IQRA NATIONAL UNIVERSITY

DEPARTMENT OF ELECTRICAL ENGINEERING

EEE101 - LINAER CIRCUIT ANALYSIS (LAB)

LAB MANUAL

NAME : ____

ROLL NO. ____

SECTION:______________________ GROUP: _________________________

DEPARTMENT OF ELECTRICAL ENGINEERING

LINEAR CIRCUIT ANALYSIS

LIST OF EXPERIMENTS

S.NO	EXPERIMENTS
0.	Introduction
1.	Analysis of a simple DC circuit by Ohm's Law
2.	Implementation of a Series DC circuit
3.	Implementation of a Parallel DC circuit
4.	Implementation of a Series-parallel DC circuit
5.	Implementation of Ladder and Bridge Circuits
6.	Implementation of Potentiometer and Rheostat in DC Circuits
7.	To analyze a DC circuit by Superposition Theorem
8.	To analyze a DC circuit by Thevenin's Theorem
9.	To analyze a DC circuit by Mesh Analysis
10.	To analyze a DC circuit by Nodal Analysis
11.	To analyze the maximum power transfer in a DC circuit
12.	Implementation of a DC RLC circuit

INTRODUCTION

OBJECTIVE:

EQUIPEMENT USED:

DC POWER SUPPLY:

Figure 1
DC power supply

DIGITAL MULTI-METER (DMM):

Figure 2
Digital multi-meter

RESISTOR:

Figure 3
Resistor

CONNECTING WIRES:

Figure 4
Connecting wires

BREAD BOARD;

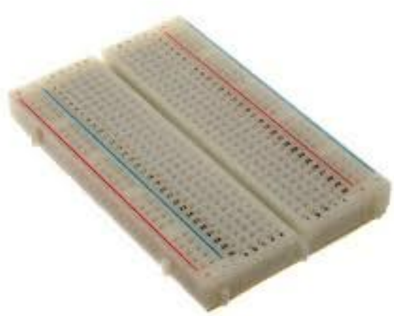


Figure 5
Bread board

CONCLUSION:

POST LAB QUESTION:

DATE: _________________

MARKS OBTAINED: ___________________

INSTRUCTOR'S SIGNATURE: ______________________

EXPERIMENT #01

ANALYSIS OF A SIMPLE DC CIRCUIT BY OHM'S LAW

OBJECTIVE:

THEORY:

RESISTOR:

A **resistor** is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, to adjust signal levels. Like the other components resistors are not manufactured to perfection. That is there will always be the variance in the true value of the component compared to nameplate.

MEASUREMENT OF RESISTANCE BY DMM:

Measurement of resistance by DMM is very straight forward method. Simply set the DMM to resistance function and choose the first scale higher than the expected value. Clip the leads to the resistors and record the value.

MEASUREMENT OF RESISTANCE BY RESISTOR COLOR CODE METHOD:

The resistor color code method uses 4 color bands. First two bands indicate the precision value, while the third band indicates the power of ten applied (i-e number of zeros to add). The fourth band indicated the tolerance.

It is important to note the size of resistor basically shows its power dissipation not the numeric value.

For first, second and third band, resistor color cod is represented as;

Color	Digit

Table 1.1

In order to learn these color codes you can use the mnemonics as;

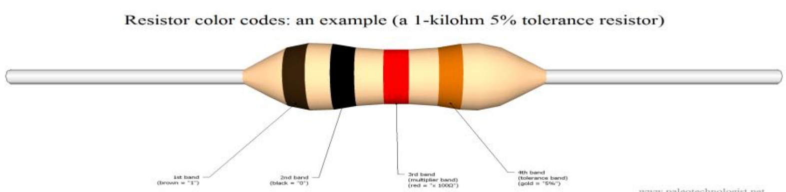
Black **B**ears **R**obbed **O**ur **Y**ummy **G**oodies **B**eating **V**arious **G**ray **W**olves

TOLERENCE:

Tolerance basically shows how much the resistor is accurate. Greater the tolerance less is the precision. Tolerance band can be represented as;

Color	Tolerance

Table 1.2



OHM'S LAW:

Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points. Introducing the constant of proportionality, the resistance one arrives at the usual mathematical equation that describes this relationship:

$$I = \frac{V}{R},$$

Where 'I' is the current through the conductor in units of amperes, **V** is the voltage measured *across* the conductor in units of volts, and **R** is the resistance of the conductor in units of ohms. For a given current an increase in the resistance results in greater voltage. For given voltage, an increase in resistance will produce decrease in current. As this is the first order linear equation, plotting voltage versus current for fixed resistance would produce a straight line graph. The slope of this line is conductance and it is the reciprocal of resistance.

GRAPH:

Figure 1.1
Linear graph of Ohm's law

SCHEMATIC DIAGRAM:

Figure 1.2
Simple DC circuit

APPARATUS:

PROCEDURE:

CALCULATIONS:

For resistor value:

Color	Nominal value	Tolerance value	Minimum value	Maximum value	Measured value

Table 1.3

For 1K ohm resistor:

V (Volts)	I Theoretical	I Measured
0V		
2V		
4V		
6V		
8V		

Table 1.4

For 3.3K ohm resistor:

V (Volts)	I Theoretical	I Measured
0V		
2V		
4V		
6V		
8V		

Table 1.5

CONCLUSION:

POST LAB QUESTIONS:

1. Would it ever be possible to find a resistor value that is outside the stated tolerance? Why or why not?

   ____
   ____
   ____

2. Do the measured values of Table 1.3 represent the exact values of the resistors tested? Why or why not?

   ____
   ____
   ____

3. Does Ohm's Law appear to hold in this exercise?

   ____
   ____
   ____

4. Is there a linear relationship between current and voltage?

   ____
   ____
   ____

DATE: ___________________

MARKS OBTAINED: ___________________

INSTRUCTOR'S SIGNATURE: ___________________

EXPERIMENT #02

IMPLEMENTATION OF A SERIES DC CIRCUIT

OBJECTIVE:

THEORY:

KIRCHHOFF'S VOLATGE LAW (KVL):

Kirchhoff's Voltage Law (KVL) states that the algebraic sum of the voltages across any set of branches in a closed loop is zero.

$$\sum_{k=1}^{n} V_k = 0$$

SERIES DC CIRCUIT:

Series circuits are sometimes called *current*-coupled or daisy chain-coupled. The current in a series circuit goes through every component in the circuit. Therefore, all of the components in a series connection carry the same current. There is only one path in a series circuit in which the current can flow. The formula to search resistance in series is Rs = R1 + R2 + R3.... R_n.The voltage across each of the components is the same, and the total current is the sum of the currents through each component.

CURRENT:

In a series circuit the current is the same for all of elements.

$$I = I_1 = I_2 = I_3 = \ldots = I_r$$

RESISTOR:

The total resistance of resistors in series is equal to the sum of their individual resistances:

$$R_{\text{total}} = R_1 + R_2 + \cdots + R_n$$

VOLTAGE:

The total voltage in the circuit is sum of all the voltages across each of the component.

$$V_{total} = V1+V2+V3\ldots\ldots\ldots\ldots\ldots\ldots\ldots. +Vn$$

SCHEMATIC DIAGRAM:

Figure 2.1
Series DC circuit

APPARATUS:

PROCEDURE:

CALCULATIONS:

Points	I Theoretical	I Measured
A		
B		
C		

Table 2.1

Points	V Theoretical	V Measured
R_1		
R_2		
R_3		
V_{AC}		
V_B		

Table 2.2

CONCLUSION:

.

POST LAB QUESTIONS:

1. Is KVL satisfied in Figure 2.1?

____
____
____

2. For the circuit of Figure 2.1, what is the expected current measurement at each node?

____
____
____

3. For the circuit of Figure 2.1, what is the expected voltage measurement across each resistor?

____
____
____

4. In Figure 2.1, R3 is greater than R2 and less than R1. Would the voltages exhibit the same ratios? What about the currents through the resistors?

____
____
____

5. What is the relation between resistance and current through the circuit?

____
____
____

DATE: ________________

MARKS OBTAINED: __________________

INSTRUCTOR'S SIGNATURE: ____________________

EXPERIMENT #03

IMPLEMENTATION OF A PARALLEL DC CIRCUIT

OBJECTIVE:

THEORY:

PARALLEL DC CIRCUIT:

If two or more components are connected in parallel they have the same potential difference (voltage) across their ends. The potential differences across the components are the same in magnitude, and they also have identical polarities. The same voltage is applicable to all circuit components connected in parallel. The total current is the sum of the currents through the individual components, in accordance with Kirchhoff's current law.

VOLTAGE:

In a parallel circuit the voltage is the same for all elements

$$V = V_1 = V_2 = \ldots = V_n$$

RESISTOR:

The total resistance of resistors in parallel circuit is given as:

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$$

CURRENT:

The current in each individual resistor is found by Ohm's law. Factoring out the voltage gives

$$I_{\text{total}} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}\right).$$

KIRCHHOFF'S CURRENT LAW (KCL):

Kirchhoff's Voltage Law (KVL) states that at any node (junction) in an electrical circuit, the sum of currents flowing into that node is equal to the sum of currents flowing out of that node.

$$\sum_{k=1}^{n} I_k = 0$$

SCHEMATIC DIAGRAM:

Figure3.1
Parallel DC circuit

APPARATUS:

PROCEDURE:

CALCULATIONS:

V Theoretical	V_A	V_B	V_C	V_D	V_E
V Measured	V_A	V_B	V_C	V_D	V_E

Table 3.1

Point	I Theoretical	I Measured
R1		
R2		
R3		
R4		
I Total		

Table 3.2

CONCLUSION:

POST LAB QUESTIONS:

1. Is KCL satisfied in Figure 3.1?

   ____

   ____

   ____

2. For the circuit of Figure 3.1, what is the expected current measurement through each path?

   ____

   ____

   ____

3. For the circuit of Figure 3.1, what is the expected voltage measurement across each resistor?

   ____

   ____

   ____

4. In Figure 3.1, R3 is greater than R2 and less than R1. Would the voltages exhibit the same ratios? What about the currents through the resistors?

   ____

   ____

   ____

DATE:____________________

MARKS OBTAINED:______________________

INSTRUCTOR'S SIGNATURE: _________________________

EXPERIMENT #04

IMPLEMENTATION OF A SERIES PARALLEL DC CIRCUIT

OBJECTIVE:

THEORY:

SERIES-PARALLEL DC CIRCUIT:

Simple series parallel networks maybe viewed as interconnected series and parallel sub-networks. Each these networks maybe analyzed through basic series and parallel techniques such as application of voltage divider and current divider rule along with Kirchhoff's voltage and current law. This is important to analyze most simple series and parallel connections in order to jump to more complex numbers.

VOLTAGE DIVIDER RULE:

A voltage divider (also known as a potential divider) is a passive linear circuit that produces an output voltage (V_{out}) that is a fraction of its input voltage (V_{in}). Voltage division is the result of distributing the input voltage among the components of the divider.

Mathematically given as;

$$V_{\text{out}} = \frac{Z_2}{Z_1 + Z_2} \cdot V_{\text{in}}$$

CURRENT DIVIDER RULE:

In electronics, a current divider is a simple linear circuit that produces an output current (I_X) that is a fraction of its input current (I_T). Current division refers to the splitting of current between the branches of the divider.

A general formula for the current I_X in a resistor R_X that is in parallel with a combination of other resistors of total resistance R_T is;

$$I_X = \frac{R_T}{(R_X) + (R_T)} I_T$$

SCHEMATIC DIAGRAM:

Figure 4.1
Series parallel circuit 1

Figure 4.2
Series parallel circuit 2

APPARATUS:

PROCEDURE:

CALCULATIONS:

V Theoretical	R_1	R_2	R_3
V Measured	**R_1**	**R_2**	**R_3**

Table 4.1

I Theoretical	R_1	R_2	R_3	R_4
I Measured	**R_1**	**R_2**	**R_3**	**R_4**

Table 4.2

V Theoretical	R_1	R_2	R_3	R_4
V Measured	**R_1**	**R_2**	**R_3**	**R_4**

Table 4.3

I Theoretical	R_1	R_2	R_3	R_4
I Measured	**R_1**	**R_2**	**R_3**	**R_4**

Table 4.4

CONCLUSION:

POST LAB QUESTIONS:

1. Are KVL and KCL satisfied in Tables 4.1 and 4.2?
____
____
____

2. Are KVL and KCL satisfied in Tables 4.3 and 4.4?
____
____
____

3. How would the voltages at A, B and C in Figure 4.1 change if a fourth resistor equal to 3.3 k was added in parallel with R3?
____
____
____

4. How would the voltages at A, B and C in Figure 4.1 change if a fourth resistor equal to 3.3 k was added in series with R3?
____
____
____

DATE: _________________

MARKS OBTAINED: ___________________

INSTRUCTOR'S SIGNATURE: ______________________

EXPERIMENT #05

IMPLEMENTATION OF LADDER AND BRIDGE CIRCUITS

OBJECTIVE:

THEORY:

LADDER NETWORKS:

A ladder network is one where the circuit elements are progressively added in series and parallel from left to right, thus forming a chain-like series of loop. One possible technique for the solution of ladder networks is a series of cascading voltage dividers. Current dividers may also be used.

BRIDGE NETWORK:

Bridge networks typically make use of four elements arranged in dual series and parallel configuration. These are often used in measurement systems with the voltage of interest derived from the difference of two series sub-circuit voltages. As in the simpler series-parallel networks; KVL, KCL, the current divider rule and the voltage divider rule may be used in combination to analyze the sub-circuits.

SCHEMATIC DIAGRAM:

Figure 5.1
Ladder Circuit

Figure 5.2
Bridge Circuit

APPARATUS:

PROCEDURE:

CALCULATIONS:

V Theoretical	V_A	V_B	V_C	V_D
V Measured	V_A	V_B	V_C	V_D

Table 5.1

I Theoretical	I_1	I_2	I_3	I_4	I_5	I_6
I Measured	I_1	I_2	I_3	I_4	I_5	I_6

Table 5.2

V Theoretical	V_A	V_B	V_{AB}
V Measured	V_A	V_B	V_{AB}

Table 5.3

I Theoretical	I_1	I_2	I_3
I Measured	I_1	I_2	I_3

Table 5.4

CONCLUSION:

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POST LAB QUESTIONS:

1. In Figure 5.1, if another pair of resistors was added across R6, would VD go up, down, or stay the same? Why?

   ____
   ____
   ____

2. In Figure 5.1, if R4 was accidentally opened would this change the potentials at B, C and D? Why or why not?

   ____
   ____
   ____

3. If the DMM leads are reversed in Step 5, what happens to the measurements in Table 5.3?

   ____
   ____
   ____

4. Suppose that R3 and R4 are accidentally swapped in Figure 5.2. What is the new VAB?

   ____
   ____
   ____

DATE: ___________________

MARKS OBTAINED: ___________________

INSTRUCTOR'S SIGNATURE: ______________________

EXPERIMENT #06

IMPLEMENTATION OF POTENTIOMETER AND RHEOSTAT IN DC CIRCUITS

OBJECTIVE:

The main objective of this lab is the practical working of variable resistors; potentiometers and rheostats in a dc circuit to analyze the effect of variable parameters in a circuit.

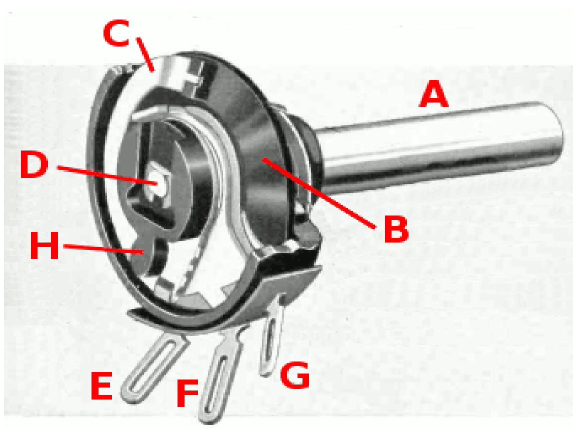
THEORY:

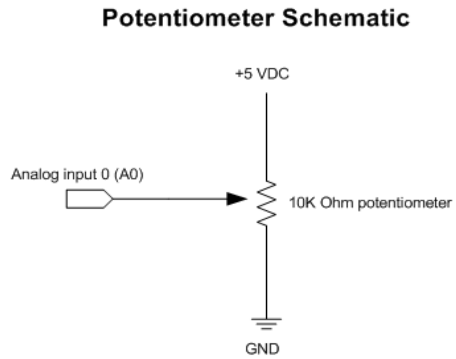
POTENTIOMETER:

A **potentiometer**, informally a **pot**, is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. A potentiometer is used for measuring electric potential (voltage).

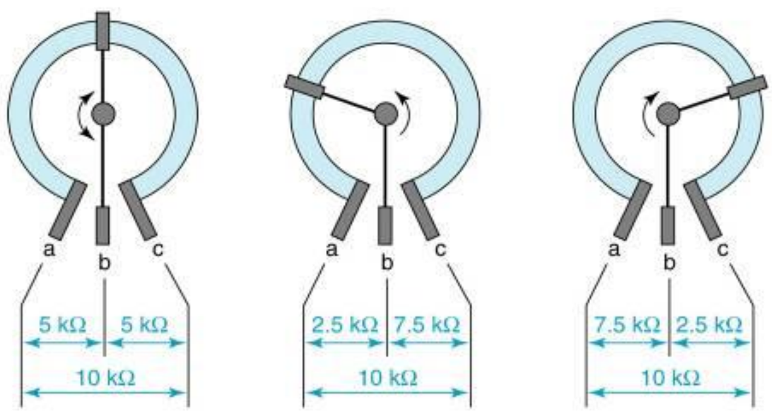
CONSTRUCTION:

Potentiometers consist of a resistive element, a sliding contact (wiper) that moves along the element, making good electrical contact with one part of it, electrical terminals at each end of the element, a mechanism that moves the wiper from one end to the other. Many inexpensive potentiometers are constructed with a resistive element (B) formed into an arc of a circle usually a little less than a full turn and a wiper (C) sliding on this element when rotated, making electrical contact. The resistive element can be flat or angled. Each end of the resistive element is connected to a terminal (E, G) on the case. The wiper is connected to a third terminal (F), usually between the other two. On panel potentiometers, the wiper is usually the center terminal of three. For single-turn potentiometers, this wiper typically travels just under one revolution around the contact.





SETTING VALUE OF RESISTORS:



RHEOSTATS:

A variable resistance used to control current. It is usually a two-terminal variable resistor. Potentiometer can be wired as a rheostat if only a single outer terminal and the wiper are used; the device is merely an adjustable resistor and is referred to as a rheostat. These may be placed in-line with a load to control the load current, the greater the resistance, the smaller the current.

SYMBOLIC REPRESENTATION:

SCHEMATIC DIAGRAM:

Figure 6.1
Potentiometer in DC circuit

Figure 6.2
Rheostat in DC circuit

APPARATUS:

PROCEDURE:

CALCULATIONS:

Position	R_{AW}	R_{WB}	$R_{AW} + R_{WB}$
Fully CCW			
1/4			
1/2			
3/4			
Fully CW			

Table 6.1

Position	V_{WB} Open	V_{WB} 3.3K	V_{WB} 2.2k
Fully CCW			
1/4			
1/2			
3/4			
Fully CW			

Table 6.2

Position	V_L 560	V_L 1k
Fully CCW		
1/4		
1/2		
3/4		
Fully CW		

Table 6.3

CONCLUSION:

POST LAB QUESTIONS:

1. What is the difference between potentiometer and rheostat?

   ____

   ____

   ____

2. How the voltage V_{WB} changes in Table 6.1 at different positions?

   ____

   ____

   ____

3. How the voltage VL changes in Table 6.2 at different positions?

   ____

   ____

   ____

DATE: ________________

MARKS OBTAINED: __________________

INSTRUCTOR'S SIGNATURE: ____________________

EXPERIMENT #07

TO ANALYZE A DC CIRCUIT BY SUPERPOSITION PRINCIPLE

OBJECTIVE:

THEORY:

SUPERPOSITON THEOREM:

The superposition theorem for electrical circuits states that for a linear system the response (voltage or current) in any branch of a bilateral linear circuit having more than one independent source equals the algebraic sum of the responses caused by each independent source acting alone, where all the other independent sources are replaced by their internal impedances.

To ascertain the contribution of each individual source, all of the other sources first must be "turned off" (set to zero) by:

1. Replacing all other independent voltage sources with a short circuit (thereby eliminating difference of potential i.e. V=0; internal impedance of ideal voltage source is zero (short circuit)).
2. Replacing all other independent current sources with an open circuit (thereby eliminating current i.e. I=0; internal impedance of ideal current source is infinite (open circuit)).

SCHEMATIC DIAGRAM:

Figure 7.1
DC circuit with two independent voltage source

APPARATUS:

PROCEDURE:

CALCULATIONS:

Source	V_A Theory	V_A Experimental
E1 Only		
E2 Only		
E1 and E2		

Table 7.1

CONCLUSION:

\

POST LAB QUESTIONS:

1. If one of the sources in Figure 7.1 had been inserted with the opposite polarity, would there be significant change in the resulting voltage at node A? Could both the magnitude and polarity change?
   ____
   ____
   ____

2. If both of the sources in Figure 7.1 had been inserted with the opposite polarity, would there be a significant change in the resulting voltage at node A? Could both the magnitude and polarity change?
   ____
   ____
   ____

3. What changes would be considered if the independent voltage sources in Figure 7.1 be replaced by independent current sources?
   ____
   ____
   ____

DATE:_________________

MARKS OBTAINED:___________________

INSTRUCTOR'S SIGNATURE: _____________________

EXPERIMENT #08

TO ANALYZE A DC CIRCUIT BY THEVENIN'S THEOREM

OBJECTIVE:

THEORY:

THEVENIN'S THEOREM:

Thevenin's Theorem for DC circuits states that any two port linear network may be replaced by a single voltage source with an appropriate internal resistance. The Thevenin equivalent will produce the same load current and voltage as the original circuit to any load.

This equivalent voltage V_{TH} is the voltage obtained at terminals A-B of the network with terminals A-B open circuited.

This equivalent resistance R_{TH} is the resistance obtained at terminals A-B of the network with all its independent current sources open circuited and all its independent voltage sources short circuited.

SCHEMATIC DIAGRAM:

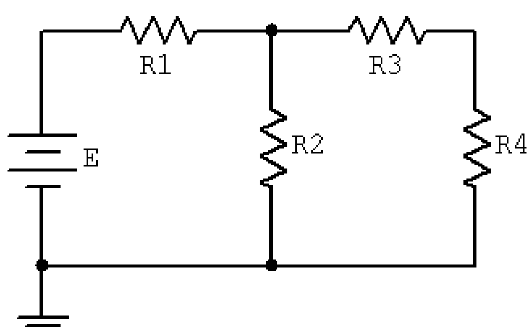


Figure 8.1 DC circuit

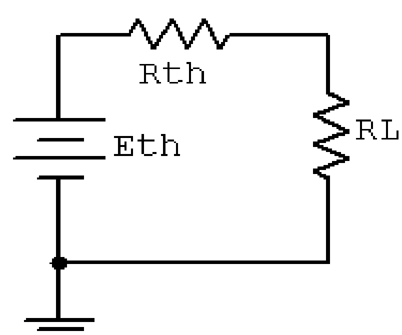


Figure 8.2 Thevenin's equivalent circuit

APPARATUS:

PROCEDURE:

CALCULATIONS:

R_4 (Load)	V_L Theory	V_L Experimental
3.3 k		
560		

Table 8.1

Thevenin values	Theory	Experimental
E_{TH}		
R_{TH}		

Table 8.2

R_4 (Load)	V_L Theory	V_L Experimental
3.3 k		
560		

Table 8.3

CONCLUSION:

POST LAB QUESTIONS:

1. Do the load voltages for the original and Thevenized circuits match for both loads?
____
____
____

2. How Eth is obtained for thevenized circuit?
____
____
____

3. How Rth is obtained for thevenized circuit?
____
____
____

***DATE:*___________________**

***MARKS OBTAINED:*___________________**

***INSTRUCTOR'S SIGNATURE:* ___________________**

EXPERIMENT #09

TO ANALYZE A DC CIRCUIT BY MESH ANALYSIS

OBJECTIVE:

THEORY:

MESH:

The smallest loop around a subset of components in a circuit is called mesh.

Or

Mesh can also be defined as; Loop within in a loop.

Or

Mesh is a loop which doesn't contain any other loop in it.

MESH ANALYSIS:

Technique to find voltage drops around a loop using the currents that flow within the loop, Kirchhoff's Voltage Law, and Ohm's Law. Multi-source DC circuits may be analyzed using a mesh current technique. The process involves identifying a minimum number of small loops such that every component exists in at least one loop. Kirchhoff's Voltage Law is then applied to each loop. The loop currents are referred to as mesh currents as each current interlocks or meshes with the surrounding loop currents. As a result there will be a set of simultaneous equations created, an unknown mesh current for each loop. Once the mesh currents are determined, various branch currents and component voltages may be derived.

STEPS FOE MESH ANALYSIS:

1. Identify all of the meshes in the circuit

2. Label the currents flowing in each mesh

3. Label the voltage across each component in the circuit

4. Write the voltage loop equations using Kirchhoff's Voltage Law.

5. Use Ohm's Law to relate the voltage drops across each component to the sum of the currents flowing through them.

6. Solve for the mesh currents

7. Once the mesh currents are known, calculate the voltage across all of the components.

SCHEMATIC DIAGRAM:

Figure 9.1
DC circuit for mesh analysis

APPARATUS:

PROCEDURE:

CALCULATIONS:

Parameter	Theory	Experimental
V_A		
I_{R1}		
I_{R2}		
I_{R3}		

Table 9.1

CONCLUSION:

POST LAB QUESTIONS:

1. Explain a difference between a mesh a loop?

   ____
   ____
   ____

2. What is mesh analysis used for?

   ____
   ____
   ____

3. Do the polarities of the sources in Figure 9.1 matter as to the resulting currents? Will the magnitudes of the currents be the same if one or both sources have an inverted polarity?

   ____
   ____
   ____

DATE: ________________

MARKS OBTAINED: __________________

INSTRUCTOR'S SIGNATURE: ___________________

EXPERIMENT #10

TO ANALYZE A DC CIRCUIT BY NODAL ANALYSIS

OBJECTIVE:

THEORY:

NODE:

In electrical engineering, node refers to any point on a circuit where two or more circuit elements meet. For two nodes to be different, their voltages must be different.

NODAL ANALYSIS:

In electric circuits analysis, **nodal analysis**, **node-voltage analysis**, or the **branch current method** is a method of determining the voltage (potential difference) between "nodes" (points where elements or branches connect) in an electrical circuit in terms of the branch currents. Multi-source DC circuits may be analyzed using a node voltage technique. The process involves identifying all of the circuit nodes, a node being a point where various branch currents combine. A reference node, usually ground, is included. Kirchhoff's Current Law is then applied to each node. Consequently a set of simultaneous equations are created with an unknown voltage for each node with the exception of the reference.

STEPS FOR NODAL ANALYSIS:

1. Note all connected wire segments in the circuit. These are the *nodes* of nodal analysis.
2. Select one node as the ground reference. The choice does not affect the result and is just a matter of convention. Choosing the node with the most connections can simplify the analysis. For a circuit of N nodes the number of nodal equations is $N-1$.
3. Assign a variable for each node whose voltage is unknown. If the voltage is already known, it is not necessary to assign a variable.
4. For each unknown voltage, form an equation based on Kirchhoff's current law. Basically, add together all currents leaving from the node and mark the sum equal to zero. Finding the current between two nodes is nothing more than "the node you're on, minus the node you're going to, divided by the resistance between the two nodes."
5. If there are voltage sources between two unknown voltages, join the two nodes as a super node. The currents of the two nodes are combined in a single equation, and a new equation for the voltages is formed.
6. Solve the system of simultaneous equations for each unknown voltage

SCHEMATIC DIAGRAM:

Figure 10.1
DC circuit for nodal analysis

APPARATUS:

PROCEDURE:

CALCULATIONS:

Parameter	**Theory**	**Experimental**
V_A		
V_B		
V_{AB}		
I_{R4}		

Table 10.1

CONCLUSION:

POST LAB QUESTIONS:

1. What is nodal analysis used for?

____
____
____

2. Do the polarities of the sources in Figure 9.1 matter as to the resulting currents? Will the magnitudes of the currents be the same if one or both sources have an inverted polarity?

____
____
____

3. How many equations would be needed to find VA and VB of Figure 10.1?

____
____
____

4. If mesh analysis was applied to the circuit of Figure 10.1, how many unknown currents would have to be analyzed and how many equations would be needed?

____
____
____

***DATE:*__________________**

***MARKS OBTAINED:*____________________**

***INSTRUCTOR'S SIGNATURE:* _____________________**

EXPERIMENT # 11

TO ANALYZE THE MAXIMUM POWER TRANSFER IN A DC CIRCUIT

OBJECTIVE;

THEORY:

MAXIMUM POWER TRANSFER:

In order to achieve the maximum load power in a DC circuit, the load resistance must equal the driving resistance, that is, the internal resistance of the source. Any load resistance value above or below this will produce a smaller load power. System efficiency (η) is 50% at the maximum power case. This is because the load and the internal resistance form a basic series loop, and as they have the same value, they must exhibit equal currents and voltages, and hence equal powers. As the load increases in resistance beyond the maximizing value the load voltage will rise, however, the load current will drop by a greater amount yielding a lower load power. Although this is not the maximum load power, this will represent a larger percentage of total power produced, and thus a greater efficiency (the ratio of load power to total power).

APPARATUS:

SCHEMATIC DIAGRAM:

Figure 11.1
Max power transfer in DC circuit

PROCEDURE:

CALCULATIONS:

R_L,	V_L	P_L	P_T	η

Table 11.1

CONCLUSION:

POST LAB QUESTIONS:

1. At what point does maximum load power occur?

____
____
____

2. At what point does maximum total power occur?

____
____
____

3. At what point does maximum efficiency occur?

____
____
____

***DATE:*_________________**

***MARKS OBTAINED:*___________________**

***INSTRUCTOR'S SIGNATURE:* ____________________**

EXPERIMENT #12

IMPLEMENTATION OF A DC RLC CIRCUIT

OBJECTIVE:

THEORY:

The inductor behaves identically to the resistor in terms of series and parallel combinations. That is, the equivalent of a series connection of inductors is simply the sum of the values. For a parallel connection of inductors either the product-sum rule or the "reciprocal of the sum of the reciprocals" rule may be used. Capacitors, in contrast, behave in an opposite manner. The equivalent of a parallel grouping of capacitors is simply the sum of the capacitances while a series connection must be treated with the product-sum or reciprocal rules. For circuit analysis in the steady state case, inductors may be treated as shorts (or for more accuracy, as a small resistance known as the coil resistance, R_{coil}, which is dependent on the construction of the device) while capacitors may be treated as opens. If multiple capacitors are in series, the applied voltage will be split among them inversely to the capacitance. That is, the largest capacitors will drop the smallest voltages.

SCHEMATIC DIAGRAM:

Figure 12.1
DC RLC circuit

APPARATUS:

PROCEDURE:

CALCULATIONS:

Components	Vs	V Theory	V Experimental
R1			
R2			
C1			
L1			

Table 12.1

CONCLUSION:

POST LAB QUESTIONS:

1. How do capacitors and inductors in series and in parallel compare with resistors?

____
____
____

2. In a series combination of capacitors, how does the voltage divide up?

____
____
____

3. For DC steady state analysis, what can be said about capacitors and inductors?

____
____
____

DATE: ________________

MARKS OBTAINED: __________________

INSTRUCTOR'S SIGNATURE: ___________________