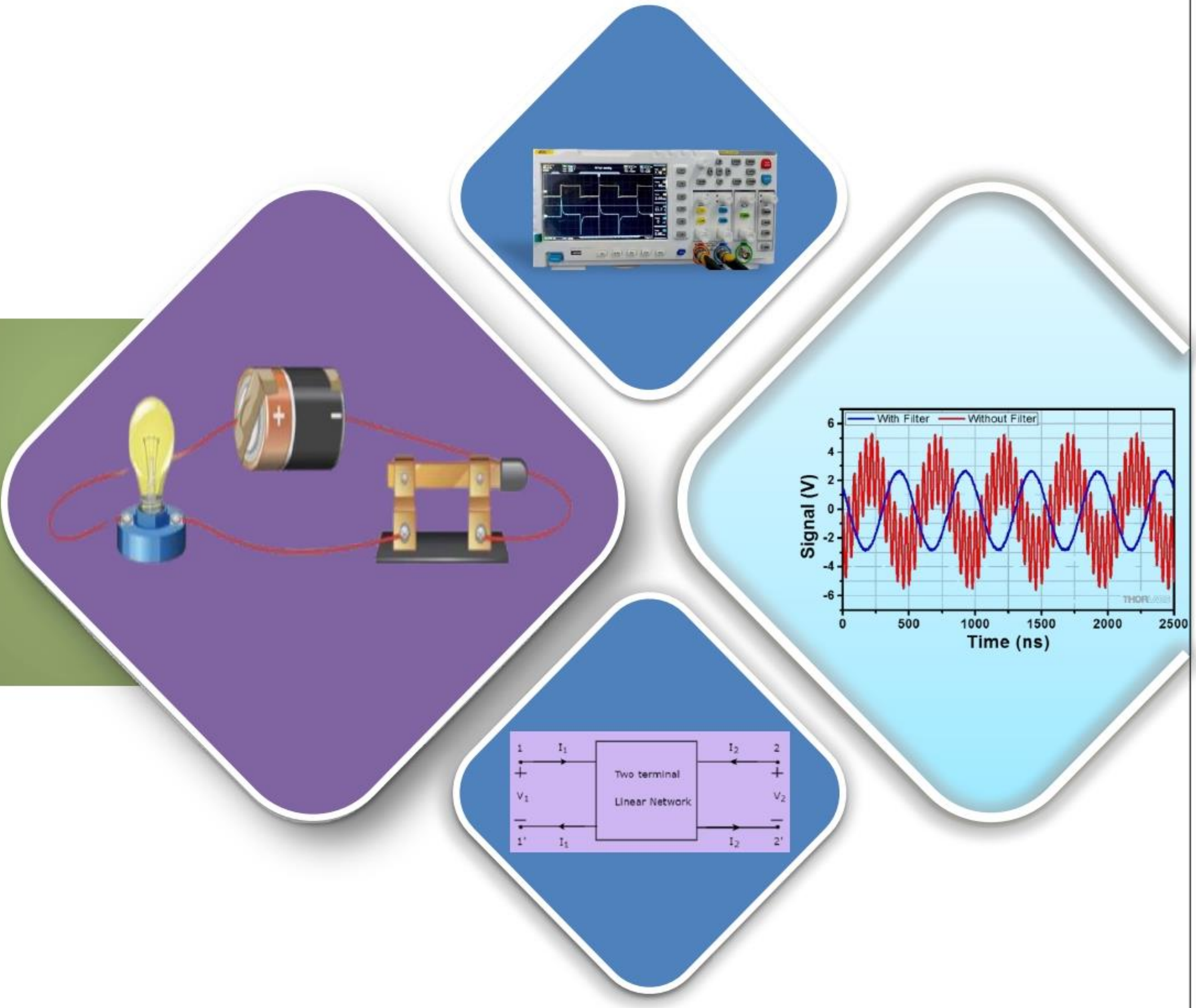
SCHEME : K

Name : ____________________________

Roll No. : ______________ Year : 20___ 20___

Exam Seat No. : ________________________

LABORATORY MANUAL FOR
CIRCUITS & NETWORKS
(313325)



ELECTRONICS ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the following

- Skill development in line with industry requirements
- Industry readiness and improved employability of Diploma holders
- Synergistic relationship with industry
- Collective and Cooperative development of all stake holders
- Technological interventions in societal development
- Access to uniform quality technical education

A Laboratory manual for

CIRCUITS & NETWORKS

(313325)

Semester – III

(DE/EJ/ET/EX/IE)

Maharashtra State

Board of Technical Education, Mumbai

(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education , Mumbai

(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

4th Floor, Government Polytechnic Building, 49,

Kherwadi, Bandra (East), Mumbai- 400051.

(Printed on July 2024)

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Certificate

This is to certify that Mr./Ms. ………………………………………..........
……………. Roll No. ……………Of Third Semester of Diploma in
…………………………………………….......................................of Institute
………………………………………………………………………………
(Code: ………) has completed the term work satisfactorily in course **Circuits & Networks (313325)** for the academic year 20…….to 20…….. as prescribed in the curriculum.

Place:…………….. **Enrollment No.:……………….**

Date: ……………… **Exam Seat No.: …………………**

Subject Teacher **Head of department** **Principal**

Seal
Of
Institute

Preface

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'K' Scheme curricula for engineering diploma programmes; with outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher, instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome- based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through "chalk and duster" activity in the classroom situation. Accordingly, the "K scheme laboratory manual development team designed the practical to focus on the outcomes, rather than the traditional age old practice of conducting practical to 'verify the theory" (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

The basic aim of this course is that the student must learn to deal with the electronic circuit while designing various elements of electric circuit/network in the industry. This course will help the students to use principles of circuit and analyze to maintain the electric circuit/network.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Program Outcomes (POs) to be achieved through Practicals of this Course

- **PO 1. Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, sciences and engineering fundamentals and engineering specialization to solve the broad based Electronic engineering problems.
- **PO 2. Problem analysis:** Identify and analyze well-defined Electronic engineering problems.
- **PO 3. Design/ development of solutions:** Design solutions for well-defined technical problems and assist with the design of Electronic engineering group program system components or processes to meet specified needs.
- **PO 4. Engineering tools, Experimentation and Testing:** Apply modern Electronic engineering group tools and appropriate technique to conduct standard tests and measurements.
- **PO 5. Engineering practices for society, sustainability and environment:** Apply appropriate Electronic engineering group program technology in context of society, sustainability, environment and ethical practices.
- **PO 6. Project Management:** Use Electronic engineering group program management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
- **PO 7. Life-long learning:** Ability to analyses individual needs and engage in updating in the context of Electronic engineering group program technological changes.

List of relevant expected psychomotor domain skills

The following industry relevant skills of the identified competency :"Use basic principles of electrical engineering in different applications." for relevant electronic applications" are expected to be developed in the student by undertaking the laboratory work as given in laboratory manual.

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1. Calculate voltage and current of the given circuit using nodal and mesh analysis.
2. Use various network theorems to calculate circuit parameters.
3. Determine the circuit parameters of two port network.
4. Calculate the electrical parameters of single phase A.C. circuit.
5. Find the resonance condition of electric/electronic circuits.
6. Measure and interpret Electric circuits/networks parameters

Practical-Course outcome matrix

COURSE LEVEL LEARNING OUTCOMES (COS)

CO1 - Calculate voltage and current of the given circuit using nodal and mesh analysis.
CO2 - Use various network theorems to calculate circuit parameters.
CO3 - Determine the circuit parameters of two port network.
CO4 - Calculate the electrical parameters of single phase A.C. circuit.
CO5 - Find the resonance condition of electric/electronic circuits.

Sr. No.	Title of the Practical	CO1	CO2	CO3	CO4	CO5
1	Measure the voltage across resistive circuit and verify it, using Kirchhoff's Voltage law (KVL).	✓	-	-	-	-
2	Measure current in various branches of the given circuit and verify it, using Kirchhoff's current law (KCL).	✓	-	-	-	-
3	Measure current through and voltage across given branch of electric network and verify it by mesh analysis.	✓	-	-	-	-
4	Measure voltage at particular node and current through branch of network and verify it by nodal analysis.	✓	-	-	-	-
5	Observe transient response of RL series circuit with DC excitation.	✓	-	-	-	-
6	Observe transient response of RC series circuit with DC excitation.	✓	-	-	-	-
7	Measure current through given branch of network and voltage across given element of the circuit and verify it applying Superposition theorem.	-	✓	-	-	-
8	Measure short circuit current and Norton's resistance of the given circuit and verify it using Norton's theorem.	-	✓	-	-	-
9	Measure open circuit voltage and thevenin's resistance of the given circuit and verify it using Thevenin's theorem.	-	✓	-	-	-
10	Vary load resistance to transfer Maximum power in the given circuit using maximum power transfer theorem.	-	✓	-	-	-
11	Measure voltage to current ratio before and after interchanging the position of voltage source and current in the given circuit to verify reciprocity theorem.	-	✓	-	-	-
12	Measure input and output voltages and currents of the given two port network and calculate open circuit(Z) parameters for the given circuit.	-	-	✓	-	-
13	Measure input and output voltages and currents of the given two port network and calculate short circuit(Y) parameters for given circuit.	-	-	✓	-	-
14	Measure input and output voltages and currents of the given two port network calculate transmission (ABCD) parameters for given circuit.	-	-	✓	-	-
15	Develop RC low pass filter on breadboard and plot its frequency response.	-	-	✓		
16	Develop RC high pass filter on breadboard and plot its frequency response.	-	-	✓	-	-

COURSE LEVEL LEARNING OUTCOMES (COS)

CO1 - Calculate voltage and current of the given circuit using nodal and mesh analysis.
CO2 - Use various network theorems to calculate circuit parameters.
CO3 - Determine the circuit parameters of two port network.
CO4 - Calculate the electrical parameters of single phase A.C. circuit.
CO5 - Find the resonance condition of electric/electronic circuits.

Sr. No.	Title of the Practical	CO1	CO2	CO3	CO4	CO5
17	Develop RC band pass filter on breadboard and plot it's frequency response.	-	-	✓	-	-
18	Test the performance of Symmetrical T attenuator.	-	-	✓	-	-
19	Test the performance of Symmetrical Pi attenuator.	-	-	✓	-	-
20	Measure voltage and current in the given R-L series circuit and calculate active, reactive and apparent power consumed in the circuit.	-	-	-	✓	-
21	Measure voltage and current in the given R-C series circuit and calculate active, reactive and apparent power consumed in the circuit.	-	-	-	✓	-
22	Measure voltage and current in the given R-L-C series circuit and calculate active, reactive and apparent power consumed in the circuit.	-	-	-	✓	-
23	Measure voltage and current in the given R-C parallel circuit and calculate power factor, active, reactive and apparent power consumed in the circuit.	-	-	-	✓	-
24	Measure voltage and current in the given R-L-C parallel circuit and calculate power factor, active, reactive and apparent power consumed in the circuit.	-	-	-	✓	-
25	Measure voltage and current in the given R-L-C parallel circuit consists of series connection of resistor and inductor in parallel with capacitor and calculate power factor, active, reactive and apparent power consumed in the circuit.	-	-	-	✓	-
26	Measure initial and final voltage across the capacitor before and after swicthing input supply.	-	-	-	✓	-
27	Measure initial and final current flowing through the inductive coil before and after switching the supply.	-	-	-	✓	-
28	Measure voltage and current in the given RLC series circuit and calculate resonance frequency and impedance at resonance using variable supply frequency.	-	-	-	-	✓
29	Measure voltage and current in the given RLC series circuit and calculate resonance frequency and impedance at resonance by varying L or C.	-	-	-	-	✓
30	Measure current of given RLC parallel circuit and calculate resonance frequency and impedance at resonance by varying supply frequency.	-	-	-	-	✓

Guidelines to Teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each experiment
3. Involve students in performance of each experiment.
4. Teacher should ensure that the respective skills and competencies are developed in. the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.
9. Teacher is expected to refer complete curriculum document and follow guidelines for implementation
10. At the beginning of the practical which is based on the simulation, teacher should make the students acquainted with any simulation software environment.

Instructions for Students

1. Listen carefully the lecture given by teacher about subject, curriculum, learning structure, skills to be developed.
2. Organize the work in the group and make record all programs.
3. Students shall develop maintenance skill as expected by industries.
4. Student shall attempt to develop related hand-on skills and gain confidence.
5. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
6. Student shall refer technical magazines.
7. Student should develop habit to submit the practicals on date and time.
8. Student should well prepare while submitting write-up of exercise.
9. Attach/paste separate papers wherever necessary.

Content Page

List of Practical's and Progressive Assessment Sheet

Content Page

List of Practical's and Progressive Assessment Sheet

Content Page

List of Practical's and Progressive Assessment Sheet

Sr. No.	Title of the Practical	Page no.	Date of Performance	Date of Submission	Assessment Marks (25)	Dated sign.of Teacher	Remarks (If any)
24	Measure voltage and current in the given R-L-C parallel circuit and calculate power factor, active, reactive and apparent power consumed in the circuit.	144					
25	* Measure voltage and current in the given R-L-C parallel circuit consists of series connection of resistor and inductor in parallel with capacitor and calculate power factor, active, reactive and apparent power consumed in the circuit.	151					
26	Measure initial and final voltage across the capacitor before and after swicthing input supply.	157					
27	Measure initial and final current flowing through the inductive coil before and after switching the supply.	163					
28	* Measure voltage and current in the given RLC series circuit and calculate resonance frequency and impedance at resonance using variable supply frequency.	168					
29	Measure voltage and current in the given RLC series circuit and calculate resonance frequency and impedance at resonance by varying L or C.	174					
30	* Measure current of given RLC parallel circuit and calculate resonance frequency and impedance at resonance by varying supply frequency.	179					
	Total						

Note :

- Out of above suggestive LLOs -'*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

Practical No.1: Measure the voltage across resistive circuit and verify it using Kirchhoff's Voltage Law (KVL).

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of loops. Many a times as per the requirement, measurement of voltage across a particular component is required. The voltage across each component in a closed loop in a circuit can be calculated by using Kirchhoff's Voltage Law (KVL). This experiment will help you to verify the theoretically obtained voltage across each component in a given loop in a circuit using KVL.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate voltage and current of the given circuit using nodal and mesh analysis**.**

IV Laboratory Learning Outcome(s)

LLO 1.1 Identify the loops in the given circuit.

LLO 1.2 Verify KVL to find out the voltage across the element.

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping.
b. Maintain tools and equipment properly.

VI Relevant Theoretical Background

According to Kirchhoff's Voltage Law, the voltage around a loop equals the sum of every voltage drop in the same loop for any closed network and equals zero. A Loop is a path that terminates at the same node where it started from. In contrast, a Mesh is a loop that doesn't contain any other loops inside it. Mathematically, KVL can be represented as $\sum_{n=1}^{N} V_n$

Where,

- V_n is the nth element's voltage in a loop (mesh).
- N is the number of network elements in the loop (mesh).

The above statement of KVL can also be expressed as "the algebraic sum of voltage sources is equal to the algebraic sum of voltage drops that are present in a loop".

SIGN CONVENSIONS:

While determining the various parameters of a given network; we have to take into account the sign of that particular parameter.

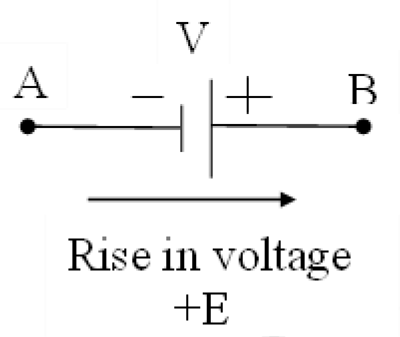

Fig (a)

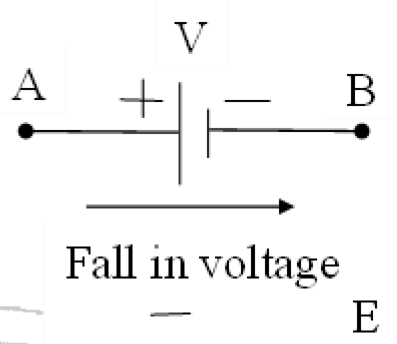

Fig (b)

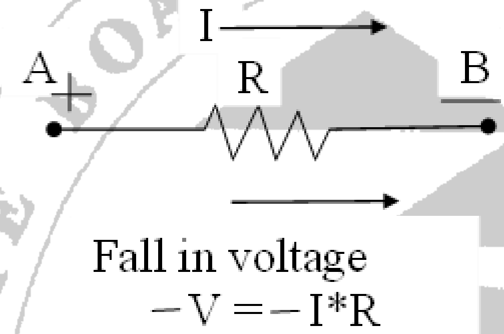

Fig (c)

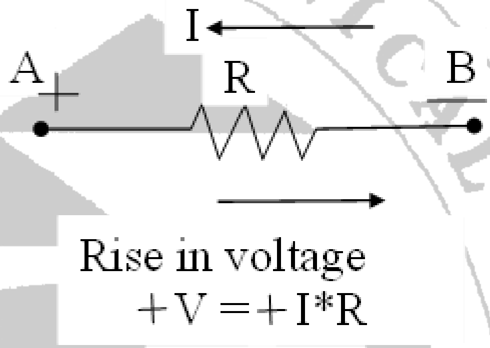

Fig (d)

<u>Sign of Battery (EMF):</u>

A rise in voltage should be given a + ve sign and a fall in voltage should be given a – ve sign. Keeping this in mind it is clear that as we go from the – ve terminal of a battery to its + ve terminal as shown in fig(a), there is a rise in potential, hence this voltage should be given + ve sign.

Similarly, if we go from +ve terminal of battery to – ve terminal of battery as shown in fig(b), then there is a fall in potential, hence the voltage should be considered as – ve sign.

<u>Sign of Voltage drop (I*R):</u>

Now take the case of resistor as shown in the above figure.

If we go through a resistor in the same direction as the current as shown in fig(c), then there is fall in potential because current flows from a higher to a lower potential. Hence this voltage fall should be taken as – ve.

However, if we go in a direction opposite to that of current as shown in fig(d), then there will be a rise in voltage. Hence this voltage should be given a + ve sign.

VII Circuit diagram
Layout of Laboratory

a) Sample Circuit:

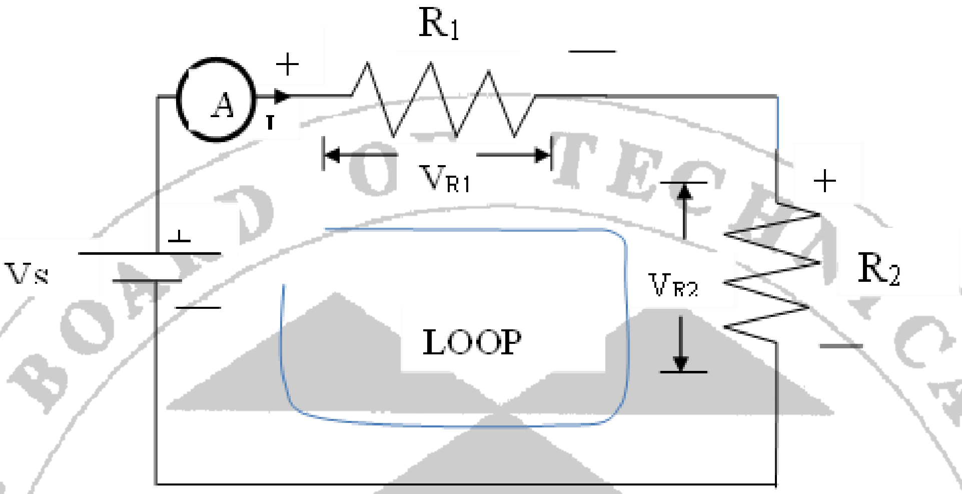

Fig 1.1

b) Actual circuit / Experimental Setup used in Laboratory with related equipment rating:

VIII Required Resources/apparatus/equipment with specifications :

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistors	Any value available in the laboratory	2
2	DC power supply	0 – 30 V	1
3	Ammeter	As per current requirement	1
4	Bread board	-----------	1

IX Precautions to be followed

1) Check the connections before connecting circuit to supply.
2) Apply voltage as per rating of the resistors.
3) Select the proper range of the multimeter as per the parameter to be measured.

X Procedure

1. Identify the components as per the resources required.
2. Connect the circuit as shown in figure 1.1 on breadboard.
3. Switch on the Supply.
4. Read and note the value of current & voltage at the given points in figure.
5. Switch off the supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

Table no: 1.1

Sr No	V_s	I		V_{R1}		V_{R2}	
		Observed	Calculated	Observed	Calculated	Observed	Calculated
1							
2							

Calculations:

Write Kirchhoff's Voltage Equation for the given loop and calculate the values of current and voltage across each component.

XIV Result(s)

1. Observed value of voltage across R_1 =
2. Observed value of voltage across R_2 =

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. State Kirchhoff's Voltage Law.
2. Write Kirchhoff's Voltage Equation for the given loop in figure 1.2 and calculate the values of current and voltage across each component.

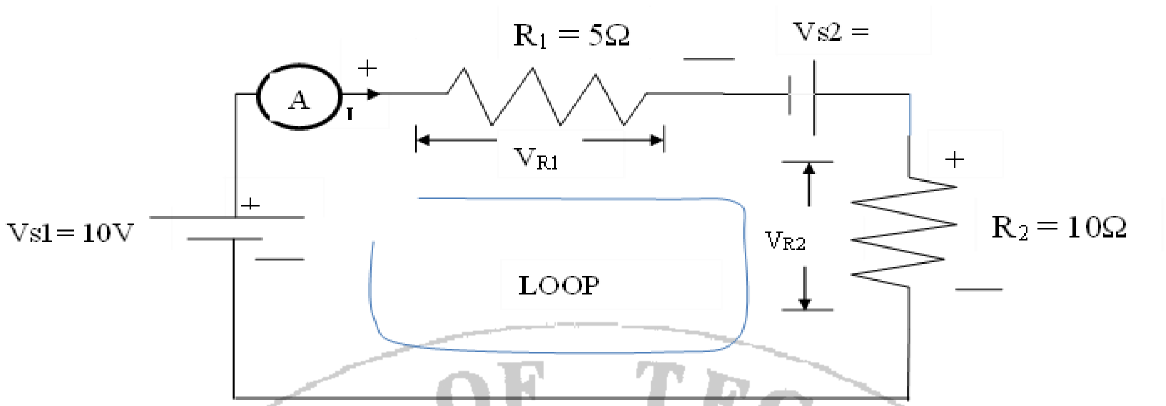

Fig 1.2

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology Vol-I", Theraja B L, Theraja A K
2. www.scilab.org/scilab, Open source simulator for simulation of theorems
3. https://youtu.be/VvmA2TZczfk?si=jH075djzbeiEC7XC, video of how to conduct the practical of KVL, courtesy: youtube

XIX Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.2: Measure current in various branches of the given circuit and verify it using Kirchhoff's Current Law (KCL).

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current flowing through a particular branch is required. The current flowing through each branch in a circuit can be calculated by using Kirchhoff's Current Law (KCL). This experiment will help you to verify the theoretically obtained the current flowing through each branch in a circuit using KCL.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate voltage and current of the given circuit using nodal and mesh analysis.

IV Laboratory Learning Outcome(s)

LLO 2.1 Identify the nodes in the given circuit.

LLO 2.2 Verify KCL at given node.

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping.

b. Maintain tools and equipment properly.

VI Relevant Theoretical Background

According to Kirchhoff's Current Law, in any electrical network the algebraic sum of the currents meeting at a point (or Node) is zero. It simply means that the total current leaving a junction is equal to the total current entering that junction. A node consists of the point where the terminals of two or more circuit elements meet.

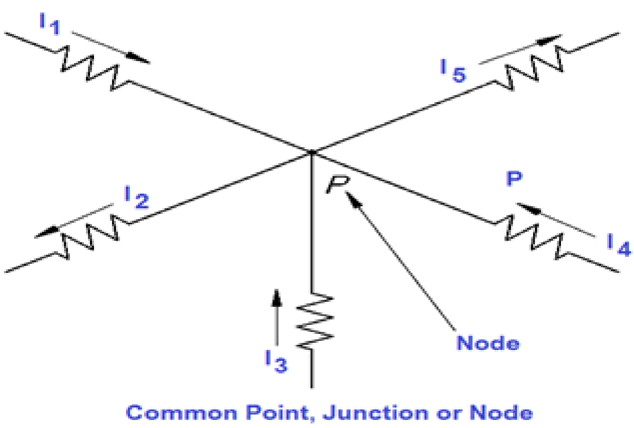

Fig 2.1

SIGN CONVENTIONS USED FOR A NODE:

As shown in the above figure 2.1 point P is identified as a node. At any particular node in a circuit, where more than one elements of the circuit meets, the value of current can be found by the following equation,

INCOMING CURRENT = OUTGOING CURRENT

Hence, as shown in above figure; we can write the current equation at node P as;

$$I_1 + I_3 + I_4 = I_2 + I_5$$

VII Circuit diagram/ Layout of Laboratory

a) Sample Circuit:

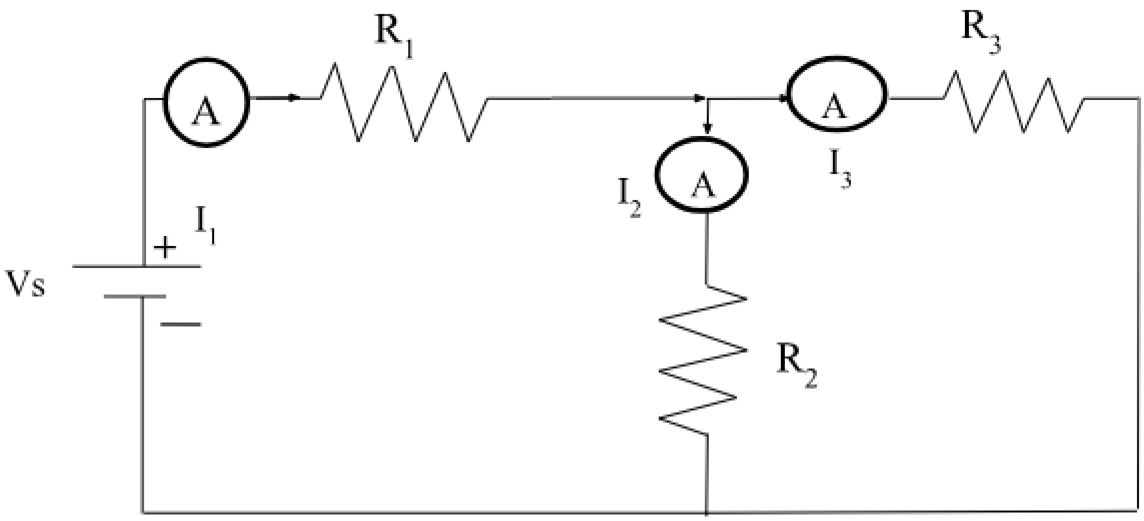

Fig 2.2

b) Actual circuit diagram used in Laboratory with related equipment rating:

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistors	Any value available in the laboratory	3
2	DC power supply	0 – 30 V	1
3	Ammeter	As per current requirement	3
4	Bread board	-----------	1

IX Precautions to be followed

1) Check the connections before connecting the circuit to supply.
2) Apply voltage as per rating of the resistors.
3) Select the proper range of the multimeter as per the parameter to be measured.

X Procedure

1. Identify the components as per the resources required.
2. Connect the circuit as shown in figure 2.2 on breadboard.
3. Switch on the Supply.
4. Read and note the value of current at the given points in figure.
5. Switch off the supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

Table no: 2.1

Sr No	V_s	I_1		I_2		I_3	
		Observed	Calculated	Observed	Calculated	Observed	Calculated
1							
2							

Calculations:

Write Kirchhoff's Current Equation for the given node and calculate the values of current entering the node and outgoing from the node.

XIV Result(s)

1. Observed value of current I_1 =
2. Observed value of current I_2 =
3. Observed value of current I_3 =

XV Interpretation of results

………
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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions to ensure the achievement of identifies CO.

1. State Kirchhoff's Current Law.
2. Write Kirchhoff's Current Equation at node A in figure 2.3 and calculate the values of incoming current and outgoing current at node A.

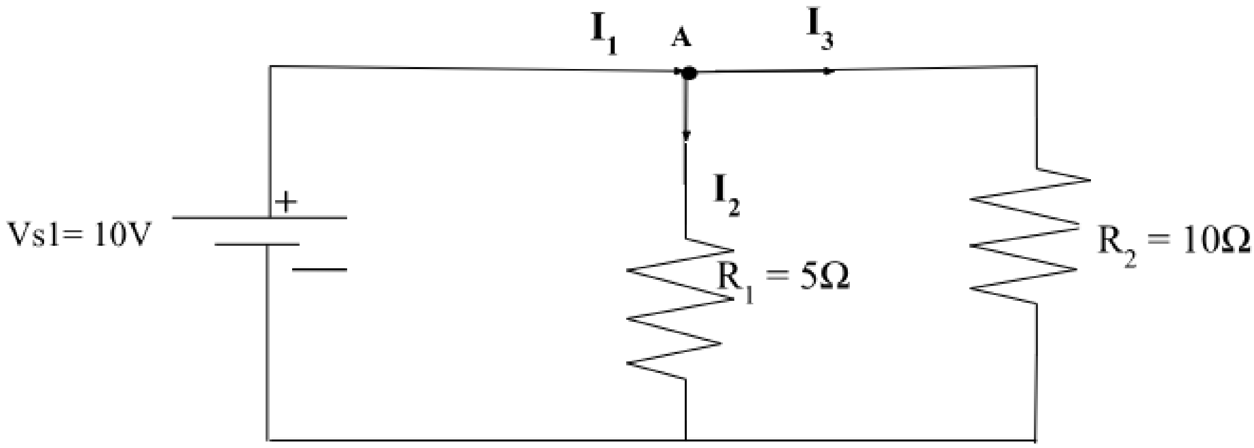

Fig 2.3

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. www.scilab.org/scilab, Open source simulator for simulation of theorems
3. https://youtu.be/-84TNVuK8Ww?si=e8spQ1rqsiroQAnq , video of how to conduct the practical of KCL, courtesy: youtube

XIX Assessment Scheme

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	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.3: Measure current through & voltage across given branch of electric network and verify it by Mesh Analysis.

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current, voltage & power across a branch is required. These parameters can be calculated using Mesh Analysis of the given circuit. This experiment will help you to verify the theoretically obtained current through a branch using mesh analysis.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate voltage and current of the given circuit using nodal and mesh analysis.

IV Laboratory Learning Outcome(s)

LLO 3.1 Identify the meshes in the given circuit.
LLO 3.2 Use Mesh analysis to calculate current through a given branch.

V Relevant Affective Domain related outcome(s)

a. Maintain tools and equipment properly.
b. Observe step by step sequence of operation.

VI Relevant Theoretical Background

In this method of analysis, Kirchhoff s Voltage Law is applied to a network to write mesh equations in terms of mesh currents. By solving simultaneous linear equations for multiple meshes, current through particular branch can be found out. Follow these steps while solving any electrical network or circuit using Mesh analysis.

- Step 1 − Identify the meshes and label the mesh currents in either clockwise or anti-clockwise direction.
- Step 2 − Observe the amount of current that flows through each element in terms of mesh currents.
- Step 3 − Write mesh equations to all meshes. Mesh equation is obtained by applying KVL first and then Ohm’s law.
- Step 4 − Solve the mesh equations obtained in Step 3 in order to get the mesh currents.

SIGN CONVENSIONS:

While determining the various parameters of a given network; we have to take into account the sign of that particular parameter.

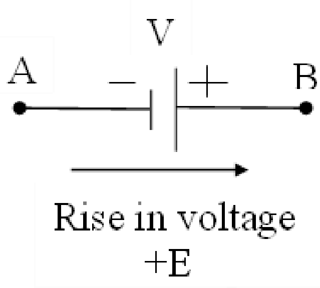

Fig (a)

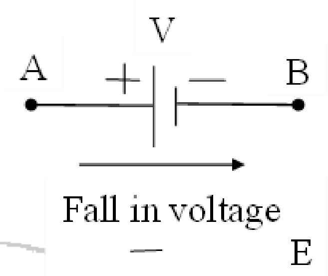

Fig (b)

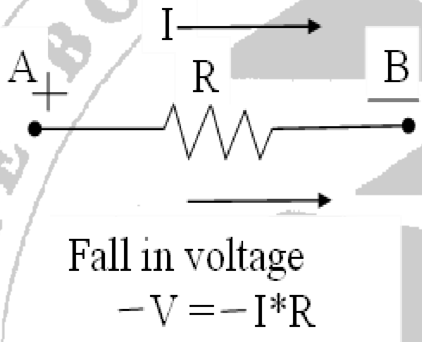

Fig (c)

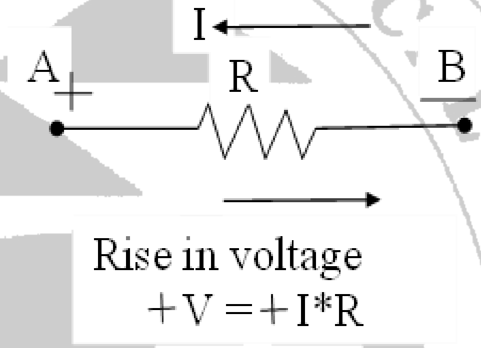

Fig (d)

<u>Sign of Battery (EMF):</u>

A rise in voltage should be given a + ve sign and a fall in voltage should be given a – ve sign. Keeping this in mind it is clear that as we go from the – ve terminal of a battery to its + ve terminal as shown in fig(a), there is a rise in potential, hence this voltage should be given + ve sign.

Similarly if we go from +ve terminal of battery to – ve terminal of battery as shown in fig(b), then there is a fall in potential, hence the voltage should be considered as – ve sign.

<u>Sign of Voltage drop (I*R):</u>

Now take the case of resistor as shown in the above figure.

If we go through a resistor in the same direction as the current as shown in fig(c), then there is fall in potential because current flows from a higher to a lower potential. Hence this voltage fall should be taken as – ve.

However if we go in a direction opposite to that of current as shown in fig(d), then there will be a rise in voltage. Hence this voltage should be given a + ve sign.

VII Circuit diagram/ Layout of Laboratory

Sample Circuit:

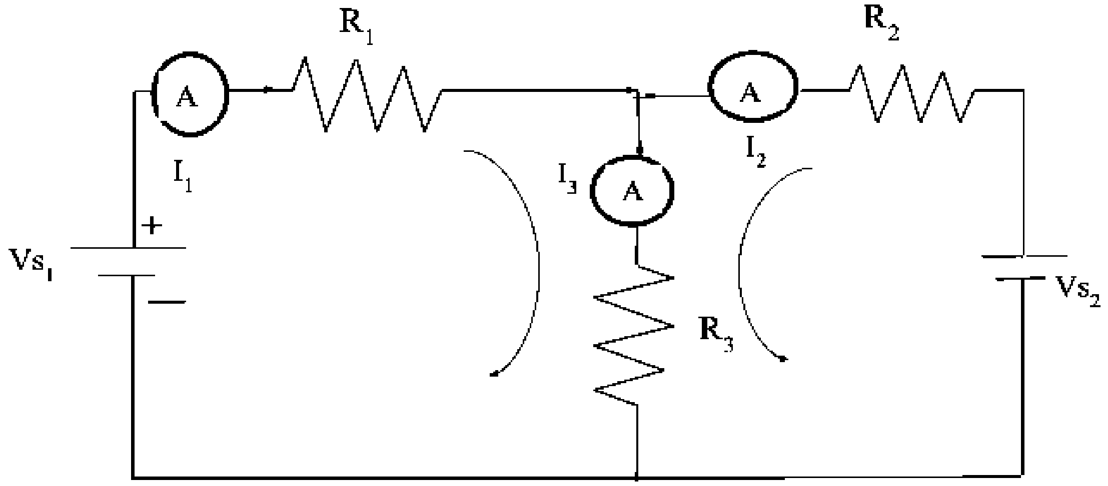

Fig 3.1

a) Actual circuit diagram used in Laboratory with related equipment ratings :

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistors	Any value available in the laboratory	3
2	DC power supply	0 – 30 V	2
3	Ammeter	As per requirement of current	3
4	Bread board	-----------	1

IX Precautions to be followed

1) Check the connections before connecting circuit to supply.
2) Apply voltage as per rating of the resistors.
3) Select proper range of multimeter as per the parameter to be measured.

X Procedure

1. Identify the components as per the resources required.
2. Connect the circuit as shown in figure 3.1 on breadboard.
3. Switch on the Supply.
4. Read and note the value of current at the given points in figure.
5. Switch off the supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

Table no: 3.1

Sr No	V_{s1}	V_{s2}	I_1		I_2		I_3	
			Observed	Calculated	Observed	Calculated	Observed	Calculated
1								
2								

Calculations:

Write Kirchhoff s Voltage Equations for the meshes. Simplify the equations. Write the equations in matrix form and find the values of mesh currents. Current through the branch 3 is the addition of mesh current 1 and mesh current 2.

XIV Result(s)

1. Observed value of current through branch 3, I_3 =
2. Calculated value of current through branch 3, I_3 =

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. Can we perform the experiment using AC supply? Justify your answer.
2. Determine the current in the 1Ω resistor branch in the circuit shown in figure 3.2.

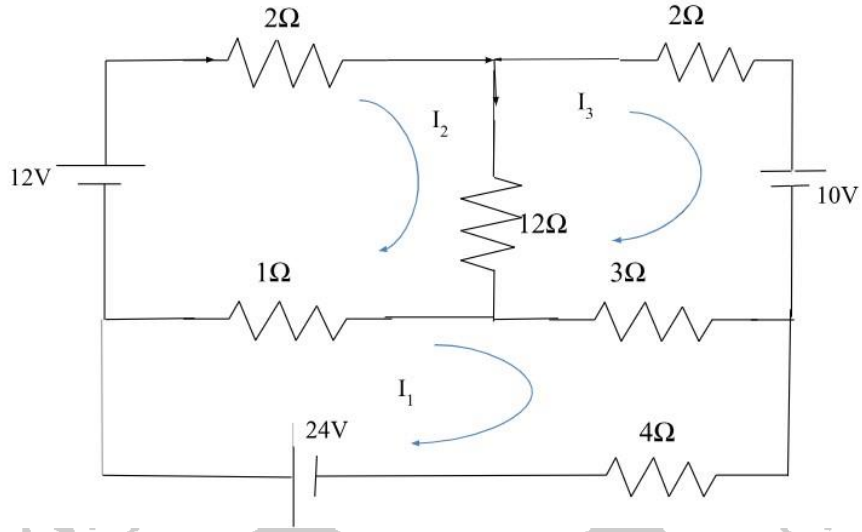

Fig 3.2

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. www.scilab.org/scilab, Open source simulator for simulation of theorems
3. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	**Weigh tage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.4: Measure voltage at particular node and current through branch of network and verify it by Nodal Analysis.

I Practical Significance

The Electrical and Electronic circuits in industrial applications involve a number of branches. Many a times current, power & voltage across a branch is required. It can be found out by using Nodal Analysis.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate voltage and current of the given circuit using nodal and mesh analysis.

IV Laboratory Learning Outcome(s)

LLO 4.1 Identify the nodes in the given circuit.

LLO 4.2 Use Nodal analysis to calculate node voltage.

V Relevant Affective Domain related outcome(s)

a. Maintain tools and equipment properly.

b. Observe step by step sequence of operations.

VI Relevant Theoretical Background

In this method of analysis, Kirchhoff s Current Law is applied to a network to write nodal equations in terms of nodal voltages. By solving simultaneous linear equations for multiple nodes, voltage at particular node can be found out.

A node consists of the point where the terminals of two or more circuit elements meet.

Follow these steps while solving any electrical network or circuit using Nodal analysis.

Step 1 − Identify the principal nodes and choose one of them as reference node. We will treat that reference node as the Ground.

Step 2 − Label the node voltages with respect to Ground from all the principal nodes except the reference node.

Step 3 − Write nodal equations at all the principal nodes except the reference node. Nodal equation is obtained by applying KCL first and then Ohm’s law.

Step 4 − Solve the nodal equations obtained in Step 3 in order to get the node voltages.

Now, we can find the current flowing through any element and the voltage across any element that is present in the given network by using node voltages.

SIGN CONVENSIONS:

While determining the various parameters of a given network; we have to take into account the sign of that particular parameter.

<u>Sign of Battery (EMF):</u>

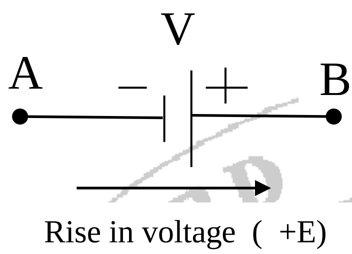
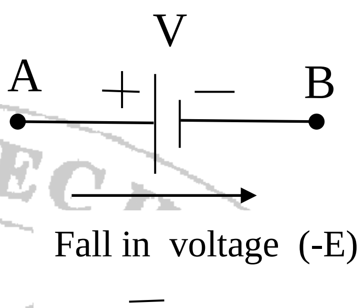


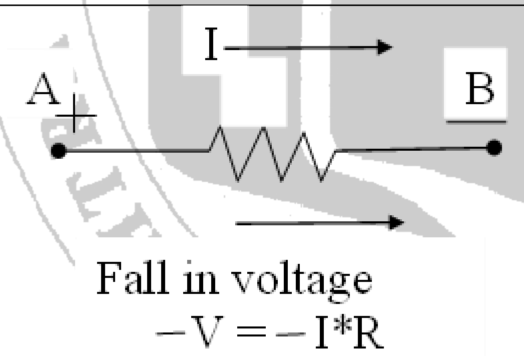
Fig (a)



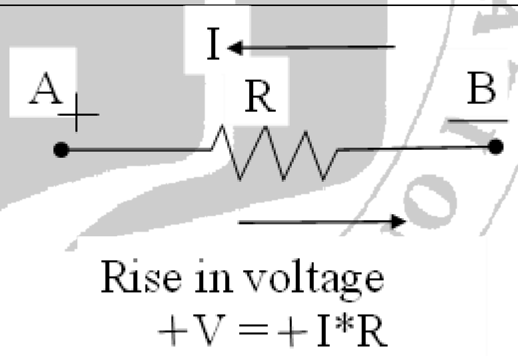
Fig(b)

A rise in voltage should be given a + ve sign and a fall in voltage should be given a – ve sign. Keeping this in mind it is clear that as we go from the – ve terminal of a battery to its + ve terminal as shown in fig(a), there is a rise in potential, hence this voltage should be given a + ve sign.
Similarly if we go from +ve terminal of battery to – ve terminal of battery as shown in fig(b), then there is a fall in potential, hence the voltage should be considered as – ve sign.

<u>Sign of Voltage drop (I*R):</u>



<u>Fig (c)</u>



<u>Fig (d)</u>

Now take the case of resistor as shown in the above figure.
If we go through a resistor in the same direction as the current as shown in fig(c), then there is fall in potential because current flows from a higher to a lower potential. Hence this voltage fall should be taken as – ve.
However if we go in a direction opposite to that of current as shown in fig(d), then there will be a rise in voltage. Hence this voltage should be given a + ve sign.

VII Circuit diagram/ Layout of Laboratory

a) Sample Circuit:

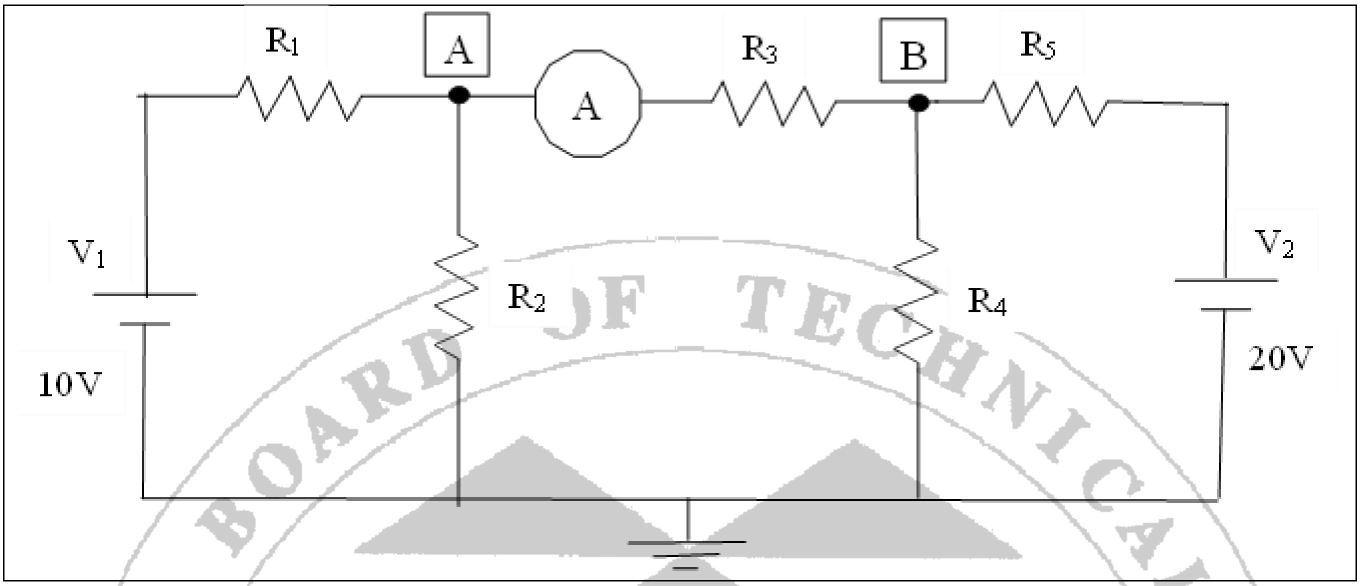


Fig 4.1

b) Actual circuit diagram used in Laboratory with related equipement ratings :

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistors	Any value available in the laboratory (0 – 100 Ω)	5
2	DC power supply	0 – 30 V	2
3	Ammeter	As per the requirement of current	1
4	Bread board	-----------	1

IX Precautions to be followed

a. Check the connections before connecting circuit to supply.
b. Apply voltage as per rating of the resistors.
c. Select proper range of multimeter as per the parameter to be measured.

X Procedure

1. Identify the components as per the resources required.
2. Connect the circuit as shown in figure 4.1 on breadboard.
3. Switch on the Supply.
4. Read and note the value of voltage at node A and node B. Also measure the current through resistor R_3 as shown in the figure.
5. Switch off the supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table:

Table no: 4.1

Sr. No.	Observed V_A (V)	Calculated V_A (V)	Observed V_B (V)	Calculated V_B (V)	Current through R3	
					Observed	Calculated
1						
2						

XIV Result(s)

1. Observed value of voltage at node A= ....
2. Calculated value of voltage at node A = ...
3. Observed value of voltage at node B = ...
4. Calculated value of voltage at node B = ...
5. Observed value of current through resistor R_3= ....
6. Calculated value of current through resistor R_3= ....

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Can we perform the experiment using AC supply? Justify your answer.
2. Frame and solve the node equations of the network shown shown in figure 4.2.

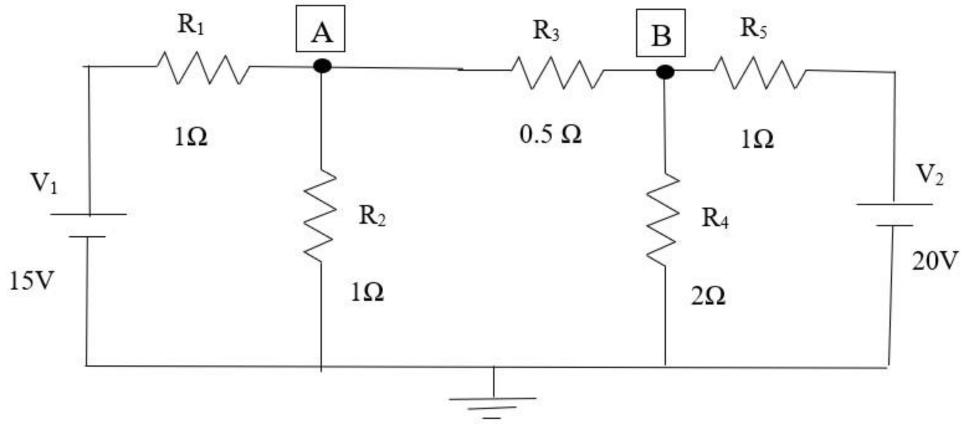

Fig 4.2

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. www.scilab.org/scilab, Open source simulator for simulation of theorems
3. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.5: Observe transient response of RL series circuit with DC excitation.

I Practical Significance

The Electrical and Electronic circuits in industrial applications involve a number of components with resistive, inductive and capacitive in nature. Many a times the nature of the response of voltage or current across a particular part of a circuit is required. This practical will help to find out the nature of the response across inductive load.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase AC circuits**.**

IV Laboratory Learning Outcome(s)

LLO 5.1 Measure the current of the RL series circuit.

LLO 5.2 Plot and interpret the transient response of given circuit on graph.

V Relevant Affective Domain related outcome(s)

a. Maintain tools and equipment properly.
b. Demonstrate working as a leader/ a team member.
c. Observe step by step sequence of operation.

VI Relevant Theoretical Background

Finding the Response of Series RL Circuit. Consider the following series RL circuit diagram.

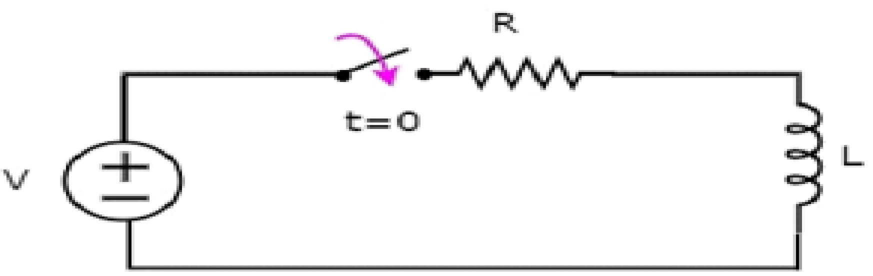


Fig 5.1

In the above circuit of fig 5.1, the switch was kept open up to t = 0 and it was closed at t = 0. So, the DC voltage source having V volts is not connected to the series RL circuit up to this instant. Therefore, there is no initial current flows through inductor.The circuit diagram, when the switch is in closed position is shown in the following figure.

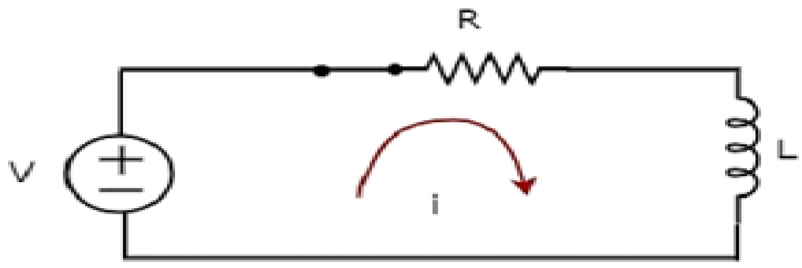


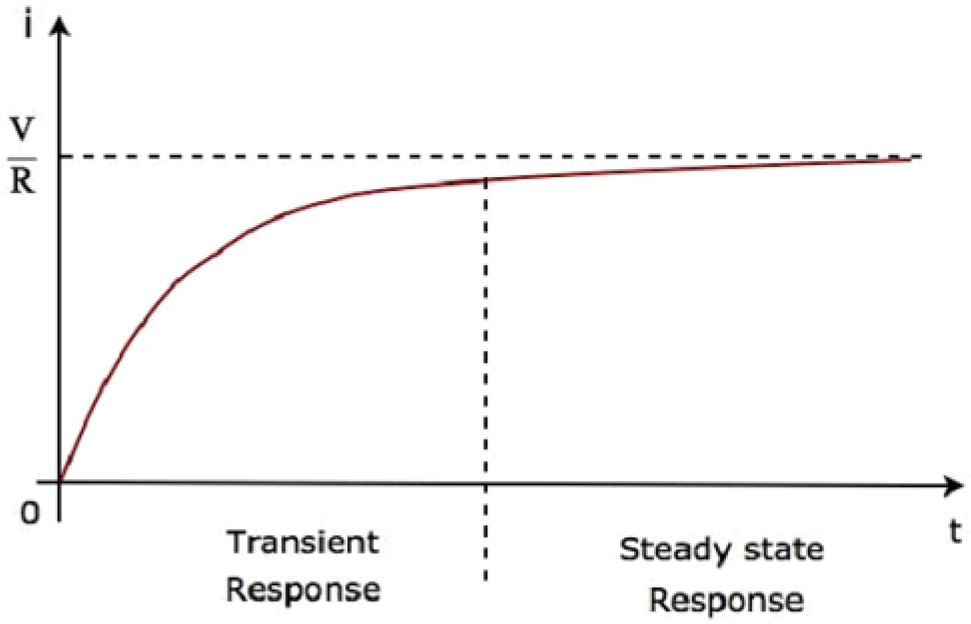
Fig 5.2

Now, as shown in fig 5.2 the current ***i*** flows in the entire circuit, since the DC voltage source having ***V*** volts is connected to the series RL circuit.

$$i = \frac{V}{R} - \frac{V}{R} e^{-\left(\frac{R}{L}\right)t}$$

So, the response of the series RL circuit, when it is excited by a DC voltage source, has the following two terms.

- The first term $-\frac{V}{R} e^{-\left(\frac{R}{L}\right)t}$ corresponds with the transient response.
- The second term $\frac{V}{R}$ corresponds with the steady state response. These two responses are shown in the following figure.



(Courtesy : www.tutorialspoint.com)
Fig 5.3

VII Circuit diagram/ Layout of Laboratory

c) Actual circuit diagram used in Laboratory with related equipment rating:

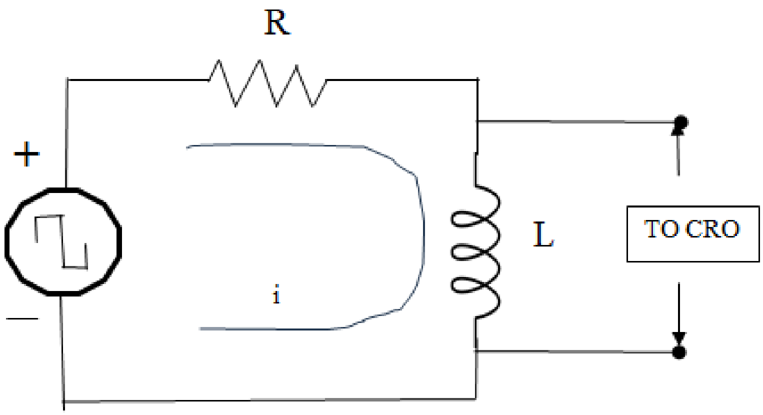


Fig 5.4

To verify our analysis, in the circuit of Figure 5.4, In order to reflect the notion of a time-varying circuit with a switch, the DC voltage source has been replaced with a rectangular pulse voltage source. The waveform shown tracks the inductor's voltage. (Which is exact the replica of the waveform of current flowing through the inductor, which we can find out by using Ohm's law as($i = V/Xl$)

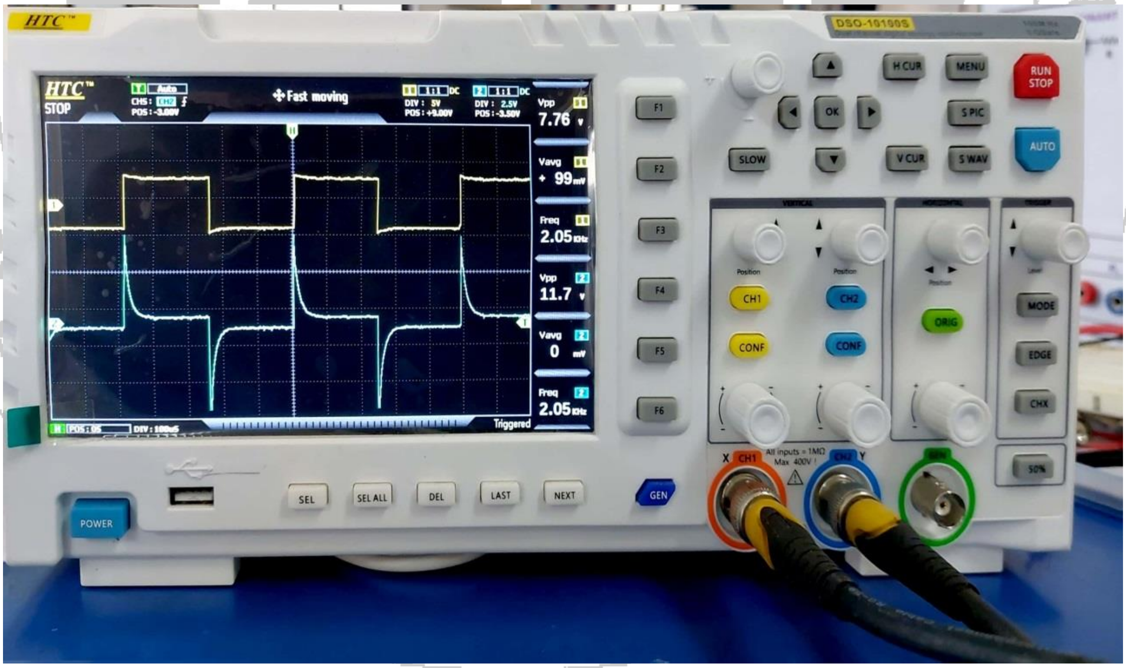


Fig 5.5

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistor	1kΩ (or any other suitable value)	1
2	Inductor	30mH (or any other suitable value)	1
3	Signal Generator	Frequency : 0.1Hz ~ 5MHz ; Output waveforms : Sine, triangle, square, positive and negative pulse	1
4	Digital Storage Oscilloscope	2 and 4 analog channel models 100 and 70 MHz bandwidth models Up to 1 GS/s sampling rate.	1
5	Bread Board		1

IX Precautions to be followed

a. Check the connections before connecting circuit to supply.

b. Select proper values of the resistors and inductor.

X Procedure

1. Identify the components as per the resources required.
2. Connect the circuit as shown in figure 5.4 on breadboard.
3. Select the square wave signal on signal generator.
4. Connect the signal generator as a input signal across resistor.
5. Switch on the Supply.
6. Observe the response across an inductor L on DSO or CRO as shown in fig 5.5.
7. Switch off the supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

(Note: Refer the waveform shown in theoretical background)

1. Voltage at the end of transient response =
2. Time period of transient response =
3. Voltage of steady state response =
4. Time period of steady state response =

XIV Result(s)

1. Voltage at the end of transient response =
2. Time period of transient response =
3. Voltage of steady state response =
4. Time period of steady state response =

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Can we perform the experiment using AC supply? Justify your answer.
2. Calculate the value of current flowing through the inductor used in your circuit. Draw the transient response of RL series circuit.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. " A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. www.tutorialspoint.com
3. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	**Weigh tage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.6: Observe transient response of RC series circuit with DC excitation.

I Practical Significance

The Electrical and Electronic circuits in industrial applications involve a number of components with resistive, inductive and capacitive in nature. Many a times the nature of the response of voltage or current across a particular part of a circuit is required. This practical will help to find out the nature of the response across capacitive load.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase AC circuits.

IV Laboratory Learning Outcome(s)

LLO 6.1 Measure the voltage across capacitor in RC series circuit.

LLO 6.2 Plot and interpret the transient response of given circuit on graph.

V Relevant Affective Domain related outcome(s)

a. Follow safe practices.
b. Maintain tools and equipment properly.
c. Observe step by step sequence of operations.

VI Relevant Theoretical Background

Finding the step response: An electric circuit consisting of a resistance (R) and a capacitor (C), connected in series, is shown in Fig 6.1. Consider the switch (S) is closed at t=0 *t*=0..

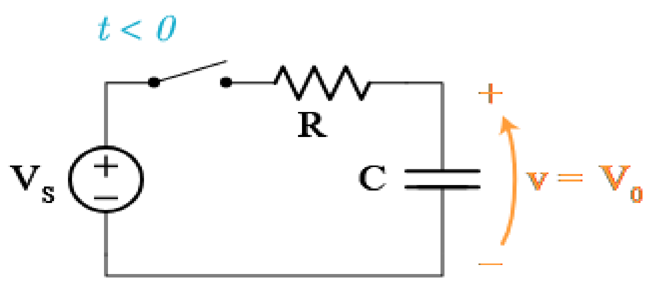

Fig 6.1 R-C Series Circuit when switch is open

We know the current in the circuit is because the switch is open. These are the *initial conditions* of the circuit.

Final state

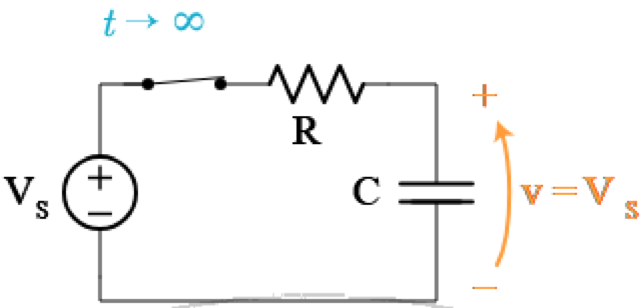

Fig 6.2 a : R-C series circuit when switch is closed

If we close the switch as shown in fig 6.2, current will start flowing around the now-completed circuit. Current will continue to flow as long as there is a voltage difference across the resistor. At some point in the future, the capacitor voltage will become the same as the source voltage, This is the *final state* of the circuit.

Transient period:

Between the initial state and the final state the current and voltage adjust to new conditions imposed by the voltage source. This is called the *transient period*, when things are changing. The change makes during this time is the *transient response* of the circuit.

$$Vc = Vs(1 - e^{\frac{-t}{RC}})$$

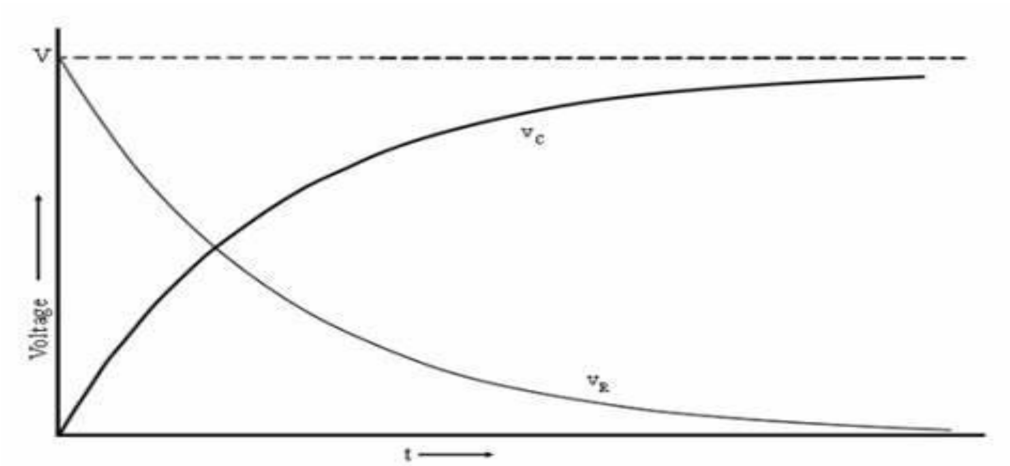

Fig: 6.2 b

VII Circuit diagram/ Layout of Laboratory

a) Actual circuit diagram used in Laboratory with related equipment ratings:

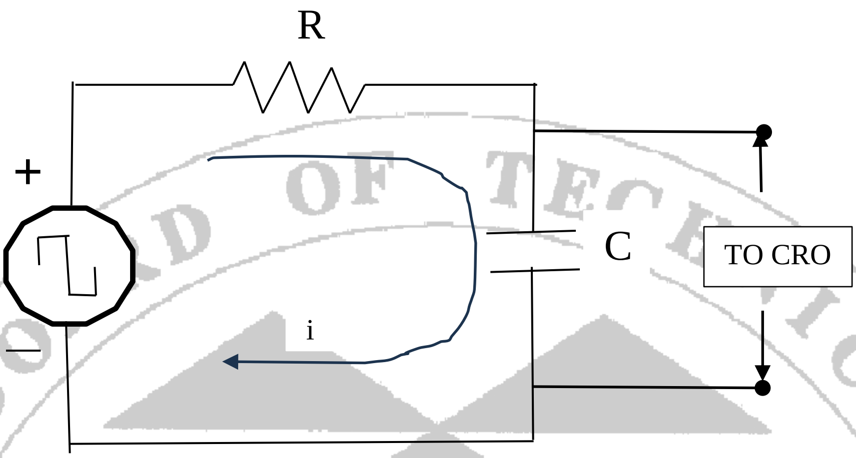

Fig 6.3: Actual circuit diagram

To verify our analysis, in the circuit of Figure 6.1, In order to reflect the notion of a time-varying circuit with a switch, the DC voltage source has been replaced with a rectangular pulse voltage source.

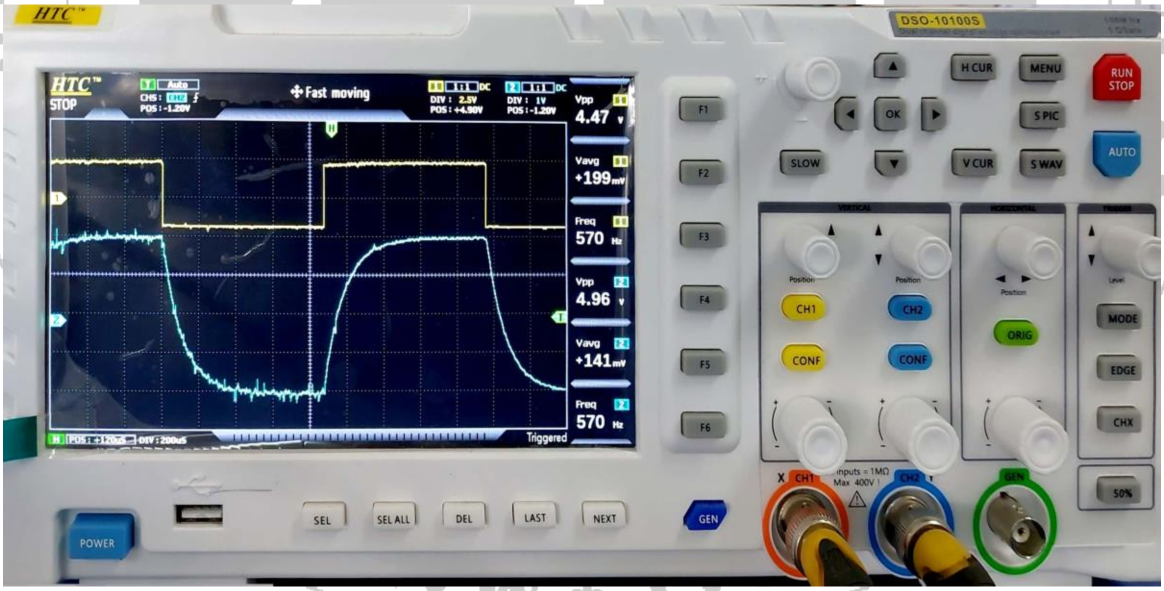

Fig 6.4: The waveform shown tracks the capacitor voltage

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistor	1kΩ (or any other suitable value)	1
2	Capacitor	0.1µF (or any other suitable value)	1
3	Signal Generator	Frequency : 0.1Hz ~ 5MHz ; Output waveforms : Sine, triangle, square, positive and negative pulse	1
4	Digital Storage Oscilloscope	2 and 4 analog channel models 100 and 70 MHz bandwidth models Up to 1 GS/s sampling rate.	1
5	Bread Board		1

IX Precautions to be followed

a. Check the connections before connecting circuit to supply.
b. Select proper values of the resistors and inductor.

X Procedure

1. Identify the components as per the resources required.
2. Connect the circuit as shown in figure 6.3 on breadboard.
3. Select a square wave signal on signal generator.
4. Connect the signal generator to resistor as an input. Switch on the Supply.
5. Observe the response across capacitor on DSO or CRO as shown in fig 6.4.
6. Switch off the supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
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XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

(Note: Refer the waveform shown in theoretical background)

1. Voltage at the end of transient response =
2. Time period of transient response =
3. Voltage of steady state response =
4. Time period of steady state response =

XIV Result(s)

1. Voltage at the end of transient response =
2. Time period of transient response =
3. Voltage of steady state response =
4. Time period of steady state response =

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Can we perform the experiment using AC supply? Justify your answer.
2. Derive the equation for voltage across capacitor of a series RC circuit.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. " A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. www.khanacademy.org/science/electrical-engineering/ee-circuit-analysis-topic/ee-natural-and-forced-response
3. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.7: Measure current through different branch of network and voltage across given element of the circuit and verify it by applying Superposition theorem.

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current, voltage & power across a branch is required. These parameters of the circuit can be calculated using Superposition theorem. This experiment will help you to verify the theoretically obtained current through a branch using Superposition theorem.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Use various network theorems to calculate circuit parameters**.**

IV Laboratory Learning Outcome(s)

LLO 7.1 Measure the voltage and current of the given circuit.
LLO 7.2 Verify Superposition theorem.

V Relevant Affective Domain related outcome(s)

a. Follow safe practices..
b. Maintain tools and equipment properly.
c. Observe step by step sequence of operation.

VI Relevant Theoretical Background

Superposition theorem states that; "In a network of linear resistances containing more than one generator (or source of emf), the current which flows at any point is the sum of all the currents which would flow at that point if each supply were considered separately and all the other supplies are replaced for time being by resistances equal to their internal resistances."

VII Circuit diagram/ Layout of Laboratory

a) Sample circuit :

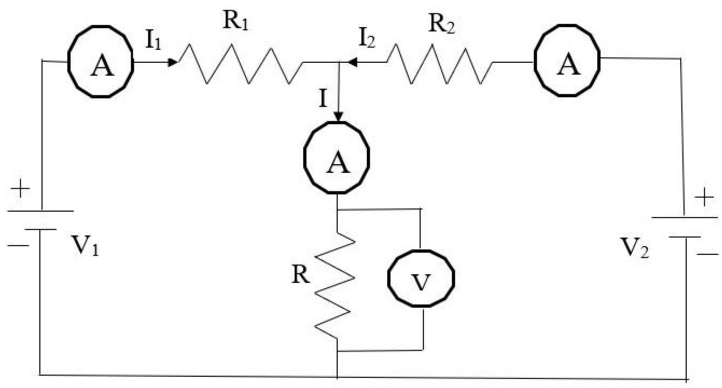

Fig 7.1: Sample circuit

b) Actual circuit diagram used in Laboratory with related equipment ratings :

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistances	Any suitable values available in the lab	3
2	Bread Board		1
3	DC voltage source	0 – 30 V, 1 Amp	2
4	Ammeter	0 – 1 Amp	3
5	Voltmeter	As per the requirement	1

IX Precautions to be followed

a. Check the connections before connecting circuit to supply.
b. Select proper values of the resistors and power supply.

X Procedure

1. Connect the circuit as shown in figure 7.1
2. Initially keep both the supplies switch off.
3. Switch on the supply V_1.
4. Read current value of I_1 and I using ammeter.
5. Switch off the supply.
6. Switch on the other supply V_2.
7. Read current value of I_2 and I using ammeter.
8. Switch off the supply
9. Switch on both supplies measure current I.
10. Measure the voltage across resistor R.
11. Switch off the supply

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

Table no: 7.1

Sr No	I_1 (A)	I_2 (A)	$I_1 + I_2$	I (A)
1				
2				

Calculations: Determine the current through the resistor R using Superposition theorem

XIV Result(s)

1. Calculated value of current through branch $I = I_1 + I_2$ = ...
2. Observed value of current through branch I = ...

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Can we perform the experiment using AC supply? Justify your answer.
2. In the above circuit shown in figure 7.1 calculate current in each branch and voltage across resistor R using Superposition theorem.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.8: Measure short circuit current and Norton's resistance of the given circuit and verify it using Norton's theorem.

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current, voltage & power across a branch is required. These parameters of the circuit can be calculated using Norton's theorem. This experiment will help you to verify the theoretically obtained current through a branch using Norton's theorem.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Use various network theorems to calculate circuit parameters.

IV Laboratory Learning Outcome(s)

LLO 8.1 Measure load current of the given circuit.
LLO 8.2 Verify **Norton'** theorem.

V Relevant Affective Domain related outcome(s)

a. Maintain tools and equipment properly.
b. Observe step by step sequence of operations.

VI Relevant Theoretical Background

Norton's theorem states that; "Any two terminal active network containing voltage sources and resistance, when viewed from its output terminals, is equivalent to a constant current source and a parallel resistance. The constant current is equal to the current which would flow in a short circuit placed across the terminals and parallel resistance is the resistance of the network when viewed from these open circuited terminals after all voltage and current sources have been removed and replaced by their internal resistances."

Steps to solve :-

1) Remove the resistances (if any) across the two given terminals and put a short circuit across them.
2) Compute the short circuit current I_{sc}.
3) Remove all voltage sources, keeping their internal resistances(if any). Similarly remove all current sources and replace them by open circuit.
4) Next find the resistance R_N of the network as looked into from the given terminals.
5) The current source I_{SC} joined in parallel across R_N between the two terminals gives Norton's equivalent circuit.

VII Circuit diagram/ Layout of Laboratory

a) Sample circuit:

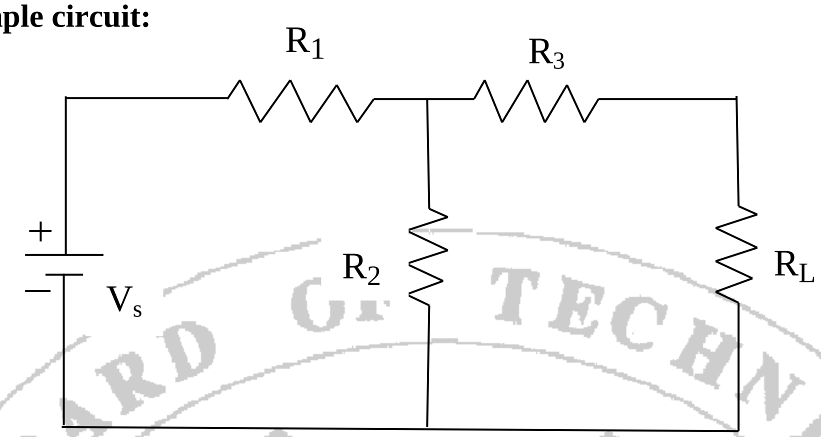

Fig 8.1: Sample circuit

To measure resistance R_N :

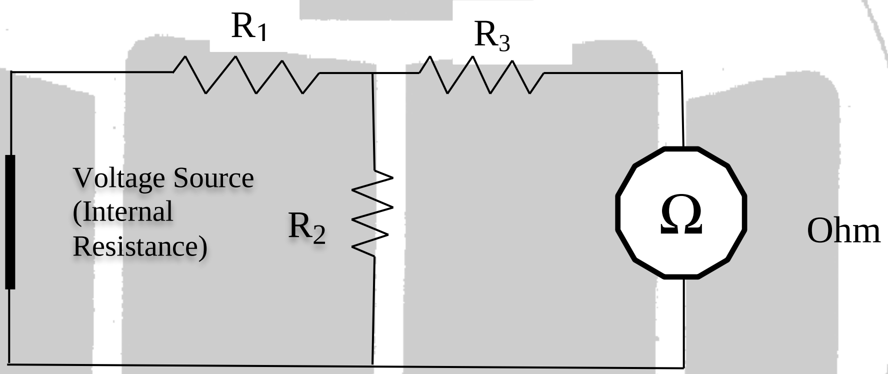

Fig 8.2: To measure resistance R_N

To find Norton's Equivalent current I_N:

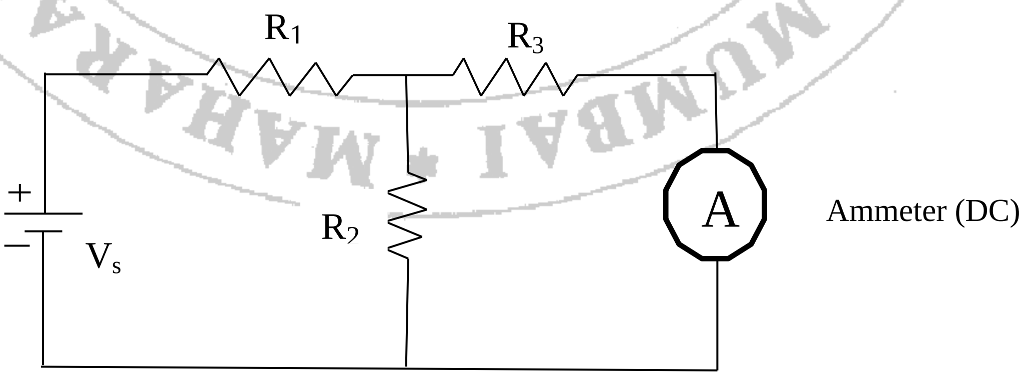

Fig 8.3 To measure resistance I_N

b) Actual circuit diagram used in Laboratory with related equipment ratings :

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistances	Any suitable values available in the lab	3
2	Bread Board		1
3	DC voltage source	0 – 30 V, 1 Amp	1
4	Ammeter	0 – 1 Amp	1
5	Multimeter	Set on Ohmmeter settings	1

IX Precautions to be followed

a. Check the connections before connecting circuit to supply.
b. Select proper values of the resistors and power supply.

X Procedure

1. Remove the resistance through which current is to be found out.
2. Replace the source by internal resistance i.e. voltage source by short circuit.
3. Measure the resistance across open terminals, R_N.
4. Replace the resistance through which current is to be found out, with an ammeter.
5. Switch on the supply.
6. Note down the reading of the ammeter I_N i.e. across removed resistance terminals.
7. Switch off the supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
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XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

Table no: 8.1

Sr No	Supply Voltage	I_N (Observed)	I_N (Calculated)	R_N

Calculations: Determine the current through the load resistor R_L using Norton's theorem

XIV Result(s)

1. Norton's equivalent current I_N = ……………………….
2. Norton's equivalent resistance R_N = ……………………….

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Can we perform the experiment using AC supply? Justify your answer.
2. In the above circuit shown in figure 8.1 calculate current in load resistor R_L using Norton's theorem.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.9: Measure open circuit voltage and Thevenin's resistance of the given circuit and verify it using Thevenin's theorem.

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current, voltage & power across a branch is required. These parameters of the circuit can be calculated using Thevenin's theorem. This experiment will help you to verify the theoretically obtained voltage across a load resistance using Thevenin's theorem.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Use various network theorems to calculate circuit parameters.

IV Laboratory Learning Outcome(s)

LLO 9.1 Measure load current of the given circuit.
LLO 9.2 Verify Thevenin's theorem.

V Relevant Affective Domain related outcome(s)

a. Maintain tools and equipment properly.
b. Observe step by step sequence of operations.

VI Relevant Theoretical Background

Thevenin's theorem states that; "Any linear, bilateral network having terminals A & B can be replaced by a single source of e.m.f. , V_{TH} in series with a single resistance, R_{TH} which is the voltage obtained across the terminals A and B with load, if any removed. The resistance R_{TH} is the resistance of the network measured between terminals A and B with load removed and sources of e.m.f. replaced by their internal resistances. Ideal voltage sources removed with short circuits and ideal current sources replaced with open circuit."

Steps to solve:-

1) Temporarily remove the resistance called load resistance across which current is to be measured.
2) Find the open circuit voltage V_{OC} which appears across the two terminals from where resistance has been removed. It is also called as Thevenin's voltage V_{TH}.
3) Compute the resistance of the network as looked into from these two terminals after all voltage sources has been removed leaving behind their internal resistances (if any) and current sources have been replaced by open circuit, that is infinite resistance. It is also called as Thevenin's resistance R_{TH}.
4) Replace the entire network by single Thevenin source, whose voltage is V_{TH} and internal resistance is R_{TH} .
5) Connect R_L back to its terminals from where it was previously removed.

6) Finally calculate the current flowing through R_L by using the equation; $I = \frac{Vth}{(Rth+RL)}$

VII Circuit diagram/ Layout of Laboratory

a) Sample circuit:

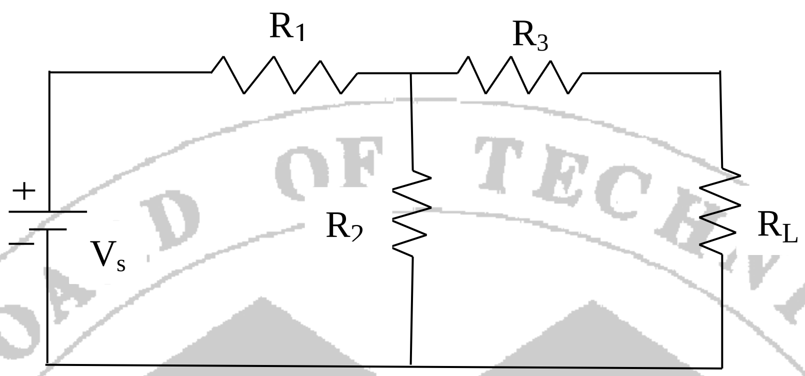

Fig 9.1 Sample circuit

b) To measure resistance R_{TH} :

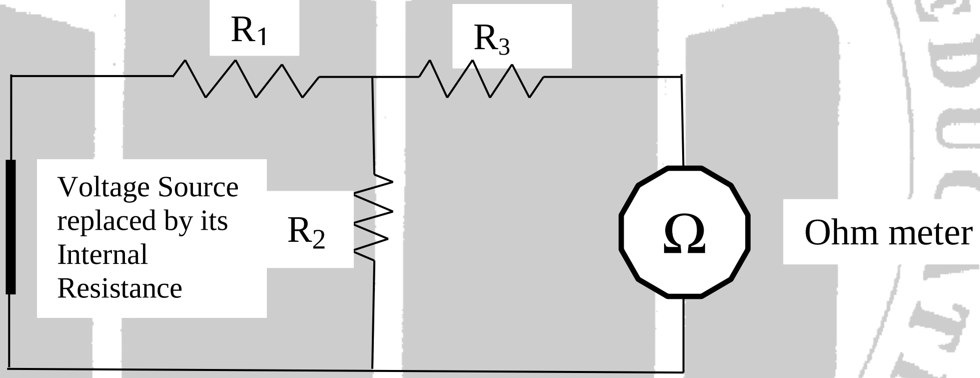

Fig 9.2 To measure resistance R_{TH}

c) To measure Thevenin's Equivalent voltage V_{TH} :

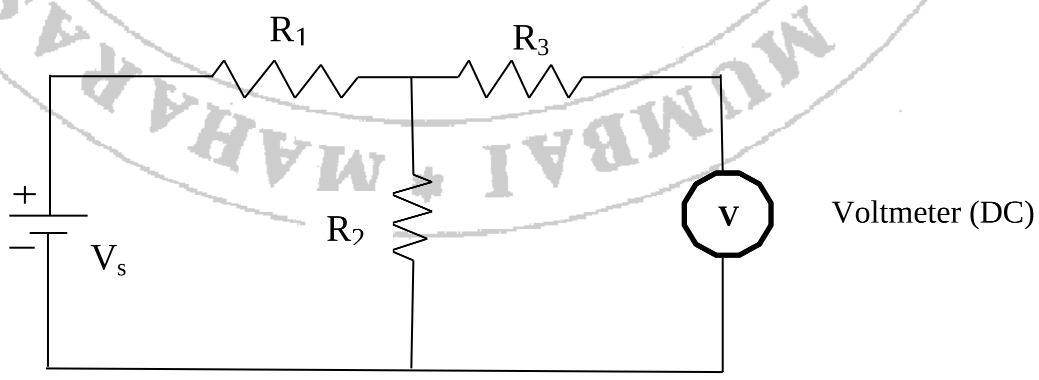

Fig 9.3: To measure resistance V_{TH}

d) Actual circuit diagram used in Laboratory with related equipment ratings:

VIII Required Resources/apparatus/equipments with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistances	Any suitable values available in the lab	3
2	Bread Board		1
3	DC voltage source	0 – 30 V, 1 Amp	1
4	Ammeter	0 – 1 Amp	1
5	Multimeter	Set on Ohmmeter rating	1

IX Precautions to be followed

a. Check the connections before connecting circuit to supply.

b. Select proper values of the resistors and power supply.

X Procedure

1. Remove the resistance through which current is to be found out.
2. Connect a DC power supply as shown in the circuit diagram.
3. Using multi meter measure voltage across the open terminals V_{TH} i.e. removed resistance terminals.
4. Switch off the supply.
5. Replace the source by internal resistance i.e. voltage source by short circuit.
6. Measure the resistance across open terminals, R_{TH}.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

Table no: 9.1

Sr No	Supply Voltage	V_{TH} (Observed)	V_{TH} (Calculated)	R_{TH}
1				
2				

Calculations: Determine the current through the load resistor R_L using Thevenin's theorem

XIV Result(s)

1. Thevenin's equivalent voltage V_{TH} = ……………………….
2. Thevenin's equivalent resistance R_{TH} = ……………………….

XV Interpretation of results

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XVI XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Can we perform the experiment using AC supply? Justify your answer.
2. In the above circuit shown in figure 8.1 calculate current in load resistor R_L using Thevenin's theorem.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. “A Textbook of Electrical Technology” Vol-I, Theraja B L, Theraja A K
2. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.10: Vary load resistance to transfer Maximum power in the given circuit using Maximum Power Transfer theorem.

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current, voltage & power across a branch is required. Maximum power transfer theorem is useful to make the circuit efficient, so the power loss will be minimum compared to power transferred.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Use various network theorems to calculate circuit parameters.

IV Laboratory Learning Outcome(s)

LLO 10.1: Verify Maximum Power Transfer Theorem and calculate current, voltage and power.

V Relevant Affective Domain related outcome(s)

a. Maintain tools and equipment
b. Note the reading carefully

VI Relevant Theoretical Background

As applied to DC networks, Maximum Power Transfer Theorem states that "A resistive load will abstract maximum power from a network when the load resistance is equal to the resistance of the network as viewed from the output terminals, with all energy sources removed leaving behind their internal resistances."

VII Circuit diagram/ Layout of Laboratory

a) Sample circuit:

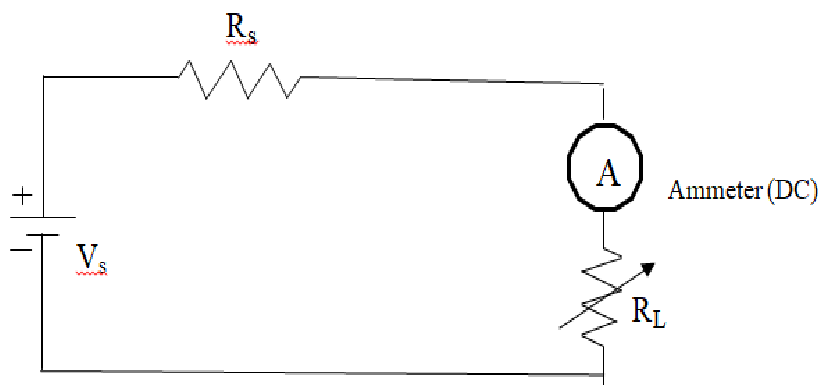

Fig 10.1: Sample circuit

b) Actual circuit diagram used in Laboratory with related equipment ratings:

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistance	Any suitable values available in the lab	1
2	Bread Board		1
3	DC voltage source	0 – 30 V, 1 Amp	1
4	Ammeter	0 – 1 Amp	1
5	Variable Resistor(Potentiometer)	Required range as per the resistance taken	1

IX Precautions to be followed

1. Keep the resistances at maximum position
2. Check the connection before connecting circuit to supply
3. Apply voltage as per rating of the resistors, ammeter

X Procedure

1. Connect the circuit as shown in figure 10.1 on breadboard.
2. Select the position of potentiometer slightly greater than the minimum value.
3. Switch on the supply.
4. Measure the current flowing through load.
5. Switch off the supply.
6. Measure the value of load resistance.
7. Repeat the above steps by varying the load resistance (potentiometer).

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

Table no: 10.1

Sr. No.	Supply Voltage	Internal resistance R_S	Current I	Load resistance R_L	Power delivered to load = I^2R_L
1					
2					
3					
4					
5					

Calculations: Calculated Power = I^2R_L

XIV Result(s)

1. Maximum power transferred = …………….Watts
2. Value of load resistance corresponding to maximum power = …………. Ω

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. List out conditions for maximum power transfer.
2. In the following circuit of Fig 10.2 , find the value of R_L such that maximum possible power will be transferred to R_L.

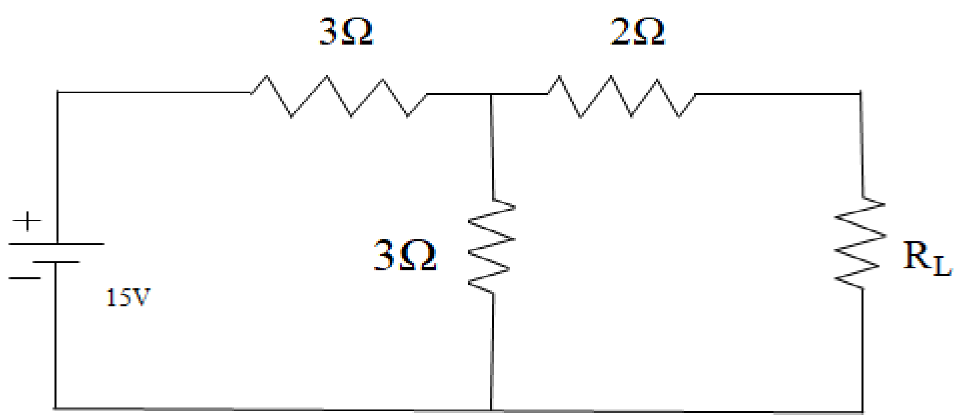

Fig 10.2

[Space for Answers]

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XVIII References/Suggestions for further reading

1. " A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K

2. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	**Weigh tage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.11: Measure voltage to current ratio before and after interchanging the position of voltage source and current in the given circuit to verify Reciprocity theorem.

I Practical Significance

The Electrical & Electronic circuit for different systems involves a number of branches. Many a times as per the requirement, measurement of current, voltage & power across a branch is required. Reciprocity theorem provides convenience of converting voltage response into current response & vice versa.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Use various network theorems to calculate circuit parameters**.**

IV Laboratory Learning Outcome(s)

LLO 11.1:Verify the concept of interchangeability of sources and detectors in the given circuit.

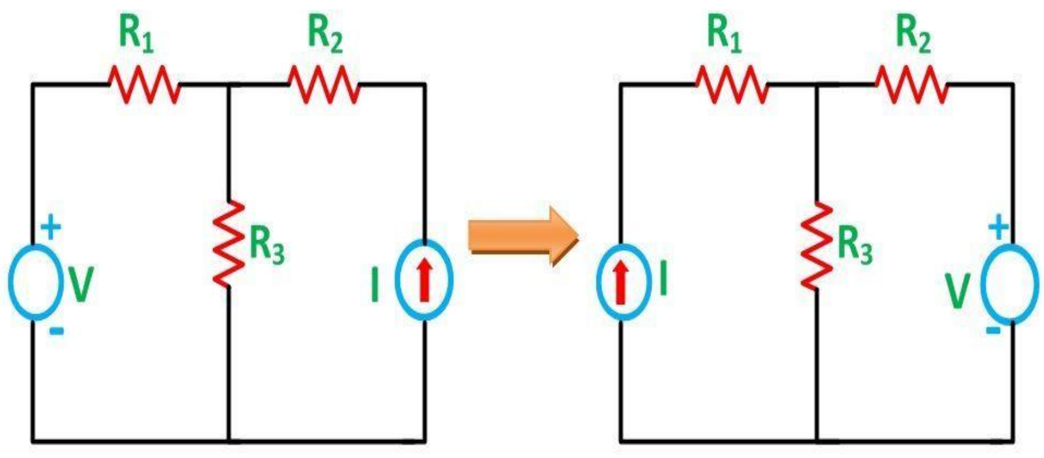
V Relevant Affective Domain related outcome(s)

a. Carefully interchange the place of devices.

VI Relevant Theoretical Background

Reciprocity theorem can be stated as " In any linear, bilateral network, if a source of emf V in any branch produces a current I in any other branch, then the same emf V acting in the second branch would produce the same current I in the first branch."

It means that V and I are mutually transferable. The ratio V/I is known as transfer resistance.



Courtesy: Circuit Globe

Fig 11.1: bilateral network

VII Circuit diagram/ Layout of Laboratory

a) Sample circuit:

A) First case:

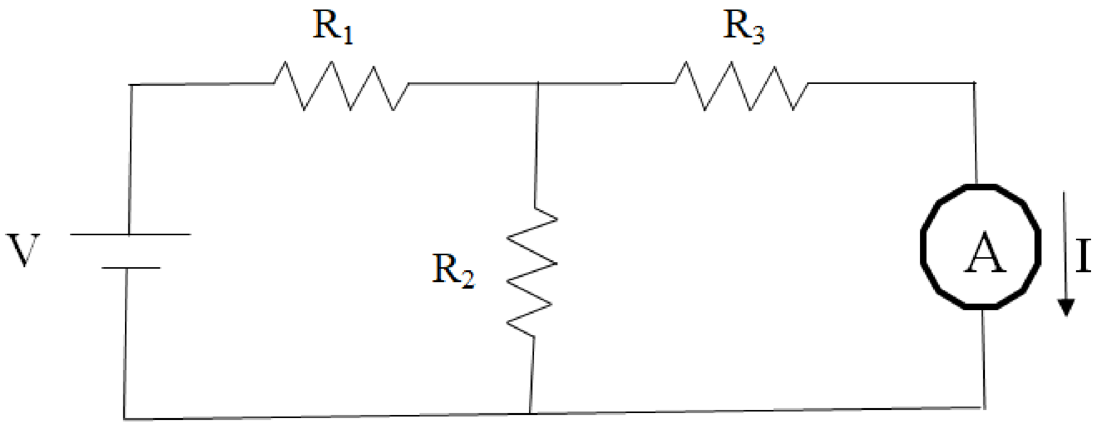


Fig 11.2: Sample circuit- case 1

B) Second case:

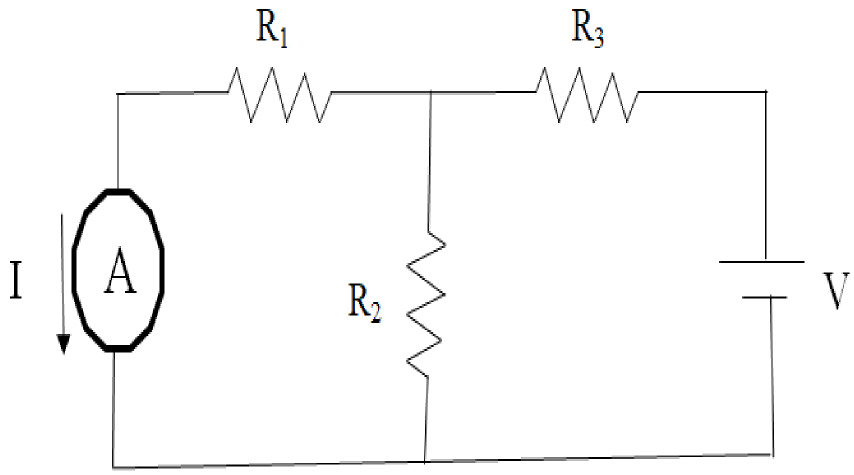


Fig 11.3 Sample circuit- case 2

b) Actual circuit diagram used in Laboratory with related equipment ratings:

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistance	Any suitable values available in the lab	3
2	Bread Board		1
3	DC voltage source	0 – 30 V, 1 Amp	1
4	Ammeter	0 – 1 Amp	1

IX **Precautions** to be followed

1. Keep the resistances at maximum position
2. Check the connection before connecting circuit to supply
3. Apply voltage as per rating of the resistors, ammeter

X Procedure

1. Connect the circuit on breadboard as shown in figure 11.2
2. Switch on the supply.
3. Read current flowing through resistor R_3 using ammeter.
4. Switch off the supply.
5. Connect the circuit on breadboard as shown in figure 11.3
6. Switch on the supply again.
7. Read the current flowing through resistor R_1 using ammeter.
8. Switch off the supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
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XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

Table no: 11.1

Sr. No.	Supply Voltage	Current I	
		As shown in Figure 11.1	As shown in Figure 11.2
1			
2			

Calculations: In the given network, calculate

a) Ammeter current for circuit connected as figure 11.1

b) Ammeter current for circuit connected as figure 11.1

c) Calculate Transfer Resistance = V/I

XIV Result(s)

1. Current Observed = ……………Amp
2. Current calculated = …………Amp
3. Transfer Resistance = ……….Ω

XV Interpretation of results

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XVI Conclusion and recommendation

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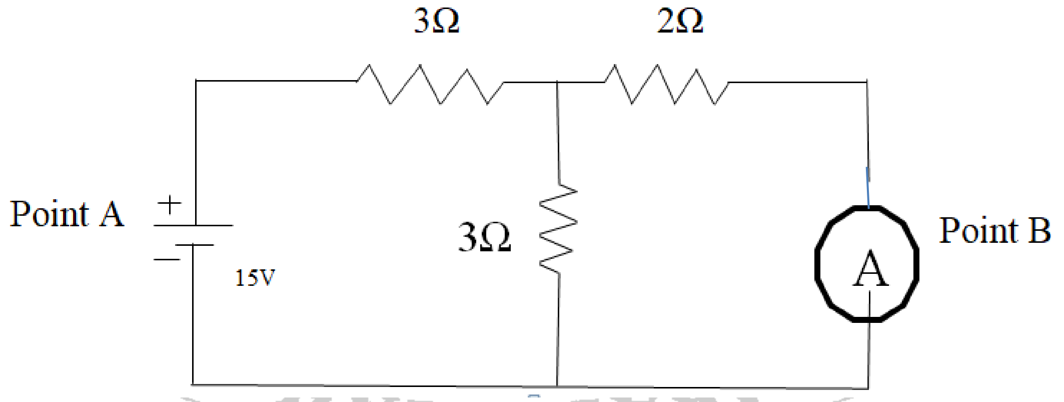
XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Can we perform the experiment with A.C. supply also? Justify.
2. In the given network, find a) Ammeter current when battery is at point A and Ammeter at point B. b) Ammeter current when battery is at point B and Ammeter at point A. c) Transfer Resistance.



[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K

2. https://www.nptelvideos.com/course.php?id=462,NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	**Weigh tage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.12: Measure input and output voltages and currents of the given two port network and calculate open circuit (Z) parameters for the given circuit.

I Practical Significance

A two port network is an electric circuit with two input ports & two output ports. The examples of two port network are bridge circuits, filters, transformers, etc. At the input terminals the external signals are fed & are transmitted through the network to the output terminals. It is useful in determining the performance of the circuit network & design filters. Z parameters represent the circuit performance.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Determine the circuit parameters of two port network**.**

IV Laboratory Learning Outcome(s)

LLO 12.1 Calculate input and output impedances of given network.
LLO 12.2 Interpret the Z-parameters matrix.

V Relevant Affective Domain related outcome(s)

To designate terminals of a port

VI Relevant Theoretical Background

Two port network is a pair of two terminal electrical network in which, current enters through one terminal and leaves through another terminal of each port. Two port network representation is shown in the following figure 12.1.

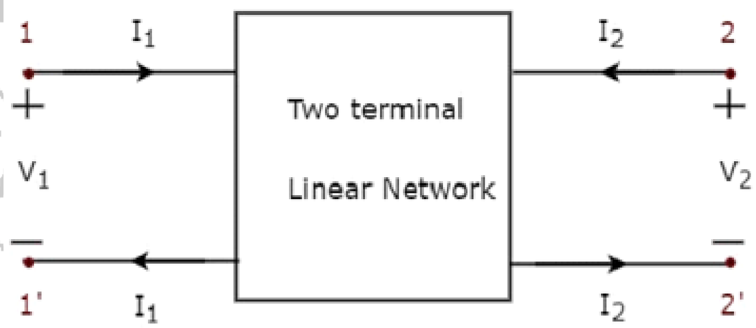

Fig 12.1 Two port network

Here, one pair of terminals, 1 & 1’ represents one port, which is called as port1 and the other pair of terminals, 2 & 2’ represents another port, which is called as port2. There are four variables V1, V2, I1 and I2 in a two port network as shown in the figure.

Open circuit Z parameters:-

V= I*R

[V] = [Z] [I]

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

By solving the above matrix

$$V_1 = Z_{11} I_1 + Z_{12} I_2$$

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

The **Z** parameters are

$$Z_{11} = \frac{V_1}{I_1} \text{ when } I_2 = 0$$

$$Z_{12} = \frac{V_1}{I_2} \text{ when } I_1 = 0$$

$$Z_{21} = \frac{V_2}{I_1} \text{ when } I_2 = 0$$

$$Z_{22} = \frac{V_2}{I_2} \text{ when } I_1 = 0$$

Z parameters are called as impedance parameters because these are simply the ratios of voltages and currents. Units of Z parameters are Ohm (Ω).We can calculate two Z parameters, Z_{11} and Z_{21}, by doing open circuit of port2. Similarly, we can calculate the other two Z parameters, Z_{12} and Z_{22} by doing open circuit of port1. Hence, the Z parameters are also called as open-circuit impedance parameters.

VII Circuit diagram/ Layout of Laboratory

a) Sample circuit:

A) First case:

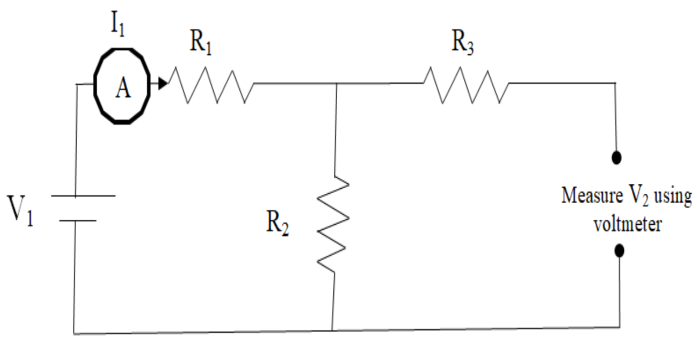

Fig 12.2 Sample circuit- case 2

B) Second case:

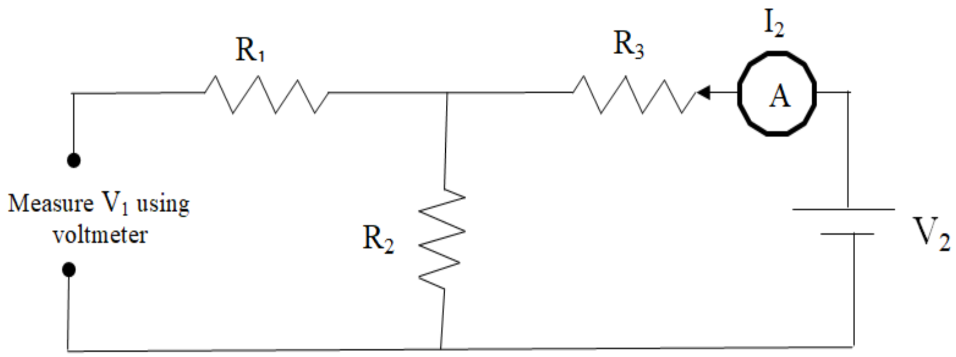

Fig 12.3 Sample circuit- case 2

b) Actual circuit diagram used in Laboratory with specification of equipments:

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistance	Any suitable values available in the lab	3
2	Bread Board		1
3	DC voltage source	0 – 30 V, 1 Amp	1
4	Ammeter	0 – 1 Amp	1
5	Voltmeter		1

IX Precautions to be followed

1. Keep the resistances at maximum position
2. Check the connection before connecting circuit to supply
3. Apply voltage as per rating of the resistors, ammeter

X Procedure

1. Connect the circuit on breadboard as shown in figure 12.2
2. Switch on the supply.
3. Measure the voltage across terminal 2 (V_2)
4. Read ammeter reading for I_1
5. Switch off the supply.
6. Connect the circuit on breadboard as shown in figure 12.3
7. Switch on the supply.
8. Measure the voltage across terminal 1 (V_1)
9. Read ammeter reading for I_2

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

a) Case 1 : When $I_2 = 0$

Table no: 12.1

Sr No	V_1	V_2	I_1
1			
2			

b) Case 2 : When $I_1 = 0$

Table no: 12.2

Sr No	V_1	V_2	I_2
1			
2			

Calculations: In the given network, calculate

a) $Z_{11} = \frac{V_1}{I_1}$ when $I_2 = 0$

b) $Z_{12} = \frac{V_1}{I_2}$ when $I_1 = 0$

c) $Z_{21} = \frac{V_2}{I_1}$ when $I_2 = 0$

d) $Z_{22} = \frac{V_2}{I_2}$ when $I_1 = 0$

XIV Result(s)

1. Z_{11} = ……………. Ω
2. Z_{12} = ……………. Ω
3. Z_{21} = ……………. Ω
4. Z_{22} = ……………. Ω

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Can we find the values of Z parameters without supply.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	**Weigh tage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.13: Measure input and output voltages and currents of the given two port network and calculate short circuit (Y) parameters for the given circuit.

I Practical Significance

A two port network is an electric circuit with two input ports & two output ports. The examples of two port network are bridge circuits, filters, transformers, etc. At the input terminals the external signals are fed & are transmitted through the network to the output terminals. It is useful in determining the performance of the circuit network & design filters. Y parameters represent the circuit performance.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Determine the circuit parameters of two port network**.**

IV Laboratory Learning Outcome(s)

LLO 13.1 Calculate Y parameters of given network.

LLO 13.2 Interpret the Y-parameters matrix.

V Relevant Affective Domain related outcome(s)

To designate terminals of a port

VI Relevant Theoretical Background

Two port network is a pair of two terminal electrical network in which, current enters through one terminal and leaves through another terminal of each port. Two port network representation is shown in the following figure.

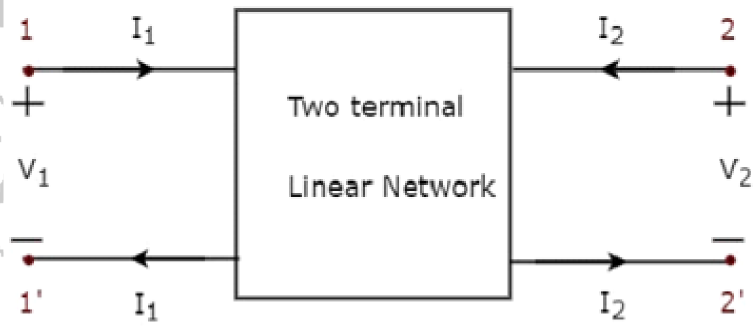

Fig 13.1 Two port network

Here, one pair of terminals, 1 & 1' represents one port, which is called as port1 and the other pair of terminals, 2 & 2' represents another port, which is called as port2.There are four variables V1, V2, I1 and I2 in a two port network as shown in the figure

Short circuit Y parameters:-

$$V = I*R$$

$$[V] = [Z]\,[I]$$

As $Y = \frac{1}{Z}$ we can rewrite the above equation as;

$$[I] = [Y]\,[V]$$

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

By solving the above matrix

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

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

The Y parameters are

$$Y_{11} = \frac{I_1}{V_1} \text{ when } V_2 = 0$$

$$Y_{12} = \frac{I_1}{V_2} \text{ when } V_1 = 0$$

$$Y_{21} = \frac{I_2}{V_1} \text{ when } V_2 = 0$$

$$Y_{22} = \frac{I_2}{V_2} \text{ when } V_1 = 0$$

Y parameters are called as admittance parameters because these are simply, the ratios of currents and voltages. Units of Y parameters are mho.

We can calculate two Y parameters, Y_{11} and Y_{21} by doing short circuit of port2. Similarly, we can calculate the other two Y parameters, Y_{12} and Y_{22} by doing short circuit of port1. Hence, the Y parameters are also called as short-circuit admittance parameters.

VII VII Circuit diagram/ Layout of Laboratory

c) Sample circuit:

A) First case:

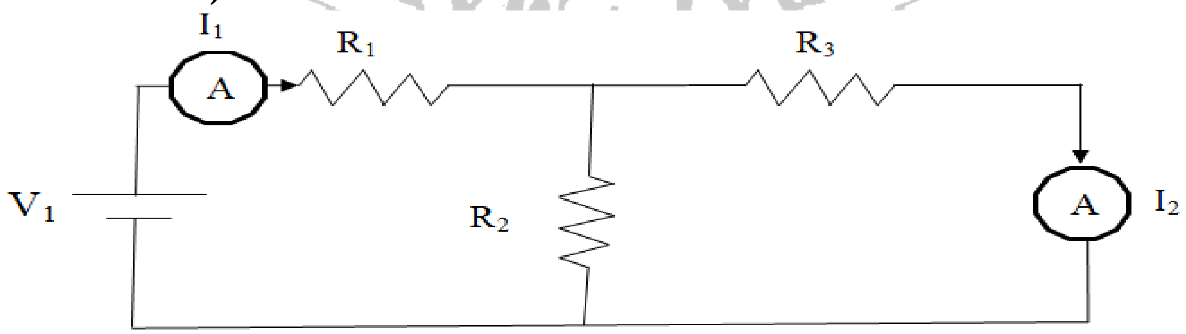

Fig 13.2 Sample circuit- case 1

B) Second case:

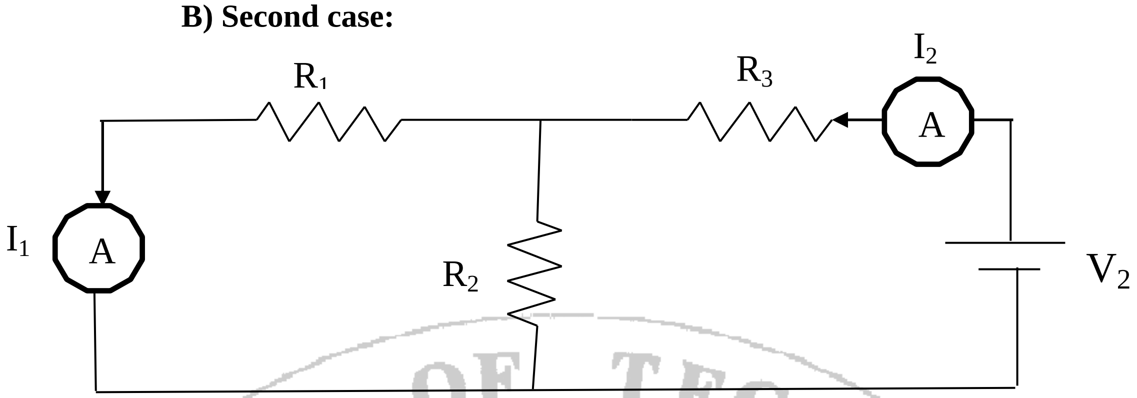

Fig 13.3 Sample circuit- case 2

d) Actual circuit diagram used in Laboratory with specifications of equipment:

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistance	Any suitable values available in the lab	3
2	Bread Board		1
3	DC voltage source	0 – 30 V, 1 Amp	1
4	Ammeter	0 – 1 Amp	1

IX Precautions to be followed

1. Keep the resistances at maximum position
2. Check the connection before connecting circuit to supply
3. Apply voltage as per rating of the resistors, ammeter

X Procedure

1. Connect the circuit on breadboard as shown in figure 13.2
2. First short the output terminals & connect the 5V supply to Input terminals.
3. Read ammeter reading for I1
4. Read ammeter reading for I2

5. Switch off the supply
6. Connect the circuit on breadboard as shown in figure 13.3
7. Short the input terminals & connect the 5V supply Output terminals.
8. Read ammeter reading for I1
9. Read ammeter reading for I2
10. 10. Switch off the supply.

XI XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

a) Case 1 : When $V_2 = 0$

Table no: 13.1

Sr No	V_1	I_1	I_2
1			
2			

b) Case 2 : When $V_1 = 0$

Table no: 13.2

Sr No	V_2	I_1	I_2
1			
2			

Calculations: In the given network, calculate

e) $Y_{11} = \frac{I_1}{V_1}$ when $V_2 = 0$

f) $Y_{12} = \frac{I_1}{V_2}$ when $V_1 = 0$

g) $Y_{21} = \frac{I_2}{V_1}$ when $V_2 = 0$

h) $Y_{22} = \frac{I_2}{V_2}$ when $V_1 = 0$

XIV Result(s)

5. Y_{11} = ……………. Ω
6. Y_{12} = ……………. Ω
7. Y_{21} = ……………. Ω
8. Y_{22} = ……………. Ω

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Can we find the values of Y parameters without supply.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.14: Measure input and output voltages and currents of the given two port network and calculate transmission (ABCD) parameters for the given circuit.

I Practical Significance

A two port network is an electric circuit with two input ports & two output ports. The examples of two port network are bridge circuits, filters, transformers, etc. At the input terminals the external signals are fed & are transmitted through the network to the output terminals. It is useful in determining the performance of the circuit network & design filters. It is also known as transmission line parameters. They express voltage & current at output port in terms of those at input port. They are useful in determining the transmission line performance.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Determine the circuit parameters of two port network.

IV Laboratory Learning Outcome(s)

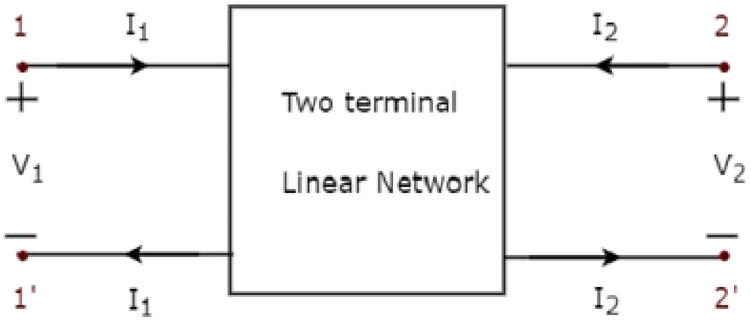
LLO 14.1 Calculate ABCD parameters of given network.
LLO 14.2 Interpret the ABCD-parameters matrix.

V Relevant Affective Domain related outcome(s)

To designate terminals of a port

VI Relevant Theoretical Background

Two port network is a pair of two terminal electrical network in which, current enters through one terminal and leaves through another terminal of each port. Two port network representation is shown in the following figure.



Here, one pair of terminals, 1 & 1' represents one port, which is called as port1 and the other pair of terminals, 2 & 2' represents another port, which is called as port2.There are four variables V1, V2, I1 and I2 in a two port network as shown in the figure.

Transmission ABCD parameters:-

$$V = I*R$$

The Transmission (ABCD) parameters can be represented in matrix format as follows;

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

By solving the above matrix

$$V_1 = AV_2 - B I_2$$

$$I_1 = C V_2 - D I_2$$

The **ABCD parameters** are

$$A = \frac{V_1}{V_2} \text{ when } I_2 = 0$$

$$B = -\frac{V_1}{I_2} \text{ when } V_2 = 0$$

$$C = \frac{I_1}{V_2} \text{ when } I_2 = 0$$

$$D = -\frac{I_1}{I_2} \text{ when } V_2 = 0$$

T parameters are called as transmission parameters or **ABCD parameters**. The parameters, **A** and **D** do not have any units, since those are dimension less. The units of parameters, **B** and **C** are ohm and mho respectively.

We can calculate two parameters, **A** and **C** by doing **open circuit of port2**. Similarly, we can calculate the other two parameters, **B** and **D** by **doing short circuit of port2**.

VII Circuit diagram/ Layout of Laboratory

a) Sample circuit:

A) First case: To calculate parameters, A and C by doing open circuit of port2 ($I_2 = 0$)

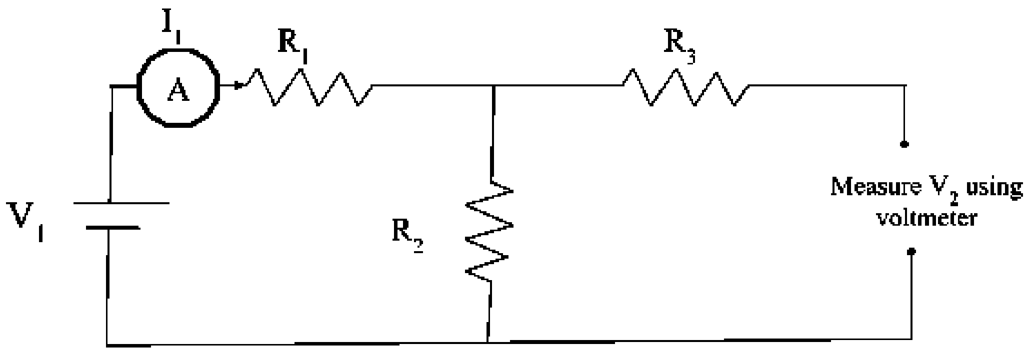


Fig 14.1 Sample circuit case -1

B) Second case: To calculate parameters, B and **D** by **doing short circuit of port2 ($V_2 = 0$)**.

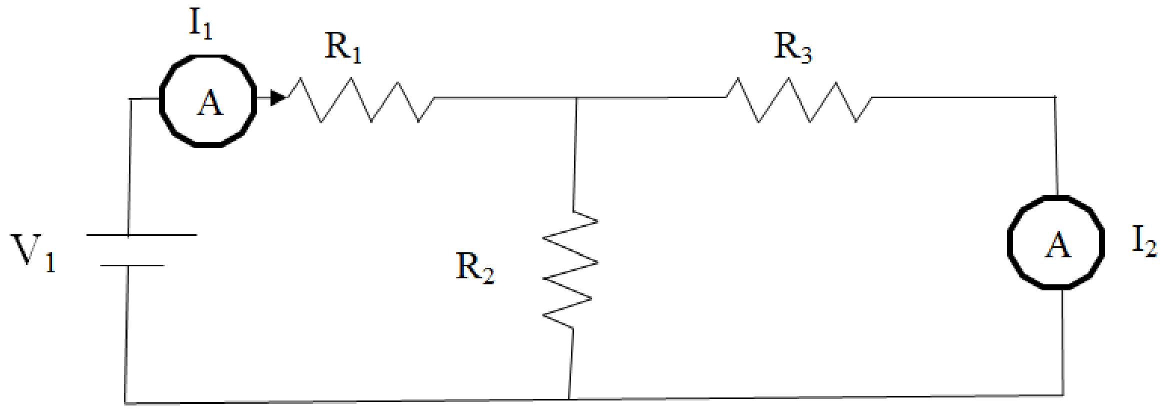


Fig 14.2 Sample circuit case -2

b) Actual circuit diagram used in Laboratory with specifications of equipment:

VIII Required Resources/apparatus/equipment with specification:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistance	Any suitable values available in the lab	3
2	Bread Board		1
3	DC voltage source	0 – 30 V, 1 Amp	1
4	Ammeter	0 – 1 Amp	1
5	Voltmeter		1

IX Precautions to be followed

1. Keep the resistances at maximum position
2. Check the connection before connecting circuit to supply
3. Apply voltage as per rating of the resistors, ammeter

X Procedure

1. Connect the circuit on breadboard as shown in figure 14.1
2. First keep the output terminals open & connect the 5V supply to Input terminal V_1.
3. Read ammeter reading for I_1.
4. Read voltmeter reading for V_2.
5. Switch off the supply.
6. Connect the circuit on breadboard as shown in figure 14.2
7. First short the output terminals & connect the voltmeter at port 2 to measure V2.
8. Connect 5V supply to Input terminals V_1.
9. Read ammeter reading for I_l.
10. Read ammeter reading for I_2.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

a) Case 1 : When $I_2 = 0$

Table no: 14.1

Sr No	V_1	V_2	I_1
1			
2			

b) Case 2 : When $V_2 = 0$

Table no: 14.2

Sr No	V_1	I_1	I_2
1			
2			

Calculations: In the given network, calculate

a) $A = \frac{V_1}{V_2}$ when $I_2 = 0$

b) $B = -\frac{V_1}{I_2}$ when $V_2 = 0$

c) $C = \frac{I_1}{V_2}$ when $I_2 = 0$

d) $D = -\frac{I_1}{I_2}$ when $V_2 = 0$

XIV Result(s)

1. A = …………….
2. B = ……………. Ω
3. C = ……………. mho
4. D = …………….

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more suchquestions so as to ensure the achievement of identifies CO.

1. Why we can call the network as transmission network
2. Can we perform the experiment with ac supply also? Justify.
3. Can we find the values without supply?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Textbook of Electrical Technology" Vol-I, Theraja B L, Theraja A K
2. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.

XIX Assessment Scheme

	Performance Indicators	**Weigh tage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.15: Develop RC low pass filter on breadboard and plot its frequency response.

I Practical Significance

Filters as the name suggests, they filter the frequency components. That means, they allow certain frequency components and / or reject some other frequency components. In this practical, we will see the frequency response of the electric circuits or networks having passive elements like resistor and capacitor which will pass the lower frequency ranges and will block the high frequencies, hence the circuit is known as Low Pass Filter.

II Industry/Employer Expected Outcome(s)

Measure & interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase AC circuits.

IV Laboratory Learning Outcome(s)

LLO 15.1 Construct low pass filter using R and C and interpret the frequency response of RC low pass filter.

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping.
b. Demonstrate working as a leader *and a* team member.
c. Maintain tools and equipment.
d. Observe step by step sequence of operations.

VI Relevant Theoretical Background

Low pass filter as the name suggests, it allows (passes) only low frequency components. That means, it rejects (blocks) all other high frequency components.

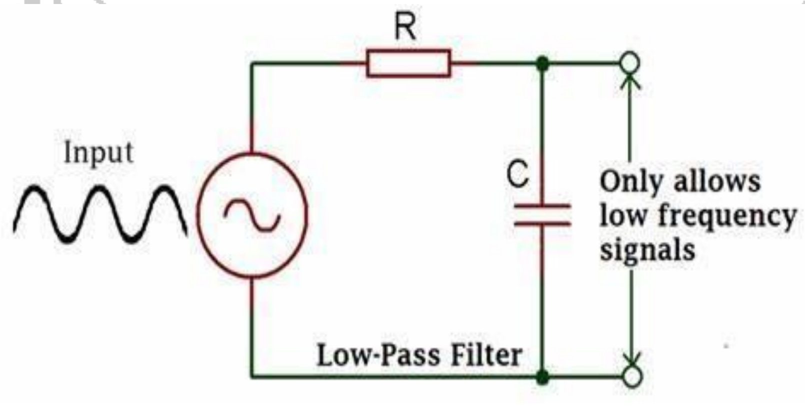

Fig 15.1 : Low pass filter

It consists of two passive elements resistor and capacitor, which are connected in series. Input voltage is applied across this entire combination and the output is considered as the voltage across capacitor. Resistor is independent to the variations of the applied frequencies in the circuit but capacitor is a sensitive component that means it responds to the changes in the frequency of input signal. The capacitive reactance is inversely proportional to the frequency applied to the circuit. The resistive value of the resistor is stable whereas the capacitive reactance value varies. This means at low frequencies the voltage drop is small and the voltage potential is large but at high frequencies the voltage drop is very high and the voltage potential is less.

Frequency Response of Low Pass Filter

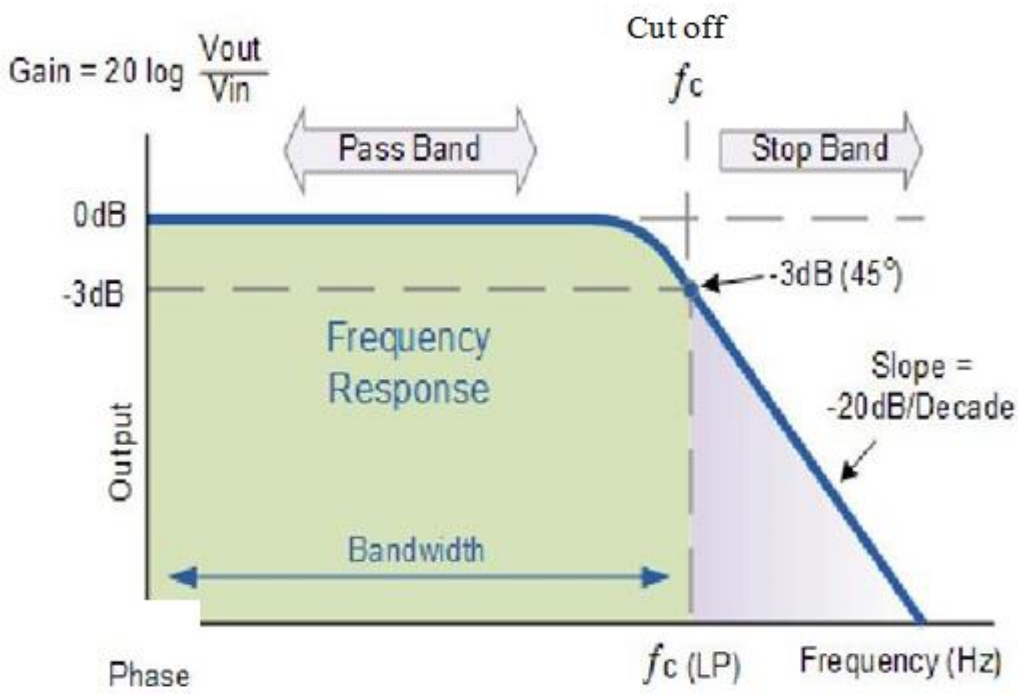

Image courtesy: www.bing.com

Fig 15.2 : Frequency response of Low pass filter

The frequency response of a low pass filter is the response between the frequency of applied signal versus the gain in dB i.e. 20 log (V_{out} / V_{in}). The band of frequencies below the cut off region is referred as 'Pass Band' and the band of frequencies after the cut off frequency are referred as 'Stop Band'. From the plot it can be observed that the pass band is the Bandwidth of the filter.

Cut-off frequency of a passive low pass filter mainly depends on the resistor and capacitor values used in filter the circuit.This cut-off frequency is inversely proportional to both resistor and capacitor values. The cut-off frequency of a passive low pass filter is given as

$f_C = 1/(2\pi RC)$

VII Circuit diagram/ Layout of Laboratory

a) **Sample circuit:**

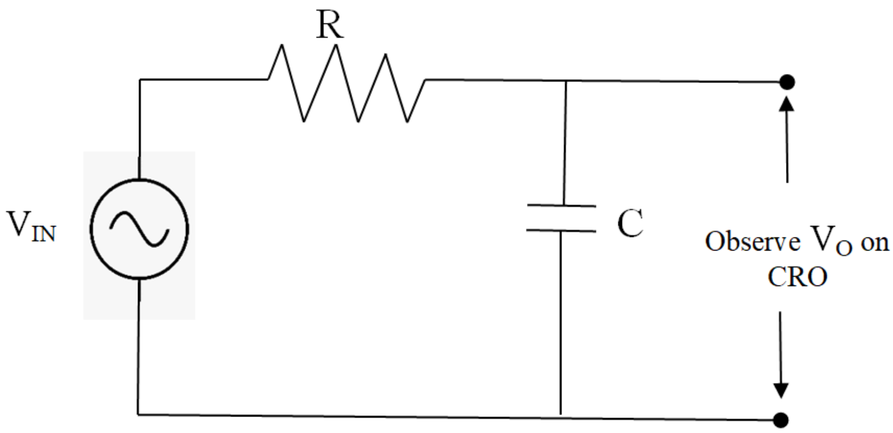

Fig 15.3 Sample circuit

b) Actual circuit diagram used in Laboratory with specifications of equipment:

VIII Required Resources/apparatus/equipment with specifications:

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistor	Any suitable values available in the laboratory in the range of KΩ	1
2	Capacitor	Any suitable values available in the laboratory in the range of µF	1
3	Bread Board		1
4	Signal generator	Frequency : 0.1Hz ~ 5MHz ; Output waveforms : Sine, triangle, square, positive and negative pulse	1
5	CRO or DSO	As available in the laboratory	1

IX Precautions to be followed

1. Select the values of resistor and capacitor as per requirement.
2. Check the connection before connecting circuit to supply

X Procedure

1. Connect the circuit on breadboard as shown in figure 15.1
2. Set the value of input voltage and note down.
3. Keep the frequency of the input signal at 100Hz.
4. Observe the output voltage on CRO.
5. Vary the value of frequency from 100Hz to 1MHz in steps and note down the respective values of output voltage.
6. Switch off the signal generator and CRO.
7. Plot the response of input frequency vs gain in dB on semilog paper.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
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XII Actual Procedure

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XIII Observations and Calculations

Observation Table:

V_{IN} = …………. V

Table no:15.1

Sr No	Input Frequency	V_{OUT} (V)	Gain = $\frac{V_{OUT}}{V_{IN}}$	Gain in dB = 20 log $\frac{V_{OUT}}{V_{IN}}$
1	100 Hz			
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19	1 MHz			

Calculations: Calculate

a) Cut off frequency $f_c = \frac{1}{2\pi RC}$

XIV Result(s)

1. Theoretically calculated value of cut off frequency f_c = ……………. Hz
2. Practically observed value of cut off frequency f_c = ……………. Hz

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. Why low pass filter passes the signal to output at low frequencies and blocks it at high frequencies?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Circuit and network", Sudhakar Shyammohan, A. S. Palli
2. https://www.nptelvideos.com/course.php?id=462, NPTEL Circuit Theory Video Lectures.
3. https://asnm-iitkgp.vlabs.ac.in/, Virtual laboratory link for theorems, R-L-C circuit analysis and its frequency response.

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.16: Develop RC high pass filter on breadboard and plot its frequency response.

I Practical Significance

In the field of electronics, the applications like Radio communications, DC power supplies, Audio electronics, Analog-to-digital conversion works on certain bands of frequencies. To get the desired frequencies filter is used. in This experiment students will be able to design and interpret the behavior of high pass filters.

II Industry/Employer Expected Outcome(s)

Measure **and interpret Electric circuits/networks parameters.**

III Course Level Learning Outcome(s)

Determine the circuit parameters of two port network.

IV Laboratory Learning Outcome(s)

LLO 16.1 Construct high pass using R and C and interpret the frequency response of RC high pass filter.

V Relevant Affective Domain related outcome(s)

Practice good housekeeping.

Demonstrate working as a leader / a team member.

Maintain tools and equipment.

Observe step by step sequence of operations.

VI Relevant Theoretical Background

A high pass filter or HPF, is the exact opposite of the LPF circuit. It attenuates or rejects all low frequency signals and passes only high frequency signals above ωc.

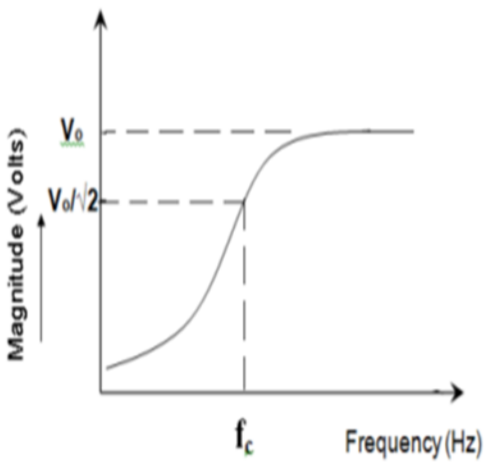

Fig 16.1: Output voltage Vs Frequency Response of High pass filter

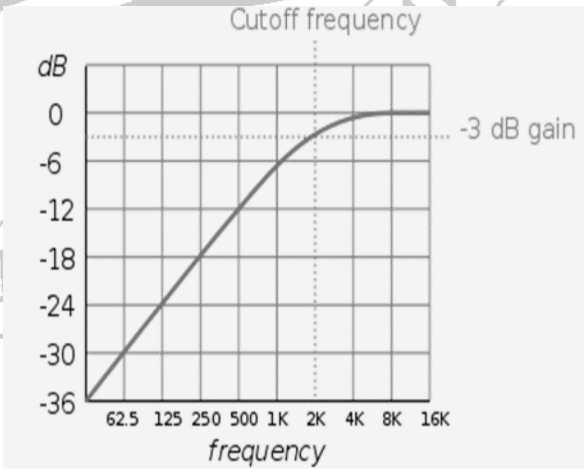

Fig 16.2 Gain Vs Frequency Response of High pass filter

(Courtesy :- https://manual.audacityteam.org/)

VII Actual Circuit diagram used in laboratory with related equipment rating.

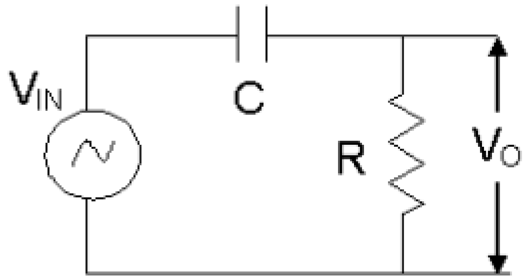

Fig 16.3: High pass filter Circuit diagram

(Student should draw the diagram & get verified from teacher)

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Function generator	0-2MHz with sine,square & triangular output .	1
2	CRO	20/30/100 MHz frequency	1
3	Resistor	Suitable value	1
4	Capacitor	Suitable value	1
5	Breadboard	Standard size	1
6	Connecting Wires	Single stranded wires	1

IX Precautions to be followed

1. Discharge the capacitor before and after use.
2. Set the function generator & CRO correctly.

X Procedure

1) Begin lab by familiarizing yourself with the function generator and oscilloscope.
2) Check the options available on oscilloscope to measure phase shift between two sinusoidal waves.
3) Read and also measure the values of R and C.
4) Set the function generator to produce a sine wave of voltage 5-10 V(pp).
5) This signal will be used for the input. Do not change the amplitude of this signal during the experiment.
6) Set up the high pass RC filter on the breadboard as shown in the circuit diagram. Apply the function generator output to the input of the filter circuit. Use the oscilloscope to look at both Vin and Vout. Be sure that the two oscilloscope probes have their grounds connected to the function generator ground.
7) Adjust the oscilloscope setting such that you can measure frequency (f), Vi, Vo and phase difference at a time.
8) For several frequencies between 100 Hz and 1MHz (the audio frequency range) measure the peak-to-peak amplitude of Vout. Check often to see that Vin remains roughly at the set value. Take enough data down to 1/10 times cut-off frequency, for high pass filter so as to make your analysis complete.
9) Plot graph between frequency and gain in dB on Semilog Paper.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table1: Measurement of output voltage & calculation of gain

Vin=.....V

Sr. No.	Frequency (Hz)	Output Voltage	Gain
1	100		
2	200		
3	400		
4	500		
5	600		
6	800		
7	1K		
8	2K		
9	4K		
10	6K		
11	8K		
12	10K		
13	20K		
14	40K		
15	60K		
16	80K		
17	100K		
18	500K		
19	800K		
20	1M		

XIV Result(s)

Gain =.................dB

Cut off Frequency =.................Hz

Bandwidth = f_H-F_L=.................Hz

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. Identify what type of filter this circuit is, and calculate its cutoff frequency given a resistor value of 1 kΩ and a capacitor value of 0.22 μF.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co.
2. https://manual.audacityteam.org/man/high_pass_filter.html
3. https://be-iitkgp.vlabs.ac.in/exp/frequency-response/simulation/rc_hpf.html

XIX Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.17: Develop RC band pass filter on breadboard and plot it's frequency response.

I Practical Significance

In the field of electronics, the applications like Radio communications, DC power supplies,Audio electronics, Analog-to-digital conversion works on certain bands of frequencies. To get the desired frequencies filter is used. in This experiment students will be able to design and interpret the behavior of band pass filters.

II Industry/Employer Expected Outcome(s)

Measure **and interpret Electric circuits/networks parameters.**

III Course Level Learning Outcome(s)

Determine the circuit parameters of two port network.

IV Laboratory Learning Outcome(s)

LLO 17.1 Construct band pass filter using R and C and interpret the frequency response of RC band pass filter

V Relevant Affective Domain related outcome(s)

Practice good housekeeping.
Demonstrate working as a leader / a team member.
Maintain tools and equipment.
Observe step by step sequence of operations.

VI Relevant Theoretical Background

Band Pass Filters passes signals within a certain "band" or "spread" of frequencies without distorting the input signal or introducing extra noise. This band of frequencies can be any width and is commonly known as the filters Bandwidth.

Bandwidth is commonly defined as the frequency range that exists between two specified frequency cut-off points (f_c), that are 3dB below the maximum centre or resonant peak while attenuating or weakening the others outside of these two points.

$BW = f_H - f_L$.

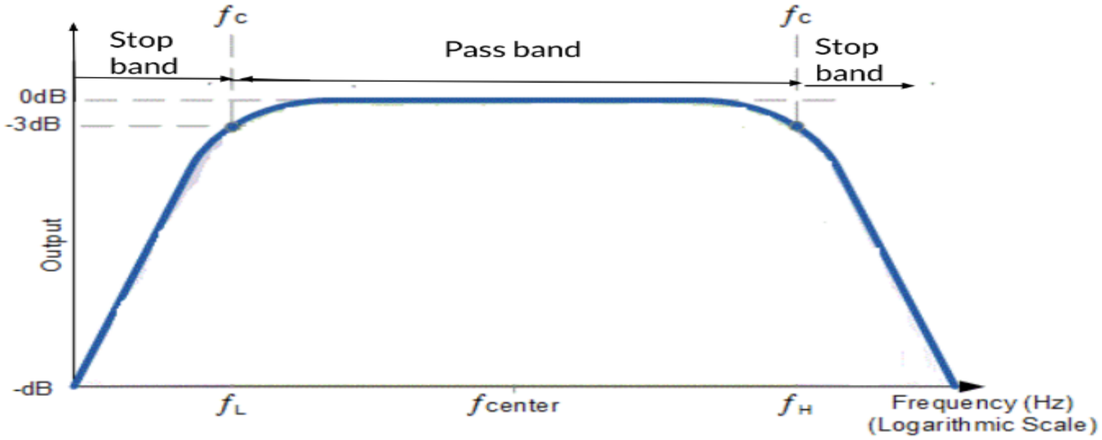

Fig 17.1 Frequency response of Band pass Filter
(Courtsey:-www.electronicspost.com)

VII Actual Circuit diagram used in laboratory with related equipment rating.

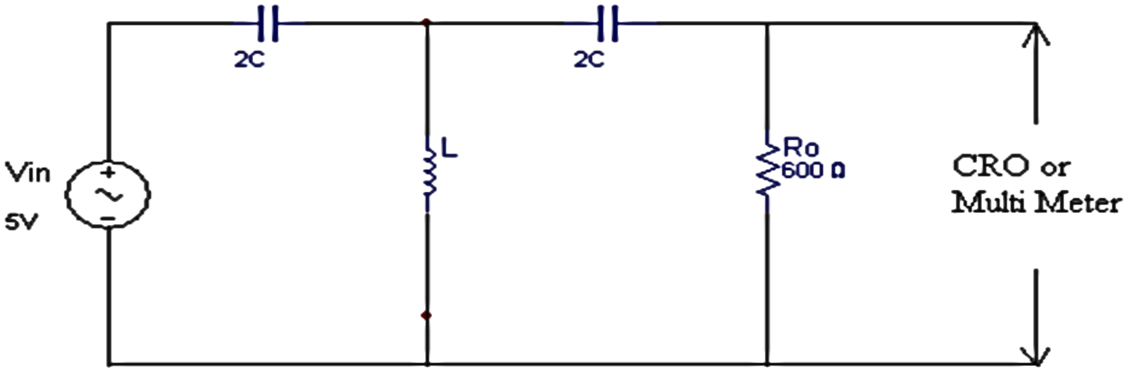

Fig 17.2 LC Band Pass Filter Circuit diagram

We know that for HPF L= Ro/4 Π fc
C= 1/4 Π fc Ro

OR

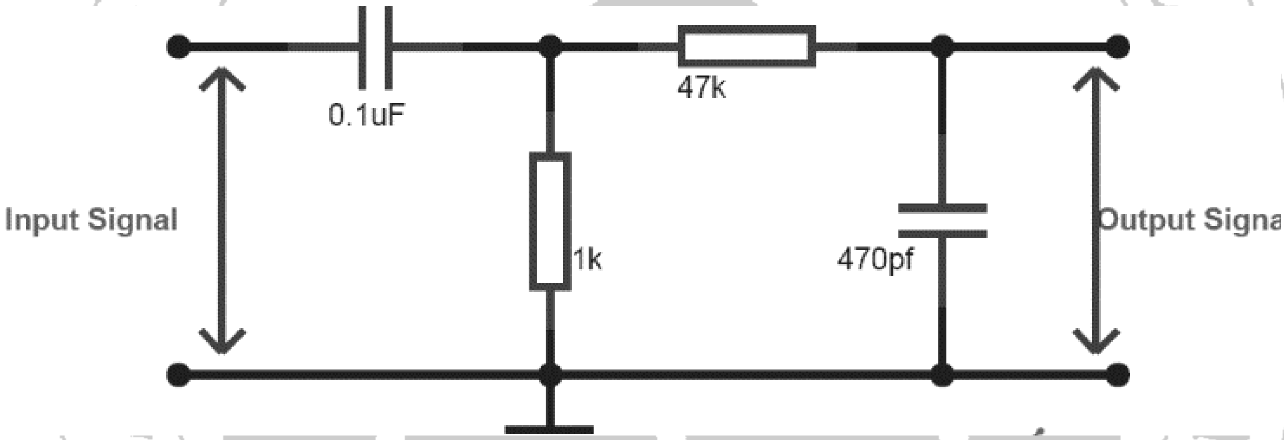

Fig 17.3 RC Band Pass Filter Circuit diagram
(Courtsey:-www.circuitdigest.com/)

(Student should draw any one of the above diagram used in set up & get verified from teacher)
Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Function generator	0-2MHz with sine,square & triangular output .	1
2	CRO	20/30/100 MHz frequency	1
3	Resistor	600Ω	1
4	Capacitor	1.1µf to 800 µf	1
	Inductor	0.47H to 2.38 mH	
5	Breadboard	Standard size	1
6	Connecting Wires	Single stranded wires	1

IX Precautions to be followed

1) Discharge the capacitor before and after use.
2) Set the function generator & CRO correctly.

X Procedure

1. Begin the lab by familiarizing yourself with the function generator and oscilloscope.
2. Check the options available on an oscilloscope to measure phase shift between two sinusoidal waves.
3. Read and also measure the values of R and C.
4. Set the function generator to produce a sine wave of voltage 5-10 V(pp).
5. This signal will be used for the input. Do not change the amplitude of this signal during the experiment.
6. Set up the band pass filter (low & high pass RC filter) on the breadboard as shown in the circuit diagram. Apply the function generator output to the input of the filter circuit. Use the oscilloscope to look at both Vin and Vout. Be sure that the two oscilloscope probes have their grounds connected to the function generator ground.
7. Adjust the oscilloscope setting such that you can measure frequency (f), Vi, Vo and phase difference at a time.
8. For several frequencies between 100 Hz and 1MHz (the audio frequency range) measure the peak-to-peak amplitude of Vout. Check often to see that Vin remains roughly at the set value. Take enough data down to 1/10 times cut-off frequency, for high pass filter so as to make your analysis complete.
9. Plot graph between frequency and gain in dB on Semilog Paper.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
3			
4			

XII Actual Procedure

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XIII Observation Table

Table1: Measurement of output voltage & calculation of gain

Vin=.....V

Sr. No.	Frequency (Hz)	Output Voltage	Gain
1	100		
2	200		
3	400		
4	500		
5	600		
6	800		
7	1K		
8	2K		
9	4K		
10	6K		
11	8K		
12	10K		
13	20K		
14	40K		
15	60K		
16	80K		
17	100K		
18	500K		
19	800K		
20	1M		

XIV Result(s)

Gain =.................dB

Cut off Frequency =.................Hz

Bandwidth = f_H-F_L=.................Hz

XV Interpretation of results

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XVI Conclusion and recommendation

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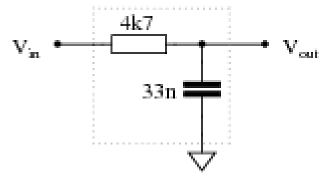
XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. Identify what type of filter this circuit is, and calculate its cutoff frequency:



2. Explain how a band-pass filter differs from either a low-pass or a high-pass filter circuit.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co.
2. https://circuitdigest.com/electronic-circuits/band-pass-filter-circuit-diagram

XIX Assessment Scheme

	Performance Indicators	**Weigh tage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.18: Test the performance of Symmetrical T attenuator

I Practical Significance

In the field of electronics, in the applications like Tele communications, Audio circuits,or RF circuits attenuators plays major role. According to applications the role of attenuators can change.Attenuators can be used as volume control equipment, or to improve the impedance matching,protective dissipation of power,to reduce signal strength.(Attenuators work by reducing the power of a signal equally across all frequencies, maintaining the integrity of the original signal.).In this experiment students will be able to design and interpret the behavior of T attenuator.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Determine the circuit parameters of two port network

IV Laboratory Learning Outcome(s)

LLO 18.1 Construct symmetrical T attenuator.
LLO 18.2 Interpret I/O of symmetrical T type attenuator

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping.
b. Demonstrate working as a leader *I* a team member.
c. Maintain tools and equipment.
d. Observe step by step sequence of operations.

VI Relevant Theoretical Background

Attenuator is an electrical network used to reduce the signal level by a given amount. The function of attenuator is exactly opposite to that of an amplifier. An amplifier is used to increase the signal level. Thus the attenuation is reverse of amplification.

Attenuation = Vin/Vout or Iin/Iout or Pin/Pout
For an attenuator attenuation is always greater than 1. (i.e. Vin/Vout > 1, Vout/Vin <1). But for amplifier attenuation is always less than 1 and gain is always greater than greater than 1. (i.e. Vin/Vout < 1, Vout/Vin>1).

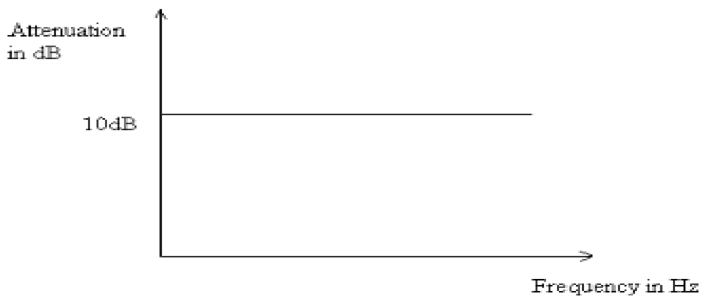

Fig 18.1: Attenuation Vs Frequency characteristics

VII Actual Circuit diagram used in laboratory with related equipment rating.

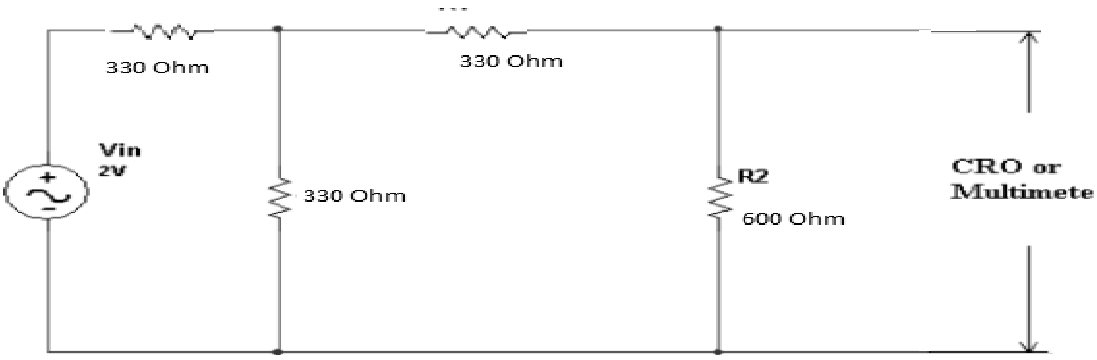

Fig 18.2: Symmetrical T attenuator

Given,

Ro= 600Ω

Attenuation = 10dB

We know that, Attenuation in dB= 20 log N

10dB= 20 log N

Therefore, log N= 10/20

N= Antilog [10/20]

N= 3.16

We know that, R1= [(N-1)/ (N+1)] Ro

R1= [(3.16-1)/ (3.16+1)] X 600

Therefore, R1 = 311.53Ω (Choose 330Ω resistor)

We know that, R2= [(2N)/ (N^2-1)] Ro

R2= [(2X3.16)/ (3.16^2-1)] X 600

Therefore, R1 = 422Ω (Choose 390Ω resistor)

(Student should draw the diagram & get verified from teacher)

Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Function generator	0-2MHz with sine,square & triangular output .	1
2	CRO	20/30/100 MHz frequency	1
3	Resistor	330 & 600 Ω	1
5	Breadboard	Standard size	1
6	Connecting Wires	Single stranded wires	1

IX Precautions to be followed

Set the function generator & CRO correctly.

X Procedure

1. Calculate the values of R1 and R0 by using appropriate formulas.
2. Make the connections as shown in the circuit diagram 18.2 choosing appropriate components.
3. Keep the input voltage Vin= 2V and maintain it constant throughout the experiment.
4. Vary the frequency in steps and note down the output voltage Vo, for each frequency.
5. Calculate the attenuation for each reading by using the formula, Attenuation in dB= 20 log(Vin/Vo)
6. Plot the graph of frequency v/s attenuation in dB on semilog paper.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

………
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………
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XIII Observation Table

Table1: Measurement of output voltage & Calculation of attenuation

Vin=.....V

Sr. No.	Frequency (Hz)	Output Voltage	Attenuation in dB= 20 log(Vin/Vo)
1	100		
2	200		
3	400		
4	500		
5	600		
6	800		
7	1K		
8	2K		
9	4K		
10	6K		
11	8K		
12	10K		
13	20K		
14	40K		
15	60K		
16	80K		
17	100K		
18	500K		
19	800K		
20	1M		

Example:-Design T type attenuator for the given attenuation of 10dB and Ro 600Ω.

Given,
Ro= 600Ω
Attenuation = 10dB
We know that, Attenuation in dB= 20 log N
10dB= 20 log N
Therefore, log N= 10/20

N= Antilog [10/20]
N= 3.16

We know that, R1= [(N-1)/ (N+1)] Ro
R1= [(3.16-1)/ (3.16+1)] X 600
Therefore, R1 = 311.53Ω (Choose 330Ω resistor)
We know that, R2= [(2N)/ (N^2-1)] Ro

R2= [(2X3.16)/ (3.16^2-1)] X 600
Therefore, R1 = 422Ω (Choose 390Ω resistor)

XIV Result(s)

Cut off frequency fc=.................Hz
Attenuation in DB=.................db

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. List features of Pi attenuator
2. State the role of attenuator in different fields such as Audio circuits,RF circuits and Telecommunication systems.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://www.allaboutcircuits.com/tools/t-pad-attenuator-calculator/

XIX Assessment Scheme

	Performance Indicators	**Weigh tage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.19: Test the performance of Symmetrical PI attenuator

I Practical Significance

In the field of electronics, in the applications like Tele communications, Audio circuits, or RF circuits attenuators plays major role. According to applications the role of attenuators can change. Attenuators can be used as volume control equipment, or to improve the impedance matching, protective dissipation of power,to reduce signal strength.(Attenuators work by reducing the power of a signal equally across all frequencies, maintaining the integrity of the original signal.).In this experiment students will be able to design and interpret the behavior of Pi attenuator.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters

III Course Level Learning Outcome(s)

Determine the circuit parameters of two port network

IV Laboratory Learning Outcome(s)

LLO 19.1 Construct symmetrical Pi attenuator.
LLO 19.2 Interpret I/O of PI type attenuator.

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping.
b. Demonstrate working as a leader *I* a team member.
c. Maintain tools and equipment.
d. Observe step by step sequence of operations.

VI Relevant Theoretical Background

Attenuator is an electrical network used to reduce the signal level by a given amount. The function of attenuator is exactly opposite to that of an amplifier. An amplifier is used to increase the signal level. Thus the attenuation is reverse of amplification.

Attenuation = V_{in}/V_{out} or I_{in}/I_{out} or P_{in}/P_{out}

For an attenuator attenuation is always greater than 1. (i.e. $V_{in}/V_{out} > 1$, $V_{out}/V_{in} < 1$). But for amplifier attenuation is always less than 1 and gain is always greater than 1. (i.e. $V_{in}/V_{out} < 1$, $V_{out}/V_{in} > 1$).

VII Actual Circuit diagram used in laboratory with related equipment rating.

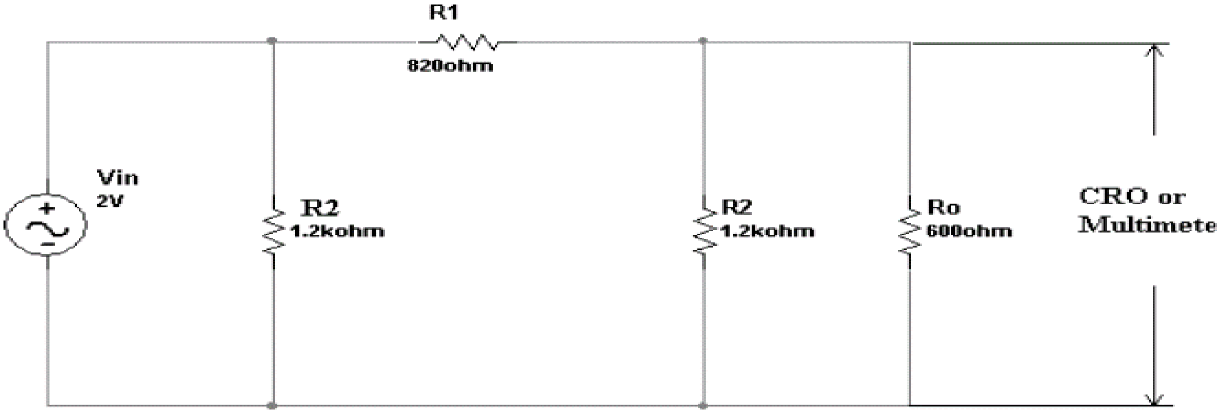

Fig 19.1: Symmetrical Pi attenuator

Given,

Ro= 600Ω

Attenuation = 10dB

We know that, Attenuation in dB= 20 log N

10dB= 20 log N

Therefore, log N= 10/20

N= Antilog [10/20]

N= 3.16

We know that, R1= [((N^2-1))/2N] Ro

R1= [(3.16^2-1)/ (2X3.16)] X 600

Therefore, R1 = 853Ω (Choose 820Ω resistor)

We know that, R2= [(N+1)/ (N-1)] Ro

R2= [(3.16+1)/ (3.16-1)] X 600

Therefore, R1 = 1.155KΩ (Choose 1.2KΩ resistor)

(Student should draw the diagram & get verified from teacher)

Space for diagram

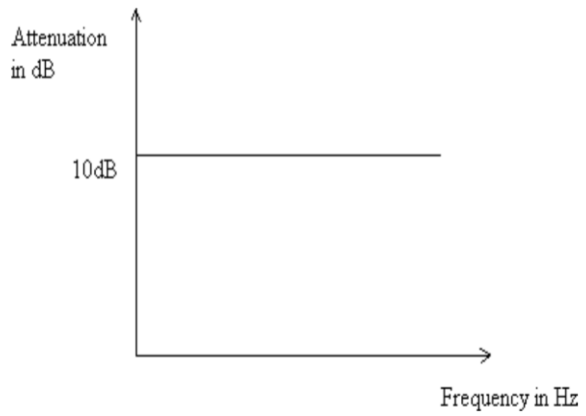

Fig 19.2 Attenuation vs frequency characteristics

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Function generator	0-2MHz with sine,square & triangular output .	1
2	CRO	20/30/100 MHz frequency	1
3	Resistor	600,800,1.2KΩ	1
4	Breadboard	Standard size	1
5	Connecting Wires	Single stranded wires	1

IX Precautions to be followed

Set the function generator & CRO correctly.

X Procedure

1. Calculate the values of R1 and R0 by using appropriate formulas.
2. Make the connections as shown in the circuit diagram choosing appropriate components.
3. Keep the input voltage Vin= 2V and maintain it constant throughout the experiment.
4. Vary the frequency in steps and note down the output voltage Vo, for each frequency.
5. Calculate the attenuation for each reading by using the formula, Attenuation in dB= 20 log(Vin/Vo)
6. Plot the graph of frequency v/s attenuation in dB on semilog paper.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table1: Measurement of output voltage & Calculation of attenuation

Vin=.....V

Sr. No.	Frequency (Hz)	Output Voltage	Attenuation in dB= 20 log(Vin/Vo)
1	100		
2	200		
3	400		
4	500		
5	600		
6	800		
7	1K		
8	2K		
9	4K		
10	6K		
11	8K		
12	10K		
13	20K		
14	40K		
15	60K		

Sr. No.	Frequency (Hz)	Output Voltage	Attenuation in dB= 20 log(Vin/Vo)
16	80K		
17	100K		
18	500K		
19	800K		
20	1M		

Example :-Design π type attenuator for the given attenuation of 10dB and Ro 600Ω.

Given,
Ro= 600Ω
Attenuation = 10dB
We know that, Attenuation in dB= 20 log N
10dB= 20 log N
Therefore, log N= 10/20

N= Antilog [10/20]
N= 3.16

We know that, R1= [((N²-1))/2N] Ro
R1= [(3.16²-1)/ (2X3.16)] X 600
Therefore, R1 = 853Ω (Choose 820Ω resistor)
We know that, R2= [(N+1)/ (N-1)] Ro

R2= [(3.16+1)/ (3.16-1)] X 600
Therefore, R1 = 1.155KΩ (Choose 1.2KΩ resistor)

XIV Result(s)

Cut off frequency fc=.................Hz
Attenuation in DB=.................db

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. Compare between T attenuator & Pi attenuator
2. List applications of attenuation

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://collegedunia.com/exams/types-of-wiring-science-articleid-3865
2. https://leleivre.com/rf_pipad.html
3. https://www.pasternack.com/t-calculator-pi-attn.aspx
4. https://www.electronics-tutorials.ws/attenuators/pi-pad-atte nuator.html

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.20: Measure voltage and current in the given R-L series circuit and calculate active, reactive and apparent power consumed in the circuit.

I Practical Significance

In industries various types of electrical loads are used such as motors, lighting devices, heating devices etc. One who is using these devices must know the different types of powers i.e. Active Power, Reactive Power and Apparent Power drawn by these devices. By performing this practical student will be able to measure and interpret the active power, reactive power and apparent power consumed by the R-L series circuit.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase A.C. circuit.

IV Laboratory Learning Outcome(s)

LLO 20.1 Connect the R and L in series with A.C. supply and measure current and voltage across the circuit element.

LLO 20.2 Interpret the phasor diagram of given RLseries circuit for various input A.C. supply.

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping
b. Maintain tools and equipment
c. Observe step by step sequence of operations

VI Relevant Theoretical Background

lf V(r.m.s.) is the applied voltage across the series combination of R-L and I(r.m.s.) is the current flowing through the circuit, then

Voltage appearing across R = V_R = IR ....in phase with current.

Voltage appearing across L = V_L = IX_L ......leading 90° with current.

$\overline{V}=\overline{VR}+\overline{VL}$

If, the applied voltage is v = Vmsin ωt,

Then, the equation of current will be I = Imsin (ωt - ø).

i.e. current lags behind voltage. The angle of lag (i.e.ø) is greater than O° but less than 90°.It is determined by the ratio of inductive reactance to resistance in the circuit.

tan ø = (X_L/R).

Active Power (True Power)=VIcosø.

This power is measured in watts. Reactive Power= VIsinø. This power is measured in VAr.

Apparent Power= VI. This power is measured in VA.

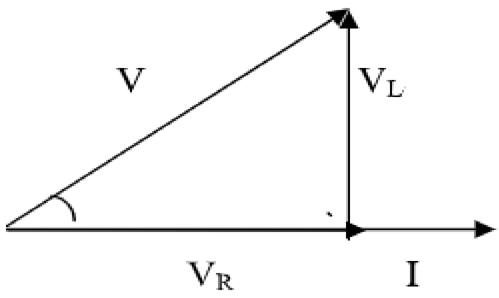

Fig 20.1: Phasor diagram for R-L series circuit

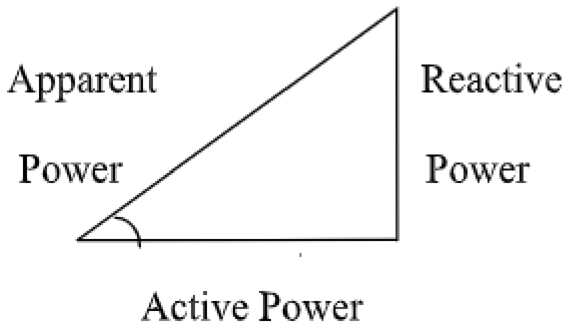

Fig 20.2: Power triangle of RL series circuit

VII Actual Circuit diagram used in laboratory with related equipment rating.

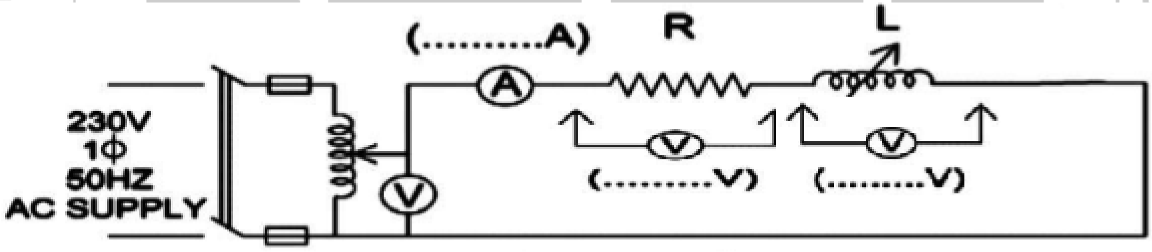

Fig 20.3: R-L series circuit diagram

(Student should draw the diagram & get verified from teacher)
Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Autotransformer	Single phase, lkVA	01
2	A.C. Voltmeter	0-600V MI type	02
3	A.C. Ammeter	0-5Amp MI type	01
4	Rheostat	1000Ω,5A	01
5	Choke coil	lOOmH	01

IX Precautions to be followed

1) Initially set the autotransformer to zero position.
2) Apply voltage as per rating of the resistor and inductor series combination.

X Procedure

1. Select equipment, instruments and components as per the resources required table.
2. Connect the circuit as shown in figure 20.3.
3. Switch on the supply.
4. Vary the voltage by using an autotransformer in steps of (say) lOOV, 150V, 200Vto get three readings.
5. Record the values of V, I, V_R and V_L table no. 1.
6. Reduce the voltage to zero and switch off the supply.
7. Calculate the values of circuit components i.e. resistance 'R', inductive reactance 'X_L' (Neglect resistance of inductor), inductance 'L'.
8. Calculate impedance 'Z' and phase angle '.
9. Now calculate active, reactive and apparent power.

XI Resources used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 20.1:Measurement of V & I & calculation of power

Sr. No	Measured				Calculated						
	V (V)	I (A)	V (V)	V_L (V)	Z (Ω)	X_L (Ω)	L (H)	I	Active Power (W)	Reactive Power (VAr)	Apparent Power (VA)
1											
2											
3											
MEAN VALUE											

Calculations: Calculate-.

1) Z=V/I Ω =

2) $R=V_R/I$ Ω =

3) $X_L=V_L/I$ Ω =

4) $L=X_L/2\Pi f$ =

5) Z= $\sqrt{R^2 \quad + X_L^2}$ =

6) cos Φ= (R I Z) =

7) Active Power = (VIcosΦ) W =

8) Reactive Power = (VlsinΦ) VAr =

9) Apparent Power = (VI) VA =

Phasor diagram for anyone reading

XIV Result(s)

1. Active Power= ....
2. Reactive Power= ....
3. Apparent Power= ....

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

2. Sketch the waveforms of voltage, current and power if v= Vm sin ωt is applied across R-L series circuit.
3. Define Impedance & Inductive reactance.
4. Draw power triangle for RL series circuit.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co

Learning websites-

a. https://vlab.amrita.edu/?sub=1&brch=75&sim=332&cnt=1
b. www.nptelvideos.in/electrical engineering/ circuit theory

XIX Assessment Scheme

	Performance Indicators	**Weigh tage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.21: Measure voltage and current in the given R-C series circuit and calculate active, reactive and apparent power consumed in the circuit.

I Practical Significance

Most of the load present on the power supply system is resistive and inductive in nature. Transmission lines also have some resistance and inductance. Due to this, the power factor of that particular system, consisting of inductive load, becomes lagging and consumption of electrical power increases. Capacitive loads have leading power factor, which compensate for lagging power drawn by the inductive load. Hence it is necessary to understand the Active Power, Reactive Power and Apparent Power consumed by resistive and capacitive load. By performing this practical you will be able to measure and interpret the active power, reactive power and apparent power consumed by the R-C series circuit

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters. .

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase A.C. circuit.

IV Laboratory Learning Outcome(s)

LLO 21.1 Connect the R and C in series with A. C. supply.

LLO 21.2 Interpret the phasor diagram of given RCseries circuit for various input A.C. supply.

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping.
b. Demonstrate working as a leader *I* a team member.
c. Maintain tools and equipment.
d. Observe step by step sequence of operations.

VI Relevant Theoretical Background

lf V(r.m.s.) is the applied voltage across the series combination of R-C and I(r.m.s.) is the current flowing through the circuit, then

Voltage appearing across R = V_R = IR ....in phase with current.

Voltage appearing across C = Vc= IXc ......lagging 90° with current

$V = V_R + V_c$

If, the applied voltage is v = Vm sinωt,

then, the equation of current will be I = Im sin(ωt +π/2).

i.e. in series R-C circuit current leads the applied voltage by angle ø .

The angle of lead (i.e.) is determined by the ratio of capacitive reactance to resistance the circuit.

$\tan^{-1}$ = (Xc/R), The negative phase angle implies that voltage lags behind the current.

Active Power (True Power)=VI cosø . This power is measured in watts.

Reactive Power= VI sinø. This power is measured in VAr.
Apparent Power= VI. This power is measured in VA.

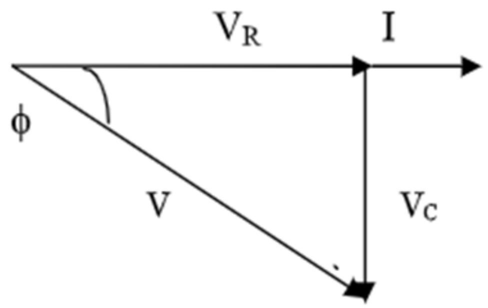

Fig 21.1: Phasor diagram for R-C series circuit

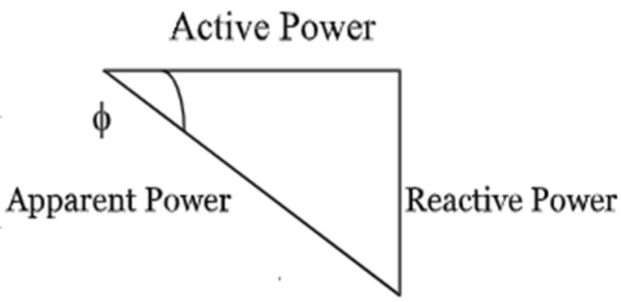

Fig 21.2: Power triangle

VII Actual Circuit diagram used in laboratory with related equipment rating.

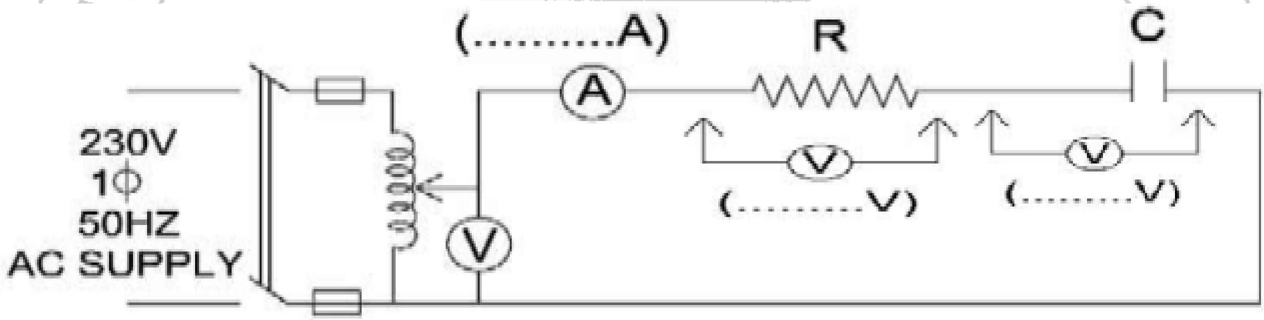

Fig 21.3 : R-C series circuit diagram

(Student should draw the diagram & get verified from teacher)

Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Autotransformer	Single phase, lkVA	01
2	A.C. Voltmeter	MI Type 0-600V	02
3	A.C. Ammeter	MI Type 0-5 Amp	01
4	Rheostat	200μΩ,5A	01
5	Capacitor	1.0 μF *I* 400V or higher value	01

IX Precautions to be followed

1) Discharge the capacitor before and after use.
2) Initially set the autotransformer to zero position.
3) Apply voltage as per rating of the resistor and capacitor series combination.

X Procedure

1. Select equipment, instruments and components as per the resources required table.
2. Connect the circuit as shown in figure 21.3.
3. Switch on the supply.
4. Vary the voltage by using an autotransformer in steps of (say) 100V, 150V, 200V to get three readings.
5. Record the values of V, I, V_R and V_C in table no. 1.
6. Reduce the voltage to zero and switch off the supply.
7. Calculate the values of circuit components i.e. resistance 'R', capacitive reactance 'Xe' (Neglect resistance of capacitor), capacitance 'C'.
8. Calculate impedance 'Z' and phase angle 'ø'.
9. Now calculate active, reactive and apparent power.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table1: Measurement of V & I & calculation of power

Sr. No.	Measured				Calculated							
	v (V)	I	V_R (V)	V_C (A)	Z (Ω)	R (Ω)	X_C (Ω)	C	I	Active Power (W)	Reactive Power (VAr)	Apparent Power (VA)
1												
2												
3												

Calculations:

Calculate-.

1)Z=V/I Ω

2)R=V_R/I Ω

3)X_C=V_C/I Ω

4)C = (1/ 2ΠfXc) F

5)Z=$\sqrt{R^2 + X_C^2}$

6)cos **Φ**= (R *I* Z)

7)Active Power = (VI cos**Φ**) W

8)Reactive Power = (VI sin**Φ**) VAr

9)Apparent Power = (VI) VA

Phasor diagrams: For any one reading

XIV Result(s)

1. Active Power= ....
2. Reactive Power= ....
3. Apparent Power = ...

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. A 25 Ω resistor and capacitor with a capacitive reactance of 120 Ω are in series across the an AC source. What will be the circuit impedance ?
2. Calculate the impedance of RC series circuit having resistance of 5Ω and capacitor of 200 μf, when frequency a) f= l00Hz. b) f=150Hz. c) f=200 Hz.
3. resistance and capacitor are in a series across 20V AC source. Calculate the circuit impedance, Vrms, total current, phase angle, voltage across each component.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co
2. https://vlab.amrita.edu/?sub=1&brch=75&sim=328&cnt=1

XIX Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.22: Measure voltage and current in the given R-L-C series circuit and calculate active, reactive and apparent power consumed in the circuit.

I Practical Significance

Electrical load present on the power supply system is mostly resistive and inductive in nature. Due to inductive load, power factor of the system becomes low and more power is consumed from the supply system. Therefore for power factor improvement capacitors are used in the circuit. Hence understanding overall behavior of the circuit when restive, inductive and capacitive loads are present is very important. One who is using these loads must understand different types of powers i.e. Active Power, Reactive Power and Apparent Power drawn by these loads. By performing this practical you will be able to measure and interpret the active power, reactive power and apparent power consumed by the R-L-C series circuit.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase A.C. circuit.

IV Laboratory Learning Outcome(s)

LLO 22.1 Connect the R, L and C in series with supply.

LLO 22.2 Interpret the phasor diagram of given RLC circuit for various input A.C. supply

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping
b. Maintain tools and equipment
c. Observe step by step sequence of operations.

VI Relevant Theoretical Background

If V(r.m.s.) is the applied voltage across the series combination of R-L-C and I(r.m.s.) is the current flowing through the circuit, then

Voltage appearing across R = VR = IR ....in phase with current.

Voltage appearing across L = V_L = IX_L ......leading 90° with current.

Voltage appearing across C = Vc = IXc ......lagging 90° with current

The circuit can either be effectively inductive or capacitive depending upon which voltage drop VL or Vc is predominant.

$\bar{V} = \overline{VR} + \overline{VL} + \overline{VC}$

Three cases of R-L-C series circuit-

i. When $X_L > X_C$, then $V_L > V_C$, phase angle is positive, and circuit current is lagging applied voltage by phase angle **φ**.
   tan **Φ** =($X_L - X_C$) /*R*.
ii. When XL <Xc , then VL <Vc , phase angle is negative and circuit current is leading

applied voltage by phase angle **φ**.

tan **Φ** = (X_C - X_L) /*R*.

iii. When X_L =Xc , then V_L =V_c , phase angle is zero and circuit current is in phase with applied voltage. Power factor of the circuit is unity. This condition is known as series resonance. Current drawn by the circuit is maximum.

Active Power (True Power)=VIcos **Φ**. This power is measured in watts Reactive Power= VIsin**Φ**. This power is measured in VAr

Apparent Power= VI. This power is measured in VA

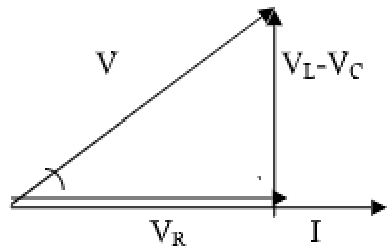

Fig 22.1: Phasor diagram for R-L-C series circuit

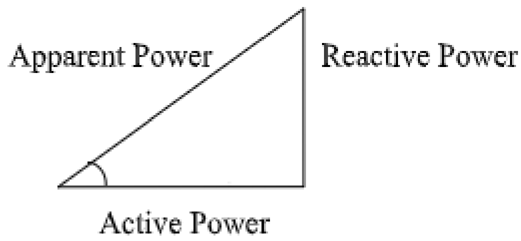

Fig 22.2:Power triangle When XL > Xc

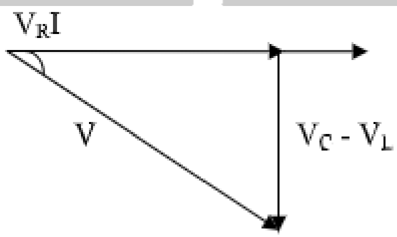

Fig 22.3: Phasor diagram for R-L-C series circuit When XL < Xc

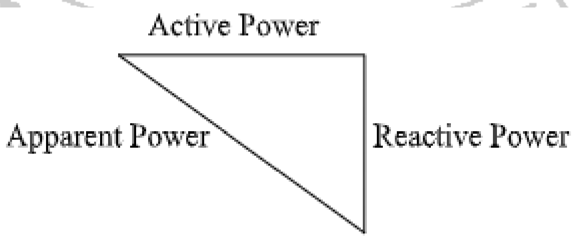

Fig 22.4: Power triangle When XL < Xc

VII Actual Circuit diagram used in laboratory with related equipment rating.

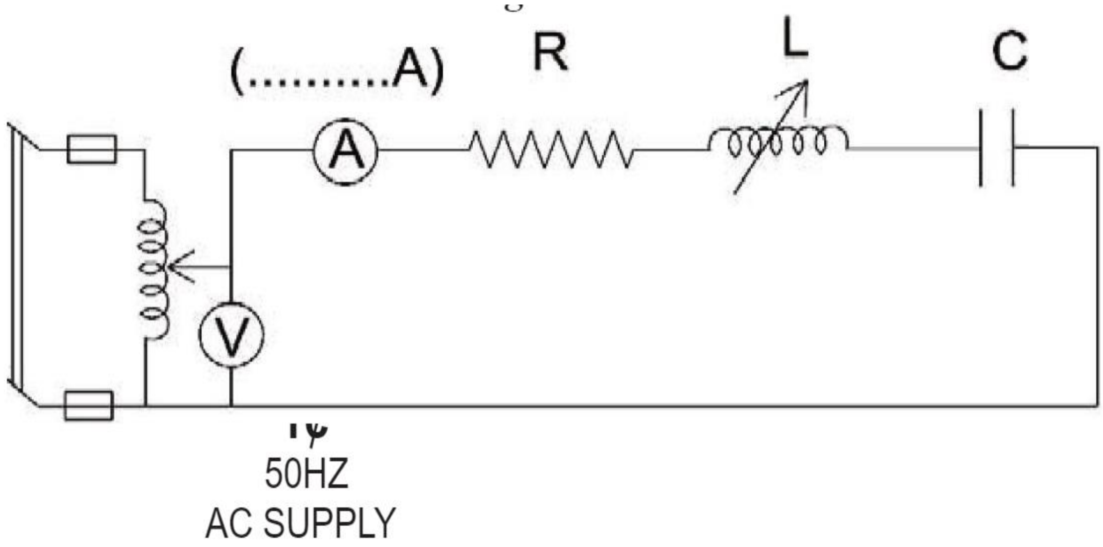

Fig 22.5: R-L-C series circuit diagram

(Student should draw the diagram & get verified from teacher)
Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No	Instrument /Components	Specification	Quantity
1.	Autotransformer	Single phase, lkVA	01
2.	A.C. Voltmeter	0-600V	02
3.	A.C. Ammeter	0-5Amp	01
4.	Rheostat	100 Ω,5A	01
5.	Choke coil	lOO mH	01
6.	Capacitor	1.0 µF / 400V or higher value	01

IX Precautions to be followed

1) Discharge the capacitor before and after use.
2) Initially set the autotransformer to zero position and rheostat to maximum position.

X Procedure

1. Select equipment, instruments and components as per the resources required table.
2. Connect the circuit as shown in figure.22.5
3. Switch on the supply.
4. Vary the voltage by using an autotransformer in steps of (say) 100V, 150V, 200V to get three readings.
5. Record the values of V, I, V_R and V_C in table no. 1.
6. Reduce the voltage to zero and switch off the supply.
7. Calculate the values of circuit components i.e. resistance 'R', capacitive reactance 'Xc' (Neglect resistance of capacitor), capacitance 'C'.
8. Calculate impedance 'Z' and phase angle .
9. Now calculate active, reactive and apparent power.

XI Resources used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 22.1:Measurement of V and I and calculation of power

Sr. No.	Measured						Calculated								
	V	I	VR	VL	VC	Z	R	XL	XC	L	C	Φ	Active Power	Reactive Power	Apparent power
1															
2															
3															
Mean Value															

Calculations: Calculate-.

1)$Z=V/I\ \Omega$

2)$R=V_R/I\ \Omega$

3)$X_L=V_L/I\ \Omega$

4)$L=X_L/2\Pi f$

5)$X_C=V_C/I\ \Omega$

6)$C = (1/\ 2\Pi fXc\ )\ F$

7)$\cos \Phi = (\ R\ I\ Z\ )$

8)Active Power = ($VI\cos\Phi$) W

9)Reactive Power = ($VI\sin\Phi$) VAr

10)Apparent Power = (VI) VA

Phasor diagrams: any one reading

XIV Result(s)

1. Active Power= ....
2. Reactive Power= ....
3. Apparent Power = ...

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are a few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What is the importance of R in the series circuit?
2. Draw and explain phasor diagram for RLC series circuit for
   a. $X_L > X_C$, b.$X_L < X_C$, c. $XL = X_C$.
3. Sketch impedance triangle and power triangle diagram with scale.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co
2. https://virtual-labs.github.io/exp-rlc-circuit-analysis-iitkgp/simulation.html

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.23: Measure voltage and current in the given R-C parallel circuit and calculate power factor, active, reactive and apparent power consumed in the circuit

I Practical Significance

Parallel circuits are used more frequently in electrical systems than series circuits. Most of the applications requiring different currents at the same voltage are to be connected to the same power supply by connecting them in parallel. This type of circuit is used to compensate for the reactive power consumed by inductive load. By performing this practical you will be able to measure and interpret the active power, reactive power and apparent power consumed by the R-C parallel circuit.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Check the working of single phase a.c .circuits.

IV Laboratory Learning Outcome(s)

LLO 23.1 Connect the R and C in parallel with supply.

LLO 23.2 Interpret the phasor diagram of given RC parallel circuit for various input A.C. supply.

V Relevant Affective Domain related outcome(s)

a. Follow safe practices.
b. Practice good housekeeping.
c. Maintain tools and equipment
d. Observe step by step sequence of operations.

VI Relevant Theoretical Background

If V(r.m.s.) is the applied voltage across the parallel combination of R-C and I(r.m.s.) is the resultant current flowing through the circuit, then

Current flowing through R = I_R.......in phase with voltage.

Current flowing through C = I_C ....leading 90° with voltage.

Phase angle, $\Phi = \tan^{-1} C\omega R$

Active Power (True Power)=VIcosΦ.

This power is measured in watts.

Reactive Power= VIsin Φ. This power is measured in VAr.

Apparent Power= VI. This power is measured in VA.

Phasor diagram:

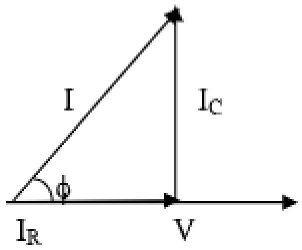

Fig: 23.1: Phasor diagram OF RC parallel circuit

VII Actual Circuit diagram used in laboratory with related equipment rating.

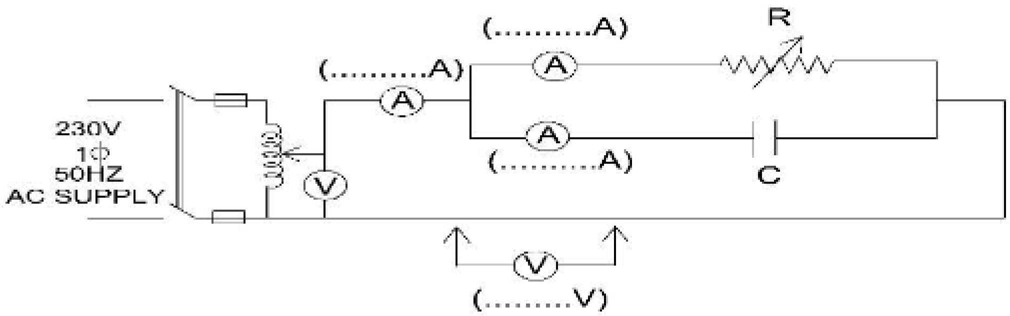

Fig: 23.2: R-C Parallel circuit diagram

(Student should draw the diagram & get verified from teacher)

Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	**Name of Resource**	Specification	Quantity
1.	Autotransformer	Single phase, lkVA	01
2.	A.C. Voltmeter	0-600V	01
3.	A.C. Ammeter	0-5A	01
4.	A.C. Ammeter	0-5Amp	02
5.	Rheostat	200 Ω, 5A	01
6.	Capacitor	l.O µF *I* 400V	01

IX Precautions to be followed

1) Discharge the capacitor before and after use.
2) Initially set the autotransformer to zero position.

X Procedure

1. Connect the circuit as shown in figure .23.2
2. Switch on the supply.
3. Adjust the voltage to rated value by using autotransformer.
4. Record the values of V, I, I_R and I_C in table no.1
5. Take three readings by varying rheostat.
6. Reduce the voltage to zero and switch off the supply.
7. Calculate the values of circuit components i.e. resistance 'R', capacitive reactance 'Xc' (Neglect resistance of capacitor), capacitance 'C'.
8. Calculate admittance 'Y' and phase angle '.
9. Now calculate active, reactive and apparent power.

XI Resources used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 23.1: Measurement of V and I and calculation of power

Sr. No.	Measured				Calculated							
	V (V)	I (A)	I_R (A)	I_C (A)	R (Ω)	X_C (Ω)	c (uF)	Y (D)	I	Active Power (W)	Reactive Power (VAr)	Apparent Power (VA)
1												
2												
3												

Calculations:

Calculate-

1. $R = (v/I)\ \Omega$
2. $X_c = (V/I_c)\ \Omega$
3. $C = (1/2\Pi f X_C)$ F
4. $Y = \sqrt{(1/R)^2 + (wC)^2}$
5. $\Phi = \tan^{-1} C\omega R$
6. Active Power = VIcosΦ watt
7. Reactive Power = VIsinΦ VAr
8. Apparent Power = VI VA

Phasor diagrams: for any one reading

XIV Result(s)

1. Active Power = ...
2. Reactive Power = ...
3. Apparent Power = ...

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are a few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the significance of parallel R-C circuits.

2. Calculate the admittance, conductance and susceptance for the parallel RC circuit of R=l0Ω, C=l00 μf.
3. What will be the main current of the R- C parallel circuit, if I_R =l0A and I_C = 5A.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co.
2. https://vlab.amrita.edu/?sub=1&brch=75&sim=320&cnt=1

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No24: Measure voltage and current in the given R-L-C parallel circuit and calculate power factor, active, reactive and apparent power consumed in the circuit.

I Practical Significance

In the industry environment Electrical Engineering diploma graduate are expected to measure basic parameters like voltage, current etc., for R-L-C parallel circuit. Therefore this practical will help you to acquire necessary a.c. parallel circuit skills.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase A.C. circuit

IV Laboratory Learning Outcome(s)

LLO 24.1 Connect the R ,L and C in parallel with supply.

LLO 24.2 Interpret the phasor diagram of given RLC parallel circuit for various input A.C. supply

V Relevant Affective Domain related outcome(s)

- Follow safe practices.
- Practice good housekeeping.
- Maintain tools and equipment.
- Observe step by step sequence of operations.

VI Relevant Theoretical Background

Current flowing through R = I_R.......in phase with voltage.

Current flowing through L = I_L.........Lagging 90° with voltage.

Current flowing through C = I_C ....leading 90° with voltage.

Phase angle, $\mathbf{\Phi}$ = ta n^{-1} $C\omega R$

Active Power (True Power)=VIcos $\mathbf{\Phi}$. This power is measured in watts.

Reactive Power= VIsin $\mathbf{\Phi}$. This power is measured in VAr.

Apparent Power= VI. This power is measured in VA.

Z1 = R,

Y1 = 1/R,

Z2 = jXL,

Y2 = 1/jXL,

Z3 = -jXc,

Y3 = 11-jXc

Y = Y1+Y2+Y3,

Y = l/R+ 1/jXL+l/-jXc,

Y = l/R + j (l/Xc - 1/XL),

Y = G+jB

Where, G = 1/R conductance of parallel circuit,

B = (1/Xc - 1/XL) Susceptance of parallel circuit.

VII Actual Circuit diagram used in a laboratory with related equipment rating.

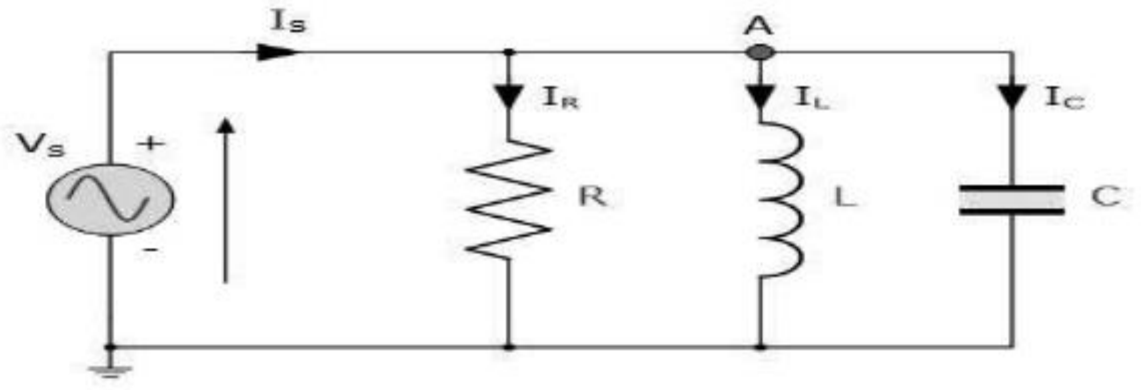

Fig 24.1: R-L-C parallel circuit diagram

(Student should draw the diagram & get verified from teacher)
Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Instrument / Components	Specification	Quantity
1	Autotransformer	Single phase, lkVA	01
2	A.C. Voltmeter	0-600V	01
3	A.C. Ammeter	0-5A	01
4	A.C. Ammeter	0-5Amp	02
5	Rheostat	(0-20Ω, 5A)	01
6	Inductor	30 mH	01
7	Capacitor	100µF	01

IX Precautions to be followed

1) Ensure proper earthing to the equipment.
2) Ensure the power switch is in ‘off’ condition initially .
3) Ensure the output voltage of the Autotransformer should be zero.

X Procedure

1. Capacitor should be discharged before and after use.
2. Connect the circuit as shown in figure no.24.5.
3. Confirm all the meters should be at zero position.
4. Keep the knob of autotransformer to zero position and rheostat to maximum
5. position.
6. Switch ON the main supply
7. Record the readings V, I, I_R ,$I_L$and I_C by varying autotransformer voltage gradually
8. Reduce the autotransformer voltage gradually to zero and switch off the supply.
9. Calculate the values of circuit components i.e. resistance 'R', Inductive reactance 'X_L',inductance 'L'.,capacitive reactance 'X_C' (Neglect resistance of capacitor), capacitance 'C'.
   Now calculate active, reactive and apparent power.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 24.1: Measurement of V and I and calculation of power

Sr. No.	Measured								Calculated							
	V	I	I_R	I_L	I_C	V_R (V)	V_L (V)	V_C (V)	Y	R	X_L	X_C	Φ	Active Power	Reactive Power	Apparent power
1																
2																
3																
Mean Value																

Calculations:

Calculate-

1) $R=V_R/I_R$
2) $X_C=V_C/I_C$
3) $C=1/2\Pi f X_C$
4) $X_L=V_L/I_L$
5) $\Phi = \tan^{-1} \; C\omega R$
6) $\cos \Phi = (R \; I \; Z)$
7) Active Power =($VI\cos\Phi$) W
8) Reactive Power = ($VI\sin\Phi$) VAr
9) Apparent Power = (VI) VA

Phasor diagrams: any one reading

XIV Result(s)

1. Active Power = ...
2. Reactive Power = ...
3. Apparent Power = ...
4. Power Factor =.........................

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifying CO.

1. State the purpose and applications of parallel circuit.
2. Draw phasor diagram for parallel RLC circuit for XL < Xc, and XL> Xc.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co.
2. https://virtual-labs.github.io/exp-rlc-circuit-analysis-iitkgp/simulation.html

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	60 %
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.25 : Measure voltage and current in the given R-L-C parallel circuit consists of series connection of resistor and inductor in parallel with capacitor and calculate power factor, active, reactive and apparent power consumed in the circuit.

I Practical Significance

Parallel circuits are used more frequently in electrical systems than series circuits. Most of the applications requiring different currents at the same voltage are to be connected to the same power supply by connecting them in parallel. In industries the majority of load is inductive, transmission lines also have R and L parameters, hence p.f. of such systems becomes low. This type of circuit is used to compensate for the reactive power consumed by inductive load by connecting capacitor banks across R-L loads. By performing this practical you will be able to measure and interpret the active power, reactive power and apparent power consumed by the R-L-C parallel circuit.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters. .

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase A.C. circuit.

IV Laboratory Learning Outcome(s)

LLO 25.1 Connect series connection of resistor and inductor in parallel with capacitor.
LLO 25.2 Interpret the phasor diagram of given RL series circuit in parallel with C for various input A.C. supply

V Relevant Affective Domain related outcome(s)

a. Follow safe practices.
b. Practice good housekeeping.
c. Maintain tools and equipment.
d. Demonstrate working as a leader *I* a team member.
e. Observe step by step sequence of operations.

VI Relevant Theoretical Background

If V(r.m.s.) is the applied voltage across the parallel R-L-C circuit with series connection of resistor and inductor in parallel with capacitor and I(r.m.s.) is the resultant current flowing through the circuit, then

Current flowing through series R-L branch = I_{RL}..lags behind voltage by a phase angle Φ
Current flowing through C = I_C .....leading 90° with voltage.
Active Power (True Power)=VIcos Φ.
This power is measured in watts. Reactive Power= VIsinΦ.
This power is measured in VAr.
Apparent Power= VI. This power is measured in VA.

VII Actual Circuit diagram used in laboratory with related equipment rating.

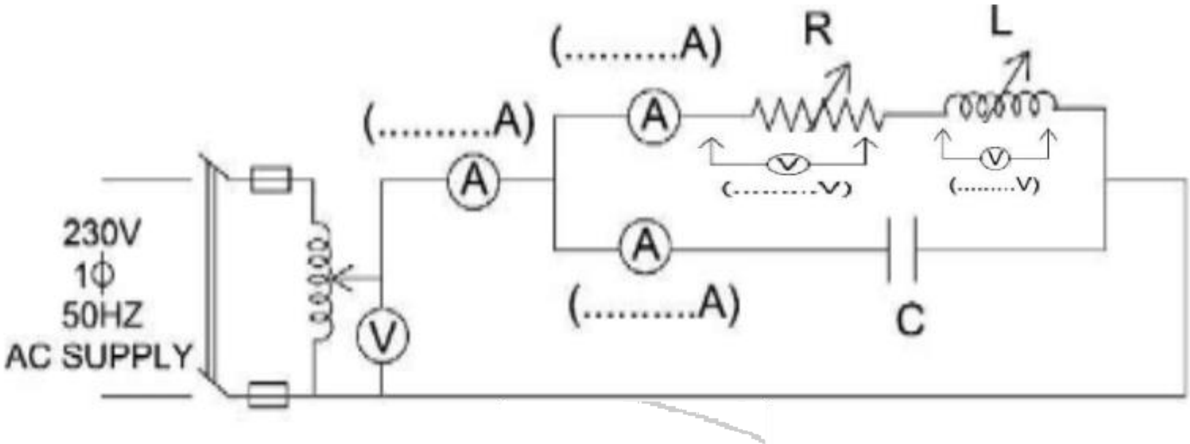

Fig 25.1: R-L-C parallel Circuit

(Student should draw the diagram & get verified from teacher)
Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Autotransformer	Single phase, lKVA	01
2.	A.C. Voltmeter	0 -600 V MI type	01
3.	A.C. Ammeter	0-10 Amp	01
4.	A.C. Ammeter	0 -5 Amp	02
5.	Rheostat	200 Ω ,5A	01
6.	Inductor	100mH	01
7 .	Capacitor	lμF / 400V	01

IX Precautions to be followed

1) Discharge the capacitor before and after use.
2) Initially set the autotransformer to zero position

X Procedure

1. Connect the circuit as shown in figure 25.1.
2. Switch on the supply.
3. Adjust the voltage to rated value by using an autotransformer.
4. Record the values of V, V_R, V_L, I, I_{RL} and Ic in table no. 1.
5. Take three readings either by varying the resistor or the inductor.
6. Reduce the voltage to zero and switch off the supply.
7. Calculate the values of circuit components i.e. resistance 'R', inductive reactance 'X_L' (Neglect resistance of inductor), inductance 'L', capacitive reactance 'Xc' (Neglect resistance of capacitor), capacitance 'C'.
8. Calculate admittance 'Y' and phase angle '.
9. Now calculate active, reactive and apparent power.

XI Resources used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 25.1: Measurement and calculation of power

Sr. No	Measured						Calculated								
	V (V)	VR (V)	V_L (V)	I (A)	I_{RL} (A)	I_C (A)	R (Ω)	X_L (Ω)	L (H)	X_C (Ω)	c (μF)	Y (D)	Active Power (W)	Reactive Power (VAr)	Apparent Power (VA)
1															
2															
3															

Calculations:

Calculate-

1. $R = V/I_{RL}\ \Omega$
2. $X_L = V/I_{RL}$
3. $L = (X_L / 2\Pi f)$ H
4. $X_c = (V / I_C$
5. $C = (1/ 2\Pi f X_c)$ F
6. $Y = \sqrt{(1/R)^2 + (\omega C - \frac{1}{\omega L})^2}$
7. $\Phi = \tan^{-1}[R(\omega C - \frac{1}{\omega L})]$
8. Active Power = (VIcosΦ) W
9. Reactive Power = (VIsinΦ) VAr
10. Apparent Power = (VI) VA

XIV Result(s)

1. Active Power = ...
2. Reactive Power = ...
3. Apparent Power = ...
4. Power Factor =.........................

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are a few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Draw phasor diagram for parallel RLC circuit for a. $X_L > X_C$, b.$X_L < X_C$, c. XL = X_C
2. RLC parallel circuit shown in the figure consumes 100 watt. Calculate the current in the inductor IL if R = 250Ω.
3. Calculate the total admittance, susceptance, and conductance for parallel RLC circuit having R = 10 Ω ,L= 20mH and C = 100 µf, frequency f =50 Hz.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Text book of Electrical Technology Vol-I" ,Theraja B.L.,Theraja A.K.

XIX Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.26: Measure initial and final voltage across the capacitor before and after switching input supply.

I Practical Significance

Capacitors are the important components in the electronics circuits. It is very important to know the response of the capacitor before switching and after switching instant which helps in designing electronic circuits.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters. .

.

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase A.C. circuit.

IV Laboratory Learning Outcome(s)

LLO 26.1 Measure and interpret initial and final condition of the capacitor in the given DC circuit.

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping

b. Maintain tools and equipment properly

VI Relevant Theoretical Background

Refer to the figure as 26. Let us assume that the capacitor, C is fully "discharged" and the switch (S) is fully open. These are the initial conditions of the circuit, then t = 0, i = 0 and q = 0.

When the switch is closed the time begins at t = 0 and current begins to flow into the capacitor via the resistor.

Since the initial voltage across the capacitor is zero, (Vc = 0) at t = 0 the capacitor appears to be a short circuit to the external circuit and the maximum current flows through the circuit restricted only by the resistor R.

The current now flowing around the circuit is called the Charging Current and is found by using Ohms law as:

i = Vs/R

OR

Before Switching at t=0-Capacitor acts as a Short circuit and after switching at t = 0+ due to flow of current capacitor charges to a voltage and appears as open circuit.

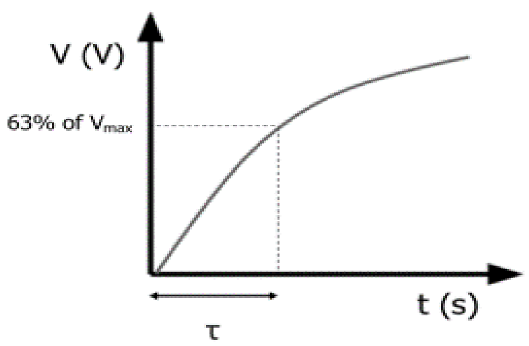

Fig 26.1: Capacitor charging curve

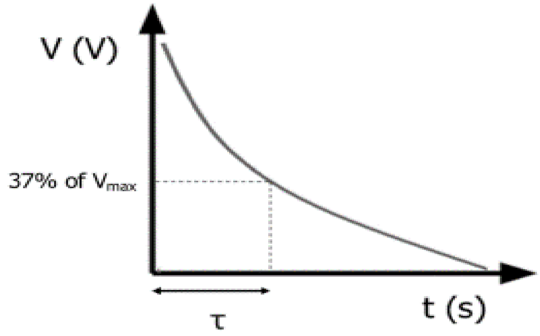

Fig 26.2: Capacitor discharging curve

VII Actual Circuit diagram used in laboratory with related equipment rating.

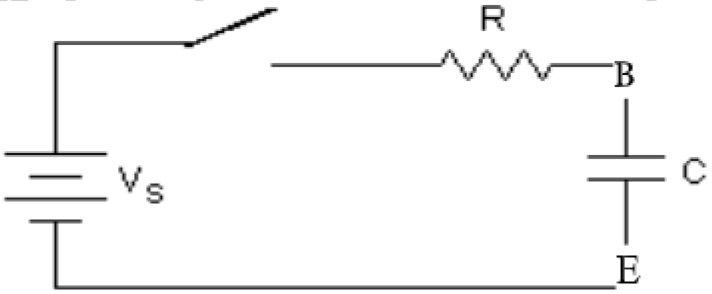

Fig 26.3: Circuit diagram to measure voltage across capacitor

(Student should draw the diagram & get verified from teacher) Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Resistances	Suitable value	1
2	Capacitor	Non Polarity of suitable value	1
3	Bread board		1
4	Ammeter	Suitable range	1
5	Voltage source	D C power supply 0-30 V 1 Amp	1
6	DSO	DSO CURRENT PROBE	1

IX Precautions to be followed

1) Check the connection before connecting circuit to supply
2) Apply voltage as per rating of the resistor & capacitor series combination

X Procedure

1. Identify the component as per the resources required
2. Connect the circuit as shown in figure 26.3
3. Switch on the supply
4. Read & note the Voltage across capacitor before switching and after switching.
5. Measure Current and voltage using DSO
6. Switch off the supply.

XI Resources used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 26.1:Observed and Calculated value of current through branch BE

Sr. No.	Observed V_C	Calculated V_C	Current In Amp

1. Voltage across capacitor at t = 0- ....

2. Voltage across capacitor at t= 0+ ....

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. How does the capacitor act before switching and after switching?
2. Can we perform the experiment using DC supply? Justify your answer

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co.

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.27: Measure initial and final current flowing through the inductive coil before and after switching the supply.

I Practical Significance

Inductors are the important components in the electronics circuits. It is very important to know the response of the Inductor before switching and after switching instant which helps in designing electronic circuits.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters. .

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III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase A.C. circuit.

IV Laboratory Learning Outcome(s)

LLO 27.1 Measure and interpret initial and final condition of the Inductor in the given DC circuit

V Relevant Affective Domain related outcome(s)

a. Practice good housekeeping
b. Maintain tools and equipment properly

VI Relevant Theoretical Background

If no initial current is passing through inductor then at t=0+ inductor acts as a open circuit if initial current I_0 is passing through inductor before switching then at t = 0+ it is represented by a constant source of value I_O due to flow of current inductor appears as short circuit.

VII Actual Circuit diagram used in laboratory with related equipment rating.

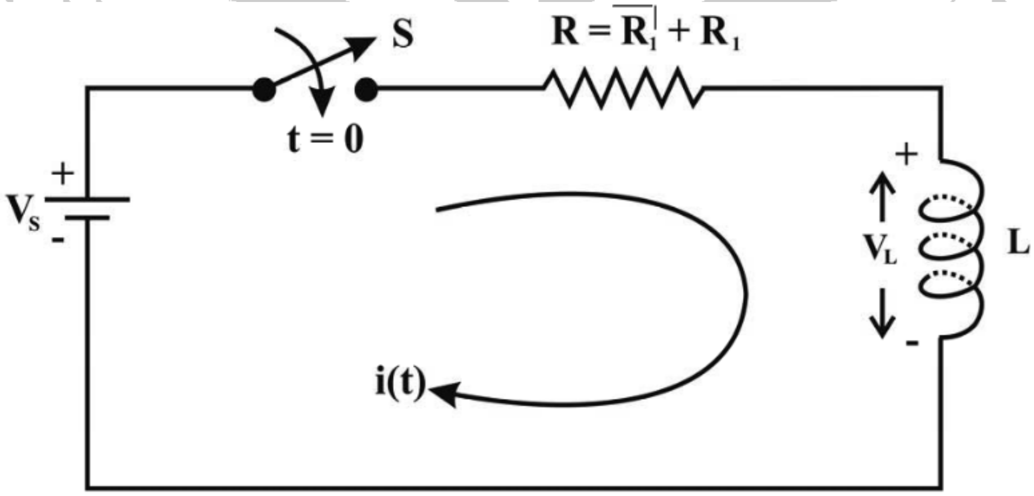

Fig 27.1:Circuit diagram to measure voltage across Inductor

(Student should draw the diagram & get verified from teacher) Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Resistance	1K -10 K Ohm	1
2.	Inductor	100mH	1
3.	Bread board		1
4.	Ammeter	0-1 Amp DC	1
5.	Voltage source	0-30 v 1 Amp	1
6	DSO	Current probe	1

IX Precautions to be followed

1) Check the connection before connecting circuit to supply
2) Apply voltage as per rating of the resistor & inductor series combination

X Procedure

1. Identify the component as per the resources required
2. Connect the circuit as shown in figure 27.1
3. Switch on the supply
4. Read & note the current value.
5. Switch off the supply

XI Resources used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 27.1:Observed and Calculated value of current through branch BE

Sr. No.	Observed I_L	Calculated I_L
1.		
2.		
3.		
4.		

Calculations: Write the current equation for the inductor.

XIV Result(s)

Observed value of current through inductor = ...

Calculated value of current through inductor = ...

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are a few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifying CO.

1. How does the inductor act before switching and after switching?
2. Can we perform the experiment using AC supply? Justify your answer.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. “Basic Electrical Engineering”, V.K. MEHTA, ROHIT MEHTA,S. Chand & Co.

XIX Assessment Scheme

	Performance Indicators	**Weightage**
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.28: Measure voltage and current in the given RLC series circuit and calculate resonance frequency and impedance at resonance using variable supply frequency.

I Practical Significance

In the industry environment, Electrical Engineering diploma graduate are expected to measure basic parameters like voltage, current etc. for R-L-C series resonance circuit. Therefore this practical will help you to acquire necessary resonance circuit kills.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters. .

III Course Level Learning Outcome(s)

Find the resonance condition of electric/electronic circuits.

IV Laboratory Learning Outcome(s)

LLO 28.1 Tune the supply frequency to create resonance in given RLC series circuit\

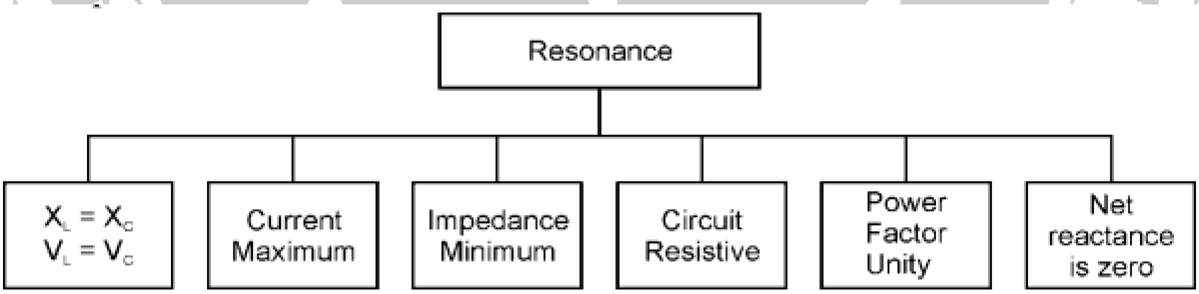
V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background

Resonance:

The phenomenon of resonance in R-L-C series circuit is the condition at which the inductive and capacitive reactances are equal, current in the circuit becomes maximum, impedance of the circuit is minimum, nature of the circuit is resistive, power factor of the circuit is unity and net reactance of the circuit is zero.



Resonance frequency (fr):

The frequency at which the resonance in series circuit occurs is called as resonance frequency (fr).

Quality factor (Q):

If the voltage magnification is produced by resonance it is called factor of the series resonant circuit. Also it is defined as the ratio of inductive reactance to resistance.

$$Q = X_L/R = \omega L/R = 2\pi\ f\ L$$

VII Actual Circuit diagram used in laboratory with related equipment rating.

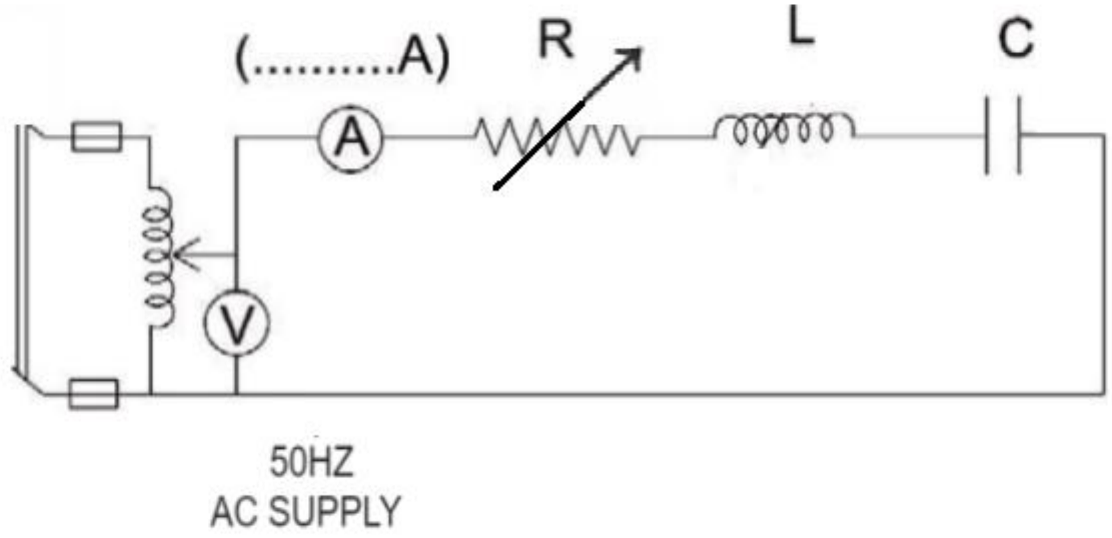


Fig 28.1: RLC series circuit

(Student should draw the diagram & get verified from teacher)

Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Rheostat	Suitable Rheostat(O-220ohm,5A)	1
2	Capacitor	Suitable capacitor	1
3	Inductor	Suitable variable Inductor	1
4	Voltmeter	0-150-300 V	1
5	Ammeter	0-2A	1
6	Autotransformer	0-300V	1

IX Precautions to be followed

1) Ensure proper earthing to the equipment.
2) Ensure the power switch is in condition initially.
3) Ensure the output voltage of the Autotransformer should be zero

X Procedure

1. Capacitor should be discharged before and after use.
2. Connect the circuit as shown in circuit diagram 28.1.
3. Confirm all the meters should be at zero position.
4. Keep the knob of autotransformer to zero position and rheostat to maximum position.
5. Switch ON the main supply
6. Increase the voltage in steps such that the voltage across capacitor should not exceed the rated value.
7. Record the readings V, I, $\mathbf{V_R}$, $\mathbf{V_L}$, $\mathbf{V_C}$, by varying inductor till you get $\mathbf{V_L = V_C}$.
8. Reduce the autotransformer voltage gradually to zero and switch off the supply.
9. Draw the phasor diagram from each reading.

XI Resources used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 28.1: Measurement of Voltages ,current at different frequencies

Sr. No.	Frequency (Hz)	I	V_R	V_L	V_C
1	100				
2	200				
3	400				
4	500				
5	600				
6	800				
7	1K				
8	2K				
9	4K				
10	6K				
11	8K				
12	10K				
13	20K				
14	40K				
15	60K				
16	80K				
17	100K				
18	500K				
19	800K				
20	1M				

XIV Result(s)

Resonant frequency=________

Impedance=_________

XV Interpretation of results

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XVI Conclusion and recommendation

XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. What is meant by resonance in R-L-C senes circuit? Derive the equation for resonant frequency.
2. Draw the curve showing variation of R, X_L, Xc, Z and current with frequency.
3. In series RLC circuit X_L =Xc. What is the power factor of the circuit?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "A Text book of Electrical Technology Vol-I" ,Theraja B.L.,Theraja A.K.
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XIX Assessment Scheme

	Performance Indicators	Weigh tage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			Dated signature of Teacher
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.29: Measure voltage and current in the given RLC series circuit and calculate resonance frequency and impedance at resonance by varying L or C.

I Practical Significance

Concept of Resonance is used in tuning the Electronic communication circuits. concept of resonance is used in troubleshooting and designing the electronic communication circuit

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters. .

III Course Level Learning Outcome(s)

Find the resonance condition of electric/electronic circuits.

IV Laboratory Learning Outcome(s)

LLO 29.1 Tune the circuit parameters (L or C) and measure the resonance frequency of RLC series circuit .

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background

In this method resonance occurs when the capacitive reactance and the inductive reactance becomes equal. The circuit becomes resistive and there is voltage magnification in series circuit and current magnification in parallel circuit.

VII Actual Circuit diagram used in laboratory with related equipment rating.

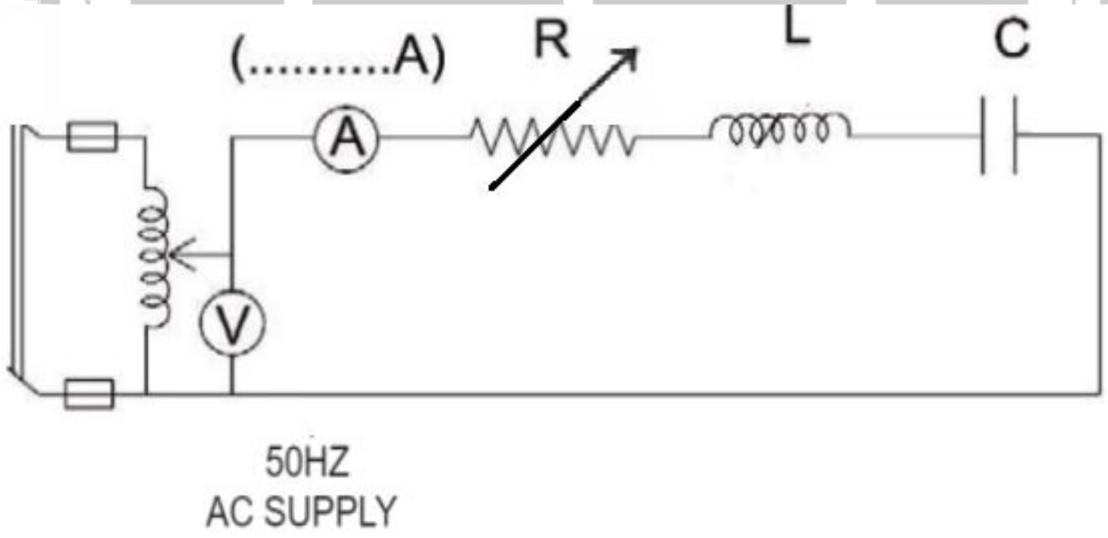

Fig 29.1: RLC series circuit

(Student should draw the diagram & get verified from teacher)

Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Rheostat	Suitable Rheostat(0-20ohm,5A)	1
2	Inductor	Suitable variable inductor (30mH)	1
3	Capacitor	Suitable variable capacitor (100µF)	1
4	Voltmeter	0-300 V	1
5	Ammeter	0-5A	1
6	Autotransformer	0-300V,10A	1

IX Precautions to be followed

1) Ensure proper earthing to the equipment.
2) Ensure the power switch is in 'off' condition initially.
3) Ensure the output voltage of the Autotransformer should be zero.

X Procedure

1. Capacitor should be discharged before and after use.
2. Connect the circuit as shown in circuit diagram.
3. Confirm all the meters should be at zero position.
4. Switch ON the supply
5. Record the readings I, V_L, V_C, V_R by varying input frequency or inductance or capacitance gradually, till you get minimum current.

6. Reduce the autotransformer voltage gradually to zero and switch off the supply.
7. Draw the phasor diagram.

XI Resources used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 29.1:Measurement of Resonant frequency & calculation of Impedance

for C = --µf

Sr. No.	L	fr	VL	VC	VR	I
1						
2						
3						
4						

for L = --mH

Sr. No.	C	fr	VL	VC	VR	I
1						
2						
3						
4						

Calculations

I. $X_L=V_L/I$

II. $X_C=V_C/I$

At fr

III. $V_L=V_C=$------V

At fr

IV. $X_L=X_C=$-------Ω

V. fr=.............Hz

VI. $Z=\sqrt{R^2}+X_L^2$

XIV Result(s)

Impedance=

Resonant frequency=

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are a few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identifies CO.

1. What is meant by resonance in R-L-C parallel circuit? Derive the equation for resonant frequency.
2. Define quality factor, and calculate its value.
3. Calculate the net reactance at the resonant frequency for parallel circuit of L=20mH and C=8µf. Also calculate the net reactance at frequency 2fo and fo/2, where fo is the resonance frequency.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co.
2. https://asnm-iitkgp.vlabs.ac.in/exp/rlc-series-circuit/simulation.html

XIX Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	

Practical No.30: Measure current of given RLC parallel circuit and calculate resonance frequency and impedance at resonance by varying supply frequency.

I Practical Significance

In the industry environment Electrical Engineering diploma graduates are expected to design parallel resonance for R-L-C parallel circuits. Therefore this practical will help you to acquire necessary skills.

II Industry/Employer Expected Outcome(s)

Measure and interpret Electric circuits/networks parameters.

III Course Level Learning Outcome(s)

Calculate the electrical parameters of single phase A.C. circuit.

IV Laboratory Learning Outcome(s)

LLO 30.1 Tune the supply frequency to create resonance in given RLC parallel circuit

V Relevant Affective Domain related outcome(s)

Follow safety electrical rules for safe practices.

VI Relevant Theoretical Background

a. The condition of the resonance in parallel circuit is as follows,
b. The net susceptance of the whole circuit is zero.
c. Impedance of the circuit is maximum and is equal to L/CR
d. Current in the circuit is minimum and is equal to VI (L/CR).
e. Nature of the circuit is resistive and power factor of the circuit becomes unity.

VII Actual Circuit diagram used in laboratory with related equipment rating.

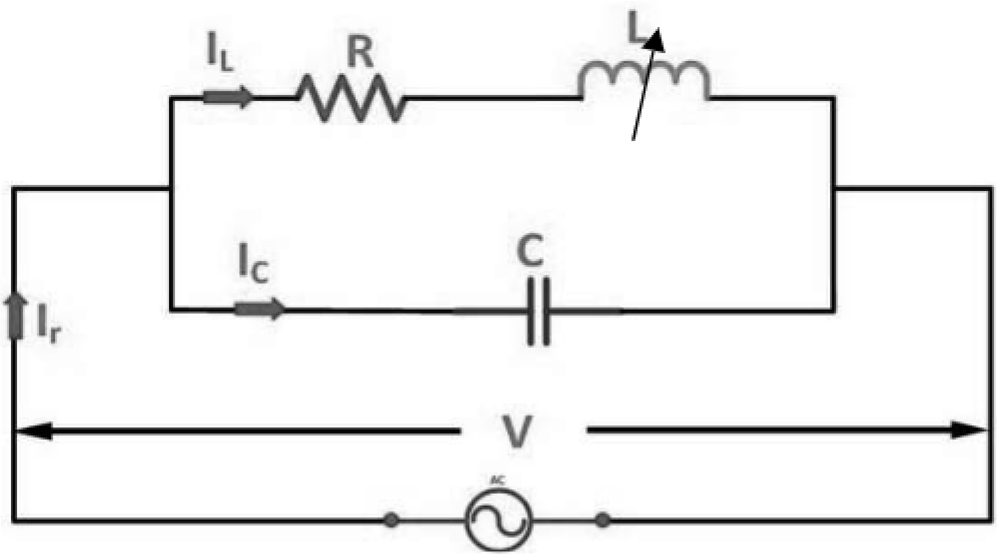

Fig 30.1: RLC parallel circuit

(Student should draw the diagram & get verified from teacher)
Space for diagram

VIII Required Resources/apparatus/equipment with specifications

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Rheostat	Suitable Rheostat (0-20ohm,5A)	1
2	Inductor	Suitable variable Inductor (30mH)	1
3	capacitor	Suitable variable Capacitor (100µF)	1
4	Voltmeter	0-300 V	1
5	Ammeter	0-5A	1
6	Autotransformer	0-300V,10A	1

IX Precautions to be followed

1) Ensure proper earthing to the equipment.
2) Ensure the power switch is in ‘off’ condition initially.
3) Ensure the output voltage of the Autotransformer should be zero.

X Procedure

1. Capacitor should be discharged before and after use.
2. Connect the components on the breadboard as shown in circuit diagram 30.1.
3. Confirm all the meters should be at zero position.
4. Switch ON the supply.
5. Note down the readings of V, I_R, I_L, I_C and V_R, V_L, V_C by varying input frequency or inductance or capacitance gradually.
6. Reduce the autotransformer voltage gradually to zero and switch off the supply.
7. Draw the phasor diagram.

XI Resources used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observation Table

Table 30.1:Measurement of fr & calculations of Impedance

Sr. No.	V	I_r	I_L	Ic	V_R	V_L	V_C	f_r
1								
2								
3								
4								

Calculations

i) $I=I_r=I_L+Ic$

ii) Z_1=R2+XL2

iii) $Z_2=X_C$

iv) Z = —-------V

At fr

i) $V_L=V_C$=------V

ii) $X_L=X_C$=-------Ω

XIV Result(s)

i) Impedance=

ii) Resonant frequency=

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. Draw graphical representation of parallel resonance.
2. Draw phasor diagram under resonance.
3. State the purpose and applications of parallel resonance circuit.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. "Basic Electrical Engineering", V.K. MEHTA, ROHIT MEHTA,S. Chand & Co
2. http://vlabs.iitkgp.ernet.in/asnm/exp12/index.html

XIX Assessment Scheme

	Performance Indicators	Weightage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**

Marks Obtained			**Dated signature of Teacher**
Process related (15)	**Product related (10)**	**Total (25)**	