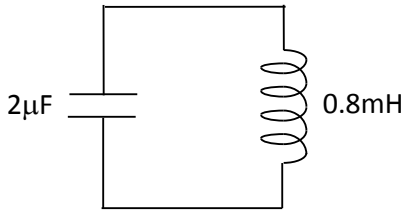
Name: _____

PHY 232 Summer 2016 Class Work

Class 36. LC Circuits Practice

Make sure your calculator is set to radian mode. Consider the following circuit




If the charge in the capacitor is given as $Q = Q_0 \sin(\omega t + \phi)$.

(a) Calculate the value of $\omega$ and then the corresponding frequency f and period T.

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2\times10^{-6}\times0.8\times10^{-3}}} = \frac{1}{\sqrt{16\times10^{-10}}} = \frac{1}{4\times10^{-5}} = 0.25\times10^{5} = \underline{\underline{2.5\times10^{4}\ \text{rad/s}}}$$

$$f = \frac{\omega}{2\pi} = \frac{2.5\times10^{4}}{2\pi} = \underline{\underline{3978.9\ \text{Hz or } 3.978\ \text{kHz}}}$$

$$T = \frac{1}{f} = \frac{1}{3978.9} = \underline{\underline{2.513\times10^{-4}\ \text{s}}}$$

(b) If the charge and current are 2μC and 0.05A at t=0. Determine $Q_0$ and $\phi$.

$$Q = Q_0 \sin(\omega t + \phi) \Rightarrow I = \frac{dQ}{dt} = Q_0\,\omega\cos(\omega t + \phi)$$

$$Q = 2\times10^{-6} \text{ at } t = 0 \Rightarrow 2\times10^{-6} = Q_0 \sin\phi \qquad \text{- (1)}$$

$$I = 0.05 \text{ at } t = 0 \Rightarrow 0.05 = Q_0\,\omega\cos\phi$$

$$\Rightarrow 0.05 = Q_0 \times 2.5\times10^{4}\cos\phi$$

$$\Rightarrow 2\times10^{-6} = Q_0\cos\phi \qquad \text{- (2)}$$

$$(1)/(2) \Rightarrow 1 = \tan\phi \Rightarrow \phi = \tan^{-1}1 \Rightarrow \underline{\underline{\phi = \frac{\pi}{4}\ \text{rad}}}$$

$$\phi = \frac{\pi}{4}\ \text{rad} \Rightarrow \sin\phi = 0.7071$$

$$\text{Substitue this to (1)} \Rightarrow 2\times10^{-6} = 0.7071 Q_0 \Rightarrow Q_0 = \underline{\underline{2.8284\times10^{-6}\ \text{C}}}$$

$$\therefore Q = 2.8284\times10^{-6}\sin(2.5\times10^{4}\ t + \frac{\pi}{4})$$

(c) What are the charge and current at t = $10^{-5}$ s?

$$Q = 2.8284 \times 10^{-6} \sin(2.5 \times 10^{4}\ t + \frac{\pi}{4})$$

$$\text{At } t = 10^{-5}\text{ s} \Rightarrow Q = 2.8284 \times 10^{-6} \sin(2.5 \times 10^{4} \times 10^{-5} + \frac{\pi}{4})$$

$$= 2.8284 \times 10^{-6} \sin(0.25 + \frac{\pi}{4})$$

$$= 2.8284 \times 10^{-6} \sin(1.0354)$$

$$= \underline{\underline{2.4326 \times 10^{-6}}}$$

$$I = \frac{dQ}{dt} = Q_0\ \omega \cos(\omega t + \phi) \Rightarrow I = 2.8284 \times 10^{-6} \times 2.5 \times 10^{4} \cos(2.5 \times 10^{4}\ t + \frac{\pi}{4})$$

$$\Rightarrow I = 0.07071 \cos(2.5 \times 10^{4}\ t + \frac{\pi}{4})$$

$$\text{At } t = 10^{-5}\text{ s} \Rightarrow I = 0.07071 \cos(2.5 \times 10^{4} \times 10^{-5} + \frac{\pi}{4})$$

$$\Rightarrow I = 0.07071 \cos(0.25 + \frac{\pi}{4})$$

$$\Rightarrow I = 0.07071 \cos(1.0354)$$

$$\Rightarrow I = \underline{\underline{0.0361\text{A}}}$$