Hanoi University of Science and Technology
School of Engineering Physics

LAB REPORT

For Electrics and Thermodynamics

Experiment 3

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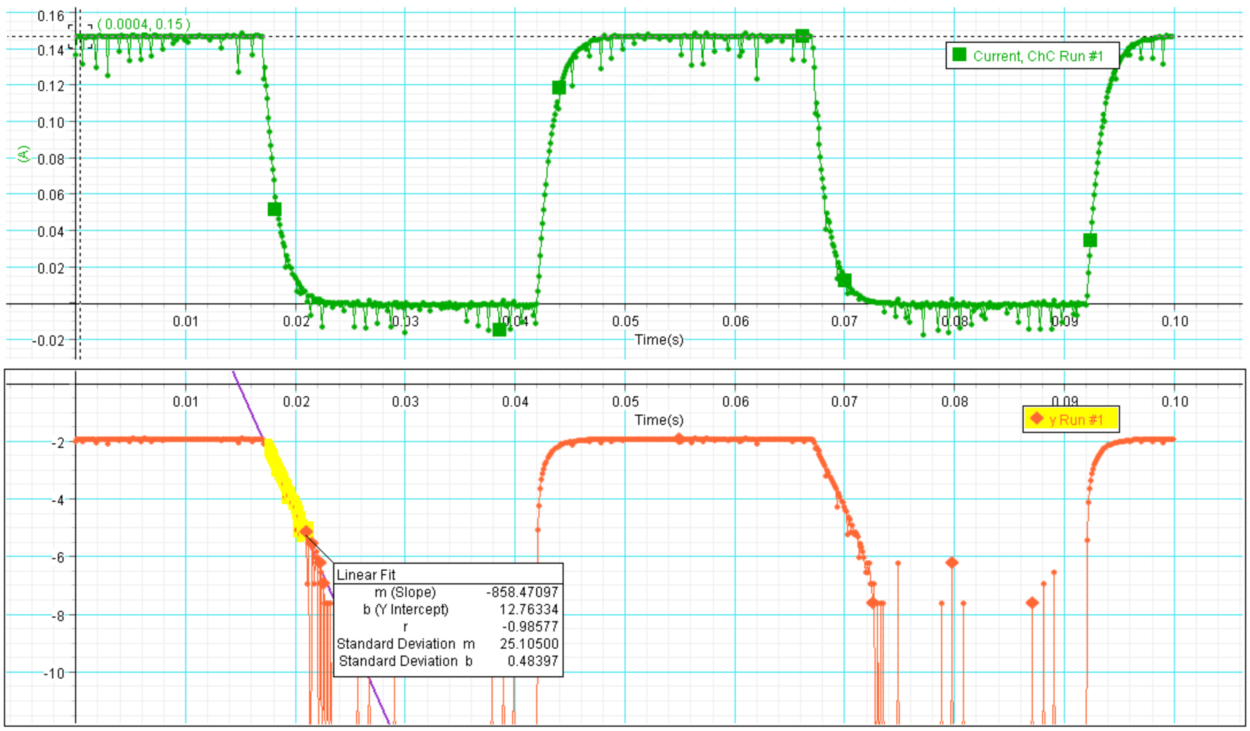
Investigation of Electric Oscillation of RL and RLC Circuits

I. EXPERIMENTAL MOTIVATION:

- Understanding the current across an inductor-resistor and RLC circuit, then calculate the energy of oscillation RLC circuit

II. EXPERIMENTAL RESULT

1. Resistance and Inductance of the Coil:



(Fig1: Current in RL without core)

*** Question 1: Measure and calculate the resistance R_L of your coil L**

Input voltage is $U = 1V$.

Measured current is $I = 0.16(A)$.

⇨ Apply the Ohm's law the R_L of the coil is:

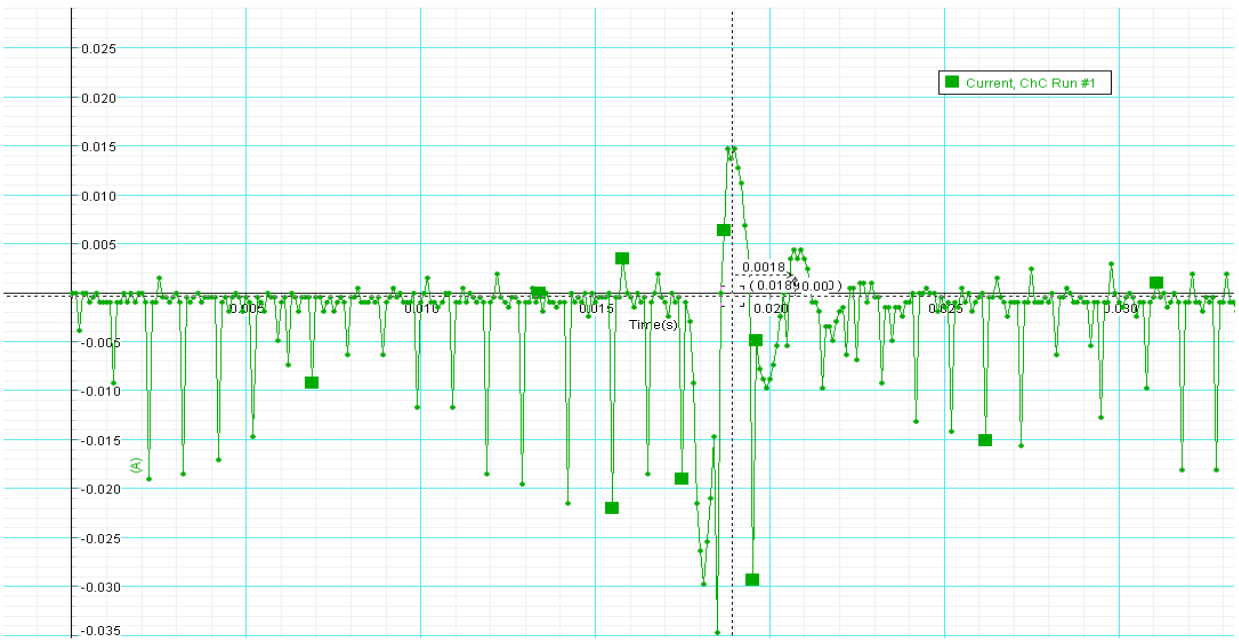
$$R_L = \frac{U}{I} = \frac{1}{0.15} = 6.67(\Omega)$$

***Question 2**: **Calculate the inductance of the coil without iron core base on the value of slope obtained by Data Studio software:**

By using graph, the function $ln(i) = -(R_T /L)t + ln(i_0)$ has a slope $m= -858.47097$;
$=> -(R_T /L)= -858.47097$
Then we have:

$$L_{w/c} = \frac{-R}{m} = \frac{-6.67}{-858{,}47097} = 7.70(mH)$$

2. Free oscillation of RLC circuit:



(Fig 2: Current in RLC circuit without core)

***Question 3: Calculate the frequency, $f_{measured}$=1/T(Hz) base on the period of oscillation determined by tools of Data Studio software**

The graph of RLC circuit without core show that the period of the RLC circuit oscillations is T=0.0018(s)

Hence $$f_{measured} = \frac{1}{T} = \frac{1}{0.0018} = 555.56(Hz)$$

***Question 4: For your circuit parameters, compute the expected value of $f_{prediction}$= $1/(2\pi\sqrt{LC})$ (Hz) and compare it to your measured value. Do you expect your result to be greater, equal, or less than the measured value ($\Delta f = f_{prediction} - f_{measured}$)?**

$$f_{prediction} = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{7.7\times10^{-3}\times10\times10^{-6}}} = 573{,}56(Hz)$$

(as we assume the value L=7.7×10^{-3}(H) and C=10 (μF))

So, the expected value of f is l larger than the measured value amount of Δf

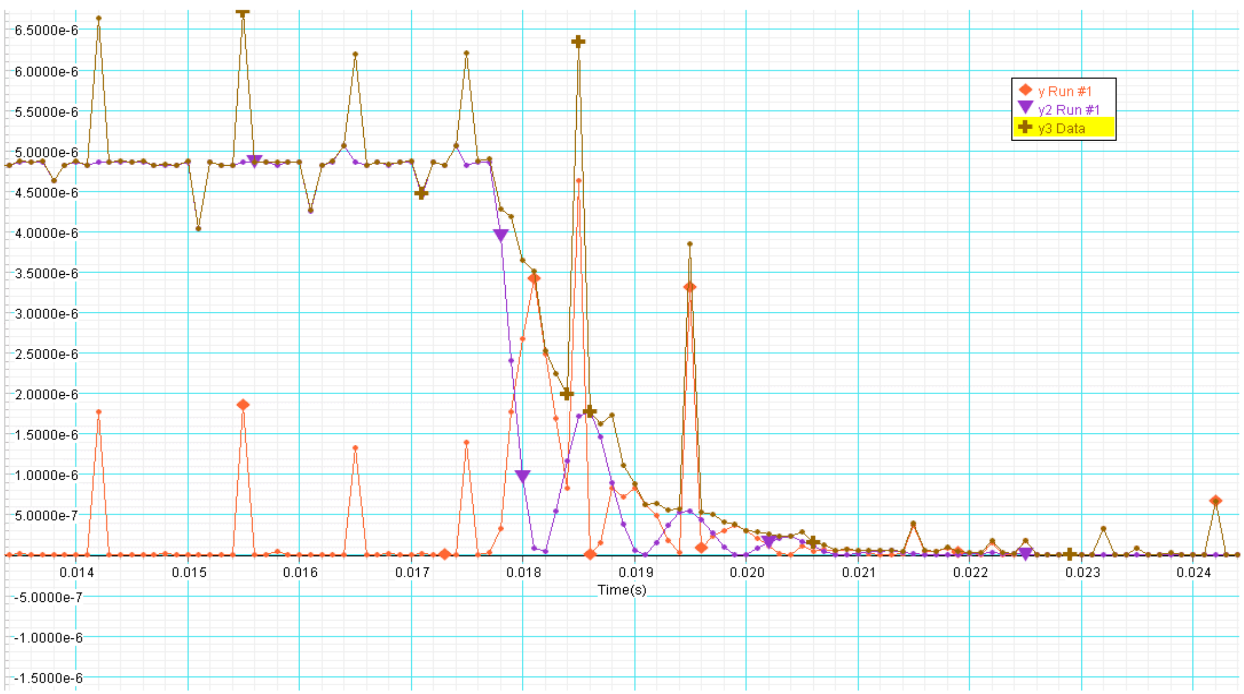
$$\Delta f = f_{prediction} - f_{measured} = 573{,}56 - 555.56 \approx 18(Hz)$$

It is obvious that in the process of computing the measured value, there is the appearance of R of the coil according to the formula:

$$\omega_{w/c}^2 = \frac{1}{L_{w/c}\,C} - \frac{R_{total}^2}{4\,L_{w/c}^2}$$

This make ω smaller => the frequency $f = \frac{\omega}{2\pi}$ is also smaller.

3. Observe the energy in RLC circuit:



(Fig 3: energy relationship in RLC circuit)

***Question 5: The circuit is losing energy most rapidly at times when the graph of total energy is steepest; these times occur at about the same times that the magnetic energy reaches a local maximum. Briefly explain why**?

As current oscillates in RLC circuit, energy would be stored in both:

+ Magnetic field energy of inductor: $U(B) = \frac{1}{2}Li^2$

+ Electric field energy of the capacitor: $U(E) = \frac{1}{2}CV^2$

The total energy is:

$$\boxed{U = U(B) + U(E) = \frac{1}{2}Li^2 + \frac{1}{2}CV^2}$$

This energy lost gradually as heat in the resistor at the rate: I^2R, then over the period of oscillation T the dissipated energy is

$$\Delta U = \int_0^t I^2 R dt$$

It means that the energy in the circuit decreases faster for larger R because it disappear more rapidly into Joule heating.