

ملاحظة مهمة جداً جداً جداً : هذا الريبورت وغيره ليس للنقل الحرفي .. هو مجرد وسيلة للمساعدة وأخذ الأفكار حول الطريقة الصحيحة لكتابة ريبورت (غير هيك مبروك عليكم علامة الصفر .. اللهم بلغت اللهم فاشهد)

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<<Experiment 3>>

The Objectives :

The objective of this experiment is to analyze resistive circuits in DC, employing the node-voltage method, the mesh-current method, superposition method. Experimental results will allow the verification of the theoretical analysis.

Theory :

Techniques Of Circuits Analysis :

In electric circuits analysis, nodal analysis or a node-voltage analysis is a method of determining the voltage between nodes in an electrical circuit in terms of the branch currents.

In analyzing a circuit using Kirchhoff's circuit laws, one can either do nodal analysis using Kirchhoff's current law (KCL) or mesh analysis using Kirchhoff's voltage law (KVL)

1- Nodal Analysis

Nodal analysis is a method that provides a general procedure for analyzing circuits using node voltages as the circuit variables. Nodal Analysis is also called the Node-Voltage Method.

Some Features of Nodal Analysis are as

Nodal Analysis is based on the application of the Kirchhoff's Current Law (KCL). Having (n) nodes there will be $(n-1)$ simultaneous equations to solve. Solving $(n-1)$ equations all the nodes voltages can be obtained. The number of non reference nodes is equal to the number of Nodal equations that can be obtained.

2- Mesh Analysis

In Mesh analysis, we will consider the currents flowing through each mesh. Hence, Mesh analysis is also called as Mesh-current method.

A branch is a path that joins two nodes and it contains a circuit element. If a branch belongs to only one mesh, then the branch current will be equal to mesh current.

If a branch is common to two meshes, then the branch current will be equal to the sum (or difference) of two mesh currents, when they are in same (or opposite) direction.

3-The Superposition

Some circuits have more than one current or voltage source. Superposition theorem defines a method to determine the currents and voltages in such a circuit. This is done by considering each source at a time, while all other sources are replaced by their internal resistances. The superposition theorem states: Current (or voltage) in any given branch of a multiple-source linear circuit can be found by determining the currents (or voltages) in a particular branch, produced by each source acting alone, with all other sources replaced by their internal resistances. The total current (or voltage) in the branch is the algebraic sum of the individual source currents (or voltages) in that branch.

Equipment :

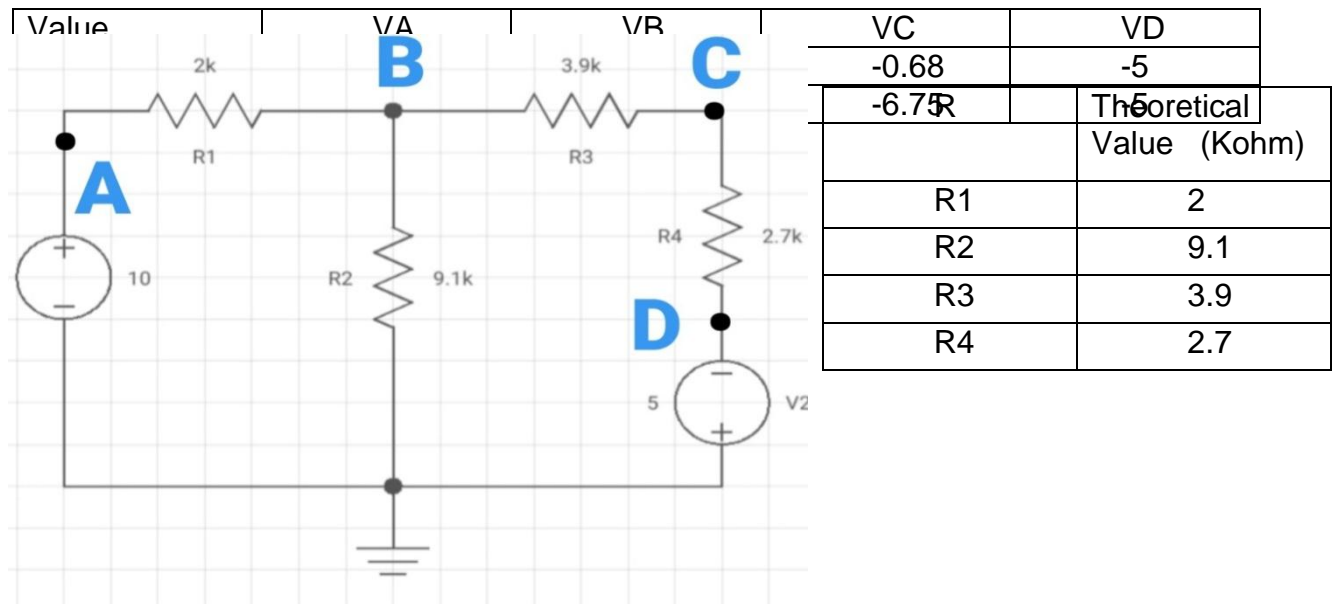
- Breadboard
- Digital Multimeter (DMM)
- 2 Power Supply
- 4 resistors

- wires

Procedure :

Part 1 : Nodal Analysis

- 1- We will take 4 resistors their values in the table and build the circuit on the breadboard as shown in the figure:



- 2- Switch on DC power supply and set it in 10 v and 5 v (we need two sources in our circuit)
- 3- use DMM to measured the voltage .
- 4- Determine the voltages across each node with respect to the ground as in the sheet (Note: connect the red wire with the node and the black wire with the ground, if we reverse the polarity of the voltages we will get opposite sign).
- 5- We record the values in the table :

There are some calculation we have dome in this experiment

In the following circuit we have 3 nodes from which one is reference node and other two are non reference nodes .

*Assign the nodes voltages as V_b and V_c also mark the directions of branch currents with respect to the reference nodes .

*Apply KCL to Nodes B and C
KCL at Node B

$$I_1 + I_2 + I_3 = 0$$

KCL at Node C

$$I_3 = I_4$$

*Apply Ohm's Law to KCL equations

- **Ohm's law** to KCL equation at Node B

$$(V_b - 10)/2 + (v_b - v_c)/3.9 + (v_b)/9.1 = 0 \dots (1)$$

- KCL equation at Node C

$$(v_c + 5)/2.7 + (v_c - v_b)/3.9 = 0 \dots (2)$$

Solve 1 and 2 \longrightarrow $v_a = 10 \text{ v}$, $v_b = 5.57 \text{ v}$, $v_c = -0.675 \text{ v}$, $v_d = -5 \text{ v}$

Part 2 : Mesh Analysis

1 – In the same circuit we will determine the current through the two loops

2- we connect the DMM as a ammeter series with each loop and record the values of currents in the table.

Value	I1	I2
Measured		
Theoretical	2.214 mA	1.6017 mA

There are some calculations we have done in this part :

we apply kvl at loop 1:

$$-10 + 2K * I_1 + 9.1K (I_1 - I_2) \longrightarrow 1$$

$$-5 + 9.1K (I_2 - I_1) + 3.9K * I_2 + 2.7K * I_2 \longrightarrow 2$$

From solving two equations we have .

$$I_1 = 2.214 \text{ mA}$$

$$I_2 = 1.6017 \text{ mA}$$

Part 3 : Superposition Analysis

- 1- In the same circuit we will Replace V1 with a short circuit, keep V2 ON and connect the DMM as a voltmeter with node B and ground (as we describe in last part to measure the VB' and we repeated the same process on the node c to measure VC' then record the measurements in the table (Be careful to follow the passive sign convention).
- 2- Replace V2 with a short circuit, return V1 ON and connect the DMM as a voltmeter with node B and the ground to measure the VB'' and we repeated the same process on the node c to measure VC'' then record the measurements in the table.
- 3- We will replace v1 with a short circuit , we keep the v2 on and we connect the DMM as a ameter to measure the current through the two loops (I1' ,I2') and record the measurement in the table .
- 4- Replace V2 with a short circuit , return v1 ON and we connect the DMM as a ammeter to measure the current through the two loops (I1'' ,I2'') and record the measurement in the table

value	VB'	VB''	VC'	VC''	I1'	I1''	I2'	I2''
measured	-1	6.55	-3.36	2.68				
theoretical	-0.994	6.566	-3.36	2.686	-0.497	1.717	0.607	0.994

There are some calculations we have done in this part :

First we killed the 10 V source and found the values using nodal analysis :

$$(VB'/9.1k)+(VB'/2k)+(VB'+5)/6.6k =0$$

$$VB' = -0.994 \text{ V}$$

$$I2'=(VB'+5)/6.6k \quad \text{---} > I2'= 0.607 \text{ mA}$$

$$(VB' - VC')/3.9K =0.607 \quad \text{---} > VC'=-3.36 \text{ V}$$

$$I1'= VB'/2k = -0.497 \text{ mA}$$

then we killed the 5 V source and found the values:

$$(VB''-10)/2k +(VB''- VC'')/3.9k + VB''/9.1k=0 \quad \text{---} > 1$$

$$(VC''/2.7k)+(VC''- VB'')/3.9k =0 \quad \text{---} > 2$$

$$V_B = 6.566 \text{ v}$$

$$V_C = 2.686 \text{ v}$$

$$I_1 = (10 - 6.566) / 2K = 1.717 \text{ mA}$$

$$I_2 = 2.686 / 2.7K = 0.994 \text{ mA}$$

Conclusion :

- We learn how to find the voltage on each node in the circuit we have built
- We should connect the red wire that come from DC source with the node we want to measure his value and the black wire will be the ground
- In super position when we want to make short circuit instead any source we put the red wire above black wire that connected to DC source