SYLLABUS FOR

Pr2. CIRCUIT AND SIMULATION LAB

Name of the Course: Diploma in Electrical Engineering			
Course code:		Semester :	3rd
Total Period:	90	Examination :	3hrs
Lab. periods:	6 P / week	Sessional:	50
Maximum marks:	100	End Semester Examination ::	50

A. Rationale:
The response of Electrical Circuit can be verified practically by applying different theorems and fundamental techniques. The students will become sure that the theoretical tricks which they have learned from books are true. The students will become competent in the field of circuit analysis

B. Objective:
On completion of the lab course the student will be able to:
1. Verify the theorems using different components.
2. Know the various types of filters.
3. Simulate different circuits using P-Spice/MATLAB software.

C. Course content in terms of specific objectives:
1. Measurement of equivalent resistance in series and parallel circuit
2. Measurement of power and power factor using series R-L-C Load.
3. Verification of KCL and KVL.
4. Verification of Super position theorem
5. Verification of Thevenin's Theorem
6. Verification of Norton's Theorem
7. Verification of Maximum power transfer Theorem
8. Determine resonant frequency of series R-L-C circuit.
9. Study of Low pass filter & determination of cut-off frequency
10. Study of High pass filter & determination of cut-off frequency
11. Analyze the charging and discharging of an R-C & R-L circuit with oscilloscope and Compute the time constant from the tabulated data and determine the rise time graphically.
12. Construct the following circuits using P-Spice/MATLAB software and compare the measurements and waveforms.
i. Superposition theorem
ii. Series Resonant Circuit
iii. Transient Response in R-L-C series circuit

EXPERIMENT - 1

Measurement of equivalent resistance in series and parallel circuit

1.1 AIM:

To Measure the equivalent resistance of the series and parallel configuration of Resistive Circuit.

1.2 APPARATUS:

S. No	Apparatus Name	Range	Quantity
1	Resistors	Different	6
2	Multi meter/ohm meter		1
3	Bread Board		1
4	Connecting Wires		As required

1.3 THEORY:

When resistors having resistances R_1 ,R_2 , R_3 are joined end-on-end as shown infig1.1,they are said to be connected in *series.*

When resistors having resistances R_1 ,R_2 , R_3 are connected as shown infig1.2,they are said to be connected in *Parallel*

1.4 CIRCUIT DIAGRAMS:

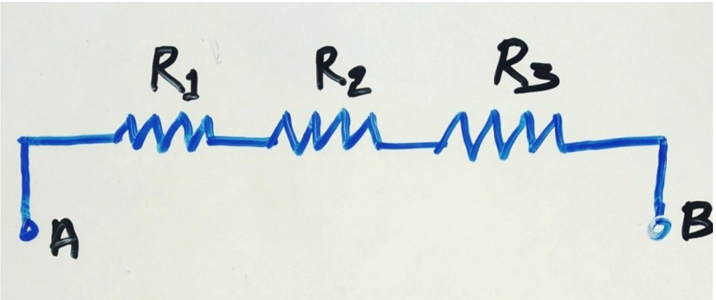


Figure –1.1. Series connection

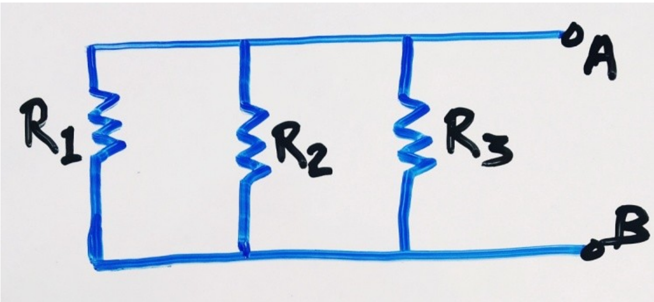


Figure –1.2. Parallel connection

1.5 PROCEDURE:

1. Connect the circuit diagram as shown in Figure 1.1 and 1.2.
2. Measure the equivalent resistance by multi meter between point A and B for both series and parallel circuit
3. Compare it with the calculated value.

1.6 OBSERVATIONS:

For Series Circuit:

R_1 =------------Ohm , R_2 =------------Ohm , R_3 =------------Ohm

R_{AB} =------------Ohm

For Parallel Circuit:

R_1 =------------Ohm , R_2 =------------Ohm , R_3 =------------Ohm

R_{AB} =------------Ohm

1.7 CALCULATIONS: R_{AB}

For Series circuit **$R_{AB} = R_1 + R_2 + R_3$**

For Parallel circuit $\frac{1}{R_{AB}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

1.8 PRECAUTIONS:

1.Check for proper connections before switching ON the supply
2. Connections should be tight.
3. Note the readings carefully.

1.9 RESULTS And CONCLUSIONS:

EXPERIMENT - 2

Measurement of power and power factor using series R-L-C Load

2.1 AIM:

To measure the power and power factor of a series R-L-C Load.

2.2 APPARATUS:

S. No	Apparatus Name	Range	Quantity
1	Resistors Box		1
2	Inductor Box		1
3	Capacitor Box		1
4	AC Volt meter	(0-300)V	1
5	AC Ammeter	(0-5)A	1
6	Single Phase Watt meter		1
7	Connecting Wires		As required

2.3 THEORY:

In a DC Circuit, power supply to the DC load is simply the product of Voltage across the load and Current flowing through it i.e., P = V I. because in DC Circuits, there is no concept of phase angle between current and voltage. In other words, there is no Power factor in DC Circuits.

But the situation is Sinusoidal or AC Circuits is more complex because of phase difference between Current and Voltage.

Therefore average value of power (Real Power) is **P = VI Cosθ** is in fact supplied to the load.

2.4 CIRCUIT DIAGRAM:

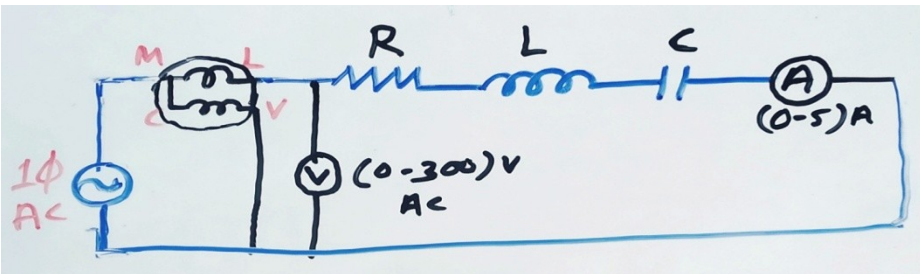


Figure -2.1. Circuit Diagram for Measurement of power

2.5 PROCEDURE

1. Connect the circuit diagram as shown in Figure 2.1.
2. Note down the readings of Ammeter, Volt meter and Watt meter
3. Calculate the value of power factor using the formula mentioned.

2.6 OBSERVATIONS:

Voltage(V)	Current(A)	Power(W)	Power factor

2.7 CALCULATIONS:

P = VI Cosθ, **Cosθ =** $\frac{P}{VI}$

2.8 PRECAUTIONS:

1.Check for proper connections before switching ON the supply
2. Connections should be tight.
3. Note the readings carefully

2.9 RESULTS And CONCLUSIONS:

EXPERIMENT - 3

VERIFICATION OF KVL AND KCL

3.1 AIM:

To verify Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL) in a Passive Resistive Network .

3.2 APPARATUS:

S. No	Apparatus Name	Range	Quantity
1	Regulated power supply		
2	Resistors		
3	Volt meter		
4	Ammeter		
5	Bread Board		
6	Connecting Wires		As required

3.3 THEORY:

Kirchhoffs Current Law or KCL, states that the "*total current or charge entering a junction or node is exactly equal to the charge leaving the node as it has no other place to go except to leave, as no charge is lost within the node*". In other words the algebraic sum of ALL the currents entering and leaving a node must be equal to zero

Kirchhoffs Voltage Law or KVL, states that "*in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop*" which is also equal to zero. In other words the algebraic sum of all voltages within the loop must be equal to zero.

3.4 CIRCUIT DIAGRAM:

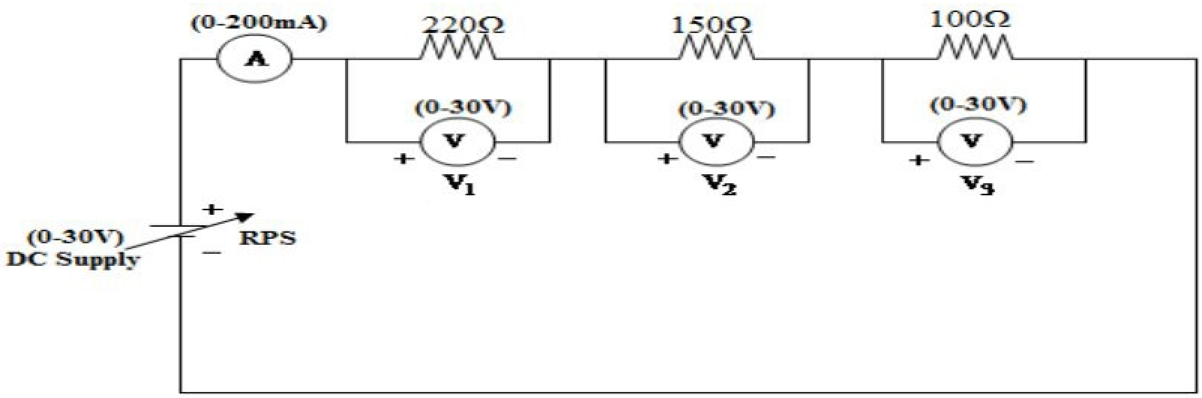


Figure – 3.1 Verification of KVL

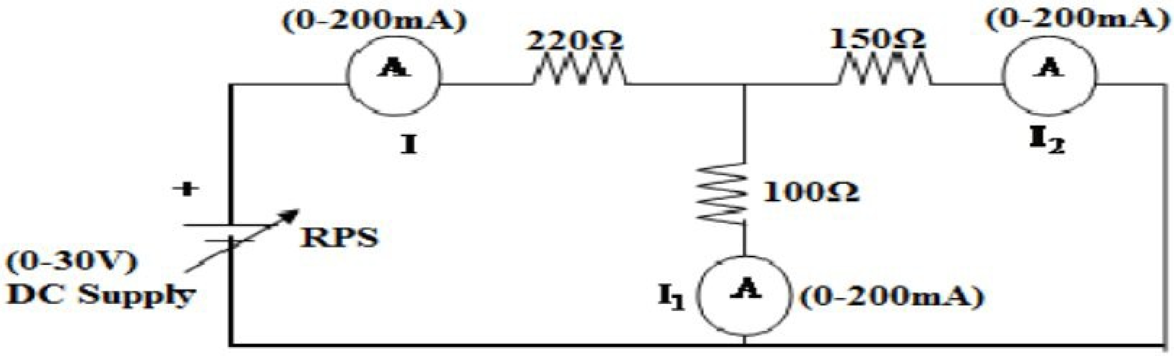


Figure – 3.2 Verification of KCL

3.5 PROCEDURE:

To Verify KVL

1. Connect the circuit diagram as shown in Figure 3.1.
2. Switch ON the supply to RPS.
3. Apply the voltage (say 5v) and note the voltmeter readings.
4. Gradually increase the supply voltage in steps.
5. Note the readings of voltmeters.
6. sum up the voltmeter readings (voltage drops) , that should be equal to applied voltage .
7. Thus KVL is Verified practically.

To Verify KCL

1. Connect the circuit diagram as shown in Figure 3.2.
2. Switch ON the supply to RPS.
3. Apply the voltage (say 5v) and note the Ammeter readings.
4. Gradually increase the supply voltage in steps.
5. Note the readings of Ammeters.
6. Sum up the Ammeter readings (I1 and I2) , that should be equal to total current (I).
7. Thus KCL is Verified practically

.

3.6 OBSERVATIONS:

For KVL

Applied Voltage V (volts)	V_1 (volts)		V_2 (volts)		V_3 (volts)		$V_1+V_2+V_3$ (volts)	
	Theoritical	Practical	Theoritical	Practical	Theoritical	Practical	Theoritical	Practical

For KCL

Applied Voltage V (volts)	I (A)		I_1 (A)		I_2 (A)		I_1+I_2 (A)	
	Theoritical	Practical	Theoritical	Practical	Theoritical	Practical	Theoritical	Practical

3.7 PRECAUTIONS:

1.Check for proper connections before switching ON the supply
2. Connections should be tight.
3. Note the readings carefully

3.8 RESULTS And CONCLUSIONS:

EXPERIMENT – 4

VERIFICATION OF SUPERPOSITION THEOREM

4.1 AIM:

To Verify principle of Superposition theoretically and practically.
.

4.2 APPARATUS:

S. No	Apparatus Name	Range	Quantity
1	Regulated Power Supply		
2	Resistors		
3	DC Ammeter		
4	Bread Board		
5	Connecting Wires		As required

4.3 THEORY:

STATEMENT:

In an linear, bilateral network the response in any element is equal to sum of individual responses While all other sources are non-operative

4.4 CIRCUIT DIAGRAM:

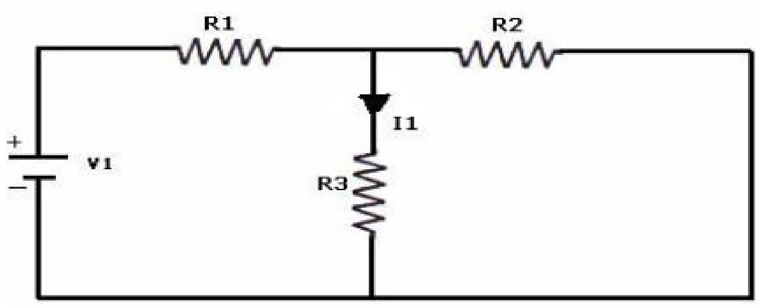


Fig- 4.1 Both Voltage Sources are acting (V_1&V_2)

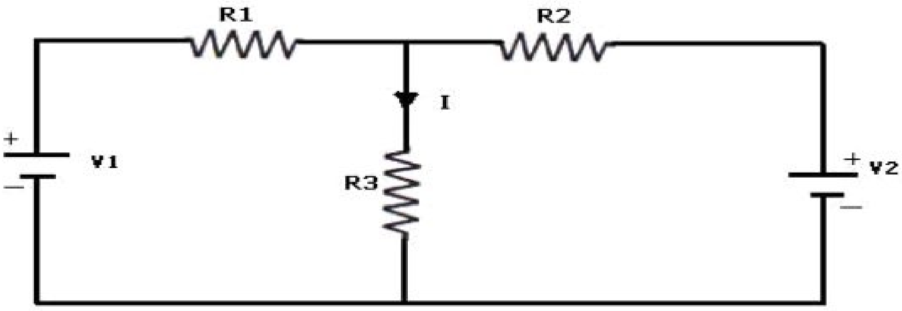


Fig - 4.2 Voltage Source V_1 is acting alone

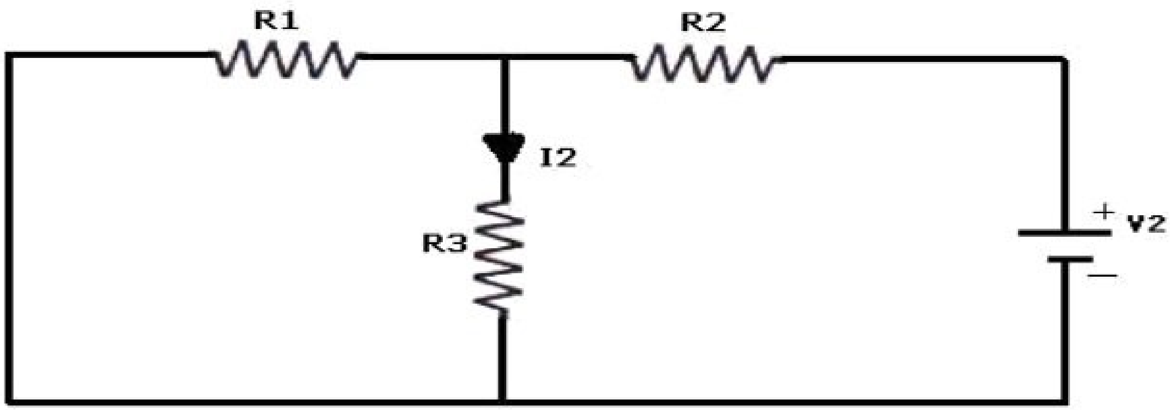


Fig - 4.3 Voltage Source V_2 is acting alone

4.5 PROCEDURE:

1. Connect the circuit as shown in figure (4.1) and note down the current flowing through R3 and let it be I.
2. Connect the circuit as shown in figure (4.2) and note down the ammeter Reading, and let it be I1.
3. Connect the circuit as shown in figure (4.3) and note down the ammeter reading, and let it be I2.
4. Verify for I=I1+I2 .
5. Compare the practical and theoretical currents

N.B. IF YOU HAVE THE EXPERIMENTAL SETUP KIT THEN FOLLOW THE PROCEDURE FOR THE KIT

4.5 OBSERVATIONS & CALCULATIONS:

PARAMETERS	WHEN BOTH V_1 & $V_2 \neq 0$ (I)	WHEN $V_1 \neq 0$ & $V_2=0$ (I_1)	WHEN $V_1=0$& $V_2 \neq 0$ (I_2)
Current through R_3 (Theoretical Values)			
Current through R_3 (Practical Values)			

4.6 PRECAUTIONS:

1.Check for proper connections before switching ON the supply
2. Connections should be tight.
3. Note the readings carefully

4.7 RESULTS And CONCLUSIONS:

EXPERIMENT – 5

VERIFICATION OF THEVENIN'S THEOREM

5.1 AIM:

To Verify Thevenin's theorem.

STATEMENT:

Any linear, bilateral 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 and the resistance is the equivalent resistance measured between the open circuit terminals with all energy sources replaced by their ideal internal resistances

5.2 APPARATUS:

S. No	Apparatus Name	Range	Quantity
1	Regulated Power Supply		
2	Resistors		
3	DC Voltmeter		
4	DC Ammeter		
5	Bread Board		
6	Connecting Wires		As required

5.3 CIRCUIT DIAGRAM:

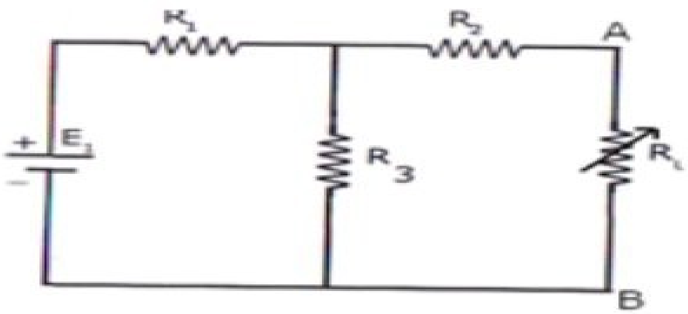
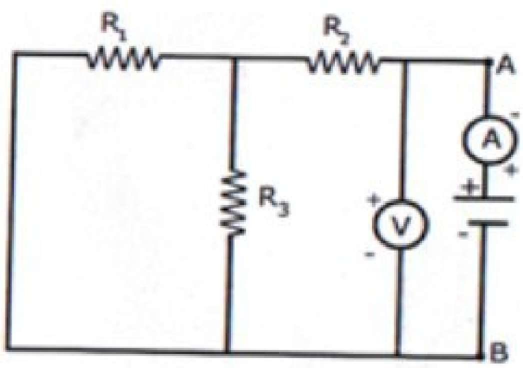


Fig-5.1 Measurement of V_{TH} or V_{OC}



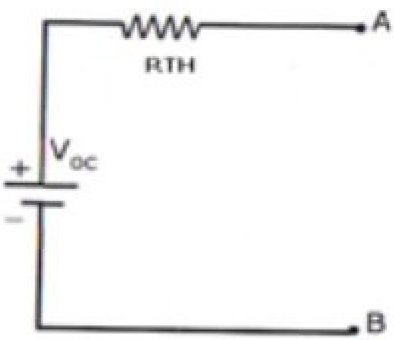


Fig – 5.2 Measurement of R_{TH}

Fig – 8.3 Measurement of I_L ($I_L = V_{TH}$ or $V_{OC}/ R_{TH}+R_L$)

5.4 PROCEDURE:

1. Connect the circuit diagram as shown in fig.5.1
2. Measure current in RL.
3. Connect the circuit as shown in fig 5.2.
4. Measure open circuit voltage Voc by open circuiting terminals i.e, VTH
5. Draw the Thevenin's equivalent circuit as shown in fig 5.3
6. Measurement current in RL

N.B. IF YOU HAVE THE EXPERIMENTAL SETUP KIT THEN FOLLOW THE PROCEDURE FOR THE KIT

5.5 TABULAR COLUMN:

Parameters	Theoretical Values	Practical Values
V_{oc}		
R_{TH}		
I_L		

5.6 PRECAUTIONS:

1.Check for proper connections before switching ON the supply
2. Connections should be tight.
3. Note the readings carefully

5.7 RESULT And CONCLUSIONS:

EXPERIMENT – 6

VERIFICATION OF NORTON 'S THEOREM

6.1 AIM:

To Verify Norton's theorem.

6.2 STATEMENT:

Any linear, bilateral 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 current flowing through the short circuit terminals of the network and the resistance is the equivalent resistance measured between the open circuit terminals of the network with all the energy sources replaced by their internal resistances.

6.3 APPARATUS:

S. No	Apparatus Name	Range	Quantity
1	Regulated Power Supply		
2	Resistors		
3	DC Voltmeter		
4	DC Ammeter		
5	Bread Board		
6	Connecting Wires		As required

6.4 CIRCUIT DIAGRAM:

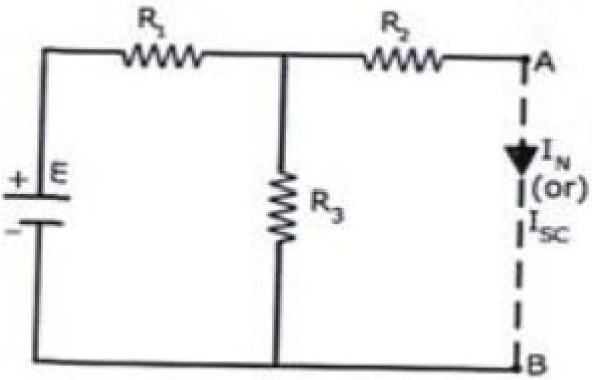


Fig – 6.1 Norton's Current Circuit

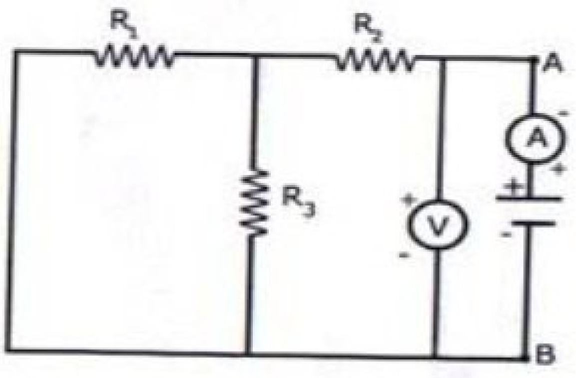


Fig – 6.2 Norton's Equivalent Resistance circuit

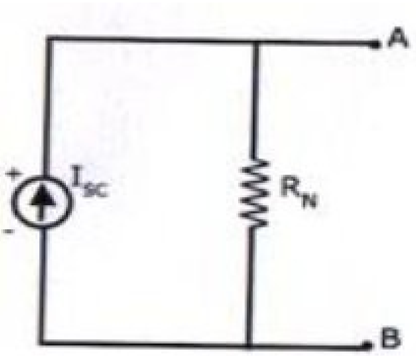


Fig – 6.3 Norton's Equivalent Circuit

6.5 PROCEDURE:

1. Connect the circuit diagram as shown in fig 6.1.
2. Measure the current Isc (or) IN through AB by short-circuiting the resistance between A and B.
3. Connect the circuit diagram as shown in fig 6.2.
4. The resistance between A and B are obtained by using. Voltmeter, ammeter method and the ratio of V and I gives RN.
5. Draw Norton's equivalent circuit by connecting IN & RN in parallel as shown in fig 6.3 and find load current.

N.B. IF YOU HAVE THE EXPERIMENTAL SETUP KIT THEN FOLLOW THE PROCEDURE FOR THE KIT

6.6 TABULAR COLUMN:

Parameters	Theoretical Values	Practical Values
Isc/ I_N		
R_N		
I_L		

6.7 PRECAUTIONS:

1.Check for proper connections before switching ON the supply
2. Connections should be tight.
3. Note the readings carefully

6.8 RESULT And CONCLUSIONS:

EXPERIMENT – 7

VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM

7.1 AIM:

To Verify Maximum power transfer Theorem

.

7.2 STATEMENT:

The maximum power transfer theorem states that maximum power is delivered from a source to an load resistance when the load resistance is equal to source resistance. (RL = Rs is the condition required for maximum power transfer).

7.3 CIRCUIT DIAGRAM:

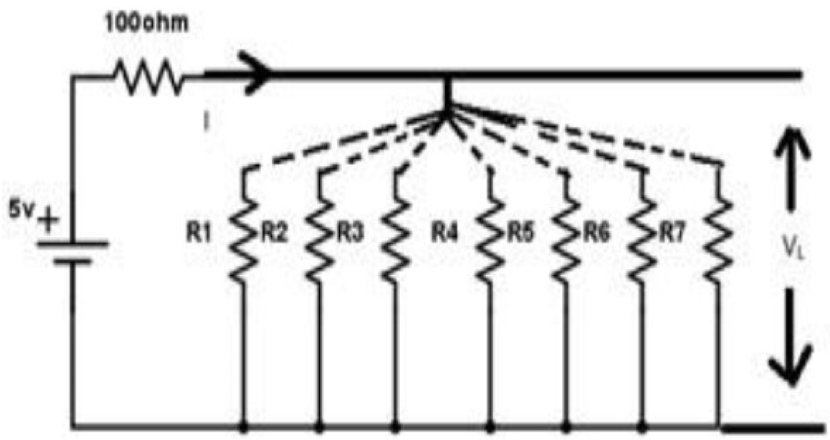


Fig – 7.1 Maximum Power Transfer Circuit

7.4 PROCEDURE:

1. Connect the circuit as shown in fig.7.1
2. Vary the load resistance in steps and note down voltage across the load and current flowing through
the circuit.
3. Calculate power delivered to the load by using formula P=V*I.
4. Draw the graph between resistance and power (resistance on X- axis and power on Y-axis).
5. Verify the maximum power is delivered to the load when RL = Rs for DC.

N.B. IF YOU HAVE THE EXPERIMENTAL SETUP KIT THEN FOLLOW THE PROCEDURE FOR THE KIT

7.5 TABULAR COLUMN:

S. No	RL	V	I	P=VI
1				
2				
3				
4				
5				

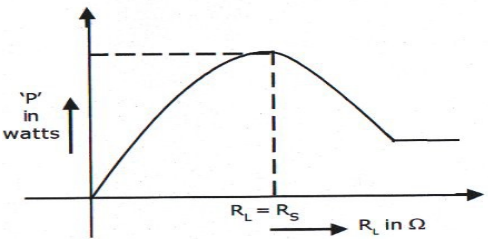


Fig – 7.2 Output Graph of Maximum Power Transfer Theorem

7.7 PRECAUTIONS:

1.Check for proper connections before switching ON the supply
2. Connections should be tight.
3. Note the readings carefully

7.8 RESULT And CONCLUSIONS:

EXPERIMENT – 8

Determine resonant frequency of series R-L-C circuit.

8.1 AIM:
To design the resonant frequency, quality factor and band width of a series resonant circuit

8.2 APPARATUS:

S. No	Apparatus Name	Range	Quantity
1	Signal generator		1
2	Required resistors		1
3	Required Inductors		1
4	Required capacitors		1
5	CRO probes		2
6	Connecting wires		As required

8.3 CIRCUIT DIAGRAM:

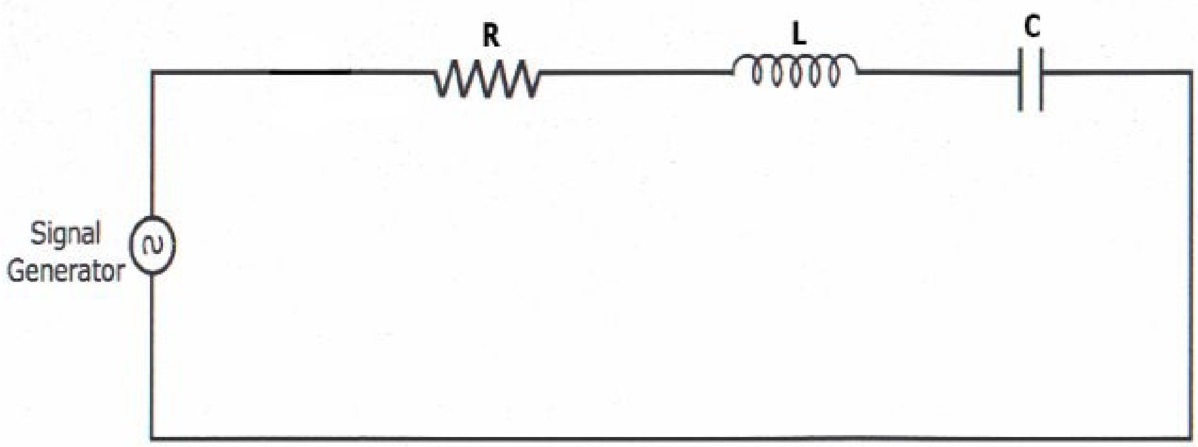


Fig – 8.1 Series Resonance

8.4 PROCEDURE:

1. Connect the circuit as shown in fig.12.1 for series resonant circuit
2. Set the voltage of the signal from function generator to 10V.
3. Vary the frequency of the signal in steps and note down the magnitude of response on CRO
respectively.(response wave form is observed across element R)
4. Form the observation table between the frequency and magnitude of response in CRO for series resonance circuit.
5. Draw a graph between frequency and magnitude of response on the semi-log sheet and determine the resonant frequency, quality factor and bandwidth of series RLC circuit.

N.B. IF YOU HAVE THE EXPERIMENTAL SETUP KIT THEN FOLLOW THE PROCEDURE FOR THE KIT

THEORETICAL CALCULATIONS:

Series Resonance

Resonant Frequency (fr) = 1/(2Π√LC)

Lower cut off frequency (f1) = fr-R/4ΠL

Upper cut off frequency (f2) = fr+R/4ΠL

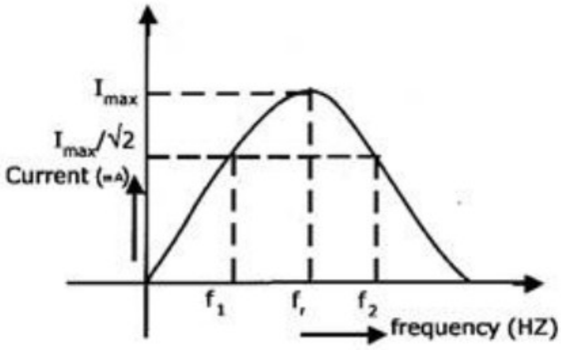
Qualityfactor Qr = ωrL/R = 1/ωrRC

Band Width f2-f1 = R/2ΠL

8.5 TABULAR COLUMN:

S.No.	Frequency *(Hz)*	Magnitude of response
1		
2		
3		
4		
5		
6		
7		
8		
9		

MODEL GRAPH:



8.6 PRECAUTIONS:

1.Check for proper connections before switching ON the supply

2. Connections should be tight.

3. Note the readings carefully.

8.7 RESULTS And CONCLUSIONS:

EXPERIMENT - 9

Study of Low pass filter & determination of cut-off frequency

9.1 AIM:

To plot the frequency response of Low pass filter and determine of cut-off frequenc

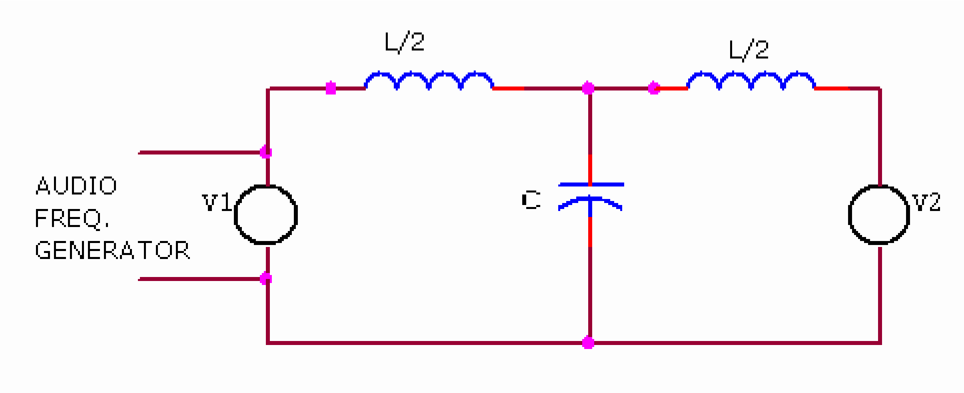
9.2 APPARATUS:

S. No	Apparatus Name	Range	Quantity
1	Signal generator		1
2	Required resistors		
3	Required Inductors		1
4	Required capacitors		2
5	Filter ckt. Kit		1
6	Connecting wires		As required

9.3 THEORY:

A Low pass filter is one which passes without attenuation all frequencies up to the cut-off frequency fc & simultaneously attenuates all other frequencies greater than fc

9.4 CIRCUIT DIAGRAM:



9.5 PROCEDURE:

a) Connect the ckt. according to the ckt. diagram
b) Connect the audio signal generator with 600Ω source impedance to the I/P of the filter. Terminate the O/P with a 600Ω resistive load.
c) Connect two voltmeters at I/P & O/P terminal.
d) Set the I/P voltage to app. 1Vrms at 1 KHz.
e) Vary the I/P freq. from 0 to 10KHz in small steps. Measure I/P& O/P voltage at each step.
f) Take more reading where the attenuation roll off is predominant.
g) Draw the graph

9.6 TABULAR COLUMN:

S.N.O	Frequency (KHz)	I/P Voltage V1 (Volts)	O/P Voltage V2 (Volts)	α = 20 log V2/V1

9.7 PRECAUTIONS:

1.Check for proper connections before switching ON the supply
2. Connections should be tight.
3. Note the readings carefully

9.8 RESULTS And CONCLUSIONS:

EXPERIMENT – 10

Study of High pass filter & determination of cut-off frequency

10.1 AIM:

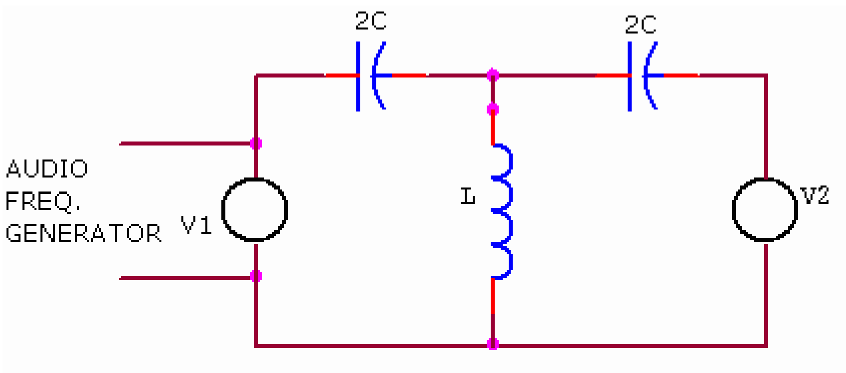
To plot the frequency response of High pass filter and determine of cut-off frequency

10.2 APPARATUS:

S. No	Apparatus Name	Range	Quantity
1	Signal generator		1
2	Required resistors		
3	Required Inductors		1
4	Required capacitors		2
5	Filter ckt. Kit		1
6	Connecting wires		As required

10.3 THEORY:

A HP filter attenuates all frequencies below a designated cut-off frequency fc , & passes all freq. above fc. Thus the pass band of this filter is the freq. range above fc & the stop band is the freq. range below fc



10.4 CIRCUIT DIAGRAM:

10.5 PROCEDURE:
a) Connect the circuit. according to the circuit diagram
b) Connect the audio signal generator with 600 Ω source impedance to the I/P of the filter terminate that the O/P with a 600Ω resistive load.
c) Connect two voltmeter at I/P & O/P terminal.
d) Set the I/P voltage to app. 1Vrms at 1 KHz.
e) Vary the I/P freq. from 0 to 10KHz in small steps. Measure I/P& O/P voltage at each Step.
f) Take more reading where the attenuation roll off is predominant.
h) Draw the graph.

10.6 TABULAR COLUMN:

S.N.O	Frequency (KHz)	I/P Voltage V1 (Volts)	O/P Voltage V2 (Volts)	$\alpha = 20 \log V2/V1$

10.7 PRECAUTIONS:

1.Check for proper connections before switching ON the supply
2. Connections should be tight.
3. Note the readings carefully

10.8 RESULTS And CONCLUSIONS:

SIMULATION OF CIRCUIT USING MATLAB

EXPERIMENT – (A)

VERIFICATION OF SUPERPOSITION THEOREM USING DIGITAL SIMULATION

AIM:

To verify Superposition theorem using digital simulation.

SOFTWARE REQUIRED:

MATLAB

CIRCUIT DIAGRAMS:

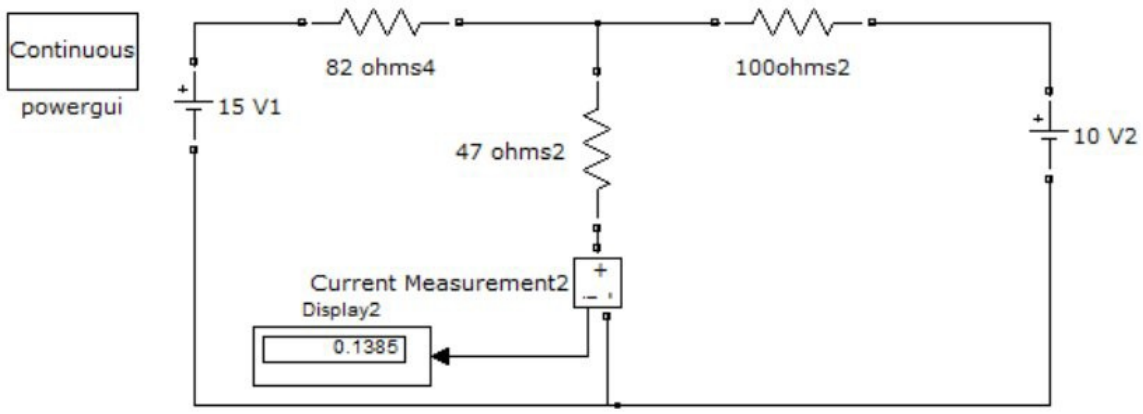


Figure –(A).1. Verification of super position theorem.

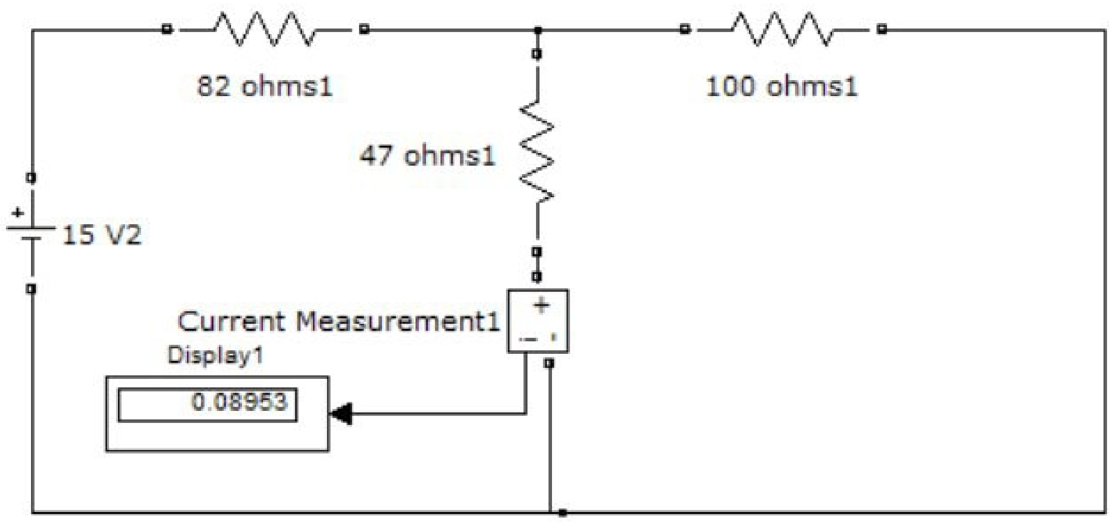


Figure – (A).2. Verification of super position theorem.

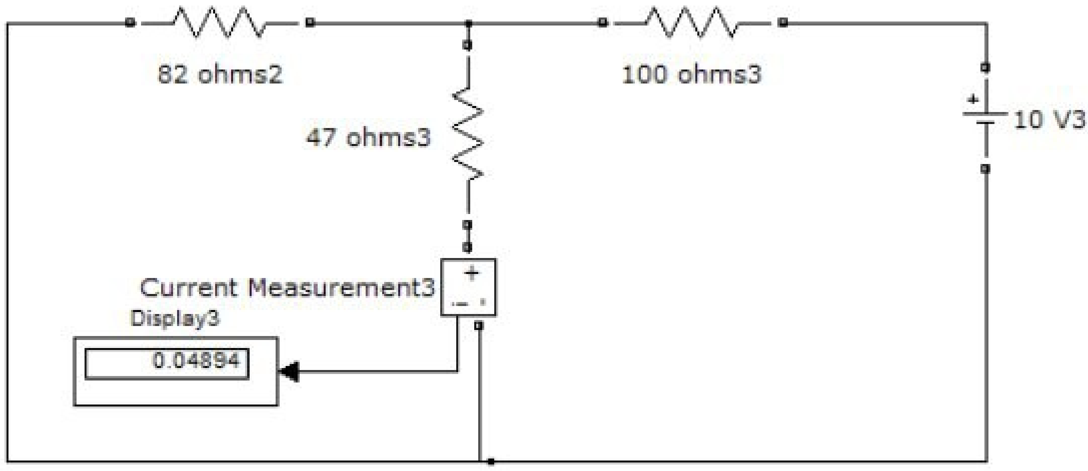


Figure – (A).3. Verification of super position theorem

PROCEDURE:

1. Make the connections as shown in the circuit diagram by using MATLAB Simulink.
2. Measure the current in each circuit using current measurement.
3. Verify with the theoretical results obtained with practical results

RESULTS And CONCLUSIONS:

EXPERIMENT –(B)

SERIES RESONANT CIRCUIT USING DIGITAL SIMULATION

AIM:

To plot the magnitude curve for various frequencies for the given RLC series circuit.

SOFTWARE REQUIRED:

MATLAB

THEORY:

A circuit is said to be in resonance when applied voltage V and current I are in phase with each other. Thus at resonance condition, the equivalent complex impedance of the circuit consists of only resistance (R) and hence current is maximum. Since V and I are in phase, the power factor is unity.

The complex impedance

$Z = R + j\,(XL – XC)$

Where $XL = \omega L$

$XC = 1/\omega C$

At resonance, XL= XC and hence Z= R

Bandwidth of a Resonance Circuit:

Bandwidth of a circuit is given by the band of frequencies which lies between two points on either side of resonance frequency, where current falls through 1/1.414 of the maximum value of resonance. Narrow is the bandwidth, higher the selectivity of the circuit. As shown in the model graph, the bandwidth AB is given by f2 – f1. f1 is the lower cut off frequency and f2 is the upper cut off frequency

CIRCUIT DIAGRAMS:

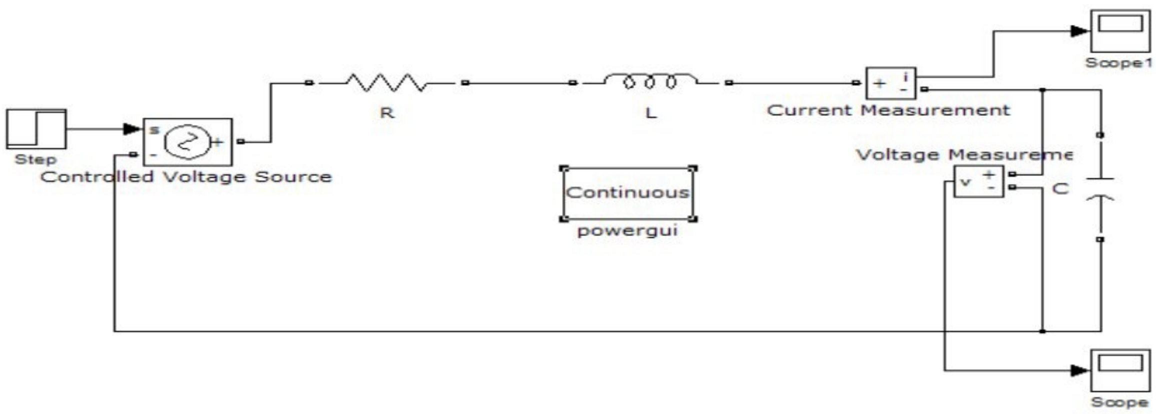
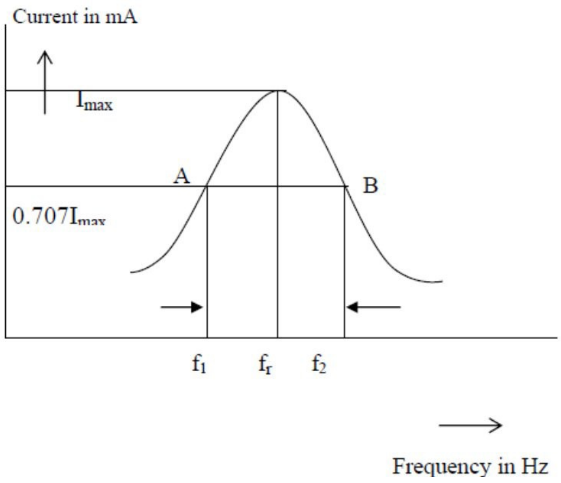


Fig –(B) Series Resonance simulation diagram

PROCEDURE:

1. Open a new MATLAB/SIMULINK model
2. Connect the circuit as shown in the figure(B).
3. Debug and run the circuit
4. By double clicking the powergui plot the value of current for the different values of frequencies

MODEL GRAPH FOR SERIES RESONANCE:



RESULTS And CONCLUSIONS:

%PROGRAM TO FIND THE SERIES RESONANCE

```
clc;
clear all;
close all;
r=input('enter the resistance value----->');
l=input('enter the inductance value------>');
c=input('enter the capacitance value----->');
v=input('enter the input voltage------->');
f=5:2:300;
xl=2*pi*f*l;
xc=(1./(2*pi*f*c));
x=xl-xc;
```



```
z=sqrt((r^2)+(x.^2));
i=v./z;
%plotting the graph
subplot(2,2,1);
plot(f,xl);
grid;
xlabel('frequency');
ylabel('X1');
subplot(2,2,2);
plot(f,xc);
grid;
xlabel('frequency');
ylabel('Xc');
subplot(2,2,3);
plot(f,z);
grid;
xlabel('frequency');
ylabel('Z');
```

```
subplot(2,2,4);
plot(f,i);
grid;
xlabel('frequency');
ylabel('I');
```

PROGRAM RESULT:

```
enter the resistance value----->100
enter the inductance value------>10e-3
enter the capacitance value----->0.1*10^-6
enter the input voltage------->10
```