**A green tree on a black background

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BIRZEIT UNIVERSITY

Physics Department

## Physics 112

**Experiment No. 6**

**Capacitor & Inductors**

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* **Abstract :**

**Introduction :** In this experiment, it is expected to discover the time constant of three electrical circuits: RC-circuit, LR-circuit, and LC-circuit. To briefly explain, RC-circuit is an electrical circuit containing resistance, which is connected to a capacitor of capacitance. Secondly, LR-circuits would be where the capacitance of inductance, L, is joined in series with a capacitance of resistance, R. Lastly, the LC-circuit is formed when an inductor, L, and capacitor, C, are joined together. Therefore, to find the time constant of the three electrical circuits would be to use a DCO to measure the voltage of RC and RL circuits, as well as find the frequency of the LC current.

**The aim of the experiment :** is to find out the time constant in RC, RL ,

and LC-circuits.

**The method used :** is by using the DCO to measure the voltage in the

RC and LR circuits and to measure the frequency in the LC circuit.

**The main result :**

1. RC circuits :

**c  =** 104 µsec

**d  =** 104 µsec

**exp  =** 104 µsec

**theo  =** 100 µsec

1. LR circuit :

**c  =** 9 µsec

**d  =** 9 µsec

**exp  =** 9 µsec

**theo  =** 10 µsec

1. LC circuit :

fexp =4.63 KHz

ftheo = 5 KHz

exp = 29.1 rad/s

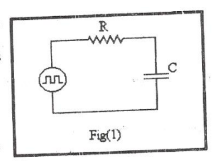
theo = 31.4 rad/s

* **Theory :**

**RC circuits :**

**Charging a capacitor :**

The voltage across the capacitor’s plates is defined by *VC =* , and

While Q(t) = C ( 1- ) (when we are talking about the positive half period of the square wave) , then Vc = ( 1- ) .

.The value of RC is usually called the time constant **(τ)** of the RC

circuit like the one shown in fig.1. **τ** is a measure of how fast the voltage across the capacitor rises. When t= τ , VC = 0.63

The current passing through the circuit is given by : I(t) = =

, while the voltage across the resistor is : VR = I(t) R = .

**Discharging a capacitor:**

Now, during the negative period of the square wave, the

capacitor, the capacitor discharges according to the following formula :

Q(t) = C , And so the voltage across the capacitor’s plates is:

VC = 0.37 *.*

In this case the voltage decays to 0.37 of its maximum value within

a time τ, which equals RC (the time constant).

The current passing through the circuit is:

I(t) = =

and so, the voltage is given by:

VR = I(t) R = -

**LR circuits:**

A diagram of a circuit

Description automatically generatedThe current passing through the LR circuit shown in

fig.3 rises with time according to the following equation:

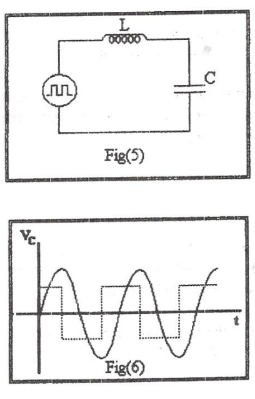
I = ( 1- )

The voltage across the resistor is : I = IR = ( 1- )

and across the inductor is : VL  = L =

In this case the time constant equals . When t = τ , and VL = 0.37 ,

and VR = 0.63 *.*

 **LC circuits :**

The following equation describes the voltage

across the capacitor’s plates of the one in the circuit

shown in fig.5,

VC = VCo cos (

Where VCo is the amplitude (constant ) and = .

Fig.6 shows the voltage across the capacitor as a

function of time .

* Data :

R = 1 kΩ C = 0.1 µf L = 10 mH

**1 ) RC-circuit :**

|  |  |  |
| --- | --- | --- |
|  | |  |
| A graph on a screen | | A screen shot of a graph  Description automatically generated |
| = 104 µsec | = 104 µsec |  |
| = (104+104)/2 = 104 µsec | | = RC = (1000Ω)×(0.1µf) = 100 µsec |

**2) LR-circuit :**

|  |  |  |
| --- | --- | --- |
|  | |  |
|  | | A screen shot of a graph  Description automatically generated |
| = 9 µsec | = 9 µsec |  |
| = (9+9)/2 = 9 µsec | | = (L/R) = (10 \* 10-3) / 103 = 10 µsec |

**3 ) LC-circuit**

|  |  |  |
| --- | --- | --- |
|  | | |
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|  | 4.36 KHz | =2f 🡺 29.1 rad/s |
| = =    = 5.0 KHz | =2f 🡺31.4 rad/s |

* **Discussion & Conclusion :**

This experiment discussed the three different circuits: RC-circuit, LR-circuit, and LC-circuit that were displayed on the DSO, where their times experimentally and theoretically were measured. With the addition of frequency being measured experimentally and theoretically in the LC-circuit. However, as shown in the data section, many of the results received from the DSO (experimental) were not similar or accurate to those calculated (theoretical). The reasoning for such would be because the digital multimeter that was used was not in a state that could display precise results. In addition to this, after using the noise-cancelling wires: it was found that there was still noise displayed on the DSO. Therefore, the reasoning for such different experimental results: would be that the tools were inaccurate and unable to measure correctly. As a result, the DSO displayed graphs that were erroneous.