ELEMENTS OF ELECTRICAL ENGINEERING
Course Code : UE25EE141A/B

PES UNIVERSITY

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ELEMENTS OF ELECTRICAL ENGINEERING

Network Terminology, Basic Concepts and Kirchhoff's laws

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Network Terminology

Electrical Network:

An interconnection of electrical elements.

Electrical Circuit:

An electrical network with at least one source and a sink and having a closed path for current flow.

Active Element:

An element which supplies or delivers energy in an electrical network.
Eg: Voltage Sources & Current Sources

Passive Element:

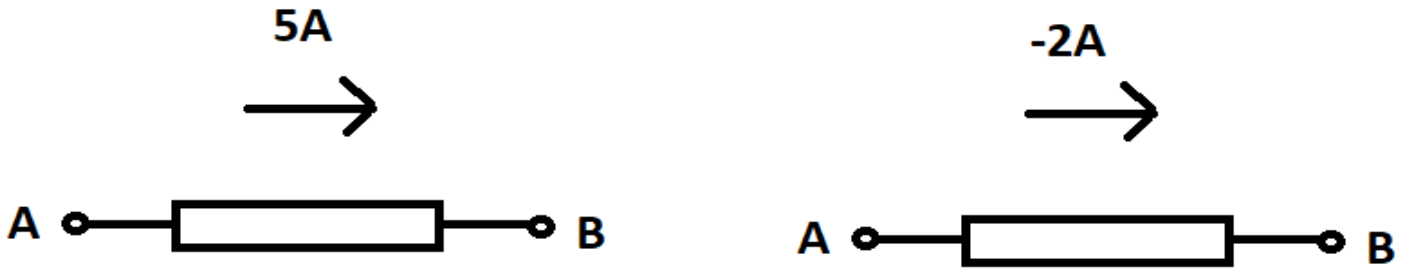
An element which absorbs or stores energy in an electrical network.
Eg: Resistors, Inductors & Capacitors

Electric Current

An electric current is defined as the rate of flow of charges across the cross section of a conductor.

It is given by, $I = \frac{Q}{t}$ (or) $i = \frac{dq}{dt}$

It is measured in Amperes (A) & 1 Ampere = 1 Coulomb/sec



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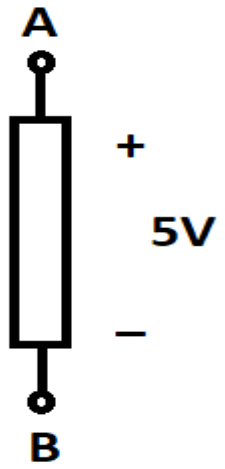
Potential Difference

The energy required to move unit positive charge from one terminal to another is defined as the potential difference between the terminals.

It is given by, $V = \frac{W}{Q}$

It is measured in Volts (V) & 1 Volt = 1 Joule/Coulomb



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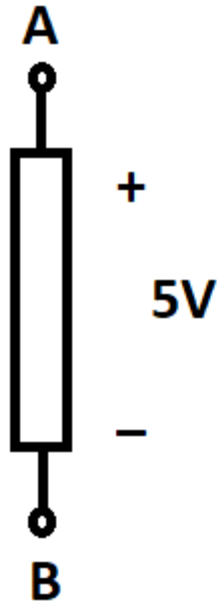
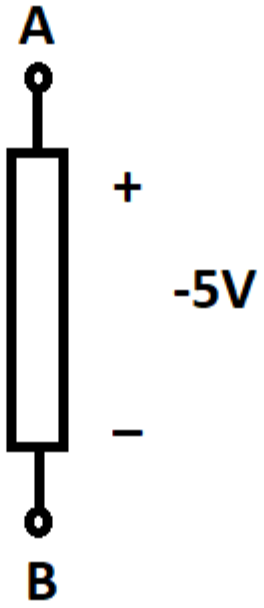
Double Subscript Notation for Voltage



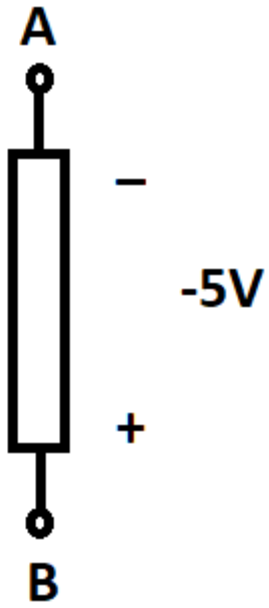
(a)

V_{AB} = 5V



(b)

V_{AB} = -5V



(c)

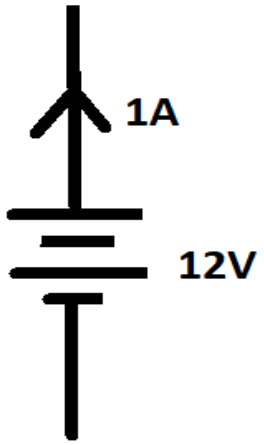
V_{AB} = 5V

Electric Power

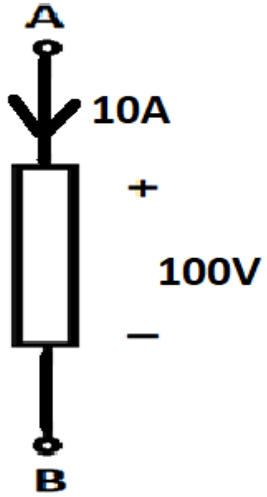
The rate of absorption or delivery of Electrical energy is called Electrical Power.

It is given by, P = V*I

It is measured in Watts (W) & 1 Watt = (1 Volt)*(1 Ampere)



P = -12W



P = 1000W

Ohm's Law

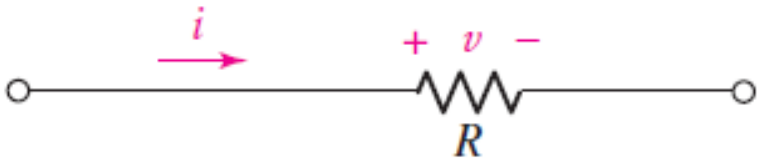
At a constant temperature, the potential difference across the terminals of a conductor is directly proportional to the current flowing through it.

i.e., $V \propto I$

$V = R*I$

Here, R is the electrical resistance of the conductor.

It is measured in Ohms (Ω) and 1 Ohm = 1 Volt/Ampere



Ohm's Law

Resistance of a conductor is the opposition offered to the flow of current through it.

It depends on the resistivity of the material & its dimensions.

i.e., $R = \frac{\rho l}{A}$

Where, ρ is the resistivity measured in Ohm-m

Conductance, $G = \frac{1}{R}$

It is measured in Siemens (S)

Active and Passive Sign Conventions

Active sign convention:

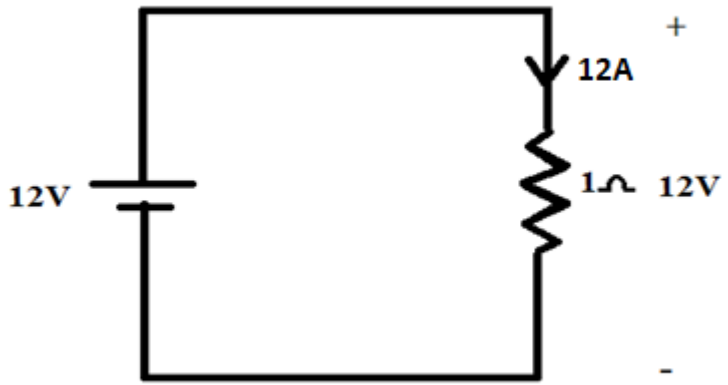
Applicable to active elements

It says “current leaves positive terminal in an active element”.

Passive Sign Convention:

Applicable to passive elements

It says “current enters positive terminal in a passive element”.



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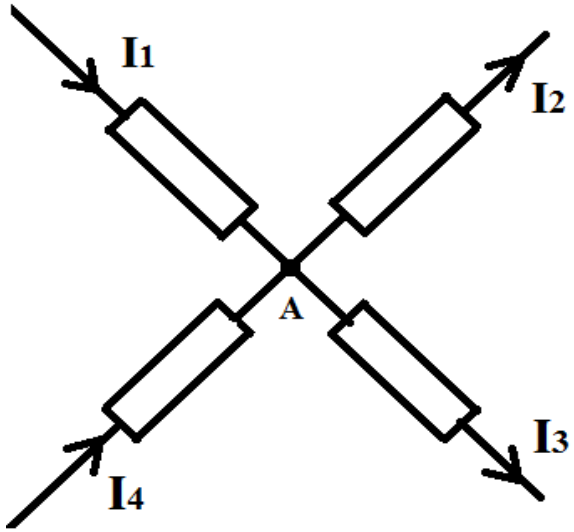
Kirchhoff's Current Law (KCL)

- KCL States "At every node in an electric network, the algebraic sum of currents is Zero (or) sum of incoming currents is equal to the sum of outgoing currents".
- A point at which two or more elements are interconnected is a node.
- KCL signifies the conservation of charge.



By KCL at node A,

$I_1 + I_4 = I_2 + I_3$

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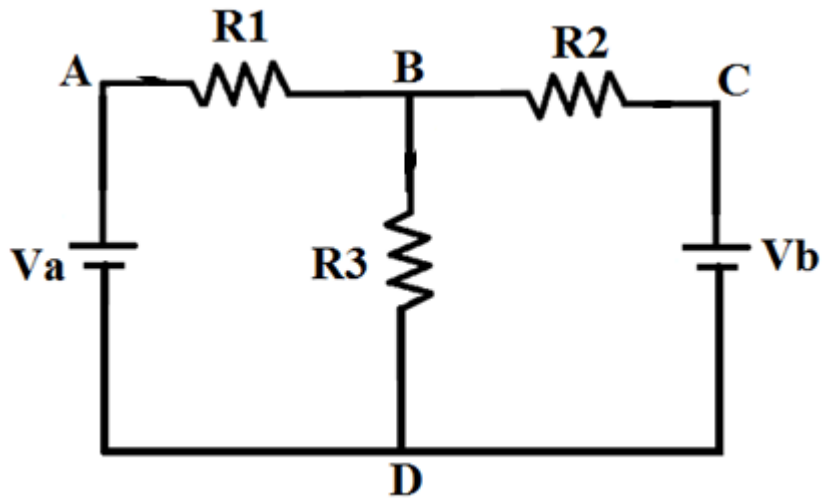
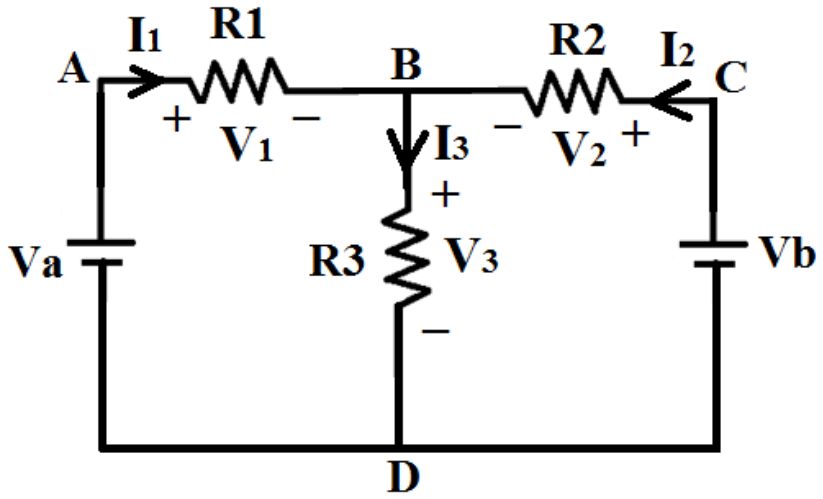
Kirchhoff's Voltage Law (KVL)

- KVL States "Around every closed path in an electric network, the algebraic sum of voltages is Zero".
- A path in an electrical network which starts and ends at the same terminal is called a closed path.



Kirchhoff's Voltage Law (KVL)

Conventionally, Voltage drop is considered negative and voltage rise as positive.



- KVL in the path ABDA:

$-V_1-V_3+V_a = 0$

- KVL in the path BCDB:

$V_2-V_b+V_3 = 0$

- KVL in the path ABCDA:

$-V_1+V_2-V_b+V_a = 0$

KVL signifies conservation of energy.

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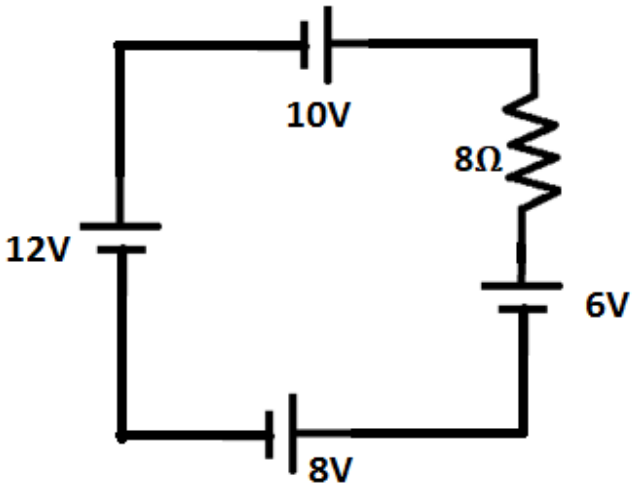
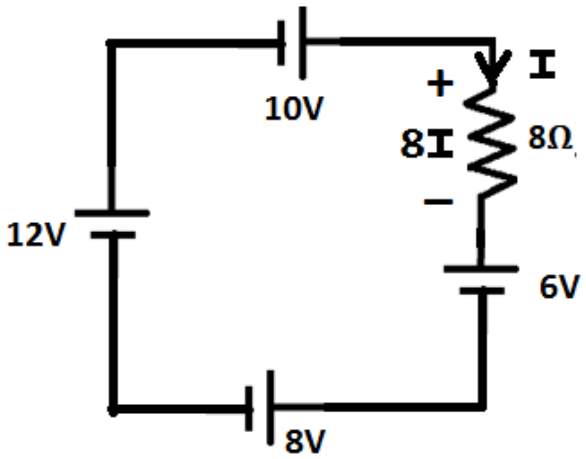
Numerical Example on KVL

Find the current through 8Ω resistor in the network given.



Solution:



KVL: +10-8I-6-8+12 = 0

Hence, I = 1A

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Text Book & References

Text Book:

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1. "Engineering Circuit Analysis" William Hayt, Jack Kemmerly, Jamie Phillips and Steven Durbin, 10th Edition McGraw Hill, 2023

2. "Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 12th Edition, Pearson Education, 2016.

THANK YOU

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