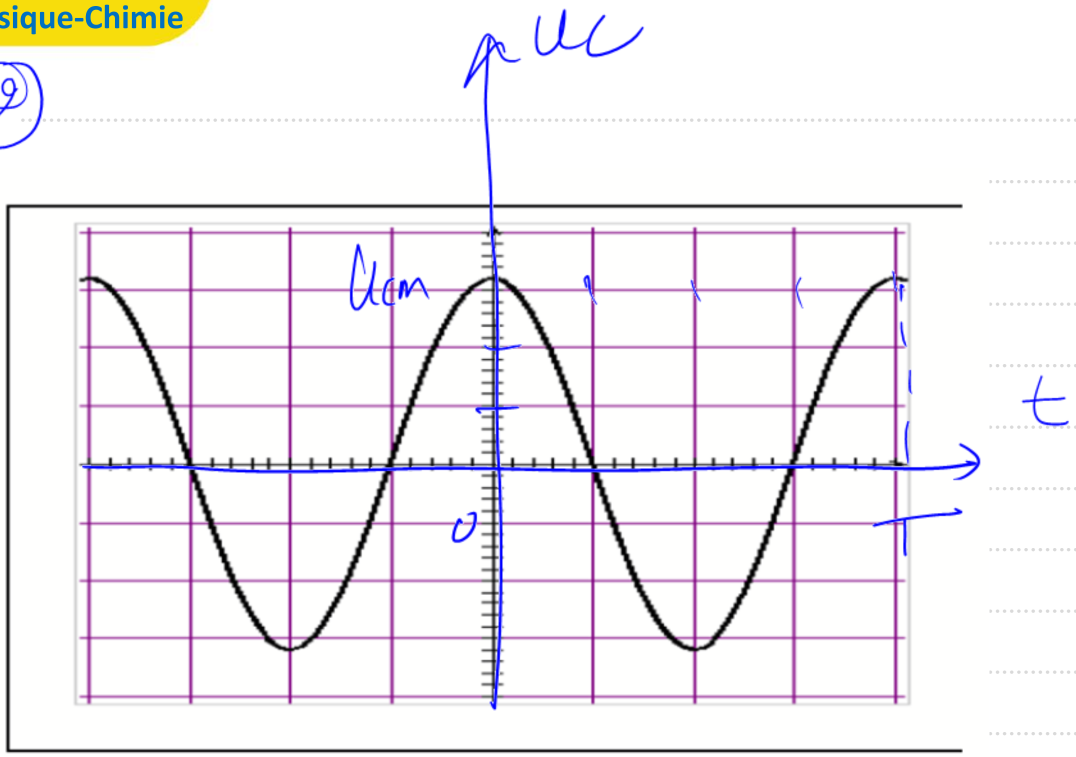


Figure-1

$U_{cm} = 3,2 \times 1 = 3,2V$

$\boxed{N_0 =} \frac{1}{T_0} = \frac{1}{4 \times 10^{-3}} = \boxed{250 Hz}$

ⓑ $\frac{1}{LC} = 4\pi^2 N_0^2 \Rightarrow 4\pi^2 LC N_0^2 = 1$

$C = \frac{1}{4\pi^2 L N_0^2} = \frac{1}{4\pi^2 \times 0,22 \times 250^2}$

$\boxed{C = 1,84\ 10^{-6} F}$

③ $u_B(t) + u_C = 0 \Rightarrow u_B(t) = -u_C(t)$

$u_B(t) = u_L = -U_{cm} \sin(\omega_0 t + \varphi_{uc})$

$u_B(t) = -3{,}2\sin(2\pi N_0 t + \frac{\pi}{2})$

$\sin(x+\pi) = -\sin x$

$u_B(t) = 3{,}2\sin(500\pi t + \pi + \frac{\pi}{2})$

$u_B(t) = 3{,}2\sin(500\pi t - \frac{\pi}{2})$ en V

4) $E = \frac{1}{2}Cu_C^2 + \frac{1}{2}Li^2$

$\frac{dE}{dt} = \frac{1}{\cancel{2}} \times \cancel{2}C\frac{du_C}{dt}u_C + \frac{1}{\cancel{2}}L\cdot\cancel{2}\frac{di}{dt}i$

$= \underbrace{C\frac{du_C}{dt}}_{i}u_C + L\frac{di}{dt}i$

$= i\,[\underbrace{u_C + L\frac{di}{dt}}_{=0}] = 0$

$E = \text{cont} = E_{C\max} = \frac{1}{2}CU_m^2$

$= \frac{1}{2}LI_m^2$

$E = \frac{1}{2}\, 1{,}84\,10^{-6} \times (3{,}2)^2$

$E = 9{,}42\,10^{-6}\,J$

Exercice 2

1°) **(K)** est sur la position **(1)**. Préciser la valeur que prend le courant délivré par le générateur à la fin de l'opération de charge. Quelle tension existe alors aux bornes du condensateur ?

- fin de charge de Condensateur $\Leftrightarrow u_C = E = \text{cst}$

$\Leftrightarrow \frac{du_C}{dt} = 0 \Leftrightarrow i = 0 \quad \Leftrightarrow u_C = E = 6V$

2°) A cet instant, que l'on choisira comme origine de temps, on commute **(K)** en position **(2)** **l'**energie electrostatique est maximale et égale **18µj**

Etablir l'équation différentielle régissant l'évolution de la tension de la bobine u_L au cours du temps.

d'après la loi des maille on a

$u_L + u_C = 0$

$\frac{du_L}{dt} + \frac{du_C}{dt} = 0 \quad$ or $i = C\frac{du_C}{dt}$

$\frac{du_L}{dt} + \frac{i}{C} = 0 \quad$ or $u_L = L\frac{di}{dt}$

$\frac{di}{dt} = \frac{u_L}{L}$

$\frac{d^2u_L}{dt^2} + \frac{1}{C}\frac{di}{dt} = 0$

$\frac{d^2u_L}{dt^2} + \frac{1}{C} \cdot \frac{u_L}{L} = 0$

$\Leftrightarrow$

$\frac{d^2u_L}{dt^2} + \frac{1}{LC}u_L = 0$

2ème méth $u_C + u_L = 0$

$$\frac{q}{C} + u_L = 0$$

$$\frac{1}{C}\frac{dq}{dt} + \frac{du_L}{dt} = 0$$

$$\frac{i}{C} + \frac{du_L}{dt} = 0$$

$$\frac{1}{C}\frac{di}{dt} + \frac{d^2u_L}{dt^2} = 0$$

$$\frac{di}{dt} = \frac{u_L}{L}$$

$$\Leftrightarrow \frac{1}{C}\cdot\frac{u_L}{L} + \frac{d^2u_L}{dt^2} = 0$$

$$\boxed{\frac{d^2u_L}{dt^2} + \frac{1}{LC}u_L = 0}$$

Rq $u_L = L\frac{di}{dt}$, $e = -L\frac{di}{dt}$

$$u_L = -e$$

$$\frac{d^2}{dt^2}(-e) + \frac{1}{LC}(-e) = 0$$

$$\frac{d^2 e}{dt^2} + \frac{1}{LC} e = 0$$

3

$$u_L(t) = U_{Lmax} \sin(\omega_0 t + \varphi_{uL})$$

$$\frac{du_L}{dt} = \omega_0 U_{Lm} \cos(\omega_0 t + \varphi_{uL})$$

$$\frac{d^2 u_L}{dt^2} = -\omega_0^2 U_{Lm} \sin(\omega_0 t + \varphi_{uL})$$

$$\frac{d^2 u_L}{dt^2} + \frac{1}{LC} u_L = 0$$

$$-\omega_0^2 U_{Lm} \sin(\omega_0 t + \varphi_{uL}) + \frac{1}{LC} U_{Lm} \sin(\omega_0 t + \varphi_{uL}) = 0$$

$$\underbrace{U_{Lmax} \sin(\omega_0 t + \varphi_{uL})}_{\neq 0} \left[-\omega_0^2 + \frac{1}{LC}\right] = 0$$

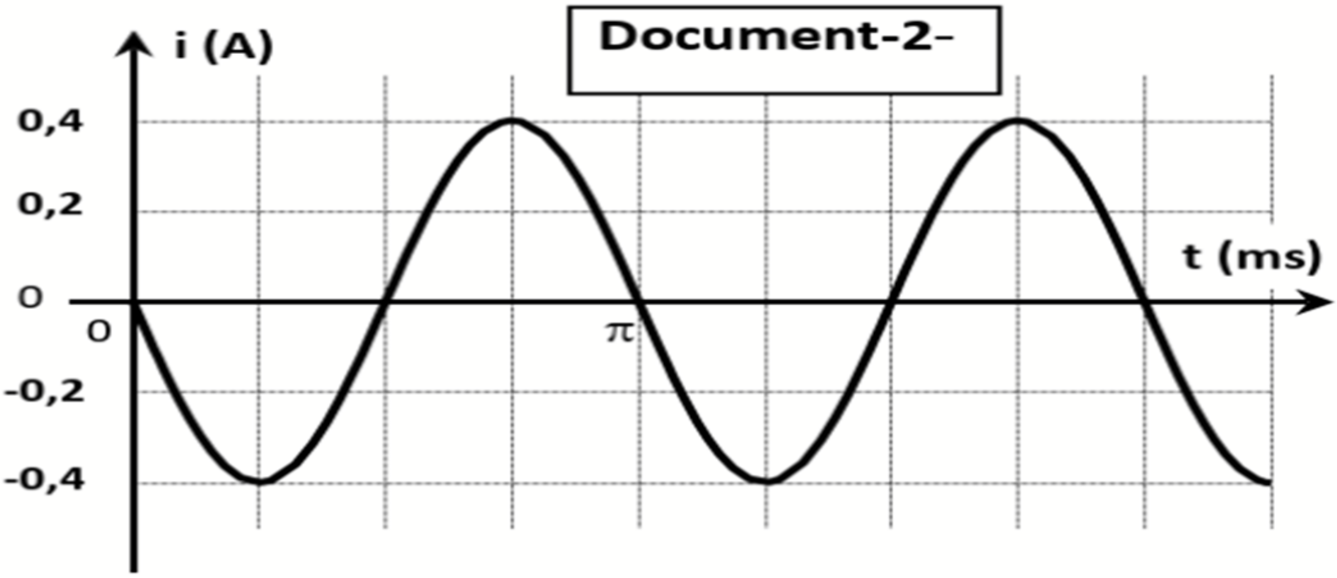
$$\Leftrightarrow -\omega_0^2 + \frac{1}{LC} = 0 \Leftrightarrow \omega_0^2 = \frac{1}{LC}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{2\pi}{T_0}$$

$$T_0 = 2\pi \sqrt{LC}$$

4

4



$I_{max} = 0,4A$

Comme les oscillations électriques sont libre non amortie ⇒ il y a conservation d'energie ⇒ $E = E_{c\,max}$

$E = E_e + E_L$

$E = \frac{1}{2} C u_c^2 + \frac{1}{2} L i^2$

$\frac{dE}{dt} = 0 \Leftrightarrow E = \text{cont} \longrightarrow$ oscillations libre non amortie ⇔ $E = \text{cont}$

$E = E_{L\,max} = E_{C\,max}$

$E = \frac{1}{2} L I_m^2$

$$2E = L I_m^2$$

$$L = \frac{2E}{I_m^2} = \frac{2 \times 18 \times 10^{-6}}{(4\,10^{-1})^2}$$

$$\boxed{L = 2{,}25\ 10^{-4}\ H}$$

$$\boxed{T_0 = \pi\ 10^{-3}\ s}$$

$$T_0 = 2\pi \sqrt{LC}$$

$$T_0^2 = 4\pi^2 LC \Rightarrow C = \frac{T_0^2}{4\pi^2 L}$$

$$C = \frac{\cancel{\pi^2}\ 10^{-6}}{4\cancel{\pi^2} \times 2{,}25\ 10^{-4}}$$

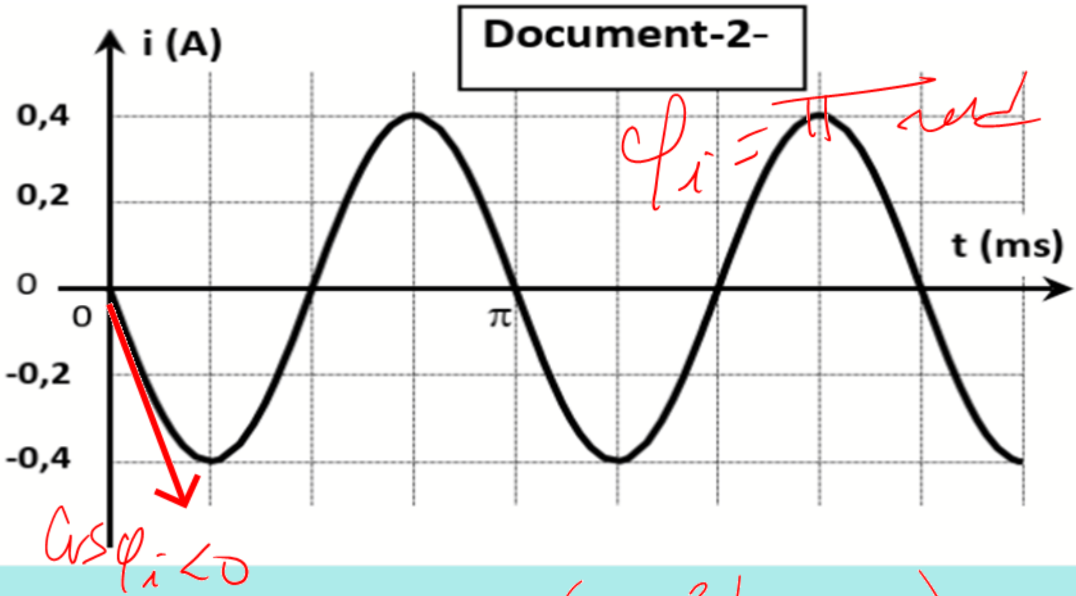
$$\boxed{C = 1{,}1\ 10^{-3}\ F}$$

e) $i(t) = I_{max} \sin(\omega_0 t + \varphi_i)$

$$\begin{cases} I_m = 0{,}4\ A \\ \omega_0 = \frac{2\pi}{T_0} = \frac{2\cancel{\pi}}{\cancel{\pi}\,10^{-3}} = 2 \times 10^3\ rad\,s^{-1} \end{cases}$$

$t = 0$ on $i(0) = I_m \sin\varphi_i = 0$

$$\begin{cases} \sin\varphi_i = 0 \\ \text{et } \cos\varphi_i < 0 \end{cases} \Rightarrow \boxed{\varphi_i = \pi\ rad}$$



$i(t) = 0{,}4 \sin(2\,10^3 t + \pi)$ en A

$q(t) = Q_m \sin(\omega_0 t + \varphi_q)$

Q_m ?

$I_m = \omega_0 Q_m \Leftrightarrow Q_m = \frac{I_m}{\omega_0}$

$Q_m = \frac{0{,}4}{2\,10^3} = 0{,}2\,10^{-3}$ C

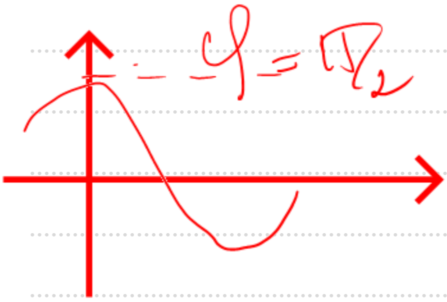
$Q_m = 2\,10^{-4}$ C

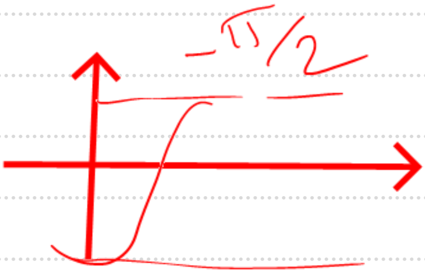
$i = \frac{dq}{dt} \Leftrightarrow \varphi_i = \varphi_q + \pi/2$

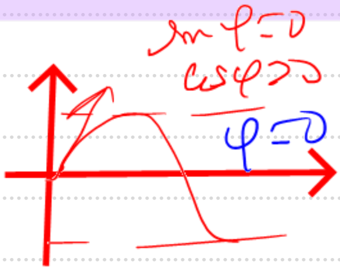
$\varphi_q = \varphi_i - \pi/2 = \pi - \pi/2$

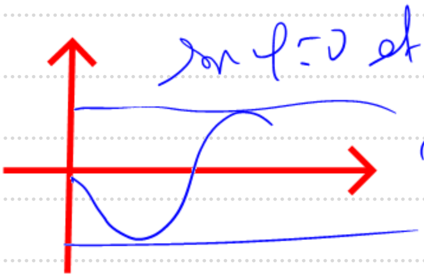
$\varphi_q = \pi/2$ rad

$q(t) = 2\cdot10^{-4}\sin(2\cdot10^{3}t + \pi/2)$ en C









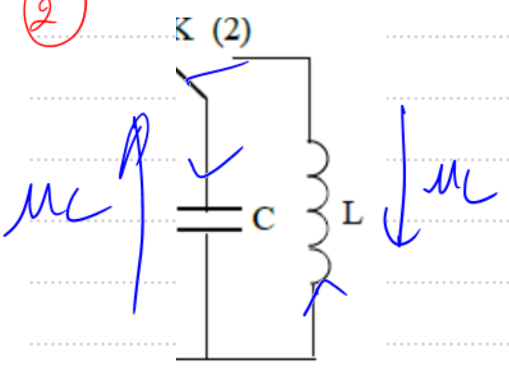
$\Rightarrow \varphi = \pi$

Exercice 3

1) $E_0 = \frac{1}{2} C U_0^2$

position (1) charge du condensateur $u_C = E$ à la fin

2)



gure -4-

$u_L + u_C = 0$

$L\frac{di}{dt} + \frac{q}{C} = 0$

or $i = \frac{dq}{dt}$

$\frac{di}{dt} = \frac{d^2q}{dt^2}$

$L\frac{d^2q}{dt^2} + \frac{1}{C}q = 0$

$$\frac{d^2q}{dt^2} + \frac{1}{LC}q = 0$$

$$\begin{cases} I_m = I\sqrt{2} \Rightarrow I_{eff} = \dfrac{I_m}{\sqrt{2}} \\ U_m = U\sqrt{2} \Rightarrow U = \dfrac{U_m}{\sqrt{2}} \end{cases}$$

Amp

Voltmetre.

3) a- Donner l'expression de l'énergie électrique totale **E** emmagasinée dans le circuit **LC** en fonction de **q, i, L** et **C.**

$$E = E_e + E_L = \frac{1}{2}\frac{q^2}{C} + \frac{1}{2}Li^2$$

b/ $$\frac{dE}{dt} = \frac{1}{\cancel{2}C}\cancel{2}\frac{dq}{dt}q + \frac{1}{\cancel{2}}L\cdot\cancel{2}i\frac{di}{dt}$$

$$\frac{dE}{dt} = \frac{q}{C}\boxed{\frac{dq}{dt}} + \boxed{i}\frac{di}{dt} \times L$$

$$i\underbrace{\left[\frac{q}{C} + L\frac{di}{dt}\right]}_{\text{loi des maille}} = 0$$

$$E = \text{Cont} \Rightarrow \boxed{E \text{ se conserve}}$$

(4) $E = E_C + E_L = \text{Cont} = E_0$

$E_C = E_0 - E_L$ or $E_L = \frac{1}{2}Li^2$

$$\boxed{E_C = E_0 - \frac{1}{2}Li^2}$$

5) Une étude expérimentale permet de tracer la courbe ci-contre **(voir figure -5-)** .

a- Déterminer à partir de la courbe :

_ la valeur de l'inductance **L** ;

_ la valeur maximale $\mathbf{I_m}$ de l'intensité de courant.

b- Déterminer la période propre $\mathbf{T_0}$ de l'oscillateur

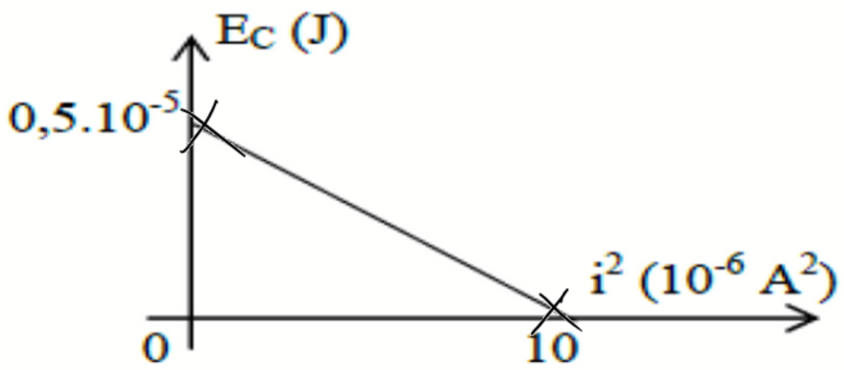


Figure -5-

$$E_C = E_0 - \frac{1}{2} L i^2$$

$$E_C = -\frac{1}{2} L i^2 + E_0$$

pente

$$E_C = a i^2 + b \quad \text{avec} \quad \begin{cases} a = -\frac{1}{2} L \\ b = E_0 \end{cases}$$

ordonné à l'origin.

$$a = \frac{0 - 0{,}5\,10^{-5}}{(10 - 0)\,10^{-6}} = \frac{-0{,}5\,\cancel{10^{-5}}}{\cancel{10^{-5}}}$$

$$\boxed{a = -0{,}5\ J\ A^{-2} = -\frac{1}{2} L}$$

$$L = 1\ H$$

$I_m^2 = 10\ 10^{-6}\ A$

$I_m > 0 \Leftrightarrow I_m = \sqrt{10\ 10^{-6}}$

$I_m = 3,16\ 10^{-3}\ A$

Verif

$E_0 = cst = \frac{1}{2} L I_m^2$

$2E_0 = L I_m^2$ avec $E_0 = 5 = 0,5\ 10^{-5}\ J$

$I_m^2 = \frac{2E_0}{L} = \frac{10^{-5}}{1} = 10^{-5}\ A^2$

$I_m = \sqrt{10^{-5}} = 3,16\ 10^{-3}\ A$

b- Déterminer la période propre T_0 de l'oscillateur

$T_0 = 2\pi\sqrt{LC}$

$T_0 = 2\pi\sqrt{1 \times 0,1\ 10^{-6}}$

$T_0 = 2\ 10^{-3}\ s$

c) $I_m = ?\ \sqrt{\frac{C}{L}} \cdot U_0$

$$I_m = \omega_0 Q_m = \omega_0 C U_{Cm}$$

$$I_m = \omega_0 . C . U_0$$

$$I_m = \frac{1}{\sqrt{LC}} C . U_0$$

$$I_m = \frac{1}{\sqrt{LC}} \sqrt{C^2} U_0$$

$$I_m = \frac{\sqrt{C^2}}{\sqrt{LC}} U_0$$

$$I_m = \sqrt{\frac{C^{\cancel{2}}}{L\cancel{C}}} U_0$$

$$\boxed{I_m = \sqrt{\frac{C}{L}} U_0}$$

2 meth

$$E = \text{cst}$$

$$E = E_e = E_L$$

$$\frac{1}{2} C U_0^2 = \frac{1}{2} L I_m^2$$

$C U_0^2 = L I_m^2$

$I_m^2 = \frac{C}{L} U_0^2$

$$I_m = \sqrt{\frac{C}{L}} U_0$$

3meth

$\mathbf{E_C = E_0 - \frac{1}{2} L i^2}$

si $i = I_m$ alors $E_C = 0$

$E_0 - \frac{1}{2} L I_m^2 = 0$

$E_0 = \frac{1}{2} L I_m^2$

$\cancel{\frac{1}{2}} C U_0^2 = \cancel{\frac{1}{2}} L I_m^2$

$$I_m = \sqrt{\frac{C}{L}} U_0$$

$$I_m = \left(\sqrt{\frac{C}{L}}\, U_0\right) \times \sqrt{\frac{L}{C}}$$

$$\sqrt{\frac{L}{C}}\, I_m = U_0$$

$$\boxed{U_0 =} \sqrt{\frac{1}{0{,}1\,10^{-6}}} \times 3{,}16\,10^{-3} = \boxed{10V}$$

6) Déterminer alors l'expression de la charge **q(t)** .

$$q(t) = Q_m \sin(\omega_0 t + \varphi_q)$$

$$\begin{cases} Q_m = C\,U_{cm} = C\,U_0 = 0{,}1 \times 10^{-6} \times 10 = 10^{-6}\,C \\ \omega_0 = \frac{2\pi}{T_0} = \frac{\cancel{2}\pi}{\cancel{2}\,10^{-3}} = 10^{3}\,\pi\ rad\,s^{-1} \end{cases}$$

$t = 0 \quad q(0) = \cancel{Q_m} \sin\varphi_q = \cancel{Q_m}$

$\sin\varphi_q = 1 \Leftrightarrow \varphi_q = \frac{\pi}{2}\ rad$

$$\boxed{q(t) = 10^{-6} \sin\left(\pi \times 10^{3} t + \frac{\pi}{2}\right) \text{ en } C}$$

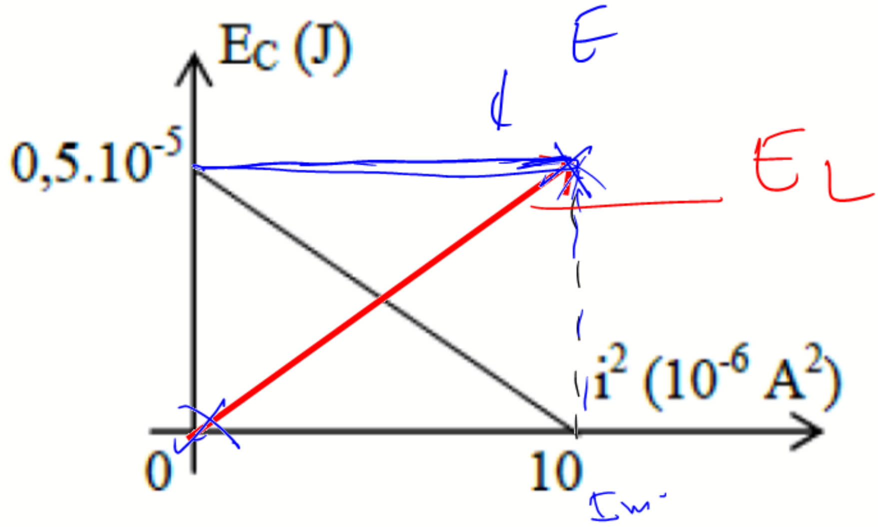


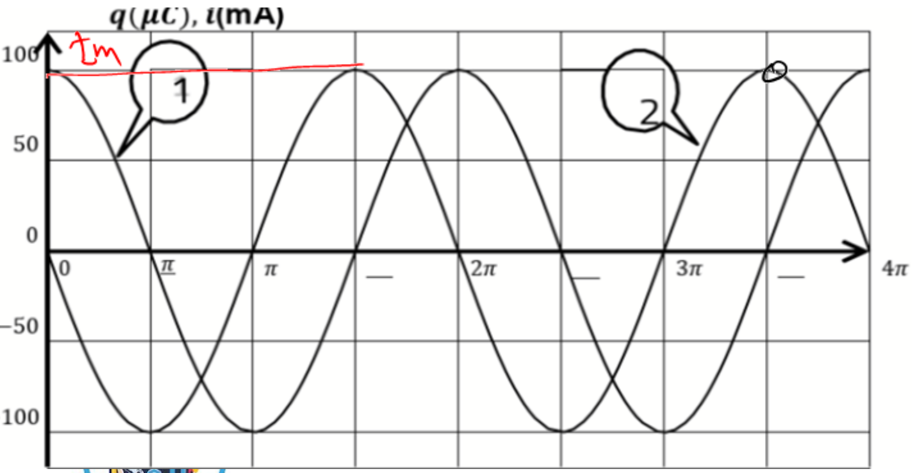
Figure -5-

$E = \text{Const}$

$E_L = \frac{1}{2} L i^2 \Leftrightarrow E_L = f(i^2)$ est une droite linéaire

i^2	0	I_m^2
E_L	0	$\frac{1}{2} L I_m^2 = E_T$

Exercice 4



① 1 meth

$t = 0 \quad u_C(0) = U_{Cm}$

$\Leftrightarrow q(0) = Q_m$

$i = 0 = \frac{dq}{dt}$

② → i

① → $q(t)$

2 meth $\quad i = \frac{dq}{dt} \Rightarrow \varphi_i = \varphi_q + \frac{\pi}{2}$

i (t) est en quadrature avance par rapport à q (t) donc i (t) atteint son max, son min avant q (t)

② atteint son max avant ①

② — i

① — q (t)

$I_m = 100 \, mA$

$Q_m = 100 \, \mu C$

$Q_m = C U_m = C E$

$$C = \frac{Q_m}{E} = \frac{100 \cdot 10^{-6}}{20} = 5 \cdot 10^{-6} F$$

$$\boxed{C = 5 \, \mu F}$$

② voir cours

$$\frac{d^2q}{dt^2} + \frac{1}{LC} q = 0$$

b) $q(t) = Q_m \sin(\omega_0 t + \varphi_q)$

$$\frac{dq}{dt} = \omega_0 Q_m \cos(\omega_0 t + \varphi_q)$$

$$\frac{d^2q}{dt^2} = -\omega_0^2 Q_m \sin(\omega_0 t + \varphi_q)$$

donc l'éq diff ?

$$\frac{d^2q}{dt^2} + \frac{1}{LC} q = 0 \quad \text{avec } \omega_0^2 = \frac{1}{LC}$$

$$\frac{d^2q}{dt^2} + \omega_0^2 q = \cancel{-\omega_0^2 Q_m \sin(\omega_0 t + \varphi_q)} + \cancel{\omega_0^2 Q_m \sin(\omega_0 t + \varphi_q)} = 0$$

donc $\boxed{\frac{d^2q}{dt^2} + \omega_0^2 q = 0}$ $\Rightarrow$ q(t) est une solution

c) $\omega_0 = \frac{2\pi}{T_0} = \frac{1}{\sqrt{LC}}$

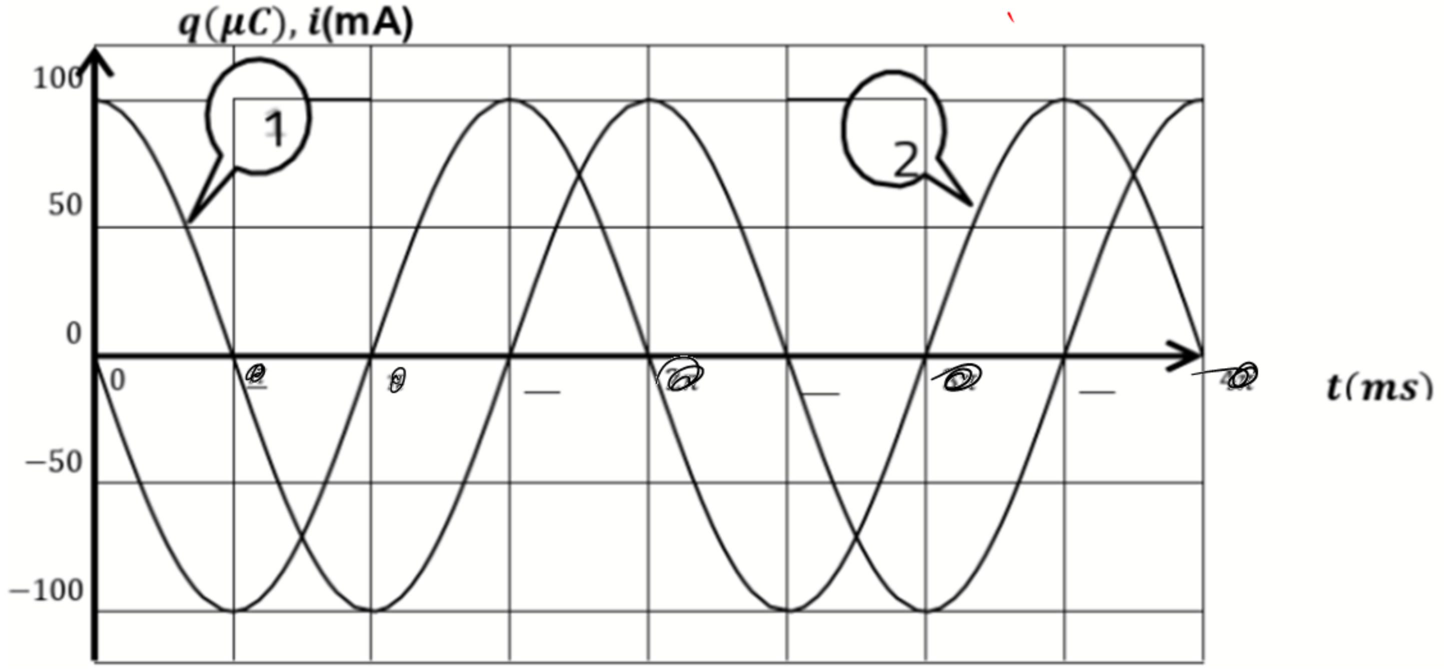
$\Rightarrow T_0 = 2\pi\sqrt{LC}$

$T_0^2 = 4\pi^2 LC \Rightarrow \boxed{L = \frac{T_0^2}{4\pi^2 C}}$

avec $T_0 = 2\pi\, 10^{-3}$ s

$$L = \frac{(2\pi \times 10^{-3})^2}{4\pi^2 \times 5\, 10^{-6}} = 0{,}2\ H$$

Rq



$I_m = 100\ mA = 100\ 10^{-3} A$

$Q_m = 100\ \mu C = 100\ 10^{-6} C$

$I_m = \omega_0 Q_m = \frac{2\pi}{T_0} \cdot Q_m$

$$T_0 = \frac{2\pi Q_m}{I_m}$$

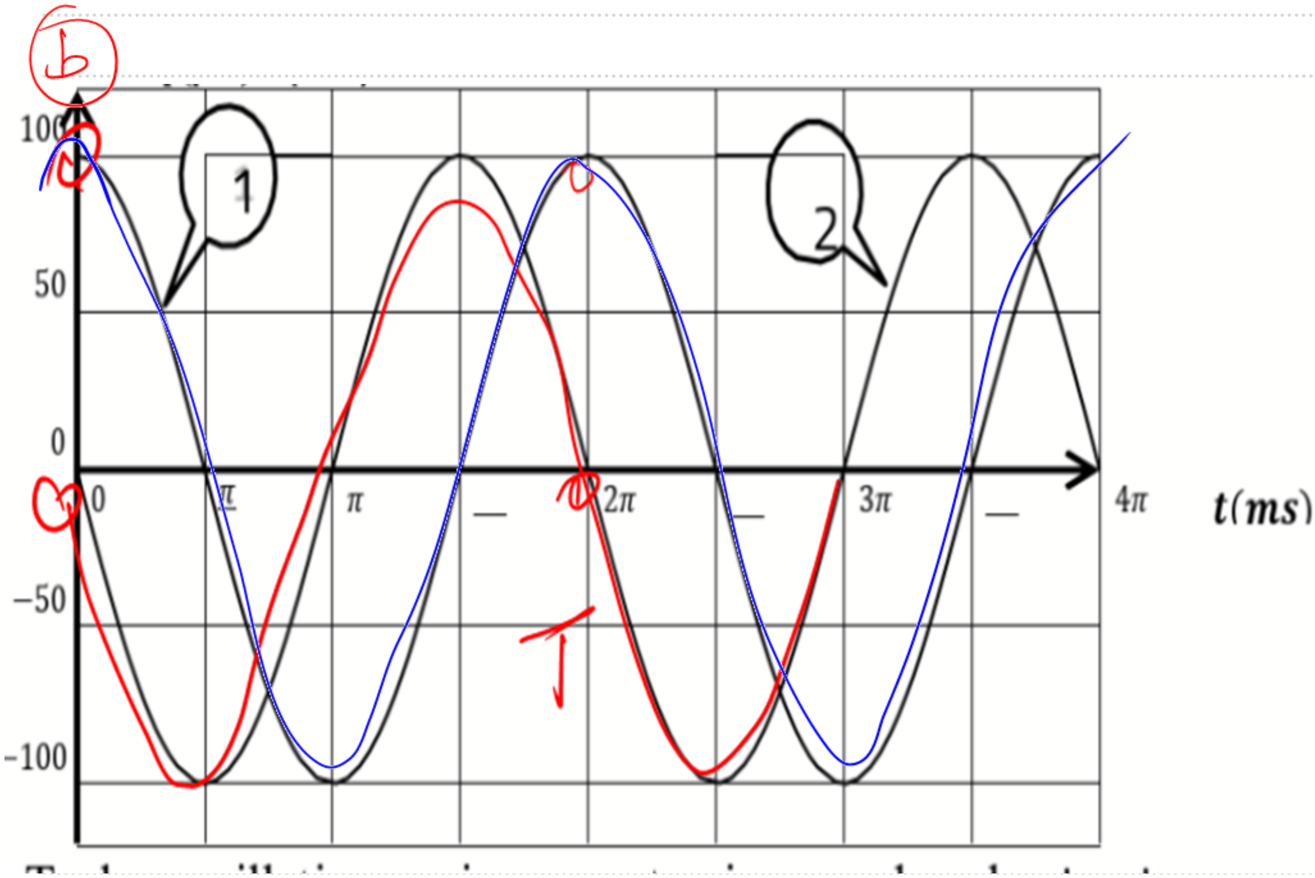
$$T_0 = \frac{2\pi \times \cancel{100}\ 10^{-6}}{\cancel{100}\ 10^{-3}}$$

$$\boxed{T_0 = 2\pi\ 10^{-3}\ s}$$

(3) $q(t) = Q_m \sin(\omega_0 t + \varphi_q)$

$i = \frac{dq}{dt} = \omega_0 Q_m \cos(\omega_0 t + \varphi_q)$

$$i = I_m \cos(\omega_0 t + \varphi_q)$$



$$q(t) = Q_m \sin(\omega_0 t + \varphi_q)$$

$$t = 0 \Rightarrow q(0) = Q_m \sin\varphi_q$$

$$\sin\varphi_q = \frac{q(0)}{Q_m} = \frac{Q_m}{Q_m} = 1$$

$$\Rightarrow \varphi_q = \frac{\pi}{2}\ \text{rad}$$

$$\Rightarrow q(t) = 100\cdot10^{-6}\sin\left(\frac{2\pi}{T_0}t + \frac{\pi}{2}\right)$$

$$= 100\cdot10^{-6}\sin\left(\frac{2\pi}{2\pi 10^{-3}}t + \frac{\pi}{2}\right)$$

$$q(t) = 10^{-4}\sin\left(10^{3}t + \frac{\pi}{2}\right)\ \text{en C}$$

$i = I_m \sin(\omega_0 t + \varphi_i)$ et $\varphi_i = \varphi_q + \pi/2$

$= \pi/2 + \pi/2$

$= \pi$

$i(t) = 100\,10^{-3} \sin(10^3 t + \pi)$

$i(t) = 0{,}1 \sin(10^3 t + \pi)$ en A

c) $\varphi_i = \pi$, $\varphi_q = \pi/2$

$\varphi_i - \varphi_q = \pi - \pi/2 = \pi/2$ rad

$\Rightarrow$ i en quadrature avance par rapport à q(t)

d) 1 méth

$q(t) = Q_m \sin(\omega_0 t + \varphi_q)$

$i = \frac{dq}{dt} = \omega_0 Q_m \cos(\omega_0 t + \varphi_q)$

$$\begin{cases} \sin(\omega_0 t + \varphi_q) = \frac{q}{Q_m} & (1) \\ \cos(\omega_0 t + \varphi_q) = \frac{i}{\omega_0 Q_m} & (2) \end{cases}$$

$(1)^2 + (2)^2 \Rightarrow$

$$\frac{q^2}{Q_m^2} + \frac{i^2}{\omega_0^2 Q_m^2} = 1$$

$$\frac{\omega_0^2 q^2 + i^2}{\omega_0^2 Q_m^2} = 1$$

$$\omega_0^2 q^2 + i^2 = \omega_0^2 Q_m^2$$

$$q^2 + \frac{i^2}{\omega_0^2} = Q_m^2$$

2meth

$$E = \cancel{\tfrac{1}{2}}\frac{q^2}{C} + \cancel{\tfrac{1}{2}} L i^2 = \text{cst} = \cancel{\tfrac{1}{2}}\frac{Q_m^2}{C}$$

$$\frac{q^2}{C} + L i^2 = \frac{Q_m^2}{C}$$

$$q^2 + LC i^2 = Q_m^2$$

or $\omega_0^2 = \frac{1}{LC}$

$LC = \frac{1}{\omega_0^2}$

$$q^2 + \frac{i^2}{\omega_0^2} = Q_m^2$$

4 i ? / $q = \frac{Q_m}{2}$

$$\frac{i^2}{\omega_0^2} = Q_m^2 - q^2$$

$$i^2 = \omega_0^2 \left(Q_m^2 - q^2\right)$$

si $q = \frac{Q_m}{2}$

$$i^2 = \omega_0^2 \left(Q_m^2 - \left(\frac{Q_m}{2}\right)^2\right)$$

$$i^2 = \omega_0^2 \left(Q_m^2 - \frac{Q_m^2}{4}\right)$$

$$i^2 = \frac{3}{4}\omega_0^2 Q_m^2$$

$$i = \pm\sqrt{\frac{3}{4}\omega_0^2 Q_m^2}$$

$$i = \pm\, \omega_0 Q_m \sqrt{\frac{3}{4}}$$

3) $E_c = \frac{1}{2}\frac{q^2}{C}$

$$q(t) = Q_m \sin(\omega_0 t + \varphi_q)$$

$$E_C = \frac{1}{2}\frac{Q_m^2}{C}\sin^2(\omega_0 t + \varphi_q)$$

$$= \frac{1}{2}\frac{Q_m^2}{C}\left(\frac{1 - \cos(2(\omega_0 t + \varphi_q))}{2}\right)$$

$$E_C = \frac{1}{4}\frac{Q_m^2}{C}\left(1 - \cos\left(2\omega_0 t + 2\varphi_q\right)\right)$$

$$\varphi_q = \pi/2$$

$$E_C = \frac{1}{4}\frac{Q_m^2}{C}\left(1 - \cos\left(2\omega_0 t + \pi\right)\right)$$

$$\cos(x + \pi) = -\cos x$$

$$E_C = 1/4\,\frac{Q_m^2}{C}\left(1 - \left(-\cos\left(2\omega_0 t\right)\right)\right)$$

$$E_C = 1/4\,\frac{Q_m^2}{C}\left(1 + \cos\left(2\omega_0 t\right)\right)$$

$$E_L = 1/2\, L i^2 \qquad i = \frac{dq}{dt} = \omega_0 Q_m \cos(\;)$$

$$E_L = 1/2\, L \underbrace{\omega_0^2}_{1/LC} Q_m^2 \cos^2(\omega_0 t + \varphi_q)$$

$$E_L = 1/2\, \cancel{L}_0 \frac{1}{\cancel{L} C} Q_m^2 \cos^2(\omega_0 t + \varphi_q)$$

$$E_L = 1/2\, \frac{Q_m^2}{C}\left(\frac{1 + \cos\left(2(\omega_0 t + \varphi_q)\right)}{2}\right)$$

$$E_L = 1/4\, \frac{Q_m^2}{C}\left(1 + \cos\left(2\omega_0 t + 2\varphi_q\right)\right)$$

$$E_L = \frac{1}{4}\,\frac{Q_m^2}{C}\left(1+\cos(2\omega_0 t+\pi)\right)$$

$$E_L = \frac{1}{4}\,\frac{Q_m^2}{C}\left(1-\cos(\underbrace{2\omega_0}_{\omega} t)\right)$$

b)

$$\omega = 2\omega_0$$

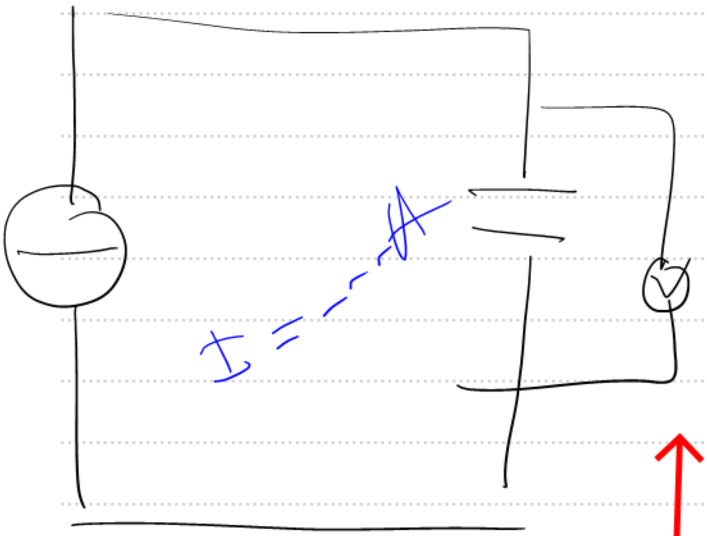
$$\frac{\cancel{2\pi}}{T} = 2\,\frac{\cancel{2\pi}}{T_0}$$

$$\frac{1}{T} = \frac{2}{T_0} \Leftrightarrow \boxed{T = \frac{T_0}{2}}$$

donc E_C et E_L sont périodique et de période $T = T_0/2$

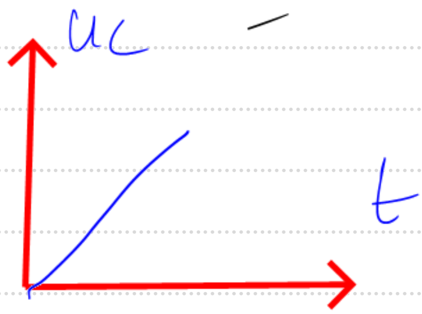
Tp physique

Tp 1



t			
u_c			

Courbe $u_c = f(t)$



$u_c = a\,t$

pente

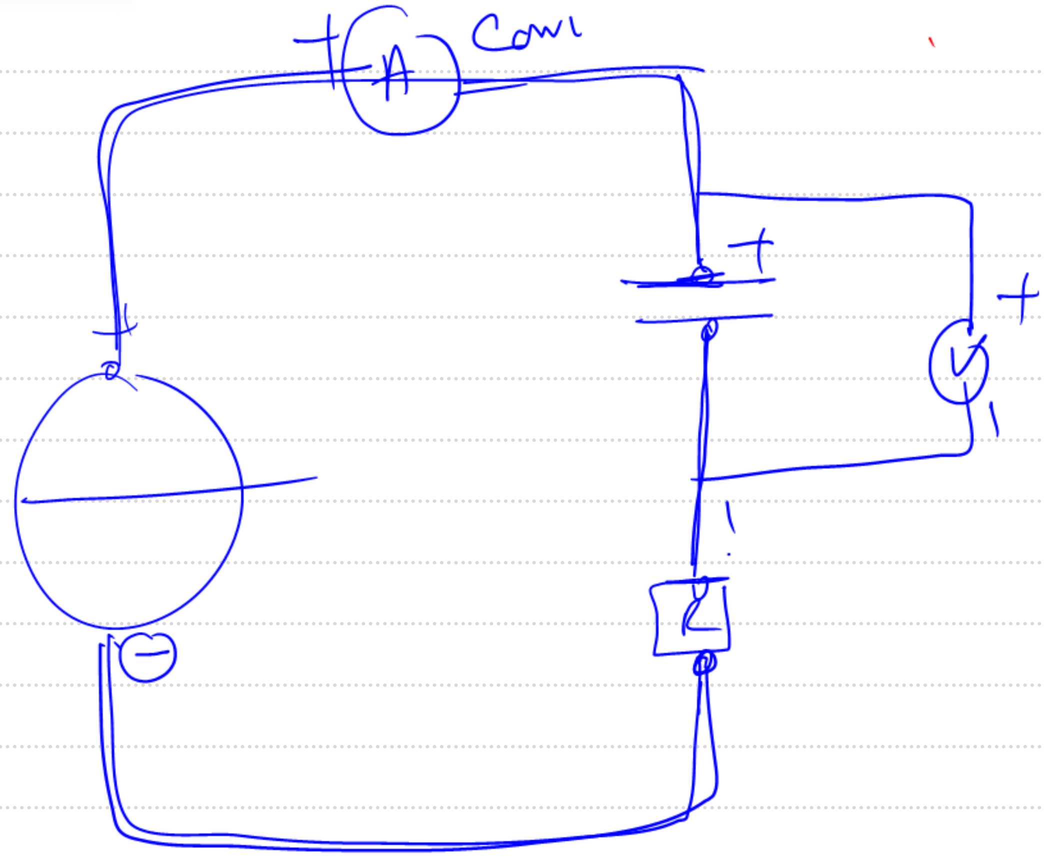
$\frac{q}{C} = a\,t$

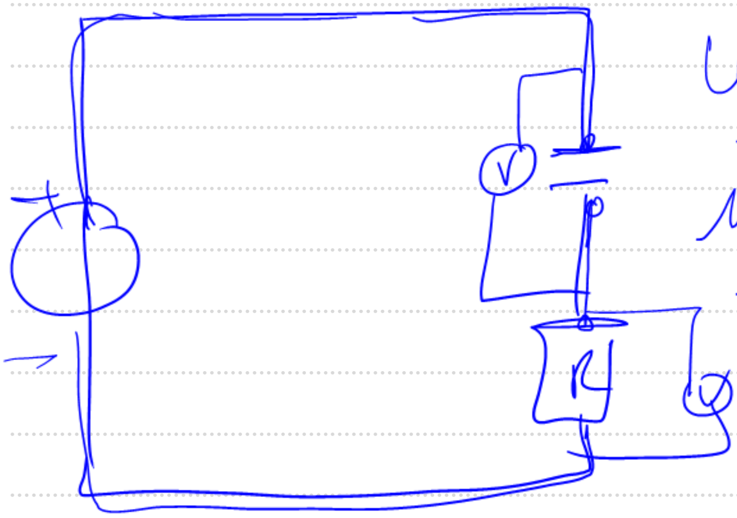
$\frac{I \times \cancel{t}}{C} = a\cancel{t}$

$a = \frac{I}{C}$

$C = \frac{I}{a}$

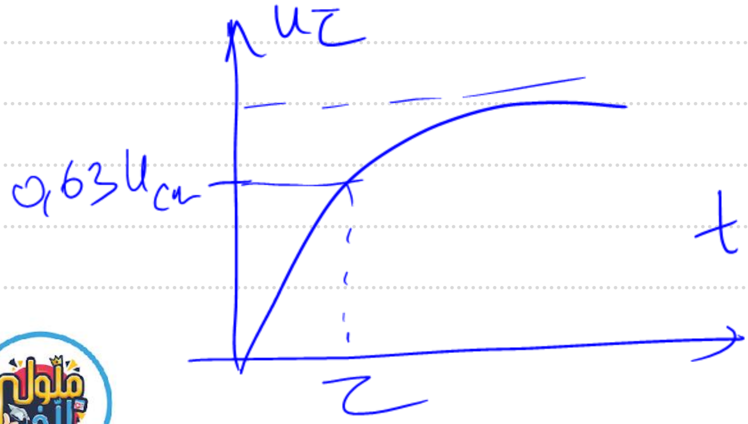
$E_c = \frac{1}{2} C u_c^2$

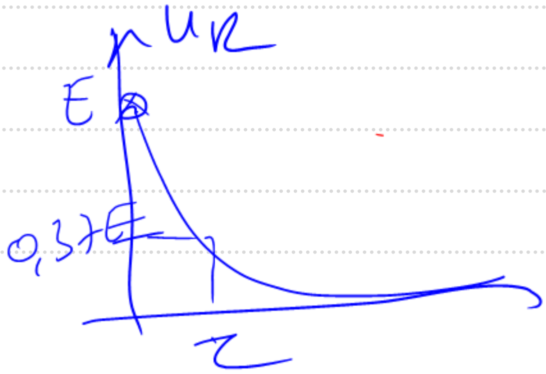




t	0	10	20	30
u_C				
u_R				

Tracer les courbes u_C et u_R

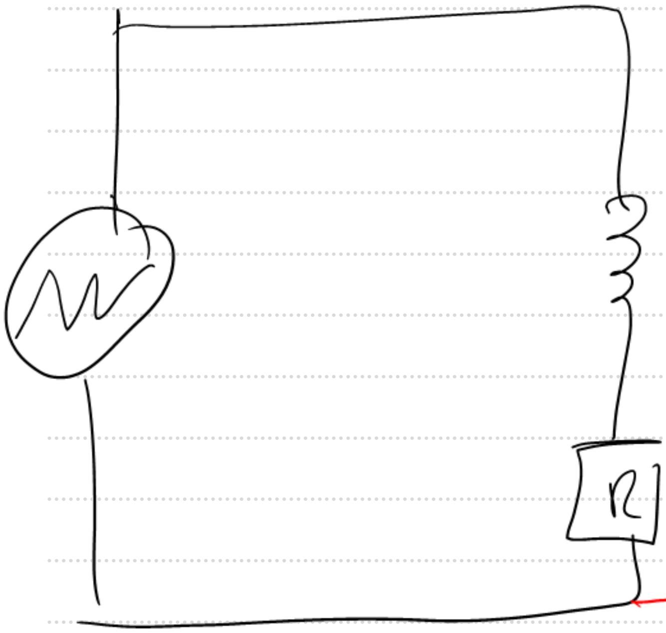


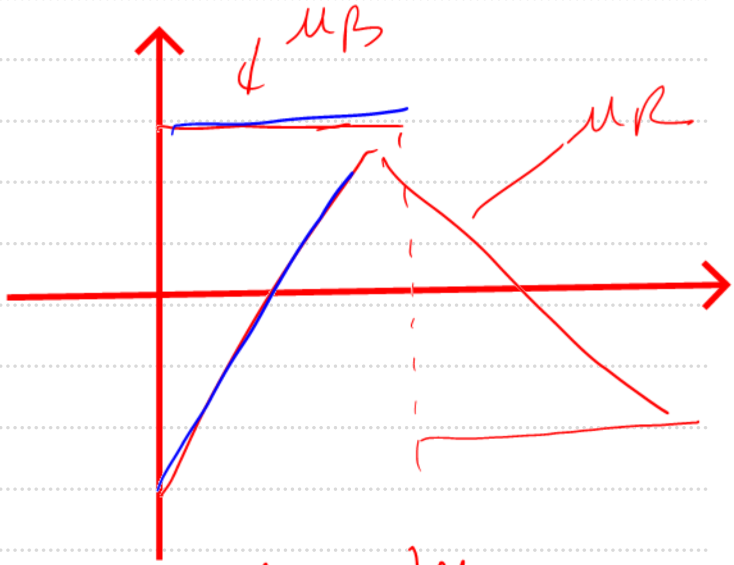


$\tau = RC$

$$\boxed{C = \frac{\tau}{R}}$$

dipole RL :





$\rightarrow u_B = \frac{L}{R} \frac{du_R}{dt}$

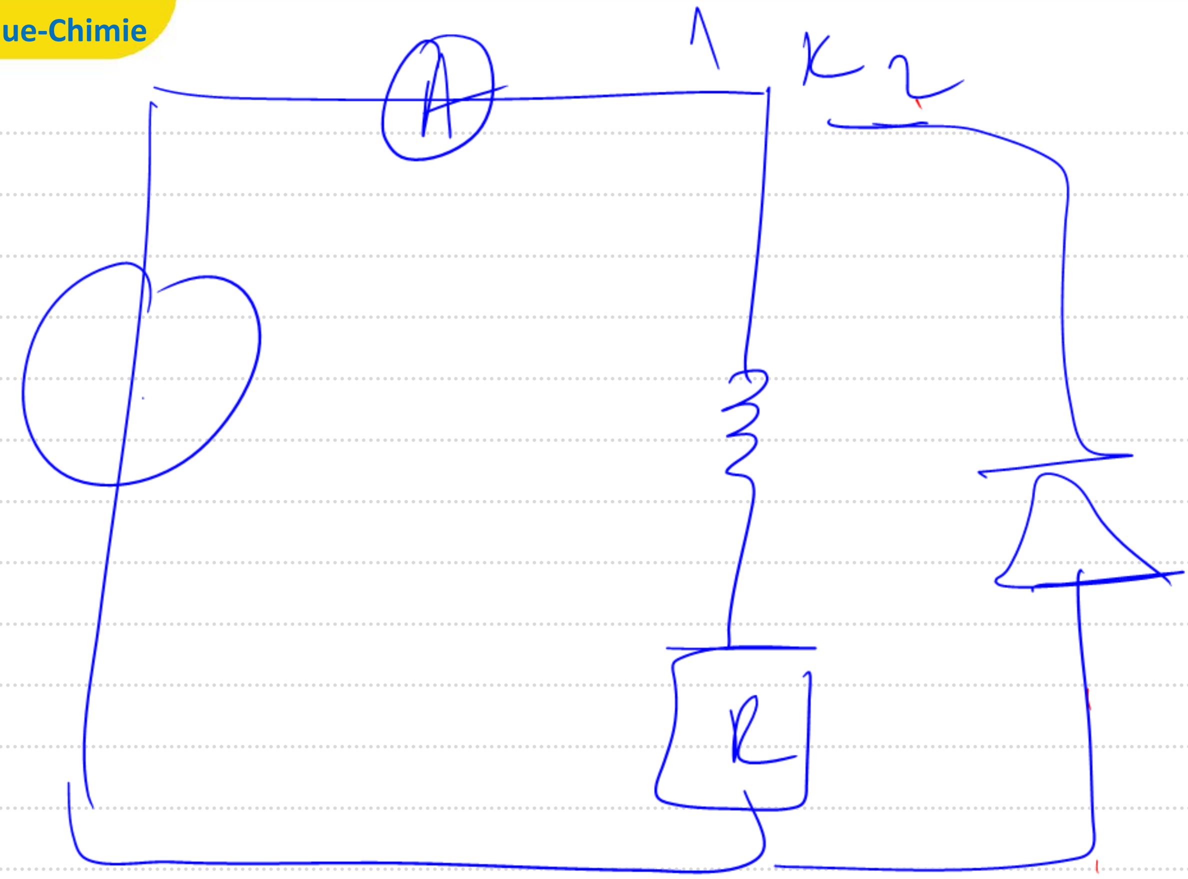
+ I n V

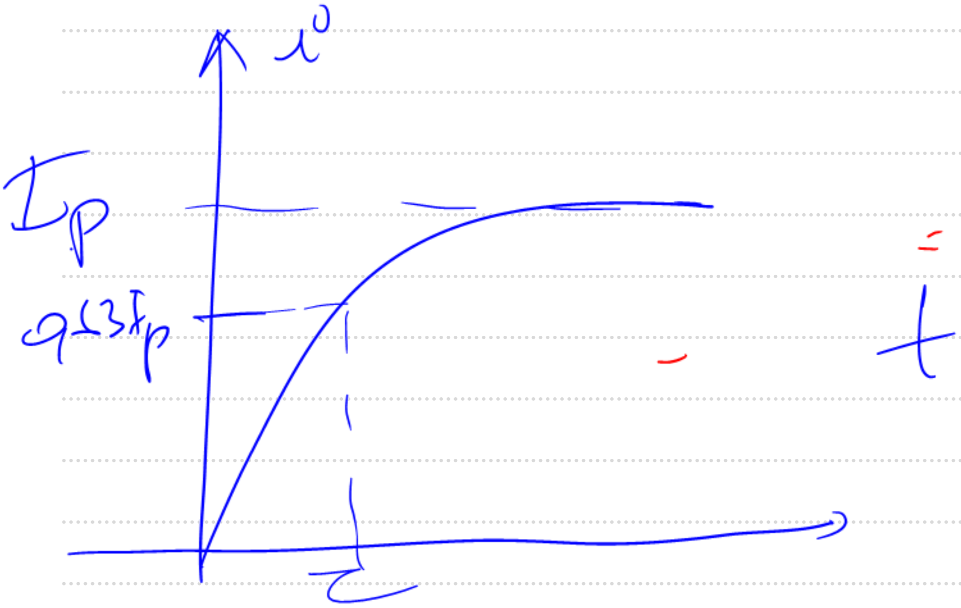
$=$

$u_B = \frac{L}{R} a$

$a = \frac{du_R}{dt} = \text{pente}$

$$\boxed{L = \frac{R\,u_B}{a}}$$





$\tau = t \;/\; i(\tau) = 0{,}63\, I_p$

$\tau = \dfrac{L}{R+r} \Leftrightarrow \boxed{L = \tau(R+r)}$