Physics Lab

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Analyse R-L-C Circuit

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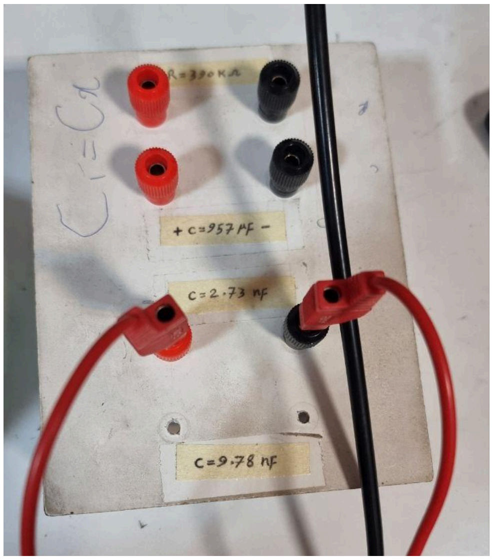
Overview

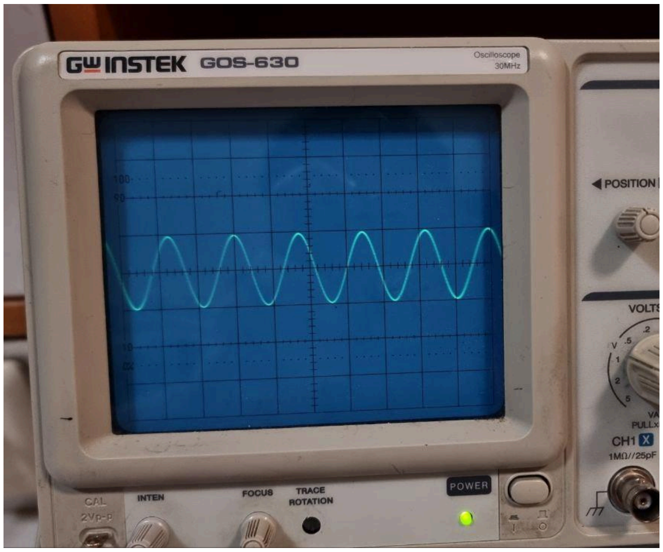
Here is book of Physics Lab experiment 9, Analyzing R-L-C Circuit

Experiment Info

- **Purpose >** Analysing Resonance Phenomenon
- **Necessary Equipment >** AC Power Source, Resistor, Inductor, Non-polarity Capacitor, Oscilloscope, Wires and Probes

Relations : $f_r = \frac{1}{2\pi\sqrt{LC}}$





Analyzing R-L-C Circuit

Steps

1. First we picked a capacitor with $C = 2.73nF$ and a transformer with $L = 3.5mH$.
2. Then we calculated the resonance frequency with a formula and wrote it down.
3. Then we assembled a related circuit.
4. Then we changed the oscilloscope's settings to see sine wave on it.
5. Then we change frequency from AC Power source and we change it as more as to see a highest scale of sine wave then leave frequency there.

Analyzing R-L-C Circuit Tables

C	L	$f_{r-measured}$	$f_{r-real} = \frac{1}{2\pi\sqrt{LC}}$
$2.73nF$	$3.5mH$	$52.401kHz$	$\alpha :\ 51487.8534Hz$

Calculations of α :

$$C = 2.73 \times 10^{-9} \quad , \quad L = 3.5 \times 10^{-3}H \quad , \quad f_{r-measured} = 52401kHz$$

$$\alpha :\ f_r = \frac{1}{2\pi\sqrt{2.73\times3.5\times10^{-12}}} = 51487.8534Hz$$

Analyzing R-L-C Circuit - Error Calculations

Error calculations are divided into 3 categories, absolute, relative and systematic errors and my personal task is to calculate errors of **first experiment** :

from absolute formula : $Absolute\ Error = |real\ value - measured\ value|$

We get this absolute error for α :

$$\varepsilon_{abs_\alpha} = |51487.8534Hz - 52401Hz| = 913.1466Hz$$

from relative formula : $Relative\ Error\ = \frac{|real\ value - measured\ value|}{real\ value}$

We get this absolute error for α : $\varepsilon_{rel_{\alpha}} = \frac{913.1466Hz}{51487.8534Hz} \approx 0.01774$

for systematic formula, We must do several mathematics operations :

1. Consider we have formula $f_r = \frac{1}{2\pi\sqrt{LC}}$.
2. Take the ln from both sides.
3. Take the differential from both sides.
4. Convert differentials to delta (Δ).
5. Convert every $-$ to $+$.
6. accuracy of **Analog Device** is equal to the lowest shown range on the device.
7. Error of **Analog Device** is equal to the lowest shown range on device multiplied by 0.5.
8. accuracy of **Digital Device** is equal to 10^{-x} where x is float level on the screen.
9. Error of **Digital Device** is equal to 10^{-x} where x is float level on the screen.

Now we can calculate systematic error using main formula :

$$Step\ 1: \quad f_r = \frac{1}{2\pi\sqrt{LC}}$$

for $V_{s_{\alpha}}$:

$$Step\ 2: \quad ln(f_r) = ln(1) - ln(2\pi\sqrt{LC})$$

$$Step\ 2: \quad ln(f_r) = -ln(2\pi) - ln(\sqrt{LC}) = -ln(2\pi) - \frac{1}{2}ln(LC)$$

$$Step\ 2: \quad ln(f_r) = -ln(2\pi) - \frac{1}{2}ln(L) - \frac{1}{2}ln(C)$$

$$Step\ 3: \quad \frac{df_r}{f_r} = -\frac{d(2\pi)}{2\pi} - \frac{1}{2}\frac{dL}{L} - \frac{1}{2}\frac{dC}{C}$$

$$Step\ 4: \quad \frac{\Delta f_r}{f_r} = -\frac{1}{2}\frac{\Delta L}{L} - \frac{1}{2}\frac{\Delta C}{C}$$

$$Step\ 5: \quad \frac{\Delta f_r}{f_r} = \frac{1}{2}\frac{\Delta L}{L} + \frac{1}{2}\frac{\Delta C}{C}$$

$$Step\ 6\sim: \quad \Delta L = 10^{-1} \quad , \quad \Delta C = 10^{-2}$$

$$Final: \quad \frac{\Delta f_r}{f_r} = \frac{0.1}{2\times3.5} + \frac{0.01}{2\times2.73} \approx 0.0161$$

$$\Rightarrow \varepsilon_{sys_\alpha} = 0.0161$$