INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

Lab Manual:

ELECTRICAL CIRCUITS LABORATORY (AEEC03)

Prepared by

Mr. A Srikanth (IARE10652)

ELECTRICAL AND ELECTRonics ENGINEERING
Institute of Aeronautical Engineering

August 7, 2021

Contents

INTRODUCTION

1.1 Introduction

This course is intended to enhance the learning experience of the student in topics encountered in Electrical circuits, (AEEC02). In this lab, students are expected to develop the practical skills required to do the experiments and gain experience in using the basic measuring devices used in electrical and electronics engineering. Students also learn to interpret the experimental results in terms of the concepts introduced in the Engineering Physics course. How the student performs in the lab depends on his/her preparation and participation. Each student must participate in all aspects of the lab to ensure a thorough understanding of the equipment and concepts. The student, Faculty teaching the lab course, Laboratory In-charge and faculty coordinator all have certain responsibilities towards successful completion of the lab's goals and objectives.

1.1.1 Student Responsibilities

The student is expected to come prepared for each lab. Lab preparation includes understanding the lab experiment from the lab manual and reading the related textbook material. Students have to write the allotted experiment for that particular week in the work sheets given and carry them to the Lab. In case of any questions or problems with the preparation, students can contact the Faculty Teaching the Lab course, but in a timely manner. Students have to be in formal dress code, wear shoes and lab coat for the Laboratory Class.

After the demonstration of experiment by the faculty, student has to perform the experiment individually. They have to note down the observations in the observation Tables drawn in work sheets, do the calculations and analyze the results. Active participation by each student in lab activities is expected. The student is expected to ask the Faculty any questions they may have related to the experiment.

The student should remain alert and use commonsense while performing the lab experiment. They are also responsible for keeping a professional and accurate record of the lab experiments in the files provided.

1.1.2 Responsibilities of Faculty Teaching the Lab Course

The Faculty shall be completely familiar with each lab prior to the laboratory. He/She shall provide the students with details regarding the syllabus and safety review during the first week. Lab experiments should be checked in advance to make sure that everything is in working order. The Faculty should demonstrate and explain the experiment and answer any questions posed by the students. Faculty have to supervise the students while they perform the lab experiments. The Faculty is expected to evaluate the lab worksheets and grade them based on their practical skills and understanding of the experiment by taking Viva Voce. Evaluation of work sheets has to be done in a fair and timely manner to enable the students, for uploading them online through their CMS login within the stipulated time.

1.1.3 Laboratory In-charge Responsibilities

The Laboratory In-charge should ensure that the laboratory is properly equipped, i.e., the Faculty teaching the lab receive any equipment/components necessary to perform the experiments.He/She is responsible for ensuring that all the necessary equipment for the lab is available and in working condition. The Laboratory In-charge is responsible for resolving any problems that are identified by the teaching Faculty or the students.

1.1.4 Course Coordinator Responsibilities

The course coordinator is responsible for making any necessary corrections in Course Description and lab manual. He/She has to ensure that it is continually updated and available to the students in the CMS learning Portal.

1.2 Lab Policy and Grading

The student should understand the following policy:

ATTENDANCE: Attendance is mandatory as per the academic regulations.

LAB RECORD's: The student must:

1. Write the work sheets for the allotted experiment and keep them ready before the beginning of eachlab.
2. Keep all work in preparation of and obtained during lab.
3. Perform the experiment and record the observations in the worksheets.
4. Analyze the resultsand get the work sheets evaluated by the Faculty.
5. Upload the evaluated reports online from CMS LOGIN within the stipulated time.

Grading Policy:

The final grade of this course is awarded using the criterion detailed in the academic regulations. A large portion of the student's grade is determined in the comprehensive final exam of the Laboratory course (SEE PRACTICALS),resulting in a requirement of understanding the concepts and procedure of each lab experiment for successful completion of the lab course.

Pre-Requistes and Co-Requisties:

The lab course is to be taken during the samesemester as AHSC03, but receives a separate grade. Students are required to have completed both AHSC03 and AHSC05 with minimum passing grade or better grade in each.

1.3 Course Goals and Objectives

The Physics Laboratory course is designed as a foundation course to provide the student with the knowledge to understand the basic concepts in Physics which have lot of applications in the field of Engineering. The experiments are designed to complement the concepts introduced in AEEC02. In addition, the student should learn how to record experimental results effectively and present these results in a written report.

More explicitly, the class objectives are:

1. Apply network theorems verification to obtain the equivalent circuit of electrical networks to simplify analysis.
2. Calculate the various parameters of two port networks for analyzing different electrical circuits.
3. The basic laws, network reduction techniques and theorems for different circuits.
4. Understand the virtual instrumentation using MATLAB.
5. To develop communication skills through:
    - Verbal interchanges with the Faculty and other students.
    - Preparation of succinct but complete laboratory reports.
    - Maintenance of laboratory worksheets as permanent, written descriptions of procedures, analysis and results.
6. To compare theoretical predictions with experimental results and to determine the source of any apparent errors.

1.4 Use of Laboratory Instruments

One of the major goals of this lab is to familiarize the student with the proper equipment andtechniques for conducting experiments. Some understanding of the lab instruments is necessaryto avoid personal or equipment damage.By understanding the device's purpose and following a fewsimple rules, costly mistakes can be avoided.

The following rules provide a guideline for instrument protection.

1.4.1 Instrument Protection Rules

1. Set instrument scales to the highest range before turning on the power/source. 2. Be sure instrument grounds are connected properly. Avoid accidental grounding of "hot" leads, i.e., those that are above ground potential. 3. Check polarity markings and connections of instruments carefully before connecting power. 4.Never connect an ammeter across a voltage source. Only connect ammeters in series with loads. 5. Do not exceed the voltage and current ratings of instruments or other circuit elements. This particularly applies to watt meters since the current or voltage rating may be exceeded with the needle still on the scale. 6. Be sure the fuse and circuit breakers are of suitable value. When connecting electrical elements to make up a network in the laboratory, it is easy to lose track of various points in the network and accidentally connect a wire to the wrong place. A procedure to follow that helps to avoid this is to connect the main series part of the network first, then go back and add the elements in parallel. As an element is added, place a small check by it on your circuit diagram. Then go back and verify all connections before turning on the power. One day someone's life may depend upon your making sure that all has been done correctly.

1.5 Data Recording and Reports

1.5.1 The Laboratory Worksheets

Students must record their experimental values in the provided tables in this laboratory manual and reproduce them in the lab worksheets. Worksheets are integral to recording the methodology and results of an experiment. In engineering practice, the laboratory notebook serves as an invaluable reference to the technique used in the lab and is essential when trying to duplicate a result or write a report. Therefore, it is important to learn to keep accurate data. Make plots of data and sketches when these are appropriate in the recording and analysis of observations. Note that the data collected will be an accurate and permanent record of the data obtained during the experiment and the analysis of the results. You will need this record when you are ready to prepare a lab report i.e worksheets.

1.5.2 The Laboratory Files/Reports

Worksheets are the primary means of communicating your experience and conclusions to other professionals. In this course you will use the lab worksheets to inform your faculty coordinator about what you did and what you have learned from the experience. Engineering results are meaningless unless they can be communicated to others. You will be directed by your faculty coordinator to prepare a lab report on a few selected lab experiments during the semester.

Your laboratory report should be clear and concise. The lab report shall be student hand written on a work sheets provided by the college. As a guide, use the format on the next page. Use tables, diagrams, sketches, and plots, as necessary to show what you did, what was observed, and what conclusions you can draw from this by using pencil and scale. Free hand diagrams and tables will reduce your marks. Even though you will work with one or more lab partners, your report will be the result of your individual effort in order to provide you with practice in technical communication.

LAB-1 ORIENTATION

2.1 Introduction

In the first experiment period, the students should become familiar with the location of equipment and components in the lab, the course requirements, and the teaching instructor.

2.2 Objective

To familiarize the students with the lab facilities, equipment, standard operating procedures, lab safety, and the course requirements.

2.3 Prelab Preparation:

Read the introduction and procedure of the experiment of respective experiments which are given this manual.

2.4 Equipment needed

Lab manual

2.5 Procedure

1. During the first laboratory period, the faculty coordinator will provide the students with a general idea of what is expected from them in this course. Each student will receive a copy of the syllabus, stating the faculty coordinator's contact information. In addition, the faculty coordinator will review the safety concepts of the course.

2. During this period, the faculty coordinator will briefly review the equipment which will be used throughout the semester. The location of instruments, equipment, and components will be indicated. The guidelines for instrument use will be reviewed.

2.6 Further Probing Experiments

Questions pertaining to this lab must be answered at the end of laboratory report.

LAB-2 VERIFICATION OF OHM'S LAW, KVL, KCL USING HARDWARE AND DIGITAL SIMULATION

3.1 Introduction

This experiment focuses on the ohms law KVL and KCL analysis. Ohms law, specifically its usage in verify the relation between current and voltage. Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL) , specifically its usage in verify voltage and current relation in a Passive Resistive Network.

3.2 Objective

By the end of this experiment, the student should be able to verify ohm's law, KVL, KCL using hardware and digital simulation.

3.3 Prelab Preparation:

Read the material in the textbook that describes ohms law and Kirchhoffs Voltage Law. Prior to coming to the lab, complete Part 1, Part 2, Part 3 and Part 4 of the procedure.

3.4 Equipment needed

R.P.S, Breadboard, Connecting Wires Digital Ammeter, Digital Voltmeter and Digital Multimeter Resistors: 1000W, 47W, 220 W, 150W, 470W, 100W.

3.5 Background

. Ohms Law states that, at constant temperature in an electrical circuit the current (I) flowing through a conductor is directly proportional to potential difference (V) applied. I V or V I or V=IR Limitations of Ohm's Law It is applicable only for metallic conductor such as copper, silver etc. It is not applicable for all electrical circuit such semiconductor devices, transistors ect. In 1845, German physicist Gustav Kirchhoff was described relationship of two quantities in Current and potential difference (Voltage) inside a circuit. This relationship or rule is called as Kirchhoff's circuit Law. Kirchhoff's Circuit Law consist two laws, Kirchhoff's First law - which is related with current flowing, inside a closed circuit and called as Kirchhoff's current law (KCL) and the other one is Kirchhoff's Second law which is to deal with the voltage sources of the circuit, known as Kirchhoff's voltage law (KVL). Kirchhoffs First Law – The Current Law, (KCL) Kirchhoffs Current Law states that the "the algebraic sum of all the currents entering and leaving a node must be equal to zero. Or Total current entering a junction or node is exactly equal to total current leaving the node. This idea by Kirchhoff is commonly known as the Conservation of Charge. Kirchhoffs Second Law – The Voltage Law, (KVL) Kirchhoffs Voltage Law, states that "in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop" which is also equal to zero. Or The algebraic sum of all voltages within the loop must be equal to zero. This idea by Kirchhoff is known as the Conservation of Energy.

3.6 Procedure

1. Part (1) Determine the theoretical currents then set up of ohms law for Figure 2.1 , and record all the currents in Table 2.1.

2. Part (2) Determine the theoretical voltages then set up of KVL for Figure 2.2 , and record all the voltages in Table 2.2.

3. Part (3) Determine the theoretical current then set up of KCL for Figure 2.3 , and record all the currents in Table 2.3.

3.7 Results and Discussion

1. Part (1) Set up the circuit as shown in Figure 2.1. Apply a DC power supply of 0 to 10V and measure the currents (I) in the circuit (i.e. connect the ammeters as shown in Figure 2.1) and complete table 2.1. Compare the values obtained from part 1 above and part 1 here.

2. Part (2) Set up the circuit as shown in Figure 2.2. Apply a DC power supply of 15V and measure the voltages (V1, V2, V3) in the circuit (i.e. connect the voltmeters across these elements as shown in Figure 2.2) and complete table 2.2. Compare the values obtained from part 1 and part 2.

3. Part (3) Set up the circuit as shown in Figure 2.3. Apply a DC power supply of 15V and measure the currents (I, I1, I2) in the circuit (i.e. connect the voltmeters across these elements as shown in Figure 2.3) and complete table 2.3. Compare the values obtained from part 2 and part 3.

4. Part (4) Design the MATLAB model the circuit as shown in Figure 2.4. and Figure 2.5. Apply a DC power supply of 15V and measure the voltages (V1, V2, V3) and currents (I, I1, I2) in the circuits and complete table 2.4.and table 2.5.Compare the values obtained from part 2 and part 3.

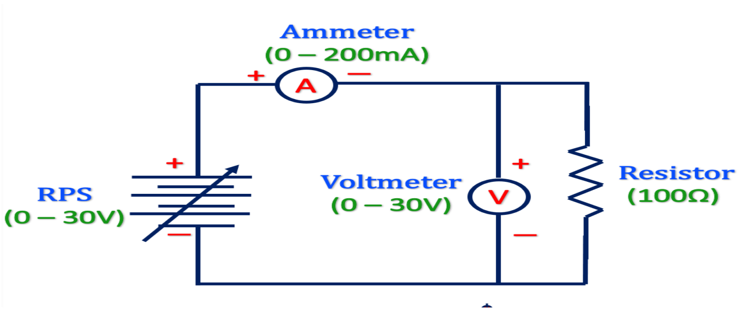

Figure 2.1.ohm's law

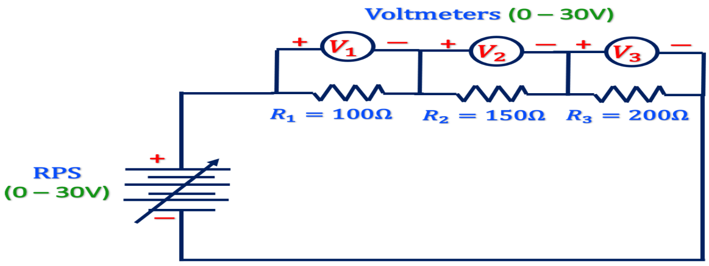

Figure 2.2. The Voltage Law, (KVL)

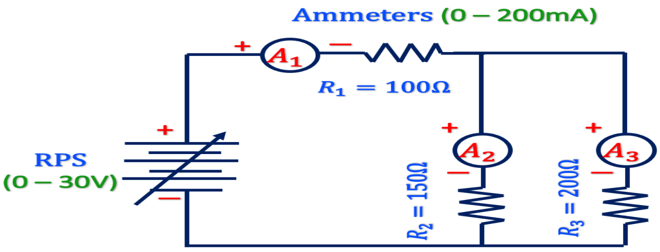

Figure 2.3. The Current Law, (KCL)

S. No.	Theoretical Voltage (V)	Practical Voltage (V)	Theoretical Current (A)	Practical Current (A)
1	5	5		
2	10	10		
3	15	15		
4	20	20		

Table 2.1. ohm's law

S. No.	Resistor (Ω)	Theoretical Voltage (V) = 10v	Practical Voltage (V) = 10v
1	100		
2	150		
3	200		

Table 2.2. The Voltage Law, (KVL)

S. No.	Resistor (Ω)	Theoretical Current (A) = 0.2A	Practical Current (A) = 0.2A
1	150		
2	200		

Table 2.3. The Current Law, (KCL)

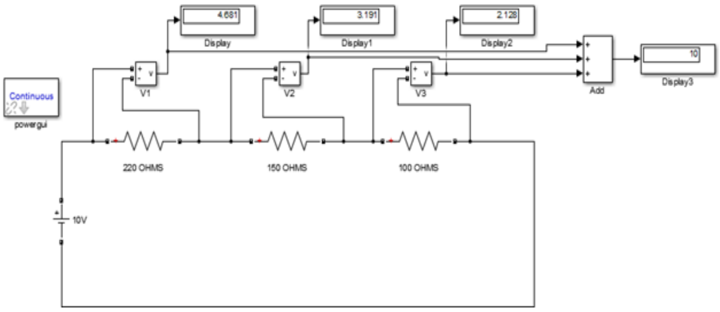

Figure 2.4. The Voltage Law, (KVL) simulation circuit

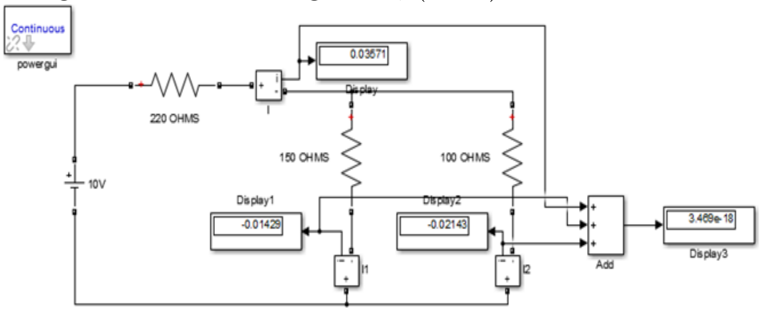

Figure 2.5. The Current Law, (KCL) simulation circuit

S. No.	Resistor (Ω)	Theoretical Voltage (V) = 10v	Practical Voltage (V) = 10v
1	100		
2	150		
3	200		

Table 2.2. The Voltage Law, (KVL) simulation result

S. No.	Resistor (Ω)	Theoretical Current (A) = 0.2A	Practical Current (A) = 0.2A
1	150		
2	200		

Table 2.3. The Current Law, (KCL) simulation result

3.8 Viva Questions

1. What do you mean by junction?
2. Derive current division rule.
3. Explain the sign conventions.
4. Explain the colour coding of resistors.

3.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to determine the Mesh analysis for the circuit in Part 1. First, enter the circuit shown in Figure 1.1 using down node as the reference or "ground" node. To measure the short-circuit currents in parallel elements, place the ammeters in series with these elements and compare to your experimentally obtained values in Part 2. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.

Q2. Use MATLAB/Simulink to determine the Nodal analysis for the circuit in Part 3 First, enter the circuit shown in Figure 1.2 using down node as the reference or "ground" node. The voltage at upper node is then the open circuit voltage. Measure the voltages (V1, V2, V3) in the circuit as per Figure 1.2 and compare to your experimentally obtained values in Part 4. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.

EXPERIMENT-3 MESH ANALYSIS

4.1 Introduction

This experiment focuses on the Mesh analysis. Mesh analysis, specifically its usage in multi-source DC circuits. Its application is finding circuit currents and voltages will be investigated.

4.2 Objective

By the end of this experiment, the student should be able to verify Mesh analysis .

4.3 Prelab Preparation:

Read the material in the textbook that describes Mesh analysis. Prior to coming to the lab, complete Part 1 of the procedure.

4.4 Equipment needed

R.P.S, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 1000Ω, 47Ω, 220 Ω, 150Ω, 470Ω, 100Ω.

4.5 Background

Mesh Analysis: Any closed electrical path is called loop. Mesh is defined as a loop which does not contain any other loops within it. If a network has a larger number of voltage sources, it is better to use mesh analysis, which mainly depends on KVL. The steps to follow in mesh analysis is given below:

- Identify all the meshes in network and select Loop/Mesh currents.
- Sign conventions for the IR drops and source/ battery emfs are the same as for KVL.
- Apply KVL around the mesh and use ohm's law to express the branch voltages in terms of unknown mesh currents and the resistance.
- Solve the simultaneous equations for unknown mesh currents.

4.6 Procedure

Part (1) Determine the theoretical currents then set up of mesh analysis for Figure 1.1 , and record all the currents in Table 1.1.

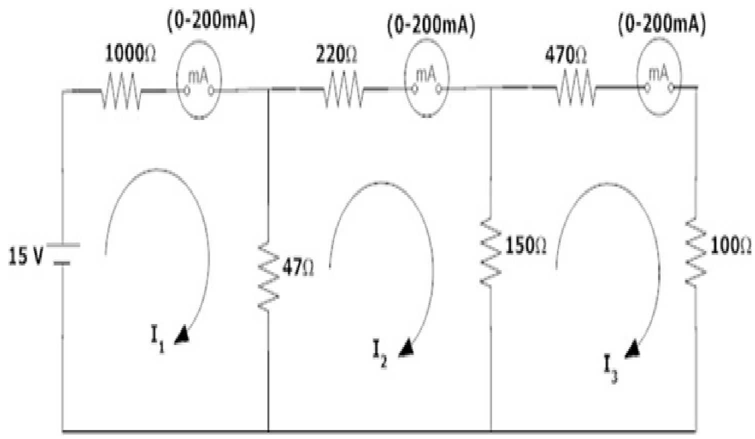

Figure 4.1: Mesh Analaysis Circuit

Applied Voltage V(volts)	Loop current(I1)		Loop current (I2)		Loop current(I3)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

Figure 4.2: Table 1.1:Calculated and Measured values using Mesh Analysis of Figure 1.1

4.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 1.1. Apply a DC power supply of 15V and measure the mesh currents (I1, I2, I3) in the circuit (i.e. connect the ammeters as shown in Figure 1.1) and complete table 1.1. Compare the values obtained from part 1 above and part 1 here.

4.8 Viva Questions

1. Explain mesh analysis?
2. Mention the application of super mesh analysis?
3. What is the equation for determining the number of independent loop equations in mesh current method?
4. How do we calculate branch currents from loop currents?

4.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to determine the Mesh analysis for the circuit in Part 1. First, enter the circuit shown in Figure 1.1 using down node as the reference or "ground" node. To measure the short-circuit currents in parallel elements, place the ammeters in series with these elements and compare to your experimentally obtained values in Part 2. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.

EXPERIMENT-4 NODAL ANALYSIS

5.1 Introduction

This experiment focuses on the Nodal analysis. Nodal analysis, specifically its usage in multi-source DC circuits. Its application in finding circuit node voltages will be investigated.

5.2 Objective

By the end of this experiment, the student should be able to verify Nodal analysis.

5.3 Prelab Preparation:

Read the material in the textbook that describes Nodal analysis. Prior to coming to the lab, complete Part 1 of the procedure.

5.4 Equipment needed

R.P.S, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 1000Ω, 47Ω, 220 Ω, 150Ω, 470Ω, 100Ω.

5.5 Background

Nodal Analysis: A node is a point in a network common to more than two circuit elements. A node voltage is the voltage of given node with respective to one particulate node, called the reference node, which we assume at zero potential. If the network has more number of current sources, then the nodal analysis is useful method, mainly depends on KCL. An 'N' node circuit will be require (N-1) unknown voltages and (n-1) equations.The steps to follow in nodal analysis is given below:

- Identify all the nodes in network and select node voltages.
- One of these nodes is taken as reference node, which is at zero potential.
- Node voltages are measured with respective to the reference node.
- Apply KCL at each node and use ohm's law to express branch currents in terms of unknown node voltages and branch resistances.
- Solve the simultaneous equations for unknown node voltages.

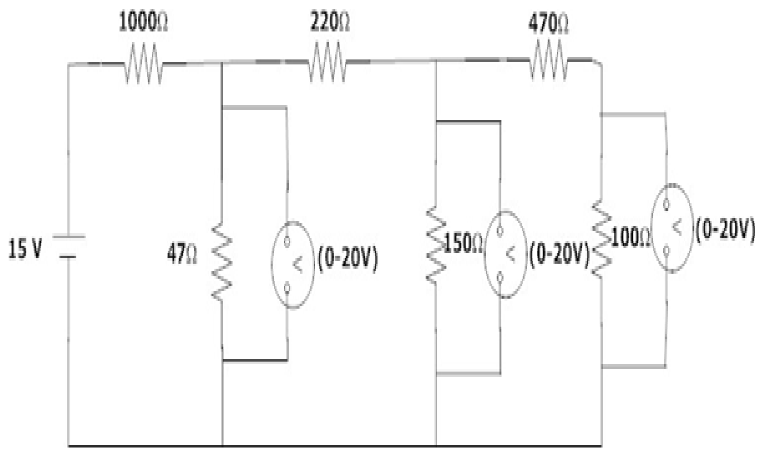

Figure 5.1: Nodal Analaysis Circuit

Applied Voltage V (volts)	Node voltage(V_1)		Node voltage(V_2)		Node voltage(V_3)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

Figure 5.2: Table 1.2:Calculated and Measured values using Nodal Analysis of Figure 1.2

5.6 Procedure

Part (1) Determine the theoretical voltages then set up of nodal analysis for Figure 1.2 , and record all the voltages in Table 1.2.

5.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 1.2. Apply a DC power supply of 15V and measure the node voltages (V1, V2, V3) in the circuit (i.e. connect the voltmeters across these elements as shown in Figure 1.2) and complete table 1.2. Compare the values obtained from part 1 and part 2.

5.8 Viva Questions

1. Name the laws on which nodal analysis based?
2. Explain nodal analysis?
3. Give the necessary conditions for applying the super node analysis?

4. Define node.
5. Is nodal analysis is applicable to both DC and AC supply?
6. How to calculate branch currents from nodal voltages?
7. How to calculate branch voltages from nodal voltages?

5.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to determine the Nodal analysis for the circuit in Part 3. First, enter the circuit shown in Figure 1.2 using down node as the reference or "ground" node. The voltage at upper node is then the open circuit voltage. Measure the voltages (V1, V2, V3) in the circuit as per Figure 1.2 and compare to your experimentally obtained values in Part 4. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.

EXPERIMENT-5 CHARACTERISTICS OF PERIODIC WAVE-FORMS

6.1 Introduction

This experiment focuses on the Characteristics of sinusoidal wave.

6.2 Objective

By the end of this experiment, the student should be able to determine the average value, RMS value, form factor, peak factor of sinusoidal wave.

6.3 Prelab Preparation:

Read the material in the textbook that describes periodic waveforms. Prior to coming to the lab, complete Part 1 of the procedure.

6.4 Equipment needed

Function Generator, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 1000Ω, Inductor: 1 mH.

6.5 Background

In alternating current (AC, also ac) the movement (or flow) of electric charge periodically reverses direction. An electric charge would for instance move forward, then backward, then forward, then backward, over and over again. In direct current (DC), the movement (or flow) of electric charge is only in one direction. Average value: Average value of an alternating quantity is expressed as the ratio of area covered by wave form to distance of the wave form.
Root Mean Square (RMS) Value: The RMS value of an alternating current is expressed by that steady DC current which when flowing through a given circuit for given time produces same heat as produced by that AC through the sane circuit for the same time period. In the common case of alternating current when I(t) is a sinusoidal current, as is approximately true for mains power, the RMS value is easy to calculate from the continuous case equation above. If we define Ip to be the peak current, then in general form
The factor is called the crest factor, which varies for different waveforms. For a triangle wave form centered about zero. For a square wave form centered about zero

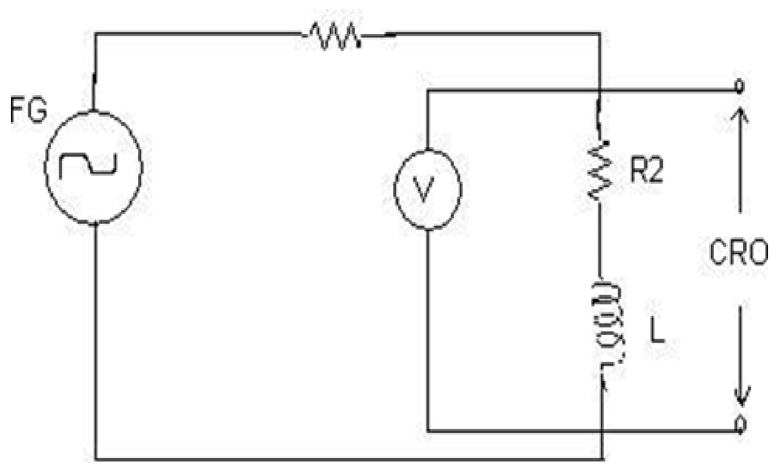

Figure 6.1: Basic Circuit

Peak Value(V)	RMS Value(V)	AverageValue(V)

Figure 6.2: Cathode Ray Oscilloscope results

6.6 Procedure

Part (1) Connect the circuit as shown in the circuit diagram of fig. 4.1., Set the value of frequency say 100 Hz in the function generator and Adjust the ground of channel 1 and 2 of Cathode Ray Oscilloscope and then set it into DC mode and Connect CRO across the load in DC mode and observe the waveform and Adjust the DC offset of function generator and Note down the amplitude and frequency.

6.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 4.1. 6. Set the multimeter into AC mode and measure input voltage and voltage across point AB. This value gives RMS value of sinusoidal AC and Measure the RMS and Average value of DC signal also where instead of function generator you can use DC supply and complete table 5.1. Compare the values obtained from part 1.

6.8 Viva Questions

1. Check for proper connections before switching ON the supply

2. Make sure of proper color coding of resistors
3. The terminal of the resistance should be properly connected

6.9 Further Probing Experiments

EXPERIMENT-5 DETERMINATION OF CIRCUIT IMPEDANCE

7.1 Introduction

This experiment focuses on the impedance of series RL, RC and RLC circuits.

7.2 Objective

By the end of this experiment, the student should be able to Find the impedance of series RL, RC and RLC circuits using hardware and digital simulation.

7.3 Prelab Preparation:

Read the material in the textbook that describes periodic waveforms. Prior to coming to the lab, complete Part 1 of the procedure.

7.4 Equipment needed

Function Generator, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 1000Ω, Inductor: 1 mH and Capacitor: 0.01F.

7.5 Background

The impedance is defined as the ratio of sinusoidal voltage to the sinusoidal current. It is also defined as the total opposition offered to the flow of sinusoidal current. Hence the impedance is measured in OHMS. The real part of the impedance is resistance and the imaginary part is reactance.
Impedance for series Resistive and Inductive : Impedance for series Resistive and Capacitive :
Impedance for series Resistive, Inductive and Capacitive :

7.6 Procedure

Part (1) Connect the circuit as shown in the circuit diagram of fig. 4.1., Set the value of frequency say 100 Hz in the function generator and Adjust the ground of channel 1 and 2 of Cathode Ray Oscilloscope and then set it into DC mode and Connect CRO across the load in DC mode and observe the waveform and Adjust the DC offset of function generator and Note down the amplitude and frequency.

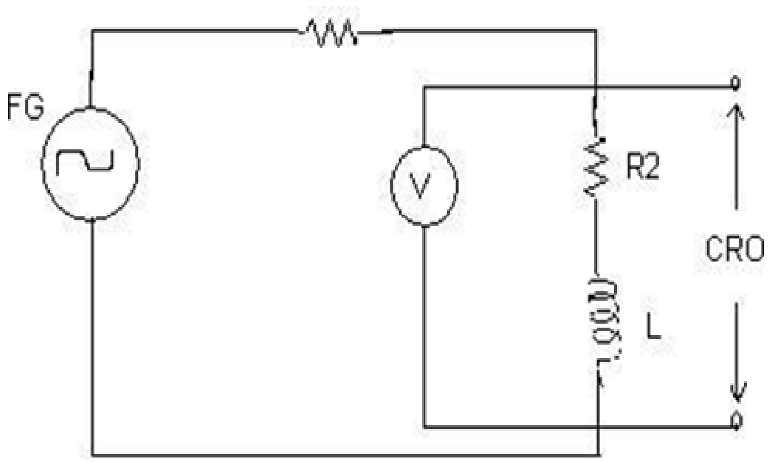

Figure 7.1: Basic Circuit

Peak Value(V)	RMS Value(V)	AverageValue(V)

Figure 7.2: Cathode Ray Oscilloscope results

7.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 4.1. 6. Set the multimeter into AC mode and measure input voltage and voltage across point AB. This value gives RMS value of sinusoidal AC and Measure the RMS and Average value of DC signal also where instead of function generator you can use DC supply and complete table 5.1. Compare the values obtained from part 1.

7.8 Viva Questions

1. Check for proper connections before switching ON the supply
2. Make sure of proper color coding of resistors
3. The terminal of the resistance should be properly connected

7.9 Further Probing Experiments

EXPERIMENT-6 THEVENIN'S THEOREMS

8.1 Introduction

This experiment focuses on the Thevenin's theorems. Complex circuits are often replaced with their Thevenin equivalent to simplify analysis. For example, in the analysis of large industrial power systems the Thevenin equivalent is used in short circuit studies.

8.2 Objective

By the end of this experiment, the student should be able to verify Thevenin's equivalence theorem.

8.3 Prelab Preparation:

Read the material in the textbook that describes Thevenin's equivalence theorem. Prior to coming to the lab, complete Part 1 and Part 2 of the Procedure.

8.4 Equipment needed

R.P.S, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 82Ω, 47Ω, 150Ω, 100Ω, and resistance substitution box.

8.5 Background

Thevenin's Theorem (Statement): It states that 'Any linear bilateral network (AC or DC) containing several voltage, current sources and resistances can be replaced by one voltage source (Vth) with a series single resistance (Rth).' Steps to apply Thevenin's theorem is given below:

- Find the Thevenin's resistance Rth:
- Replace all sources by their internal resistance (voltage sources are replaced by short circuit and current sources are replaced by open circuit)
- Find the equivalent resistance Rth across the open circuited load terminals
- Find the open circuit voltage Voc (or) Thevenin's voltage Vth:
- Remove the load resistance
- Find the thevenin's voltage Vth across the load terminals

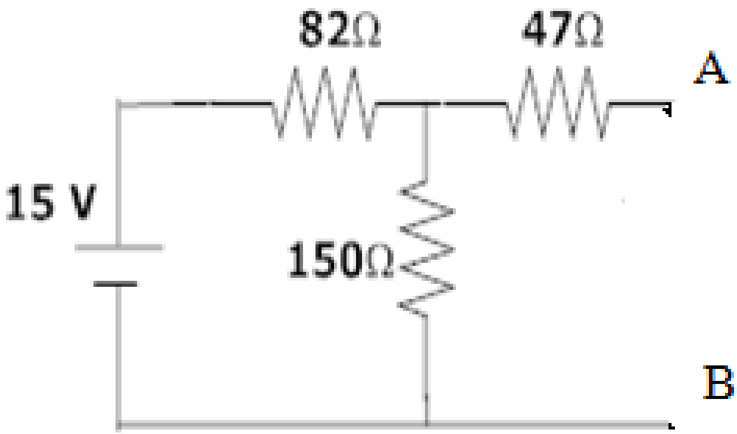

Figure 8.1: Determining the Thevenin Equivalent Circuit

	Calculated Value
V_{th} (V)	
R_{th} (Ω)	
I_{sc}(mA)	

Figure 8.2: Table 4.1: Calculated Thevenin Equivalent Parameters of Figure 4.1

8.6 Procedure

Part (1) Determine the theoretical values then set up for Thevenin equivalent circuit of Figure 4.1 from nodes A and B, and record all parameters in Table 4.1.

8.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 4.1. Adjust the output of the DC power supply to 15V and verify with the digital multimeter. Measure the open circuit voltage (Vth) between nodes A and B (i.e. connect the voltmeter between nodes A and B). Measure the short circuit current (Isc) between nodes A and B (i.e. connect the ammeter between nodes A and B). Using these measurements, determine the Rth by using ohm's law (V = I x R) and complete Table 4.2.

Part (2) Set up the newly determined Thevenin equivalent circuit as shown in Figure 4.2 (i.e. use the values from Part 2) and verify that this circuit has the same open circuit voltage and short circuit current as the previous circuit by performing the same procedures as in Part 2. Record all your measurements in Table 4.3 and compare with the values obtained from Parts 2

	Calculated Value
V_{th} (V)	
R_{th} (Ω)	
I_{sc}(mA)	

Figure 8.3: Table 4.2: Measured Th´evenin Equivalent Parameters of Figure 4.1

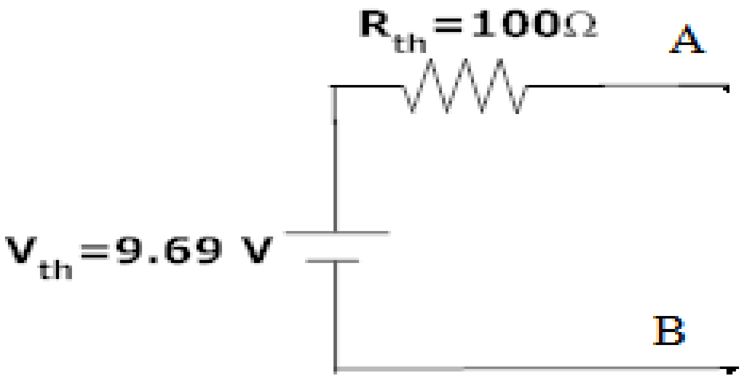

Figure 8.4: Thevenin Equivalent Circuit of Figure 4.1

and 3.

8.8 Viva Questions

1. What is load resistance?
2. Define Thevenin's resistance RTH ?
3. What is Thevenin's voltage VTH?
4. How will you calculate load current IL?
5. Is Thevenin's theorem is applicable to both AC and DC supply?
6. State Thevenin's theorem.

	Newly Measured Value	Value from Part 2	Value from Part 1
V_{th} (V)			
I_{sc} (mA)			
R_{th} (Ω)			

Figure 8.5: Table 4.3: Measured Thevenin Equivalent Parameters of Figure 4.2

8.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to determine the Th´evenin equivalent for the circuit in Part 1. First, enter the circuit shown in Figure 4.1 using node B as the reference or "ground" node. The voltage at node A is then the open circuit voltage. To measure the short-circuit current between points A and B, place an ammeter between the points. Determine the Th´evenin equivalent and compare to your experimentally obtained equivalent circuit in Part 1. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts. Highlight the open-circuit voltage value and short-circuit current value obtained from the simulation.

Q2. Use MATLAB/Simulink to determine the Norton equivalent for the circuit in Part 4. First, enter the circuit shown in Figure 4.1 using node B as the reference or "ground" node. To measure the short-circuit current between points A and B, place an ammeter between the points. The voltage at node A is then the open circuit voltage. Determine the Norton equivalent and compare to your experimentally obtained equivalent circuit in Part 4. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts. Highlight the short-circuit current value and open-circuit voltage value obtained from the simulation.

EXPERIMENT-8 NORTONS'S THEOREMS

9.1 Introduction

This experiment focuses on the Norton's theorems. Complex circuits are often replaced with their Norton's equivalent to simplify analysis. For example, in the analysis of large industrial power systems the Norton equivalent is used in short circuit studies.

9.2 Objective

By the end of this experiment, the student should be able to verify Norton's equivalence theorem.

9.3 Prelab Preparation:

Read the material in the textbook that describes Norton's equivalence theorem. Prior to coming to the lab, complete Part 1 and Part 2 of the Procedure.

9.4 Equipment needed

R.P.S, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 82Ω, 47Ω, 150Ω, 100Ω, and resistance substitution box.

9.5 Background

Norton's Theorem (Statement): It states that 'Any linear bilateral network (AC or DC) containing several voltages, currents and resistances can be replaced by just one current source 'IN' with a parallel resistance 'RN'.

- Find the Norton's resistance RN (same as thevenin's resistance):
- Replace all sources by their internal resistance (voltage sources are replaced by short circuit and current sources are replaced by open circuit)
- Find the equivalent resistance Rth across the open circuited load resistance
- Find the short circuit current Isc (or) Norton's current IN:
- Replace the load resistance with a short circuit
- Find the Norton's current IN through the short circuit

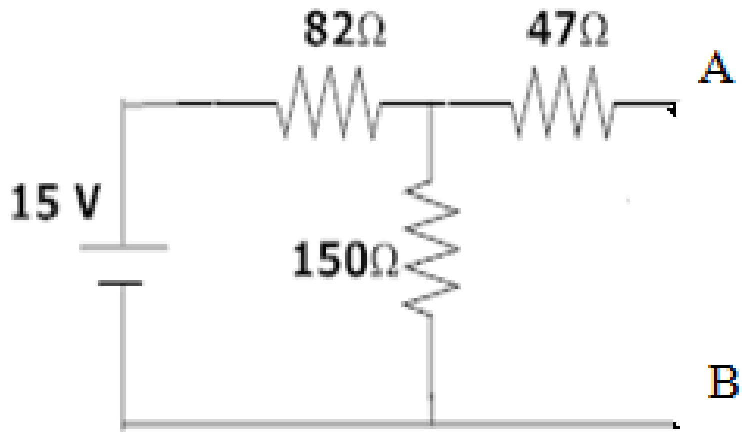

Figure 9.1: Determining the Norton Equivalent Circuit

	Calculated Value
I_{sc}(mA)	
R_{th} (Ω)	
V_{th} (V)	

Figure 9.2: Table 4.4: Calculated Norton Equivalent Parameters of Figure 4.1

9.6 Procedure

Part (1) Determine the theoretical values then set up for Norton's Equivalent Circuit of Fig. 4.1 from nodes A and B, and record all parameters in Table 4.4.

9.7 Results and Discussion

Part (3) Set up the circuit as shown in Figure 4.1. Apply a DC power supply of 15V and verify with the digital multimeter. Measure the short circuit current (Isc), also called Norton's current (IN) between nodes A and B (i.e. connect the ammeter between nodes A and B). Measure the open circuit voltage (Vth) or Voc between nodes A and B (i.e. connect the voltmeter between nodes A and B). Using these measurements, determine the Rth or RN by using ohm's law (V = I x R) and complete Table 4.5.

Part (4) Set up the newly determined Norton equivalent circuit as shown in Figure 4.3 (i.e. Use the values from Part 5) and verify that this circuit has the same short circuit current and open circuit voltage as the previous circuit by performing the same procedures as in Part 5. Record all your measurements in Table 4.6 and compare with the values obtained from Parts 4 and 5.

	Calculated Value
I_{sc}(mA)	
R_{th} (Ω)	
V_{th} (V)	

Figure 9.3: Table 4.5: Measured Norton's Equivalent Parameters of Figure 4.1

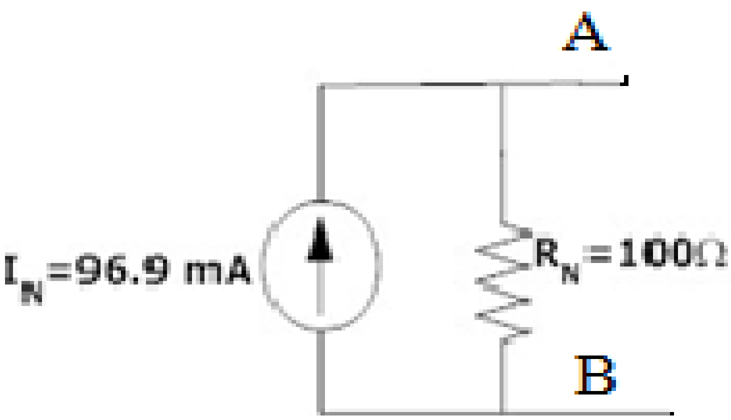

Figure 9.4: Norton Equivalent Circuit of Figure 4.1

	Newly Measured Value	Value from Part 5	Value from Part 4
I_{sc}(mA)			
V_{th}(V)			
R_{th} (Ω)			

Figure 9.5: Table 4.6: Measured Norton Equivalent Parameters of Figure 4.3

9.8 Viva Questions

1. State Norton's theorem.
2. Define Norton's resistance RN.
3. Explain the procedure for finding the Norton's current IN.
4. Convert Thevenin's equivalent into Norton's equivalent.
5. Is it possible to apply Norton's theorem ac as well as dc circuit?
6. What are the applications of Norton' s theorem?

9.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to determine the Th´evenin equivalent for the circuit in Part 1. First, enter the circuit shown in Figure 4.1 using node B as the reference or "ground" node. The voltage at node A is then the open circuit voltage. To measure the short-circuit current between points A and B, place an ammeter between the points. Determine the Th´evenin equivalent and compare to your experimentally obtained equivalent circuit in Part 1. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts. Highlight the open-circuit voltage value and short-circuit current value obtained from the simulation.
Q2. Use MATLAB/Simulink to determine the Norton equivalent for the circuit in Part 4. First, enter the circuit shown in Figure 4.1 using node B as the reference or "ground" node. To measure the short-circuit current between points A and B, place an ammeter between the points. The voltage at node A is then the open circuit voltage. Determine the Norton equivalent and compare to your experimentally obtained equivalent circuit in Part 4. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts. Highlight the short-circuit current value and open-circuit voltage value obtained from the simulation.

EXPERIMENT-9 SUPERPOSITION THEOREMS

10.1 Introduction

This experiment focuses on the Superposition theorems. In complex circuits, Superposition theorem is used to find current or voltage in any element.

10.2 Objective

By the end of this experiment, the student should be able to verify Superposition theorem.

10.3 Prelab Preparation:

Read the material in the textbook that describes Superposition theorem. Prior to coming to the lab, complete Part 1 and Part 2 of the procedure.

10.4 Equipment needed

R.P.S, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 82Ω, 47Ω, 150Ω, 100Ω, 220 Ω, 150 Ω, 10 Ω.

10.5 Background

Superposition Theorem: It states that in any linear network containing two or more sources, the response in any element is equal to the algebraic sum of the responses caused by individual sources acting alone, while other sources are non-operative; that is, while considering the effect of individual sources , other ideal voltage sources and ideal current sources in the network are replaced by short circuit and open circuit across their terminals. This theorem is valid only for linear system.

10.6 Procedure

Part (1) Determine the theoretical current then set up of superposition theorem (to find current in middle element) for Figure 2.1, and record all parameters in Table 2.1.

10.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 2.1. Apply the first DC power supply of 15V and second supply of 10V. Measure the current (I) in middle element of Figure 2.1.1 (i.e. connect

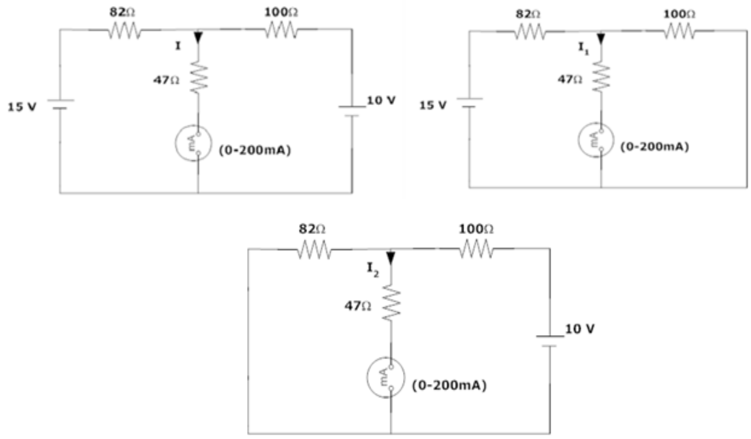

Figure 10.1: Determining the Currents using Superposition Theorem

	Calculated Value
I (mA)	
I_1 (mA)	
I_2 (mA)	

Figure 10.2: Table 2.1: Calculated Currents using Superposition Theorem of Figure 2.1

	Measured Value
I (mA)	
I_1 (mA)	
I_2 (mA)	

Figure 10.3: Table 2.2: Measured Currents using Superposition Theorem of Figure 2.1

	Calculated Value	Measured Value
I (mA)		
I_1 (mA)		
I_2 (mA)		

Figure 10.4: Tbale 2.3: Currents using Superposition Theorem of Figure 2.1

the ammeter as shown in Figure 2.1.1). Similarly measure the currents (I1 and I2) w.r.t Figure 2.1.2 and Figure 2.1.3. and complete table 2.2. And compare the values obtained from part 1 of procedure with part 1 here.

10.8 Viva Questions

1. State reciprocity theorem.
2. Is it possible to apply both theorems to ac as well as dc circuit?
3. Is Reciprocity is applicable for unilateral and bilateral networks?
4. Comment on the applicability of reciprocity theorem on the type of network.
5. Is reciprocity theorem is applicable to nonlinear circuits?

10.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to verify the Superposition theorem for the circuit in Part 1. First, enter the circuit shown in Figure 2.1 using down node as the reference or “ground” node. To measure the short-circuit current in middle element, place an ammeter in series with that element. Determine the currents in middle element of Figure 2.1 and compare to your experimentally obtained currents in Part 2. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.

EXPERIMENT-10 RECIPROCITY THEOREMS

11.1 Introduction

This experiment focuses on the Reciprocity theorems. In complex circuits, Reciprocity theorem is used to find the ratio of excitation to response w.r.t any element in any electrical circuit.

11.2 Objective

By the end of this experiment, the student should be able to verify Reciprocity theorem.

11.3 Prelab Preparation:

Read the material in the textbook that describes Reciprocity theorem. Prior to coming to the lab, complete Part 1 and Part 2 of the procedure.

11.4 Equipment needed

R.P.S, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 82Ω, 47Ω, 150Ω, 100Ω, 220 Ω, 150 Ω, 10 Ω.

11.5 Background

Reciprocity Theorem: It states that in any linear, bilateral, single source network the ratio of input to output (or source to response) is constant even when their positions are interchanged.

11.6 Procedure

Part (1) Determine the theoretical values then set up of reciprocity theorem i.e. current I1 in the branch of Figure 2.2.1, and record it in Table 2.4. Inter - change voltage source and response as shown in Figure 2.2.2 and determine the currentI2 and record it in Table 2.4.

11.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 2.1. Apply the DC power supply of 10V. Measure the current (I1) in branch of Figure 2.2.1 (i.e. connect the ammeter as shown in Figure 2.1.1). Next measure the current (I2) of Figure 2.2.2 and complete table 2.4. And compare the values obtained from part 3 and part 4. Measure the ratio of excitation and response and check whether they are equal in both cases are not.

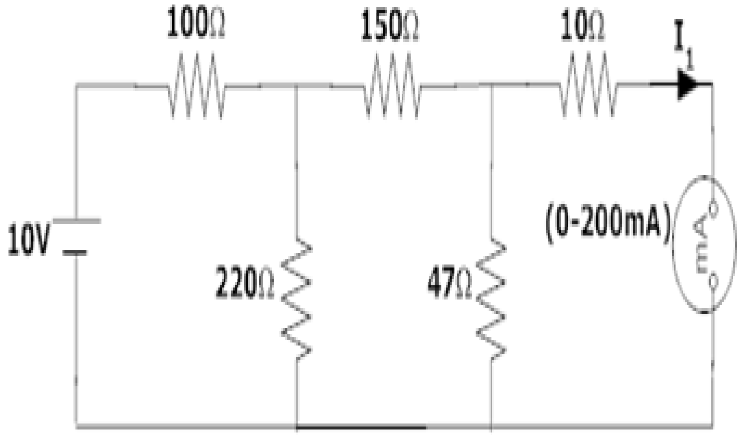

Figure 11.1: Response due to 10V before interchanging load

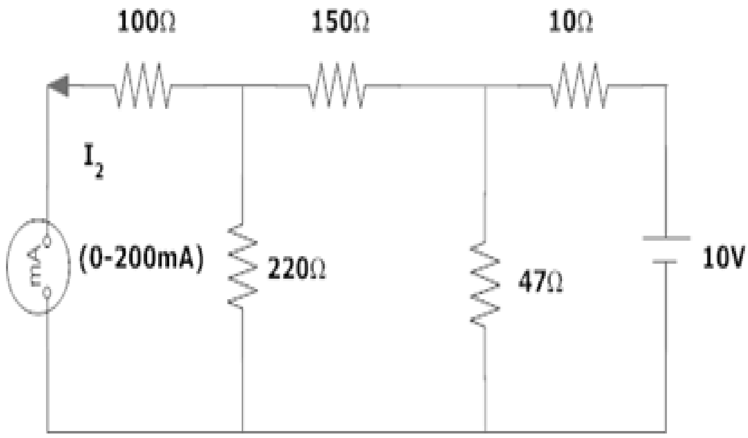

Figure 11.2: Response due to 10V after interchanging load

Parameters	Calculated Values	Measured Values

Figure 11.3: Table 2.4: Calculated and Measured values using Reciprocity Theorem of Figure 2.2

11.8 Viva Questions

1. State reciprocity theorem.
2. Is it possible to apply both theorems to ac as well as dc circuit?
3. Is Reciprocity is applicable for unilateral and bilateral networks?
4. Comment on the applicability of reciprocity theorem on the type of network.
5. Is reciprocity theorem is applicable to nonlinear circuits?

11.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to verify the Reciprocity theorem for the circuit in Part 3. First, enter the circuit shown in Figure 2.2.1 using down node as the reference or "ground" node. To measure the short-circuit current in branch of Figure 2.2.1 , place an ammeter in series with that element. Determine the current in element of Figure 2.2.2 and compare them with experimentally obtained currents in Part 4. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.

EXPERIMENT-4 MAXIMUM POWER TRANSFER THEOREM

12.1 Introduction

This experiment focuses on the maximum power transfer theorem. Complex circuits are often replaced with their Th´evenin equivalent to simplify analysis. For example, in the analysis of large industrial power systems the Th´evenin equivalent is used in short circuit studies. Maximum power transfer is also an important concept which allows the designer to determine an optimal design when power is a constraint.

12.2 Objective

By the end of this experiment, the student should be able to verify the concept of maximum power transfer.

12.3 Prelab

Read the material in the textbook that describes maximum power transfer. Prior to coming to the lab, complete Part 1 of the Procedure.

12.4 Equipment needed

R.P.S, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 82Ω, 47Ω, 150Ω, 100Ω, and resistance substitution box.

12.5 Background

Maximum Power Transfer Theorem (Statement): It states that in any linear bilateral network a load will receive maximum power from the source when the load resistance is exactly equal to the thevenin's resistance of the network.Steps to appply maximum power transfer is below:

- Find the Thevenin's resistance Rth:
- Replace all sources by their internal resistance (voltage sources are replaced by short circuit and current sources are replaced by open circuit)
- Find the equivalent resistance Rth across the open circuited load terminals
- Find the open circuit voltage Voc (or) Thevenin's voltage Vth:
- Remove the load resistance
- Find the thevenin's voltage Vth across the load terminals

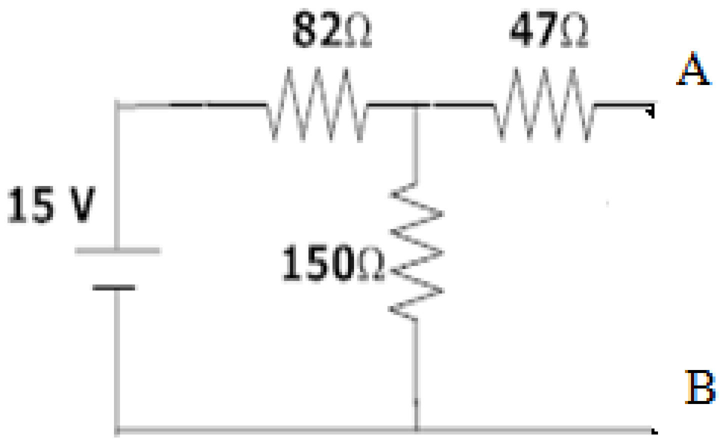

Figure 12.1: Determining the Thevenin Equivalent Circuit

	Calculated Value
V_{th} (V)	
R_{th} (Ω)	
I_{sc}(mA)	

Figure 12.2: Table 3.1: Calculated Th´evenin Equivalent Parameters of Figure 3.1

12.6 Procedure

Part (1) Determine the theoretical values then set up of Th´evenin's equivalent circuit for Figure 3.1 from nodes A and B, and record all parameters in Table 3.1.

12.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 3.1. Apply a DC power supply of 15V and verify with the digital multimeter. Measure the open circuit voltage (Vth) between nodes A and B (i.e. connect the voltmeter between nodes A and B). Measure the current (Isc) between nodes A and B (i.e. connect the ammeter between nodes A and B). Using these measurements, determine the Rth by using ohm's law (V = I x R) and complete Table 3.2.

Part (2) Set up the newly determined Th´evenin equivalent circuit as shown in Figure 3.2 (i.e. use the values from Part 1) and verify that this circuit has the same open circuit voltage and short circuit current as the previous circuit by performing the same procedures as in Part 1. Record all your measurements in Table 3.3 and compare with the values obtained from Parts 1 and 2.

Part (3) This part of the lab is to illustrate maximum power transfer. Use the Th´evenin

	Calculated Value
V_{th} (V)	
R_{th} (Ω)	
I_{sc}(mA)	

Figure 12.3: Table 3.2: Measured Th´evenin Equivalent Parameters of Figure 3.1

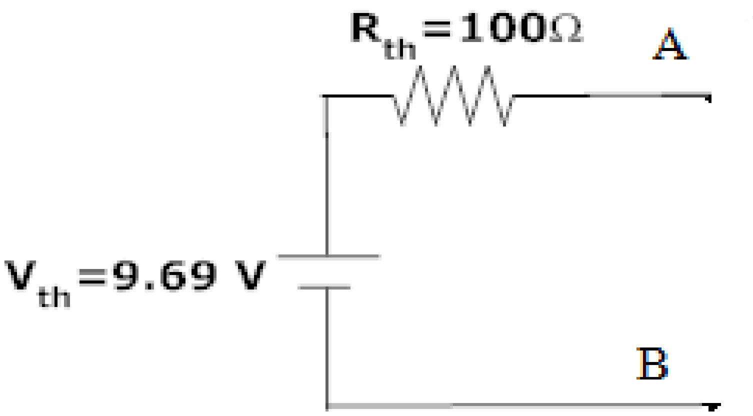

Figure 12.4: Thevenin Equivalent Circuit of Figure 3.1

	Newly Measured Value	Value from Part 2	Value from Part 1
V_{th} (V)			
I_{sc}(mA)			
R_{th} (Ω)			

Figure 12.5: Table 3.3: Measured Thevenin Equivalent Parameters of Figure 3.2

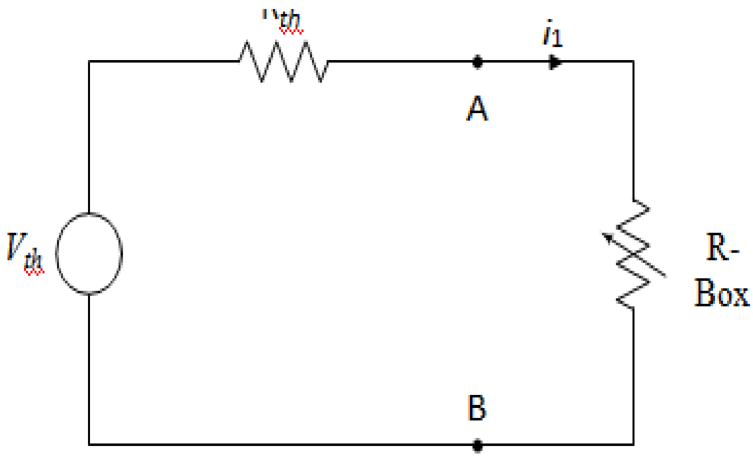

Figure 12.6: Circuit for Maximum Power Transfer

R-Box	V_{R-Box} (V)	P_{R-Box} (mW)
1Ω		
50Ω		
100Ω		
145Ω		
180Ω		
220Ω		
300Ω		
400Ω		
500Ω		

Figure 12.7: Table 3.4: Voltage and Power for Figure 3.3

equivalent circuit developed in Part 2. As shown in Figure 3.3, connect a resistance substitution box R between nodes A and B.
Measure the voltage across R-Box if R = 1Ω and calculate the power dissipated by this resistor (P=V2/R). Repeat with R = 50Ω, 100Ω, 145Ω, 180Ω, 220Ω, 250Ω, 300Ω, and 320Ω. Record all your measurements in Table 3.4.
Part (4) Model graph of resistance Vs power is shown in Figure 3.4.

12.8 Viva Questions

1. State maximum power transfer theorem.
2. Is it possible to apply maximum power transfer theorem to ac as well as dc circuit?
3. How to find power using maximum power transfer theorem?
4. What are conditions for maximum power transfer theorem?
5. Is it possible to apply maximum power transfer theorem to nonlinear circuit?

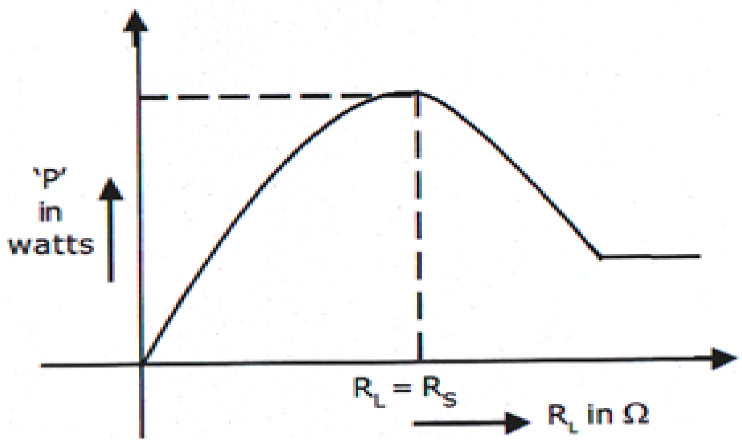

Figure 12.8: Output Graph of Maximum Power Transfer Theorem

12.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to simulate the circuit of Part 4. Start with the value of R = Rmaxpower that you determined experimentally to give maximum power transfer and find, from the MATLAB/Simulink simulation, the power delivered to this resistance. Then repeat with 20Ω increments through 100Ω, Compare the values of power obtained by simulation with those you obtained experimentally. Record your MATLAB/Simulink file and the data obtained from them in your laboratory notebook

EXPERIMENT-7 IMPEDANCE(Z) AND ADMITTANCE(Y) PARAMETERS

13.1 Introduction

This experiment focuses on the calculation of Impedance (Z) and Admittance(Y) Parameters of a two-port network. Determination of Impedance (Z) and Admittance(Y) Parameters of a two-port network is important for analyzing different electrical circuits.

13.2 Objective

By the end of this experiment, the student should be able to calculate the Impedance (Z) and Admittance(Y) Parameters of any electrical circuit.

13.3 Prelab Preparation:

Read the material in the textbook that describes the Impedance (Z) and Admittance(Y) Parameters of a two-port network. Prior to coming to the lab, complete Part 1 and Part 2 of the Procedure.

13.4 Equipment needed

R.P.S, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 220Ω, 150Ω, 100Ω.

13.5 Background

Impedance (Z) Parameters: It can represent voltage in terms of current by impedance parameters of a two port network. Then we will represent the voltage current relations as,
V1 = Z11I1 + Z12 I2
V2 = Z21I1 + Z22 I2
V1 and V2are dependent variables, I1 and I2 are independent variables, Z11 and Z22 is Input and Output driving point impedance. Z12 and Z21 is Reverse and Forward transfer impedance.
Admittance (Y) Parameters: It can represent current in terms of voltage by admittance parameters of a two port network. Then we will represent the current voltage relations as,
I1 = Y11V1 + Y12 V2
I2 = Y21V1 + Y22 V2
I1 and I2are dependent variables, V1 and V2 are independent variables, Y11 and Y22 is Input and Output short circuit admittance. Y12 and Y21 is Short circuit transfer admittance from output to input and from input to output port.

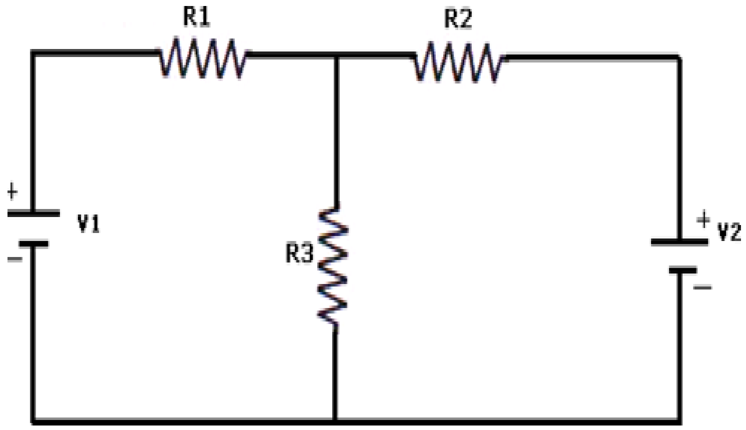

Figure 13.1: Basic Circuit

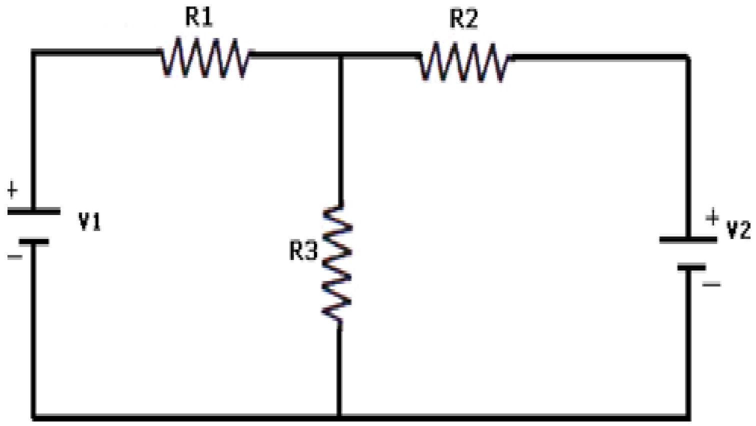

Figure 13.2: Basic Circuit

13.6 Procedure

Part (1) Determine the theoretical values then set up for Impedance (Z) parameters of Figure 6.1 , and record all parameters in Table 6.1.

Part (2) Determine the theoretical values then set up for Admittance (Y) parameters of Figure 6.2 , and record all parameters in Table 6.2.

13.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 6.1. Apply the first DC power supply of 15V and measure the current (I1) in the circuit (i.e. connect the ammeter in first loop of Figure 6.1) and also measure the open circuit voltage (V2) by keeping port2 open circuit (i.e. connect the voltmeter across port2). Now calculate Z11 and Z21 using the formulas

To calculate Z12 and Z22, open circuit port1 (i.e. I1=0) and measure V1 with the voltmeter and I2 with ammeter and calculate Z12 and Z22 using the formulas

Complete table 6.1. And compare the values obtained from part 1 and part 2.

Part (2) Set up the circuit as shown in Figure 6.2. Apply the first DC power supply to 15V and measure the current (I1) in the circuit (i.e. connect the ammeter in first loop of Figure 6.1)

$$A = V_1/V_2 \quad |_{I_2=0}$$

$$C = I_1/V_2 \quad |_{I_2=0}$$

$$B = -V_1/I_2 \quad |_{V_2=0}$$

$$D = -I_1/I_2 \quad |_{V_2=0}$$

When $I_2=0$

S.No	V_1(V)	I_1(mA)	V_2(V)
1			
2			
3			

When $I_1=0$

S.No	V_1(V)	V_2(V)	I_2(mA)
1			
2			
3			

Figure 13.3: Table 6.1:Calculated and Measured values of Z-Parameters of Figure 6.1

$$h_{11} = V_1/I_1 \quad |V_2=0$$

$$h_{21} = I_2/I_1 \quad |V_2=0$$

$$h_{12} = V_1/V_2 \quad |I_1=0$$

$$h_{22} = I_2/V_2 \quad |I_1=0$$

and also measure the short circuit current (I2) with another ammeter by keeping port2 short circuit (i.e. V2= 0). Now calculate Y11 and Y21 using the formulas

To calculate Y12 and Y22, short circuit port1 (i.e. V1= 0) and apply V2 = 10V and measure I1, I2 with ammeters and calculate Y12 and Y22 using the formulas

Complete table 6.2. And compare the values obtained from part 3 and part 4.

13.8 Viva Questions

1. What are Z parameters?
2. What are Y parameters?
3. What is the other name of Z parameter?
4. What is the other name of Y parameter?
5. Give the reciprocity and symmetry condition in terms of Z parameters.
6. Give the reciprocity and symmetry condition in terms of Y parameters.
7. Give the relation between Y and Z parameters.
8. What are the different parameters used to represent two port networks?
9. Represent Z parameter in terms of Y parameter.

When V_2=0

S.No	V_1(V)	I_1(mA)	I_2(mA)
1			
2			
3			

When V_1=0

S.No	I_1(mA)	I_2(mA)	V_2(V)
1			
2			
3			

Figure 13.4: Table 6.2:Calculated and Measured values of Y- Parameters of Figure 6.2

13.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to calculate the Z-parameters for the circuit in Part 1. First, enter the circuit shown in Figure 6.1 using down node as the reference or "ground" node. To measure the short-circuit current in a loop, place an ammeter in each loop in series and to measure the voltage across open circuited terminals connect a voltmeter across the open circuited terminals. Determine the Z-parameters using the formulas by using measured values and compare to your experimentally obtained values in Part 2. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.
Q2. Use MATLAB/Simulink to calculate the Y-parameters for the circuit in Part 3. First, enter the circuit shown in Figure 6.2 using down node as the reference or "ground" node. To measure the short-circuit current in each loop, place an ammeter in each loop in series. Determine the Y-parameters using the formulas by using measured values and compare to your experimentally obtained values in Part 4. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.

EXPERIMENT-8 TRANSMISSION(ABCD) AND HYBRID(H) PARAMETERS

14.1 Introduction

This experiment focuses on the calculation of Transmission (ABCD) and Hybrid (H) Parameters of a two-port network. Determination of Transmission (ABCD) and Hybrid (H) Parameters of a two-port network is important for analyzing power transmission line networks.

14.2 Objective

By the end of this experiment, the student should be able to calculate the Transmission (ABCD) and Hybrid (H) Parameters of any electrical circuit.

14.3 Prelab Preparation:

Read the material in the textbook that describes the Transmission (ABCD) and Hybrid (H) Parameters of a two-port network. Prior to coming to the lab, complete Part 1 and Part 2 of the Procedure.

14.4 Equipment needed

R.P.S, Breadboard, Connecting Wires
Digital Ammeter, Digital Voltmeter and Digital Multimeter
Resistors: 220Ω, 150Ω, 100Ω.

14.5 Background

Hybrid (H) Parameters: Hybrid parameters are also referred as h parameters. These are referred as hybrid because, here Z parameters, Y parameters, voltage ratio, current ratio, all are used to represent the relation between voltage and current in a two port network. The relations of voltages and current in hybrid parameters are represented as,
V1 = Z11I1 + Z12 V2
I2 = Z21I1 + Z22 V2
Transmission (ABCD) Parameters: A major section of power system engineering deals in the transmission of electrical power from one particular place (eg. generating station) to another like substations or distribution units with maximum efficiency. So it's of substantial importance for power system engineers to be thorough with its mathematical modeling. Thus the entire transmission system can be simplified to a two port network for the sake of easier calculations. Transmission parameters represent the input voltage and input current can be expressed in terms of output voltage and output current.

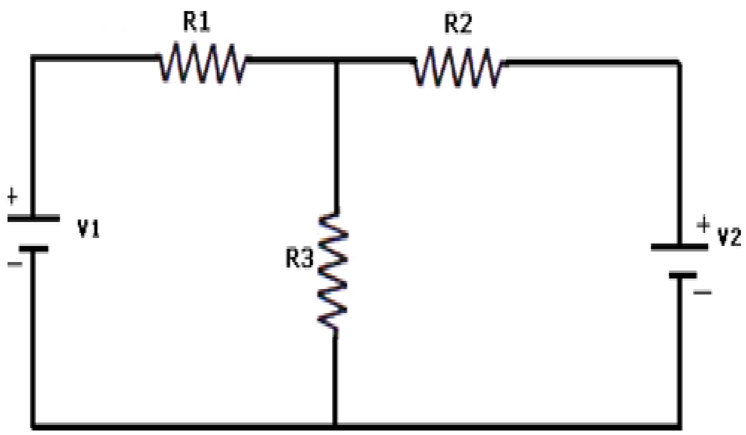

Figure 14.1: Basic Circuit

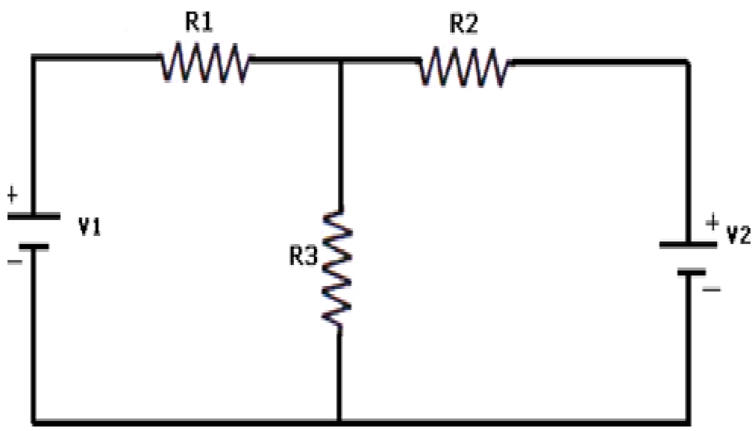

Figure 14.2: Basic Circuit

V1 = AV2 - B I2
I1 = CV2 - D I2

14.6 Procedure

Part (1) Determine the theoretical values then set up of Transmission (ABCD) parameters for Figure 7.1 , and record all parameters in Table 7.1.
Part (2) Determine the theoretical values then set up of Hybrid (H) parameters for Figure 7.2 , and record all parameters in Table 7.2.

14.7 Results and Discussion

Part (1) Set up the circuit as shown in Figure 7.1. Apply the first DC power supply to 15V and measure the current (I1) in the circuit (i.e. connect the ammeter in first loop of Figure 6.1) and also measure the open circuit voltage (V2) by keeping port2 open circuit (i.e. connect the voltmeter across port2). Now calculate A and C using the formulas
To calculate B and D, short circuit port2 (i.e. V2= 0) and apply V1 = 15V and measure I1, I2 with ammeters and calculate B and D using the formulas

$$A = V_1/V_2 \quad |I_2=0$$

$$C = I_1/V_2 \quad |I_2=0$$

$$B = -V_1/I_2 \quad |V_2=0$$

$$D = -I_1/I_2 \quad |V_2=0$$

Complete table 7.1. And compare the values obtained from part 1 and part 2.
Part (2) Set up the circuit as shown in Figure 7.2. Apply the first DC power supply to 15V and measure the current (I1) in the circuit (i.e. connect the ammeter in first loop of Figure 6.1) and also measure the short circuit current (I2) with another ammeter by keeping port2 short circuit (i.e. V2= 0). Now calculate h11 and h21 using the formulas
To calculate h12 and h22, open circuit port1 (i.e. I1=0) and measure V1 with the voltmeter with V2=10V. Also measure I2 with ammeter and calculate h12 and h22 using the formulas
Complete table 7.2. And compare the values obtained from part 3 and part 4.

14.8 Viva Questions

1. What are ABCD parameters?
2. What are h parameters?
3. What is the other name of ABCD parameter?
4. What is the other name of h parameter?
5. Give the reciprocity and symmetry condition in terms of ABCD parameters.
6. Give the reciprocity and symmetry condition in terms of h parameters.
7. Give the relation between ABCD and H parameters.

When $I_2=0$

S.No	V_1(V)	I_1(mA)	V_2(V)
1			
2			
3			

When $V_2=0$

S.No	V_1(V)	I_1(mA)	I_2(mA)
1			
2			
3			

Figure 14.3: Table 7.1:Calculated and Measured values of ABCD- Parameters of Figure 7.1

$$h_{11} = V_1/I_1 \quad |V_2=0$$

$$h_{21} = I_2/I_1 \quad |V_2=0$$

$$h_{12} = V_1/V_2 \quad |I_1=0$$

$$h_{22} = I_2/V_2 \quad |I_1=0$$

When $I_1=0$

S.No	V_1(V)	V_2(V)	I_2(mA)
1			
2			
3			

When $V_2=0$

S.No	V_1(V)	I_1(mA)	I_2(mA)
1			
2			
3			

Figure 14.4: Table 7.2: Calculated and Measured values of h- Parameters of Figure 7.2

8. What are the different parameters used to represent two port networks?
9. Represent ABCD parameter in terms of H parameter.

14.9 Further Probing Experiments

Q1. Use MATLAB/Simulink to calculate the ABCD-parameters for the circuit in Part 1. First, enter the circuit shown in Figure 6.1 using down node as the reference or "ground" node. To measure the short-circuit current in a loop, place an ammeter in each loop in series and to measure the voltage across open circuited terminals connect a voltmeter across the open circuited terminals. Determine the ABCD-parameters using the formulas by using measured values and compare to your experimentally obtained values in Part 2. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.

Q2. Use MATLAB/Simulink to calculate the H-parameters for the circuit in Part 3. First, enter the circuit shown in Figure 6.2 using down node as the reference or "ground" node. To measure the short-circuit current in each loop, place an ammeter in each loop in series. Determine the H-parameters using the formulas by using measured values and compare to your experimentally obtained values in Part 4. Record your MATLAB/Simulink file and the data obtained from the simulation in your laboratory notebook by pasting in the printouts.

.