Nepal Engineering Council Registration Examination Preparation Class

Computer Engineering

1. Concept of Basic Electrical and Electronics Engineering (AExE01)

1.1 Basic concept: Ohm´s law, electric voltage current, power and energy, conducting and insulating materials. Series and parallel electric circuits, start-delta and delta-star conversion, Kirchhoff's law, linear and non-linear circuit, bilateral and unilateral circuits, active and passive circuits.

1.2 Network theorems: concept of superposition theorem, Thevenin`s theorem, Norton`s theorem, maximum power transfer theorem. R-L, R-C, R-L-C circuits, resonance in AC series and parallel circuit, active and reactive power.

1.3 Alternating current fundamentals: Principle of generation of alternating voltages and currents and their equations and waveforms, average, peak and rms values. Three phase system.

1.4 Semiconductor devices: Semiconductor diode and its characteristics, BJT Configuration and biasing, small and large signal model, working principle and application of MOSFET and CMOS.

1.5 Signal generator: Basic Principles of Oscillator, RC, LC and Crystal Oscillators Circuits. Waveform generators.

1.6 Amplifiers: Classification of Output Stages, Class A Output Stage, Class B Output Stage, Class AB Output Stage, Biasing the Class AB Stage, Power BJTs, Transformer-Coupled Push-Pull Stages, and Tuned Amplifiers, op-amps.

Basic Concept

1. Electric Voltage

- Voltage is an electrical force, also known as an electromotive force that aids the movement of electrons.
- The voltage between two points is equal to the electrical potential difference between those points.
- It is actually the electromotive force (emf), responsible for the movement of electrons (electric current) through a circuit.
- Voltage is the cause and current is its effect. Voltage can exist without current.
- Symbol : V
- Unit : Volts, Joule/ coulomb
- Measuring Instrument : Voltmeter

What is the unit of electrical voltage ?

A. Volts

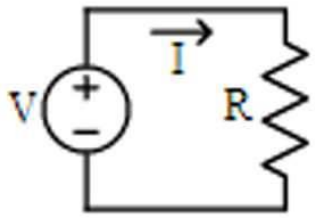
B. Joule / Coulomb

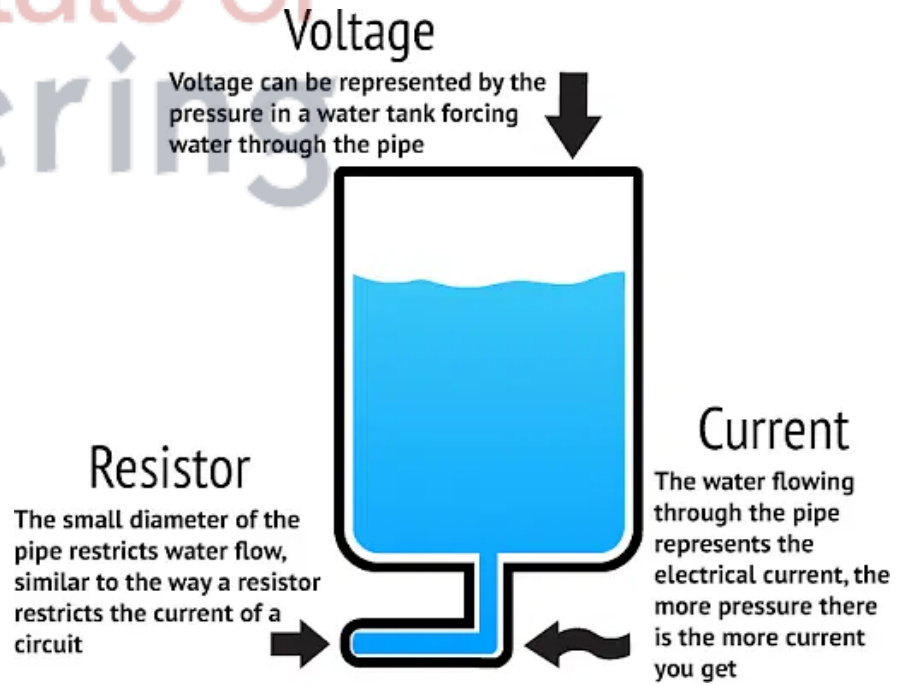
C. Both A and B

D. Non of the above

1. Electric Current

- A flow of electrons forced into motion by voltage is current.
- Current is the rate of flow of electric charge.
- Current is the effect (voltage being the cause). Current cannot flow without Voltage.
- Symbol : I
- Unit : Ampere, Coulomb/Sec
- Measuring Instrument : Ammeter





One coulomb passing a point in one second is one

A. Ampere

B. Volt

C. Ohm

D. Charge

The term used to designate electrical pressure is

A. Voltage

B. Current

C. Resistance

D. All of the above

Current is considered as the movement of

A. Electron

B. Proton

C. Neutron

D. All of the above

Current is

A. The presence of positive charge

B. The abundance of electrons

C. The movement of electrons

D. The repulsion of electrons

3. Power

Power is the rate at which work is done, or energy is transmitted.

Power = Voltage X Current

Unit : Watt or Joule/Sec

Power (P)= $VI = I^2R = V^2/R$ Watts

4. Energy

Energy is the capacity to do work. Energy is power integrated over time.

Energy = Power X time

Unit : Wattsec, Joule

Energy consumed = $P*t = I^2R\ t = V^2\ t/R$

Which of the following instrument is used to measure voltage ?

A. Ammeter

B. Voltmeter

C. Wattmeter

D. Energy meter

Which of the following relation is not correct ?

A. $P = VI$

B. $P = I^2R$

C. $P = V^2 / R$

D. $P = V^2R$

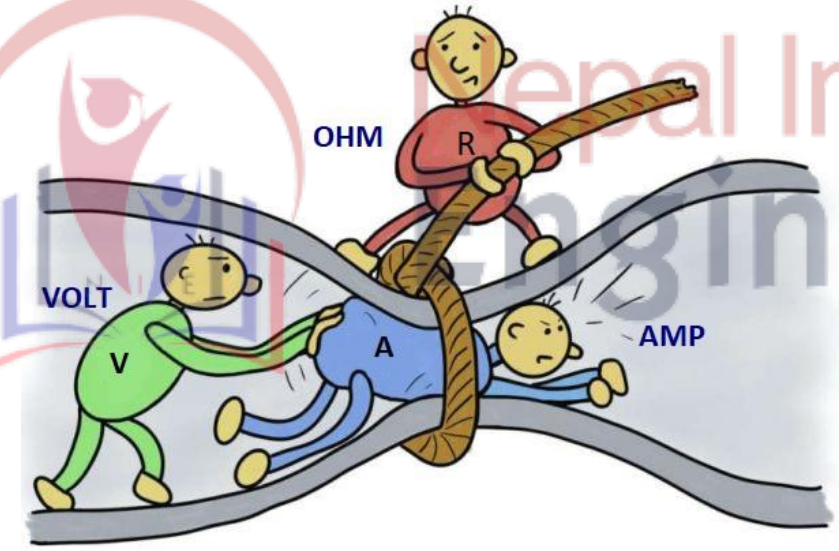
Ohm's Law

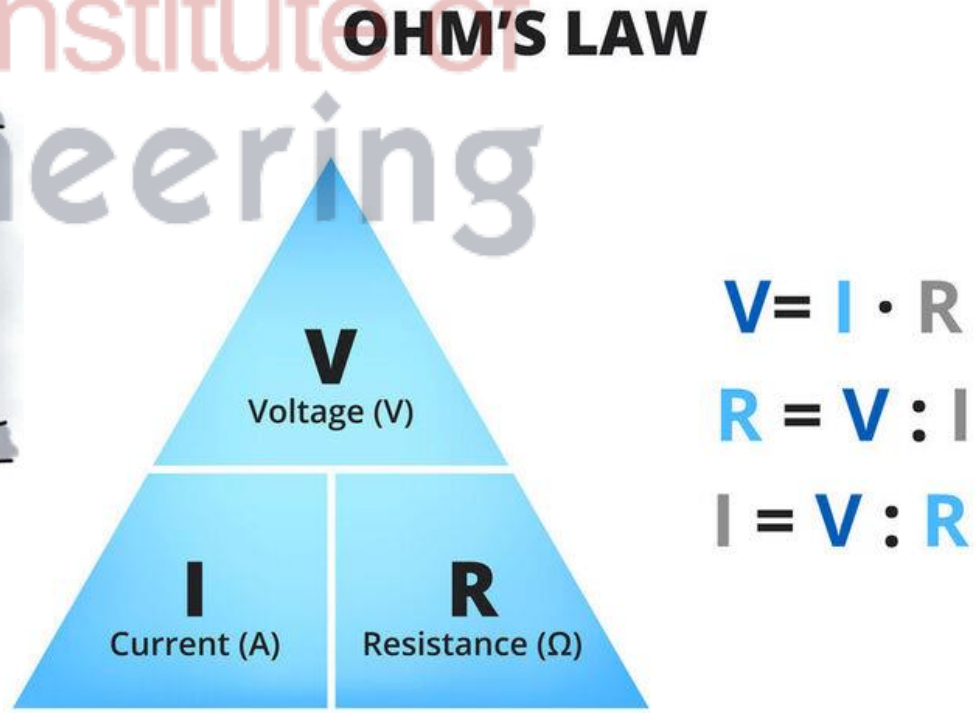
Current flowing through conductor is directly proportional to the potential difference between its two ends, provided that temp. and other physical parameters remains constant.

$I \alpha V$

$I = V/R$

So $V = IR$





Which of the following relation is not correct ?

A. $V = I \times R$

B. $V = I/R$

C. $I = V/R$

D. $R = V/I$

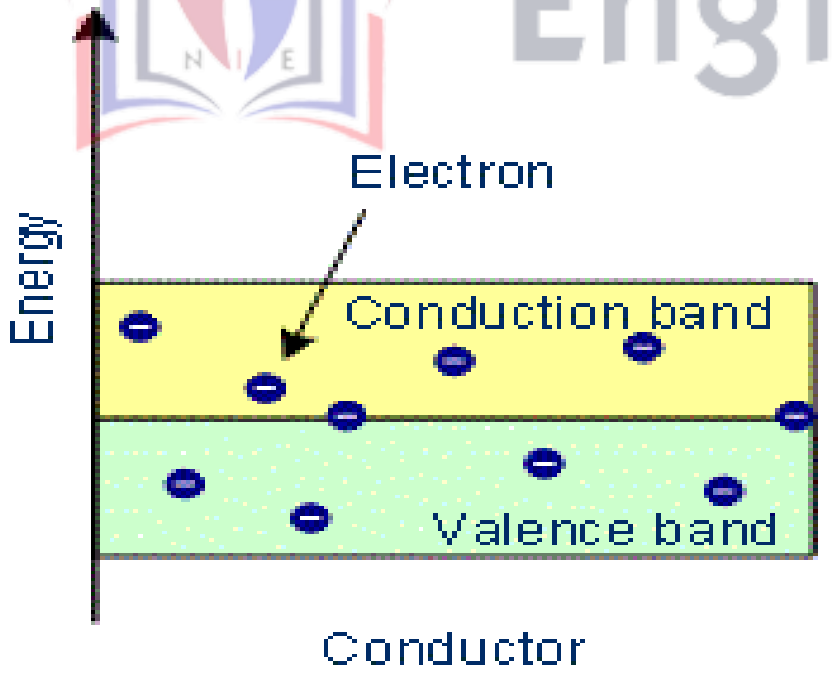
Conducting materials

Conductors are those substances which easily allows the passage of electrical current through them.

Example : Copper, Aluminium, Gold, Silver, Steel, Sea water

Valance band and conduction band overlap each other.

There are large number of free electrons available in a conductor.



Properties of Conducting materials

- Conductor allows current to flow easily through it.
- Electric charge exists on the surface of conductors.
- Conductors don’t store energy when kept in a magnetic field.
- Thermal conductivity (heat allowance) of a conductor is very high.
- The resistance of a conductor is very low.
- Conductors are used in making electrical equipment.

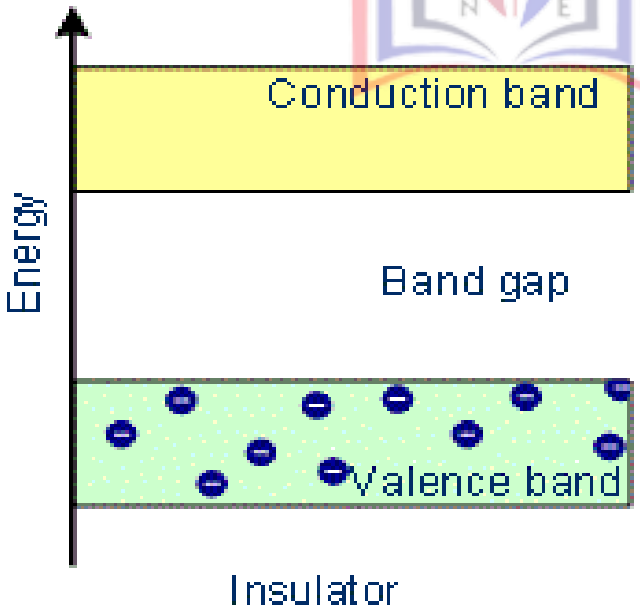
Insulating materials

Insulators are those substances which do not allows the passage of electrical current through them.

Example : Rubber, Dry wood, glass, oil, diamond,

Valance band is full but conduction band is empty and there is large energy gap between them.

Very high electric field is required to push the valance electrons to the



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Properties of Insulating materials

- It doesnot allows current to flow easily through it.
- Electric charge are absent in insulator.
- Insulator store energy when kept in a magnetic field.
- Thermal conductivity (heat allowance) of insulator is very low.
- The resistance of insulator is very high.
- Insulators are used in insulating electrical equipment for safety.

Conductivity level (Decreasing)

Silver → Copper → Gold → Aluminium → Calcium

Tungsten → Zinc → Nickel → Steel……..

……. Graphite → Diamond → Sea water

Silicon → Glass Rubber → Wood → Air → qurtz

Teflon

The substance which have a large number of free electrons and offer a low resistance are called

A. Insulators

B. Inductors

C. Semiconductors

D. Conductors

Which of the following is not a poor conductor ?

A. Cast iron

B. Copper

C. Carbon

D. Tungstain

Which of the following is insulating material?

A. Gold

B. Copper

C. Silver

D. Paper

Which is the best conductor of electricity?

A. Iron

B. Silver

C. Copper

D. Carbon

Which has the poorest electrical conductivity among the following?

A. Silver

B. Aluminium

C. Copper

D. Gold

Series electric circuits

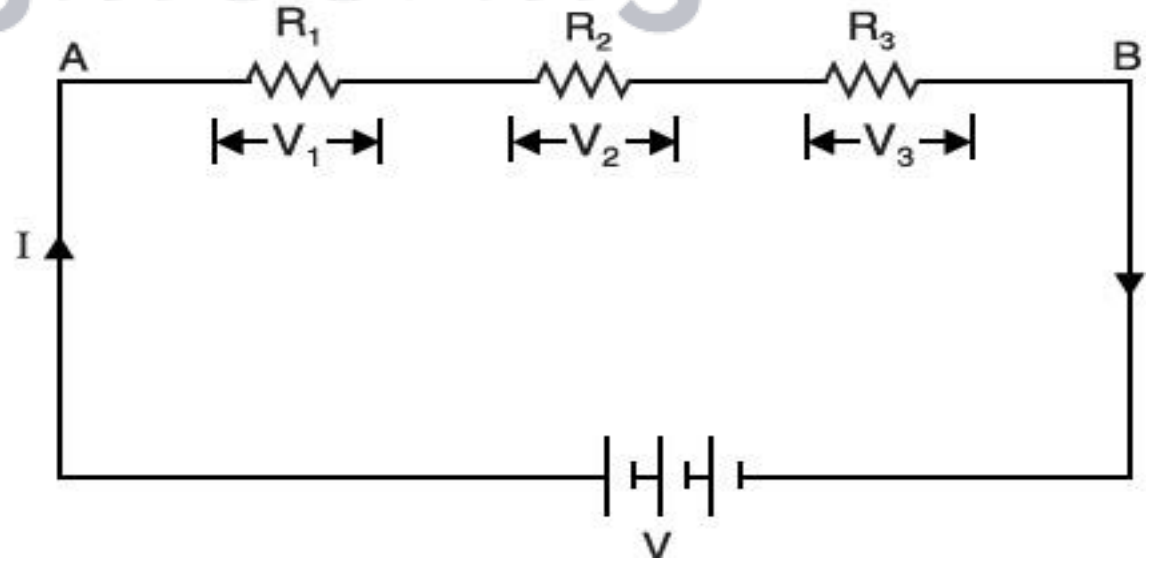
All components are connected end-to-end to form a single path for current flow.

The total resistance in a series circuit is equal to the sum of the individual resistors, and

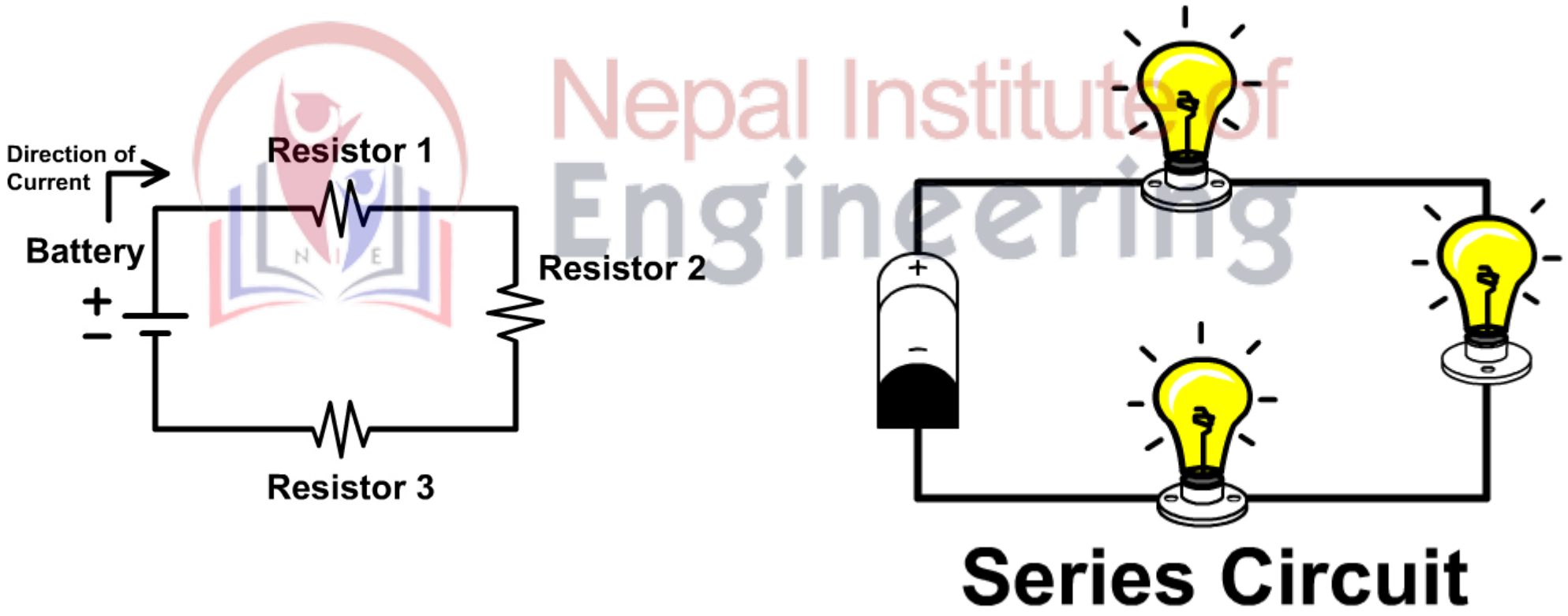
The total voltage drop is equal to the sum of the individual voltage drops across those resistors.

$$V = V_1 + V_2 + V_3$$

$$R = R_1 + R_2 + R_3$$



When lights are connected in a series circuit and one goes out the circuit becomes open and no other light works. This is because there is no path to the negative terminal of the battery when a circuit is open.

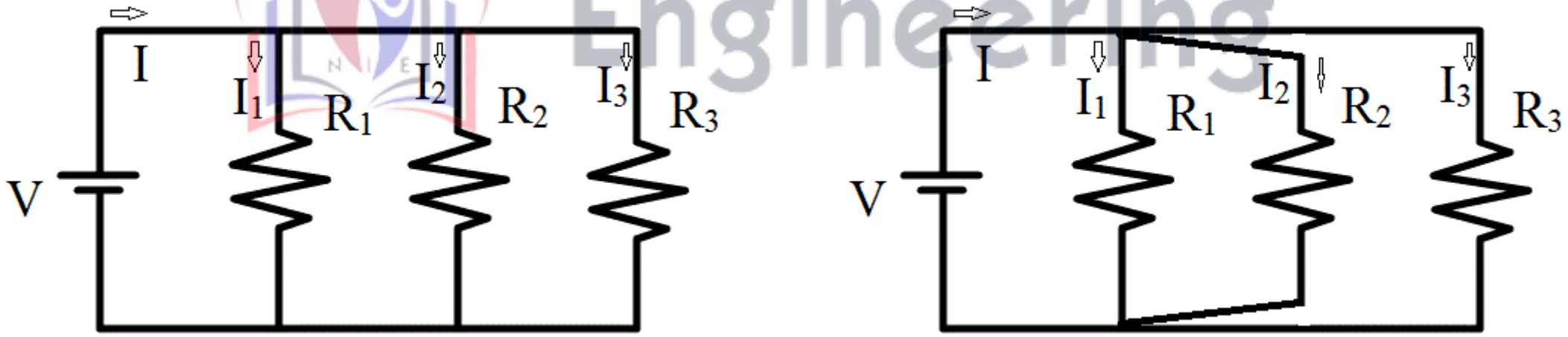


Parallel electric circuits

A Parallel circuit includes branches providing multiple paths for current to flow.

In a parallel circuit, all components share the same electrical nodes.

Therefore, the voltage is the same across all parallel components.



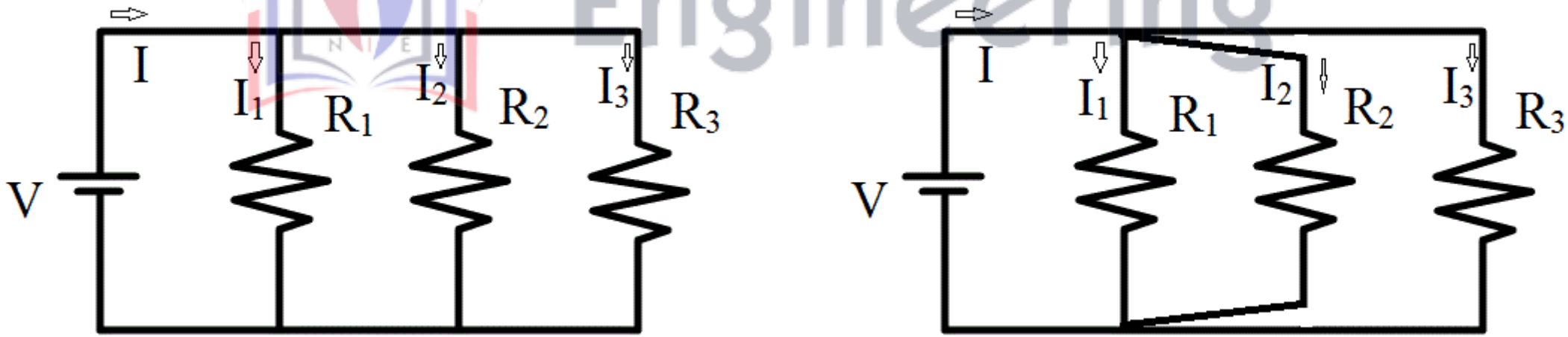
In a parallel circuit,

The voltage is the same across all parallel components.

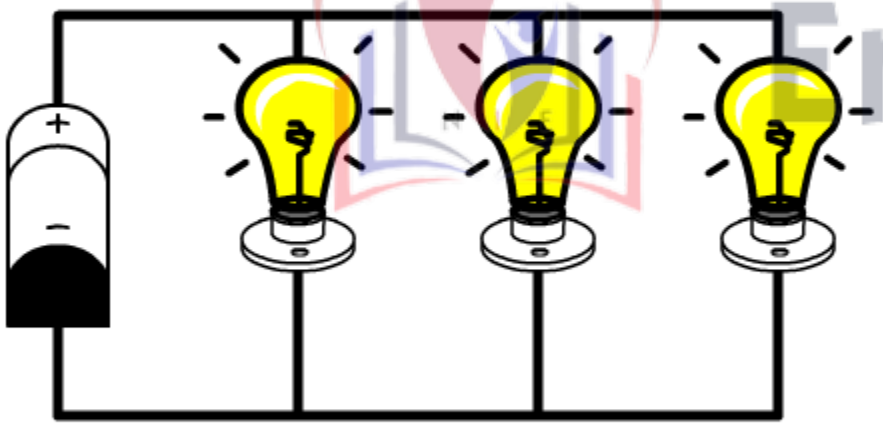
Total Current (I) = $I_1 + I_2 + I_3$

Total Conductance (1/R) = $(1/R_1) + (1/R_2) + (1/R_3)$

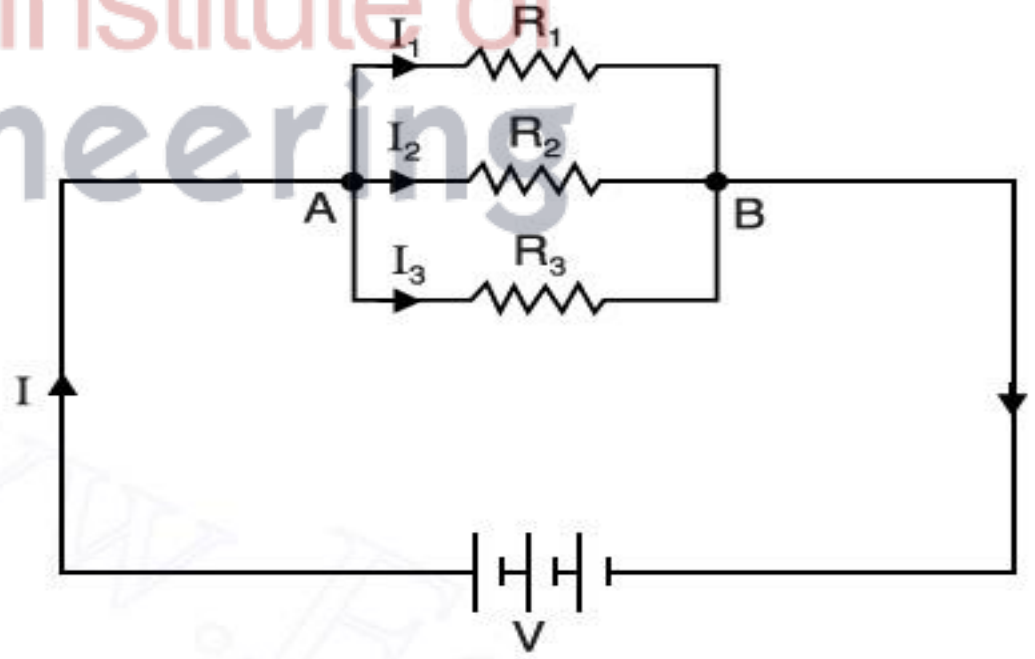
Total resistance (R) = $\{(1/R_1) + (1/R_2) + (1/R_3)\}^{-1}$



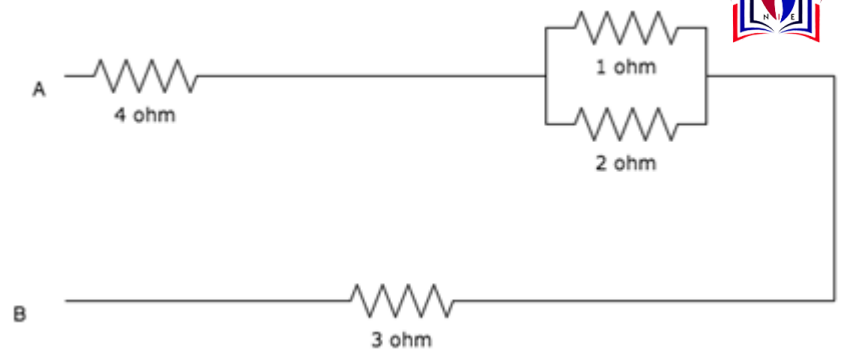
Because of branching, additional paths for current, when light bulbs are in parallel and one goes out the others remain on.



Parallel Circuit



Calculate the resistance between A and B



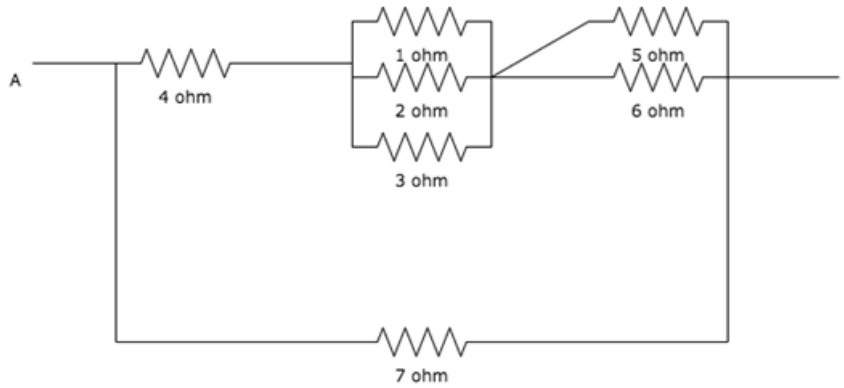
A. 7 ohm

B. 0 ohm

C. 7.67 ohm

D. 9 ohm

Calculate the resistance between A and B



A. 3.56 ohm

B. 7 ohm

C. 14.26 ohm

D. 29.69 ohm

In a _____ circuit, the total resistance is greater than the largest resistance in the circuit.

A. Series

B. Parallel

C. Either series or parallel

D. Neither series nor parallel

In a _____ circuit, the total resistance is smaller than the smallest resistance in the circuit.

A. Series

B. Parallel

C. Either series or parallel

D. Neither series nor parallel

In a parallel circuit, with a number of resistors, the voltage across each resistor is

A. Divided equally among all resistors

B. Same for all resistors

C. Divided proportionally among all resistors

D. Zero for all resistors

The currents in the three branches of a parallel circuit are 3A, 4A and 5A. What is the current leaving it?

A. 3 A

B. 0 A

C. 5 A

D. 12 A

Many resistors connected in series will

A. Divide the voltage proportionally among the resistors

B. Divide the current proportionally

C. Increase the source voltage

D. Reduce the Power to zero

What is the voltage measured across a series short ?

A. Zero

B. Infinite

C. Value of source voltage

D. None of the above

What is the voltage measured across a series short ?

A. Zero

B. Infinite

C. Value of source voltage

D. None of the above

What happens to the current in the series circuit if the resistance is doubled?

A. It becomes half of its original value

B. It becomes double of its original value

C. It becomes zero

D. It becomes infinite

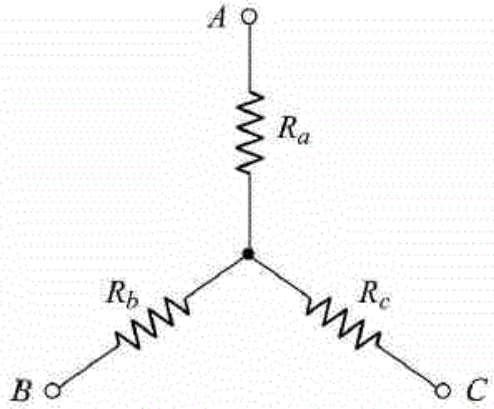
Star delta and Delta star conversion

Star Connection :

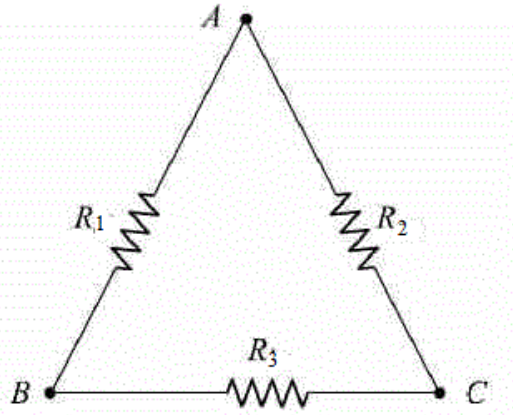
In the Star Connection, the similar ends (either start or finish) of the three windings are connected to a common point called star or neutral point.

Delta Connection :

In Delta (Δ) or Mesh connection, the finished terminal of one resistor is connected to start terminal of the other and so on which gives a closed circuit.



(a) Star (Y) connection

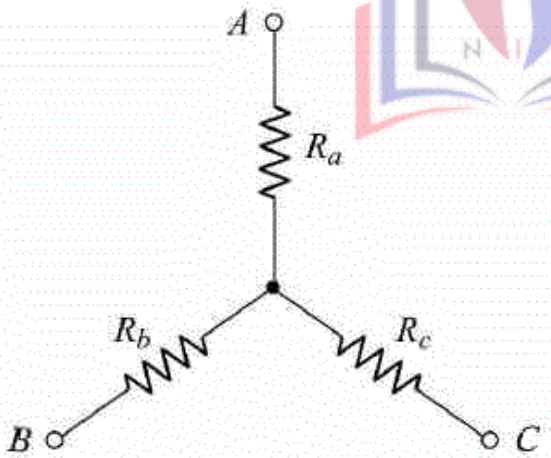


(b) Mesh or Delta (Δ) connection

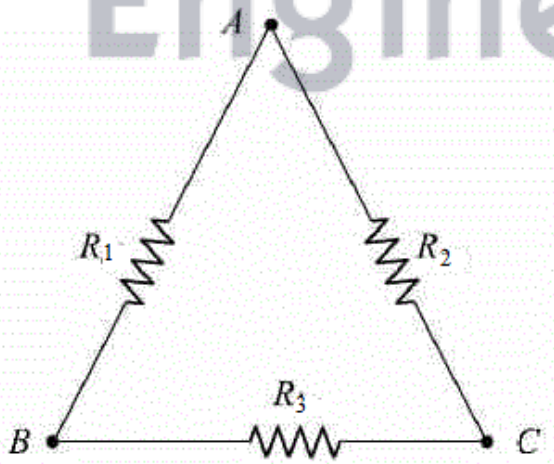
Star to delta conversion

$$R_1 = (R_aR_b + R_bR_c + R_cR_a) / R_c \qquad R_2 = (R_aR_b + R_bR_c + R_cR_a) / R_b$$

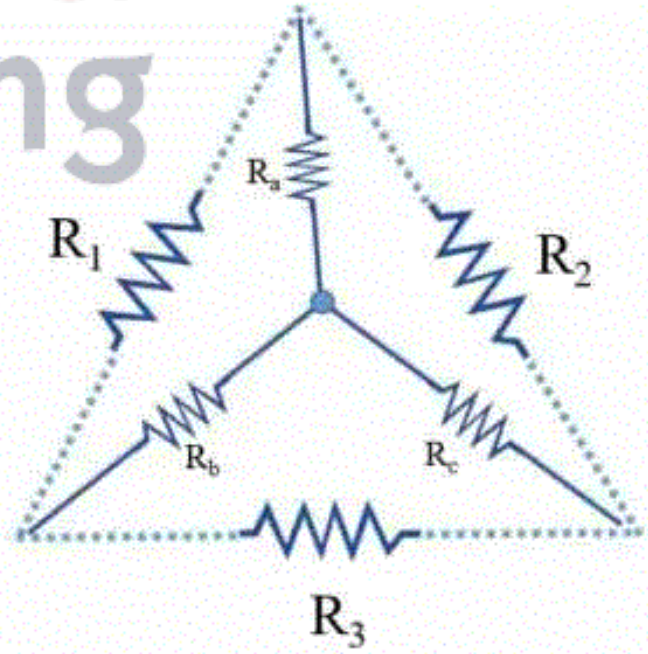
$$R_3 = (R_aR_b + R_bR_c + R_cR_a) / R_a$$



(a) Star (Y) connection



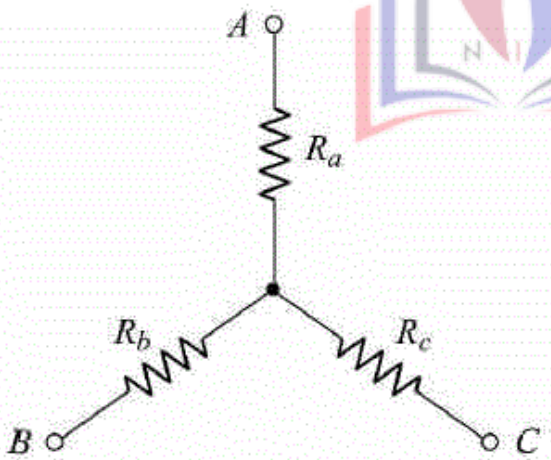
(b) Mesh or Delta (Δ) connection



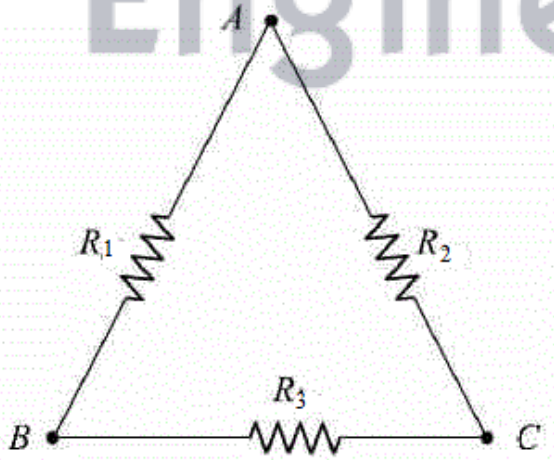
Delta to star conversion

$R_a = (R_1R_2)/ (R_1 + R_2 + R_3)$ $R_b = (R_1R_3)/ (R_1 + R_2 + R_3)$

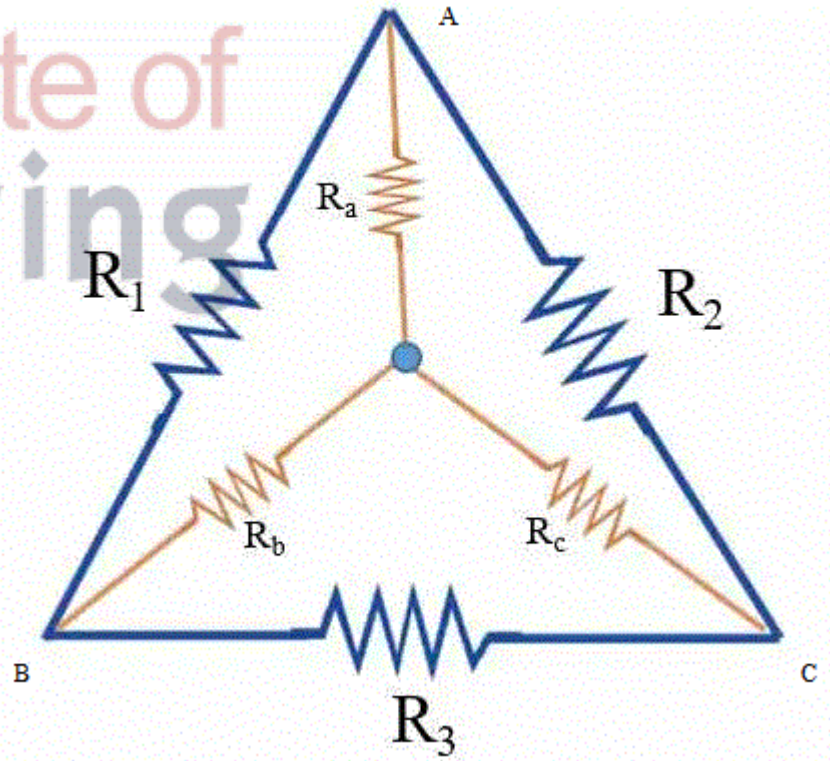
$R_c = (R_2R_3)/ (R_1 + R_2 + R_3)$



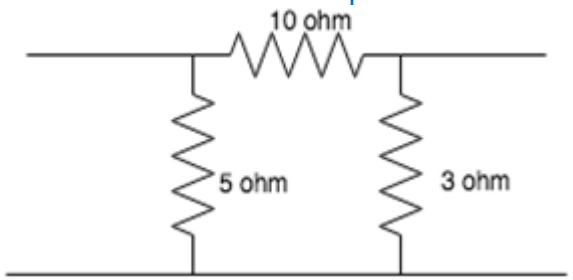
(a) Star (Y) connection



(b) Mesh or Delta (Δ) connection



The value of three resistors when connected in star will be



A. 2.32ohm,1.22ohm, 4.54ohm

B. 3.55ohm, 4.33ohm, 5.67ohm

C. 2.78ohm, 1.67ohm, 0.83ohm

D. 4.53ohm, 6.66ohm, 1.23ohm

If a 6 ohm, 2ohm and 4ohm resistor is connected in delta, find the equivalent star connection

A. 1 ohm, 2 ohm, 3 ohm

B. 2 ohm, 1/4 ohm, 7ohm

C. 5 ohm, 4 ohm, 2/3 ohm

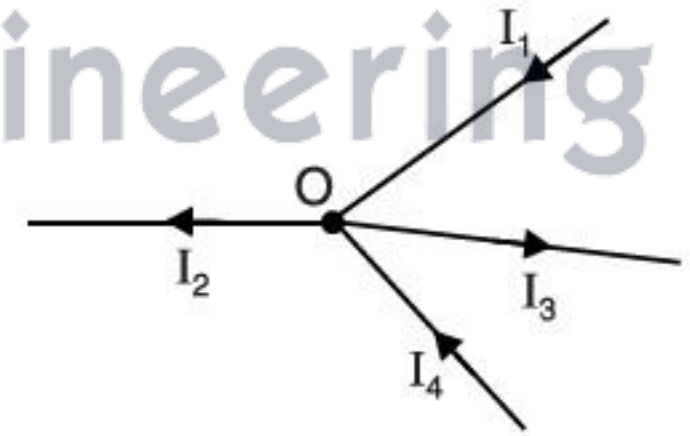
D. 1 ohm, 2 ohm, 2/3 ohm

1. Kirchhoff's Current Law (KCL):

- Statement: The algebraic sum of currents meeting at a junction at any instant of time is zero.

i.e. $I_1 + (-I_2) + (-I_3) + I_4 = 0$

$I_1 + I_4 = I_2 + I_3$



KCL deals with the conservation of

A. Momentum

B. Mass

C. Potential energy

D. charge

KCL is applied at

A. Node

B. Mesh

C. Both mesh and node

D. Neither mesh nor node

2. Kirchhoff's Voltage Law

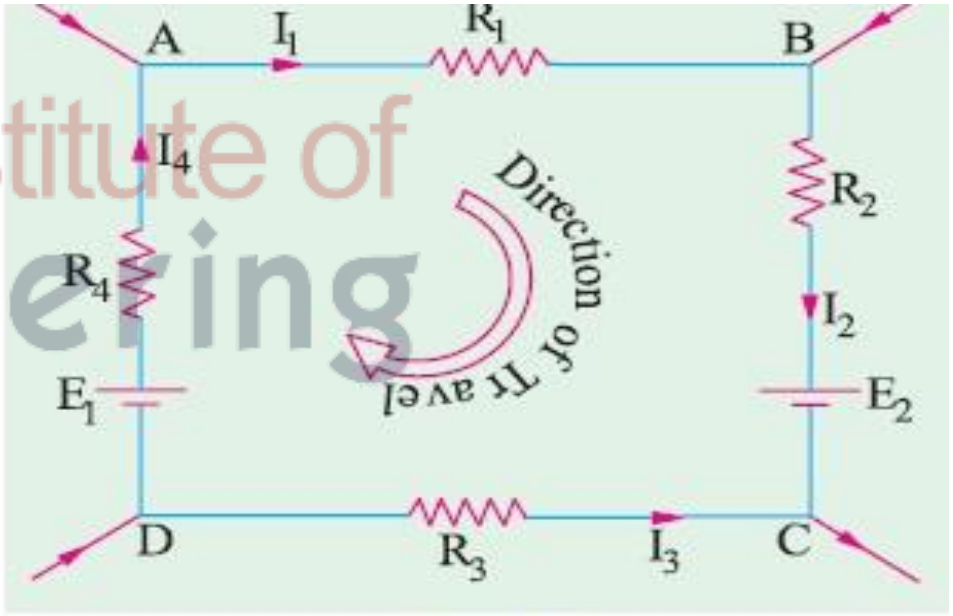
- Statement: It states that algebraic sum of all emfs and the product of resistance and current flowing through it in a closed path at any instant is zero. i.e Σ emf + Σ IR = 0

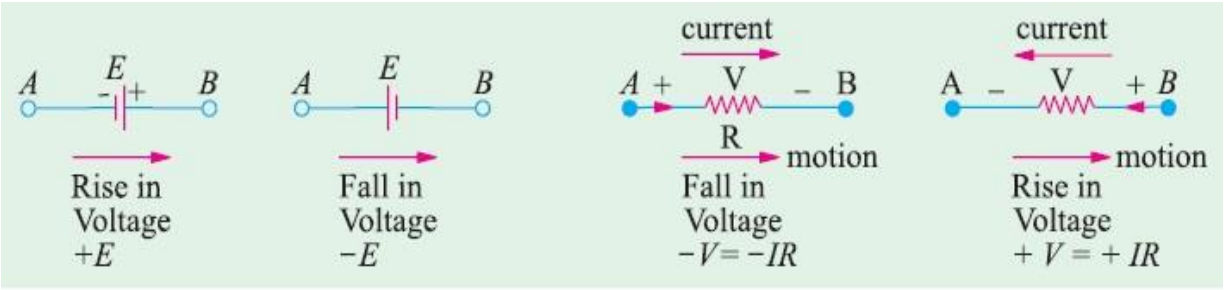
I_1R_2 is $-$ve (fall in potential)
I_2R_2 is $-$ve (fall in potential)
I_3R_3 is $+$ve (rise in potential)
I_4R_4 is $-$ve (fall in potential)
E_2 is $-$ve (fall in potential)
E_1 is $+$ve (rise in potential)

Using Kirchhoff's voltage law, we get

$$-I_1R_1 - I_2R_2 + I_3R_3 - I_4R_4 - E_2 + E_1 = 0$$

or $$I_1R_1 + I_2R_2 + I_3R_3 + I_4R_4 = E_1 - E_2$$





KVL deals with the conservation of

A. Momentum

B. Mass

C. Potential energy

D. charge

KVL is applied at

A. Node

B. Mesh

C. Both mesh and node

D. Neither mesh nor node

The sum of the voltages over any closed loop is equal to

A. Zero

B. Infinity

C. unity

D. All of the above

Linear and Non Linear Circuits

A Linear circuit is one whose parameters are constant with time and they do not change with voltage or current and circuit obeys Ohm's Law.

Example : Circuit with resistors

A Non Linear circuit is that circuit whose parameters change with voltage or current and circuit does not obey Ohm's Law.

Example : Circuits with diodes

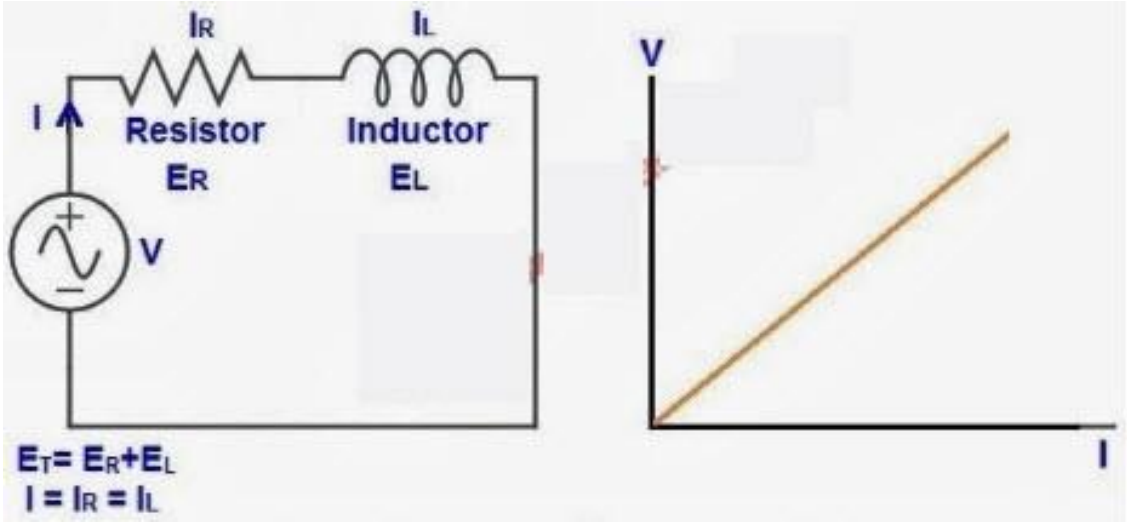
Linear Circuits

- In a linear circuit, the output response of the circuit is directly proportional to the input.
- In an electric circuit, in which the applied sinusoidal voltage having frequency “f”, the output (current through a component or voltage between two points) of that circuit is also sinusoidal having frequency “f”.
- They obey the properties of ohm law.
- The network can be obtained by using the law of superposition.
- Example:

Resistor and resistive circuit

Inductor and inductive circuit

Capacitor and Capacitive circuit



Non Linear Circuits

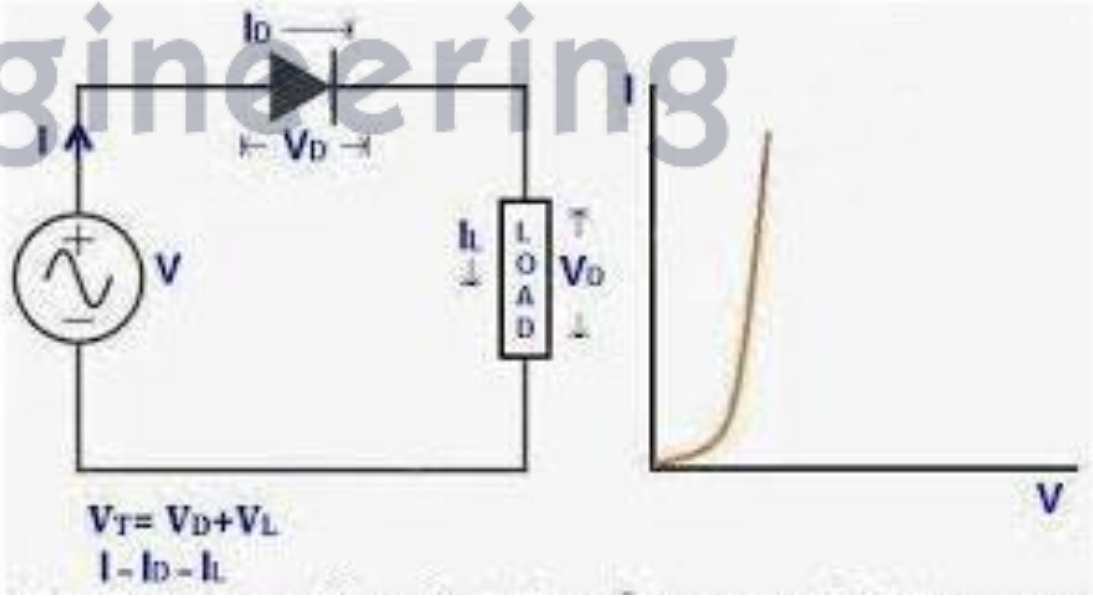
- circuit parameters (resistance, inductance, capacitance, waveform, frequency etc.) are not constant
- They donot obey the properties of ohm law.
- The network doesnot obey the law of superposition.
- Example:

Diode

Transformer

Transistor

Iron core inductor



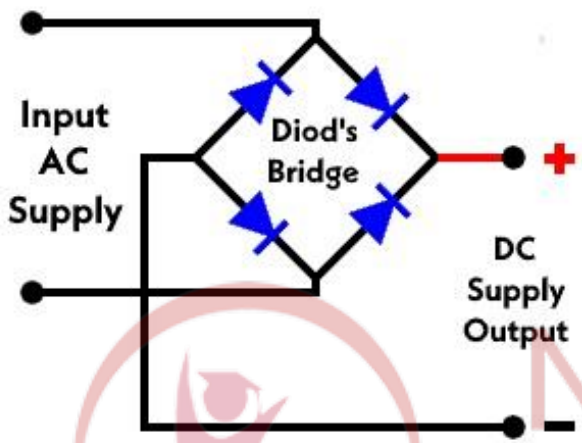
Bilateral and Unilateral circuits

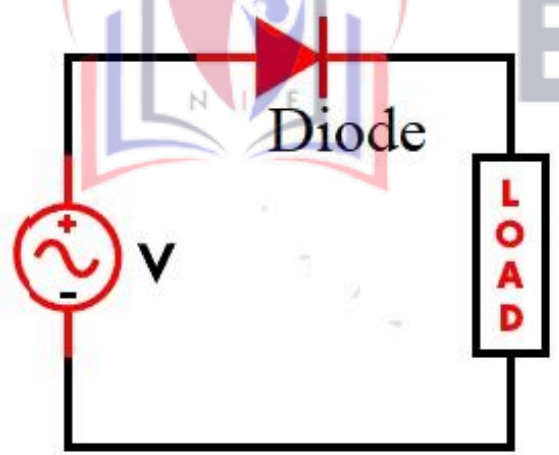
The main difference between unilateral and bilateral circuits lies in their ability to control or regulate current or voltage levels within the system in a specific direction.

In unilateral circuits, the property and characteristics of a circuit changes with the changes in direction of supply voltage or current. In other words, a unilateral circuit allows the current to flow only in one direction for specific operation to be performed. Eg. Circuit with diodes

In bilateral circuits, the property and characteristics of a circuit does not change with the change in direction of supply voltage or current. In other words, bilateral circuit allows the current to flow in both directions for specific operation. Eg. Tr lines

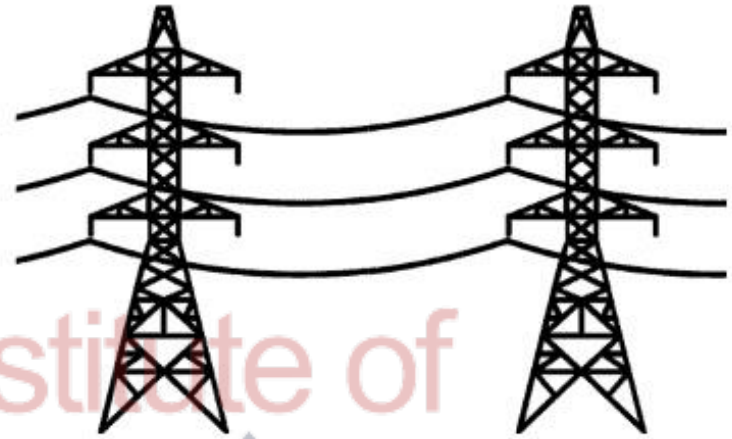
Difference Between Unilateral & Bilateral Circuits

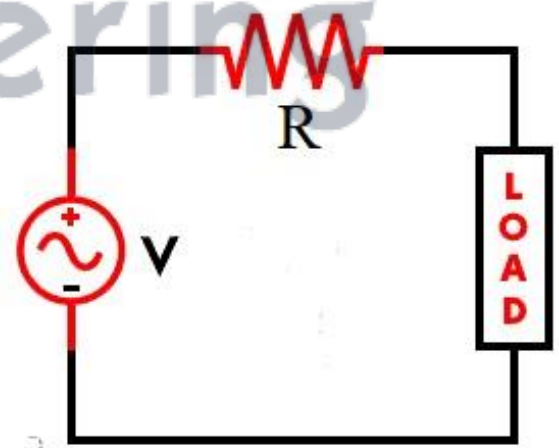




Unilateral

Bilateral



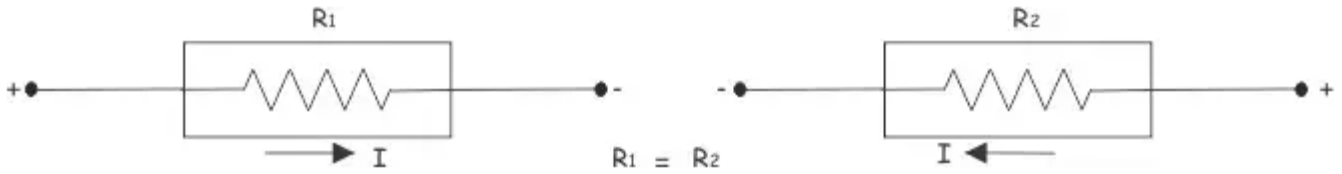


- Bilateral Elements

  Conduction of current in both directions in a circuit element with same magnitude is termed as a **bilateral circuit element**. It offers some resistance to current flow in both directions.

  Examples: Resistors, inductors, capacitors etc.

  A bilateral circuit element can conduct from both sides and offer same resistance for current from either side.

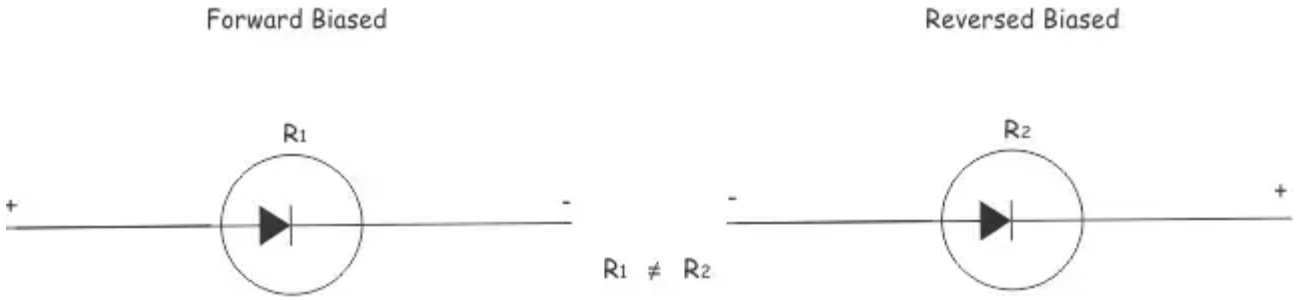


- Unilateral Elements

  The **unilateral circuit element** does not offer same resistance to the current of either direction. The resistance of the **unilateral circuit element** is different for forward current than that of reverse current.

  Examples: diode, transistor etc.

  When diode is forward biased it offers very small resistance and conducts. While it is reverse biased, it offers very high resistance and doesn't conduct.



Active and Passive circuits

An active component can supply power to an electric circuit, whereas a passive component cannot deliver power, it can only absorb the power in the circuit.

Active elements : Battery, transistor, SCR, MoSFET

Passive elements : Resistor, inductor and Capacitor

- Active element supply electric power to the circuit or power gain in the circuit.
- Passive element only absorb electrical energy and dissipate it in the form of heat or store it in a magnetic or electric field. They cannot provide electric power or power amplification in an electric circuit.

Active Component	Passive Component
An active device transforms and injects power or energy into a circuit.	A passive device uses power or energy from a circuit.
Examples: Diodes, transistors, SCR, integrated circuits, battery,etc.	Examples: Resistors, capacitors, inductors, etc
They are capable of providing power gain (amplifier).	They are incapable of providing power gain.
They are energy donors.	They are energy acceptors.
They can control the flow of current.	They cannot control the flow of current.

- **Lumped Elements**

  When the voltage across and current through the element don't vary with dimension of the element, it is called lumped circuit elements.

  Examples: Resistor connected in any electrical circuit.

- **Distributed Elements**

  When the voltage across and current through the element change with dimensions of the element, it is called distributed circuit element.

  Examples: Resistance of a transmission line. It varies with the length of the line.

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