LAB-5

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v. good.

NORTH SOUTH UNIVERSITY

Department of Mathematics & Physics

Experimental Physics

PHY-108L

Name of the Experiment: RL Series Circuit

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Serial No: 05

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Group Number: E

Date: (i) Experiment Performed: 10.04.2023

(ii) Report Submitted: 08.05.2023

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Experiment Name: RL Seriese Circuit.

Objective:

- To observe the rise and decay characteristic of an inductor using an oscilloscope.
- To verify the time constant of an RL circuit.

Apparatus:

- Resistor 1 kΩ
- Inductor 100 mH
- Function Generator
- Oscilloscope
- Bread board
- Wires

Theory:

An inductor is a passive electronic component that stores energy in the form of a magnetic field. In its simplest form, an inductor consists of a wire loop or coil. If a source EMF is introduced in a circuit containing an inductor and a resistor, an induced emf (ϵ_L) will be observed across the inductor while there is a change in the current (like switch 'on' or 'off'). written below:

$$\epsilon_L = -L\frac{di}{dt} \quad \cdots (i)$$

It follows the Faraday's law of induction. The "minus" sign in the equation 1 indicates that ϵ_L is oppose the change in current, explained by the Lenz's Law.

If a constant emf V_0 is introduced in a circuit containing R and L, when the current rises exponentially to $\frac{V_0}{R}$, and because of the change the voltage across the inductor will decay exponentially, written as,

$$V_L(t) = V_0 e^{-t/\tau} \quad \cdots (ii)$$

Where τ_L is the inductive time constant of the inductor measured in terms of second, given by

$$\tau = \frac{L}{R} \quad \cdots (iii)$$

Similarly, if the constant emf V_0 is withdrawn, current decays exponentially and the voltage across the inductors also decay exponentially, written as,

$$V_L(t) = -V_0 e^{-t/\tau} \quad \ldots \text{(iv)}$$

Here the inductive time constant, τ is the time required to decay the inductor, through the resistor, 37% of its initial voltage.

Circuit Diagram:

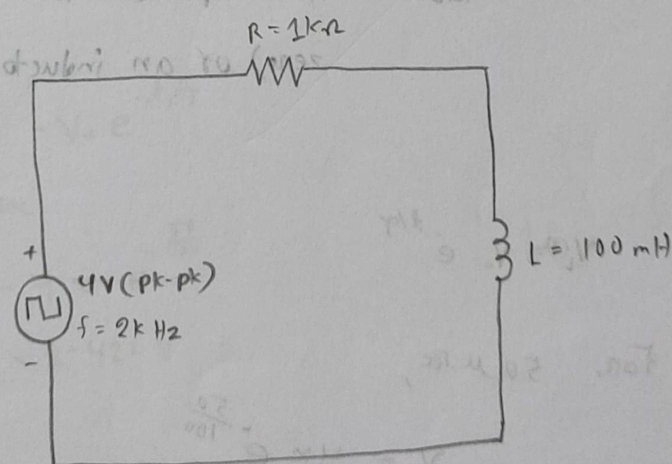

Fig.: RL Series Circuit

Data Table & Calculation:

Time (μs)	Calculated V_L (positive to zero) (V)	Measured V_L (V)	Time (μs)	Calculated V_L (Positive to zero) (V)	Measured V_L (V)
0	4	4	175	0.695	1.040
25	3.115	3.200	200	0.541	0.960
50	2.426	2.480	225	0.422	0.880
75	1.889	2.080	250	0.328	0.800
100	1.472	1.760	275	0.256	
125	1.146	1.520	300	0.199	
150	0.893	1.200	325	0.155	

Table 1: Time dependent for the voltage decay (positive to zero) of an inductor

$V_L(t) = V_0 \, e^{-t/\tau}$

For, 50 μsec,

$V_L = 4 \times e^{-\frac{50}{100}}$

$= 2.426$ V

Time (μs)	Calculated V_L (negative to zero) (V)	Measured V_L (V)	Time (μs)	Calculated V_L (negative to zero) (V)	Measured V_L (V)
0	-4	-4	175	-0·695	-0·880
25	-3·115	-3·120	200	-0·541	-0·800
50	-2·426	-2·320	225	-0·422	-0·720
75	-1·889	-1·840	250	-0·328	-0·640
100	-1·472	-1·520	275	-0·256	
125	-1·146	-1·200	300	-0·199	
150	-0·893	-0·96	325	-0·155	

Table 2: Time dependent for the voltage decay (negative to zero) of an inductor.

$$V_L(t) = -V_0 e^{-t/\tau}$$

For, $t = 50\ \mu sec$

$$V_L = -4 \times e^{-\frac{50}{100}}$$

$$= -2·426\ V$$

Graph: Attached.

~~Result Analysis~~:

Tasks and Questions:

1.

$$\text{Time constant (theoretical)} = \frac{L}{R} = \frac{100\times10^{-3}\ H}{1\times10^{3}\ \Omega}$$

$$= 100\ \mu sec$$

Time constant measured from the graph = $121.25\ \mu sec$

$$\text{Error} = \left|\frac{100-121.25}{100}\right| \times 100\%$$

$$= 21.25\%$$

2.

$$\text{Time constant} = \frac{L}{R} = 100\ \mu sec$$

Time constant from graph-2 = $100\ \mu sec$

$$\text{Error} = \left|\frac{100-100}{100}\right| \times 100\%$$

$$= 0\%$$

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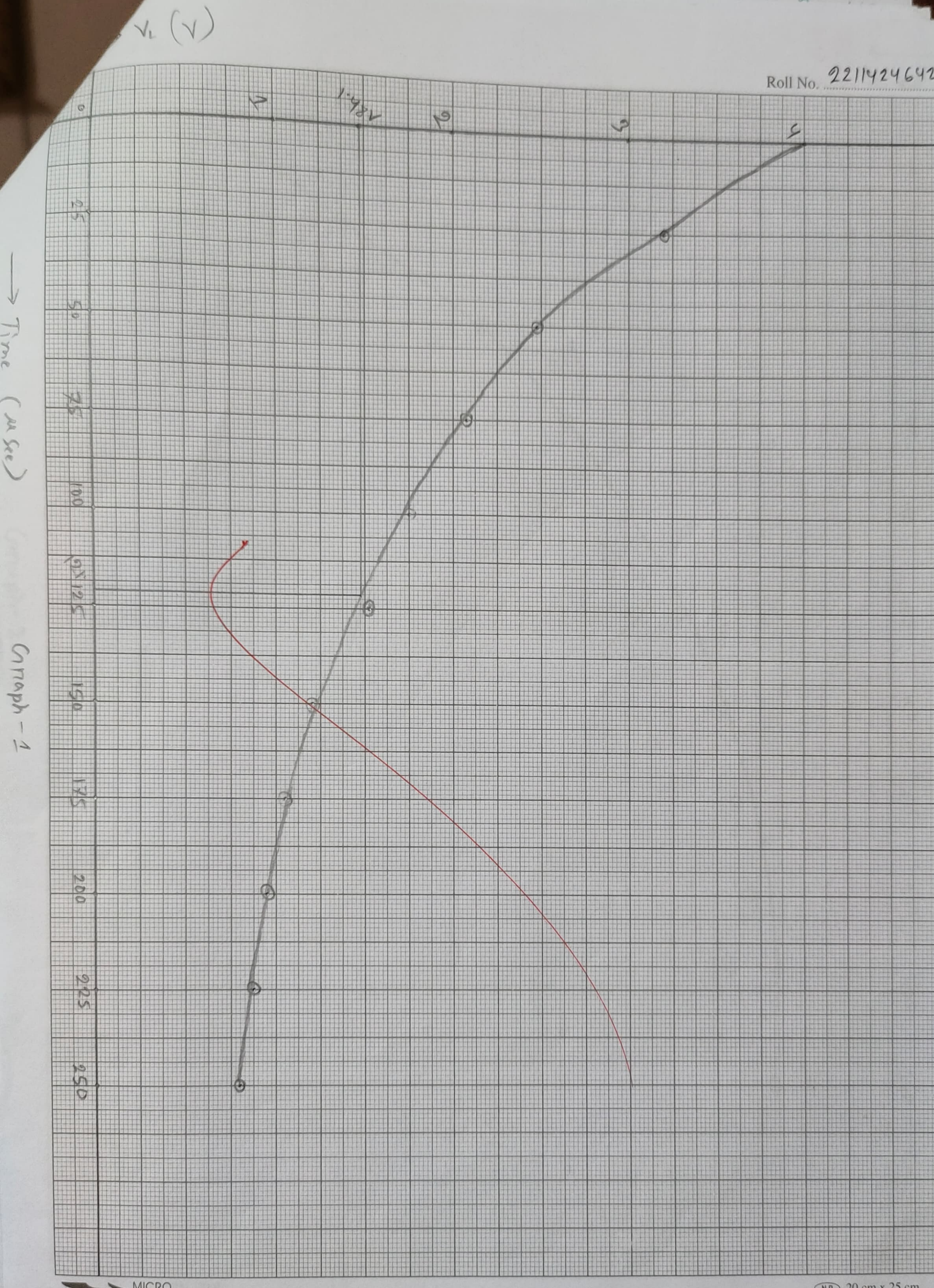
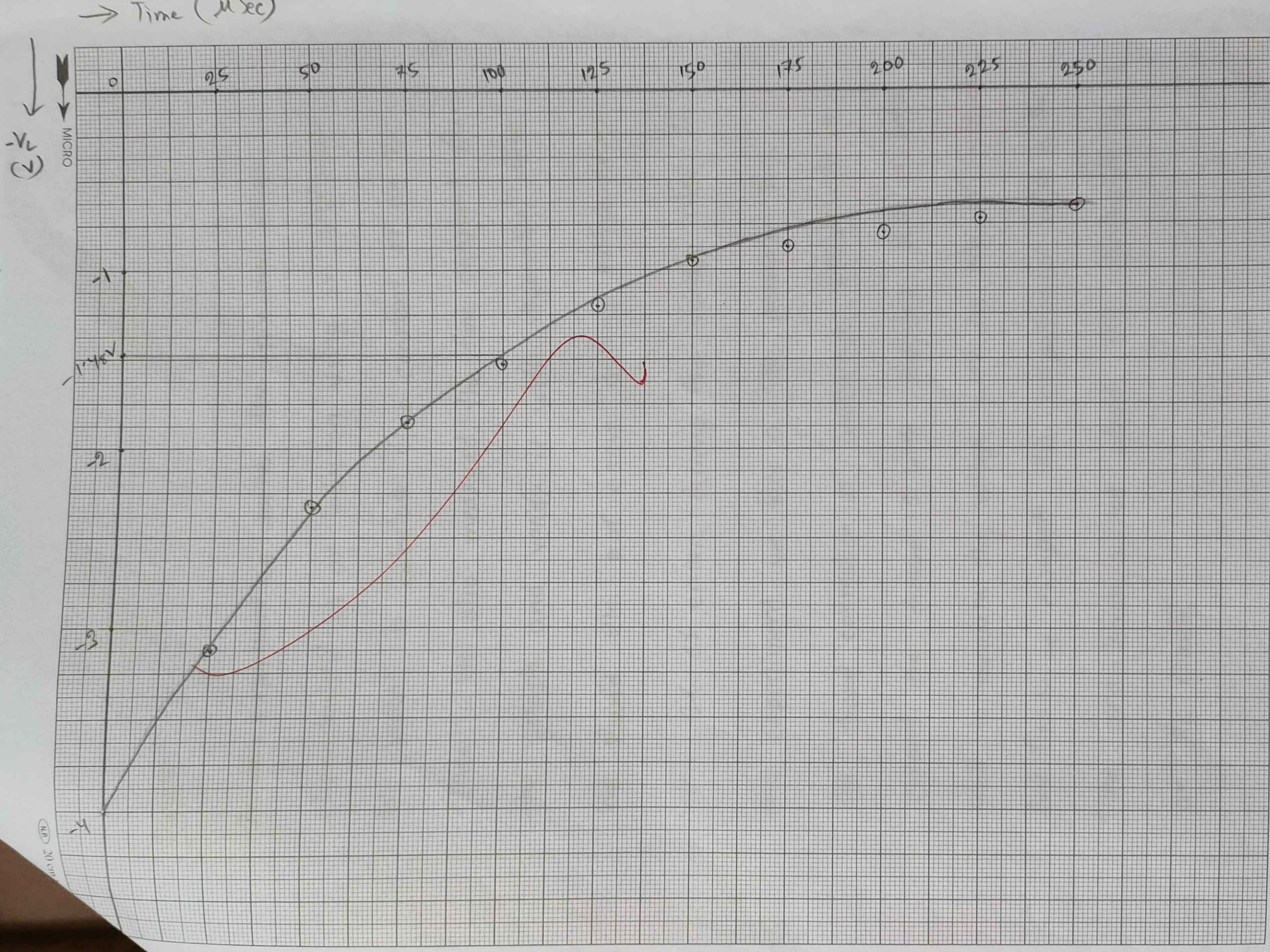


MICRO

N.P. 20 cm x 25 cm



Graph-2

Roll No. 2211424642

Discussion:

In this experiment we observe the rise and decay characteristic of an inductor using an oscilloscope. We learnt to calculate time constant of an RL circuit. We also measured the time constant from the graph and verify it with theoretical value. We found 2% of error during voltage decay and 0% of error during the voltage rise. In this experiment we face a little problem for the chanel connection of oscilloscope. Mistakenly we connect the channel-1 with inductor. But we were able to measure the voltage with the help of instructor. And finally we complete this experiment with in the time and learn a lot about the characteristic of an RL circuit.

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Data Tables:

Table 1: Time dependent for the voltage decay **(positive to zero)** of an inductor

Time (µs)	Calculated V_L (positive to zero) (V)	Measured V_L (V)	Time (µs)	Calculated V_L (positive to zero) (V)	Measured V_L (V)
0	4	4	175	0.695	1.04
25	3.115	3.200	200	0.541	0.96
50	2.426	2.480	225	0.422	0.88
75	1.889	2.08	250	0.328	0.8
100	1.472	1.76	275	0.256	
125	1.146	1.52	300	0.199	
150	0.893	1.2	325	0.155	

Table 2: Time dependent for the voltage decay **(negative to zero)** of an inductor

Time (µs)	Calculated V_L (negative to zero) (V)	Measured V_L (V)	Time (µs)	Calculated V_L (negative to zero) (V)	Measured V_L (V)
0	-4	-4	175	-0.695	-0.880
25	-3.115	-3.12	200	-0.541	-0.800
50	-2.426	-2.32	225	-0.422	-0.72
75	-1.889	-1.84	250	-0.328	-0.64
100	-1.472	-1.52	275	-0.256	
125	-1.146	-1.2	300	-0.199	
150	-0.893	-0.96	325	-0.155	