SNS COLLEGE OF ENGINEERING

Coimbatore-35
An Autonomous Institution
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New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

I ECE / II SEMESTER

Unit 1 –BASIC CIRCUITS ANALYSIS

Topic 5 -– Mesh Analysis

Mesh Analysis

Mesh Analysis?

What is Mesh Analysis

Mesh analysis is defined as

The method in which the current flowing through a planar circuit is calculated.

A planar circuit is defined as the circuits that are drawn on the plane surface in which there are no wires crossing each other. Therefore, a mesh analysis can also be known as loop analysis or mesh-current method.

What is Branch

A branch is defined as the path that connects two nodes such that it contains a circuit element. If the branch belongs to only one mesh, then the branch current and the mesh current will be equal to each other.

Procedure of Mesh Analysis

The following steps are to be followed while solving the given electrical network using mesh analysis:

Step 1:

To identify the meshes and label these mesh currents in either clockwise or counterclockwise direction.

Step 2:

To observe the amount of current that flows through each element in terms of mesh current.

Step 3:

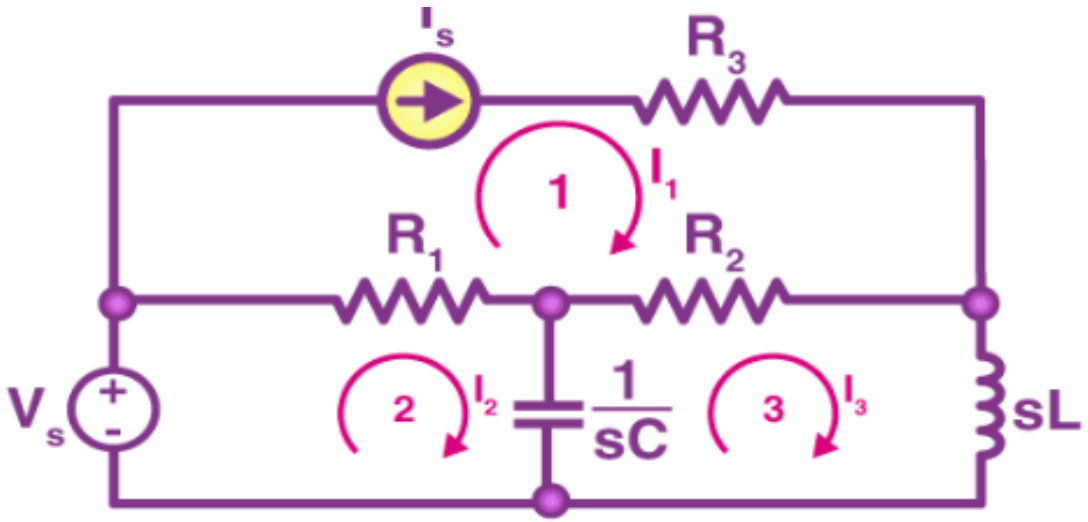
Writing the mesh equations to all meshes using Kirchhoff's voltage law and then Ohm's law.

Step 4:

The mesh currents are obtained by following Step 3 in which the mesh equations are solved. Hence, for a given electrical circuit the current flowing through any element and the voltage across any element can be determined using the node voltages.

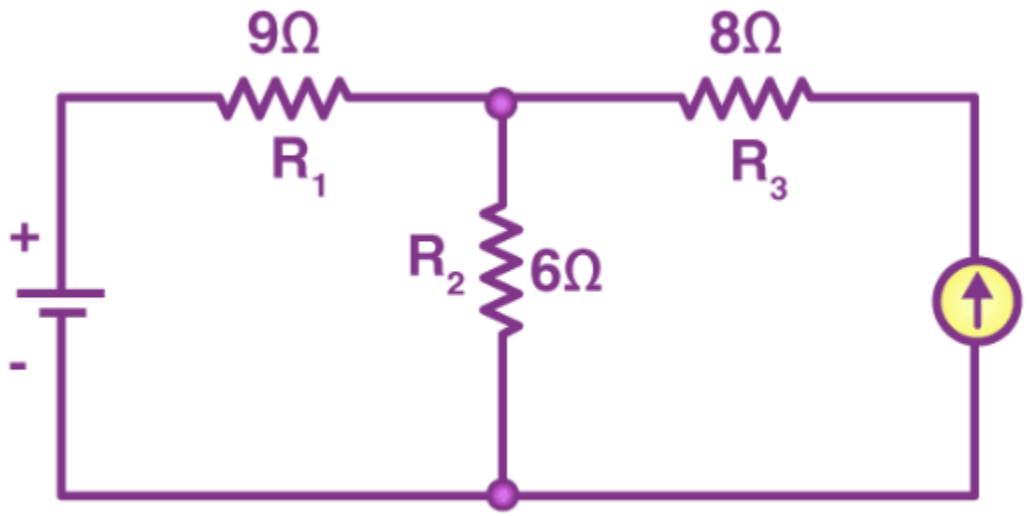
Mesh Current Diagram

The below diagram is a circuit with mesh currents labelled as I_1, I_2, and I_3 and the arrows represent the direction of the mesh current.



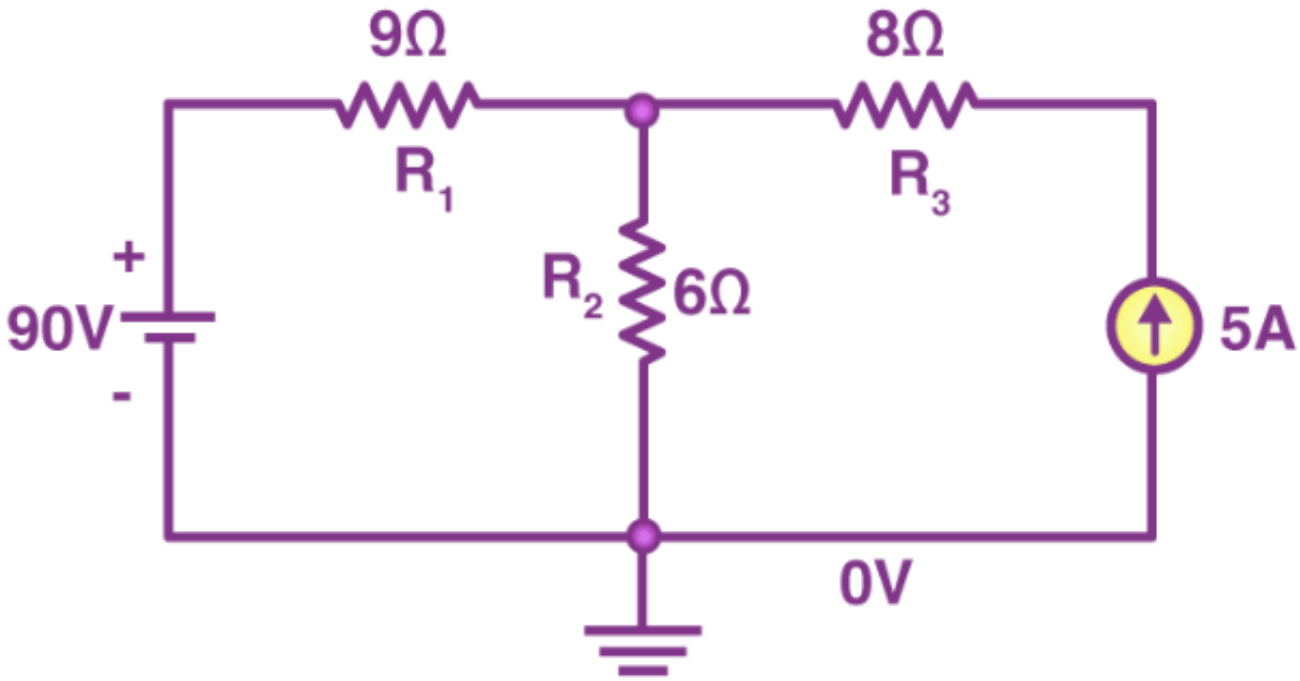
Example of Mesh Analysis

Example 1:
In the given circuit 90v is the battery value, 5A is the current source and the three resistors are 9 ohms, 6 ohms, and 8 ohms. Using mesh analysis, determine the current across each resistor and potential difference.

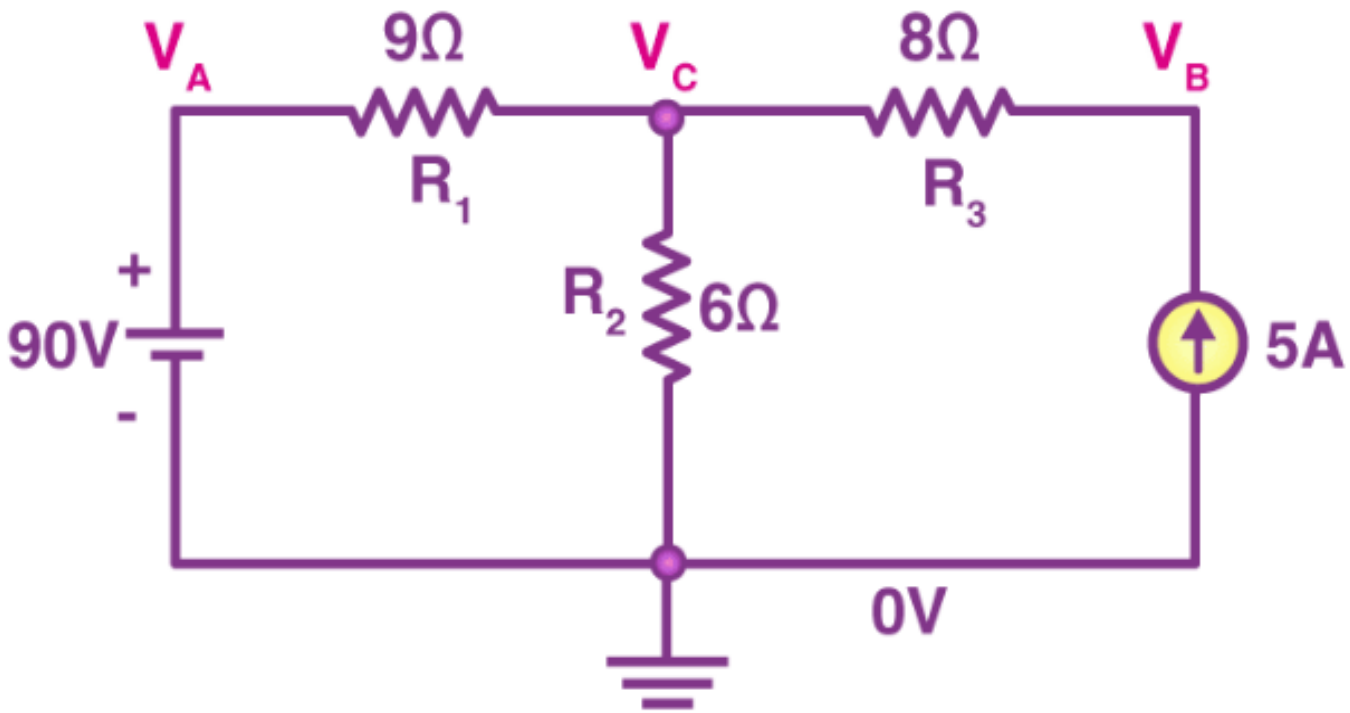


Solution:

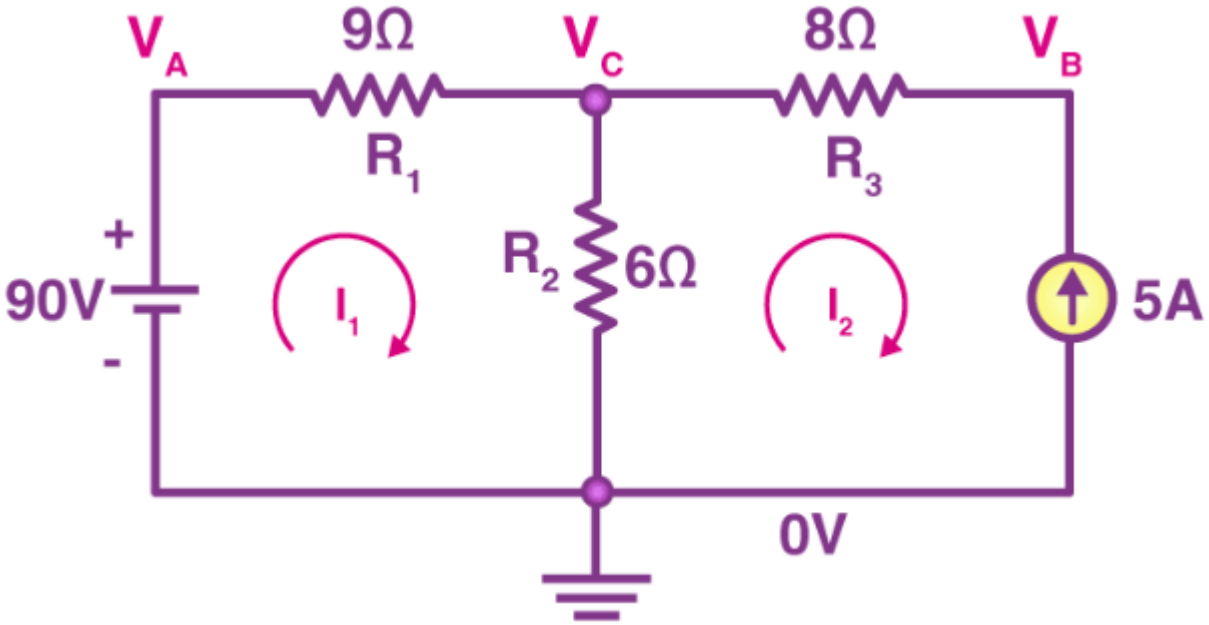
Let’s first determine the ground as shown in the figure



Let the potential be V_A, V_B, and V_C as shown in the figure



Let I_1 and I_2 be the currents flowing through the two loops in the clockwise direction as shown in the figure



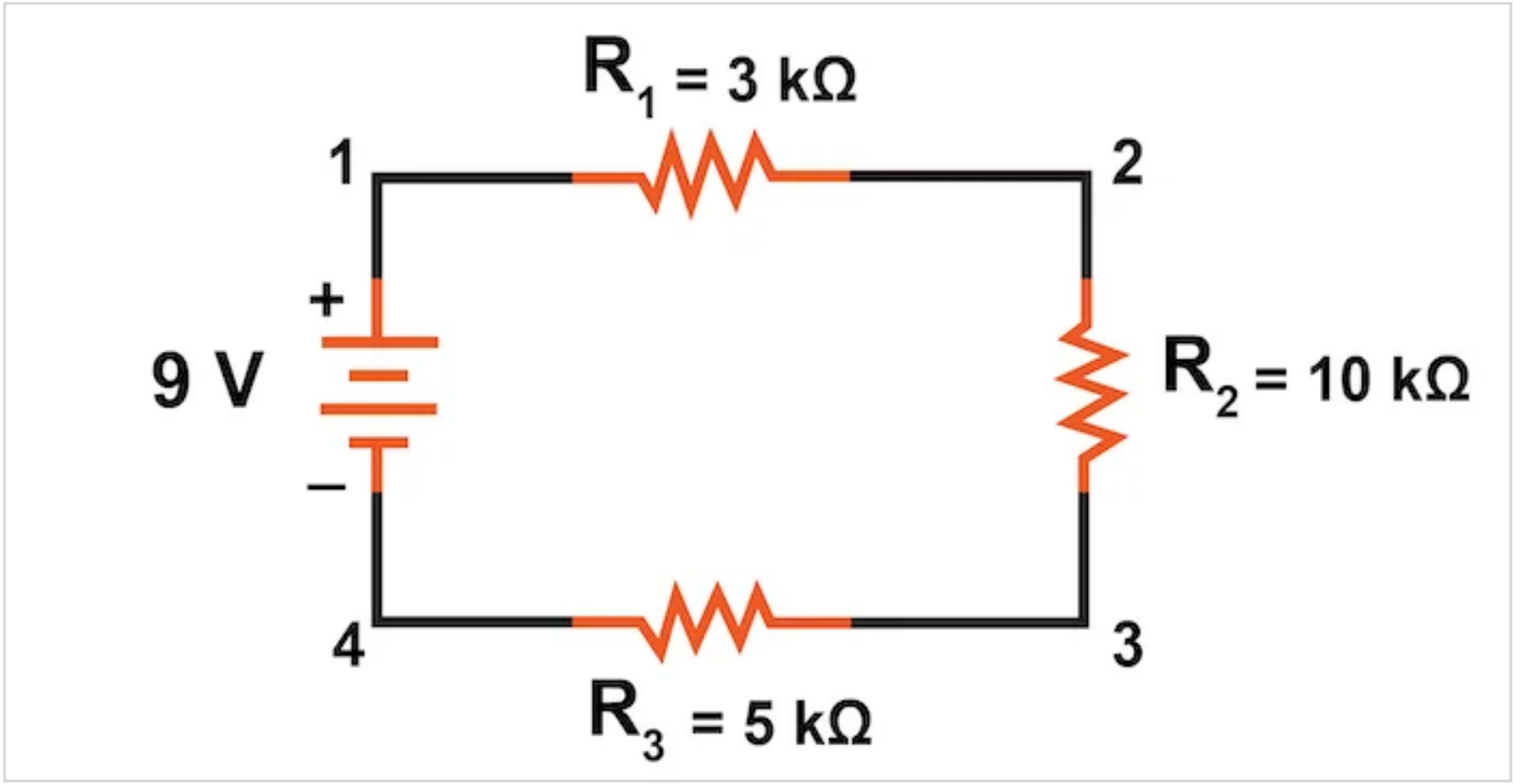
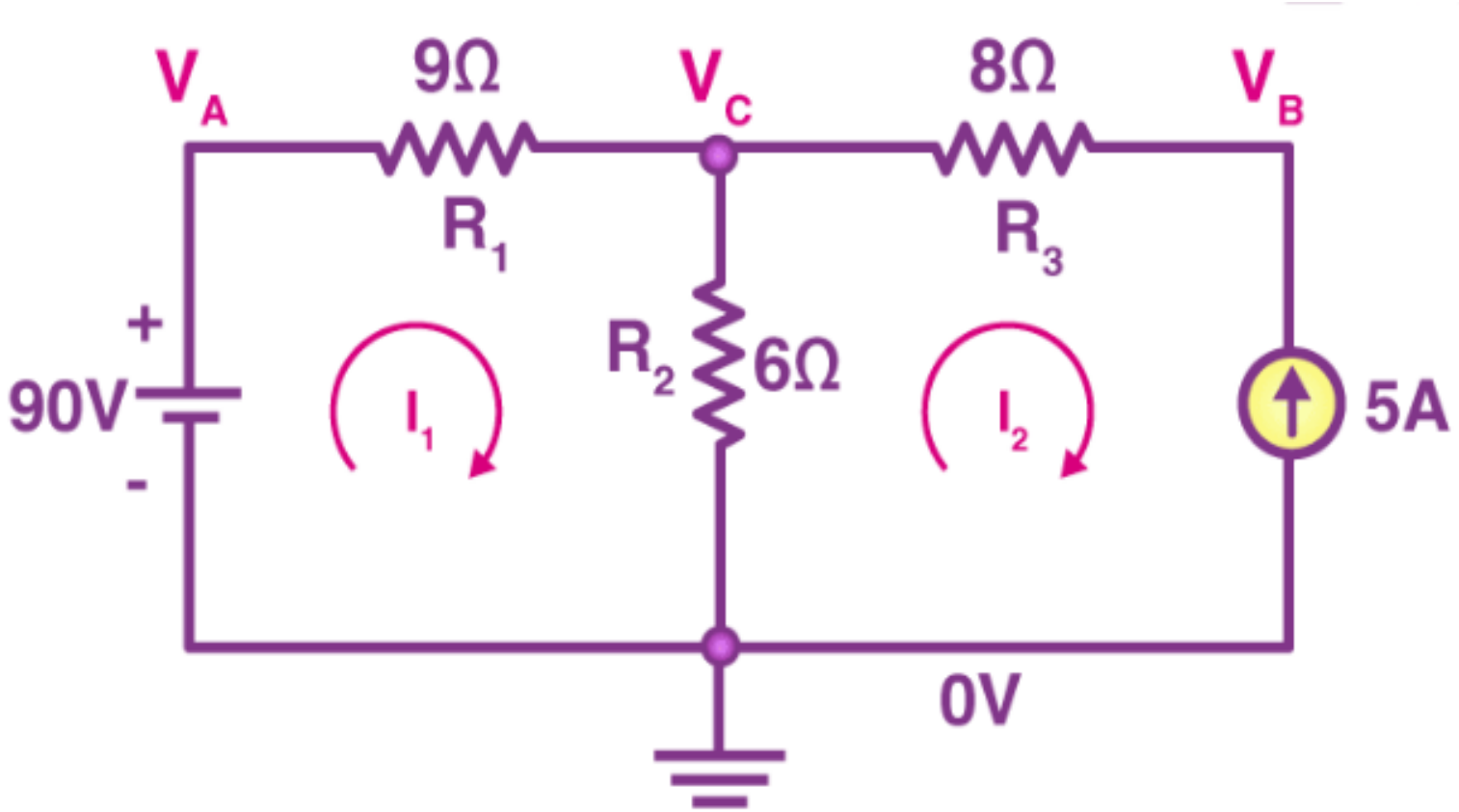


Figure 1. *Series circuit with a battery and three resistors.*


V_A
9Ω
V_C
8Ω
V_B
R_1
R_3
+
90V
-
R_2
6Ω
I_1
I_2
5A
0V

Therefore,

$+V_B - V_1 - V_2 = 0$

$90 - I_1R_1 - R_2(I_1 - I_2) = 0$

$90 - 9I_1 - 6(I_1 - I_2) = 0$

$-15I_1 + 6I_2 = -90$

$5I_1 - 2I_2 = 30$ (this is obtained by dividing the equation with -3)

Substituting I_2 as -5 since the direction of I_2 is opposite to the actual direction of current

Therefore,

$I_1 = 4A$

So, through R_1, 4A current is flowing and through R_3, 5A current is flowing.

Now the potential difference at $V_A = 90V$

At V_B, the potential difference is $V_2 = I_2 - R_2$

Therefore, $V_B = 54V$

At V_C, the potential difference is $V_3 = I_3 - R_3$

$V_C - 54 = 40$

$V_C = 94V$

Q1.What is the difference between loop and mesh?

The difference between loop and mesh is that a loop is a closed path in a circuit in which none of the nodes repeat more than once. While a mesh is a closed path in a circuit in which no other paths are present.

Q2.**What are the limitations of mesh analysis?**

The following are the disadvantages of mesh analysis:

•Mesh analysis is useful only when the circuit is planar.

•As the number of meshes increases, the number of equations increases, which makes it inconvenient for solving.

Q3.**Which Kirchhoff's law is used in mesh analysis?**

Kirchhoff's voltage law is used in mesh analysis.

Q4

What is the difference between mesh and nodal analysis?

The difference between mesh and nodal analysis is that nodal analysis is an application of Kirchhoff's current law, which is used for calculating the voltages at each node in an equation. While mesh analysis is an application of Kirchhoff's voltage law which is used for calculating the current.

Q5

What is a dependent source?

A dependent source in an electrical network is defined as either a voltage source or a current source whose value is dependent on the voltage or current in the network. Voltage-controlled voltage source, voltage-controlled current source, current-controlled current source, and current-controlled voltage source are the classification of the dependent sources.

Multiple choice question

1.What is the primary purpose of mesh analysis in circuit analysis? a) To find the voltage at different nodes in the circuit
b) To find the current in each mesh of the circuit
c) To find the resistance in the circuit
d) To calculate the power dissipated in the circuit

2.In mesh analysis, what is a mesh? a) A voltage loop
b) A current loop
c) A resistance loop
d) A point in the circuit

3.Which of the following is the correct procedure for mesh analysis?
a) Assign loop currents to each mesh
b) Apply Ohm's Law to each mesh
c) Set up the system of equations based on Kirchhoff's Voltage Law (KVL)
d) All of the above

Multiple choice question

4.In mesh analysis, when there is a current source in the circuit, how is the current source treated?
A)As a voltage source
b) By substituting a voltage in the mesh equation
c) As an additional mesh equation
d) Ignored in the analysis

5. **What is the unit of mesh current in mesh analysis?**
a) Ampere
b) Ohm
c) Volt
d) Watt

6.What does the mesh current represent? a) The voltage across the mesh
b) The total current flowing through the mesh
c) The total power consumed by the mesh
d) The current flowing through each component in the mesh

7.In a circuit with two meshes and shared components, how do you account for the components common to both meshes? a) Use the same mesh current for both meshes
b) Use the difference of the mesh currents for the shared components
c) Ignore the shared components in the analysis
d) Treat them as separate components in each mesh equation

8.In mesh analysis, what happens when there are voltage sources in the circuit?

a) They are treated as resistors
b) They are ignored
c) They create an additional mesh equation
d) They create a direct relationship between mesh currents

9.When using mesh analysis, how do you solve the system of equations formed by KVL?

a) By substitution method
b) By simultaneous equations
c) By using Kirchhoff's Current Law (KCL)
d) All of the above

10. **What is the purpose of assigning mesh currents in the clockwise or counterclockwise direction?**

a) To simplify the analysis
b) To standardize the approach
c) To define the direction of voltage drops and current relations
d) To make sure the current is positive

Answers:

1.b) To find the current in each mesh of the circuit

2.b) A current loop

3.d) All of the above

4.c) As an additional mesh equation

5.a) Ampere

6.b) The total current flowing through the mesh

7.b) Use the difference of the mesh currents for the shared components

8.d) They create a direct relationship between mesh currents

9.b) By simultaneous equations

10.c) To define the direction of voltage drops and current relations

1. What is the main purpose of mesh analysis in electrical circuits?
a) To determine the voltage across each component
b) To find the current flowing through each mesh
c) To calculate the power dissipated in the circuit
d) To simplify complex circuits to resistive ones
Answer: b) To find the current flowing through each mesh

2. Which law is primarily used in mesh analysis to set up equations?
a) Kirchhoff's Current Law (KCL)
b) Ohm's Law
c) Kirchhoff's Voltage Law (KVL)
d) The Superposition Theorem
Answer: c) Kirchhoff's Voltage Law (KVL)

3. In mesh analysis, what is the first step when setting up the system of equations?
a) Assign mesh currents to each loop in the circuit
b) Identify the total current in the circuit
c) Assign a voltage source to each mesh
d) Write down the power dissipated in each resistor
Answer: a) Assign mesh currents to each loop in the circuit

4. When two meshes share a component, how is the current through that component treated in mesh analysis?
a) The current is the sum of the mesh currents
b) The current is the difference of the mesh currents
c) The current is set to zero
d) The current is averaged between the two mesh currents
Answer: b) The current is the difference of the mesh currents

Thank you