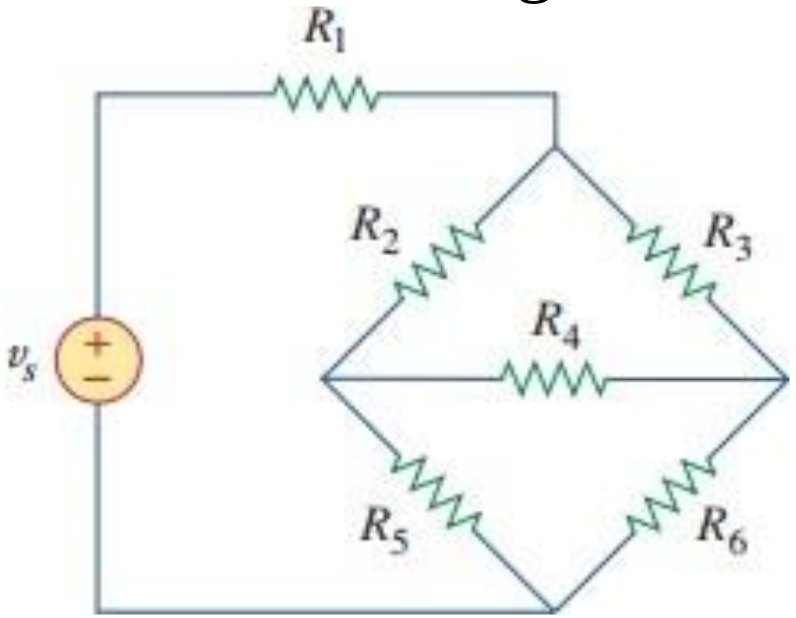
UNIT 1: DC CIRCUITS

Lecture 4 and 5

Star Delta Transformation

- Situations often arise in circuit analysis when the resistors are neither in parallel nor in series. For example, consider the bridge shown in the figure.



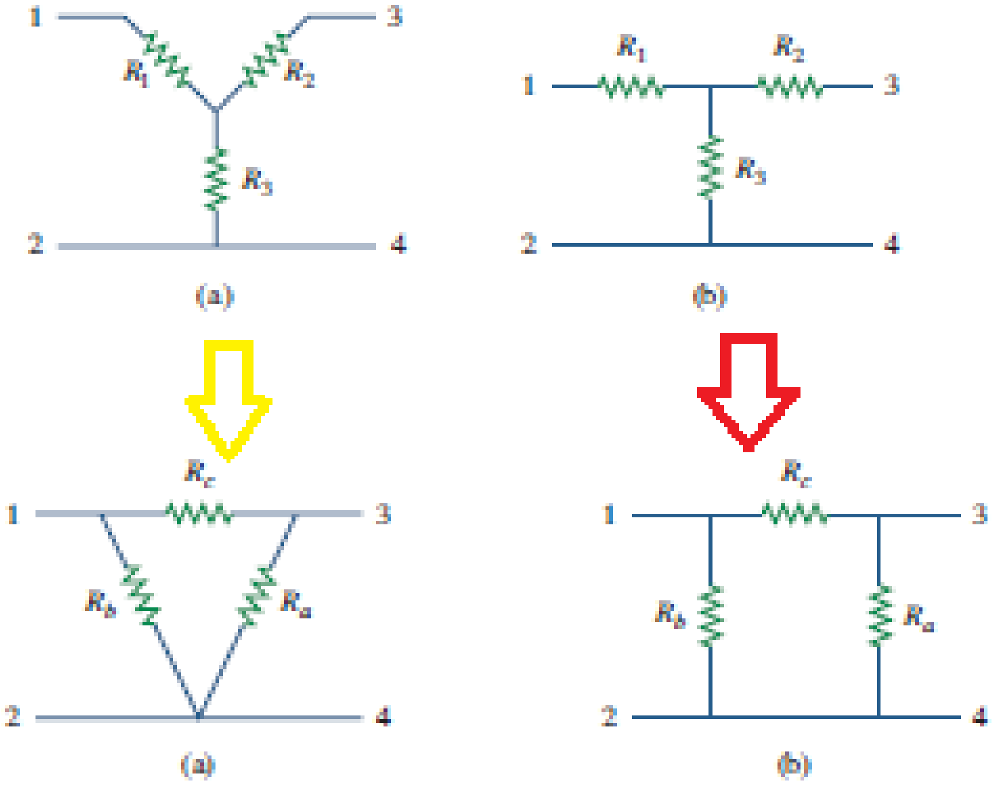
Star Delta Transformation

There are two types of such circuits

1. Star Connection
2. Delta Connection

STAR

DELTA

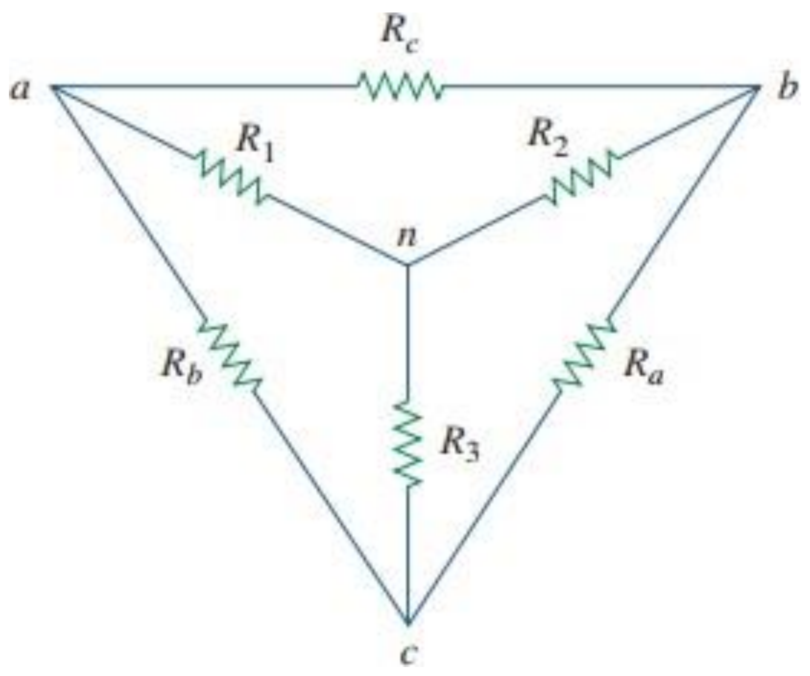


Delta to Star Conversion

$$\boxed{R_1 = \frac{R_b R_c}{R_a + R_b + R_c}}$$

$$\boxed{R_2 = \frac{R_c R_a}{R_a + R_b + R_c}}$$

$$\boxed{R_3 = \frac{R_a R_b}{R_a + R_b + R_c}}$$

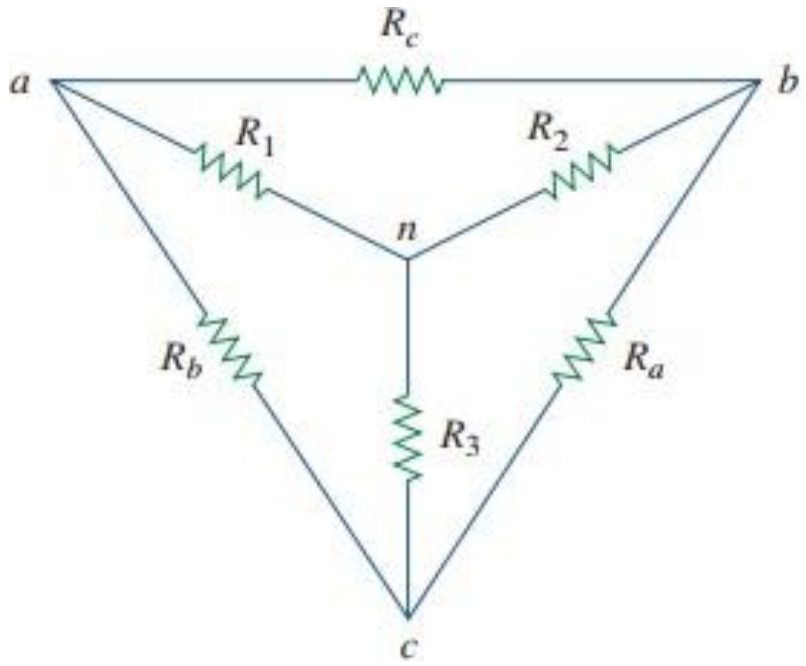


Star to Delta Conversion

$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$

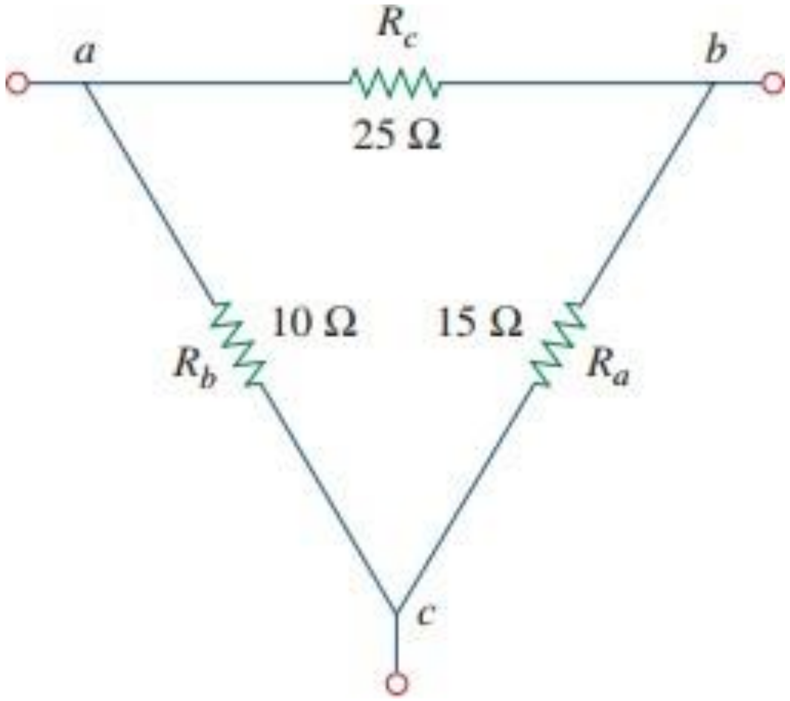
$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$



Practice Problem

Q: Convert Δ network into a Y network?



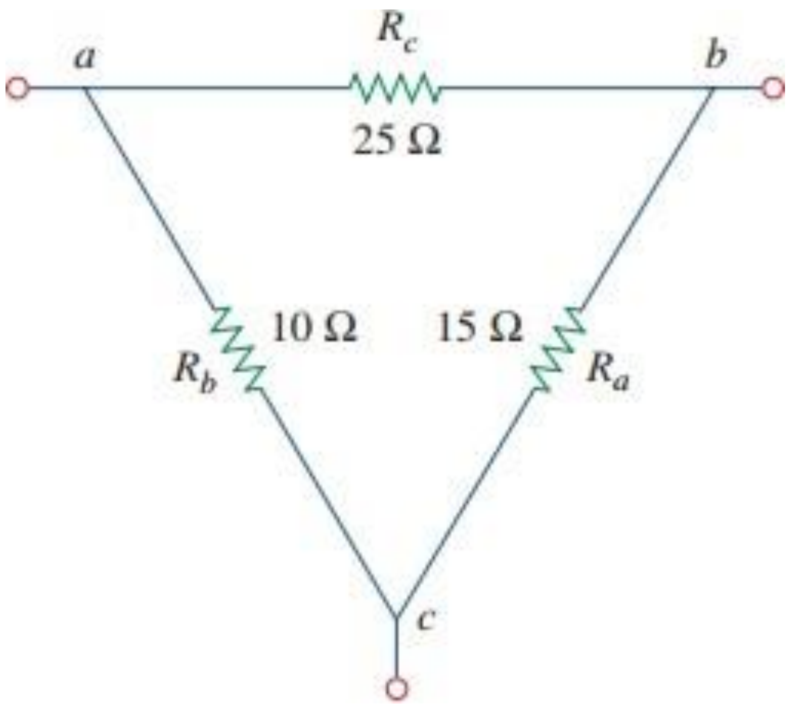
Practice Problem

Q: Convert Δ network into a Y network?

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{10 \times 25}{15 + 10 + 25} = \frac{250}{50} = 5\ \Omega$$

$$R_2 = \frac{R_c R_a}{R_a + R_b + R_c} = \frac{25 \times 15}{50} = 7.5\ \Omega$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c} = \frac{15 \times 10}{50} = 3\ \Omega$$



QUICK QUIZ (Poll 1)

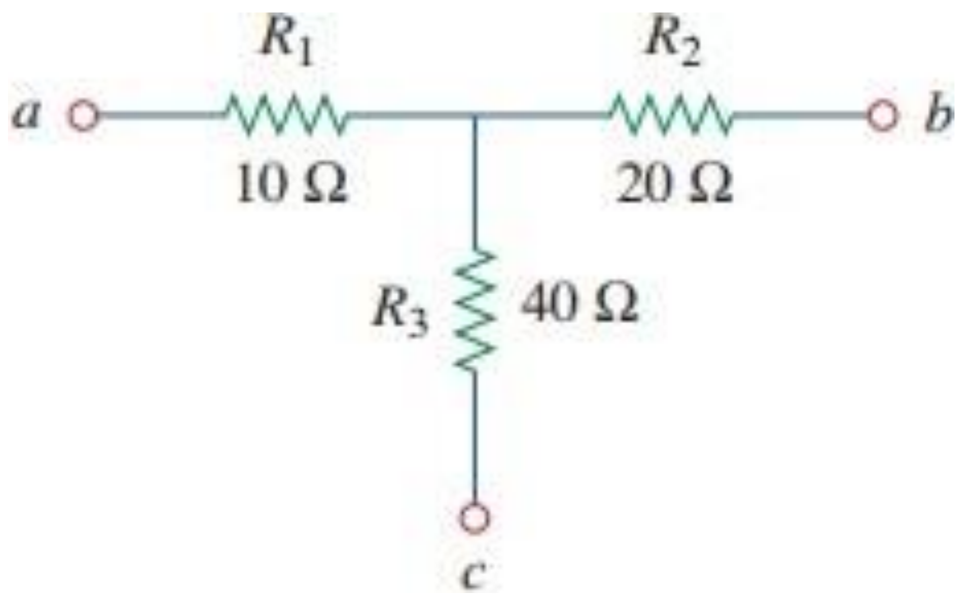
Resistance R_{bc} for the Δ network of the corresponding Figure is:

A. 140

B. 70

C. 35

D. 100



QUICK QUIZ (Poll 2)

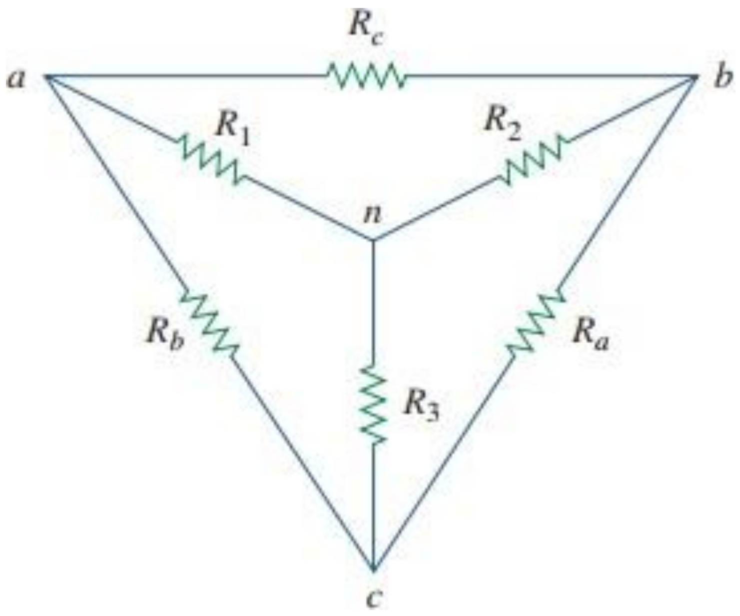
Q: If $R_a = R_b = R_c = R$ in a Δ network , then $R_1 = R_2 = R_3$=?

A. 3R

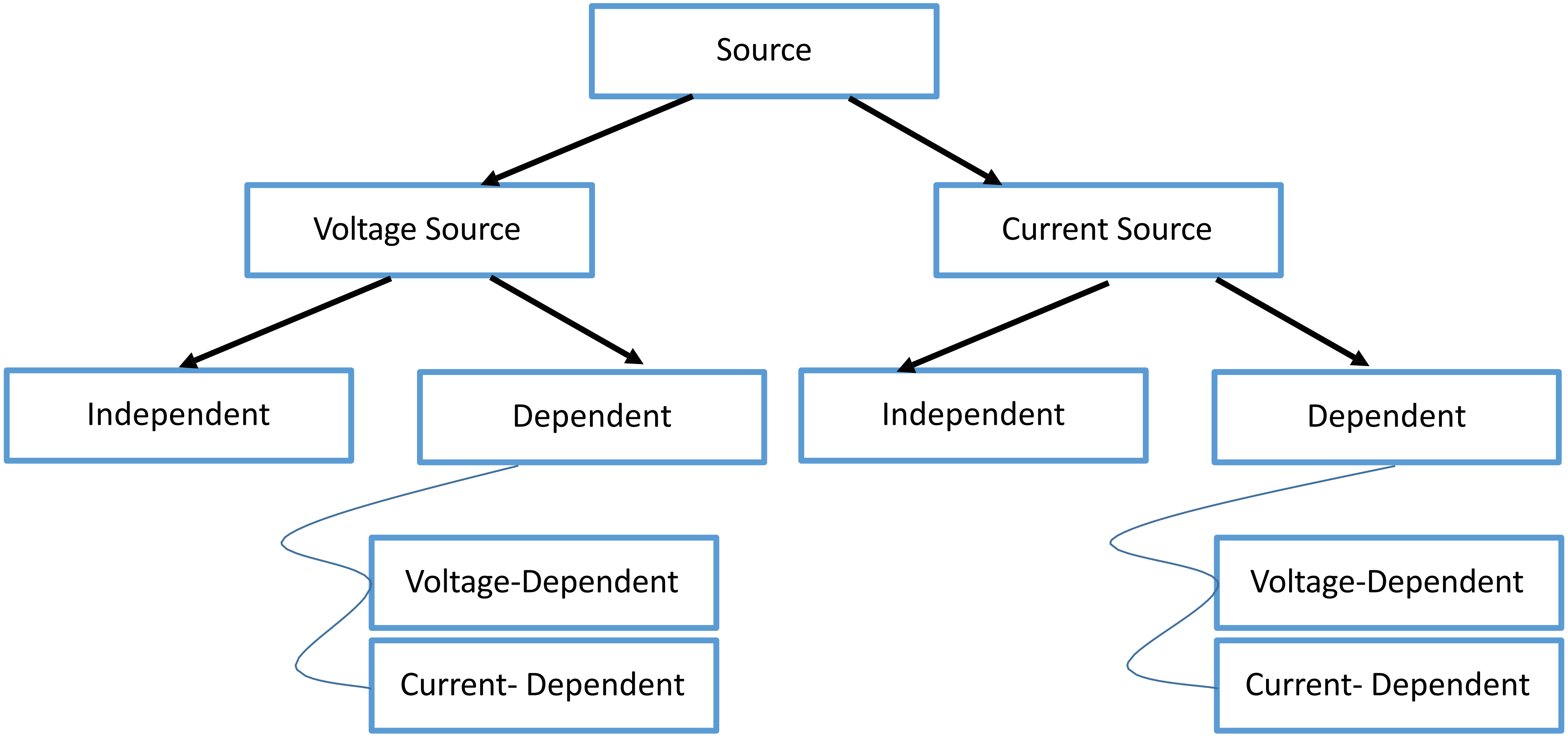
B. R/3

C. R

D. R/2



Energy Sources



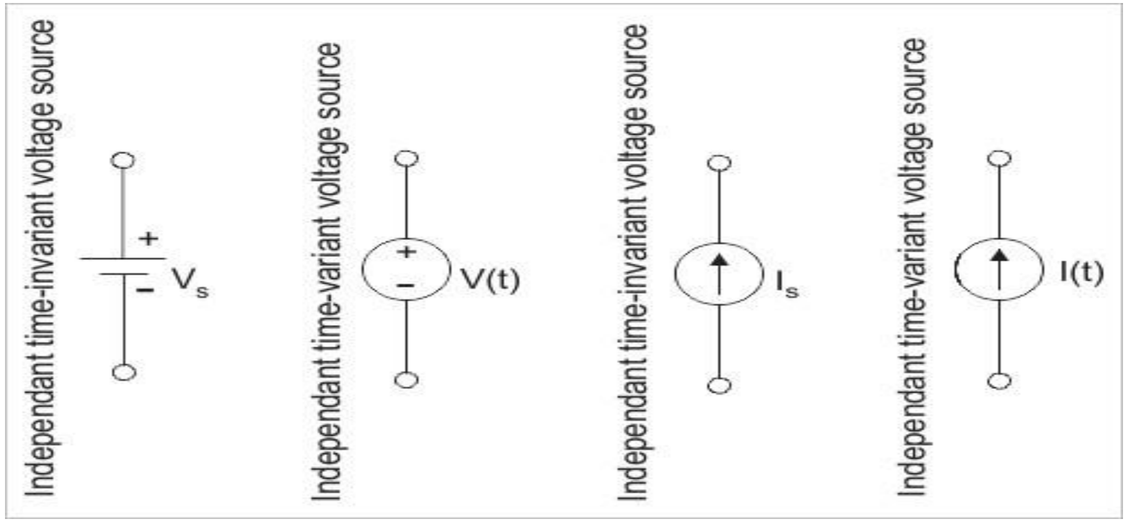
Independent and Dependent Sources

- Independent sources are those which does not depend on any other quantity in the circuit. They are two terminal devices and has a constant value, i.e. the voltage across the two terminals remains constant irrespective of all circuit conditions. The Independent sources are represented by a circular shape.

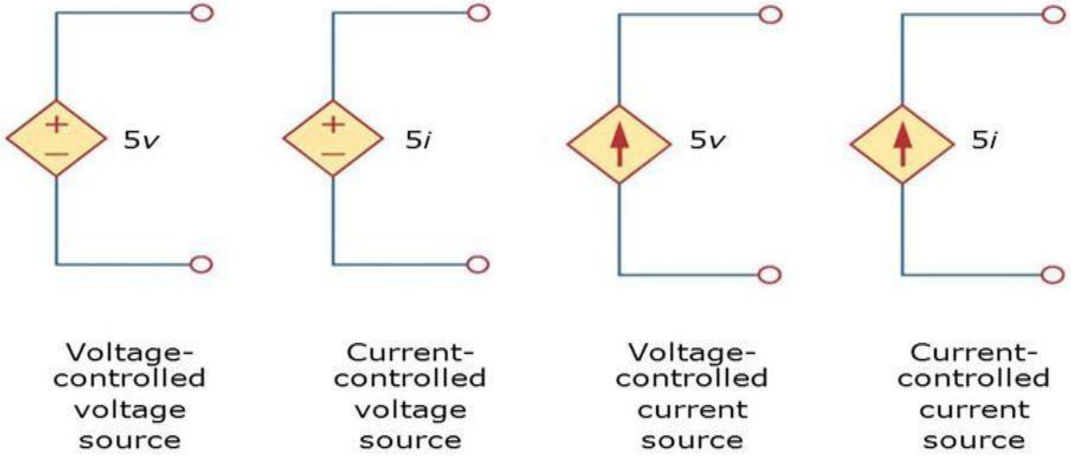
- Dependent or Controlled sources are those whose output voltage or current is NOT fixed but depends on the voltage or current in another part of the circuit. When the strength of voltage or current changes in the source for any change in the connected network, they are called dependent sources. The dependent sources are represented by a diamond shape.

Independent and Dependent Sources

- Independent



- Dependent



Ideal and Practical Voltage Source

- Ideal is one where internal resistance does NOT exist. NOTE:

1. For a voltage source, internal resistance must be ZERO.
2. For a current source, internal resistance must be INFINITY.

- Practical is one where internal resistance is present.

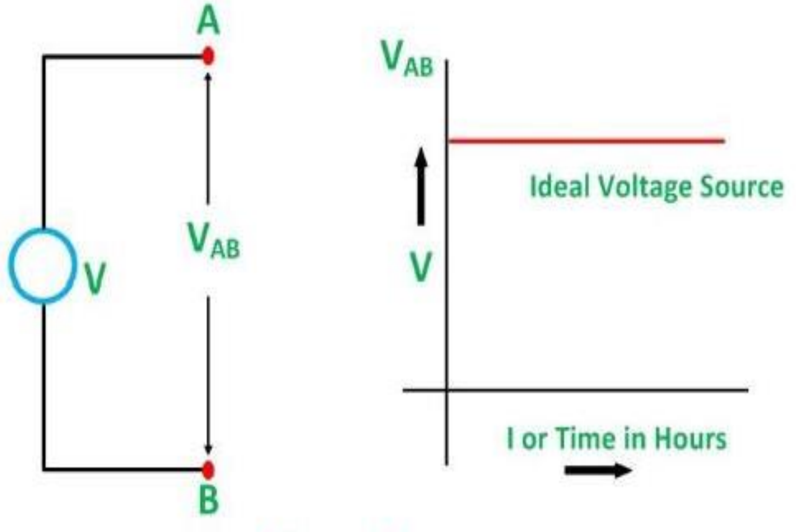


Figure A

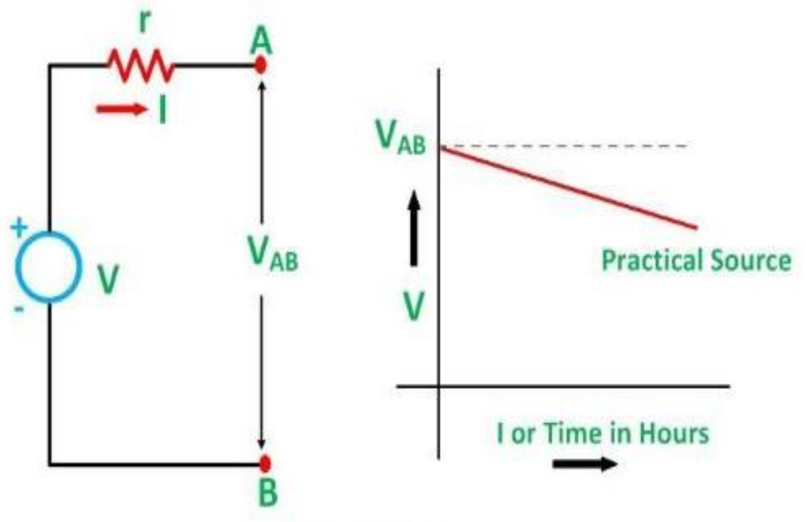


Figure B

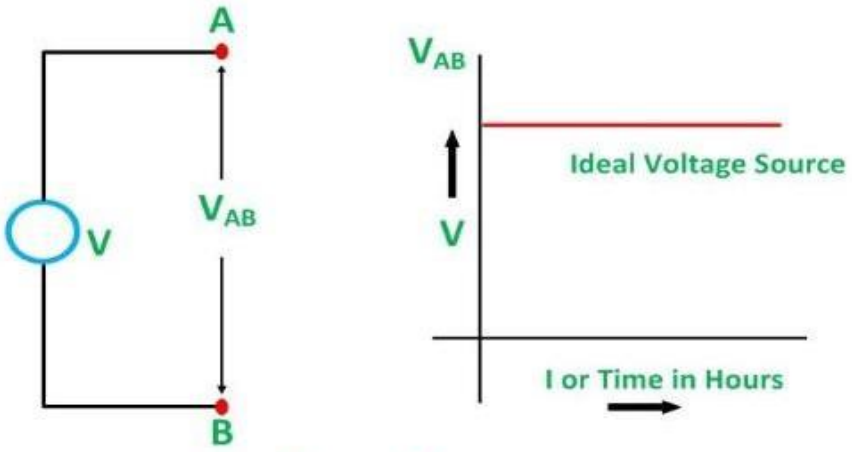


Figure A

The figure B shown below gives the circuit diagram and characteristics of Practical Voltage Source

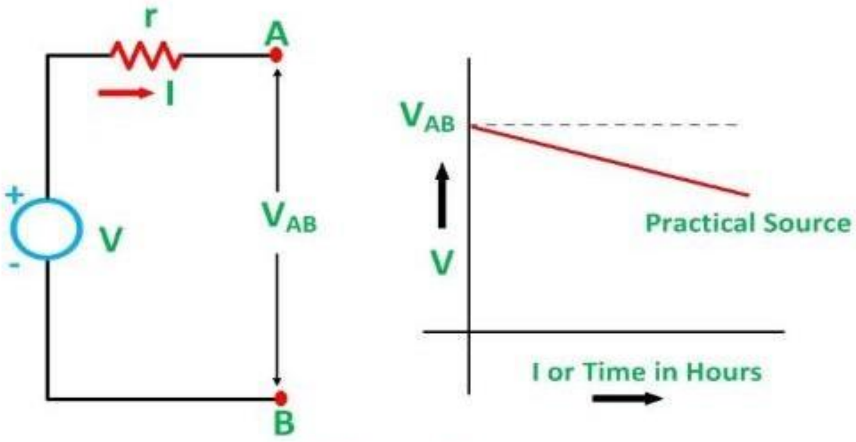


Figure B

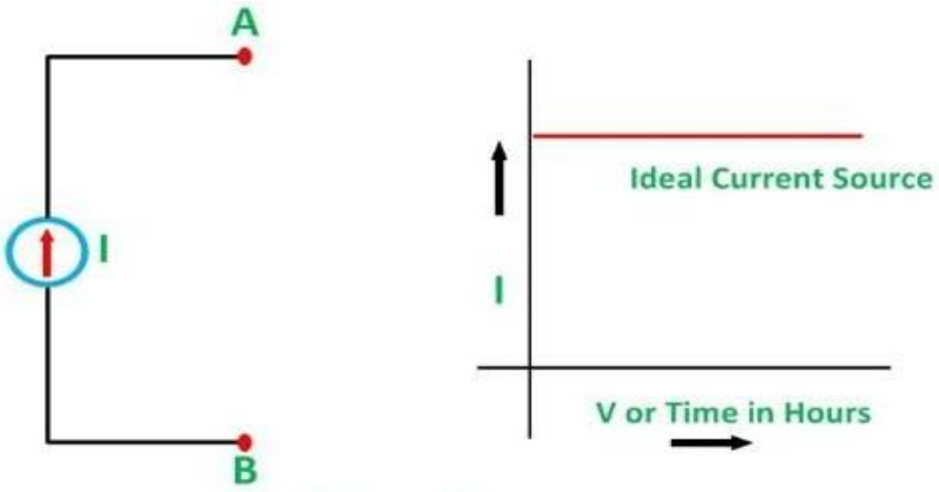


Figure C

Figure D shown below shows the characteristics of Practical Current Source.

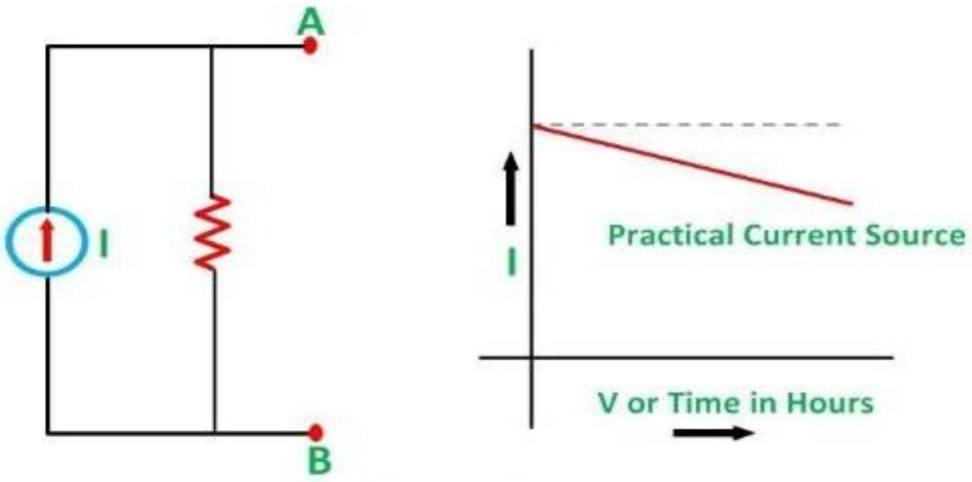


Figure D

QUICK QUIZ (Poll 3)

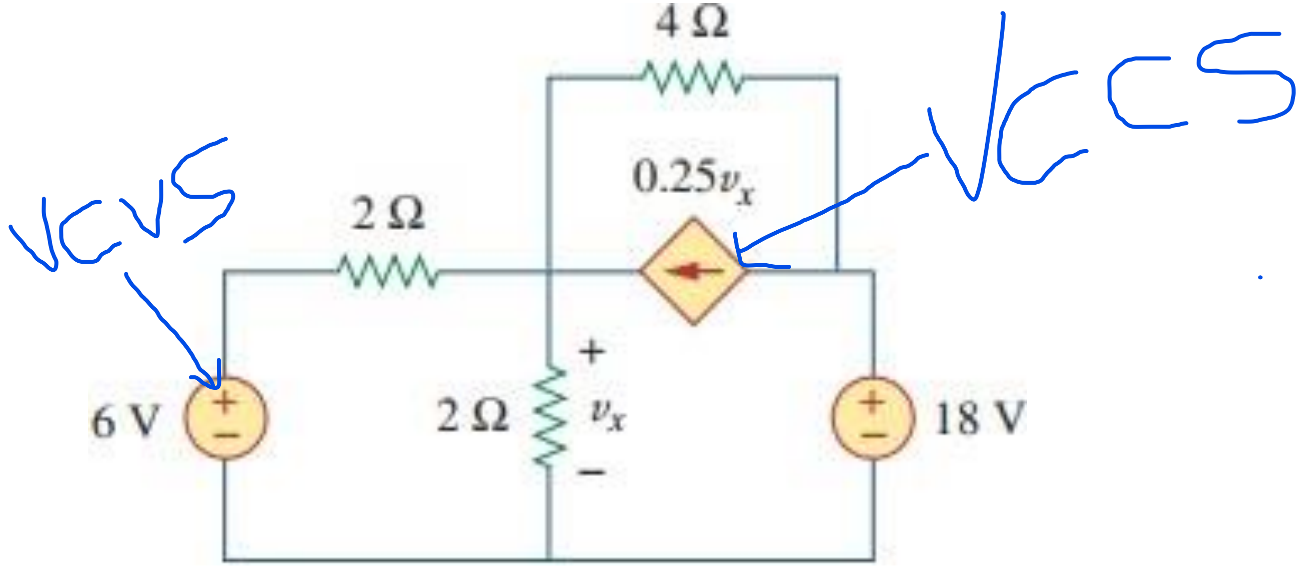
Identify the type of dependent source used in the network:

A. VCVS

B. CCCS

C. VCCS

D. CCVS



Nodal Analysis

- Nodal analysis provides a general procedure for analyzing circuits using node voltages as the circuit variables.

- Choosing node voltages instead of element voltages as circuit variables is convenient and reduces the number of equations one must solve simultaneously.

- Applicable to nodes only.

- It is used to find the unknown node voltages.

- This Method is Application of KCL+Ohm’s Law Only

Steps to Determine Node Voltages

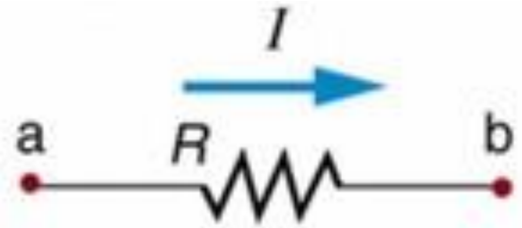
1. Select one nodes out of ‘n’ node as the reference node. Assign voltages to the remaining nodes. The voltages are referenced with respect to the reference node.

2. Apply KCL to each of the non-reference nodes. Use Ohm’s law to express the branch currents in terms of node voltages.

3. Solve the resulting simultaneous equations to obtain the unknown node voltages.

- The number of non-reference nodes is equal to the number of independent equations that we have to derive.

- Current flows from a higher potential to a lower potential in a resistor



$$i = \frac{v_{\text{higher}} - v_{\text{lower}}}{R}$$

QUICK QUIZ

For “N” number of nodes, the number of non-reference nodes is equal to:

A. $N+1$

B. $N-1$

C. 2N

D. $2N-1$

QUICK QUIZ

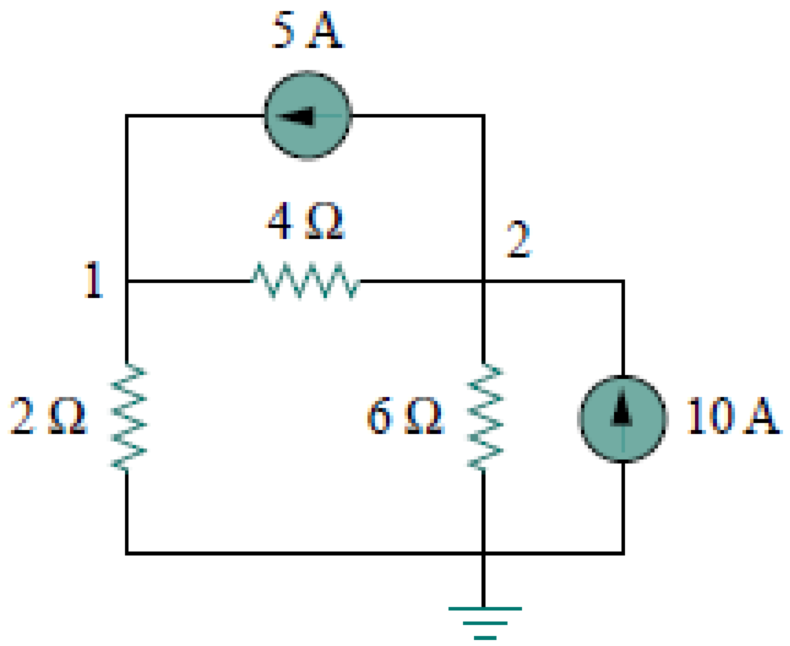
Nodal analysis, which is based on KCL is used to find unknown:

A. *current*

B. *voltage*

Example 1

- Obtain the node voltages in the given circuit?



Mesh Analysis

- Mesh analysis provides another general procedure for analyzing circuits, using mesh currents as the circuit variables.
- It is based on KVL.

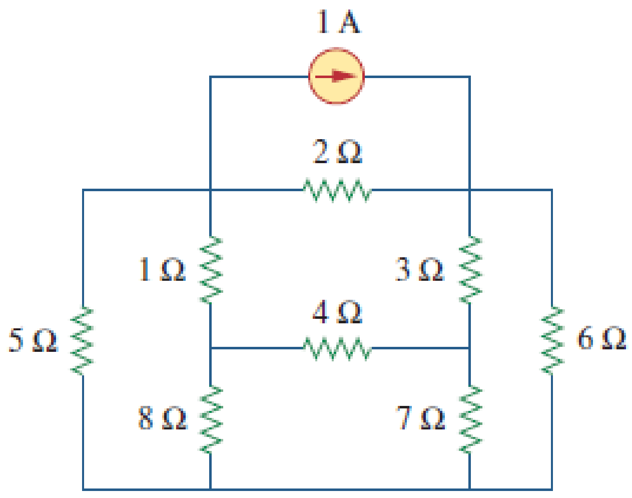
RECALL!

- LOOP: A loop is a closed path with no node passed more than once.
- MESH: A mesh is a loop that does not contain any other loop within it.
- Mesh analysis is not quite as general as nodal analysis because it is only applicable to a circuit that is planar.
- **PLANAR CIRCUIT:** A planar circuit is one that can be drawn in a plane with no branches crossing one another; otherwise it is nonplanar.

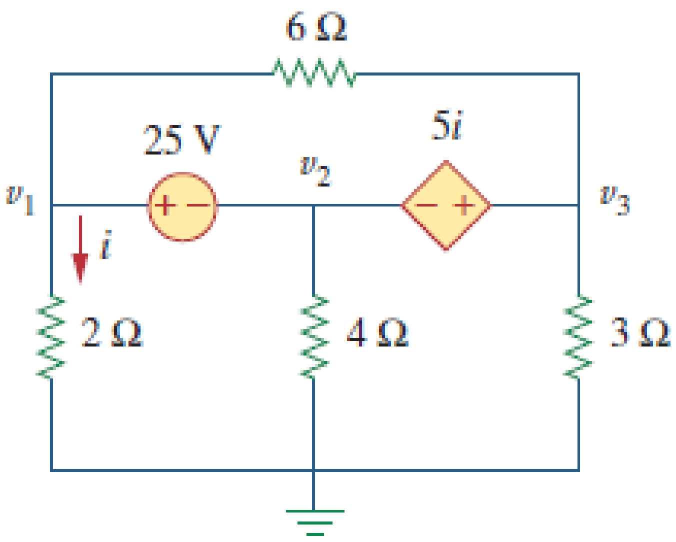
Steps to Determine Mesh Currents

1. Assign mesh currents to ‘n’ meshes
2. Apply KVL to each of the ‘n’ meshes.
3. Solve the resulting ‘n’ simultaneous equations to obtain the unknown mesh currents.

Examples of Planar Circuits



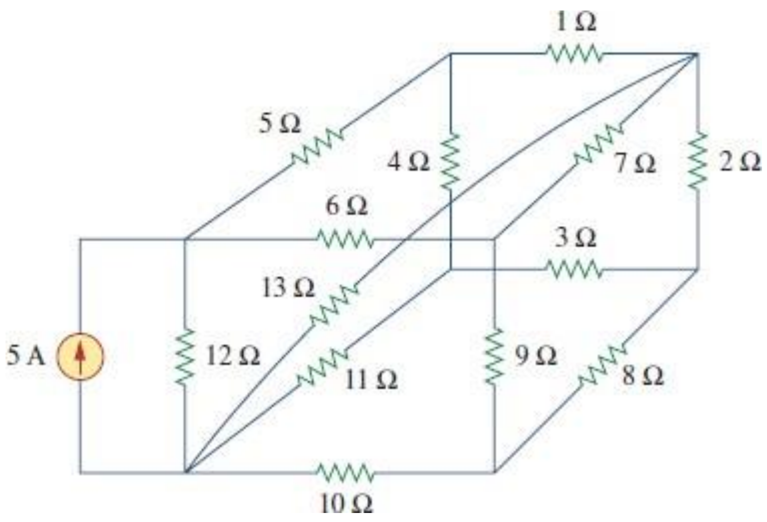
(b)

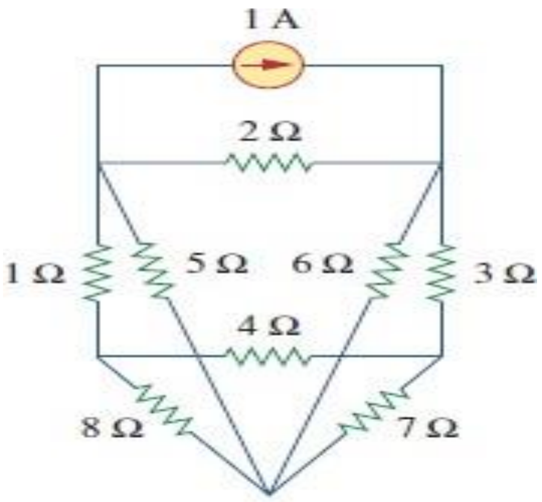


NOTE: A mesh is a loop which does not contain any other loops within it.

Mesh Analysis can be applied to meshes only inside the circuit, Not to LOOP.

Examples of Non-Planar Circuits





(a)

QUICK QUIZ

Mesh Analysis to applicable to______type networks.:

A. Planar and Loop
B. Non planar and mesh
C. Planar and mesh
D. Non planar and Loop

QUICK QUIZ

Mesh analysis, which is based on KVL is used to find unknown:

A. $current$

B. voltage

Example 1

- Obtain the mesh currents in the given circuit?