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: 07

Experiment Name:

Measurement and Calculation of Power in AC Circuits

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Group Number: 04

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Lab 7 : Measurement and Calculation of Power in AC circuits

A:-

- Study the concept of instaneous power and average power
- Measure the instaneous power and average power.
- Study the concept of Real power, Reactive power, Apparent power, power factor, complex factor, power triangle and power factor improvement.

B. Background:

Instantaneous power is the power dissipated by the body at a given instant of time. In devices where the current and voltage are not constant like AC devices, power dissipated can be calculated as a function of time as current and voltage changes with time.

$$P = VI = I^2R = \frac{V^2}{R}$$

Average power:

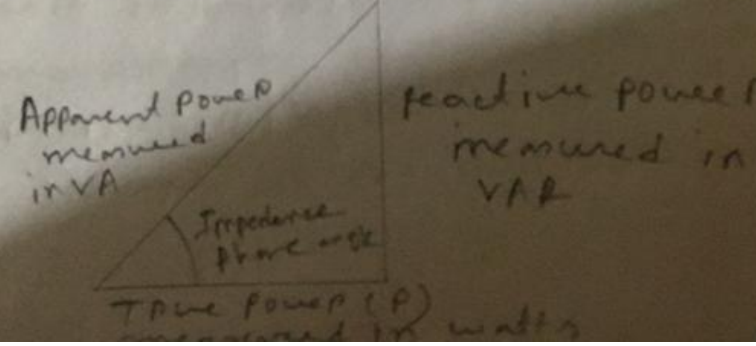
Average power is simply called power when the content makes it clear. The instaneous power is then the limiting value of the average power as the time interval Δt approaches zero.

True, Reactive and Apparent Power :-

Power merely absorbed and returned in load due to its reactive properties is referred to as reactive power. Total power in an AC circuit, both dissipated and absorbed is referred to as apparent power. Apparent power is symbolized by the letter S and is measured in the unit of Volt-Amps (VA)

Power Triangle :-

Power triangle is the representation of a right angle triangle showing the relation between active power, reactive power and apparent power.



Power factor:-

Power factor is the ratio between the power that can be used in electric circuit and the power from the result of multiplication between the current and voltage circuit.

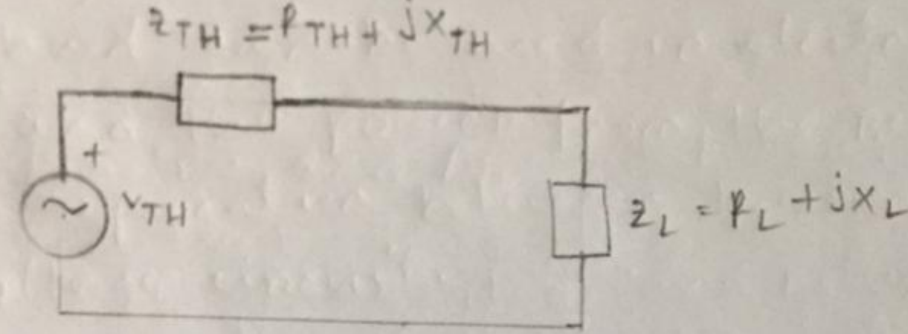
$$pf = \cos\theta$$
$$= \frac{P}{S}$$

Power factor improvement:-

power factor is an important aspect to consider in an AC circuit, because any power factor less than 1 means that the circuit wiring has to carry more current than zero reactance. For the leading currents, the power triangle becomes reversed. This fact provides a key to the power factor improvement.

Maximum power transfer theorem:-

Maximum power transfer theorem states that, to obtain maximum external power from a source with a finite internal resistance, the resistance of the load must equal the resistance of the source as viewed from its output terminals.



circuits:-

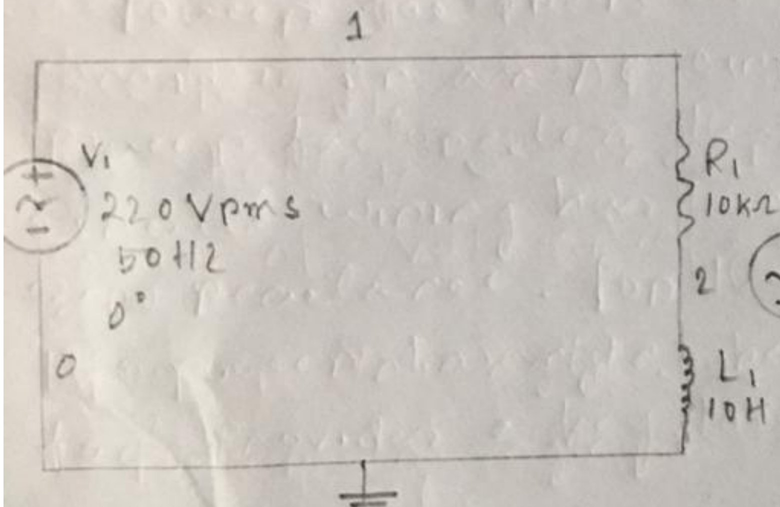


Fig 1: Inductive load in a series circuit

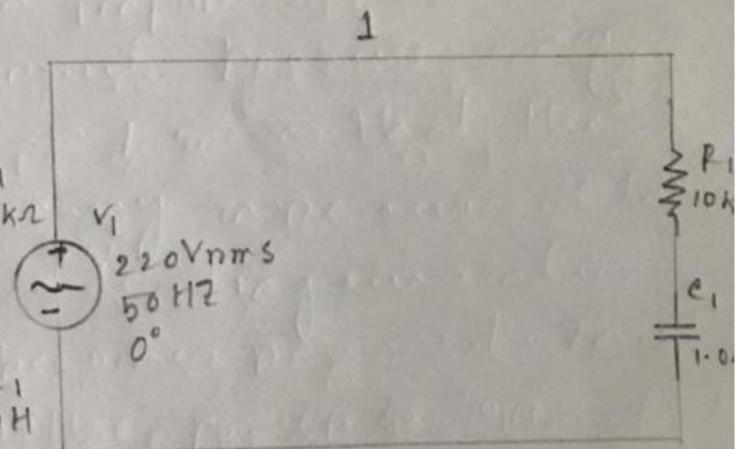


Fig 2: capacitive load in a series circuit.

Table 1.1:

	0°	90°	180°	270°
$V_S(t)$ (V)	310.67	310.66	310.66	310.66
$V_{Rload}(t)$ (V)	217.2	217.28	217.19	217.28
$V_{L\,load}(t)$ (V)	93.47	93.38	93.47	93.38
$i_s(t)$ (A)	0.022	0.022	0.022	0.022
$P_{Rload}(t)$ (W)	4.78	4.78	4.78	4.78
$P_{Lload}(t)$ (W)	2.06	2.05	2.06	2.05

Table 1.2

	Experimental Peak
V_S	310.67 V
V_{Rload}	217.2 V
$V_{L\,load}$	93.47 V
$I_s = \frac{V_{Rload}}{R_{load}}$	0.0217 A
Δt	2 s
$\theta = \Delta t \times f \times 360$	36,000
Δt_L	1.875 s
Φ	17.40

	Theoretical	Experimental	Difference(%)
V_S (rms)	220 V	219.999 V	4.54×10^{-4}
V_{Rload} (rms)	209 V	207.93 V	0.51 %
V_{Lload} (rms)	65.66 V	65.57 V	0.14 %
V_{load} (rms)			
I_S (rms)	0.0209 A	0.0209 A	0 %
$P_{Rload} = V_{Rload} \times I_S \times \cos\theta$	4.37 W	4.35	0.46 %
$P_{Lload} = V_{Lload} \times I_S \times \cos\theta$	1.37 W	1.37	0 %
$P_{load} = V_{load} \times I_S \times \cos\theta$			
$P_{total} = P_{Rload} + P_{Lload}$	5.74 W	5.72	0.35 %
$P_S = V_S \times I_S \times \cos\theta$	4.598 W	4.598 W	0 %

Table 1.4

	0°	90°	180°	270°
$V_S(d)$ (V)	310.69	310.61	310.69	310.51
$V_{Rload}(d)$ (V)	211.92	190.74	218.54	225.96
$V_{Cload}(d)$ (V)	98.77	119.87	92.15	84.55
$i_S(d)$ (A)	0.021	0.019	0.022	0.023
$P_{Rload}(d)$	4.45	3.62	4.81	5.19
$P_{Cload}(d)$	2.07	2.28	2.03	1.94

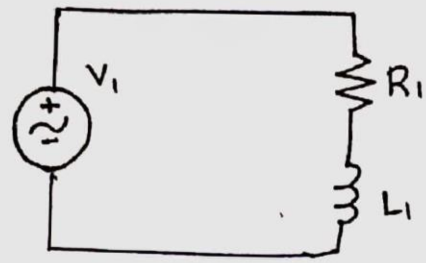
Table 1.5

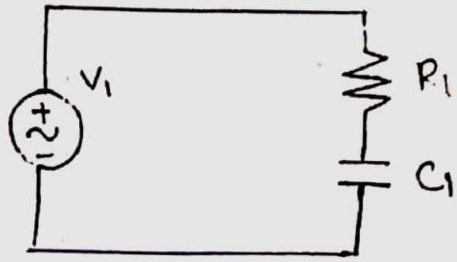
	Experimental Peak
V_S	310.69
V_{Rload}	211.92
V_{Cload}	98.77
$I_S = V_{Rload}/R_{load}$	0.021
Δd	2s
$\theta = \Delta t \times f \times 360$	36,000
Δt_C	2.6 s
Φ_C	17.65

Table 1.6!

	Theoretical	Experimental	% Difference
V_S (rms)	220 V	219.982 V	8.18×10^{-3}
V_{Rload} (rms)	209 V	209.69 V	0.33%
V_{Cload} (rms)	66.527 V	66.53 V	4.6×10^{-3}
V_{load} (rms)			
I_S (rms)	0.0209	0.02097	0.33%
$P_{Rload} = V_{Rload} \times I_S \times \cos\theta$	4.3681	4.397 W	0.66%
$P_{Cload} = V_{Cload} \times I_S \times \cos\theta$	1.390	1.395 W	0.36%
$P_{load} = V_{load} \times I_S \times \cos\theta$			
$P_{total} = P_{Rload} + P_{Cload}$	5.7581	5.792 W	0.59%
$P_S = V_S \times I_S \times \cos\theta$	4.598	4.613	0.33%

Questions :-





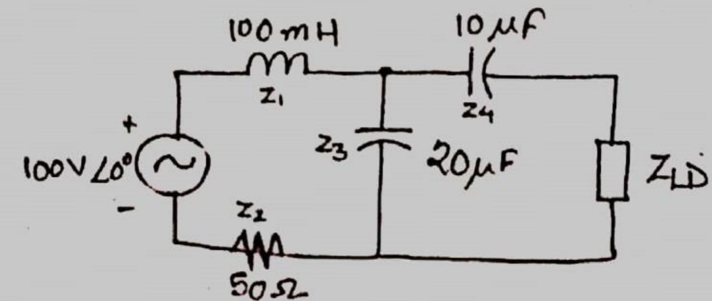
1) How much average power is consumed by the inductor & Capacitor?

Ans: The average power consumed by the inductor and the capacitor is zero. Since the voltage (V) and current (I) are 90° out of phase for all reactive loads, the power factor for them, $Pf = \cos \pm 90° = 0$. Therefore the average power consumed by reactive load is zero. as ~~and~~ the power recieved capacitor and inductor is returned back in the cycle.

2. What is the effect of the inductor and capacitor on the instantaneous power of the R1

Ans: A circuit element produces or dissipates power according to $P = I.V$ where I is the current ~~accross~~ through the element and V is the voltage accross it. Since the current and voltage depends on time in a AC circuit, instantanious power is also time dependent For R1, I(t) and V(t) are in phase and ~~as~~ therefore Always it have the same sign but for a capacitor and inductor, the relative sign of V(t) and I(t) vary over ~~time~~ ~~due to~~ a ~~ey~~ cycle due to their phase difference. Consequently, P(t) is positive at times and negative at others indicating that capacitive and inductive element produces power at some instants and absorbs it at other.

3) Determine the load Z_{LD} that will allow maximum power delivered to the load for the following circuit, if the frequency is 192.241 Hz. What should be the maximum power of the load? Construct a final circuit in multisim and measure the power at the load. Is the result similar to the theoretical maximum power. Attach the simulation screenshot in the lab report.



Ans: Maximum power delivered where $Z_{LD} = Z_{TH}$

$\therefore Z_{LD} = \{(Z_1 + Z_2) \parallel Z_3\} + Z_4$ where

$\{(j120.79 + 50) \parallel -j41.39\} + (j82.79)$

$= 9.731 - j139.63$

$= 139.98 \angle -86.013$

$Z_1 = j \times 2\pi \times 192.241 \times 100 \times 10^{-3}$

$= j120.79\ \Omega$

$Z_2 = 50\ \Omega$

$Z_3 = -j41.994\ \Omega$

$Z_4 = -j82.79\ \Omega$

~~Maximum power~~ $\cancel{P_{max} = \frac{V_{TH}^2}{4R_L}}$

$\cancel{= \frac{100^2}{}}$

$$V_{TH} = \frac{-j41.394}{j120.79 + 50 + (-j41.394)} \times 100$$

$= -34.096 - j2.429$

$= 34.18 \angle \cancel{-175}.92$

$$P_{max} = \frac{|V_{TH}|^2}{8R_{TH}}$$

$$= \frac{34.18^2}{8 \times 139.98}$$

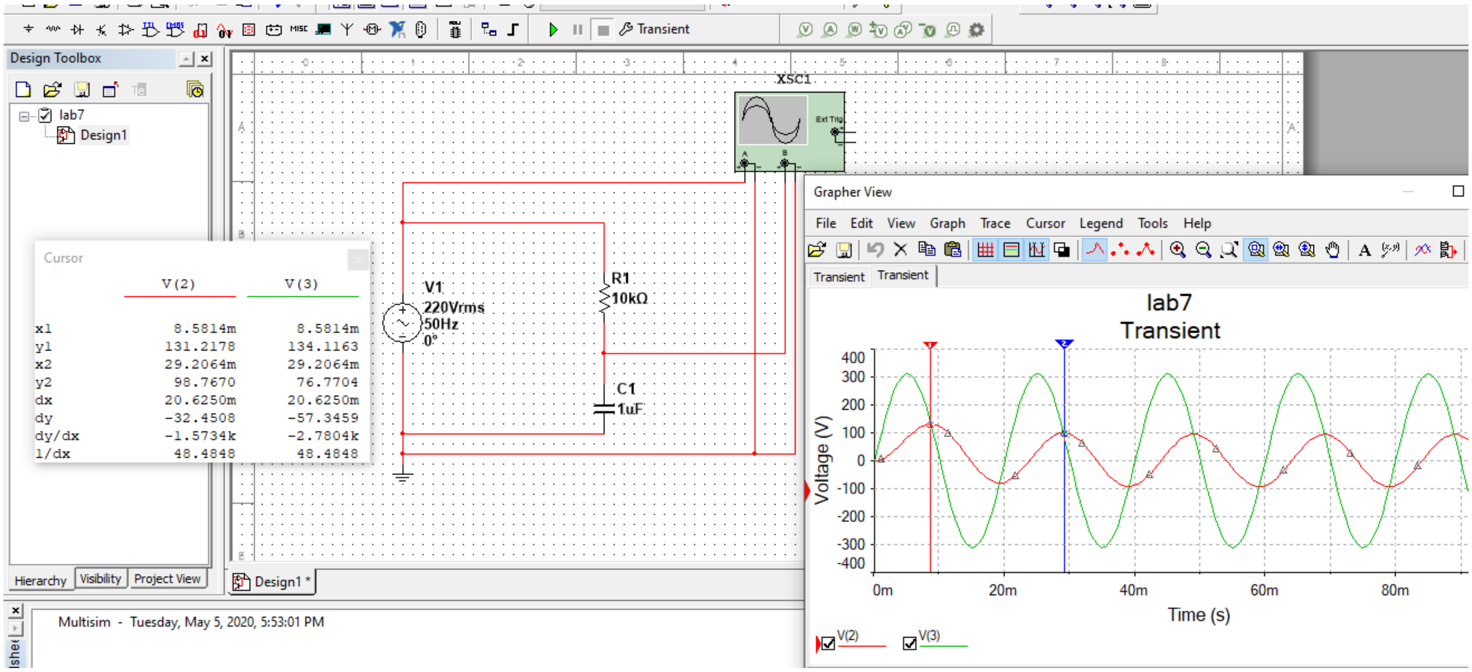
Discussion:

We have completed the experiment of power measurement for two circuits. One is RC series circuit & other is RL series circuit. For the both circuits our theoretical value matched with the observed value. Percentage of difference betweet theoretical & measured value was less ~~that~~ than 0.5% in both cases which is acceptable. The minimal error causes may be the equipment we have used also were not accurate as theoretical values. There was some fluctuation while observing values.

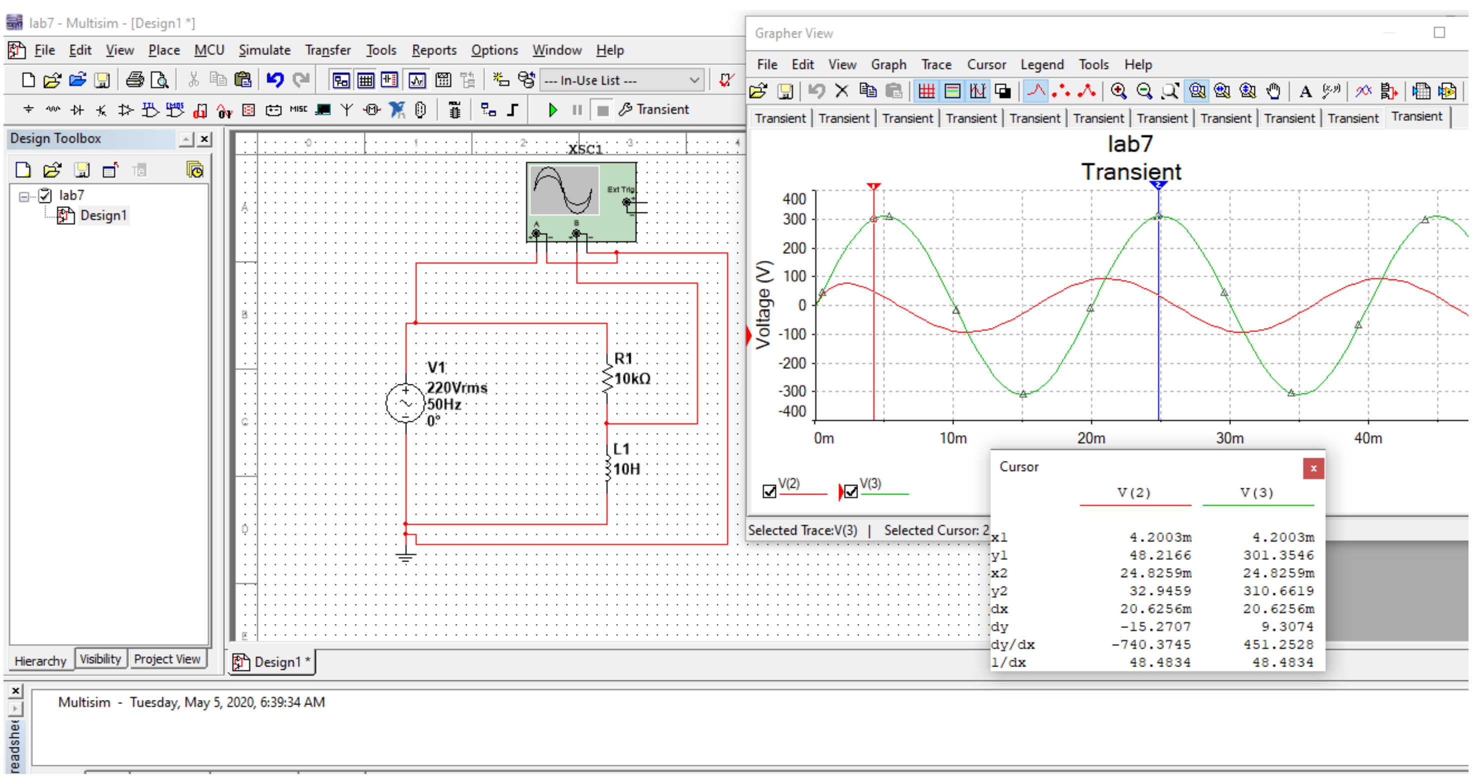
During this experiment while measuring Voltage we were a bit confused about the node. measuring tools. Then we contacted with our instructor & learned about them.

This experiment ~~feet~~ fills up our gaps between theoretical learning about on Power & practical learning. We learned to implement our theoretical ideas in practical sector.

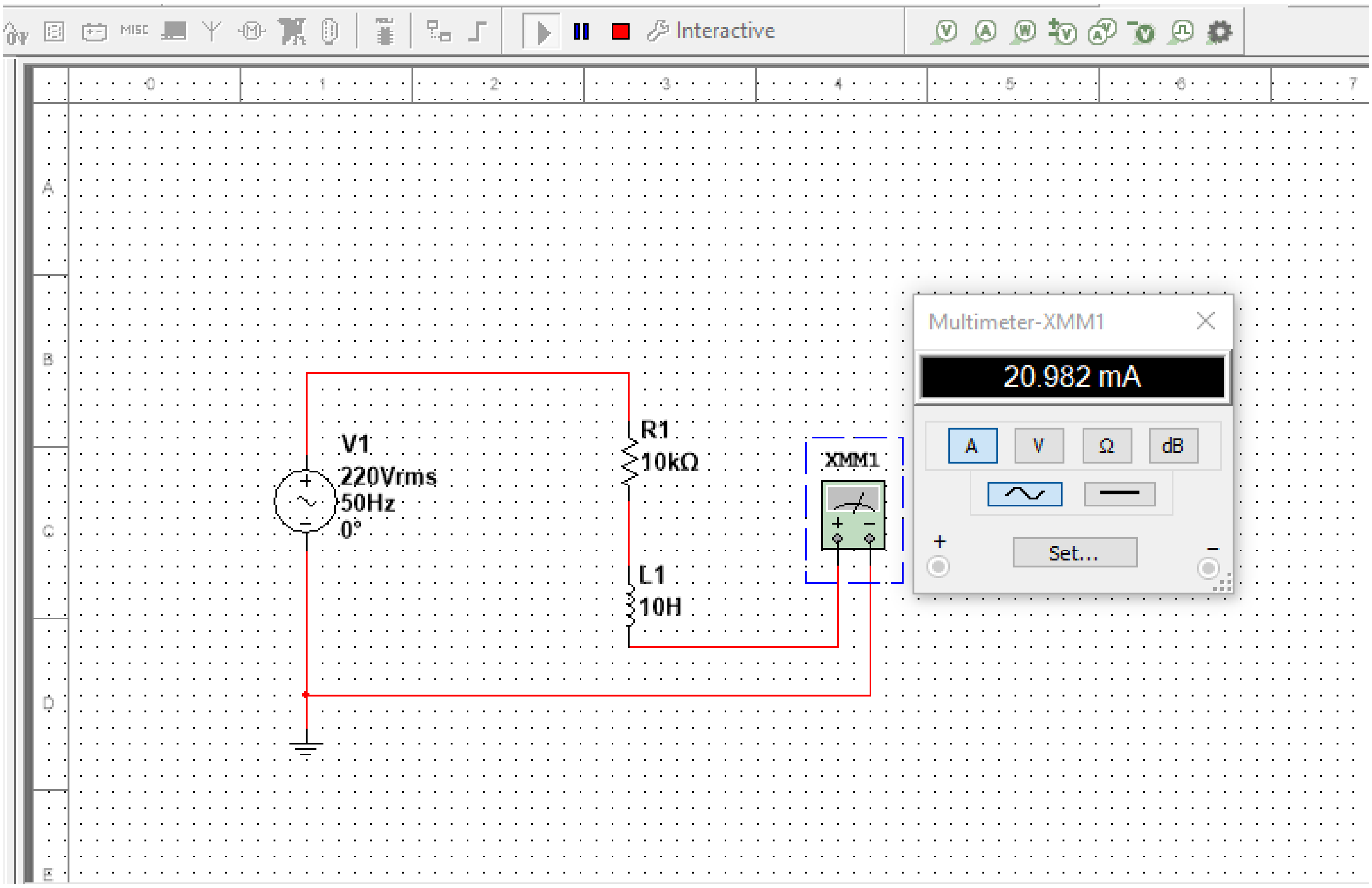
Measuring Del-Tc and V(load) across Capacitor at 0 Degree Phase shift



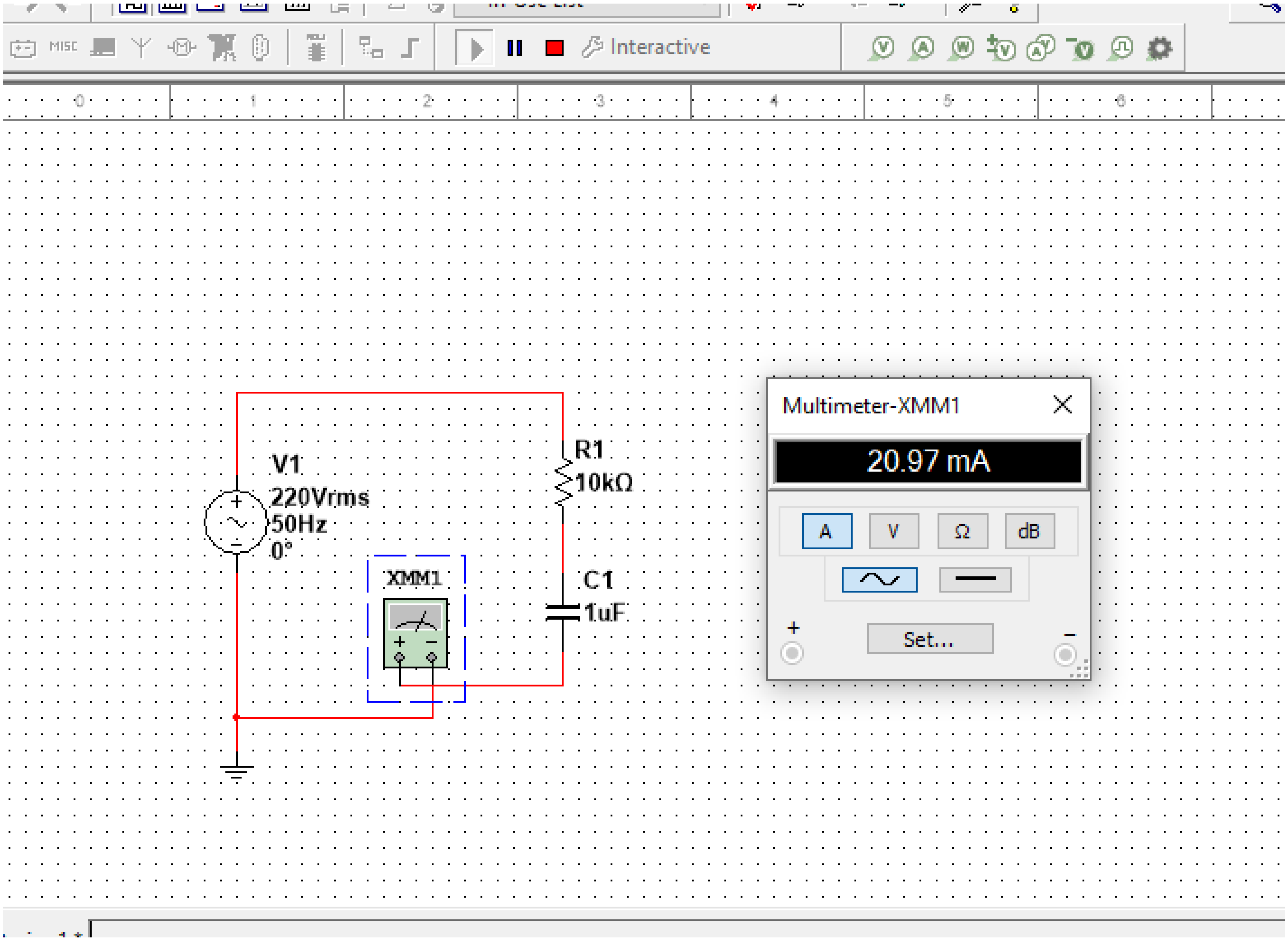
Measuring Del-Tc and V(source) across Capacitor at 0 Degree Phase shift



Measuring Source RMS Current in RL series circuit, I(source)



<u>Measuring Source RMS Current in RC series circuit, I(source)</u>



<u>Measuring Source RMS Voltage across Resistor and Capacitor, I(source)</u>