1. VERIFICATION of KCL & KVL THEOREM

AIM:

To Verify KCL & KVL from the given circuit

APPARATUS REQUIRED:

S.NO.	Name of the Apparatus	Range	Quantity
1	Bread Board	-	1
2	Resistor	1 KΩ	3
3	Ammeter	0-25 mA	3
4	Voltmeter	0-30 V	2
5	RPS	0-30 V	1

THEORY:

Kirchhoff's Voltage Law (KVL) states that the algebraic sum of all branch voltages around any closed path in a circuit is always zero at all instants of time. Inthe figure 1.1, if KVL is applied then the equation is

$$V_s = V_1+V_2+V_3$$

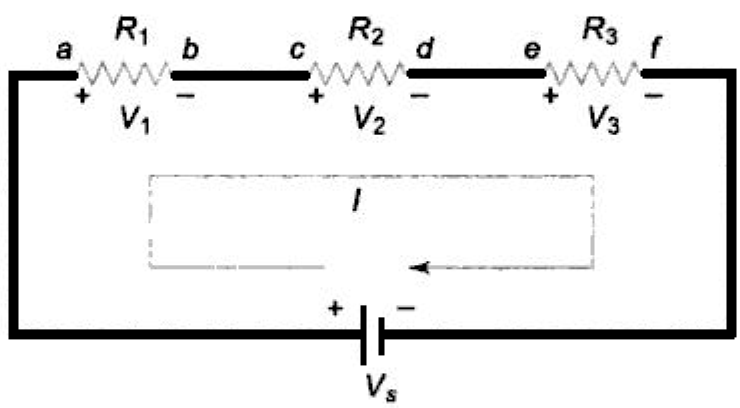


Figure 1.1

Kirchhoff's Current Law (KCL) states that the sum of the currents entering into any node/point/junction is equal to the sum of the currents leaving that node/point/junction. In the figure 1.2, if KCL is applied then the equation is

$$I_T = I_1 + I_2 + I_3$$

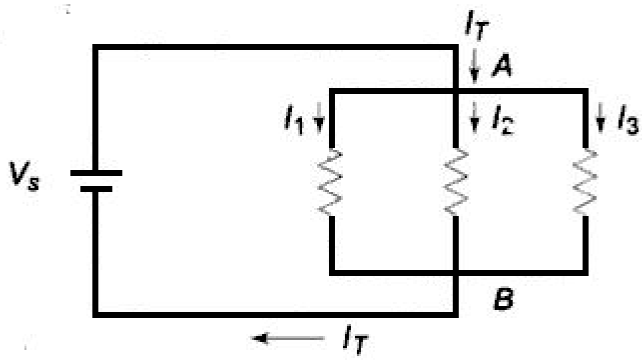


Figure 1.2

PROCEDURE:

a. Verification of KCL

1. Give the connection according to circuit shown in figure 1.3
2. Vary the supply voltage and take the corresponding readings of I_L, I_1 & I_2 from the ammeter.
3. Verify the reading.

b. Verification of KVL

1. Connection are made as per the circuit diagram shown in figure 1.4
2. Vary the supply voltage and take the corresponding readings V_1 & V_2 from the voltmeter.
3. Verify the reading.

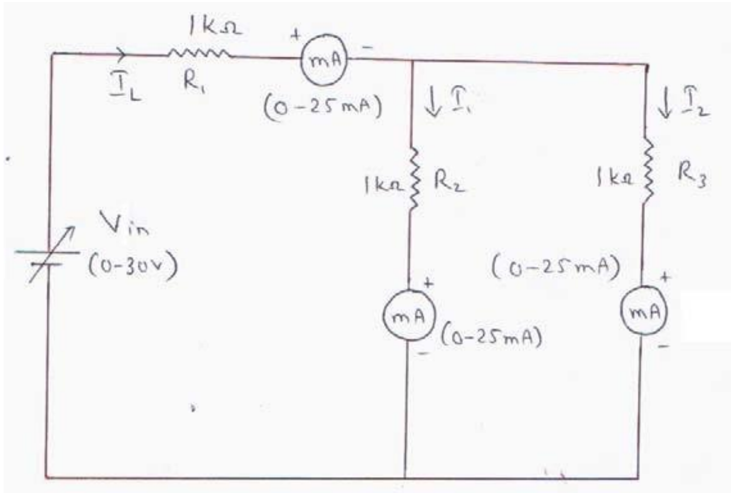


Figure 1.3

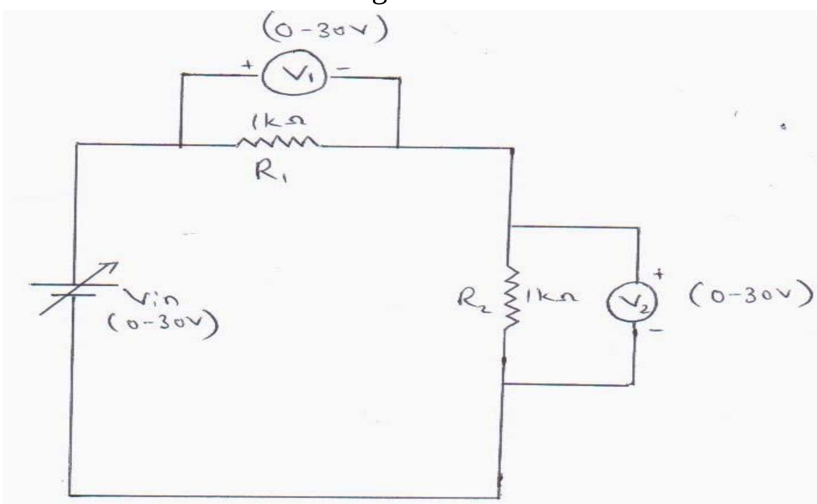


Figure 1.4

Tabulation:

Table 1(for KCL):

Vin (v)	I_1 (mA)		I_2 (mA)		$I_L = I_1 + I_2$ (mA)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

Table 2 (for KVL):

Vin (v)	V_1 (v)		V_2 (v)		$V_{in} = V_1 + V_2$ (v)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

Note: *All theoretical values can be found by using either mesh analysis or nodal analysis and also using voltage division rule and current division rule where it is applicable.*

RESULT :

2. VERIFICATION of SUPERPOSITION THEOREM

AIM:

To verify the superposition theorem in the given network.

APPARATUS REQUIRED:

S.NO.	Name of the Apparatus	Range	Quantity
1	Bread Board	-	1
2	Resistor	1 KΩ	2
3	Resistor	2.2 KΩ	2
4	Ammeter	0-25 mA	1
5	Voltmeter	0-30 V	1
6	RPS	0-30 V	1

THEORY:

The superposition theorem states that in any linear network containing two or more sources, the response in any element is equal to the algebraic sum of the responses caused by individual sources acting alone, while the other sources are non-operative; that is, while considering the effect of individual sources, other ideal voltage sources and ideal current sources in the network are replaced by short circuit and open circuit across their terminals.

PROCEDURE:

1. Connection are made as per the circuit diagram shown in figure 4.1
2. Vary the supply voltage V_{S1} & V_{S2} and take the corresponding reading I_2 from the ammeter.
3. Now V_{S2} is short circuited. Vary V_{S1} & take the corresponding reading I_2^1 from the ammeter as shown in figure 4.2
4. Now V_{S1} is short circuited. Vary V_{S2} & take the corresponding reading I_2^{11} from the ammeter as shown in figure 4.3
5. Finally Verify whether $I_2 = I_2^1 + I_2^{11}$

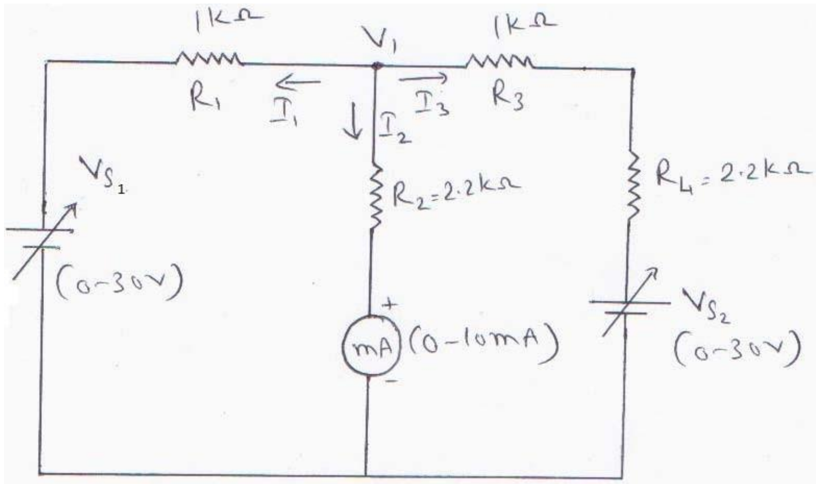


Figure 4.1

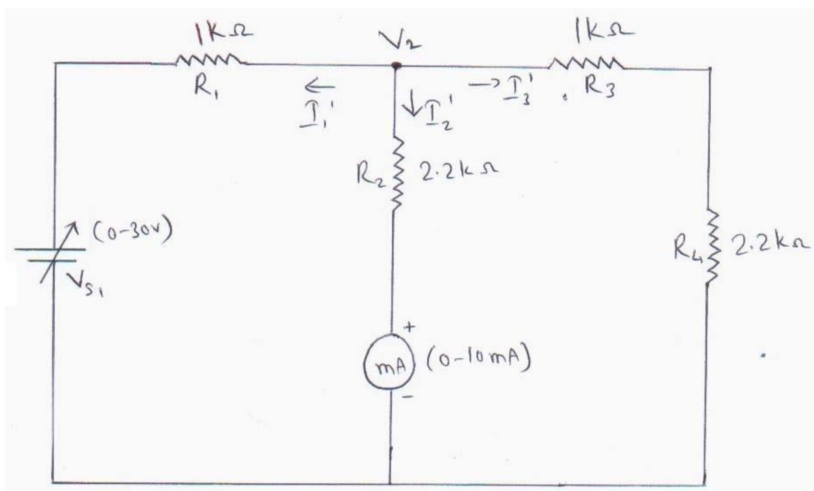


Figure 4.2

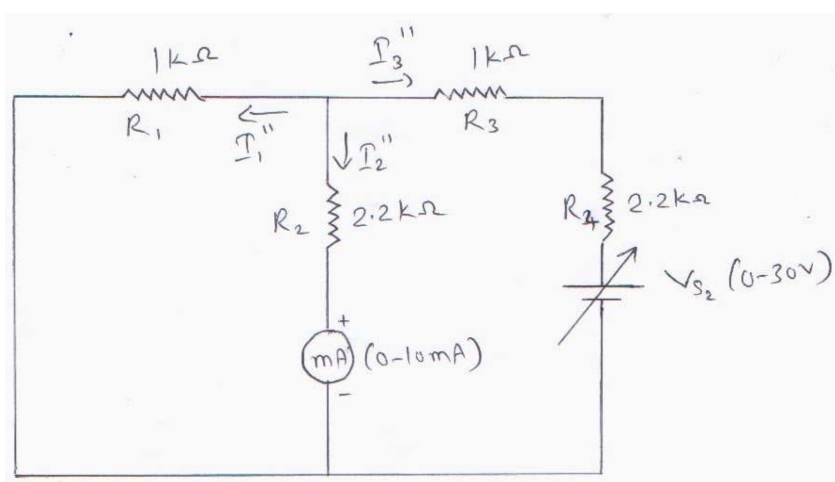


Figure 4.3

Tabulation:

Table 1(for I_2):

V_{S1} (v)	V_{S2} (v)	I_2 (mA)	
		Theoretical	Practical

Table 2 (for I_2^1 & I_2^{11}):

V_{S1} acting alone, V_{S2} replaced by internal Resistance (v)			V_{S2} acting alone, V_{S1} replaced by internal Resistance (v)			Total I_2 (mA) $I_2 = I_2^1 + I_2^{11}$	
V_{S1}(v)	I_2^1 (mA)		V_{S2}(v)	I_2^{11} (mA)		Theoretical	Practical
	Theoretical	Practical		Theoretical	Practical		

Note: *All theoretical values can be found by using either mesh analysis or nodal analysis and also using voltage division rule and current division rule where it is applicable.*

RESULT :

3. VERIFICATION of THEVENIN'S THEOREM

AIM:

To find the Thevenin's equivalent circuit from the given circuit.

APPARATUS REQUIRED:

S.NO.	Name of the Apparatus	Range	Quantity
1	Bread Board	-	1
2	Resistor	1 KΩ	3
3	Resistor	2.2 KΩ	2
4	Resistor	4.7 KΩ	1
5	Ammeter	0-100 mA	1
6	Voltmeter	0-30 V	1
7	RPS	0-30 V	1

THEORY:

Thevenin's theorem states that any two terminal linear network having a number of voltage current sources and resistances can be replaced by a simple equivalent circuit consisting of a single voltage source in series with a resistance, where the value of the voltage source is equal to the open circuit voltage across the two terminals of the network, and resistance is equal to the equivalent resistance measured between the terminals with all the energy sources are replaced by their internal resistances.

PROCEDURE:

1. Connection are made as per the circuit diagram shown in figure 2.1
2. Vary the supply voltage V_1 and take the corresponding reading I_3 from the ammeter.
3. Now connect the circuit diagram in figure 2.2 in bread board (Removing the load resistor $R_{6)}$.
4. Vary the supply voltage V_1 in the same way as done in step 2 and note down the corresponding V_{AB} or V_{TH} from the voltmeter.
5. Find out the R_{TH} and draw the Thevenin equivalent ciruit.

6. Now connect the circuit diagram in figure 2.3 in bread board and note down the I_L value by varying V_{TH} (fix the values of V_{TH} got from step 4).

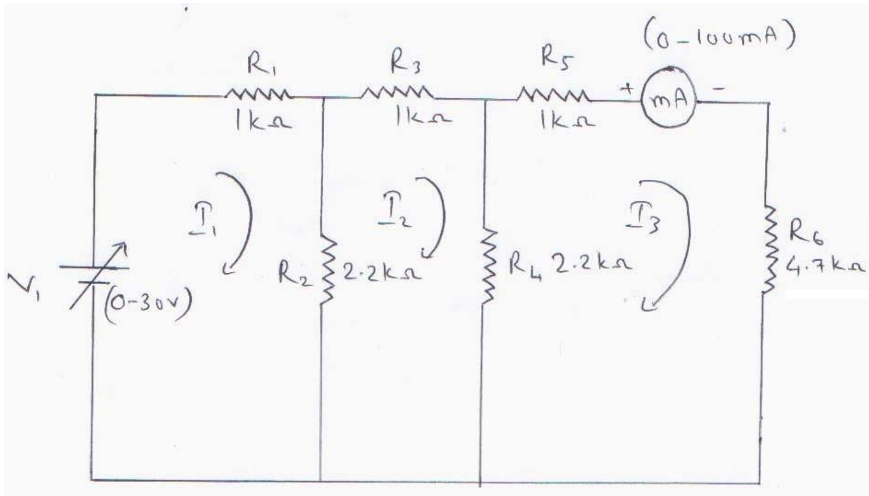


Figure 2.1

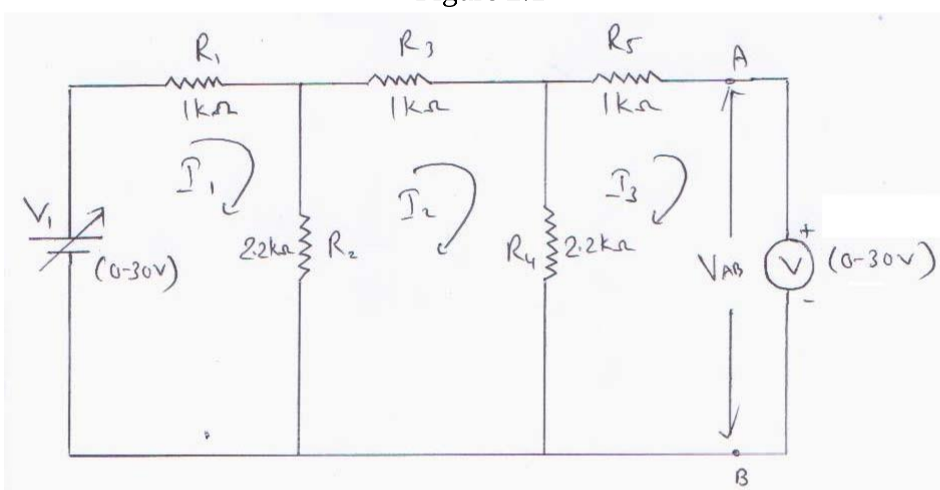


Figure 2.2

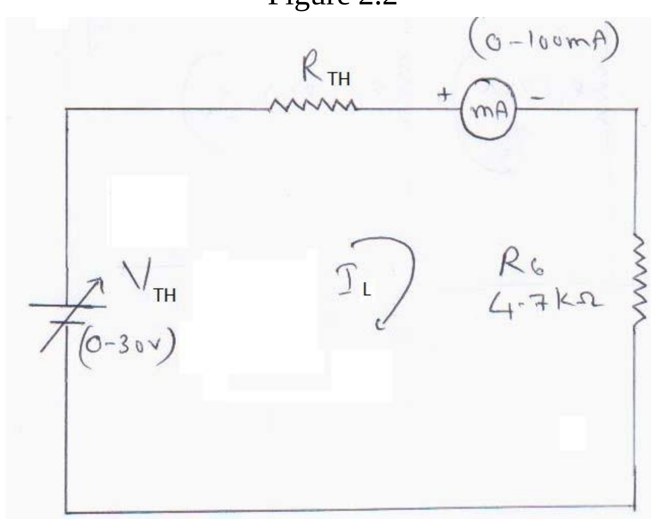


Figure 2.3

Tabulation:

Table 1(for I_3 & V_{TH} or V_{AB}):

V_1 (v)	I_3 (mA)		V_{TH} (v)	
	Theoretical	Practical	Theoretical	Practical

Table 2 (for I_L):

V_{TH} (v) (practical)	I_L (mA)	
	Theoretical	Practical

Note: *All theoretical values can be found by using either mesh analysis or nodal analysis and also using voltage division rule and current division rule where it is applicable.*

RESULT :

4. VERIFICATION of NORTON'S THEOREM

AIM:

To find the Norton's equivalent circuit from the given circuit.

APPARATUS REQUIRED:

S.NO.	Name of the Apparatus	Range	Quantity
1	Bread Board	-	1
2	Resistor	1 KΩ	3
3	Resistor	2.2 KΩ	2
4	Resistor	4.7 KΩ	1
5	Ammeter	0-100 mA	1
6	Voltmeter	0-30 V	1
7	RPS	0-30 V	1

THEORY:

Norton's theorem states that any two terminal linear network with current sources, voltage sources and resistances can be replaced by an equivalent circuit consisting of a current source in parallel with a resistance. The value of the current source is the short circuit current between the two terminals of the network and the resistance is equal to the equivalent resistance measured between the terminalswith all the energy sources are replaced by their internal resistances.

PROCEDURE:

1. Connection are made as per the circuit diagram shown in figure 3.1
2. Vary the supply voltage V_1 and take the corresponding reading I_3 from the ammeter.
3. Now connect the circuit diagram in figure 3.2 in bread board (Removing the load resistor R_6 and shorting the terminals).
4. Vary the supply voltage V_1 in the same way as done in step 2 and note down the corresponding I_N from the ammeter.
5. Find out the R_N and draw the Norton's Equivalent circuit

6. Now apply source transformation in the circuit diagram as shown in figure 3.3 and obtain the circuit as shown in figure 3.4.
7. Connect the circuit as shown in figure 3.4 in bread board and vary the supply voltage and note down the corresponding I_L from the ammeter.

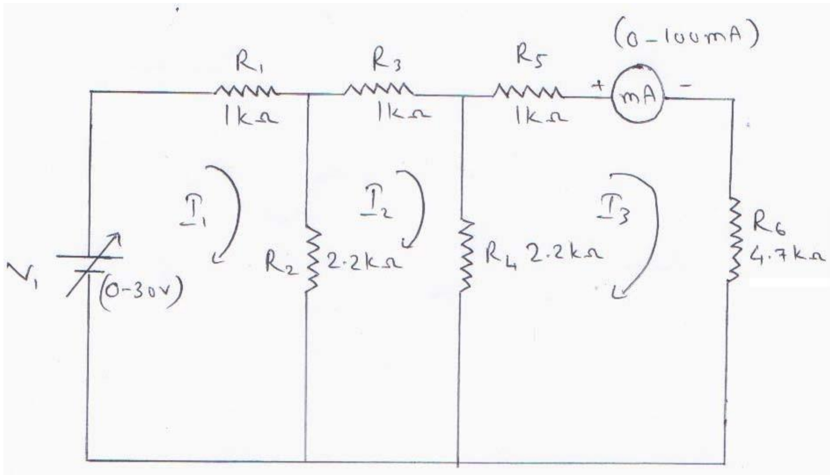


Figure 3.1

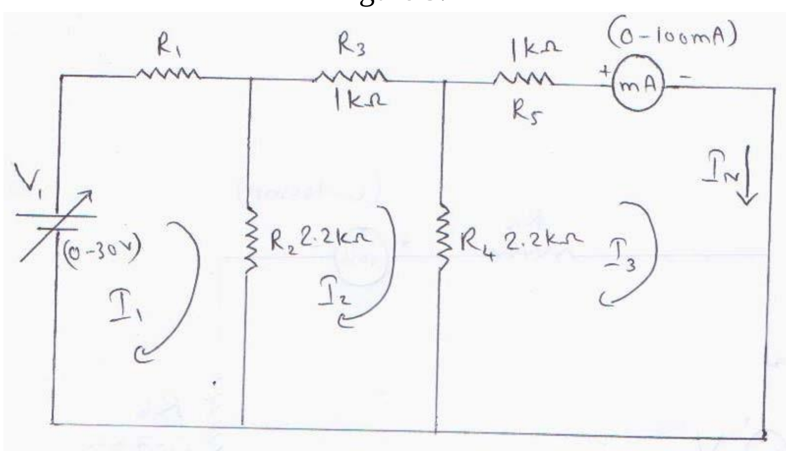


Figure 3.2

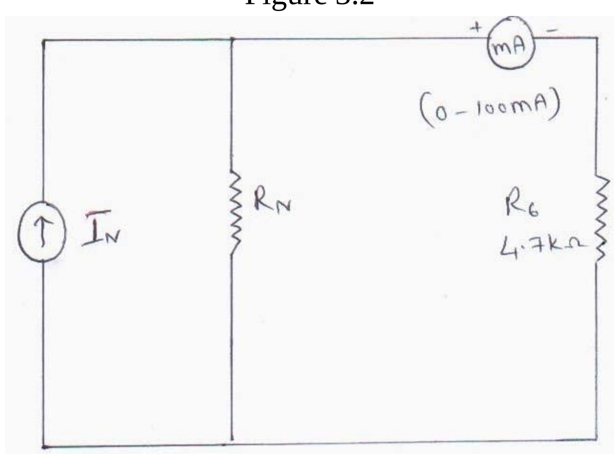


Figure 3.3

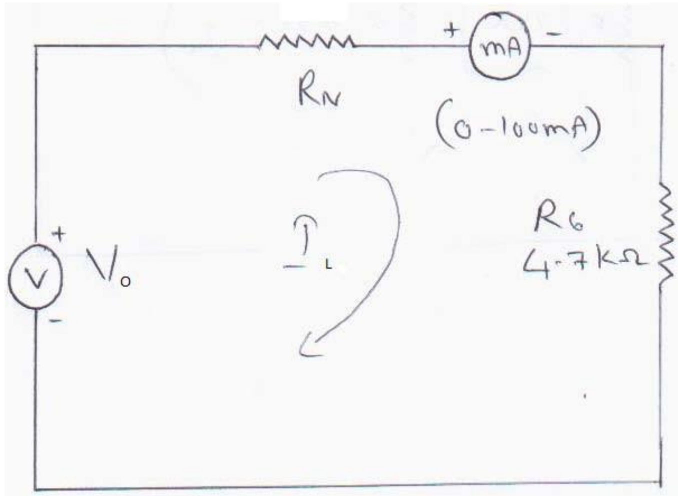


Figure 3.4

Tabulation:

Table 1(for I_3 & I_N):

V_1 (v)	I_3 (mA)		I_N (mA)	
	Theoretical	Practical	Theoretical	Practical

Table 2 (for I_L):

V_o (v)	I_L (mA)	
	Theoretical	Practical

Note: *All theoretical values can be found by using either mesh analysis or nodal analysis and also using voltage division rule and current division rule where it is applicable.*

RESULT :

5. VERIFICATION of MAXIMUM POWER TRANSFER THEOREM

AIM:

To verify Maximum Power Transfer Theorem.

APPARATUS REQUIRED:

S.NO.	Name of the Apparatus	Range	Quantity
1	Bread Board	-	1
2	Resistors	470 Ω, 750 Ω	1 Each
3	Resistors	560 Ω, 330 Ω	1 Each
4	Ammeter	0-10 mA	1
5	Voltmeter	0-30 V	1
6	RPS	0-30 V	1
7	DRB	-	1

THEORY:

Maximum power transfer theorem states that the maximum power is delivered from a source to a load when the load resistance is equal to the source resistance. Depending upon the conditions of the circuit, there are three cases:

CASE 1: (Purely Resistive circuit & Load resistance is variable) - "Maximum power is delivered from a source to a load when the load resistance is equal to the source resistance". ($R_L = R_S$)
CASE 2: (Reactants present & load resistance and reactance can be independently varied) - "Maximum power is delivered from a source to a load when the load impedance is the complex conjugate of source impedance". ($X_L = -X_S$ & $R_L = R_S$)
CASE 3: (Reactants present but only the magnitude of the load resistance can be varied) - "Maximum power is delivered from a source to a load when the magnitude of the load impedance is equal to the magnitude of source impedance".

PROCEDURE:

1. First find the Thevenin equivalent circuit for circuit shown in figure 7.1.

2. After finding R_{TH} & V_{TH}, vary the load resistance R_L (DRB) from the minimum value to maximum value (shown in figure 7.2).
3. Plot the graph between R_L & Power ($I_L^2R_L$) where, theoretical $I_L = [V_{TH}/(R_{TH}+R_L)]$
4. Finally verify that when $R_L = R_{TH}$, maximum power is delivered or not.

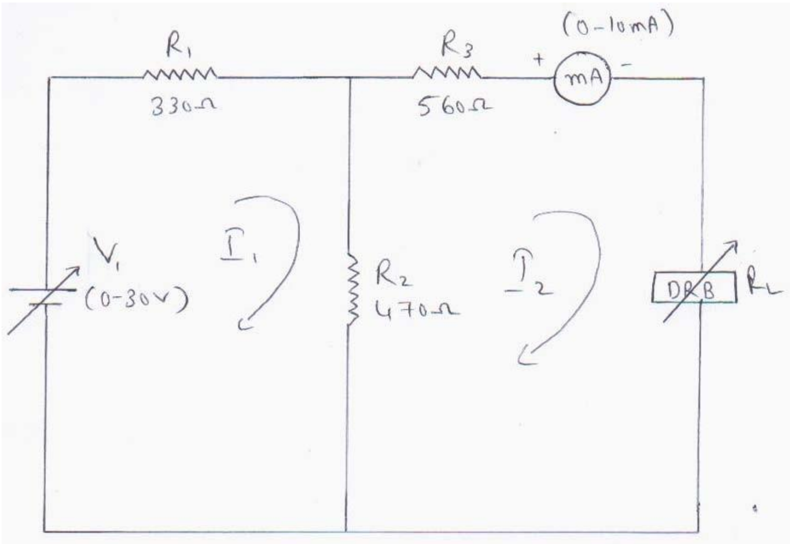


Figure 7.1

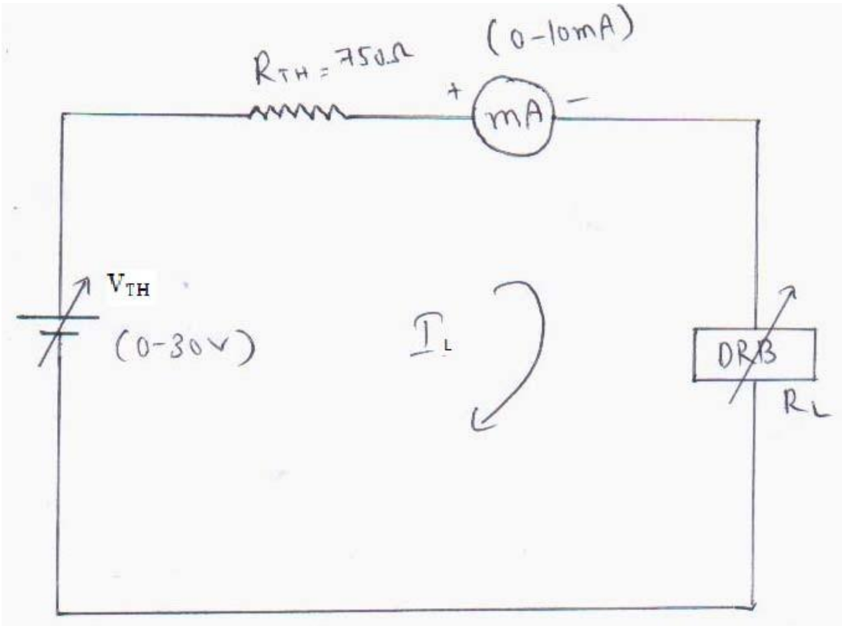
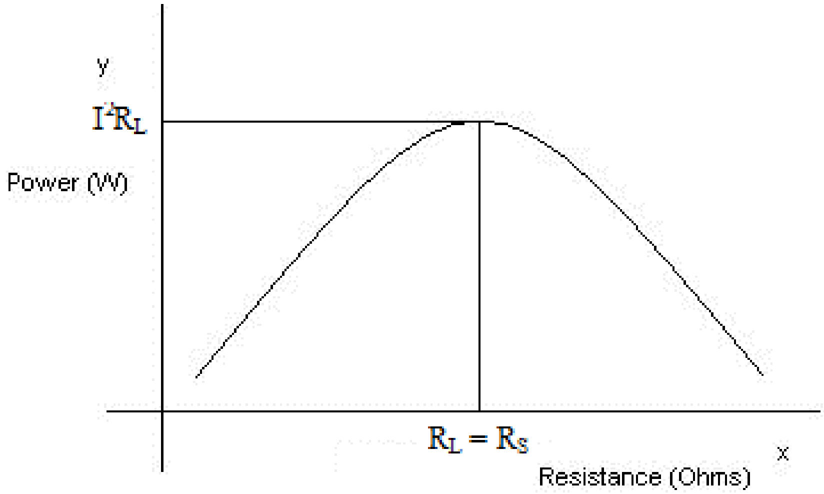


Figure 7.2

Model Graph:



Tabulation:

Table 1:

R_L (Ω)	I_L (mA)	$P = I_L^2R_L$ (mW)

Note: *All theoretical values can be found by using either mesh analysis or nodal analysis and also using voltage division rule and current division rule where it is applicable.*

RESULT :

6. VERIFICATION of RECIPROCITY THEOREM

AIM:

To verify Reciprocity theorem for a given network.

APPARATUS REQUIRED:

S.NO.	Name of the Apparatus	Range	Quantity
1	Bread Board	-	1
2	Resistor	1 KΩ	3
3	Resistor	2.2 KΩ	3
4	Ammeter	0-10 mA	1
5	Voltmeter	0-30 V	1
6	RPS	0-30 V	1

THEORY:

In any linear bilateral network, if a single voltage source V_a in branch 'a' produces a current I_b in branch 'b', then if the voltage source V_a is removed and inserted in branch 'b' will produce a current I_b in branch 'a'. The ratio of response to excitation is same for the two conditions mentioned above. This is called the reciprocity theorem.

Consider the network shown in figure 5.1. AA^1 denotes input terminals and BB^1 denotes output terminals. The application of voltage V across AA^1 produces current I at BB^1. Now if the position of source and responses are interchanged, by connecting the voltage source across BB^1, the resultant current I will be at terminals AA^1. According to Reciprocity theorem, the ratio of response to excitation is the same in both cases.

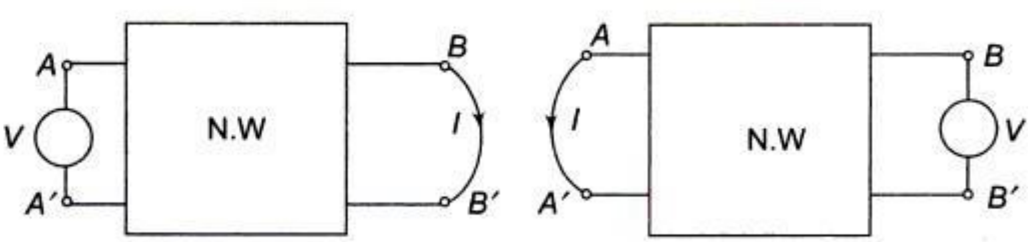


Figure 5.1

PROCEDURE:

1. Connection are made as per the circuit diagram shown in figure 5.2
2. Vary the supply voltage V_1 and take the corresponding reading I_3 from the ammeter.
3. Find out the ratio $R = (V_1/I_3)$
4. Now interchange the position of ammeter and Variable voltage supply V_1 as shown in figure 5.3.
5. Vary the supply voltage V_1 and take the corresponding reading I_3^1 from the ammeter.
6. Find out the ratio $R^1 = (V_1/I_3^1)$
7. Now check whether R and R^1 are same.

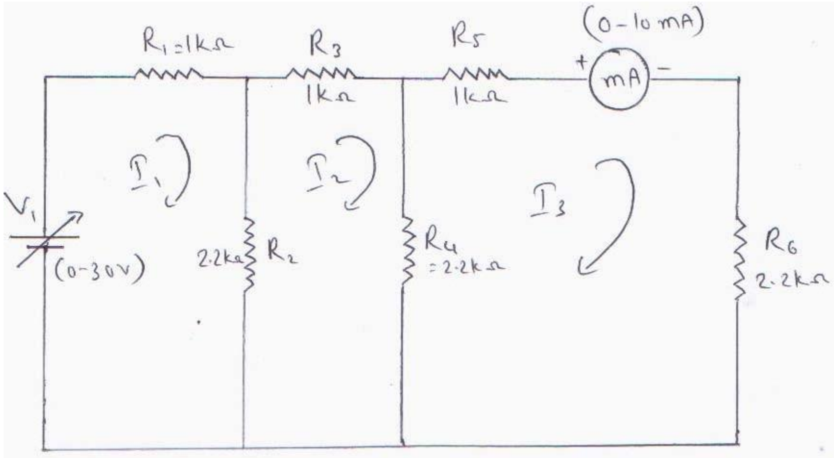


Figure 5.2

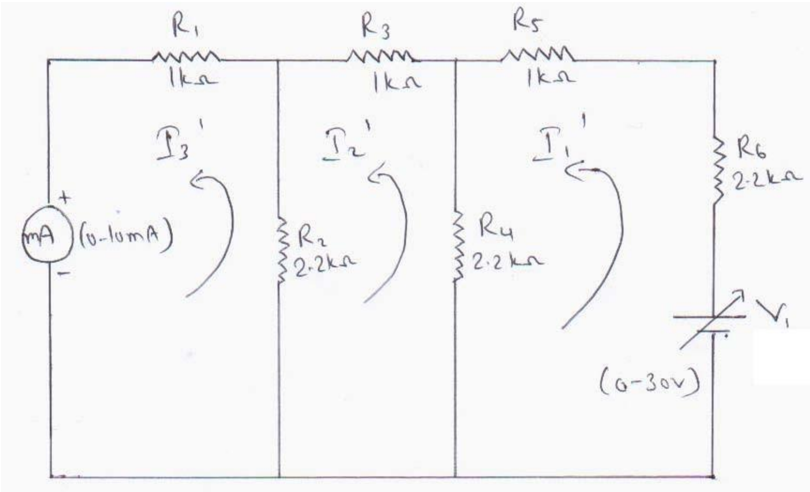


Figure 5.3

Tabulation:

Table 1(for I_3):

V_1 (v)	I_3 (mA)		$R = (V_1/ I_3)$ (Ω)	
	Theoretical	Practical	Theoretical	Practical

Table 2 (for I_3^1):

V_1 (v)	I_3^1 (mA)		$R^1 = (V_1/ I_3^1)$ (Ω)	
	Theoretical	Practical	Theoretical	Practical

Note: *All theoretical values can be found by using either mesh analysis or nodal analysis and also using voltage division rule and current division rule where it is applicable*.

RESULT: :

7. To Study of Resonance in RLC Series Circuit

Objective

To investigate the resonance phenomenon in an RLC series circuit by observing the relationship between frequency, impedance, and phase angle.

Theory

Resonance occurs in an RLC circuit when the inductive reactance equals the capacitive reactance, resulting in maximum current flow at a specific frequency called the resonant frequency. This frequency can be calculated using the formula:

f0=12πLCf_0 = \frac{1}{2\pi\sqrt{LC}}f0=2πLC1

where:

- f0f_0f0 is the resonant frequency,
- LLL is the inductance,
- CCC is the capacitance.

Materials

1. Resistor (R)
2. Inductor (L)
3. Capacitor (C)
4. Function generator
5. Oscilloscope
6. Multimeter
7. Connecting wires
8. Breadboard or circuit board
9. Variable resistor (optional)

Procedure

1. **Circuit Setup**:
   - Connect the resistor, inductor, and capacitor in series on a breadboard.
   - Connect the function generator across the RLC series circuit.
   - Connect the oscilloscope probes across the circuit to measure voltage.
2. **Initial Measurements**:
   - Set the function generator to a low frequency (e.g., 100 Hz).
   - Measure the voltage across each component (R, L, C) using the oscilloscope.
   - Record the frequency and the voltages.
3. **Vary Frequency**:
   - Gradually increase the frequency of the function generator (e.g., in increments of 100 Hz) and record the voltage across each component at each frequency.
   - Continue this until you observe the peak voltage across the circuit.
4. **Identify Resonance**:

- Note the frequency at which the voltage across the circuit reaches its maximum value. This is your resonant frequency.

5. **Calculate Resonance**:
   - Use the measured values of L and C to calculate the theoretical resonant frequency using the formula mentioned earlier.
   - Compare this value with the observed resonant frequency.

Data Analysis

1. **Impedance Calculation**:
   - Calculate the impedance (ZZZ) of the circuit at different frequencies using the formula:

Z=R2+(XL−XC)2Z = \sqrt{R^2 + (X_L - X_C)^2}Z=R2+(XL−XC)2

where XL=2πfLX_L = 2\pi f LXL=2πfL and XC=12πfCX_C = \frac{1}{2\pi f C}XC=2πfC1.

2. **Phase Angle**:
   - Determine the phase angle (ϕ\phiϕ) using:

ϕ=tan−1(XL−XCR)\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)ϕ=tan−1(RXL−XC)

3. **Graphical Representation**:
   - Plot a graph of voltage versus frequency.
   - Plot impedance versus frequency and observe the characteristics of the resonance peak.

Conclusion

- Summarize your findings regarding the resonant frequency and its relationship with the circuit components.
- Discuss any discrepancies between theoretical and experimental values, considering factors like component tolerances and measurement errors.

Safety Precautions

- Ensure all connections are secure to avoid short circuits.
- Do not exceed the voltage ratings of the components used.
- Handle the function generator and oscilloscope with care.

8. To Study of Resonance in RLC Parallel Circuit

Objective

To investigate the resonance phenomenon in an RLC parallel circuit by analyzing the relationship between frequency, impedance, and current.

Theory

In an RLC parallel circuit, resonance occurs when the total impedance reaches a maximum, which happens when the inductive reactance equals the capacitive reactance. The resonant frequency can be calculated using the formula:

f0=12πLCf_0 = \frac{1}{2\pi\sqrt{LC}}f0=2πLC1

where:

- f0f_0f0 is the resonant frequency,
- LLL is the inductance,
- CCC is the capacitance.

At resonance, the circuit behaves predominantly resistively, and the total current is maximized.

Materials

1. Resistor (R)
2. Inductor (L)
3. Capacitor (C)
4. Function generator
5. Oscilloscope
6. Multimeter
7. Connecting wires
8. Breadboard or circuit board

Procedure

1. **Circuit Setup**:
    - Connect the resistor, inductor, and capacitor in parallel on a breadboard.
    - Connect the function generator across the parallel RLC circuit.
    - Connect the oscilloscope probes to measure voltage across the circuit.
2. **Initial Measurements**:
    - Set the function generator to a low frequency (e.g., 100 Hz).
    - Measure the total current in the circuit using the multimeter and note the voltage across the circuit.
3. **Vary Frequency**:
    - Gradually increase the frequency of the function generator (e.g., in increments of 100 Hz).

- Record the total current and the voltage across the circuit at each frequency.
- Continue until the current reaches its maximum value.

4. **Identify Resonance**:
   - Note the frequency at which the total current reaches its maximum. This is the resonant frequency.
5. **Calculate Resonance**:
   - Use the measured values of LLL and CCC to calculate the theoretical resonant frequency using the formula given earlier.
   - Compare this value with the observed resonant frequency.

Data Analysis

1. **Impedance Calculation**:
   - Calculate the total impedance (ZZZ) of the circuit at different frequencies using:

Z=1(1R)2+(1XL−1XC)2Z = \frac{1}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{X_L} - \frac{1}{X_C}\right)^2}}Z=(R1)2+(XL1−XC1)21

where XL=2πfLX_L = 2\pi f LXL=2πfL and XC=12πfCX_C = \frac{1}{2\pi f C}XC=2πfC1.

2. **Phase Angle**:
   - Determine the phase angle (ϕ\phiϕ) using:

ϕ=tan−1(XC−XLR)\phi = \tan^{-1}\left(\frac{X_C - X_L}{R}\right)ϕ=tan−1(RXC−XL)

3. **Graphical Representation**:
   - Plot a graph of current versus frequency.
   - Plot impedance versus frequency to observe the characteristics of the resonance peak.

Conclusion

- Summarize findings regarding the resonant frequency and its relationship with circuit components.
- Discuss any discrepancies between theoretical and experimental values, considering factors like component tolerances and measurement errors.

Safety Precautions

- Ensure all connections are secure to avoid short circuits.
- Do not exceed the voltage ratings of the components used.
- Handle the function generator and oscilloscope carefully.