ELECTRICAL CIRCUITS LABORATORY MANUAL

(II – SEMESTER)

LIST OF EXPERIMENTS

1. Verification of Ohm’s laws and Kirchhoff’s laws.
2. Verification of Thevenin’s and Norton’s Theorem.
3. Verification of Superposition Theorem.
4. Verification of Maximum power transfer theorem.
5. Verification of Reciprocity theorem.
6. Measurement of Self inductance of a coil.
7. Verification of Mesh and Nodal analysis.
8. Transient response of RL and RC circuits for DC input.
9. Frequency response of Series and Parallel resonance circuits.
10. Frequency response of Single tuned coupled circuits.

1. A.VERIFICATION OF OHM`S LAW

AIM:

To conduct a suitable experiment for verifying the ohm's law

APPARATUS REQUIRED:

S.NO.	NAME OF THE EQUIPMENT	RANGE	TYPE	QTY.
1.	RPS	(0-30)V	DC	1
2.	Ammeter	(0-10)mA	MC	3
3.	Voltmeter	(0-10)V	MC	3
4.	Resistor	10KΩ	-	3
5.	Bread board	-	-	1
6.	Connecting wires	-	Single strand	As required

THEORY:

OHM`S LAW:

Ohm's law states that at constant temperature the current flow through a conductor is directly proportional to the potential difference between the two ends of the conductor.

$$I \alpha V$$

Or $$V \alpha I$$

$$V = IR$$

Where R is a constant and is called the resistance of the conductor.

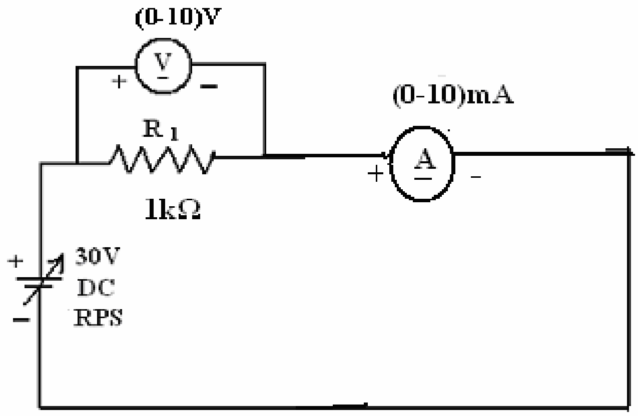
FORMULA:

$$V = IR$$

PROCEDURE:

- Connections are made as per the circuit diagram
- Switch on the power supply.
- For various values of voltage V, note the values of current I.
- Draw a graph of Voltage Vs Current.
- The Slope of the graph gives the resistance value.
- Ohm's law is verified by measuring the value of R using multimeter and comparing with the experimental value.

OHM`S LAW:

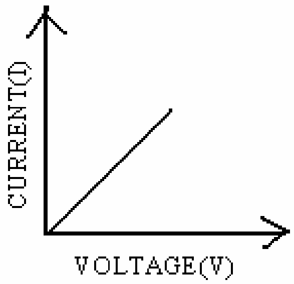


TABULATION:

	S.NO	APPLIED VOLTAGE V (Volts)	CURRENT I (mA)	R=V/I (Ω)
PRACTICAL				

MODEL CALCULATION & ANALYSIS:

MODEL GRAPH.



RESULT:

Thus the ohm's law is verified.

1.B.VERIFICATION OF KVL & KCL

AIM:

To verify (i) kirchoff's current law (ii) kirchoff's voltage law

(i) KIRCHOFF'S CURRENT LAW:

APPARATUS REQUIRED:

S.No	Name of the apparatus	Range	Quantity
1	RPS	(0-15)V	1
2	Resistor	1 KΩ	3
3	Ammeter	(0-10)mA	3
4	Bread board	------	1
5	Connecting wires	------	As required

THEORY:

Kirchoff's current law:

The algebraic sum of the currents entering in any node is Zero.

The law represents the mathematical statement of the fact change cannot accumulate at a node. A node is not a circuit element and it certainly cannot store destroy (or) generate charge. Hence the current must sum to zero. A hydraulic analog sum is zero. For example consider three water pipes joined pn the shape of Y. we defined free currents as following into each of 3 pipes. If we insists that what is always

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Check your connections before switch on the supply.
3. Vary the regulated supply.
4. Measure the current using ammeter.
5. Note the readings in the tabulation.
6. Compare the observation reading to theoretical value.

ii) KIRCHOFF'S VOLTAGE LAW:

APPARATUS REQUIRED:

S.No	Name of the apparatus	Range	Quantity
1	RPS	(0-15)V	1
2	Resistor	1KΩ,2.2KΩ,3.3KΩ	Each 1
3	voltmeter	(0-20)V	3
4	Bread board	------	1
5	Connecting wires	------	As required

THEORY:

(i) kirchoff's voltage law

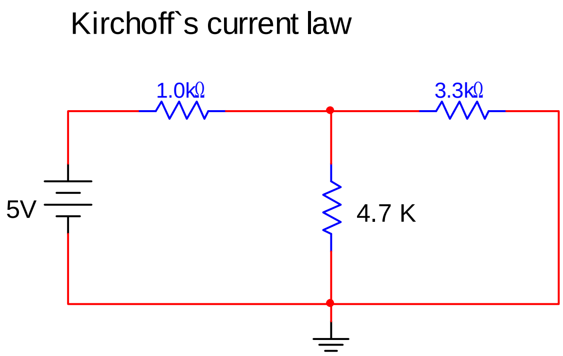
The algebraic sum of the voltage around any closed path is zero.

PROCEDURE:

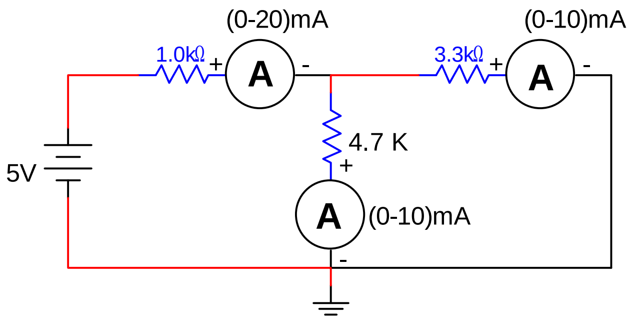
1. Connections are made as per the circuit diagram.
2. Check your connections before switch on the supply.
3. Vary the regulated supply.
4. Measure the voltage using voltmeter.
5. Note the readings in the tabulation.
6. Compare the observation reading to theoretical value.

Circuit diagram

1. **krichoff's current law:**



Practical measurement:

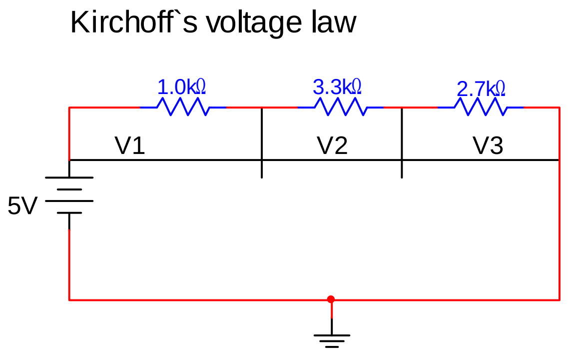


Tabulation:

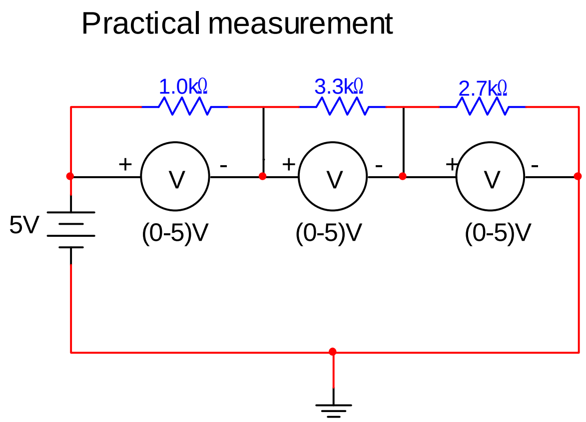
Voltage	Total current I(mA)	I_1(mA)	I_2(mA)

Circuit diagram

Krichoff's voltage law:



Practical measurement:



Tabulation:

Voltage (V)	V1 (volts)	V2 (volts)	V3 (volts)

Calculation:

RESULT:

Thus the kirchoff's current law and voltage law were verified.

2.A.VERIFICATION OF THEVENIN'S THEOREM

AIM:

To verify Thevenin's theorem and to find the current flowing through the load resistance.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Range	Quantity
1	RPS	(0-15)V	1
2	Resistor	1KΩ,2.2KΩ,3.3KΩ 2,7KΩ	Each 1
3	Ammeter	(0-5)mA	1
4	voltmeter	(0-5)V	1
5	Bread board	------	1
6	Connecting wires	------	As required

THEORY:

Thevenin`s theorem:

Any linear active network with output terminals can be replaced by a single voltage source V_{th} in series with a single impedance Z_{th}. V_{th} is the Thevenin`s voltage. It is the voltage between the terminals on open circuit condition, Hence it is called open circuit voltage denoted by $V_{oc.}$ $Z_{th}$ is called Thevennin`s impedance. It is the driving point impedance at the terminals when all internal sources are set to zero too.

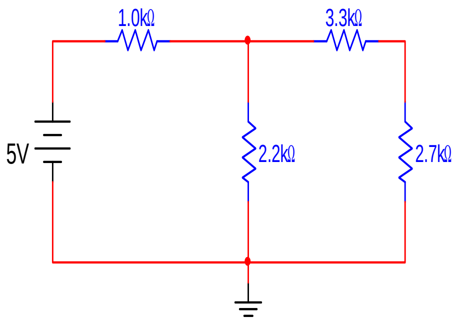
If a load impedance Z_L is connected across output terminals, we can find the current through it $I_L = V_{th}/(Z_{th} + Z_L)$.

PROCEDURE:

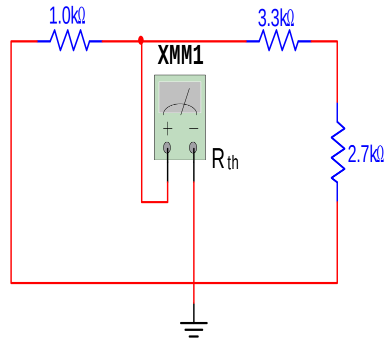
1. Connections are made as per the circuit diagram.
2. Check your connections before switch on the supply.
3. Find the Thevenin's voltage (or) open circuit voltage.
4. Replace voltage source by internal resistor.
5. Determine the Thevenin's resistance.
6. Find I_L by using Thevenin's formula.
7. Compare the observation reading to theoretical value.
8. switch off the supply
9. Disconnect the circuit.

Thevenin

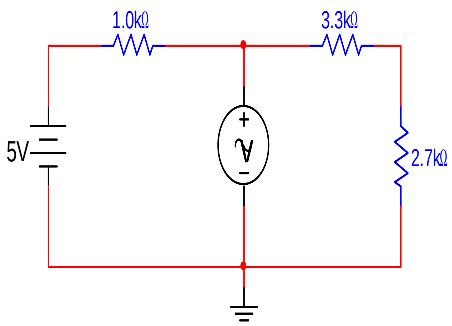
Circuit diagram



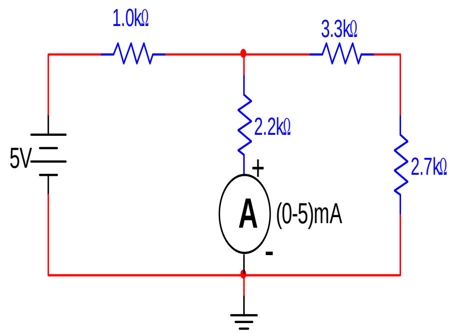
To find R_{th}



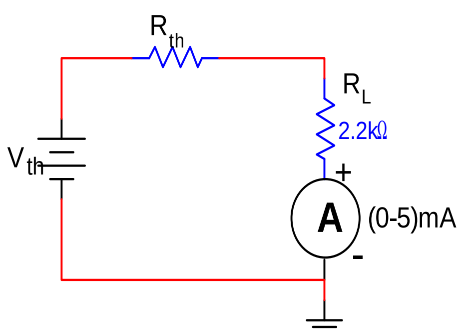
To find V_{th}



To find I_L



Equivalent ciruitl



Tabulation

V_{th}		R_{th}		I_L(mA)	
theoretical	practical	theoretical	practical	theoretical	practical

Calculation:

<u>RESULT:</u>

Thus the Thevenin's theorem was verified.

Theoretical:

$\mathbf{V_{th}}$ =

$\mathbf{R_{th}}$ =

I_L =

Practical:

$\mathbf{V_{th}}$ =

$\mathbf{R_{th}}$ =

I_L =

3.SUPER POSITION THEOREM

AIM:

To verify the superposition theorem and determine the current following through the load resistance.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Range	Quantity
1	RPS	(0-15)V	1
2	Resistor	1KΩ,220Ω,470Ω	Each 1
3	Ammeter	(0-1)mA,mc (0-5)mA mc	1 1
5	Bread board	------	1
6	Connecting wires	------	As required

Superposition theorem

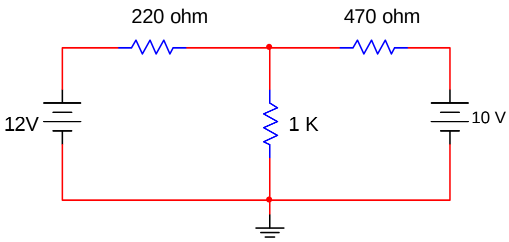
In a linear circuit containing more than one source, the current that flows at any point or the voltage that exists between any two points is the algebraic sum of the currents or the voltages that would have been produced by each source taken separately with all other sources removed.

PROCEDURE:

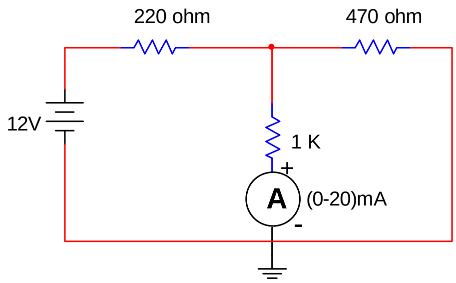
1. Connections are made as per the circuit diagram.
2. Check your connections before switch on the supply.
3. Determine the current through the load resistance.
4. Now one of the sources is shorted and the current flowing through the resistance I_L measured by ammeter.
5. Similarly, the other source is shorted and the current flowing through the resistance I_L measured by ammeter.
6. Compare the value obtained with the sum of I_1&I_2 should equal to I
7. Compare the observation reading to theoretical value.
8. switch off the supply
9. Disconnect the circuit.

Circuit diagram

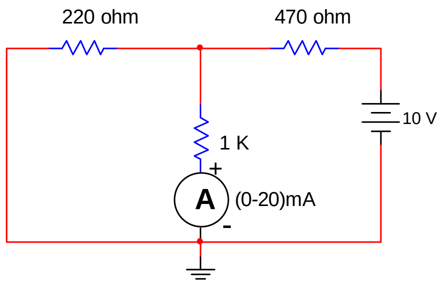
Superposition



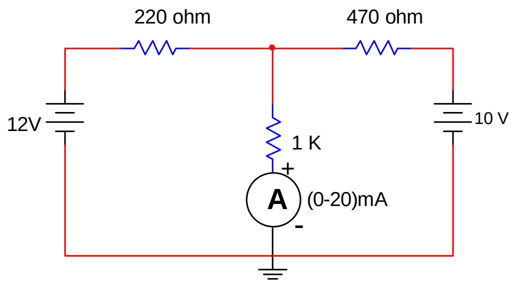
To find I_1 when 12V source is acting alone



TO find I_2 When 10V source is acting alone



To find I when two sources are acting



Tabulation:

V(volt)		I_1(mA)		I_2(mA)		I(mA)	
V1	**V2**	theoretical	practical	theoretical	practical	theoretical	practical

Calculation:

<u>RESULT:</u> Thus the superposition theorem was verified

2.B. NORTON'S THEOERM

AIM:

To verify Norton's theorem and to determine the current flow through the load resistance.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Range	Quantity
1	RPS	(0-15)V	1
2	Resistor	10KΩ,5.6KΩ,8.2KΩ 6KΩ	Each 1
3	Ammeter	(0-10)mA,mc (0-5)mc,mc	1 1
4	Bread board	------	1
5	Connecting wires	------	As required

Norton's theorem:

Any linear active network with output terminals can be replaced by a single current source. I_{sc} in parallel with a single impedance Z_{th}. I_{sc} is the current through the terminals of the active network when shorted. Z_{th} is called Thevennin`s impedance.

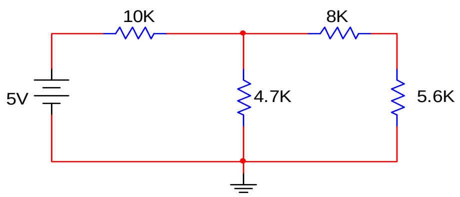
Current through $R_L = I_{sc} Z_{th} / (Z_{th} + Z_L)$

PROCEDURE:

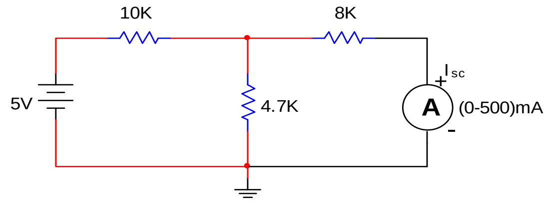
1. Connections are made as per the circuit diagram.
2. Check your connections before switch on the supply.
3. Find the Norton's current (or) short circuit current in load resistance.
4. Replace voltage source by internal resistor.
5. Determine the equivalent's resistance.
6. Find I_L by using Norton's formula.
7. Compare the observation reading to theoretical value.
8. switch off the supply
9. Disconnect the circuit.

Circuit diagram

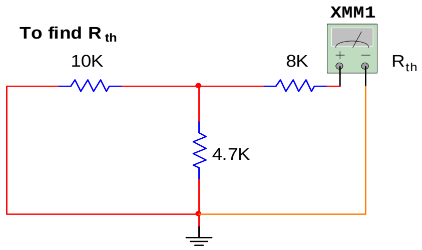
Norton



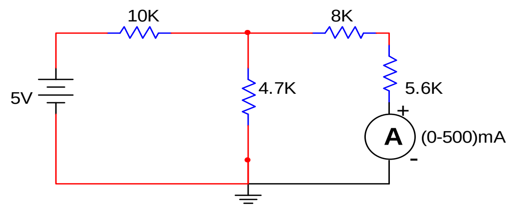
To find I_{sc}



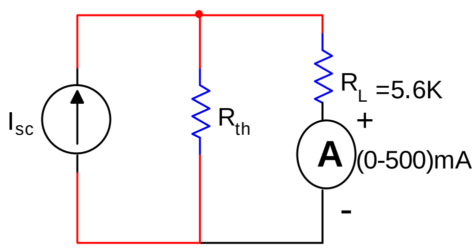
To find R_{th}



To find I_L



Norton`s Equivalent circuit



Tabulation:

Theoretical		Practical	
$\mathbf{I_{sc}}$	$\mathbf{R_{th}}$	$\mathbf{I_{sc}}$	$\mathbf{R_{th}}$

Calculation:

<u>RESULT:</u>

Thus the Norton's theorem was verified.

Theoretical:

Isc =

$\mathbf{R_{th}}$ **=**

I_L =

Practical:

Isc =

$\mathbf{R_{th}}$ **=**

I_L =

4. VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM

AIM:

To find the value of resistance R_L in which maximum power is transferred to the load resistance.

APPARATUS REQUIRED:

Sl.No	Name of the apparatus	Range	Quantity
1	Resistor	1KΩ,2.2 KΩ	1
2	Ammeter	(0-10) mA	1
3	Bread board	-----	1
4	Connecting wires	------	As required
5	RPS	(0-30)V	1
6	DRB	(0-10)KΩ	1

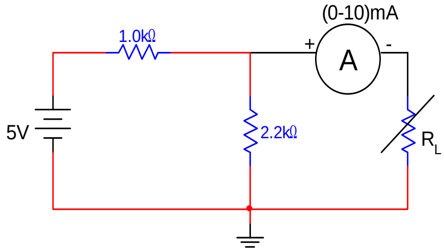
Maximum power transfer theorem:

Maximum power transfer to the load resistor occurs when it has a value equal to the resistance of the network looking back at it from the load terminals.

PROCEDURE:

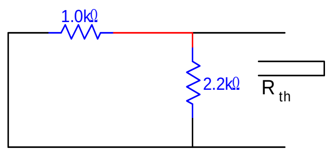
1. Connections are given as per the circuit diagram.
2. By giving various values of the resistance in DRB, note the ammeter reading.
3. Calculate the power and plot the power Vs resistance graph.
4. Note the maximum power point corresponding resistance from the graph.

Circuit diagram
Max power transfer theorem



Theoretical calculation

To find R_{th}



Theoretical value:

Tabulation:

Resistance (R_L)	**Current I(mA)**	**Power =I^2R_L**

Theoretical calculation:

RESULT:

Thus the value of unknown resistance in which the maximum power is transferred to the load was found.

Theoretical load resistance =
Practical load resistance =
Maximum power =

5. VERIFICATION OF RECIPROCITY THEOREM

AIM:

To verify Reciprocity theorem and to determine the current flow through the load resistance.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Range	Quantity
1	RPS	(0-15)V	1
2	Resistor	100Ω,470Ω, 820Ω, 100Ω	Each 1
3	Ammeter	(0-30) mA,	1
4	Bread board	------	1
5	Connecting wires	------	As required

THEORY:

Reciprocity theorem

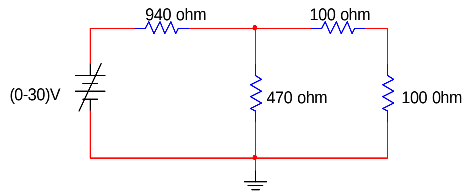
In a linear, bilateral network a voltage source V volt in a branch gives rise to a current I, in another branch. If V is applied in the second branch the current in the first branch will be I. This V/I are called transfer impedance or resistance. On changing the voltage source from 1 to branch 2, the current in branch 2 appears in branch 1.

PROCEDURE:

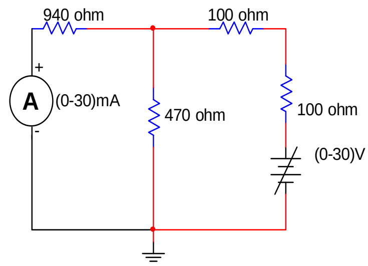
1. Connect the circuit as per the circuit diagram.
2. Switch on the supply and note down the corresponding ammeter readings.
3. Find ratio of input voltage to output current.
4. Interchange the position of the ammeter and power supply. Note down the Corresponding ammeter readings
5. Verify the reciprocity theorem by equating the voltage to current ratio.

CIRCUIT DIAGRAM

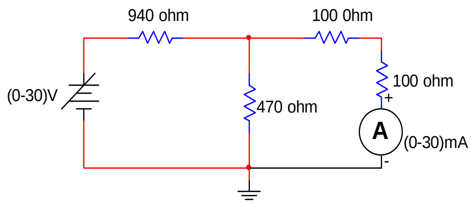
Reciprocity theorem



To find I



To find I



Tabulation:
Practical value :(circuit -I)

V(volt)	I(mA)	Z=V/I

Practical value :(circuit -I)

V(volt)	I(mA)	Z=V/I

Calculation:

RESULT:

Thus the reciprocity theorem was verified

6. MEASUREMENT OF SELF INDUCTANCE OF A COIL

AIM:

To determine the values of self inductance using Maxwell's Bridge.

APPARATUS REQUIRED:

S.No.	Name of the apparatus	Range	Quantity
1.	Maxwell's bridge kit	-	1
2.	Unknown resistance	-	1
3.	Connecting wires	-	As required
4.	Galvanometer	(-50 to 50)	1

THEORY:

SELF INDUCTANCE OF A COIL

Maxwell's bridge is an AC bridge, which is used to measure self inductance. The inductance Maxwell's bridge can be inductive or inductance – capacitance Bridge.

FORMULA USED:

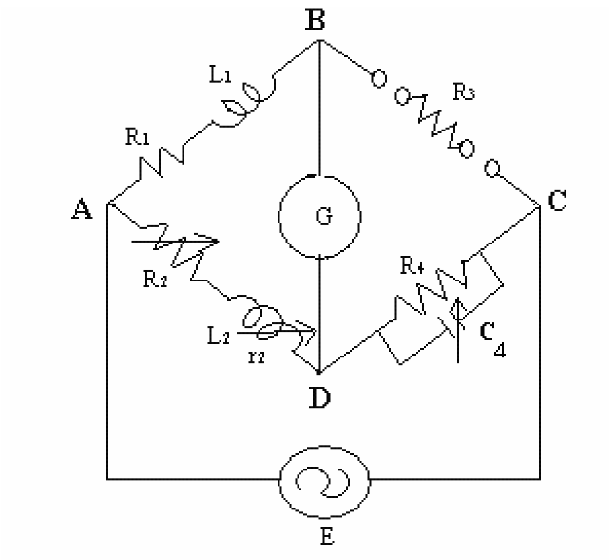
Unknown inductance $L1=R_2R_3C_1$ Henry.

PROCEDURE:

1. Connect the oscillator to the Maxwell's Inductance Bridge.
2. Connect the unknown inductance coil to the Maxwell's Inductance Bridge.
3. Switch on the oscillator power supply.
4. Patch the Head phone.
5. If noise is produced in the head phone, tune the capacitance value to reduce the noise and the bridge is kept in balanced condition.
6. Note down the resistance and capacitance value.
7. The unknown inductance is calculated using formula:-

$$L_1 = R_2 R_3 C_4 \text{ (Henry)}$$

CIRCUIT DIAGRAM



L_1 -Unknown Inductance

R_2 -Variable resistance

C_4-Standard capacitor

R_1 -Effective resistance of inductance L_1

R_3, R_4- Known resistance

E- AC source

G- Null detector

Unknown inductance $L1=R_2R_3C_1$ Henry.

RESULT:

Thus the self inductance is measured using Maxwell's bridge.

7. VERIFICATION OF MESH & NODAL ANALYSIS.

AIM:

To Verify Mesh & nodal analysis for a given electrical network.

APPARATUS REQUIRED:

S.No.	Name of the apparatus	Range	Type	Quantity
1.	Ammeter	(0-10)mA	MC	2
2.	Voltmeter	(0-10)V	MC	2
3.	RPS	(0-30)V	-	1
4.	Resistors	1kΩ,	Carbon	5
5.	Breadboard	10kΩ	-	4
6.	Connecting wires	-		As required

THEORY:

Mesh is defined as a loop which does not contain any other loops within it. It is a basic important technique to find solutions in a network. If network has large number of voltage sources, it is useful to use mesh analysis.

Node is defined as a point where two or more elements meet together .But only nodes with three or more elements are considered. If the circuits consists of `N` nodes including the reference node, then (N-1) nodal equation is obtained.

To apply Mesh analysis :

- Select mesh currents .
- Write the mesh equation using KVL.
- Solve the equation to find the mesh currents

To apply nodal analysis:

- Identify & mark the node assign node voltages.
- Write the kirchoffs current law equations in terms of unknowns .Solve them to find the node voltages.

PRECAUTION:

- Before giving connection all the power supply should be switched off.
- Before switching on the power supply, ensure that the voltage adjustment knob is in minimum position and the current adjustment knob is in maximum position

PROCEDURE :

MESH ANALYSIS:

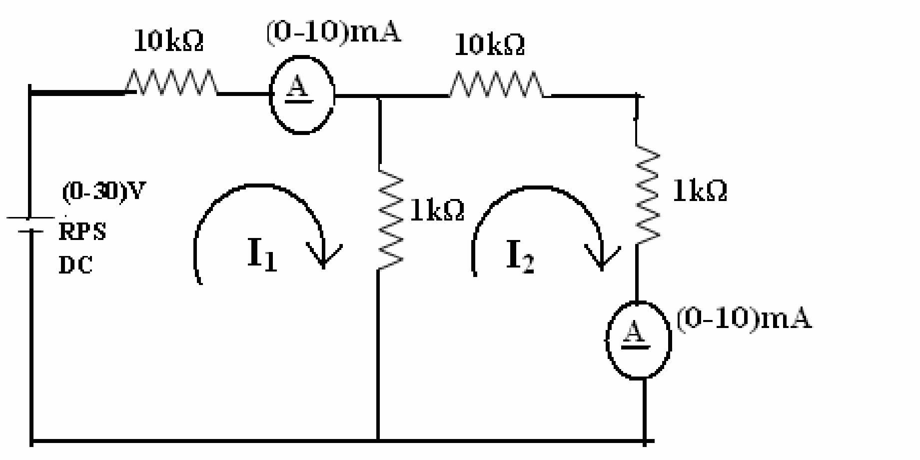
- The given circuit is solved for mesh currents I_1 &I_2 using mesh analysis.
- Connections are made as per the circuit diagram.
- Mesh currents are measured and compared.

NODAL ANALYSIS:

- The given circuit is solved for nodal voltages V_1 & V_2 using mesh analysis.
- Connections are made as per the circuit diagram.
- Nodal voltages are measured and compared

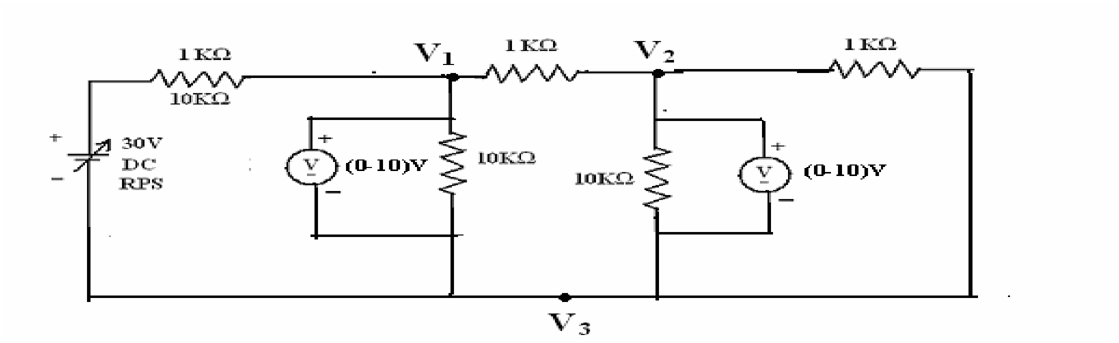
CIRCUIT DIAGRAM:

MESH ANALYSIS :



CIRCUIT DIAGRAM:

NODAL ANALYSIS :



TABULATION:

MESH ANALYSIS:

Input voltage $V_{1\,(V)}$	Mesh currents			
	$I_{1(A)}$		$I_{2(A)}$	
	Measured value	Theoretical value	Measured value	Theoretical value

MODEL CALCULATION & ANALYSIS:

NODAL ANALYSIS:

Input voltage $V_{1\,(V)}$	Nodal voltages					
	Measured value			Theoretical value		
	V_1 (V)	V_2 (V)	V_3 (V)	V_1 (V)	V_2 (V)	V_3 (V)

MODEL CALCULATION & ANALYSIS:

RESULT:

Thus the mesh & nodal analysis are verified.

8. TRANSIENT RESPONSE OF RC AND RL CIRCUITS FOR DC INPUT'S.

AIM:

To construct RL & RC transient circuit and to draw the transient curves.

APPARATUS REQUIRED:

S.NO.	NAME OF THE EQUIPMENT	RANGE	TYPE	QTY.
1.	RPS	(0-30)V	DC	1
2.	Ammeter	(0-10)mA	MC	1
3.	Voltmeter	(0-10)V	MC	1
4.	Resistor	10 KΩ	-	3
5.	Capacitor	1000 μ F	-	1
6.	Bread board	-	-	1
7.	Connecting wires	-	Single strand	As required

THEORY:

Electrical devices are controlled by switches which are closed to connect supply to the device, or opened in order to disconnect the supply to the device. The switching operation will change the current and voltage in the device. The purely resistive devices will allow instantaneous change in current and voltage.

An inductive device will not allow sudden change in current and capacitance device will not allow sudden change in voltage. Hence when switching operation is performed in inductive and capacitive devices, the current & voltage in device will take a certain time to change from pre switching value to steady state value after switching. This phenomenon is known as transient. The study of switching condition in the circuit is called transient analysis.The state of the circuit from instant of switching to attainment of steady state is called transient state. The time duration from the instant of switching till the steady state is called transient period. The current & voltage of circuit elements during transient period is called transient response.

FORMULA:

Time constant of RC circuit = RC

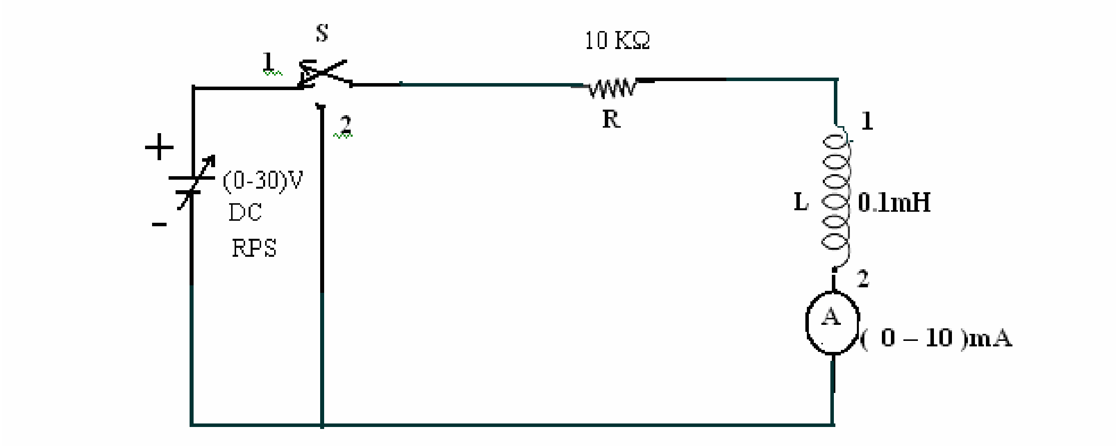
PROCEDURE:

- Connections are made as per the circuit diagram.
- Before switching ON the power supply the switch S should be in off position
- Now switch ON the power supply and change the switch to ON position.

- The voltage is gradually increased and note down the reading of ammeter and voltmeter for each time duration in RC.In RL circuit measure the Ammeter reading.
- Tabulate the readings and draw the graph of V_c(t)Vs t

CIRCUIT DIAGRAM:

RL CIRCUIT:

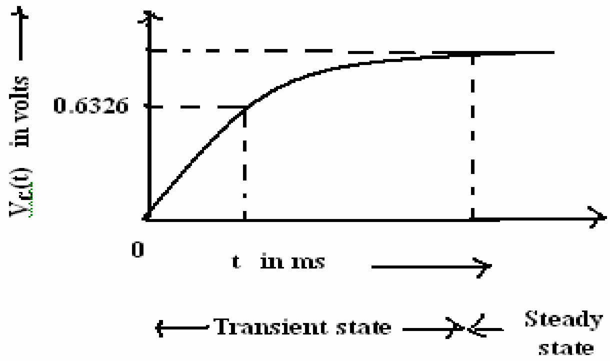


TABULATION:

S.NO.	TIME (msec)	CHARGING CURRENT (I) A	DISCHARGING CURRENT (I) A

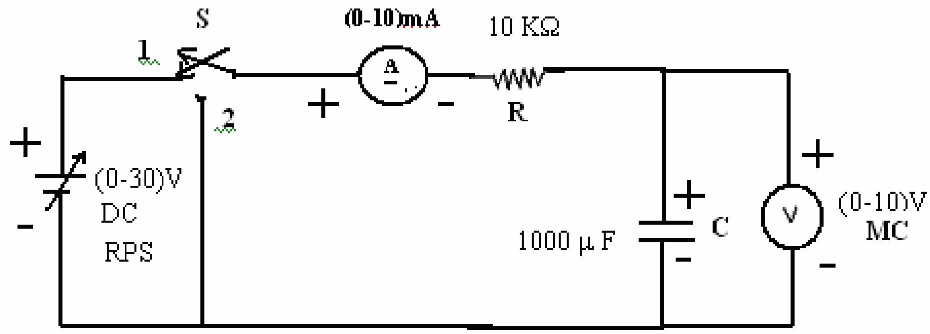
MODEL CALCULATION & ANALYSIS:

MODEL GRAPH:



CIRCUIT DIAGRAM:

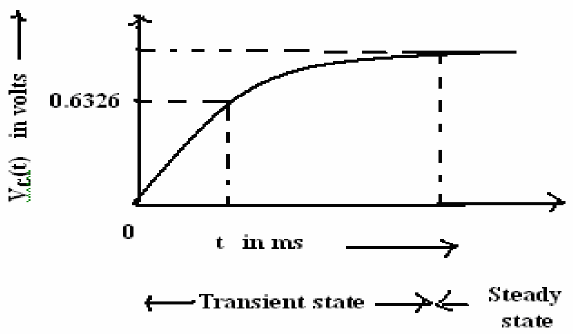
RC CIRCUIT:

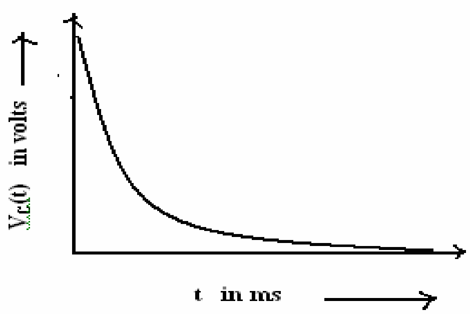


MODEL GRAPH:

CHARGING

DISCHARGING





TABULATION:

CHARGING:

S.NO.	TIME (msec)	VOLTAGE ACROSS 'C' (volts)	CURRENT THROUGH 'C' (mA)

MODEL CALCULATION & ANALYSIS:

TABULATION:

DISCHARGING:

S.NO.	TIME (msec)	VOLTAGE ACROSS 'C' (volts)	CURRENT THROUGH 'C' (mA)

MODEL CALCULATION & ANALYSIS:

RESULT:

Thus the transient response of RL & RC circuit for DC input was verified.

9.A. FREQUENCY RESPONSE OF SERIES RESONANCE CIRCUIT

AIM:

To obtain the resonance frequency of the given RLC series electrical network.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Range	Quantity
1	Function generator	0-2MHz	1
2	Resistor	1KΩ,	1
3	Voltmeter	(0-5) V	1
4	capacitor	1μF	1
5	Bread board	-----	1
6	Connecting wires	------	As required
7	Decade inductance box	(0-100)mH	1

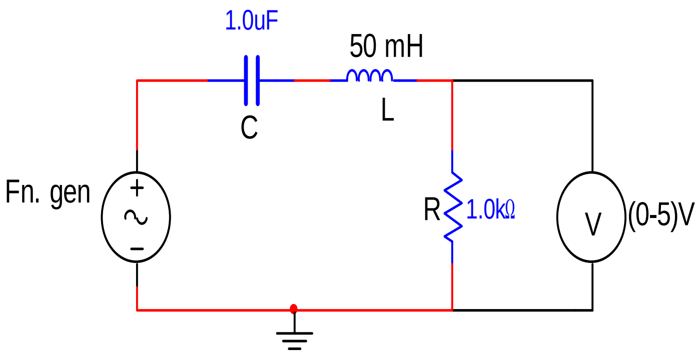
FORMULA USED:

Series resonance frequency $F=1/(2\pi\sqrt{(LC)})$

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Vary the frequency of the function generator from 50 Hz to 20 KHz.
3. Measure the corresponding value of voltage across the resistor R for series RLC circuit.
4. Repeat the same procedure for different values of frequency.
5. Tabulate your observation.
6. Note down the resonance frequency from the graph.

Circuit diagram:
Series resonance



Tabulation:

Frequency (Hz)	V_R(volt)

Calculation:

<u>RESULT:</u>

Thus the resonance frequency of series RLC circuit is obtained.

Practical value =

Theoretical value =

9.B. FREQUENCY RESPONSE OF PARALLEL RESONANCE CIRCUIT

AIM:

To obtain the resonance frequency of the given RLC parallel electrical network.

APPARATUS REQUIRED:

Sl.No	Name of the apparatus	Range	Quantity
1	Function generator	0-3MHz	1
2	Resistor	1KΩ,	1
3	Voltmeter	(0-5) V	1
4	capacitor	1µF	1
5	Bread board	-----	1
6	Connecting wires	------	As required
7	Decade inductance box	(0-100)mH	1

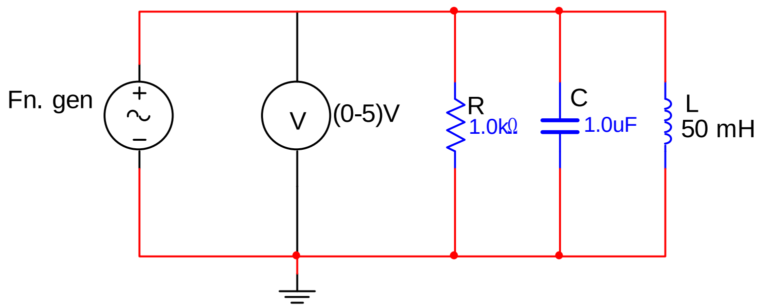
FORMULA USED:

Parallel resonance frequency $F=1/ (2\pi \sqrt{(LC)}$

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Vary the frequency of the function generator from 50 Hz to 20 KHz.
3. Measure the corresponding value of voltage across the resistor R for series RLC circuit.
4. Repeat the same procedure for different values of frequency.
5. Tabulate your observation.
6. Note down the resonance frequency from the graph.

Circuit diagram
Parallel resonance



Tabulation:

Frequency (Hz)	V_R(volt)

Calculation:

<u>RESULT</u>:

Thus the resonance frequency of series RLC circuit is obtained.

Practical value =
Theoretical value =

10. FREQUENCY RESPONSE OF SINGLE TUNED COUPLED CIRCUIT

AIM:

To determine the frequency response of a single tuned coupled circuits.

APPARATUS REQUIRED:

S.No.	Name of the apparatus	Range	Quantity
1.	Single tuned coupled circuits.	-	1
2.	Connecting wires	-	As required

THEORY:

When two coils are placed nearby and current passes through any one or both of the coils, they become magnetically coupled. Then the coils are known as coupled coils. If the coils are part of a circuit, the circuit is known as a coupled circuit. A Single tuned to resonance.

FREQUENCY RESPONSE OF SINGLE TUNED CIRCUITS:

The variation of the amplification factor or output voltage with frequency is called the frequency response. It can be observed that the output voltage, current and amplification depend on mutual inductance at resonance frequency. The maximum amplification depends on M and it occurs at resonance frequency. Amplification factor is given by,

$$\frac{V_0}{V_i} = \frac{M}{C\,(R_s R_2 + \omega_r^2 M^2)}$$

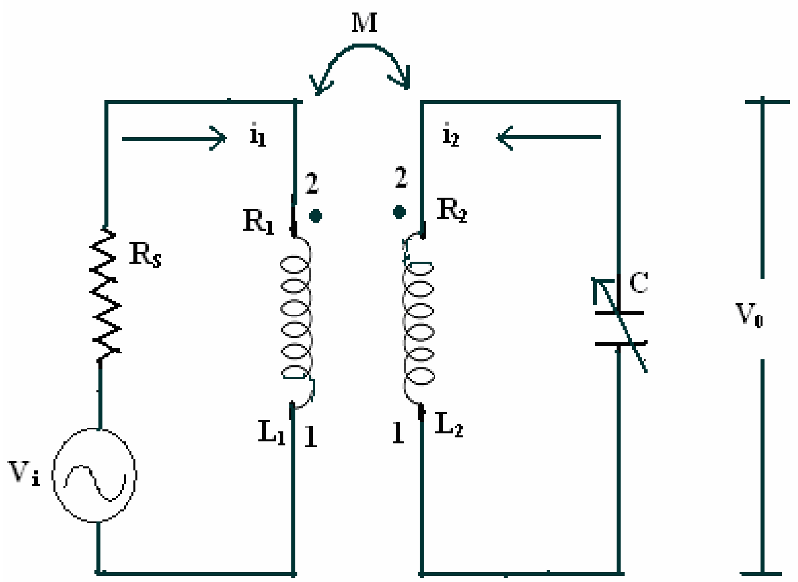
Maximum amplification is given by :

$$A_m = \frac{1}{2\omega_r^2 C\sqrt{(R_s R_2)}}$$

PROCEDURE:

- Connections are given as per the circuit diagram.
- Power supply is switched ON.
- Input frequency is varied by AFO, corresponding input & output Voltage are noted.
- Graph is drawn between Frequency & Amplification factor.

CIRCUIT DIAGRAM:

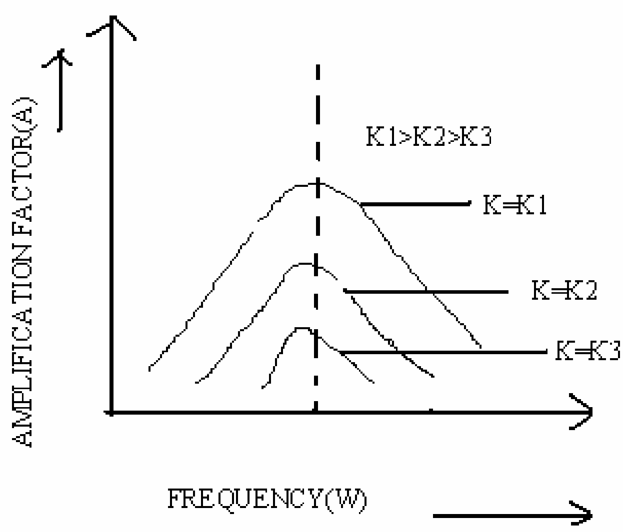


TABULATION:

Frequency (w) in Hz	Output Voltage V_0 (V)	Input voltage V_i (V)	Amplification factor $A = V_0 / V_i$

MODEL CALCULATION & ANALYSIS:

MODEL GRAPH:



RESULT:

The frequency of single tuned coupled circuits was verified.