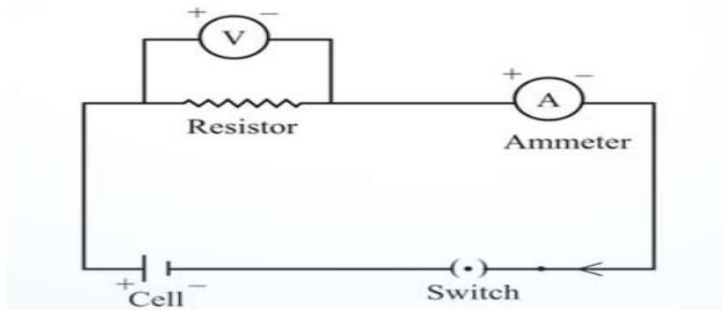


CIRCUITS

DEFINE:

1)CIRCUIT: A circuit is a closed conducting path through which electric current flows from the source, through electrical components, and back to the source.



2)CIRCUIT PARAMETERS:

Circuit parameters are the electrical quantities that describe the behavior and characteristics of an electrical circuit.

Common Circuit Parameters:

1. Resistance (R) – Opposition to current flow
2. Current (I) – Rate of flow of electric charge
3. Voltage (V) – Electrical potential difference
4. Capacitance (C) – Ability to store electric charge
5. Inductance (L) – Ability to oppose change in current
6. Power (P) – Rate of electrical energy consumption

3)LINEAR CIRCUIT:

A linear circuit is an electrical circuit in which the circuit parameters (resistance, inductance, and capacitance) are constant and the output is directly proportional to the input.

**A linear circuit is one that obeys the principles of superposition and homogeneity.*

Examples of Linear Circuits

1. Resistive circuit with ohmic resistor
 - o Follows Ohm's law: $V = IR$
2. R–L circuit with ideal inductor
3. R–C circuit with ideal capacitor

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4. R–L–C circuit using ideal components
5. AC circuits containing only linear elements

- **Linear Circuit:** A circuit in which output is directly proportional to input and obeys superposition.

4)Non-Linear Circuit :

A non-linear circuit is an electrical circuit in which the output is not directly proportional to the input and the circuit parameters change with voltage or current.

Examples of Non-Linear Circuits

1. Diode circuits
2. Transistor circuits
3. SCR / Thyristor circuits
4. Saturated inductors
5. Varistors and thermistors

**A non-linear circuit is one in which the output is not proportional to the input and circuit parameters vary with operating conditions.*

- **Non-Linear Circuit:** A circuit in which output is not directly proportional to input and superposition does not apply.

5)Bilateral Network :

A bilateral network is an electrical network in which the characteristics and behavior remain the same in both directions of current flow.

Examples:

- Resistor
- Inductor
- Capacitor

** Property does not change when input and output terminals are interchanged.*

**Bilateral network: Same behavior in both directions of current flow*

6) Unilateral Network :

A unilateral network is an electrical network in which the behavior depends on the direction of current or voltage, and it does not operate the same in both directions.

Examples:

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- Diode
- Transistor
- SCR (thyristor)

*Current flows mainly in one direction only.

*Circuit behavior changes when direction of supply is reversed.

7) Electric network: An electric network is an interconnection of electrical elements such as resistors, capacitors, inductors, voltage sources, and current sources, which may or may not form a closed path.

8) Passive network: A passive network is an electrical network that contains only passive elements and does not generate electrical energy.

Passive elements include:

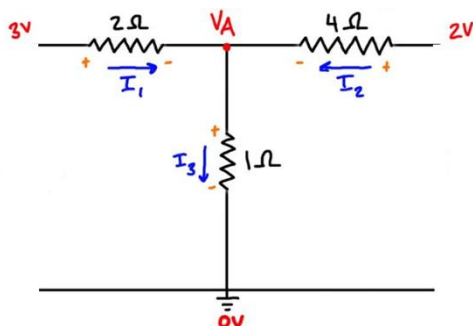
- Resistors
- Inductors
- Capacitors

9) Active Network: An active network is an electrical network that contains one or more active elements and is capable of supplying electrical energy to the circuit.

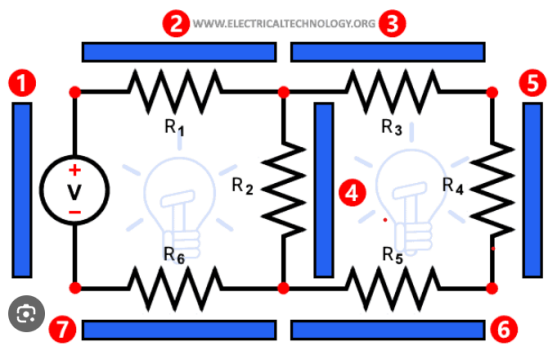
Active elements include:

- Voltage sources
- Current sources

10) Node of a Network: A node in an electrical network is a junction point where two or more circuit elements are connected together.



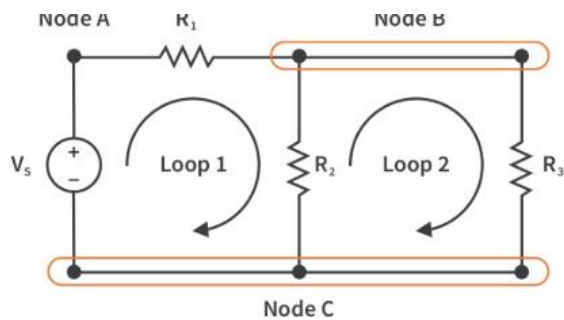
11) Branch of a Circuit: A branch of a circuit is the part of an electrical circuit that lies between two nodes and contains one or more circuit elements through which the same current flows.



***Branch:** A branch is a single current path between two nodes in an electrical network.

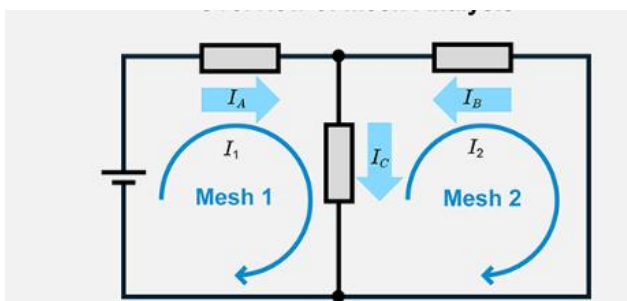
12) Loop of an Electrical Circuit:

A loop in an electrical circuit is any closed conducting path in which current can flow, starting and ending at the same node without passing through any node more than once.



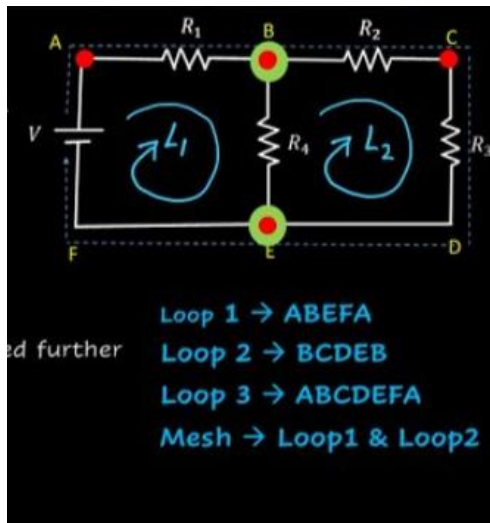
13) Mesh : A mesh is a loop that does not contain any other loop within it. It is the smallest closed path in an electrical circuit.

*All meshes are loops, but all loops are not meshes.



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Representing Node, Branch, Loop, Mesh in one circuit.



*Kirchhoff's Current Law (KCL):

Statement

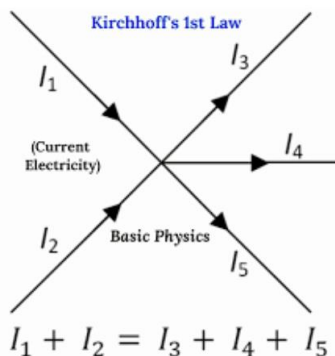
Kirchhoff's Current Law states that the algebraic sum of currents at any node (junction) in an electrical circuit is zero.

Explanation :

At any junction in a circuit, current cannot accumulate. Therefore, the total current flowing into the junction must be equal to the total current flowing out of the junction. This law is based on the principle of conservation of charge.

Mathematical Representation:

- $\Sigma I_{in} = \Sigma I_{out}$ (Sum of currents entering is equal to sum of currents going out)
- $\Sigma I = 0$ (Algebraic sum of all currents is zero, where entering is positive and leaving is negative)
- Sum of currents entering a node = Sum of currents leaving the node



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Imagine a junction with currents I_1 and I_2 entering, and I_3 , I_4 , and I_5 leaving.

- According to KCL: $I_1 + I_2 = I_3 + I_4 + I_5$.
- Using the algebraic sum: $I_1 + I_2 - I_3 - I_4 - I_5 = 0$.

SIMPLE PROBLEMS:(DONE IN CLASS WORK.)

Kirchhoff's Voltage Law (KVL)

Statement

Kirchhoff's Voltage Law states that the algebraic sum of all voltages around any closed loop in an electrical circuit is zero.

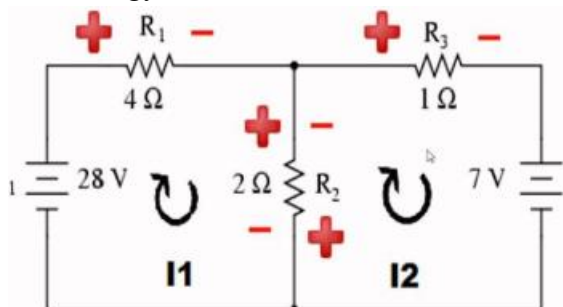
Mathematically:

- $\sum V = 0$ Algebraic sum of voltages in the loop is equal to zero.
- $V = V_1 + V_2$

Explanation

When electric charge moves around a closed loop, it gains energy from sources (like batteries) and loses energy across circuit elements (like resistors).

According to the law of conservation of energy, the total energy gained must be equal to the total energy lost. Hence, the sum of all voltage rises and drops in a closed loop is zero.



for loop 1

$$28 - 4 \cdot I_1 - 2 \cdot (I_1 - I_2) = 0$$

for loop 2

$$-7 - 2 \cdot (I_2 - I_1) - 1 \cdot I_2 = 0$$

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