LABORATORY MANUAL

GOVERNMENT COLLEGE OF ENGINEERING KEONJHAR

NETWORK THEORY

Prepared By :

Dr. Sangram Keshori Mohapatra

Asscociate Professor

DEPRATMENT OF ELECTRICAL ENGINEERING

GOVERNMENT COLLEGE OF ENGINEERING

Old Town, Jmunalia,,Odisha 758002

CONTENTS

5.b	To study the frequency response of high pass filters.					
6.a 6.b	To study the frequency response of band pass filters. To study the frequency response of band stop filters.					
Sl. No.	**Experiment**	**Page No.**	**Date of Experiment**	**Date of Submission**	**Mark Secured**	**Remarks**
7.	Determination of self inductance, mutual inductance and coupling coefficient of a single phase two winding transformer representing a coupled circuit.					
8.	Study of resonance in R-L-C series circuit.					
9.	Study of resonance in R-L-C parallel circuit.					
10.	Spectral analysis of a non-sinusoidal waveform.					

DOS AND DON’TS IN LABORATORY

GENERAL

1. Do not handle any equipment before reading the instructions/Instruction manuals.

2. Apply proper voltage to the circuit as given in procedure.

3. Check the CRO probe before connecting it.

4. Strictly observe the instructions given by the teacher/Lab Instructor**.**

5. Substantial footwear is required. No flip-flops or sandals are allowed.

6. Chairs and stools should be kept under laboratory benches when no one is sitting on them.

ELECTRICAL CIRCUIT SAFETY

1. Do not work alone on energized electrical equipment.

2. Power must be switched off whenever an experiment or project is being assembled or disassembled.Discharge any high voltage points to ground with a well-insulated jumper.Remember that capacitors can store dangerous quantities of energy.Make measurements in live circuits with well insulated probes and one hand behind your back. Do not allow any part of your body to contact any part of the circuit or equipment connected to the circuit.

3. Never touch electrical equipment while standing on a damp or metal floor.

4. Never handle wet, damp or ungrounded electrical equipment.

5. Wearing a ring or watch can be hazardous in an electrical laboratory since such items make good electrodes for the human body.

6. Never lunge for a falling part of a live circuit such as leads or measuring instruments.

7. Never touch two pieces of equipment simultaneously.

8. Never touch even one wire of a circuit; it may be “hot” (i.e. capable of delivering an electric shock).

9. Ask the instructor to check out your constructed circuit before applying power.

LABORATORY INSTRUMENT SAFETY

1. Fuse circuits to protect ammeters and watmeters for the current range being used.

2. Do not drop or bang instruments on the lab tables. They are delicate.
3. Never short circuit a power source.
4. When using instruments which are connected to the power line, connect all ground leads to the same point. Otherwise, a short circuit may result.
5. When using a voltmeter or ammeter, begin with the highest range and work your way down to a suitable range.
6. When using an ohmmeter, never measure resistance in a live circuit.
7. Keep instruments away from the edge of the work bench.

OTHER RULES

1. Use safe laboratory practices at all times.

2. No food or drink is allowed in the laboratory.

3. Do not write on bench surfaces or equipment.

4. Report defective equipment and blown fuses to the instructor.

5. Students must not replace blown fuses, move instruments from one station to another, or turn on the main or secondary circuit breakers.

6. The instructor has to inspect and initial your data before circuit disassembly.

7. Put all waste paper, newspapers, etc. in the wastebasket.

8. Return all equipment and supplies to proper storage locations.

THE EXPERIMENTS

With the preliminaries out of the way, you are ready to begin the experiments. Remember:

1.Read each week’s experiment before coming to the lab. Try to understand the objectives of the experiment and determine what information you should gather (in your laboratory notebook, of course).

2. Note the questions that are asked within the experiment description, especially those that are bold-faced.Make sure you understand these questions and know how to get the information to answer them.

3. Do any pre-lab calculations and be prepared to show these to your instructor.

4. Make sure you bring your notebook with you to the lab! . You can’t do the experiment without it.

Essential Electronics Laboratory Equipment

Setting up an electronics laboratory requires just a few essential pieces of equipment and tools. While specialty pieces of equipment may be essential for your application, the essential pieces of equipment are the same for nearly any electronics lab.

Multimeter

A multimeter's measurement flexibility combined with their precision and accuracy make multimeters an essential tool in any electronics lab. Multimeters will typically be able to measure both AC and DC voltage and current as well as resistance. Multimeters are often used in troubleshooting designs and testing prototype circuits. Multimeter accessories include transistor testing modules, temperature sensor probes, high voltage probes, and probe kits. Multimeters are available for as little as $10 and can run several thousand for a high accuracy, high precision bench top unit.

LCR Meter

As versatile as multimeters are, they cannot measure capacitance or inductance which is where the LCR meter (Inductance (L), Capacitance (C), and Resistance (R)) comes into the picture. LCR meters come in two variants, a lower cost version that measures the total impedance of a component and a more expensive type that measures all of the components of the impedance of the component, equivalent series resistance (ESR) and the Quality (Q) factor of the component. Accuracy of low cost LCR meters is often quite poor, with tolerances as high as 20%. Since many capacitors have a 20% tolerance themselves, compounding the tolerance of the meter and component can cause additional problems in designing and troubleshooting electronics.

Oscilloscope

Electronics are all about the signals and the oscilloscope is the primary measurement tool to observe the shape of signals. Oscilloscopes, often called oscopes or just scopes, display signals in a graphical format on a pair of **axis**, generally with Y as the voltage and X as the time. This is a very powerful way to quickly see the shape of a signal, determine what is going on in an electronic circuit and monitor performance or track down problems. Oscilloscopes are available in digital and analog variants, starting at a few hundred dollars and running **into** the tens of thousands for the top of the line models. Digital scopes have several measurement and trigger options built in to the system which make measurement of peak-to-peak voltage, frequency, pulse width, rise time, signal comparisons, and recording waveforms simple tasks.

Soldering Iron

The core tool for assembling electronics is the soldering iron, a hand tool used to melt solder to form an electrical and physical connection between two surfaces. Soldering irons come in a few forms, with the cheapest being plugged directly into an outlet from the hand tool. While these soldering irons work, for most electronics work a temperature controlled soldering station is much preferred. The tip of a soldering iron is heated by a resistive heater and often monitored by a temperature sensor to keep the temperature of the tip steady. Soldering iron tips are often removable and are available in a range of shapes and styles to accommodate different types of soldering work.

Precision Mechanical Tools

Every electronics lab needs a few key mechanical hand tools to help with the basic tasks and make the more complex tasks much easier. Some of the key tools include shear cutters, wire strippers, ESD-safe tweezers, needle nose pliers, precision screwdriver set, "third hand" tools, and alligator/test clips and leads. Some tools, such as the ESD safe tweezers, are essential for surface mount work while other tools, such as the "third hand" tool are very useful when soldering components to a PCB and the component, PCB, soldering iron and solder all need to be held in place.

Power Supply

In the end, it's difficult to test a circuit without applying power to it. Several types of power supplies are available to support electronics design and testing with a number of features. For a general purpose laboratory power supply, variable voltage and current controls are one of the most important features. This allows one supply to provide a wide range of voltages that can be adjusted for any application. Often these power supplies can operate in either a constant voltage or constant current mode, allowing rapid testing of components or portions of a design without building a specific power regulation circuit.

Other Equipment

The equipment above only scratches the surface of the equipment that is available and might be critical for your application. Some of the other common equipment with more of a focused use includes:

- Function Generators
- Signal Generators
- Spectrum Analyzers
- Signal Analyzers
- Pattern Generator
- Protocol Analyzer
- Network Analyzer
- Transistor Tester

EXPERIMENT NO.1(a)

AIM OF THE EXPERIMENT: Verification of Superposition Theorems.

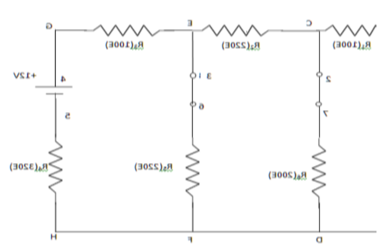
APPARATUS REQUIRED:

SL. NO.	Name	Specification	Quantity
1.	Superposition Theorem Kit		
2.	Digital Multimeter		
2.	Patch Cord		

THEORY:

Superposition theorem states that in a linear bilateral multi source DC circuit, the current through or voltage across any particular element may be determined by considering the contribution of each source independently with the remaining sources replaced with their internal resistance. The combinations are then summed, having attention to the polarities, to find the total value in general superposition cannot be applied to non- linear circuits or to non-linear functions such as power.**Superposition theorem** states that in any linear, active, bilateral network having more than one source, the response across any element is the sum of the responses obtained from each source considered separately and all other sources are replaced by their internal resistance.

CIRCUIT DIAGRAM:



SPACE FOR DRAWING CKT DIAGRAM FOR STUDENT:

PROCEDURE:

1. Connect +5V DC power supplies using patch cords to terminals 1 and 8.
2. Connect +12V DC power supplies using patch cords to terminals 4 and 5.
3. Connect an ammeter between terminals 2 and 7 to measure current/voltage flowing through branch CD in presence of both voltage sources, say it is V/I.
4. Remove one of the supplies (say +5V) from branch AB and replace it with its internal resistance(or by short circuit).
5. Measure the value of current/voltage flowing through the branch CD in presence of a single voltage source of +12V, say it is V'.
6. Again remove other supply(say +12V) from branch GH and replace it by its internal resistance(or by a short circuit).
7. Measure the value of the current flowing through the branch CD in the presence of a single voltage source of +5V, say it is V''/I".
8. Compare the amount of current/voltage flowing in presence of both of the sources with the sum of the currents flowing in case of individual sources. These currents much follow the relation:-

$$V = V' + V'' \text{ OR } I = I' + I''$$

9. Repeat above procedures for other branches like EF, GH etc.

OBSERVATION TABLE:

Sl.No.	I in Amp/ V in volts	I' in Amp/V' in volts	I" in Amp/V" in volts	I=I'+I"/ V=V'+V"	% error

RESULT:

……………………………………………………………………………………………………
……………………………………………………………………………………………………
………………

CONCLUSION:

As the total voltage of the circuit is the algebraic sum of voltages/current measured when only one source is active, the superposition theorem is verified.

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

1. State and explain superposition theorem.

   Ans.

2. What are the limitations of the superposition theorem?

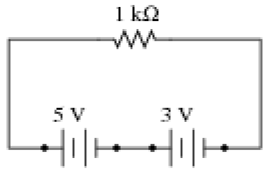
   Ans.

3. Can superposition principle be applied for power calculation?

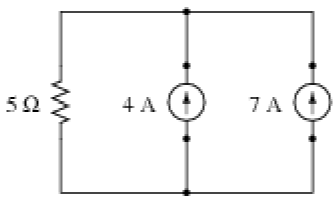
   Ans.

4. Suppose we have a single resistor powered by two series-connected voltage sources. Each of the voltage sources is ïdeal," possessing no internal resistance:

Calculate the resistor's voltage drop and current in this circuit.



5. Suppose we have a single resistor powered by two parallel-connected current sources. Each of the current sources is ïdeal," possessing infinite internal resistance:
Calculate the resistor's voltage drop and current in this circuit.



Student's Details **Teacher's Signature**

EXPERIMENT NO.1(b)

AIM OF THE EXPERIMENT : Verification of Norton's Theorem.

APPARATUS REQUIRED:

Sl.no.	Name	Specification	Quantity
1.	Norton's Theorem Kit		
2.	Digital Multimeter		
2.	Patch Cord		

THEORY:

Norton's theorem states that it is possible to simplify any linear circuit to an equivalent circuit with just a single current source and parallel resistance connected to load . The branch of the network through which the current is to be found is removed from the network and short circuit current Isc is found which is Norton's current. Norton's equivalent resistance R_N is found looking back into the load terminals when all the sources are replaced by their internal resistance.

The current flowing through the load I_L Is given by:-

$$I_L = I_N R_N / R_N + R_L$$

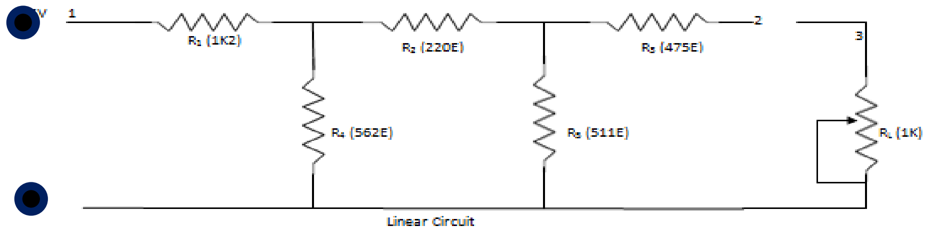
Where I_N= Norton's short circuit current

R_N= Norton's equivalent resistance

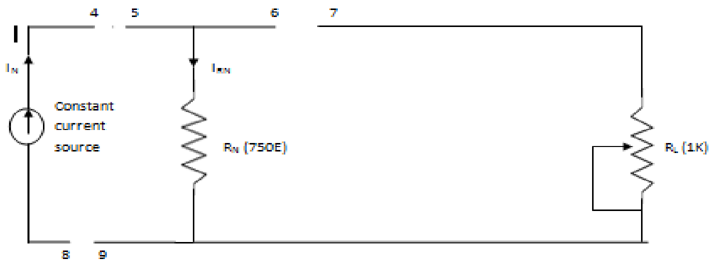
$R_{L=}$Load resistance

$I_{L=}$Current (Load)

CIRCUIT DIAGRAM:



Linear Circuit



Norton's equivalent circuit

SPACE FOR DRAWING CKT DIAGRAM FOR STUDENTS

PROCEDURE:

1. Remove the load resistor and find the internal resistance of the load resistor by deactivating the constant sources. Let this resistance be R_N.
2. Short the load terminals and find the short circuit current flowing through the shortest load terminals using conventional network analysis. Let this current be I_N.
3. Norton's equivalent circuit is drawn by keeping R_N in parallel to I_N as shown in the figure.
4. Reconnect the load resistor R_L across the load terminals and the current through it is

$$I_L = \frac{I_N R_N}{R_N + R_L}$$

Given by TABULATION:

SL. NO	V_{in}	I_L	$I_N(I_{SC})$	R_N	R_L	$I_L = \frac{I_N R_N}{R_N + R_L}$

CALCULATION:

RESULT :

Theoretical value of Norton’s equivalent current I_L = …………

Practical value of Norton’s equivalent current I_L =……………...

% of error=

Theoretical value of Norton’s equivalent current I_N = …………

Practical value of Norton’s equivalent current I_N =……………...

% of error=

Theoretical value of Norton’s equivalent resistance R_N = ………

Practical value of Norton's equivalent resistance R_N = …………

% of error=

(Yes/No), the value of current flowing through the load resistance in bothof the cases is approximately equal. Hence Norton’s theorem is verified.

CONCLUSION: As the voltage across the load resistance in both the cases is approximately equal Norton’s theorem is verified.

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

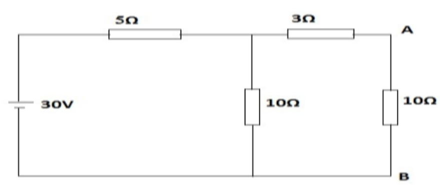
3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. What does a Norton's equivalent circuit consist of?

Q2. What are the various steps for obtaining the Norton's equivalent circuit?

Q3. Find the Norton's equivalent circuit across A-B terminals for the circuit shown in figure .



Q4. Can Norton's theorem be applied to AC circuits?

Student's Details **Teacher's Signature**

EXPERIMENT NO.1(C)

AIM OF THE EXPERIMENT : Verification of Thevenin's Theorem.

APPARATUS REQUIRED:

Sl. no.	Name	Specification	Quantity
1.	Thevenin’s Theorem Kit		
2.	Digital Multimeter		
2.	Patch Cord		

THEORY:

Thevnin’s theorem states that any linear active network through which a load is connected can be reduced to a voltage source where the generated voltage i.e Thevenin voltage is equal to the open circuit voltage that appears across the load terminals. Thevenin's resistance is found by replacing the sources with their internal resistances looking back into the load terminals.

$$I = V_{th} / R_{th}+R_L$$

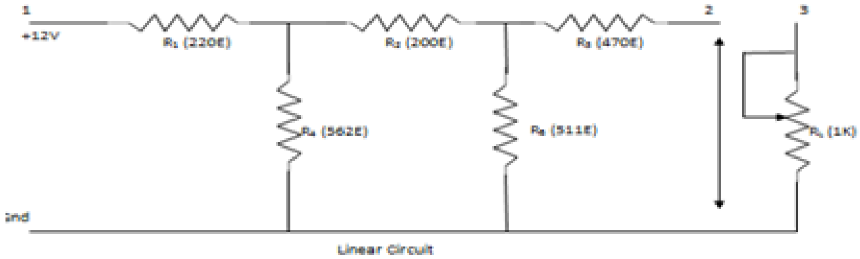
Where Vth = Thevenin's voltage

Rth =Thevenin’s equivalent resistance

R_L= Load resistance

I_L= Load current

CIRCUIT DIAGRAM:



SPACE FOR DRAWING CKT DIAGRAM FOR STUDENTS:

PROCEDURE:

1. Remove the load resistor R_L and find the open circuit voltage V_{TH} across the open circuited load terminal .
2. Deactivate the voltage source and remove it by internal resistance and find the thevenin's resistance R_{TH} of the source side looking through the open circuited load terminals.
3. Obtain the Thevenin's equivalent circuit by replacing R_{TH} in series with V_{TH} as shown in figure.
4. Reconnect R_L across the load terminal as shown in figure**.**
5. Load current is given by $$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

TABULATION:

SL NO-	V_{in}	I_L	V_{TH}	R_L	R_{TH}	$I_L = \frac{V_{TH}}{R_{TH}+R_L}$

CALCULATION:

RESULT:

1. Theoretical value of Thevenin's equivalent voltage V_{TH}=

2. Practical value of Thevenin's equivalent voltage V_{TH}=

3.% Of Error =

4. Theoretical value of Thevenin's equivalent resistance R_{TH}=

5. Practical value of Thevenin's equivalent resistance R_{TH}=

6.% Of Error =

7. The value of current flowing through the load in linear circuit=

8. The value of current flowing through the equivalent circuit=

9.% Of Error =

CONCLUSION:………………………………………………………………………………………
…………………………………..………………………………………………………………

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q.1 Where and why Thevenin’s theorem is applied?

Q2. List out the steps for applying Thevenin's Theorem.

Q3..What is the duality (relationship) of Thevenin and Norton’s Theorem?

Q4. What is Thevenin’s Voltage?

Q5. What are the limitations of Thevenin’s Theorem?

Q6.To what type of circuit thevenin's theorem is applicable

Q7. What is the use of thevenin’s theorem?

Student’s Details **Teachers Signature**

EXPERIMENT NO.1(D)

AIM OF THE EXPERIMENT: Verification of Maximum Power Transfer Theorem.

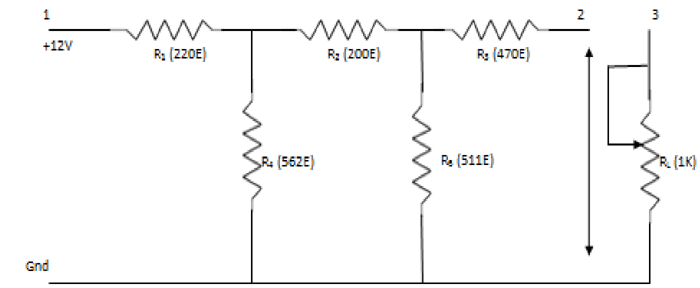
APPARATUS REQUIRED:

SL. NO.	NAME	SPECIFICATION	QUANTITY
1.	Maximum Power Transfer Theorem Kit		
2.	Digital Multimeter		
3.	Patch Cord		

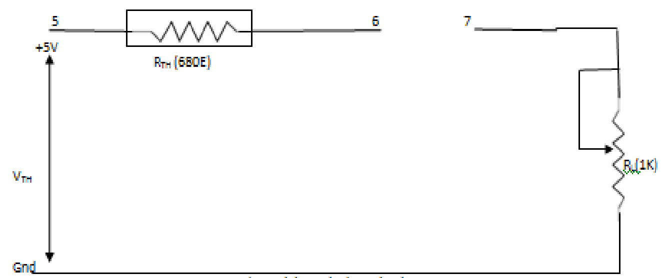
THEORY:

The maximum power transfer theorem states that in a linear, bilateral DC network, maximum power is delivered to the load when the load resistance is equal to the internal resistance of a source.In order to achieve the maximum load power in a DC circuit, the load resistance must equal the driving resistance i.e the internal resistance of source . The internal resistance of the source can be calculated as the thevenin's resistance of the source's electric circuit . Any load resistance value above or below with this procedure a smallest load power system & efficiency (**η**) is 50% at the minimum power case . This is because the load and as they have the same value, they must exhibit equal current and voltage and hence equal power . As the load increase in resistance behave the value of the load voltage will rise, however the load current will drop by a greater amount of load power.

CIRCUIT DIAGRAM:



Linear Circuit



Thevenin's equivalent circuit

SPACE FOR DRAWING CKT DIAGRAM FOR STUDENTS

PROCEDURE:

1. Remove the load resistance and find the Thevenin's Resistance(R_{TH}) of the source network looking through the open circuited load terminals.
2. As per Maximum power transfer theorem this R_{TH} is the load resistance of the network i.e, R_L=R_{TH}, that allows maximum power transfer.
3. Find the Thevenin's voltage V_{TH} across the open circuited load terminals.
4. Maximum power transfer is given by

$$P_{\max} = \frac{V_{TH}^2}{4R_{TH}}$$

OBSERVATION TABLE:

Sl. No.	Load Resistance R_L	Load Current I_L	Power Dissipated (P_L)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			

CALCULATION:

RESULT:

(Yes/No), the maximum amount of power will be dissipated by a load resistance, when that load resistance is equal to the Thevenin resistance of the network supplying the power and the value of Maximum power dissipated is found equal to ……….

CONCLUSION:

………

……

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3.Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. Where and why Maximum Power Transfer theorem is applied?

Q2. What will be the value of load impedance for maximum power transfer in case of a complex source impedance?

Q3. Prove how the load impedance will be equal to the source impedance for maximum power transfer.

Q4. What is load matching?

Students details **Faculty's signature**

EXPERIMENT NO.2

AIM OF THE EXPERIMENT:

Study the transient response of a series RLC circuit for under-damped, critically-damped and overdamped cases.

APPARATUS REQUIRED:

Sl. no.	Name	Specification	Quantity
1.	Trainer Kit		
2.	Cathode ray Oscilloscope		
3.	Patch Cord		

THEORY:

The damping of the RLC circuit affects the way the voltage response reaches its final (or steady state) value.

As shown on the previous page there are three different types of solutions of the differential equation that describes the

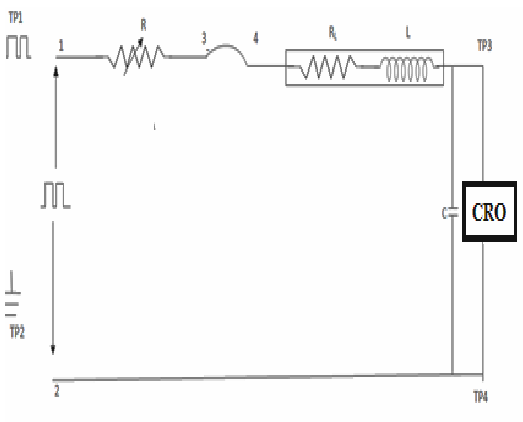
(i) When which means there are two real roots and relates to the case when the circuit is said to be over-damped.

(ii) When which means there are two complex roots (as root(-1) is imaginary) and relates to the case when the circuit is said to be under-damped.

(iii) When which means that the two roots of the equation are equal (i.e. there is only one root) and relates to the case when the circuit is said to be critically damped.

The following applet can be used to show the current response for a series RLC circuit.
The graph shows the current response of the circuit. It is also possible to zoom in by dragging a box over the area of interest.The range of time displayed can be set using the first two input boxes. The initial voltage across the capacitor is set by the third box. The next three boxes set the values of the resistor, inductor and capacitor. The final box tells whether the system is over, under or critically-damped.

CIRCUIT DIAGRAM:



SPACE FOR DRAWING CKT DIAGRAM FOR STUDENTS:

PROCEDURE:

1. Make the connections on the Transient Analysis of RLC Circuits as shown in above Figure.
2. Set the POT at some lower value of resistance (say, 50Ω-100Ω) by connecting multimeter between terminal 1 and terminal 3.Lower the value of resistance more will be the number of oscillation
3. Connect terminal 3 and terminal 4.

4. Connect square wave (TTL)to the input of RLC circuit i.e. connect TTL signal terminal to terminal 1 and Gnd terminal to terminal 2. Square Wave (TTL) is just like manual switching as it automatically switches on and off.
5. Connect the mains cord to the Trainer and switch on the mains supply.
6. Now switch on the power switch of the trainer.
7. Connect DSO across capacitor i.e. across TP3 and TP4.

Under-damped Case:

8. Keep DSO at 50µsTime Base (for viewing maximum oscillations)or at 20µs Time Base (for measuring frequency easily).

9. Observe the response on DSO. The response is oscillatory and the system is said to be under-damped.

10. Measure the frequency of oscillations and compare it with the theoretical value which is given by

$$1/2\pi\sqrt{LC}$$

11. Now we know the value of potentiometer's resistance. Add the resistance of the potentiometer with the inductor resistance which is 133Ω and compare with the theoretical condition given below for under-damped case.

For **Under-damped Case**

$\alpha < \omega_0$

i.e. $(R/2L) < 1/\sqrt{LC}$

where $R/2L = \alpha$ = Damping Factor

and $1/\sqrt{LC} = \omega_0$= Resonant Frequency

Critically dampedCase:

12. Increase the resistance R by rotating the POT in clockwise direction till the oscillations disappear. This is the critically damped system.

13. Remove the TTL Generator connections and open terminals 3 and 4. Measure the resistance of POT. Add the resistance of the inductor also which is 133Ω and compare with the theoretical value for critical damping, R = 2 L/C.

For Critically damped case, $\alpha = \omega_0$

i.e, $(R/2L) = 1/\sqrt{LC}$

$$\therefore R = 2\sqrt{\frac{L}{C}}$$

where R/2L = α = Damping Factor

and $1/\sqrt{LC}$ = ω_0= Resonant Frequency

Over damped Case:

14. Now again make the connections as given in the figure.

15. Increase the resistance R(larger than the critical damping value) by rotating the POT in clockwise direction. This is the over damped system.

16. Remove the TTL Generator connections and open terminals 3 and 4. Measure the resistance of POT. Add the resistance of the inductor also which is 133Ω and compare with the theoretical condition given below for over damped case.

For Over damped Case, $\alpha > \omega_0$

i.e, $(R/2L) > 1/\sqrt{LC}$

where R/2L = α = Damping Factor

and $1/\sqrt{LC}$ = ω_0= Resonant Frequency

OBSERVATION TABLE:

Sl no.	Case	$R = R_L + R(in\,\Omega)$	$\alpha = R/2L$	$\omega_0 = 1/\sqrt{LC}$ in rad	R'' theoretical In Ω
1.	Over damped				10KΩ >R'
2.	Critically damped				10KΩ =R'
3.	Underdamped				10KΩ <R'

CALCULATION:

Given values:

R_L=133Ω

C=1000PF

L=25mH

SPACE FOR TRACING PAPER:

CONCLUSION:

………

……………………………………………………………………………………………………

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. Define Steady State.

Q2. Define Transient State and Transient time.

Q3. Write the function of Inductor.

Q4. Inductor doesn't allow sudden changes

a) In currents b) In Voltages c) Both in (a) and (b) d) none of these

Q5. The Transient response occurs

a) Only in resistive circuit b) Only in inductive circuit

c) Only in capacitive circuit d) Both in (b) and (c)

Students Details **Teacher's Signature**

EXPERIMENT NO. 3(a)

AIM OF THE EXPERIMENT:

Determination of open circuit parameters of a passive two port network.

APPARATUS REQUIRED:

Sl.no.	Name	Specification	Quantity
1.	Two Port Network Trainer Kit		
2.	Digital Multimeter		
3.	Patch Cord		

THEORY:

Open Circuit Parameter (2 Parameter)

In a two port network configuration the Z-parameter relate the i/p and o/p voltage V_1 and V_2 in terms of the input and output circuit $I_1$and I_2. Out of four variables , V_1 and V_2 are the dependent variables & I_1 and I_2 are the independent variables.

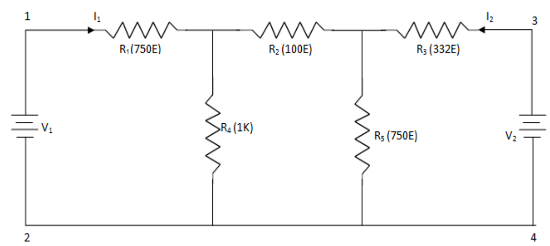
Thus we have,

$V_1 = Z_{11}I_1+Z_{12}I_1$

$V_2 = Z_{21}I_1+Z_{22}I_2$

Where Z_{12} and $Z_{22}$are the input and output driving point impedance while Z_{11} and Z_{21} are reverse and forward transfer impedance.

CIRCUIT DIAGRAM:



SPACE FOR DRAWING CIRCUIT DIAGRAM FOR STUDENTS

PROCEDURE:

1. To measure Z_{11} and Z_{21} parameters, let the output port of the network i.e. terminals 3 and 4 remain open. This will make $I_2 = 0$.

2. Calculating Z_{11} :

a. Switch 'On' the power switch of the trainer.

b. Measurement of V_1: Connect voltmeter (DMM) between terminals named as +12 V and Gnd.

c. Measurement of I_1: Connect Gnd terminal to terminal 2. Now connect ammeter (DMM) between terminal named as +12 V and terminal 1, to measure I_1.

d. Switch 'Off' the power switch of the trainer.

e. Calculate Z_{11} by the formula, $Z_{11} = \frac{V_1}{I_1} \Omega$.

3. Calculating Z_{21} :

Connect +12 V DC Supply to port 1 i.e., connect terminal named as +12 V to terminal 1 and terminal named as Gnd to terminal 2.

b. Switch 'On' the power switch of the trainer.

c. Measurement of V_2: Connect voltmeter (DMM) between terminal 3 and terminal 4.

d. Measurement of I_1: Remove DC Supply connections between +12 V terminal and terminal 1. Connect an ammeter (DMM) between +12 V terminal and terminal 1, to measure I_1.

e. Switch 'Off' the power switch of the trainer.

f. Calculate Z_{21} by the formula given in Table 1 i.e., $Z_{21} = \frac{V_2}{I_1} \Omega$

4. To measure Z_{12} and Z_{22} parameters, let the input port of the network i.e., terminals 1 and 2 remain open. This will make $I_1 = 0$.

5. Calculating Z_{12} :

a. Connect +5 V DC Supply to port 2 i.e. terminal named as +5 V to terminal 3 and terminal named as Gnd to terminal 4.

b. Switch 'On' the power switch of the trainer.

c. Measurement of V_1: Connect voltmeter (DMM) between terminal 1 and terminal 2.

d. Measurement of I_2: Remove DC Supply connections between +5 V terminal and terminal 3. Connect an ammeter (DMM) between +5 V terminal and terminal 3 to measure I_2.

e. Switch 'Off' the power switch of the trainer.

f. Calculate Z_{12} by the formula, $Z_{12} = \frac{V_1}{I_2} \Omega$

6. Calculating Z_{22} :

a. Switch 'On' the power switch of the trainer.

b. Measurement of V_2: Connect voltmeter (DMM) between terminals named as
+5 V and Gnd.

c. Measurement of I_2: Connect Gnd terminal to terminal 4. Now connect ammeter
(DMM) between terminals named as +5 V and terminal 3, to measure I_2.

d. Switch 'Off' the power switch of the trainer.

e. Calculate Z_{22} by the formula $Z_{22} = \frac{V_2}{I_2} \Omega$

CALCULATION:

$Z_{11} = \frac{V_1}{I_1} \Omega$ =

$Z_{12} = \frac{V_1}{I_2} \Omega$ =

$Z_{21} = \frac{V_2}{I_1} \Omega$ =

$Z_{22} = \frac{V_2}{I_2} \Omega$ =

CONCLUSION:

………
………
………
………………

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1**.** Define Z-parameters.

Q2. List out the dependent and independent variables used in Z-parameter representation.

Q3. Define input and output Driving point impedance.

Q4. Define forward and reverse Transfer impedance.

Q5. Write down the condition for reciprocity and symmetry.

Student's Details **Teacher's Signature**

EXPERIMENT NO.3(b)

AIM OF THE EXPERIMENT:

Determination of short circuit parameters of a passive two port network.

APPARATUS REQUIRED:

Sl. no.	Name	Specification	Quantity
1.	Two Port Network Trainer Kit		
2.	Digital Multimeter		
3.	Patch Cord		

THEORY:

Short circuit parameter(Y parameter)

In two port network configurations , the Y parameter relates the input and output currents I_1 and I_2 in terms of input and output voltage V_1 andV_2 . Out of four variables ,in Y parameter configuration of a two port network I_1 and I_2 are the dependent variables & V_1 and V_2 are the independent variables.

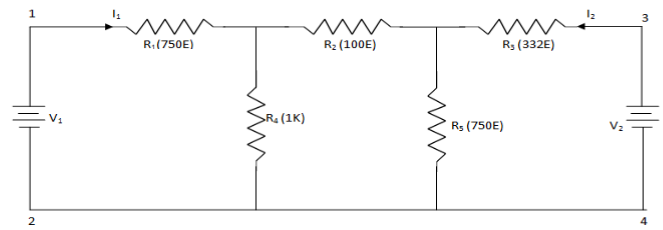
Thus we have,

$I_1 = Y_{11}V_1+Y_{12}V_1$

$I_2 = Y_{21}V_1+Y_{22}V_2$

Where Y_{11} and Y_{22} are the input and output driving point admittance while Y_{12} and Y_{21} are reverse and forward transfer admittance.

CIRCUIT DIAGRAM:



SPACE FOR DRAWING CIRCUIT DIAGRAM FOR STUDENTS:

PROCEDURE:

1. To measure Y_{11} and Y_{21} parameters, the output port of the network i.e., terminals 3 and 4 are shorted with the help of patch cord. This will make $V_2 = 0$.

2. Calculating Y_{11} :

a. Switch 'On' the power switch of the trainer.

b. Measurement of V_1: Connect voltmeter (DMM) between terminals named as +12 V and Gnd.

c. Measurement of I_1 : Connect Gnd terminal to terminal 2. Now connect the ammeter (DMM) between the terminal named as +12 V and terminal 1, to measure I_1.

d. Switch 'Off' the power switch of the trainer.

e. Calculate Y_{11} by the formula $Y_{11} = \frac{I_1}{V_1}$ ℧.

a. Switch 'On' the power switch of the trainer.

b. Measurement of V_1: Connect voltmeter (DMM) between terminals named as +12V and Gnd.

c. Connect +12 V DC Supply to port 1 i.e., connect terminal named as +12 V to terminal 1 and terminal named as Gnd to terminal 2.

d. Measurement of I_2: Remove shorted connections of output port i.e., disconnect terminal 3 and terminal 4 from each other. Connect an ammeter (DMM) between terminal 3 and terminal 4 to measure I_2.

e. Switch 'Off' the power switch of the trainer.

f. Calculate Y_{21} by the formula $Y_{21} = \frac{I_2}{V_1}$ ℧.

4. To measure Y_{12} and Y_{22} parameters, the input port of the network i.e. terminals 1 and 2 are shorted with the help of patch chord. This will make $V_1 = 0$.

5. Calculating Y_{12}:

a. Switch 'On' the power switch of the trainer.

b. Measurement of V_2: Connect voltmeter (DMM) between terminals named as +5 V and Gnd.

c. Connect +5 V DC Supply to port 2 i.e., connect terminal named as +5 V to terminal 3 and terminal named as Gnd to terminal 4.

d. Measurement of I_1: Remove shorted connections of input port i.e., disconnect terminal 1 and terminal 2 from each other. Connect an ammeter (DMM) between terminal 1 and terminal 2 to measure I_1.

e. Switch 'Off' the power switch of the trainer.

f. Calculate Y_{12} by the formula $Y_{12} = \frac{I_1}{V_2}$ ℧.

6. Calculating Y_{22} :

a. Switch 'On' the power switch of the trainer.

b. Measurement of V_2: Connect voltmeter (DMM) between terminals named as
+5 V and Gnd.

c. Measurement of I_2: Connect terminals 1 and 2 to make $V_1 = 0$.

4. Connect Gnd terminal to terminal 4. Now connect the ammeter (DMM) between the terminal named as +5 V and terminal 3 to measure I_2.

d. Switch 'Off' the power switch of the trainer.

e. Calculate Y_{22} by the formula $Y_{22} = \frac{I_2}{V_2}$ ℧.

CALCULATION:

$Y_{11} = \frac{I_1}{V_1}$ ℧=

$Y_{12} = \frac{I_1}{V_2}$ ℧=

$Y_{21} = \frac{I_2}{V_1}$ ℧=

$Y_{22} = \frac{I_2}{V_2}$ ℧=

CONCLUSION:

……
……
……
……………

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. Define Y-parameters.

Q2. List the dependent and the independent variables used in Y-parameter presentation.

Q3. Define input and output driving point impedance.

Q4. Define reverse and forward transfer admittance.

Q5. Write the condition for reciprocity and symmetry.

Student's Details **Teacher's Signature**

EXPERIMENT NO.4(a)

AIM OF THE EXPERIMENT:

Determination of Hybrid parameters of a passive two port network.

APPARATUS REQUIRED:

Sl.no.	Name	Specification	Quantity
1.	Two Port Network Trainer Kit		
2.	Digital Multimeter		
3.	Patch Cord		

THEORY:

In the ‘h’ parameter of a two port network voltage of the input port and current of the output are expressed, in terms of current of the input port and voltage of output port .

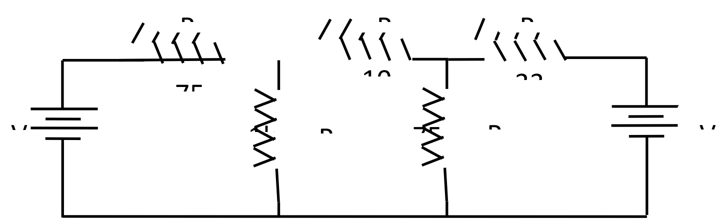
Due to this reason out of the four variables(V_1,V_2,I_1,I_2). V and I are dependent variables . Thus,

$V_1 = h_{11}I_1+h_{12}V_2$

$I_2 = h_{21}I_1+h_{22}V_2$

Where h_{11} and h_{22} are input and output admittance respectively h_{12} and h_{21} are y forward current gain and reverse voltage gain respectively.

CIRCUIT DIAGRAM:



SPACE FOR DRAWING CIRCUIT DIAGRAM FOR STUDENTS

PROCEDURE:

1. To measure h_{11} and h_{21} parameters, the output port of the network i.e., terminals 3 and 4 are shorted with the help of patch cord. This will make $V_2 = 0$.

2. Calculating h_{11} :

a. Switch 'On' the power switch of the trainer.

b. Measurement of V_1: Connect voltmeter (DMM) between terminals named as +12 V and Gnd.

c. Measurement of I_1 : Connect Gnd terminal to terminal 2. Now connect the ammeter (DMM) between the terminal named as +12 V and terminal 1, to measure I_1.

d. Switch 'Off' the power switch of the trainer.

e. Calculate h_{11} by the formula $h_{11} = \frac{V_1}{I_1}$ Ω.

3. Calculating h_{21}

a. Switch 'On' the power switch of the trainer.

b. Measurement of I_1: Connect an ammeter (DMM) between terminals named as +12V and Gnd.

c. Connect +12 V DC Supply to port 1 i.e., connect terminal named as +12 V to terminal 1 and terminal named as Gnd to terminal 2.

d. Measurement of I_2: Remove shorted connections of output port i.e., disconnect terminal 3 and terminal 4 from each other. Connect an ammeter (DMM) between terminal 3 and terminal 4 to measure I_2.

e. Switch 'Off' the power switch of the trainer.

f. Calculate h_{21} by the formula $h_{21} = \frac{I_2}{I_1}$.

4. 4. To measure h_{12} and h_{22} parameters, let the input port of the network i.e., terminals 1 and 2 remain open. This will make $I_1 = 0$.

5. Calculating h_{12} :

a. Connect +5 V DC Supply to port 2 i.e. terminal named as +5 V to terminal 3 and terminal named as Gnd to terminal 4.

b. Switch ‘On’ the power switch of the trainer.

c. Measurement of V_1: Connect voltmeter (DMM) between terminal 1 and terminal 2.

a. Switch ‘On’ the power switch of the trainer.

b. Measurement of V_2: Connect voltmeter (DMM) between terminals named as +5 V and Gnd.

c. Calculate h_{12} by the formula, $h_{12} = \frac{V_1}{V_2}$.

6. Calculating h_{22} :

a. Measurement of V_2: Connect voltmeter (DMM) between terminals named as +5 V and Gnd.

b. Measurement of I_2: Remove DC Supply connections between +5 V terminal and terminal 3. Connect an ammeter (DMM) between +5 V terminal and terminal 3 to measure I_2.

. Calculate h_{22} by the formula $h_{22} = \frac{I_2}{V_2}$ ℧

c. Switch ‘Off’ the power switch of the trainer.

CALCULATION:

$h_{11} = \frac{V_1}{I_1}$ Ω=

$h_{12} = \frac{V_1}{V_2}$ =

$h_{21} = \frac{I_2}{I_1}$ =

$h_{22} = \frac{I_2}{V_2}$ ℧=

CONCLUSION:

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. Define h-parameters.

Q2. What is the significance of the name hybrid parameter.

Q3. Write the expression for h-parameters in terms of z-parameters.

Q4. What is the condition for reciprocity of h-parameters?

Q5. What is the condition of symmetry for h-parameters?

Student's Details **Teacher's Signature**

EXPERIMENT NO. 4(b)

AIM OF THE EXPERIMENT:

Determination of Transmission parameters of a passive two port network.

APPARATUS REQUIRED:

Sl.no.	Name	Specification	Quantity
1.	Two Port Network Trainer Kit		
2.	Digital Multimeter		
3.	Patch Cord		

THEORY:

Transmission parameters :

ABCD parameters generally used in analysis of power transmission engineering where they are termed as circuit parameters ABCD parameters are also called as transmission parameters. In these parameters the voltage and current at the terminals of the port & can be expressed in terms of voltage and current at the terminals of port 2. Thus,

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

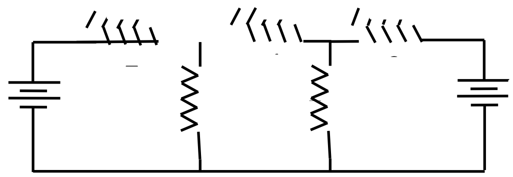
Where , A is called the Reverse voltage gain

B is called the transfer impedance

C is called the transfer admittance

D is called the Reverse current gain

CIRCUIT DIAGRAM:



SPACE FOR DRAWING CIRCUIT DIAGRAM FOR STUDENTS:

PROCEDURE:

1. To measure A and C parameters, let the output port of the network i.e. terminals 3 and 4 remain open. This will make $I_2 = 0$.

2. Calculating A :

a. Switch ‘On’ the power switch of the trainer.

b. Measurement of V_1: Connect voltmeter (DMM) between terminals named as +12 V and Gnd.

c. Connect +12 V DC Supply to port 1 i.e., connect terminal named as +12V to terminal 1 and terminal named as Gnd to terminal 2.

d. Measurement of V_2: Connect voltmeter (DMM) at the output port of the network i.e., between the terminal 3 and terminal 4.

e. Switch ‘Off’ the power switch of the trainer.

f. Calculate A by the formula $A = \frac{V_1}{V_2}$.

3. Calculating C :

a. Connect +12 V DC Supply to port 1 i.e., connect terminal named as +12 V to terminal 1 and terminal named as Gnd to terminal 2.

b. Switch ‘On’ the power switch of the trainer.

c. Measurement of V2: Connect voltmeter (DMM) between terminal 3 and terminal 4.

d. Measurement of I1: Remove DC Supply connections between +12 V terminal and terminal 1. Connect an ammeter (DMM) between +12 V terminal and terminal 1 to measure I1.

e. Switch 'Off' the power switch of the trainer.

f. Calculate C by the formula $C = \frac{I_1}{V_2}$ ℧.

4.Calculating B:

a. Switch 'On' the power switch of the trainer.

b. Measurement of V_1: Connect voltmeter (DMM) between terminal named as +12 V and terminal named as Gnd.

c. Connect +12 V DC Supply to port 1 of the network i.e. connect terminal named as +12 V to terminal 1 and terminal named as Gnd to terminal 2.

g. Measurement of I_2: Remove shorted connection of output port i.e. disconnect terminal 3 and terminal 4 from each other. Connect an ammeter (DMM) between terminal 3 and terminal 4 to measure I_2.

d. Switch 'Off' the power switch of the trainer.

e. Calculate B by the formula, $B = \frac{V_1}{-I_2}\,\Omega$

5. Calculating D:

a. Switch 'On' the power switch of the trainer.

b. Measurement of I_1: Connect terminal 3 and terminal 4 to short the output port of the network. Connect Gnd terminal to terminal 2. Connect an ammeter (DMM) between terminal named as +12 V and terminal 1 to measure I_1.

c. Measurement of I2: Connect +12 V DC Supply to port 1 of the network i.e. connect terminal named as +12 V to terminal 1 and terminal named as Gnd to terminal 2. Remove shorted connections of output port i.e. disconnect terminal 3 and terminal 4 from each other. Connect an ammeter (DMM) between terminal 3 and terminal 4 to measure I_2.

d. Switch 'Off' the power switch of the trainer.

e. Calculate D by the formula $D = \frac{I_1}{-I_2}$.

CALCULATION:

$B = \frac{V_1}{-I_2}\,\Omega$ =

$A = \frac{V_1}{V_2}$ =

$C = \frac{I_1}{V_2}$ ℧ =

$D = \frac{I_1}{-I_2}$ =

CONCLUSION:

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. Define Transmission parameters and where they are used?

Q2. Why are ABCD parameters also called transmission parameters?

Q3. Define reverse voltage and reverse current ratio.

Q4. Define transfer impedance and admittance.

Q5. Write the condition for symmetry and reciprocity.

Student's Details **Teacher's Signature**

EXPERIMENT NO. 5(a)

AIM OF THE EXPERIMENT:

To plot the frequency response of low pass filters.

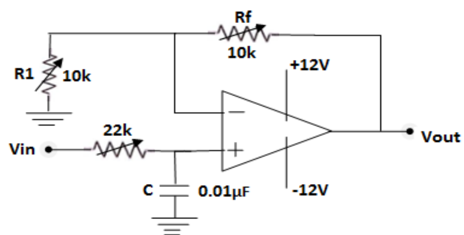
APPARATUS REQUIRED:

Sl.no.	Name	Specification	Quantity
1.	Active Filter Trainer Kit		
2.	Oscilloscope		
3.	Digital Multimeter		
4.	Patch Cord		

THEORY:

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.

CIRCUIT DIAGRAM:



Low pass filter

SPACE FOR DRAWING CIRCUIT DIAGRAM FOR STUDENTS:

PROCEDURE:

1. Initially rotate potentiometers R_1 and R_f 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 is given by the formula:

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

3. Connect an Ohmmeter between Vin of Low Pass Filter and TP6. Adjust resistance value at 1.59K by varying the potentiometer of 22K to set the high cutoff frequency (fh) at 10K.

4. Connect +12V and -12V DC power supplies at their indicated position from the Power Supply section.

5. Connect all the ground test points using patch cords.

6. Switch 'On' the Power Supply.

7. Set the output of function generator at 2 volt, 500 Hz using Oscilloscope with sinusoidal waveform.

8. Connect TP1 with Vin of Low Pass Filter to give a sinusoidal signal of amplitude 2Vpp of frequency 500 Hz to Low Pass Filter.

9. Observe output 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 is directly proportional to the R_f and inversely proportional to the R_1. So, we can adjust the gain of the output by increasing the value of R_f as well as by decreasing the value of R_1.

12. So, change the values of R_1 and R_f and observe the change in output.

13. Increase the frequency of input signal step by step and observe the effect on output V_{out} on Oscilloscope.

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

OBSERVATION TABLE:

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

CALCULATION:

SPACE FOR GRAPH PAPER:

CONCLUSION:

……
……
…………………………………………………………………………

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. Define a low pass filter.

Q2. Define cut-off frequency.

Q3. What are the frequency ranges of the pass band and stop band?

Q4. Write down the relation between decibels and nepers.

Q5. Define half power frequency and what is its significance?

Student's Details **Teacher's Signature**

EXPERIMENT NO. 5(b)

AIM OF THE EXPERIMENT:

To plot the frequency response of high pass filters.

APPARATUS REQUIRED:

Sl.no	Name	Specification	Quantity
1.	Active Filter Trainer Kit		
2.	Oscilloscope		
3.	Digital Multimeter		
4.	Patch Cord		

THEORY:

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:

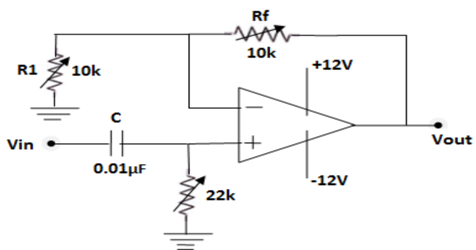


Fig: High Pass Filter

SPACE FOR DRAWING CIRCUIT DIAGRAM FOR STUDENTS

PROCEDURE :

1.Initially rotate potentiometers R_1 and R_f 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 Low cutoff frequency is given by the formula: $f_l = 1/2\pi RC$

3. Connect an Ohmmeter between TP4 and TP7. Adjust resistance value at 15.9K by varying the potentiometer of 22K to set the Low cutoff frequency (f_l) at 1K.

4. Connect +12V and -12V DC power supplies at their indicated position from the Power Supply section.

5. Connect all the ground test points with each other using patch cords.

6. Switch 'On' the Power Supply.

7. Set the output of the function generator at 2 volt, 100 Hz using Oscilloscope with sinusoidal waveform.

8. Connect TP_1 with Vin of High Pass Filter to give a sinusoidal signal of amplitude 2V (p-p) of frequency 100Hz.

9. Observe output 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 is directly proportional to the R_f and inversely proportional to the R_1. So, we can adjust the gain of the output by increasing the value of R_f as well as by decreasing the value of R_1.

12. So, change the values of R_1 and R_f and observe the change in output.

13. Increase the frequency of input signal step by step and observe the effect on output V_{out} on Oscilloscope.

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

OBSERVATION TABLE:

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

CALCULATION:

SPACE FOR GRAPH PAPER:

CONCLUSION:
……………………………………………………………………………………………………
……………………………………………………………………………………………………
………………………………………………………………………………….

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. Define a high pass filter and write some of its applications.

Q2. What are the filter specifications?

Q3. What are the units of attenuations?

Q4. An ideal filter should have

a) Zero attenuation in the pass band
b) Infinite attenuation in the pass band
c) Zero attenuation in the pass band

Q5. Define pass band and stop band for high pass filter.

Student's Details **Teacher's Signature**

EXPERIMENT NO.6(a)

AIM OF THE EXPERIMENT:

To plot the frequency response of band pass filters.

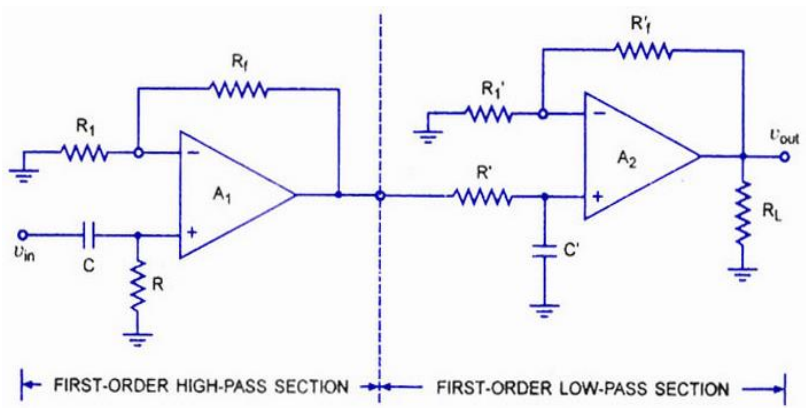
APPARATUS REQUIRED:

Sl.no.	Name	Specification	Quantity
1.	Active Filter Trainer Kit		
2.	Oscilloscope		
3.	Digital Multimeter		
4.	Patch Cord		

THEORY:

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

CIRCUIT DIAGRAM:



SPACE FOR DRAWING CIRCUIT DIAGRAM FOR STUDENTS:

PROCEDURE:

1. Connect the Output of High Pass Filter to the input of Low Pass Filter in order to make a Band Pass Filter.
2. Connect an Ohmmeter between TP4 and TP7 (Gnd) Adjust resistance value to 15.9K by varying the potentiometer 22K of High Pass Filter to set the Low cutoff frequency (f_L) at 1K.
3. Connect Ohmmeter between Vin of Low Pass Filter and TP6. Adjust resistance value to 1.59K by varying the potentiometer 22K of High Pass Filter to set the Low cutoff frequency (f_L) at 10K.
4. Connect +12V and -12V DC Power Supplies at their indicated position from the Power Supply section.
5. Switch 'On' the Power Supply.
6. Set the output of the function generator at 2 Volt, 100 Hz using Oscilloscope with sinusoidal waveform.
7. Connect TP1 with Vin of High Pass Filter to give a sinusoidal signal of amplitude 2 V_{pp} of frequency 100 Hz.
8. Observe output on Oscilloscope.
9. Similarly you can give the triangular and square wave instead of sinusoidal wave, from the function generator section.
10. Increase the frequency of input signal step by step and observe the effect on output V_{out} on Oscilloscope.
11. Tabulate the values of V_{out}, gain, gain (db) at different values of input frequency shown in the Observation Table.

12. Plot the frequency response of a high pass filter using the data obtained at different input frequencies.
13. Similarly perform the experiment on the different values of Fh and Fl.

OBSERVATION TABLE:

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

CALCULATION:

SPACE FOR GRAPH PAPER:

CONCLUSION:
………
………
…………………………..

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. Define band pass filter.

Q2. Explain how BPF can be obtained using HPF and LPF.

Q3.Write the expression for the resonant frequency in terms of two cut-off frequencies.

Q4. Define attenuators.

Q5. Draw the frequency characteristic of an ideal BPF.

Student's Details **Teacher's Signature**

EXPERIMENT NO.6(b)

AIM OF THE EXPERIMENT:

To plot the frequency response of band rejection filters.

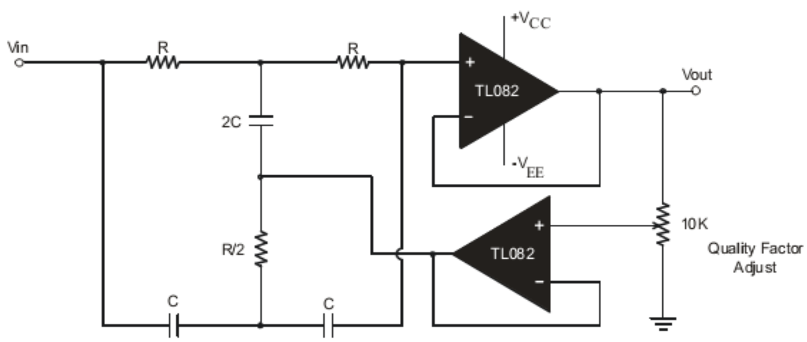
APPARATUS REQUIRED:

Sl.no.	Name	Specification	Quantity
1.	Active Filter Trainer Kit		
2.	Oscilloscope		
3.	Digital Multimeter		
4.	Patch Cord		

THEORY:

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:



Active Twin-T Notch Filter

SPACE FOR DRAWING CIRCUIT DIAGRAM FOR STUDENTS:

PROCEDURE:

1. Initially rotate potentiometer of Quality Factor Adjust anticlockwise to set it at some lower value of resistance.

2. The notch frequency of the filter is given by

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

3. Connect +12V, -12V and Gnd terminals from Power Supply Section at their indicated position of Twin-T Notch Filter.

4. Switch 'On' the Power Supply.

5. Set the output of the Function Generator for sinusoidal signal at 20 Hz with a fixed amplitude using Oscilloscope.

6. Connect TP1 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. Connect Gnd terminal of Function Generator to Gnd terminal of Twin-T Notch Filter i .connectTP2 to TP14.

8. Observe output (V_{out}) on Oscilloscope and note down the output voltage in the Observation Table.

9. Increase the frequency of input signal step by step and observe the effect on output (V_{out}) on Oscilloscope. Tabulate the corresponding value of V_{out} at different values of input frequency shown in the Observation Table.

OBSERVATION TABLE:

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

CALCULATION:

SPACE FOR GRAPH:

CONCLUSION:

………

………

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

QUESTIONS:

Q1. Define the band rejection/band stop filters.

Q2. Draw the reactance characteristic of BSF.

Q3. Write the expression for all the parameters in terms of nominal characteristics impedance (R_0) and the cut-off frequencies f_1 and f_2.

Q4. Draw the impedance characteristics of both T and π type BSF.

Student's Details **Teacher's Signature**

EXPERIMENT NO. 07

AIM OF THE EXPERIMENT:

Determination of self inductance, mutual inductance and coupling coefficient of a single phase two winding transformer representing a coupled circuit.

APPARATUS REQUIRED:

Sl No.	Name of the Equipment	Specification	Quantity
1.	1-phase Transformer		
2.	DC power supply		
3.	Voltmeter		
4.	Voltmeter		
5.	Voltmeter		
6.	Ammeter		
7.	Ammeter		
8.	Ammeter		
9.	Variac		
10.	Connecting Wires		

THEORY:

When an inductor generator induces an emf within itself as a result of the changing magnetic field around its own turns and when this emf is induced in the same circuit in which the current is changing this effect is called self inductance .

And when the emf is induced into an adjacent will situated with the same magnetic field , the emf is said to be induced magnetically , inductively on by mutual inductance(M). Then when two or more coils are magnetically linked together by a common magnetic flux they are said to be in mutual inductance .

Formulae used for calculation of self and mutual inductance is voltage across induction (V) = LdI/dt

(i) W×L×I =W×M×I

Where W = 2ΠF = angular Frequency

F = 50 Hz = Frequency of input signal

Ip = Measured primary input current (Mp)

$V_p = 230$, V_{AC} - Applied primary signal voltage

$L_p = V_P/ (W_p * I_p.)$.............. (1)

Lp = Self inductance primary coil

(ii) $L_S = V_s/(W \times I_s)$

Where Ls = Self inductance it secondary coil (Hener)

Vs = 12Vac = Applied secondary signal voltage

F = 50Hz = Frequency if input signal

W= $2\Pi f$ = Angular frequency , Is = Measured secondary input connect (mA)

(iii) Mutual Inductance :

$M = V_s / W^* I_p$

This Formulae indicates relationship between input and output emf

M = Mutual inductance of both coils (henry)

W= Angular Frequency

Ip = Measures Of primary input current (in mA)

Vs = Measured secondary voltage (in Volts)

(iv)Coefficient of coupling :

The amount of inductive coupling coupling that exists between the two couples is expressed as a functional number between o and 1 , where 0 indicates zero no inductance coupling and induating full on maximum coupling .

$$\mathbf{K} = \frac{M}{\sqrt{LPXLS}}$$

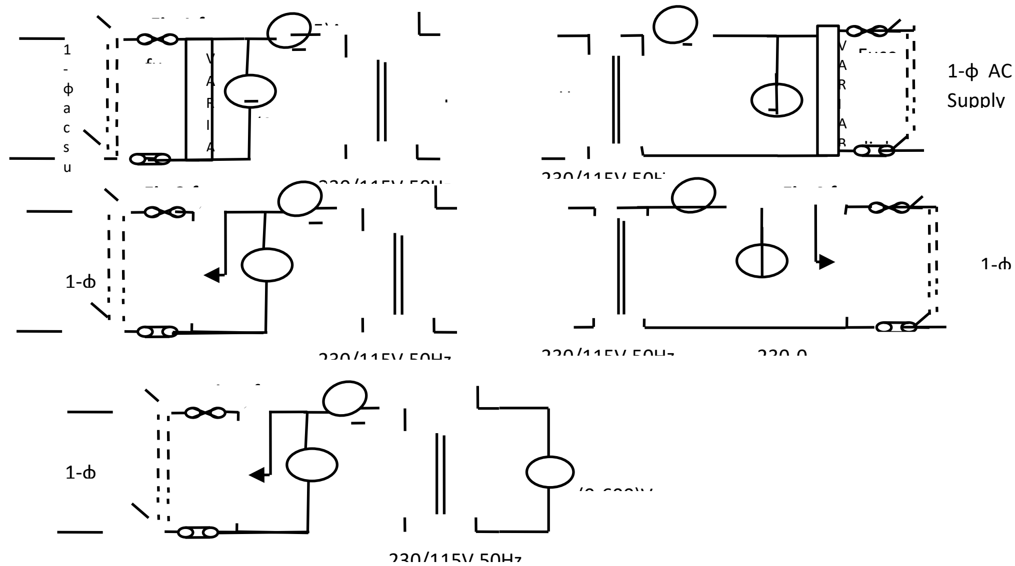
where M = mutual inductance (henry)

Lp = Self inductance of primary coil (henry)

Ls = Self inductance of secondary coil (henry)

CIRCUIT DIAGRAM:

Fig.2for R_2



SPACE FOR DRAWING CIRCUIT DIAGRAM BY STUDENTS:

PROCEDURE:

1. Make the connections as per the circuit diagrams.
2. Keep the variac at zero position and switch on the supply.
3. Gradually increase the supply voltage to its rated value.
4. Take the corresponding reading of voltmeter V_1 & V_2 and ammeter I_1&I_2.

OBSERVATION TABLE:

(For R_1,R_2,Z_1 and Z_2)

Sl.No.	condition	Voltmeter Reading in V	Ammeter reading in amp	Resistance/Impedance in ohms
1	H.V.			
2	L.V.			
3	H.V.			
4	L.V.			

(For M)

Sl No.	Voltmeter Reading in V (V_1)	Ammeter reading in amp(I_1)	Voltmeter Reading in V (V_2)

CALCULATION:

CONCLUSION:

………

PRECAUTION:

1. All connections should be right and tight.
2. Do not touch any live terminal.
3. Power must be switched off whenever an experiment or project is being assembled or disassembled.
4. All the voltmeters and ammeters should be chosen carefully, so that their range is suitable to measure the maximum value.

QUESTIONS:

Q1. What is the coefficient of coupling?

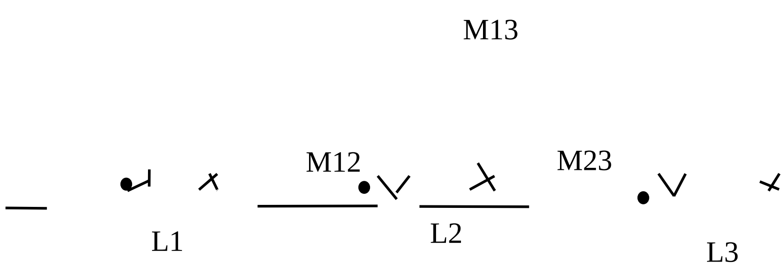
Q2. What is a coupled circuit?

Q3. What is dot convention and why it is used?

Q4.Determine the total inductance of the three series connected coupled coils as shown in figure below.

L_1=1H L_2=2H L_3=5H

M_{12}=0.5H M_{23}=1H M_{13}=1H



Q5. Differentiate between self and mutual inductance

Student's Details **Teacher's Signature**

EXPERIMENT NO.8

AIM OF THE EXPERIMENT: To study the resonance in R-L-C series circuit.

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 . Ap-p sinusoidal signal of amplitude to it and its frequency response would be verified.

The transfer function of this circuit is given by :-

$$H(S) = \frac{1}{LC} / s^2 + (\frac{R}{L})s + \frac{1}{u}$$

$$= wn\frac{2}{s}2 + (2zwn)s + wn2$$

where Wn = $\frac{1}{\sqrt{}}$

The gain and phase response against frequency will be typical of a second order system .

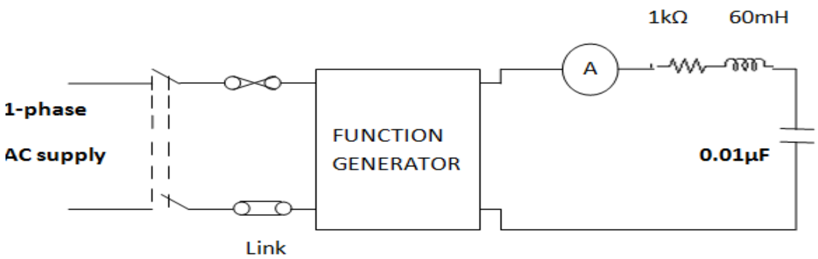
The expected maximum gain for each 2 can be observed from the plot in the experiment.

The theoretical expression for obtaining maximum gain is ,

$$Mm = \frac{1}{2w\sqrt{}}$$

$$Wn = \sqrt{}^{2}$$

CIRCUIT DIAGRAM:



SPACE FOR DRAWING CIRCUIT DIAGRAM:

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Set the frequency to 1kHz in the function generator.
3. Vary the frequency upto 15kHz and take corresponding current readings from multimeter.
4. Plot a graph between frequency and current.
5. Find resonant frequency(f_o).

OBSERVATION TABLE:

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

CALCULATION:

SPACE FOR GRAPH PAPER:

CONCLUSION:

………

………

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

4. All the voltmeters and ammeters should be chosen carefully, so that their range is suitable to measure the maximum value.

QUESTIONS:

Q1. Define resonance.

Q2.Define bandwidth.

Q3. Define selectivity.

Q4.In series resonance the current is ……………………… and impedance is………………………. .

Q5. What is the value of current, reactance and impedance of an ac RLC series circuit resonance.

Students Details **Teacher's Signature**

EXPERIMENT NO. 09

AIM OF THE EXPERIMENT:

To study the Resonance in R-L-C parallel circuit.

APPARATUS REQUIRED:

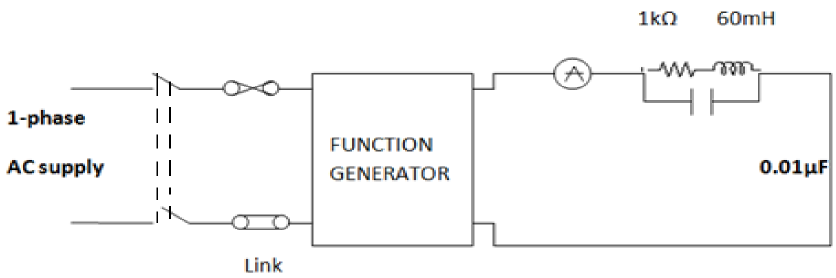
Sl.no.	Name of the Apparatus	Specification	Quantity
01	RLC Trainer Kit		
02	Function Generator		
03	Multimeter		
04	Connecting Probes		
05	Patch Wires		

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:



SPACE FOR DRAWING CIRCUIT DIAGRAM BY STUDENTS:

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Set the frequency to 1kHz in the function generator.
3. Plot a graph between frequency and current.
4. Find resonant frequency(f_o).

OBSERVATION TABLE:

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

CALCULATION:

SPACE FOR GRAPH PAPER:

PRECAUTION:

1. All connections should be right and tight.

2. Do not touch any live terminal.

3. Power must be switched off whenever an experiment or project is being assembled or disassembled.

4. All the voltmeters and ammeters should be chosen carefully, so that their range is suitable to measure the maximum value.

CONCLUSION:

……
……
………

QUESTIONS:

Q1. In the parallel resonance the current is …………………. And the impedance is…………………… .

Q2. What is the value of resonance frequency of a practical parallel R-L-C circuit.

Q3. Does resonance occur in dc or ac circuits.

Q4. Define Q-factor, and what is its value for parallel R-L-C resonance.

Q5. What is the value of admittance, susceptance and current at resonance of a practical parallel R-L-C circuit?

Student's Details **Teacher's Signature**

EXPERIMENT NO. 10

AIM OF THE EXPERIMENT:- Study of spectrum analyzers.

APPARATUS REQUIRED:-

Sl .No.	Name of the apparatus	Quantity
1.	Oscilloscope	
2.	Spectrum Analyzer	

THEORY:

The flux density at transformer care is usually maintained at a fairly high value in order to Keep the required volume of iron to a minimum. Due to nonlinearity at the magnetization curve some third. harmonies distartation is always produced. Also there is some percentage at 5th harmonics. The magnetization current drawn by the primary contains mainly 3rd harmonic where proportion mainly depends on the size of the primary supplied voltage. The fourier series for the function f(x) in the interval is given by:

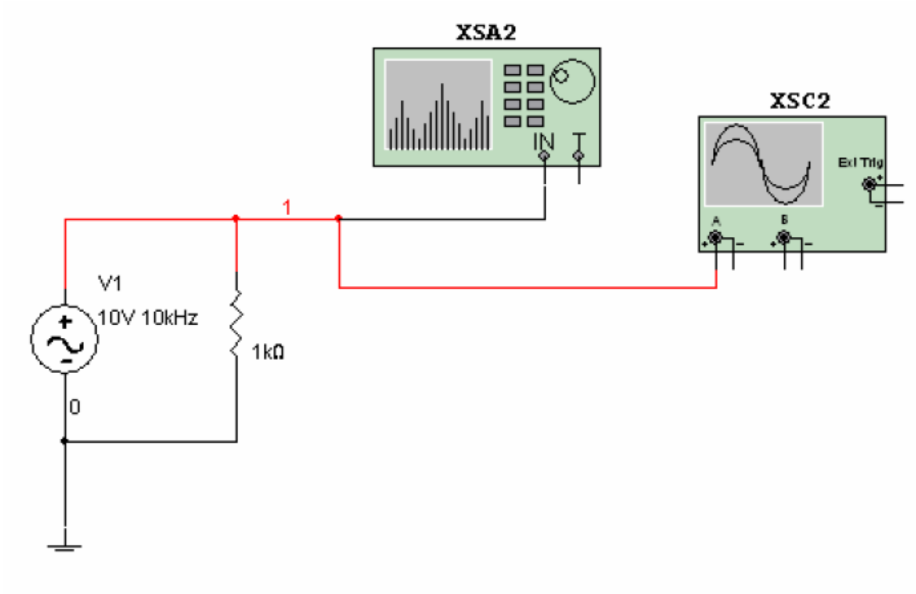
$f(x) = \frac{\alpha 2}{2}\sum_{n=1}^{\infty} a_n \cos nx + \sum_{n=1}^{\infty} b_n \sin nx$

$\alpha < X < \alpha + 2\Pi$

The fourier series up to 3rd hard harmonics can be represented as:-

y =

Circuit Diagram:



PROCEDURE :

1. Connect the circuit illustrated in the Figure.

2. Double-click on the AC Voltage Source. Select the Value tab and set Voltage (Pk)= 10V, Voltage Offset = 0V and Frequency = 1 kHz. Click OK.

3. Double-click on the Oscilloscope. Set the time division to 1 ms/Div and the Amplitude to 5 V/Div. Start the simulation and observe the 1 kHz frequency onthe time versus amplitude scale. Stop the simulation.

4. Double-click on the Spectrum Analyzer. Select Set Span under *Span Control* and

5. Lin under *Amplitude*. Under *Frequency*, set the *Start* and *End* frequencies. Since

6. We are interested in a frequency of 1 kHz, select *Start* = 0 Hz and *End* = 2 kHz.This will define the frequency settings for the beginning and end of the window ,thus centering the 1 kHz frequency. Click *Enter* to enter the values. This method of setting the Spectrum

Analyzer parameters is called the Frequency Control method.

7. Start the simulation. Place the cursor over the vertical marker line and drag the line to the center of the peak of the spectrum shown. Observe the frequency value in the lower-left portion of the window changes as the marker is moved.

8. Record the frequency and voltage values in Table 1-1.Verify that the frequency and amplitude values correspond to the AC Voltage Source settings.

9. Stop the simulation. Double-click on the AC Voltage Source and select Voltage Amplitude = 10V and Frequency = 10 kHz.

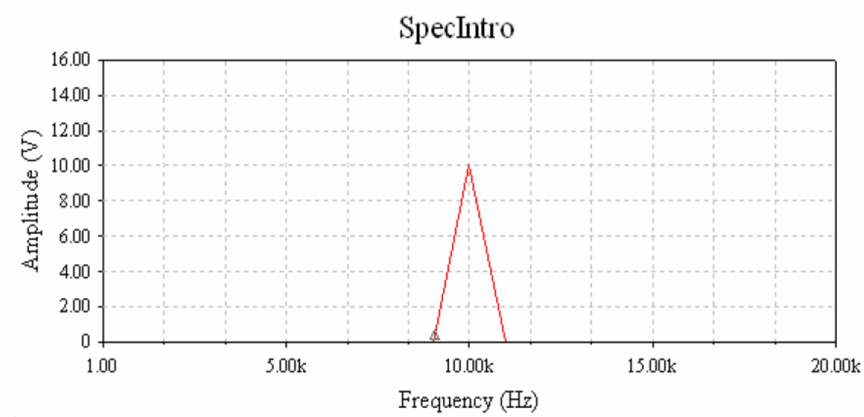
10. Since the frequency of interest is now 10 kHz, set the *Center* frequency to 10 kHz. Set *Span* to 10 kHz. This will designate a total window span of 10 kHz.

11. Click *Enter*. Notice that the *Start* and *End* frequencies are automatically calculated. This technique is called the Span method. Note that one of the two illustrated methods may be used, but not both at once.

12. Start the simulation and move the marker to the left side of the window then the right side of the window, noting that the frequencies at each end correspond to the *Start* and *End* frequency settings. In order to obtain the *Span* setting, subtract the *Start* frequency from the *End* frequency. Record your results .

13. Record LIN voltage and mW values as in Step 5,

EXPECTED OUTCOME



(Frequency Spectrum of a 1 kHz Signal)

OBSERVATION TABLE:

Frequency (measured)	LIN Voltage (V) (measured)	Power (mW) (calculated)	Frequency (Hz) (expected)	LIN Voltage (V) (expected)
1 kHz				
10 kHz				

Table 1-1

Frequency (Hz)	Start (Hz)	End (Hz)	Span (Hz) (measured)	Span (Hz) (expected)
10 kHz				

Table 1-2

PRECAUTION:

3. All the connections should be right and tight.
4. Any live terminal should not be touched while supply is on.

QUESTIONS:

1. What is a ‘ wave analyser’?

2. Define harmonic distortion.

3. Name the instruments used for signal analysis.

4. What is a frequency counter?

Student’s Details **Teacher’s Signature**