EEPC2201 Electrical Circuit Analysis Lab. (0-0-3)

LIST OF EXPERIMENTS

EXP NO.	NAME OF THE EXPERIMENT
1	To determine and verify Super Position theorem.
2	To determine and verify Thevenin’s and Norton’s theorem.
3	Determination of Circuit Parameters: Open Circuit & Short Circuit Parameters.
4	Determination of Circuit Parameters: Hybrid & Transmission Parameters
5	Frequency Response of Low Pass & High Pass Filters.
6	Frequency Response of Band Pass & High Band Elimination Filters.
7	Study of resonance in R-L-C Series circuit using Oscilloscope
8	Study of resonance in R-L-C Parallel circuit using Oscilloscope

EXPERIMENT -1

AIM:

To determine and verify Super Position theorem.

APPARATUS REQUIRED:

Sl. No.	Apparatus	Range	Quantity
1	RPS (regulated power supply)		
2	Ammeter		
3	Resistors		
4	Bread Board		
5	Wires		

THEORY:

Super Position theorem states that in any linear resistive network, the voltage across or the current through any resistor or source may be calculated by adding algebraically all the individual voltages or currents caused by the separate independent sources acting alone, with all other independent voltage sources replaced by short circuits and all other independent current sources replaced by open circuits. In case of non-ideal sources, the voltage source must be replaced by series impedance and current sources by shunt impedance. The superposition theorem is applied to determine currents and node voltages which are linearly related to the source acting on a network. Power can't be determined by superposition theorem since the relationship between power and voltage or current is quadratic.

CIRCUIT DIAGRAM:

PROCEDURE:

1. Connections were made as per the circuit diagram.
2. Before the supply was given, the responses were calculated in each branch by acting two sources and also each source acting alone.
3. If the sum of the responses obtained by each source acting alone is equal to the response obtained when both sources are acting, then the superposition theorem is said to be verified theoretically.
4. Now switched on the circuit and the readings of ammeters and voltmeters were noted when both sources were acting.
5. By shorting one after the other source, the corresponding responses were noted down in each branch.
6. If the sum of the responses obtained by each source acting alone is equal to the response obtained when both sources are acting, then the superposition theorem is said to be verified practically.

OBSERVATION TABLE:

No. of Observations	R_1 (Ω)	R_2 (Ω)	R_3 (Ω)	I (with E_1 & E_2 active) amps	$I^{/}$ (with only E_1 & active) amps	$I^{//}$ (with only E_2 active) amps

CALCULATION:

CONCLUSION:

Name:

Branch:

Regd.No:

EXPERIMENT -2

AIM:

To determine and verify Thevenin's and Norton's theorem.

APPARATUS REQUIRED:

1. Power Supply
2. Bread Board
3. Connecting Leads
4. Voltmeter
5. Ammeter

THEORY:

THEVENIN'S THEOREM:

As applied to the network circuit may be stated as the current flowing through a load resistance R_L connected across any two terminals A and B of a linear bilateral network is given by V_{TH} /R_{TH} +R_L where V_{TH} is the open circuit voltage and R_{TH} is the internal resistance of the network from the terminal A to B with all voltage sources replaced with their internal resistances and current sources with infinite resistance.

NORTON'S THEOREM:

Replace the electrical network by an equivalent constant current source and a parallel resistance. Norton's equivalent resistance $R_N = R_1 \times R_2 / R_1 + R_2$. Actual load current in the circuit I_{L1} theoretical load current $I_{L2} = I_{SC} \times R_N / (R_N + R_L)$, I_{SC} is the short circuit current.

CIRCUIT DIAGRAM:

THEVENIN'S CIRCUIT DIAGRAM:

NORTON'S CIRCUIT DIAGRAM:

PROCEDURE:

THEVENIN PROCEDURE:

Thevenin's Theorem is a way to reduce a network to an equivalent circuit composed of asingle voltage source, series resistance, and series load.

Steps to follow for Thevenin's Theorem:

1. The current flowing through the load resistance R_L was found as shown in fig. $R_L$was removed from the circuit temporarily and the terminals A and B were open circuited.
2. The open circuit voltage V_{TH} was calculated which appears across terminal A and B. $V_{TH} = I R_{TH.}$ This is called Thevenin's voltage.
3. Now $R_{TH} = R_1 R_2 / R_1 + R_2$ was calculated. This is called Thevenin's Resistance.
4. Voltage and current for the load resistor were analyzed by using following rules for series circuits.

$$I_L = V_{TH} / (R_L + R_{TH}),\ V_{TH} = E \times R_2 / (R_1 + R_2)$$

NORTON THEOREM:

Norton's Theorem is a way to reduce a network to an equivalent circuit composed of a singlecurrent source, parallel resistance, and parallel load.

Steps to follow for Norton's Theorem:

1. The Norton source current was found by removing the load resistor from the original circuit and calculating current through a short (wire) jumping across the open connection points where the load resistor used to be.
2. The Norton resistance was calculated by removing all power sources in the original circuit (voltage sources shorted and current sources open) and calculating total resistance between the open connection points.
3. The Norton equivalent circuit was drawn, with the Norton current source in

parallel with the Norton resistance. The load resistor re-attaches between the two open points of the equivalent circuit.
4. Voltage and current for the load resistor were analyzed by using following rules for parallel circuits.

OBSERVATION TABLE:

THEVENIN'S TABLE

Sl. No.	Applied Voltage (volts)	V_{TH} (volts) Theo.	V_{TH} (volts) Pract.	R_{th} (ohms)	I_L (amp) Theo.	I_L (amp) Pract.

NORTON'S TABLE

Sl. No.	Applied Voltage (volts)	I_N (amp.)	R_N (ohms)	I_{L1} (amp)	I_{L2} (amp)

CALCULATION:

CONCLUSION:

Name:
Branch:
Regd.No:

EXPERIMENT -3

AIM:

Determination of Circuit Parameters: Open Circuit & Short Circuit Parameters

APPARATUS REQUIRED:

(1) Power Supply
(2) Bread Board
(3) Five resistances
(4) Connecting Leads
(5) Voltmeter
(6) Ammeter

THEORY:

Open Circuit Parameter:

In Z parameters of a two-port, the input & output voltages V_1 & V_2 can be expressed in terms of input & output currents I_1 & I_2. Out of four variables (i.e. V_1, V_2, I_1, I_2) V_1& V_2 are dependent variables whereas I_1 & I_2 are independent variables. Thus,

$V_1 = Z_{11}I_1 + Z_{12} I_2$ -- (1)

$V_2 = Z_{21}I_1 + Z_{22} I_2$ --- (2)

Here Z_{11} & Z_{22} are the input & output driving point impedances while Z_{12} &

Z_{21} are the reverse & forward transfer impedances.

Short Circuit Parameter:

In Y parameters of a two-port, the input & output currents I_1 & I_2 can be expressed in terms of input & output voltages V_1 & V_2. Out of four variables (i.e. I_1, I_2, $V_{,}V_2$) I_1& I_2 are dependent variables whereas V_1 & V_2 are independent variables.

$I_1 = Y_{11}V_1 + Y_{12}V_2$ -- (3)

$I_2 = Y_{21}V_1 + Y_{22}V_2$ --- (4)

Here Y_{11} & Y_{22} are the input & output driving point admittances while Y_{12} & Y_{21} are the reverse & forward transfer admittances.

CIRCUIT DIAGRAM:

Open Circuit Parameter:

Short Circuit Parameter:

PROCEDURE:

Open Circuit Parameter:

(a)The circuit was connected as shown in fig. & the experimental board was switched on.
(b)First the O/P terminal was opened & supplied 5V to I/P terminal. The O/P Voltage & I/P Current were measured. Secondly, I/P terminal was opened & supplied 5V to O/P terminal. I/P Voltage & O/P current were measured using multi-meter.
(c)The values of Z parameters were calculated using Equation (1) & (2).

(d) The supply was switched off after taking the readings.

Short Circuit Parameter:

(a) The circuit was connected as shown in fig. & the experimental board was switched on.
(b) First the O/P terminal was shorted & supplied 5V to I/P terminal. O/P & I/P current were measured.
(c) Secondly, I/P terminal was shorted & supplied 5V to O/P terminal. I/P & O/P current were measured using multi-meter.
(d) The values of Y parameter were calculated using Eq. (3) & (4).
(e) The supply was switched off after taking the readings.

OBSERVATION TABLE:

Open Circuit Parameter:

Sl. No	When I/P is open ckt			When O/P is open ckt		
	V_2	V_1	I_2	V_2	V_1	I_1

CALCULATION:

Short Circuit Parameter:

S.No	When I/P is short ckt			When O/P is short ckt		
	V_2	I_1	I_2	V_1	I_1	I_2

CALCULATION:

CONCLUSION:

Name:

Branch:

Regd. No:

EXPERIMENT -4

AIM:

Determination of Circuit Parameters: Hybrid & Transmission Parameters.

APPARATUS REQUIRED:

(1) Power Supply
(2) Bread Board
(3) Five resistances
(4) Connecting Leads
(5) Multimeter
(6) Voltmeter
(7) Ammeter

THEORY:

Hybrid Parameter

In 'h' parameters of a two port network, voltage of the input port and the current of the output port are expressed in terms of the current of the input port and the voltage of the output port. Due to this reason, these parameters are called as 'hybrid' parameters, i.e. out of four variables (i.e. $V_{1,}$ V_2, I_1, I_2) $V_{1,}$ I_2 are dependent variables.
Thus,

$$V_1 = h_{11}I_1 + h_{12}V_2 \qquad (1)$$

$$I_2 = h_{21}I_1 + h_{22}V_{22} \qquad (2)$$

H_{11} and H_{22} are input impedance and output admittance.
H_{21} and H12 are forward current gain and reverse voltage gain.

Transmission Parameter

ABCD parameters are widely used in analysis of power transmission engineering where they are termed as "Circuit Parameters". ABCD parameters are also known as "Transmission Parameters". In these parameters, the voltage & current at the sending end terminals can be expressed in terms of voltage & current at the receiving end. Thus,

$$V_1 = AV_2 + B(-I_2)$$
$$I_1 = CV_2 + D(-I_2)$$

Here "A" is called reverse voltage ratio, "B" is called transfer impedance "C" is called transfer admittance & "D" is called reverse current ratio.

CIRCUIT DIAGRAM:

Hybrid Parameter:

Transmission Parameter:

PROCEDURE:

Hybrid Parameter:

a) The circuit was connected as shown in fig. & the experimental board was switched on.

b) The output port was shorted and input port was excited with a known voltage source Vs. So that V_1 = Vs and V_2 = 0.I_1 and I_2 were determined to obtain h_{11} and h_{21}.

c) Input port was open circuited and output port was excited with the same voltage source Vs. So that $V_2 = V_S$ and I_1 = 0. I_2 and V_1 were determined to obtain h_{12} and h_{22}.

d) The supply was switched off after taking the readings.

Transmission Parameter:

a) The circuit was connected as shown in fig. & the experimental board was switched on

b) First the O/P terminal was opened & supplied 5V to I/P terminal. O/P voltage & I/P current were measured.

c) Secondly, the O/P terminal was shorted & supplied 5V to I/P terminal. I/P & O/P current were measured using multi-meter.

d) The A, B, C, & D parameters were calculated using the Eq. (1) & (2).

e) The supply was switched off after taking the readings.

OBSERVATION TABLE:

Hybrid Parameter:

Sl. No	When O/P is short ckt			When I/P is short ckt.		
	V_1	I_1	I_2	V_2	V_1	I_2

CALCULATION:

Transmission Parameter:

Sl. No	When O/P is open ckt			When O/P is short ckt		
	V_1	V_2	I_1	V_1	I_2	I_1

CALCULATION:

CONCLUSION:

Name:

Branch:

Regd.No:

EXPERIMENT -5

AIM:

Frequency Response of Low Pass & High Pass Filters.

APPARATUS REQUIRED:

(1) Active filter trainer lit
(2) Oscilloscope
(3) Digital Multimeter
(4) Patch cord

THEORY:

Low Pass Filter:

A low pass filter is one which passes without alteration all frequencies up to the cut off frequency fc while all other frequencies greater than fc are attenuated. The filter transmits all frequencies from zero to cut off voltage. The band is called pass band. The frequency range over which transmission does not take place is called the stop band.

High Pass Filter:

A high pass filter attenuated all the frequencies below a designated cutoff frequency fc and passes all the frequencies above fc. Thus the pass band of this filter is the frequency range above fc and the step band is the frequency range below fc.

CIRCUIT DIAGRAM:

Low Pass Filter:

High Pass Filter:

PROCEDURE:

Low Pass Filter:

1. Initially potentiometers R_1 and R_f were rotated in fully clockwise direction in order to make $R_1 = R_f$ = 10K, so that according to the formula given below

$$V_o = (1+(R_f /R_1))\, V_{in}$$

The gain of the output will be twice of the input.

2. The high cutoff frequency was given by the formula:

$$f_h = \frac{1}{2\pi RC}$$

3. An Ohmmeter was connected between V_{in} of Low Pass Filter and TP6.Resistance value was adjusted at 1.59K by varying the potentiometer of 22K to set the high cutoff frequency (f_h)at 10K.

4. +12V and -12V DC power supplies were connected at their indicated position from the PowerSupply section.

5. All the ground test points were connected using patch cords.

6. The Power Supply was switched on.

7. The output of function generator was set at 2 volt, 500 Hz using Oscilloscope with sinusoidal waveform.

8. TP_1 was connected with V_{in} of Low Pass Filter to give a sinusoidal signal of amplitude 2Vpp of frequency 500 Hz to Low Pass Filter.

9. The output was observed on Oscilloscope.

10. Similarly you can give the triangular and square wave instead of sinusoidal wave, from

the function generator section.

11. As we know according to the formula, Output gain was directly proportional to the R_f and inversely proportional to the R_1. So, we were adjusted the gain of the output by increasing the value of R_f as well as by decreasing the value of R_1.

12. So, the values of R_1 and R_f were changed and the change in output was observed.

13. The frequency of input signal was increased step by step and the effect on output V_{out} was observed on Oscilloscope.

14. The values of V_{out}, gain (db) were tabulated at different values of input frequency shown in the Observation Table.

High Pass Filter:

1. Initially potentiometers R_1 and R_f were rotated in fully clockwise direction in order to make $R_1 = R_f = 10K$, so that according to the formula given below $V_o = (1+R_f /R_1)V_{in}$, The gain of the output would be twice of the input.
2. The Low cutoff frequency was given by the formula: $f_1=1/2\pi RC$
3. An Ohmmeter was connected between TP_4 and TP_7.Resistance value was adjusted at 15.9K by varying the potentiometer of 22K to set the Low cutoff frequency (f_1) at 1K.
4. +12V and -12V DC power supplies were connected at their indicated position from the PowerSupply section.
5. All the ground test points were connected with each other using patch cords.
6. The Power Supply was switched on.
7. The output of the function generator was set at 2 volt, 100 Hz using Oscilloscope with sinusoidal waveform.
8. TP_1 was connected with V_{in} of High Pass Filter to give a sinusoidal signal of amplitude 2V(p-p) of frequency 100Hz.
9. The output was observed on Oscilloscope.
10. As we knew according to the formula, Output gain was directly proportional to the R_f and inversely proportional to the R_1. So, we were adjusted the gain of the output by increasing the value of R_f as well as by decreasing the value of R_1.

11. So, the values of R_1 and R_f were changed and the change in output was observed.

12. Increase The frequency of input signal was increased step by step and the effect on output Vout was observed on Oscilloscope.

13. The values of Vout, gain, gain (db) were tabulated at different values of input frequencies as shown in the Observation Table.

OBSERVATION TABLE:

Low Pass Filter:

Sl. No.	Input frequency(kHz)	V_i (in V)	V_o (in V)	V_o/V_i	Gain (in dB)

CALCULATION:

High Pass Filter:

Sl. No.	Input frequency(kHz)	V_i (in V)	V_o (in V)	Gain (V_o/V_i)	Gain (in dB)

CALCULATION:

CONCLUSION:

Name:

Branch:

Regd. No:

EXPERIMENT -6

AIM:

Frequency Response of Band Pass & High Band Elimination Filters.

APPARATUS REQUIRED:

(1) Active filter trainer lit

(2) Oscilloscope

(3) Digital Multimeter

(4) Patch cord

THEORY:

Band Pass Filter:

A band pass filter is a device that passes frequencies within a certain range and rejects (attenuates) frequencies outside that range.

Band Elimination Filter:

The band-stop filter rejects a band of frequencies, while passing all others. This is also called a band reject or band elimination filter.

CIRCUIT DIAGRAM:

Band Pass Filter:

Band Elimination Filter:

PROCEDURE:

Band Pass Filter:

1. The Output of High Pass Filter was connected to the input of Low Pass Filter in order to make a Band Pass Filter.
2. An Ohmmeter was connected between TP_4 and TP_7 (Gnd), resistance value was adjusted to 15.9K by varying the potentiometer 22K of High Pass Filter to set the Low cutoff frequency (f_L)at 1K.
3. Ohmmeter was connected between V_{in} of Low Pass Filter and TP_6. The resistance value was adjusted to 1.59K by varying the potentiometer 22K of High Pass Filter to set the Low cutoff frequency (f_L) at 10K.
4. +12V and -12V DC Power Supplies were connected at their indicated position from the Power Supply section.
5. The Power Supply was switched on.
6. The output of the function generator was at 2 Volt, 100 Hz using Oscilloscope with sinusoidal waveform.
7. TP_1 was connected with V_{in} of High Pass Filter to give a sinusoidal signal of amplitude 2 Vpp of frequency 100 Hz.
8. The output was observed on Oscilloscope.
9. The frequency of input signal was increased step by step and the effect on output V_{out} was observed on Oscilloscope.
10. The values of Vout, gain, gain (db) were tabulated at different values of input frequency shown in the Observation Table.

11.The frequency response of a high pass filter was plotted using the data obtained at differentinput frequencies.

12.Similarly the experiment on the different values were performed at F_h and F_l.

Band Elimination Filter:

1. Initially potentiometer was rotated. Quality Factor was adjusted anticlockwise to set it at some lower value of resistance.
2. The notch frequency of the filter was given by

$$f_N = \frac{1}{2\pi RC}$$

3. +12V, -12V and Ground terminals from Power Supply Section were connected at their indicated position of Twin-T Notch Filter.
4. The Power Supply switched on.
5. The output of the Function Generator was set for sinusoidal signal at 20 Hz with a fixed amplitude using Oscilloscope.
6. TP_1 was connected with V_{in} of Twin-T Notch Filter to give a sinusoidal signal of fixed amplitude of frequency 20Hz to Twin-T Notch Filter.
7. Ground terminal of Function Generator was connected to Ground terminal of Twin-T Notch Filter.
8. The output (V_{out}) was observed on Oscilloscope and the output voltage was noted down in the Observation Table.
9. The frequencies of input signal was increased step by step and observe the effect on output (V_{out}) on Oscilloscope. The corresponding value of V_{out} was tabulated at different values of input frequency shown in the Observation Table.

OBSERVATION TABLE:

Band Pass Filter:

Sl. No.	Input frequency(kHz)	V_i (in V)	V_o (in V)	Gain (V_o/V_i)	Gain (in dB)

CALCULATION:

Band Elimination Filter:

Sl. No.	Input frequency(kHz)	V_i (in V)	V_o (in V)	Gain (V_o/V_i)	Gain (in dB)

CALCULATION:

CONCLUSION:

Name:

Branch:

Regd. No:

EXPERIMENT -7

AIM:

Study of resonance in R-L-C Series circuit using Oscilloscope.

APPARATUS REQUIRED:

Sl. No.	Name of the Apparatus	Specification	Quantity
01	RLC Trainer Kit		
02	Function Generator		
03	Multimeter		
04	Connecting Probes		
05	Patch Wires		

THEORY:

Series RLC circuit consists of a capacitance and an inductance connected in series across an alternating supply. Series RLC circuits are closed as second order circuits because they contain two energy storage elements: an inductance L and a capacitance C. Consider the R-L-C circuits. In this experiment a circuit will be provided. A p-p sinusoidal signal of amplitude to it and its frequency response would be verified. The gain and phase response against frequency will be typical of a second order system. The expected maximum gain for each 2 can be observed from the plot in the experiment.

CIRCUIT DIAGRAM:

PROCEDURE:

1. The connections were made as per the circuit diagram.
2. Set the frequency was set to 1 kHz in the function generator.

3. The frequency was varied up to 15 kHz and corresponding current readings were taken from multimeter.
4. A graph was plotted between frequency and current.
5. Resonant frequency (f_o) was found.

OBSERVATION TABLE:

Sl. No.	**Frequency (f) in kHz**	**Current (I) in mA**

CALCULATION:

CONCLUSION:

Name:

Branch:

Regd. No:

EXPERIMENT-8

AIM:

Study of resonance in R-L-C Parallel circuit using Oscilloscope.

APPARATUS REQUIRED:

Sl.no.	Name of the Apparatus	Specification	Quantity
01	RLC Trainer Kit		
02	Function Generator		
03	Multimeter		
04	Connecting Probes		
05	Patch Wires		

THEORY:

The parallel resonant circuit has the basic configuration of fig (1). This circuit is often called the tank circuit due to the storage of energy by the inductor and capacitor . A transfer of energy similar to that discussed for the series circuit also occurs in the parallel resonant circuit. In the ideal case (no radiation losses, and so on),the capacitor absorbs energy during one half-cycle of the power curves at the same rate at which it is released by the inductor .during the next half-cycle of the power curves ,the inductor absorbs energy at the same rate at which the capacitor releases it. The total reactive power at resonance is therefore zero. And the total power factor is 1.

CIRCUIT DIAGRAM:

PROCEDURE:

1. The circuit was connected as per the circuit diagram.
2. The frequency was set to 1 kHz in the function generator.
3. A graph was plotted between frequency and current.
4. Resonant frequency (f_o) was found.

OBSERVATION TABLE:

Sl. No.	Frequency (f) in kHz	Current (I) in mA

CALCULATION:

CONCLUSION:

Name:

Branch:

Regd. No: