Basics of Electric Circuit

BY :MANKIRAN KAUR

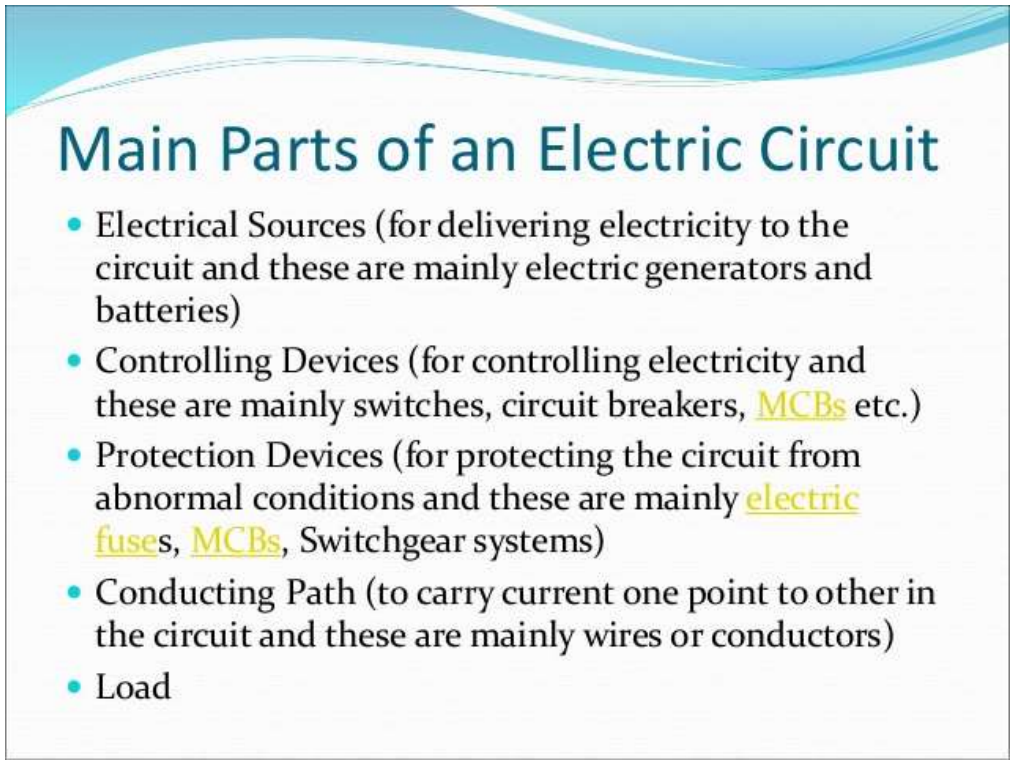
CONTENTS

- BASICS OF ELECTRIC CIRCUIT,voltage and current sources, Kirchoff’s current and voltage laws

Electric Circuit

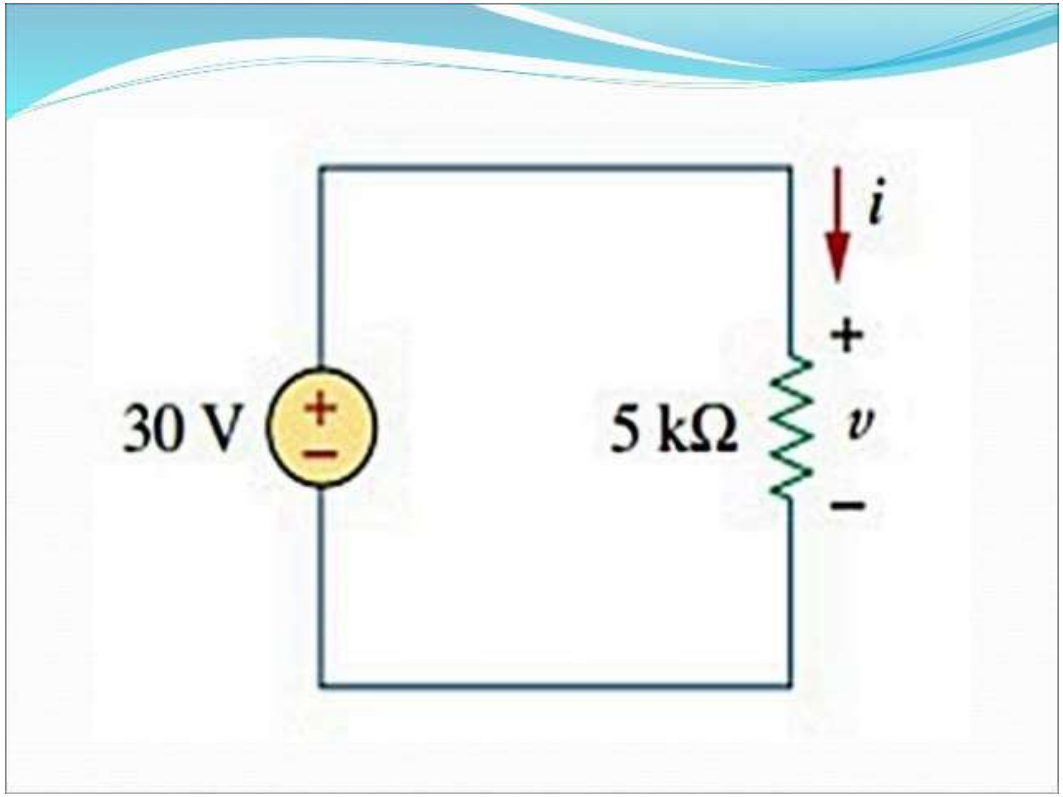
- The system in which **electric current** can flow from source to load through one path and after delivering energy at load, the current can return to the other terminal of source through another path is referred as electric circuit.

voltage and current sources



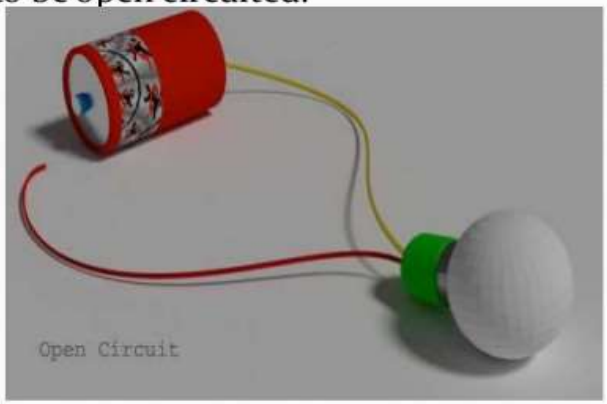
Basic Properties of an Electric Circuit

- A circuit is always a closed path.
- A circuit always contain an energy source which acts as source of electrons.
- The electric elements include uncontrolled and controlled source of energy, resistors, capacitors, inductors, etc.
- In an electric circuit flow of electrons takes place from negative terminal to positive terminal.
- Direction of flow of conventional current is from positive to negative terminal.
- Flow of current leads to potential drop across the various elements.

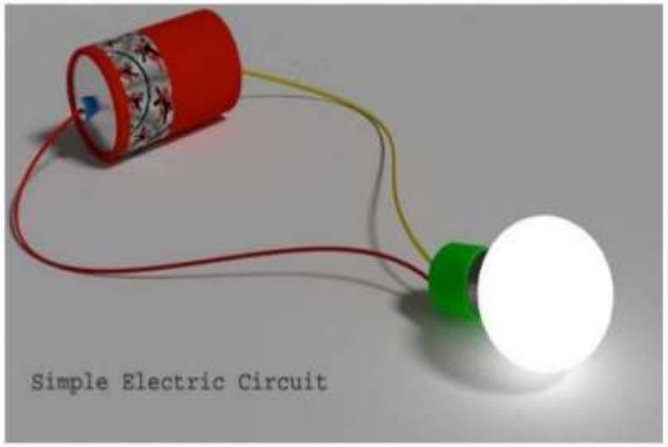

i
+
30 V
+
−
5 kΩ
v
−

Types of Electric Circuit

- **Open Circuit**-If due to disconnection of any part of an electric circuit if there is no flow of current the circuit is said to be open circuited.



- **Closed Circuit**-If there is no discontinuity in the circuit and current can flow from one part to another part of the circuit then the circuit is said to be closed circuit.



Electric circuits can further be categorized according to their structural features.

- Series Circuit
- Parallel Circuit
- Series Parallel Circuit.

Passive Components

- The element which receives energy (or absorbs energy) and the either converts it into heat or stored it in an electric or magnetic field called **Passive Element**.

Example: Resistor, Inductor, Capacitor etc.

Passive Components

Component	Symbol	Basic Measure (Unit)
Resistor		Ohm (Ω)
Inductor		Henry (H)
Capacitor		Farad (F)

CURRENT

- Current is Defined as the Flow of the Electric Charge..
- Current is Basically Denoted by Symbol **I**.
- The Unit for the Current is **A** or ampere.
- SI Unit of Current is **Coulomb/Second**
- Measuring Element used for Current is Ammeter.

VOLTAGE

- Voltage is a Potential Difference between Two Points of an Electrical Field.
- It is Denoted by Symbol **V**
- The Unit for Measurement of Voltage is **Volts**.
- SI Unit for Voltage is **Joule/Coulomb**
- Measuring Element for Voltage is Voltmeter.

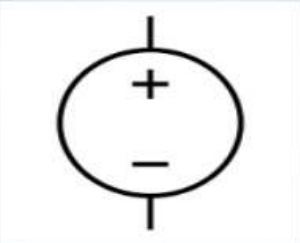
Energy Sources

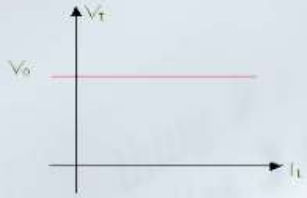
- According to the Terminal Voltage-Current Characteristics, Electrical energy Sources are Categorized into two Parts.

1. Voltage Source
2. Current Source

VOLTAGE SOURCE

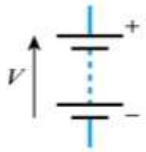
- The Voltage Source is a Two Terminal Element in which the Voltage is completely independent of the Current.



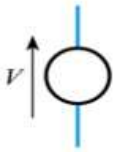


- The Representation of Voltage Source is Done by the Fig Shown Above.

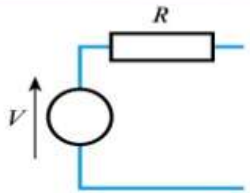
Different Voltage Sources



(a) A battery

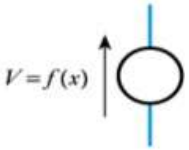


(b) An ideal voltage source



(c) Modelling a battery using an ideal voltage source

(d) An alternating voltage source



(e) A controlled voltage source

Facts about Voltage Source

- A Voltage source produces an **Electromotive Force** (**e.m.f.**) which causes a current to flow within a circuit
  - Unit of e.m.f. is the **volt**
  - a volt is the potential difference between two points when a joule of energy is used to move one coulomb of charge from one point to the other
- Real voltage sources, such as batteries have resistance associated with them
  - In analysing circuits we use **Ideal Voltage sources**
  - we also use **controlled** or **dependent Voltage sources**

OHM's Law

- The Relationship between Voltage and Current is Given by OHM's Law.

$$V \propto I$$

- Constant of Proportionality is Resistance R Hence

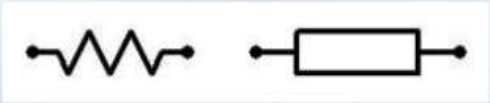
$$V = IR \qquad I = \frac{V}{R} \qquad R = \frac{V}{I}$$

- Current through a Resistor causes power dissipation

$$P = IV \qquad P = \frac{V^2}{R} \qquad P = I^2R$$

Resistors

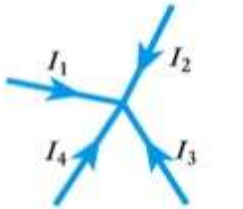
- The Components used to Oppose the Flow of Current through it is Called **Resistor**.



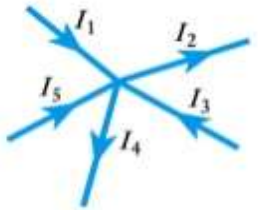
- And the Property of a Material to Oppose Current is called **Resistance.**

Law of Current

- *At any instant, the algebraic sum of all the currents flowing into any node in a circuit is zero*
- If currents flowing *into* the node are positive, currents flowing *out of* the node are negative, then $\sum I = 0$



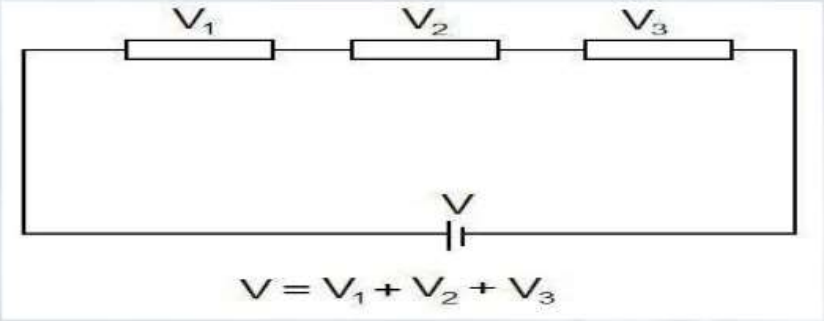
$I_1 + I_2 + I_3 + I_4 = 0$



$I_1 - I_2 + I_3 - I_4 + I_5 = 0$

Law of Voltage

- *At any instant the algebraic sum of all the voltages around any loop in a circuit is zero*
- If clockwise voltage arrows are positive and anticlockwise arrows are negative then $\Sigma V = 0$



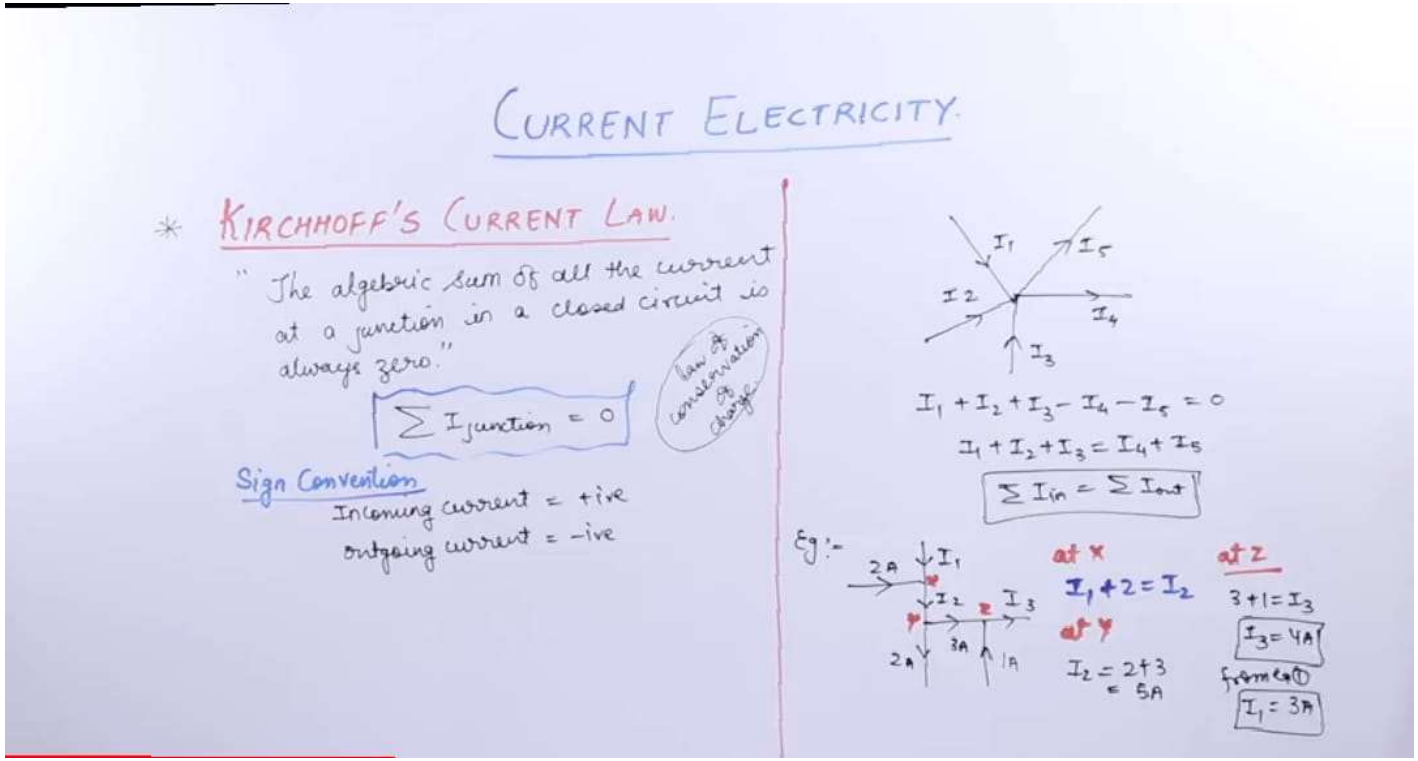
Kirchoff’s law

- Kirchhoff's current law (1st Law) states that current flowing into a node (or a junction) must be equal to current flowing out of it. This is a consequence of charge conservation.
- Kirchhoff's voltage law (2nd Law) states that the sum of all voltages around any closed loop in a circuit must equal zero. This is a consequence of charge conservation and also conservation of energy.

Kirchoff's current law

- Current flow in circuits is produced when charge carriers travel though conductors. Current is defined as the rate at which this charge is carried through the circuit. A fundamental concept in physics is that charge will always be conserved. In the context of circuits this means that, since current is the rate of flow of charge, the current flowing into a point must be the same as current flowing out of that point.

KIRCHOFFS LAW



CURRENT ELECTRICITY

KIRCHHOFF'S VOLTAGE LAW

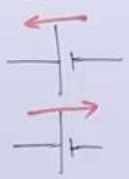
In a closed circuit, algebraic sum of all emf and potential drop in a loop is equal to zero.

$$\sum (E + IR)_{loop} = 0$$

Law of conservation of energy

SIGN CONVENTION

For Cell :-



$+E$

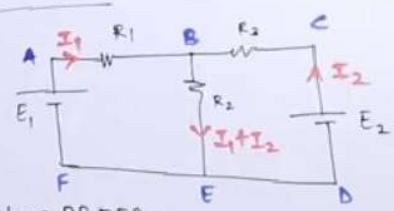
$-E$

For Potential drop :-

$-IR$

$+IR$

Example :-



In loop ABEFA

$$-I_1R_1 - R_2(I_1+I_2) + E_1 = 0 \quad \text{--- (1)}$$

In loop BCDEB

$$+I_2R_3 - E_2 + R_2(I_1+I_2) = 0 \quad \text{--- (2)}$$

In loop ABCDEFA

$$-I_1R_1 + I_2R_3 - E_2 + E_1 = 0 \quad \text{--- (3)}$$

quiz

Kirchhoff's First Law says that:

A — Current loses strength as it flows about a circuit

B — Voltage loses strength as it flows about a circuit

C — Wires need insulation to stop electrons from leaking out of the wire

D — Total current flowing into a point is the same as the current flowing out of that point

Question 1

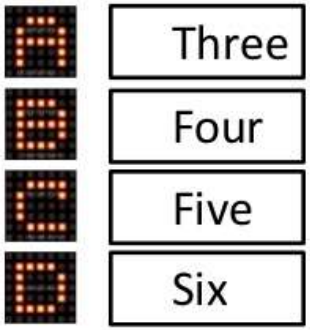
Question 2

KCL is used when solving circuits with...

- Closed loops
- Sufficient nodes/ junctions
- Capacitors
- None

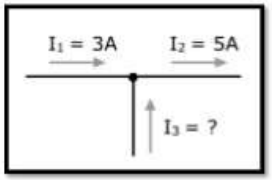
Question 5

If a circuit contains three loops, how many *independent* equations can be obtained with Kirchhoff's Second laws?



- Three
- Four
- Five
- Six

How much is current I_3 in the node shown?

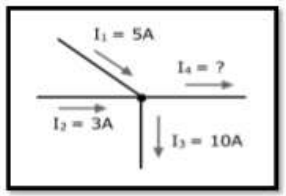


Question 6

- 2A
- -2A
- 0A
- 8A

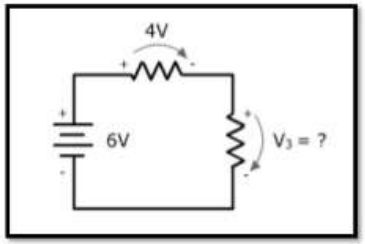
Question 7

How much is current I_4 in the node shown?



- 2A
- -2A
- 18A
- 8A

How much is voltage V_3 in the closed loop circuit shown?



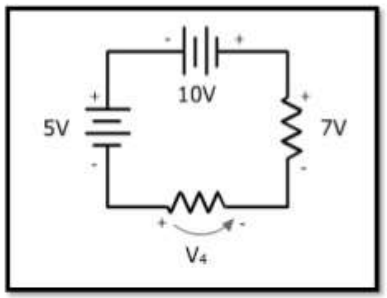

2A


-2A


10A


-10A

How much is voltage V_4 in the closed loop circuit shown?




4A


-4A


8A


-8A