



The Hashemite University

Faculty of Engineering

Department of Electrical Engineering

Experiment "8" (Complex Power & Power Factor)

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Date: 27/12/2020

Day: Sunday

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.

Theoretical:

In the previous experiment we analyze the circuit using Kirchhoff's & ohm's laws, but if the circuit contain more element it will be difficult to use this law's so there is a new method will used to analyze this kind of circuits such that ,node-voltage method , mesh-current method, and superposition method,(mesh & node method using for all types of circuit in general but superposition used only in linear circuits).

Definitions of Linear circuits:

linear element: it is a passive element has a linear voltage – current relationship (if you multiply the current by constant k the voltage will also multiply by the same constant).

linear dependent source: it is a dependent current or voltage source whose output is proportional only to the first power of a specified current or voltage variable in the circuit or to the sum of each quantities.

linear circuit: it is a circuit composed entirely of independent sources, linear dependent sources & linear elements.

1.Node- Voltage Method:

It's technique permits description of the circuit in term of $n-1$ equations (n : # of nodes), when you calculate the # of node N we select one of it as reference(which usually the ground or the node with the most branches) then the equation written by KCL in term of node voltage.

2.Mesh- Current Method:

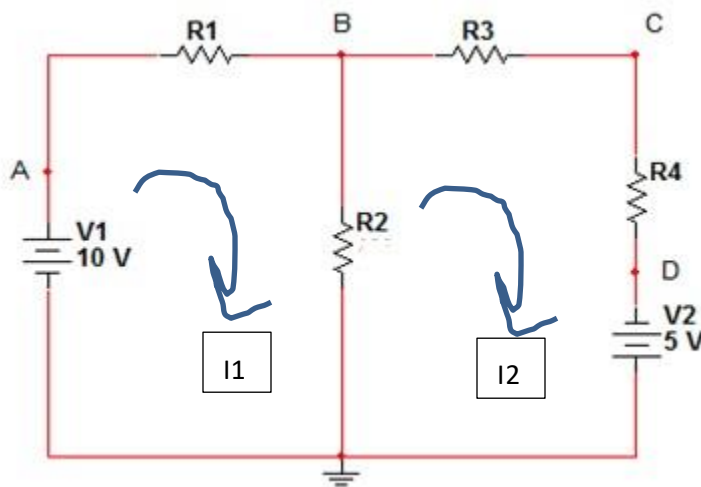
It's technique permits description of the circuit in term of $b-(n-1)$ equations (n : # of nodes, b : # of branches), the equations are formulated by applying KVL to each mesh , expressing the voltage across each element on mesh current, then the system of equation will solved & the current in each branch can be calculated.

3. Superposition Principle:

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.

Procedure:

- **Nodal Analysis:** Use the Nodal Analysis to find the theoretical values.



R	Theoretical Value (Kohm)	Measured Value (Kohm)
R1	1.8	1.79
R2	9.1	9.04
R3	3.9	3.83
R4	2.7	2.66

	VA	VB	VC	VD
Measured Value	10	5.84	-0.55	-4.99
Theoretical Value	10	5.873	-0.552	-5

To calculate Theoretical Value

Node A \rightarrow $V_A = V_1 = 10V$

Node B \rightarrow $\frac{V_B - 10}{R_1} + \frac{V_B}{R_2} + \frac{V_B - V_D}{R_4 + R_3} = 0$

$V_D = V_2 = -5V$

$V_B = 5.873V$

Node C \rightarrow $\frac{V_C + 5}{R_4} + \frac{V_C - V_B}{R_3} = 0$

$V_C = -0.552$

- **Mesh Analysis** Use the Mesh Analysis to find the theoretical values

Value (mA)	I1	I2
Measured Value	2.2 mA	1.66 mA
Theoretical Value	2.29mA	1.647mA

To calculate Theoretical Value

Mesh 1

$$-10 + I_1 \times R_1 + R_2(I_1 - I_2) = 0$$

Eq 1

Mesh 2

$$I_2(R_3 + R_4) - 5 + R_2(I_2 - I_1) = 0$$

Eq2

Eq1 in Eq2

$$I_1 = 2.29 \text{ mA}$$

$$I_2 = 1.647 \text{ mA}$$

- **Superposition Analysis:** Use the Superposition Analysis to find the theoretical values.

Kill source v2 to find VB', VC'

0

$$\frac{V_B' - V_C'}{R_3} - \frac{V_B'}{R_2} + \frac{V_B' - 10}{R_1} = 0$$

Eq1

$$\frac{V_C'}{R_4} - \frac{V_C' - V_B'}{R_3} = 0$$

Eq 2

Eq1 in Eq2

$$V_C' = 2.78 \text{ V}$$

$$V_B' = 6.80 \text{ V}$$

And then kill v1 to find V_B'' , V_C''

$$\frac{V_B''}{R1} + \frac{V_B''}{R2} + \frac{V_B'' - (-5)}{R1} = 0 \quad \text{Eq1}$$

$$\frac{V_C'' - (-5)}{R4} + \frac{V_C'' - V_B''}{R3} = 0 \quad \text{Eq12}$$

Eq1 in Eq2

$$V_C'' = -4.9V$$

$$V_B'' = -0.9V$$

Value(V)	V_B'	V_B''	V_C'	V_C''
Measured	6.78	-0.933	2.78	-4.99
Theoretical	6.80	-0.9	2.7819	-4.9

Equipments:

- Digital Multimeter (DMM)
- Breadboard ○ Power Supply (PS)
- Resistors
- Wires

Conclusion:

Methods: Nodal, Mesh and Superposition

You can find values in a circuit depend on KVL and KCL using mesh and nodal analysis easily.

Nodal to measure voltage for node with respect with ground, Mesh to measure current, leading to obtain the needed responses and Superposition make to find values of circuit through turn on for one source and turn off for other source and using kvl and kcl .

All of method used to measure values of circuit but it varies depending on the circuit.