North South University

Department of Electrical & Computer Engineering

LAB REPORT

Course Code : EEE/ETE 241 L

Course Title: Electrical Circuit 2

Course Instructor: NNP

Experiment Number: 03

Experiment Name:

Series RLC Circuit

Date of Experiment: May, 2020

Date of Submission: January, 2021

Section: 02

Group Number: 04

Submitted By	Score

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Objective:- To analyse the relationship between the voltage and phase of reactive elements and the source in series RC, RL and RLC circuits.

Background:-

B.1 Voltage and current in an AC circuit:-

An RLC circuit is an electrical circuit consisting of a resistor, an inductor, and a capacitor, connected in series or in parallel. The complex impedance in an AC circuit is represented by Z and expressed in cartesian form by formula $Z = R + jX$ where the real part of impedance is the resistance R and the imaginary part is the reactance X. Here, impedance can also be expressed in magnitude and phase form $|Z| \angle \theta$ where θ is the phase difference between the voltage and the current. The magnitude of the impedance can be expressed as $|Z| = \sqrt{R^2 + X^2}$ and the phase can be expressed as, $\theta = \tan^{-1} \frac{X}{R}$. Ohm's law is true for AC circuits and the current flow caused by a voltage V can be given by:-

$$I = \frac{V}{Z}$$

Here, V_s is the voltage source and I_s is the source current and V_R, V_L and V_C the voltage across the resistor, inductor and capacitor respectively.

circuit:-

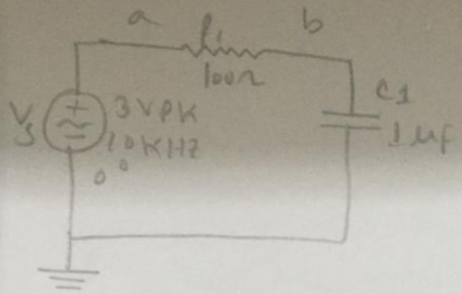


Fig B.1.1.: Series RC circuit

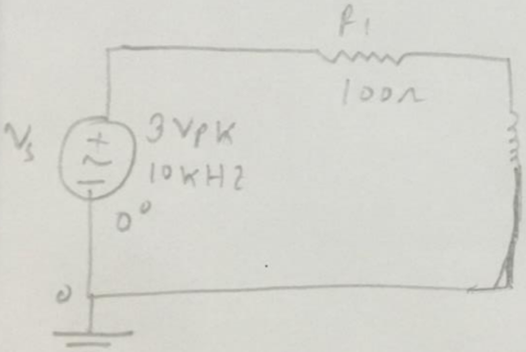


Fig. B.1.2 · Series RL circuit

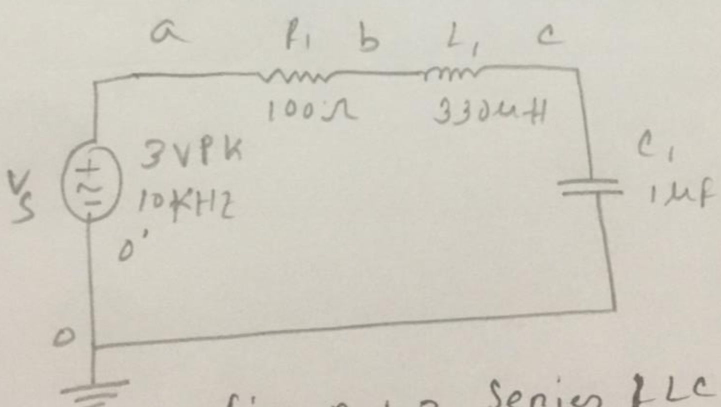


fig. B.1.3. Series RLC circuit.

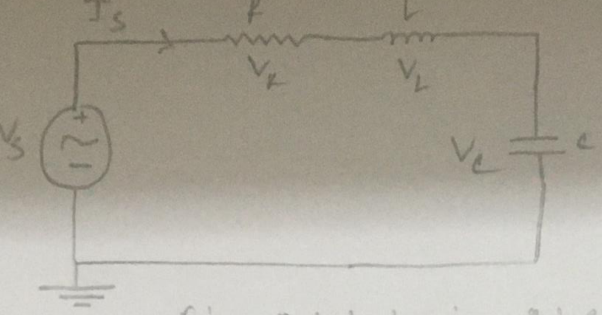


fig B.1.1. Series RLC circuit.

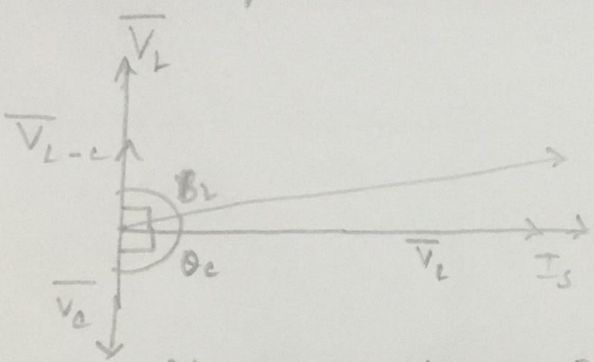


fig B 1.2. Phasor Diagram

A. Apparatus / Equipment:-

Components	Instruments
· Resistor ; 1x 100 Ω · Capacitor : 1x 1uF · Inductor :- 1x 330uH	· 1x Bread board · 1x function Generator · 1x digital Storage Oscilloscope (DSO) -connecting wires and Probes.

0.03A.

Table 1.1.

R (measured) (Ω)	C (measured) (F)	$X_C = \frac{1}{2\pi f C}$ Ω	$Z = \sqrt{R^2+X^2}$ (Ω)	$Z \angle (\tan^{-1} X/R)$ θ.
100 Ω	1 μF	15.92	101.26	9.05.

Table 1.2.

	V_{Peak} (Theory)	θ (Theory)	Delay ΔT (Practical)	V_{Peak} Practical	θ (Practical) $\Delta T \times f \times 360$	% Diff (θ)	% Diff (V).
V_C	~~467 mV~~ [illegible] 8.5V	86°	24 μS	467.5mV	86.4°	0.47%.	6.5%.
V_R	5.5V	18°	5 μS.	5.53V	18°	0%.	0.55%.

Table: 1.3.

R (measured) (Ω)	L (measured) (H)	X_L (Theory) $(2\pi f L)$ Ω	$Z = \sqrt{R^2+X^2}$ (Ω)	$Z \angle [\tan^{-1} X/R]$ θ.
100	330 μH	20.73	102.13	11.71

Table 1.4

	V_{Peak} (Theory)	θ (Theory)	V_{Peak} (Practical	Delay ΔT (Practical)	θ (Practical) $\Delta T \times f \times 360$	% Diff θ	% Difference (V)
V_L	600mV	357°	608mV	99.2 μS	357.12°	0.03%.	1.16%.
V_R	5.4V	~~5~~ 11°	5.382V	3.3 μS	11.88°	7.2%.	0.33%.

36.65

Table: 1.5.

R(Ω)	C(F)	L(H)	X_C (Theory) $\frac{1}{2\pi f C}$ (Ω)	X_L (Theory) $2\pi f L$ (Ω)	$Z = \sqrt{R^2 + X^2}$ (Ω)	$Z = \tan^{-1}(X/R)$ (θ).
100 Ω	1 μF	330 μH	15.92	20.73	106.505	20.13

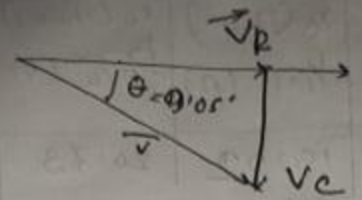
Table: 1.6

	V_{Peak} ~~(Theory)~~ (Practical)	~~Del~~ Delay ΔT ~~(Theory)~~ (Practical)	~~V Peak~~ θ (Practical)
V_L	820 mV	28.3 μS	101.88
V_R	6.06 V	~~6.06 V~~ 2.8 μS	10.08
V_C	475.028 mV	27 μS	97.2

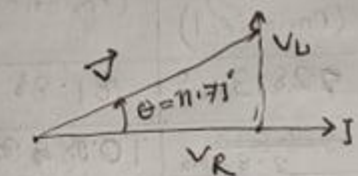
Question - Answers:

① In step 6 we have used a Math function to obtain the voltage drop in the resistor by ~~ab~~ substituting V_C from V_S. If we'd switched the position of resistor & capacitor then, we would get the voltage drop across the capacitor again through Math function of Ch1 - Ch2.

(ii) Phasor diagram for RC circuit:

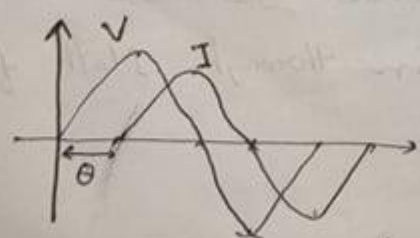


⇒ Phasor diagram for RL circuit:



⇒ Phasor diagram for RLC circuit:

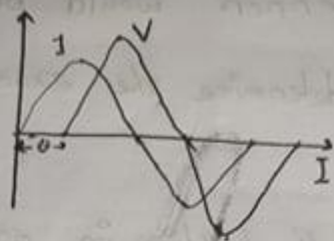
(iii) For Series R_L circuit:



So, if we increas the frequency here asper $\left(T=\frac{1}{f}\right)$ T will get smaller which will reduce the θ eventually.

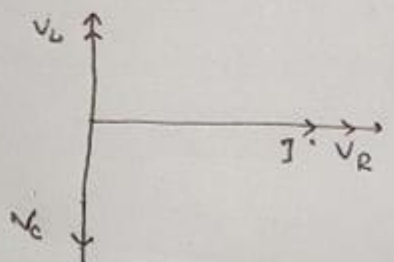
$\sqrt{V_R^2+V_L^2}$

For Series ~~Rb~~C circuit:



In this case, we can see current leads the voltage by θ. So, if we increase frequency the leading angle would decrease.

For series RLC Circuit:



Here, when $X_C > X_L$, voltage will lag the current by θ.

And for $(X_C < X_L)$, voltage will lead the current by θ.

By raising the frequency we can decrease the angle θ.

(iv) As we have completed software simulation due to pandemic, we did not noticed ~~man~~ a huge difference between theoretical and practical values. Rather, it was an acceptable ~~difference~~ error. The cause that ~~may be~~ for this error would be:

(a) We couldn't determine the exact peak values using cursor.

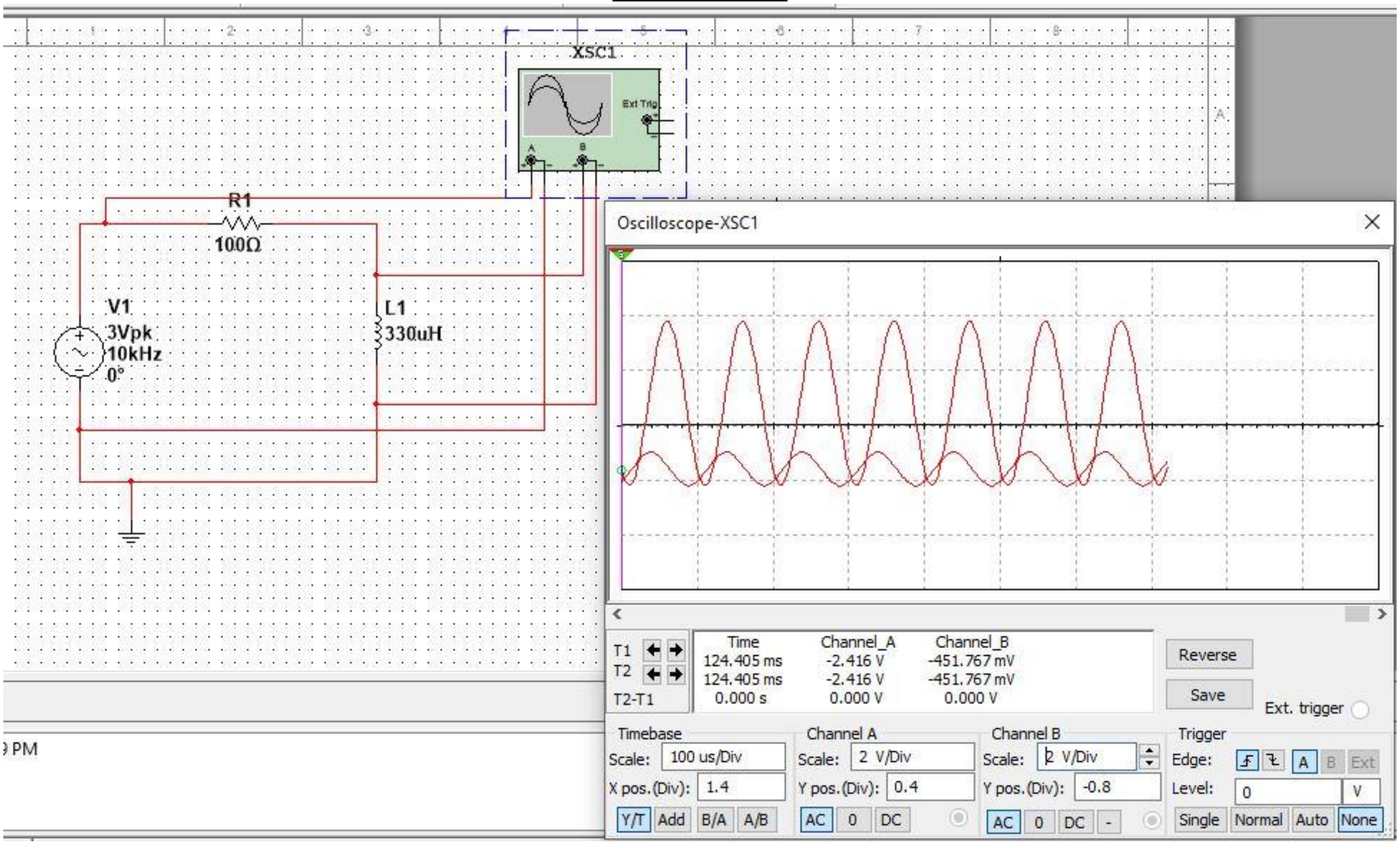
(b) There was a fluctuation in oscilloscope values.

(c) Unavoidable human error.

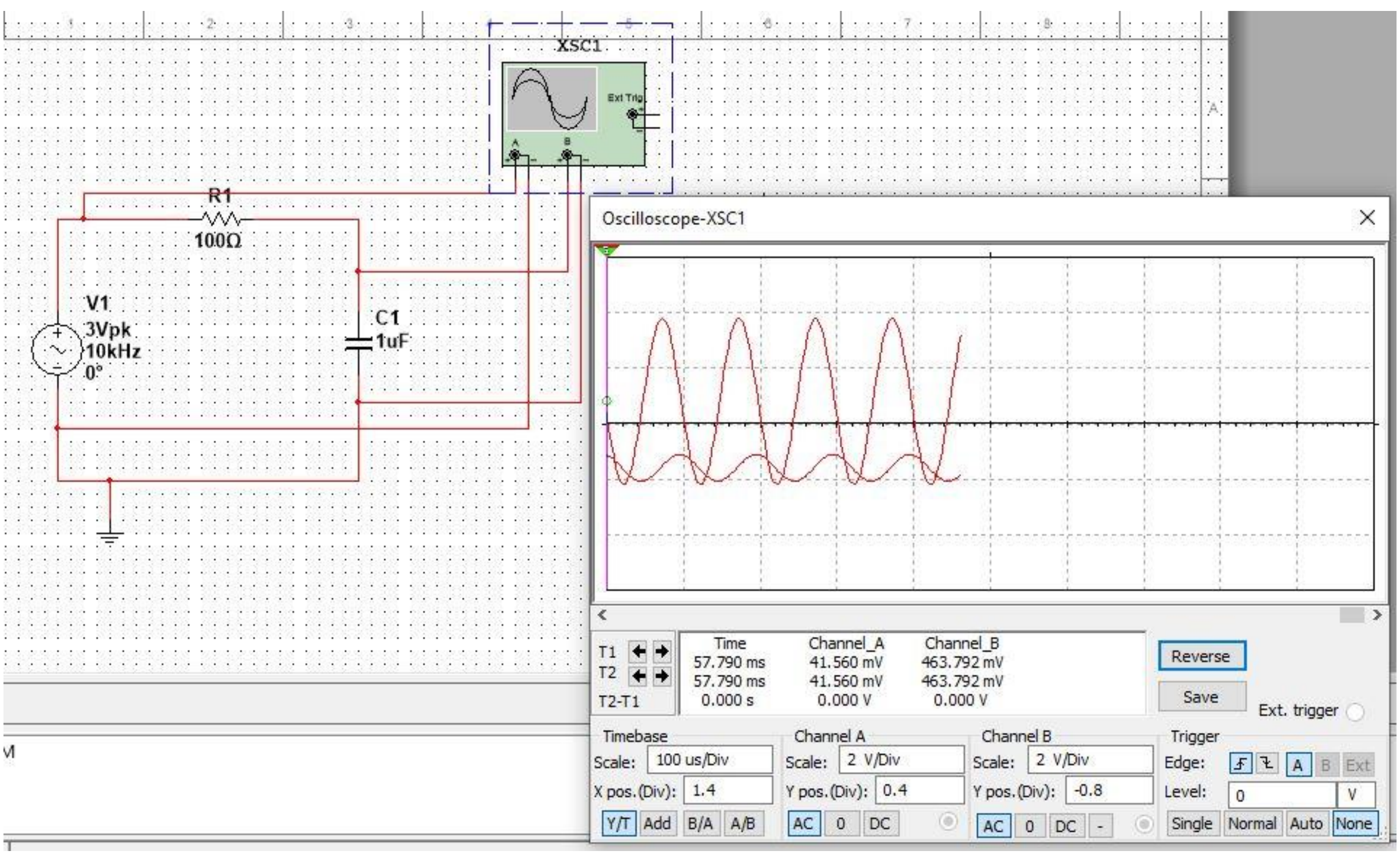
Discussion:

Due to pandemic, we have completed the lab in online. Through software simulation we've completed the circuit & measured the value. The measurement procedure was a bit complex but we've learned from youtube & ~~a~~ honourable instructor. As, the experiment was done in software thus, value of the component was ~~a~~ same as theory & our measured value ~~were~~ ~~at~~ had also minimum percentage of error.

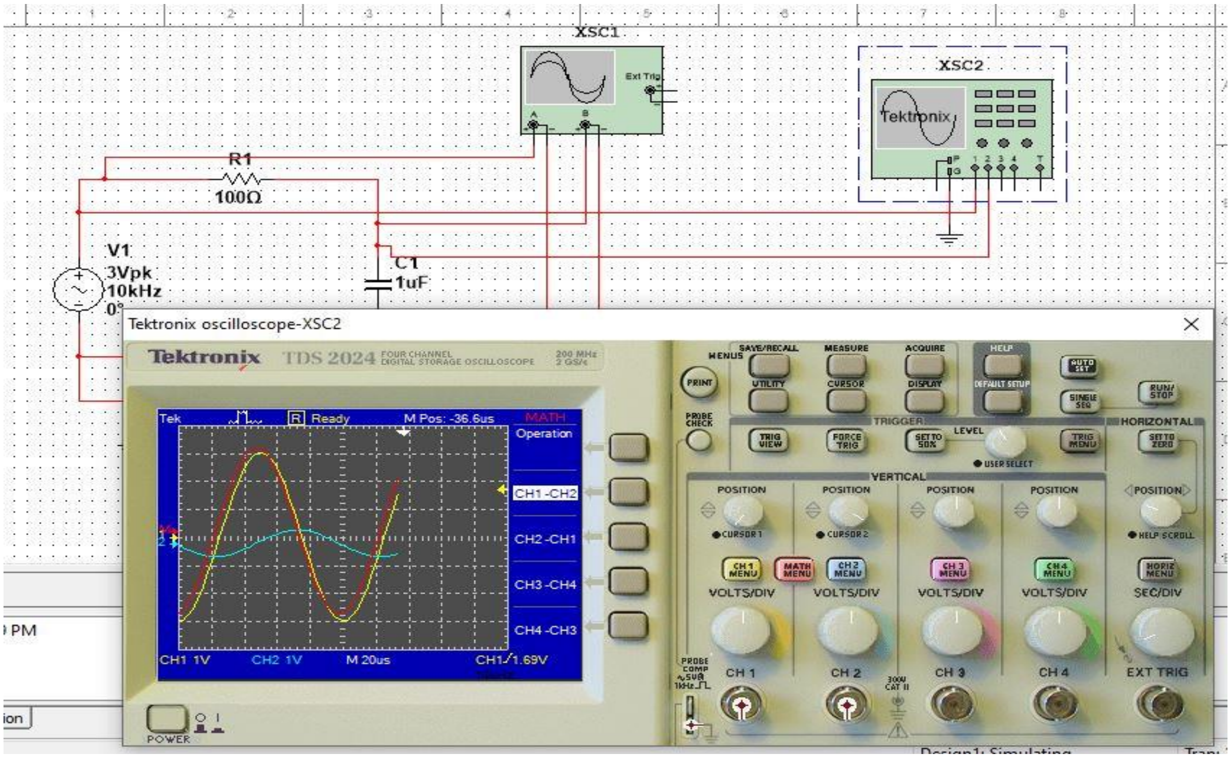
RL Circuit



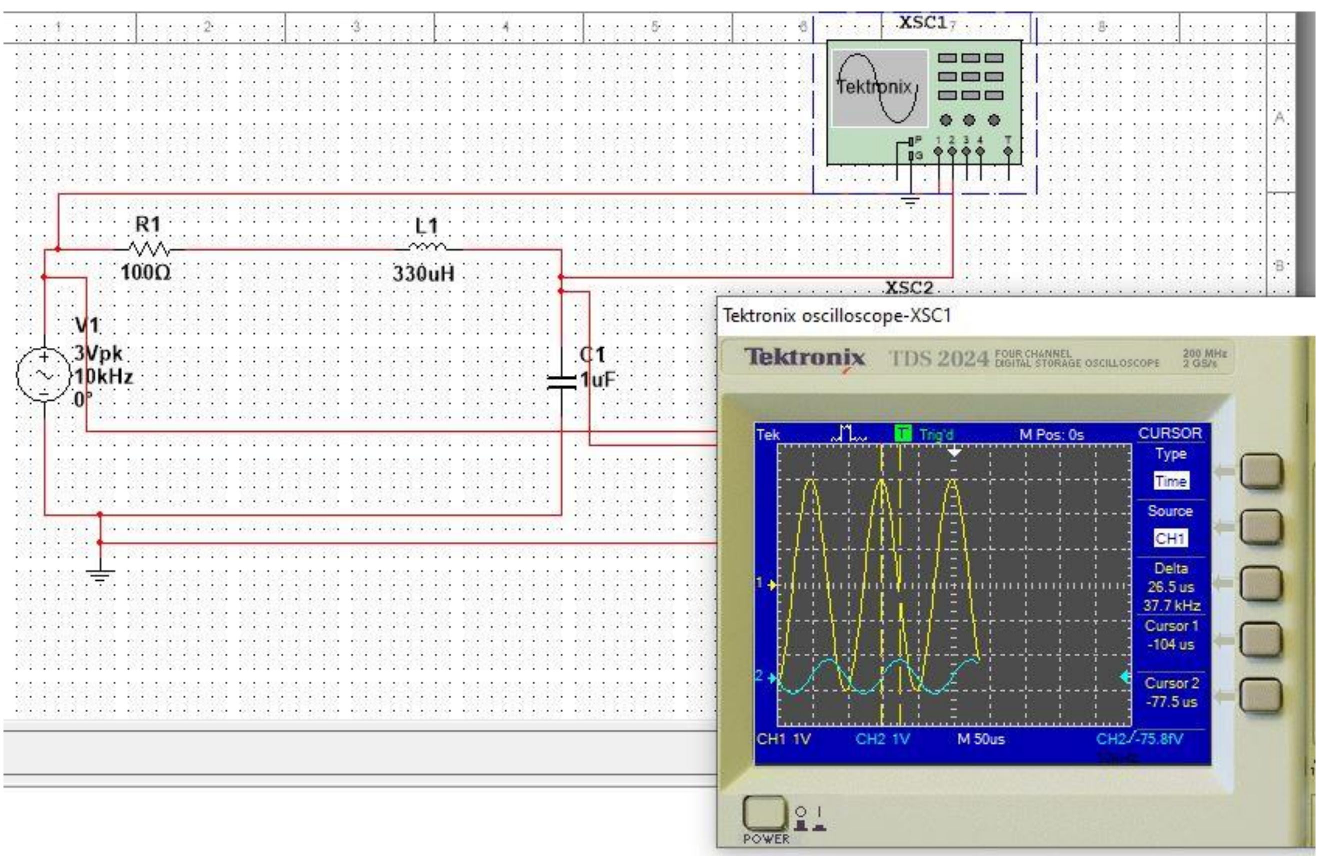
RC Circuit



Math Generated Signal in RC Circuit



Calculating Del-T for RLC Circuit:



Measuring Del-T for Inductor in RLC Series Circuit