EXPERIMENT 6

CAPACITORS AND INDUCTORS

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Abstract:

By measuring the amount of time it takes for the voltage across the element to vary by 0.37 during charge decay or 0.63 during charge accumulation, we were able to calculate the time constants in these three circuit types—RC, RL, and LC. we may also determine (ω0) By measuring the circuit frequency that corresponds to the maximum amplitude and then figuring out ω0.

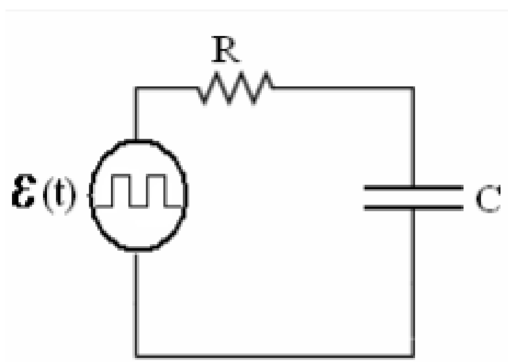
Introduction:

Apparatus:

Resistor (1 kΩ), Capacitor (0.1 µF), Inductor (10 mH), Signal Generator, and an Osilloscope.

In this experiment, we will build three electrical circuits as follows:

1. RC Circuits:



During the positive half period of the square wave, the charge in the straightforward RC circuit accumulates on the capacitor plates according to the following formula:

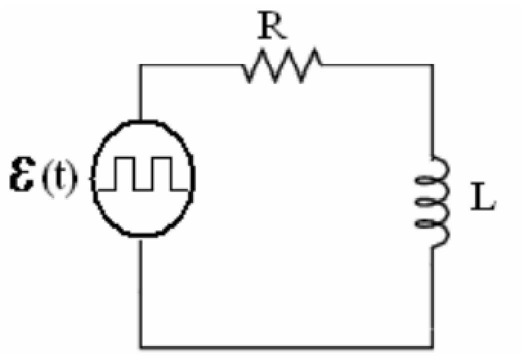
$$Q(t) = C\varepsilon(1 - e^{-\frac{t}{RC}})$$

During the negative half cycle of the square wave, the capacitance in the RC circuit becomes Discharge according to the following formula:

$$Q(t) = C\varepsilon e^{-\frac{t}{RC}}$$

About the voltage : $V_C = \dfrac{Q}{C}$

2. RL Circuits:



The voltage across the resistor is:

$$V_R = IR = \varepsilon(1 - e^{-\frac{Rt}{L}})$$

the voltage across the inductor is:

$$V_L = L\frac{dI}{dt} = \varepsilon e^{-\frac{Rt}{L}}$$

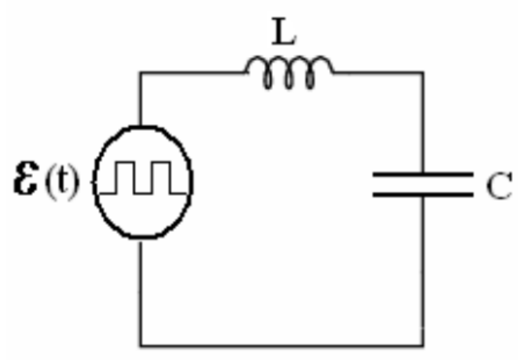
The quantity L/R is called the time constant (τ) of the circuit, it measures how quickly the current in the circuit increases.

When t = τ

$$V_R = 0.63\varepsilon,$$

$$V_L = 0.37\varepsilon.$$

3. LC Circuits:



The circuit frequency that corresponds to the maximum amplitude by equation

$$F = \frac{\omega}{2\pi} \quad , \quad \omega = \frac{1}{\sqrt{LC}}$$

Data & Analysis:

For RC Circuits:

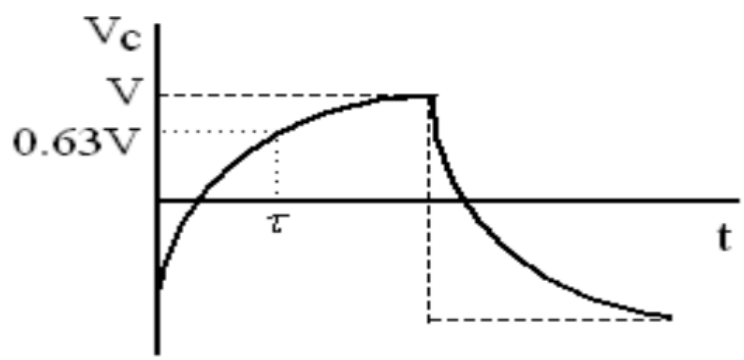
$\tau_{exp} = 100\ \mu s$

$\tau_{theo} = RC$

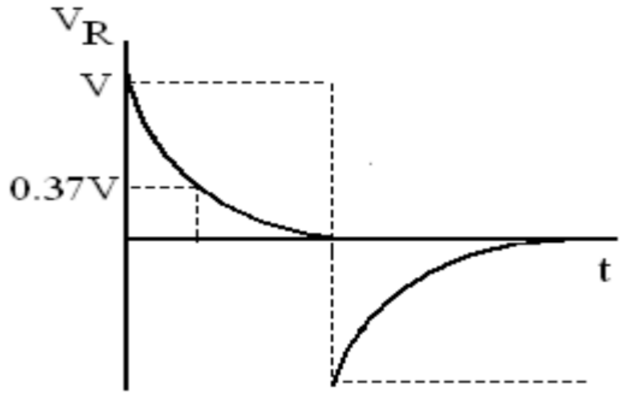
$= 1000 * 0.1 * 10^{-6}$

$= 100\ \mu s$

Charging graph:



Discharging graph:



A positive charge will build up on one of the capacitor plates when it is linked to a power source, and a similar negative charge will build up on the other. The charge build-up causes an electric field to develop between the capacitor plates. The capacitor is charged throughout this procedure. and the capacitor will discharge and each of its plates will turn neutral.

For RL Circuits:

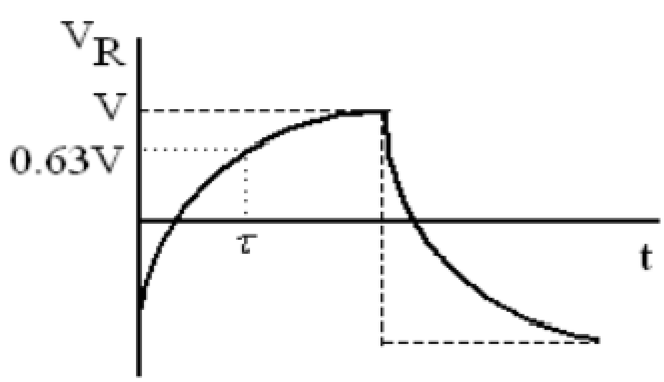
$$\tau_{exp} = 10\ \mu s$$

$$\tau_{theo} = L/R$$

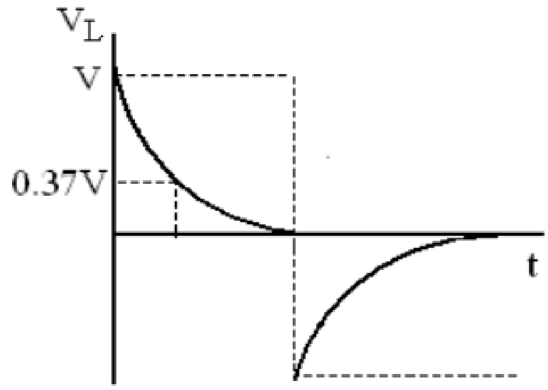
$$= 10 * 10^{-3} / 10^{3}$$

$$= 10\ \mu s$$

Charging graph:



Discharging graph:



For LC Circuits:

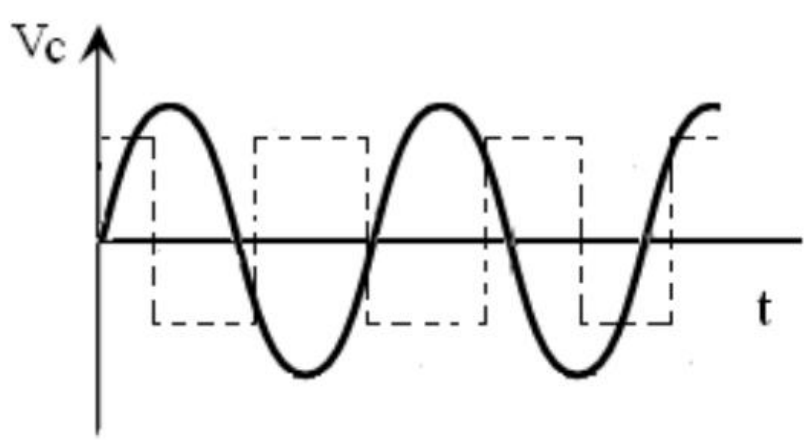
$$f_{exp} = 5.13 \ kHz \qquad \omega_{exp} = 32216 \ rad$$

$$f_{theo} = \frac{1}{2\pi\sqrt{CL}} \qquad \omega_{theo} = \frac{1}{\sqrt{CL}}$$

$$f_{theo} = \frac{1}{2*3.14\sqrt{10^{-9}}} \qquad \omega_{theo} = \frac{1}{\sqrt{10^{-9}}}$$

$$f_{theo} = 5.03 \ kHz \qquad \omega_{theo} = 31622 \ rad$$

The voltage across the capacitor as a function of time:



Conclusion:

After measuring τ in both the RC circuit and the RL circuit we found The values for and that we empirically achieved in our experiment closely matched the values that we theoretically predicted, After connecting the LC circuit and measuring the frequency by the experiment and then finding the frequency in a theoretical way, we find that there is a match between them, And through the frequency we can calculate the value of ω.