EXPERIMENT NO: 01

SUPERPOSITION THEOREM

OBJECTIVE:

To Verify Superposition Principle in DC Circuits

REQUIRED:

1- DMM
2- 2 DC Power Supplies,
3- Resistances (1k Ω, 2k Ω, 430k Ω)

THEORY:

The superposition principle states that:

> **"The current through or voltage across, any resistive branch of a multisource network is the algebraic sum of the contribution due to each source acting independently."**

When the effect of one source is considered, the others are replaced by their internal resistances. This principle permits one to analyze circuits without restoring to simultaneous equations.

Superposition is effective only for linear circuit relationship. Non-linear effects, such as power, which varies as the square of the current or voltage, cannot be analyzed using this principle.

FIGURE:

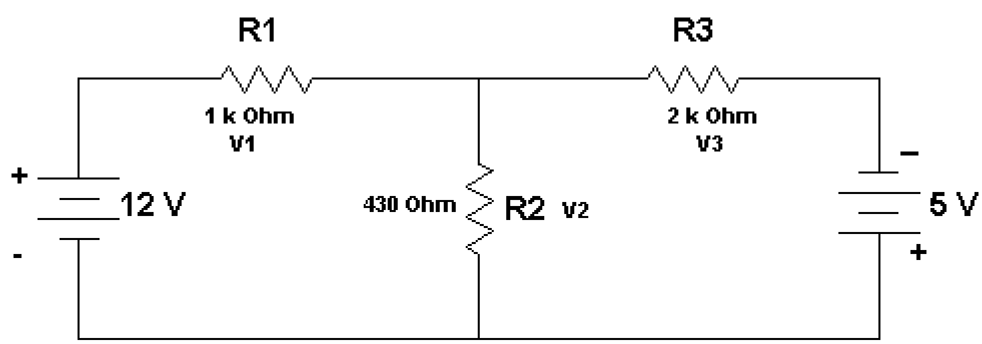

Fig-1

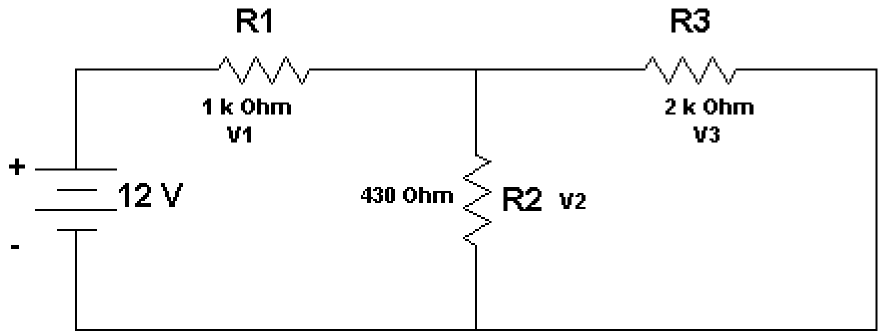

Fig – 2

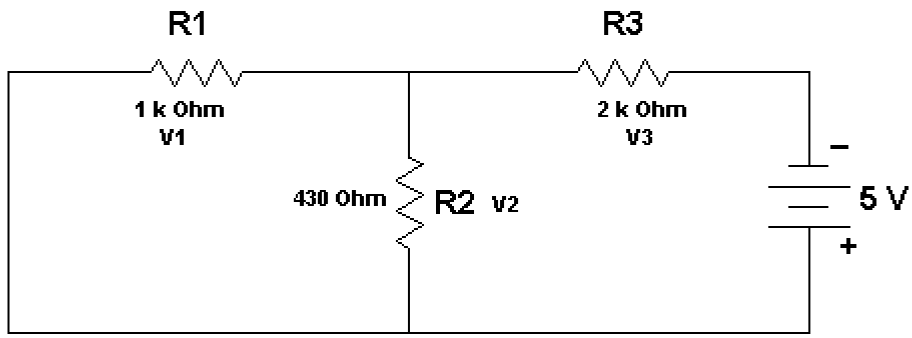

Fig – 3

PROCEDURE:

1. Construct the Network of Fig-1, where R1 = 1 k Ω, R2 = 430 Ω, R3 = 2 k Ω. Verify the resistances using DMM.
2. Using superposition and measured resistance values, calculate the currents indicated in observation Table (a), for the network of Fig-1. Next to each magnitude include a small arrow to indicate the current direction for each source and for the complete network.
3. Energize the network of Fig-1 and measure the voltages indicated in observation table b, calculate current in Table (b) using Ohm's Law. Indicate the polarity of the voltages and direction of currents on Fig-1.
4. Construct the network of Fig -2. Note that source E2 has been removed.
5. Energize the network of Fig -2 and measure the voltages indicated in Table (c). Calculate currents using Ohm's Law.
6. Now construct the network of Fig -3. Note that source E1 has been removed.
7. Energize the network of Fig -3 and measure the voltages indicated in Table (d). Calculate currents using Ohm's Law.
8. Using the results of steps # 3, 5 and 7, determine the power delivered to each resistor and insert in Table (e).

OBSERVATIONS:

Resistors:

	Nominal Values (Ω)	Measured Values (Ω)
1	1K	
2	430	
3	2K	

a) Calculated Values for the Network of Fig. 1

Due to E1	Due to E2	Algebraic Sum (∑)
I_1 =	I_1 =	I_1 =
I_2 =	I_2 =	I_2 =
I_3 =	I_3 =	I_3 =

b) Measured Values for the Network of Fig.1

V_1	V_2	V_3	I_1	I_2	I_3

c) Measured Values for the Network of Fig.2

V_1	V_2	V_3	I_1	I_2	I_3

d) Measured Values for the Network of Fig. 3

V_1	V_2	V_3	I_1	I_2	I_3

e) Power Absorbed (use measured values of I and V)

Due to E_1	Due to E_2	Sum of Columns 1 & 2	E_1 & E_2 Acting Simultaneously

EXPERIMENT NO: 02

VERIFICATION OF THEVENIN'S THEOREM

OBJECTIVE:

To Verify Thevenin Theorem by finding its Thevenin's Equivalent Circuit

REQUIRED:

1. VOM/DMM
2. Power Supply
3. Resistances (120Ω, 1k Ω, 390Ω)

THEORY:

Any linear circuit is equivalent to a single voltage source (Thevenin's Voltage) in series with single equivalent resistance (Thevenin's Equivalent Resistances)

The current flowing through a load resistance RL connected across any two terminals **A** and **B** of a network is given

FIGURE:

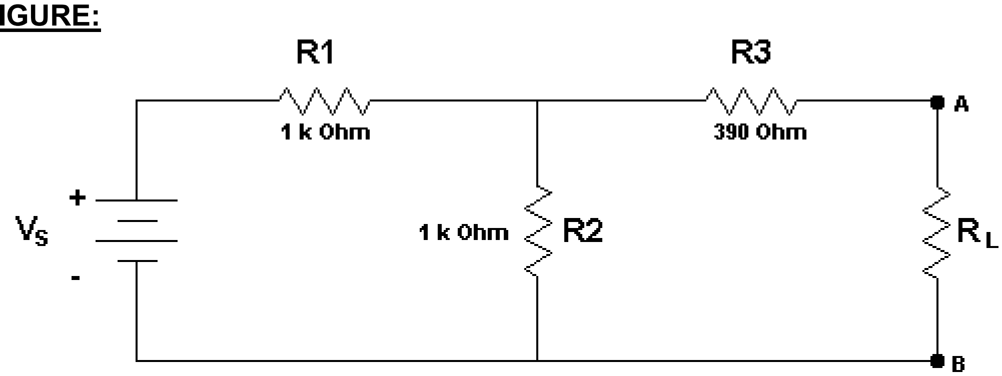

Fig – 1

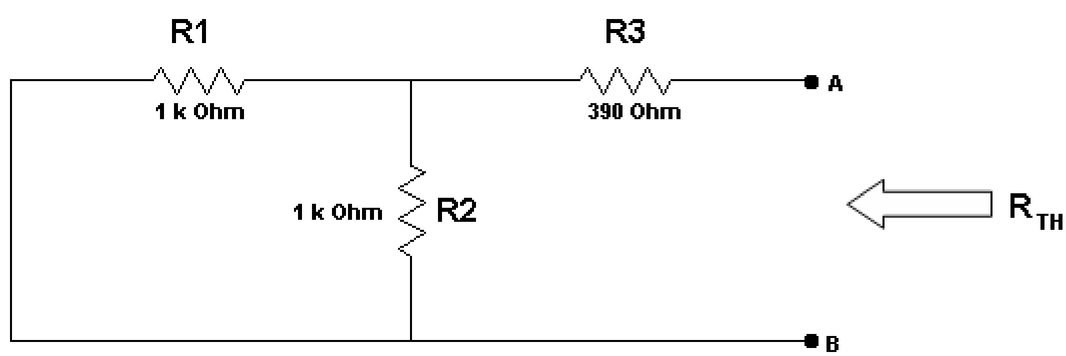

Fig – 2

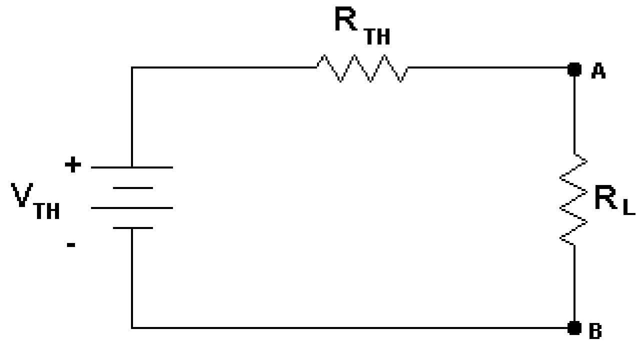

Fig – 3

PROCEDURE:

1. Reduce the circuit by calculating the Thevnin equivalent resistance across the terminals **A** & **B**
2. Determine the Thevinin equivalent voltage across terminals **"A"** and **"B"** for 5V, 10V, 15V.
3. Now, combine the Thevenin voltage with its resistance determines across 120Ω, 1K Ω, and 390 Ω resistors.

TABLE-1:

V_S	R_1	R_2	R_3	V_{TH}	R_{TH}
5V					
10V					
15V					

TABLE-2:

V_S	V_{TH}	R_{TH}	R_L	I_L
5V			**120**	
			390	
			1K	
10V			**120**	
			390	
			1K	
15V			**120**	
			390	
			1K	

EXPERIMENT NO: 03

VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM

OBJECTIVE:

To Verify Maximum Power Transfer Theorem

Discussion

Maximum power transfer theorem states that any linear network, if the load resistance equals its Thevenin's equivalent resistance, the load can yield a maximum power from sources.

Now we consider the Thevenin's equivalent shown in Fig 1. By Ohm's Law, the power dissipated in the Load P_{RL} can be expressed as follows.

$$I = E_{TH} / (R_{TH} + R_L)$$

$$P_{RL} = I^2 * R_L$$

$$P_{RL} = [E_{TH} / (E_{TH} + R_L)^2 * R_L$$

or

$$P_{RL} = (E_{TH}^2 * R_L) / (R_{TH} + R_L)^2$$

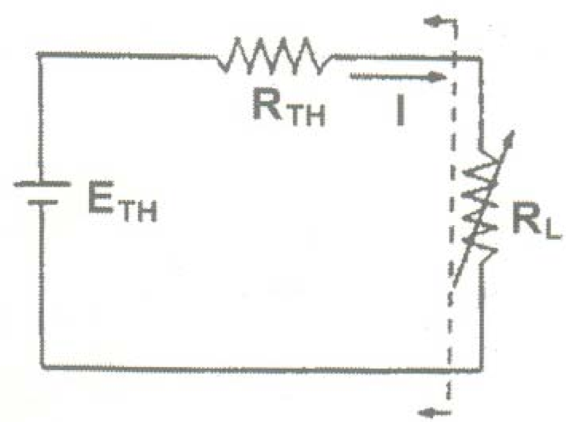

Figure-1

Suppose E_{TH} = 4V and R_{TH} = 5Ω, then P_{RL} can be expressed by the equation $P_{RL} = 16\ _{RL} / (5+R_L)^2$. Now we calculate and record each of the P_{RL} values for each R_L value from 1 Ω to 9 Ω increasing the step to 1 Ω. The results are listed in Table 1 and plotted in Fig 2. From both Table 1 and fig- 2, you can find that the maximum value of P_{RL} occurs at $R_L = R_{TH}$.

Table – 1

(Ohms)	(Watts)
1	0.445
2	0.655
3	0.750
4	0.790
5	0.800 ←
6	0.792
7	0.780
8	0.760
9	0.735

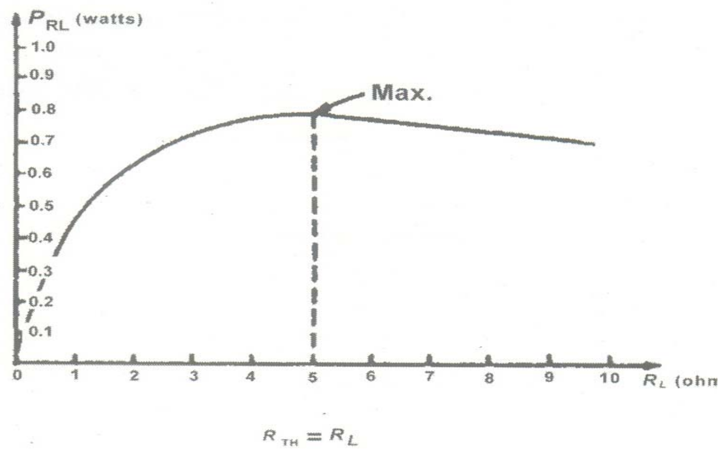

Figure -2

Procedure

1. Set the Module KL-13001 on the main KL-21001, and locate the block a.
2. According to Figs. 1 , complete the experiment circuit with short-circuit clips.
3. Apply +15V to +V.
   Turn off the power switch.
4. Adjust V_{R1} to 250 Ω. (Let R_1=R_{TH}, V_{R1}=R_l).
   Turn on the power.
   Measure and record the current flowing through VR1 as indicated by the milliammter.

   I = ________________________________ mA.

   Calculate and record the power dissipated by V_{R1} using the equation

   $P_{RL} = I^2 * R_L$. P_{RL}=________________________________ W.

   Turn off the power.
5. Adjust V_{R1} to 500 Ω and repeat step 4.

   I = ________________________________ mA

   P_{RL} = ________________________________ W
6. Adjust V_{R1} to 1 K Ω and repeat step 4.

   I = ________________________________ mA

   P_{RL} = ________________________________ W
7. Adjust V_{R1} to 1.25 K Ω and repeat step 4.

   I = ________________________________ mA

   P_{RL} = ________________________________ W
8. Adjust V_{R1} to 1.5 K Ω and repeat step 4.

   I=________________________________ mA

   P_{RL}= ________________________________ W
9. Complete Fig. 4 by using you measured I and calculated PRL values.

EXPERIMENT NO: 4

To observe variation in impedance and current of an RL series network in ac circuit

Discussion

When an ac voltage is applied across a pure inductance, the current lags the voltage by **90** .Inductance therefore has phase angle associated with it .The opposition that an inductance offers to the flow of alternating current is called inductive reactance and may be expressed as $X_L < 90°$, or jX_L

The magnitude of X_L is X_L = 2πfL =2ωL

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An RL series circuit with an ac supply voltage is shown in Fig-1.The impedance of this circuit can be expressed as

$$Z_T - Z_1 + Z_2$$
$$= R < 0° + X_L < +90°$$

The current in the circuit is

L =E/Z_T (the current lags the voltage)

The voltage across R is

V_R =l R

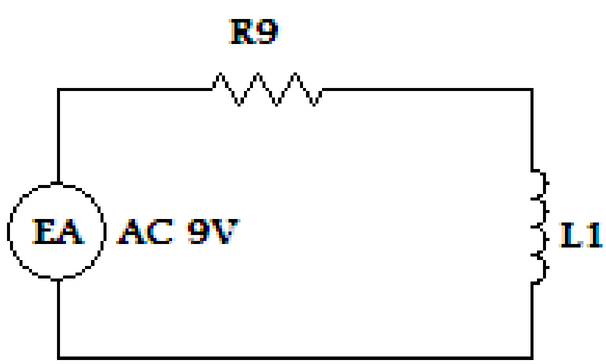
The voltage across l is

V_L =IX_L

By Kirchhoff s voltage law, then

$\sum$V= E - V_R - V_L =0

$$E = \overrightarrow{V_R} + \overrightarrow{V_L}$$



Figure

Procedure

1. Set the module KL -13001 on the main unit KL-21001, and locate the block f, link 0.5H inductance at L1 position.
2. According to Figure complete the experiment circuit with short –circuit clips. Apply the AC power 9V to EA.

   Measure and record EA. EA =________________________V
3. Calculate and record the values below.

Reactance of L1	X_L =	____________________	Ω
Total impedance	Z_T =	____________________	Ω
Current in circuit	I =	____________________	mA
Voltage across R9	V_R =	____________________	V
Voltage across L1	V_L =	____________________	V
Phase angle	θ=	____________________	
Power dissipated	P=	____________________	mW

4. Measure and record the values of V_R = and V_L =by Using the AC voltmeter.

Voltage across R9	V_R =	____________________	V
Voltage across L1	V_L =	____________________	V

5. Do the measured values equal the calculated values of step 3?

   Yes **No**

6. Using the equation $E = \vec{V_R} + \vec{V_L}$, calculate the applied voltage of the circuit

   EA = ________________________ V

   Does the calculated value equal the measured value of step 2?

   Yes **No**

   If No explain it.

   ____

   ____

   ____

   ____

EXPERIMENT NO: 5

To observe variation in impedance and current of an RC series network in ac circuit

Discussion

When an ac voltage is applied across a pure resistance, the resultant current is in phase with the applied voltage. Resistance therefore has no phase angle associated with it and is written as R□0. When an ac voltage is applied across a pure capacitor, the resultant current leads the voltage by 90. Capacitance therefore has a phase angle associated with it. The opposition that a capacitor offers to the flow of alternating current is called capacitive reactance and is written as Xc□ -90, or –jXc. The magnitude of Xc is Xc=1/2π fC= 1/wC.

An RC series circuit with an ac supply voltage is shown Fig . The impedance of this circuit can be expressed as

$$Z_T = Z_1 + Z_2 = R\ 0 + X_C\ {-90}$$

The current in the across R is

$$E_R = I\ R$$

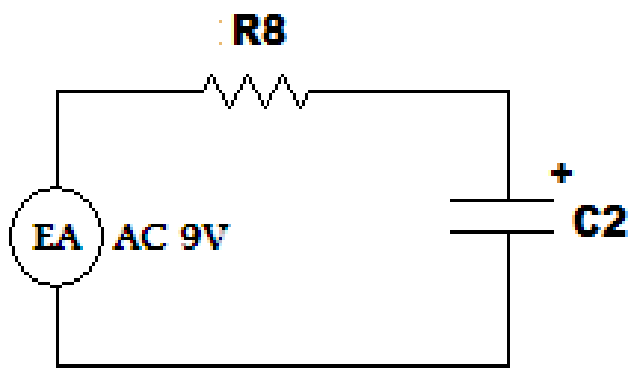
The voltage across C is

$$E_C = I\ X_C$$

By Kirchhoff's voltage law, then

$$\Sigma V = E - V_R - V_C = 0$$

Or $$E = \overrightarrow{V_R} + \overrightarrow{V_C}$$



Figure

Procedure

1. Set the module KL-13001 on the main unit KL-21001, and locate the block e.
2. According to Figs. 1 complete the experiment circuit with short-circuit clips. Apply the AC power 9V to E_A.

   Measure and record E_A = ______________________________ V
3. Calculated and record the values below.

Reactance of C_2	X_C	=	______________________________	Ω
Total impedance	Z_T	=	______________________________	Ω
Current in circuit	I	=	______________________________	mA
Voltage across R_8	R	=	______________________________	V
Voltage across C_2	E_C	=	______________________________	V
Power dissipated	P	=	______________________________	mW

4. Measure and record the values of ER and EC by using the ac voltmeter.

Voltage across R_8	R	=	______________________________	V
Voltage across C_2	E_C	=	______________________________	V

   Are you sure the measured values equal to the calculated values of step 3?

   Yes NO

4. Using the equation $E = \overrightarrow{V_R} + \overrightarrow{V_C}$, calculate the applied voltage of the circuit.

   E_A = ______________________________ V

   Does the calculated value equal the measured value of step 2?

   Yes NO

   If no, explain it.

   ____

5. Using the measured values of ER and EC, calculate and record the current I.

   I = ______________________________ mA

   Does the calculated value equal the measured value of step 3?

   YES **NO**
6. Using the values of R, X_C and Z_T, plot a vector diagram in space below.

EXPERIMENT NO: 6

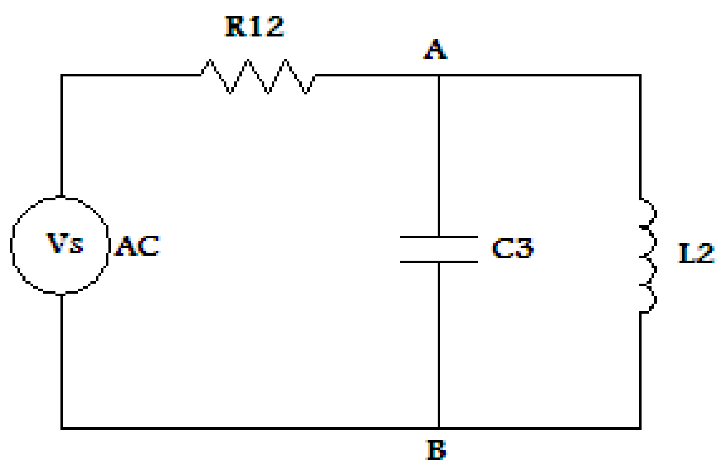
To Observed and determine the Resonant Frequency of a resonant circuit

OBJECTIVE:

To understand the characteristics of an RLC series network in ac circuit

Discussion:

Figure shows an RLC series-parallel circuit with an ac power supply as mentioned before. The capacitive reactance X_C and inductive reactance X_L very with frequency. Therefore, the net impedance of the parallel circuit consisting of L2 and C3 will vary with input frequency. At some frequency which we will define as the resonant frequency f_r .the parallel circuit operates in resonance and X_L equals X_C the resonant frequency can be expressed as $f_r = 1/2\pi\sqrt{LC}$



Figure

Procedure

1. Set the module KL -13001 on the main unit KL -21001, and locate the block h.
2. According to Figure, complete the experiment circuit with short –circuit clips.
   The L2 is the 0.1H inductor provided.

3. Set the function selector of function generator to sine wave position .connect the oscilloscope to the output of function generator.

Adjust the amplitude and frequency control knobs to obtain an output of 1 KHz, 5Vp-p and connect it to the circuit input (I/P).

4. Using the oscilloscope, measure and record the voltage acrossL2, C3 and R12.

   V_L = ____________________V p-p

   V_C = ____________________V p-p

   V_R = ____________________V p-p

5. Using the equation $f_r = 1/2\pi\sqrt{LC}$, calculate and record the resonant frequency of the circuit.

   f_r =_____________________Hz

6. Vary the output frequency of function generator to obtain a maximum value of VAB.

   Using the oscilloscope, measure and record the input frequency

   f = ____________________Hz

7. Is there agreement between the frequency value f and the resonant frequency f_r of step 5?

   Yes **No**