DC CIRCUITS

Subject Name: Electrical Fundamentals

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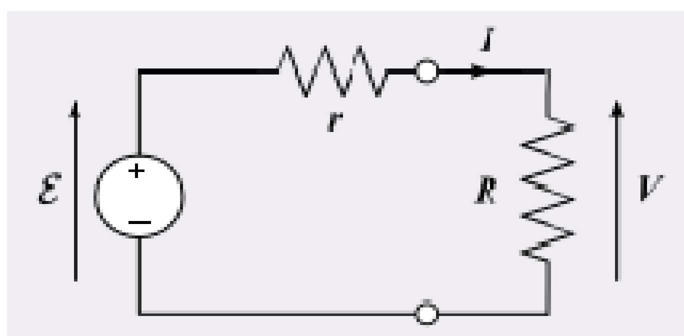
1	Ohms law, Kirchhoff’s first & second laws,
2	Calculation using the above laws to find resistance , voltage and current.
3	Significance of the Internal resistance of a supply

1.Ohm's law

Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points. Introducing the constant of proportionality, the resistance, one arrives at the usual mathematical equation that describes this relationship: I=V/R, where I is the current through the conductor in units of amperes, V is the voltage measured across the conductor in units of volts, and R is the resistance of the conductor in units of ohms.

$$I = \frac{\mathcal{E}}{r + R},$$

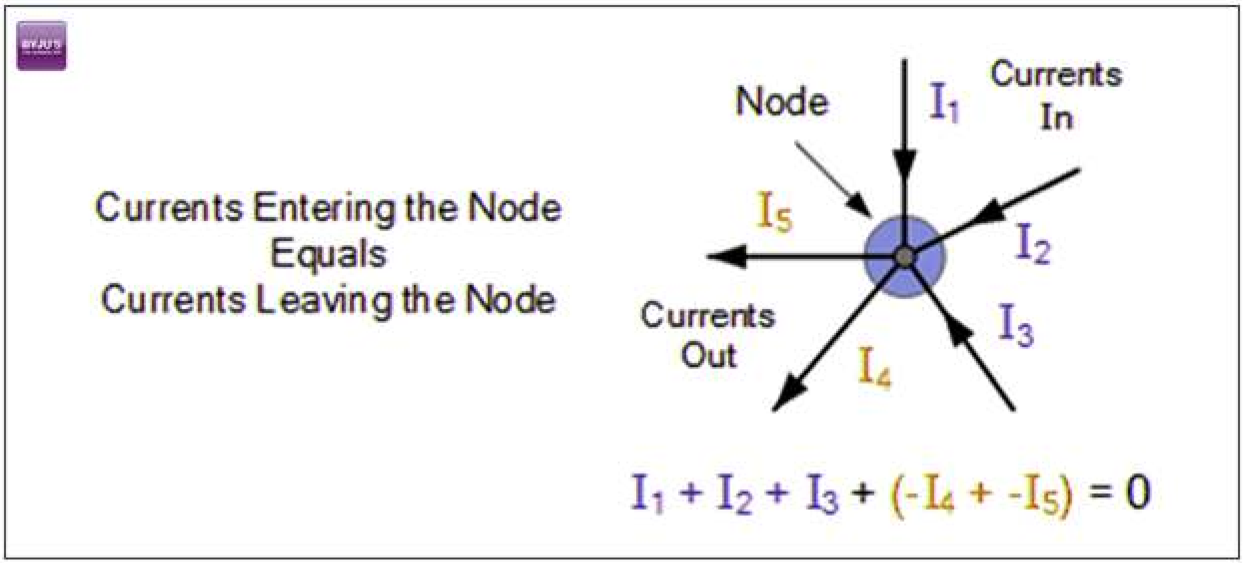


Kirchhoff’s Current Law

- The total current entering a junction or a node is equal to the charge leaving the node as no charge is lost.

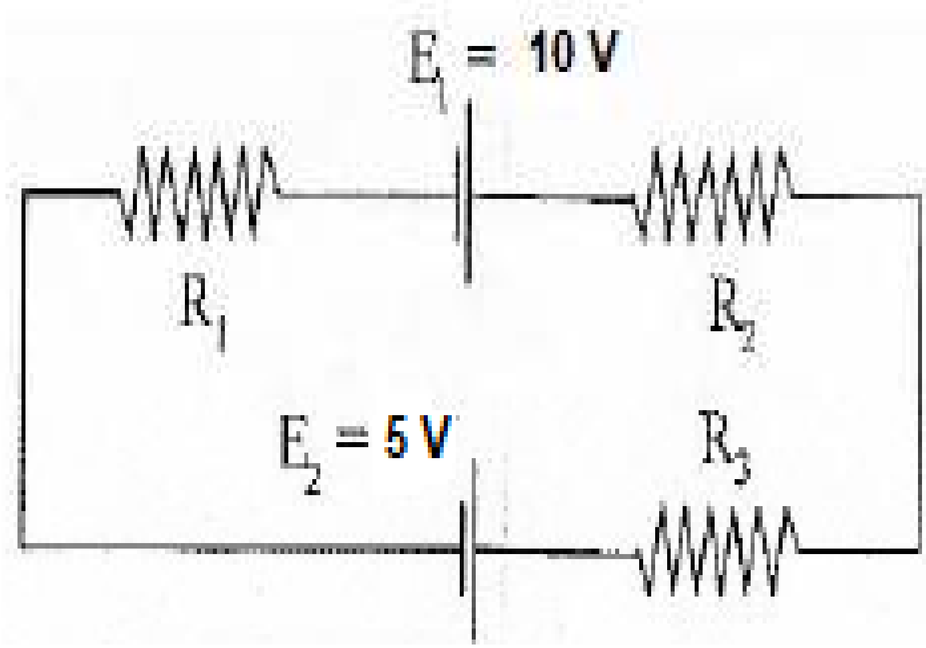
- the algebraic sum of every current entering and leaving the node has to be null. This property of Kirchhoff law is commonly called as Conservation of charge wherein,
- I(exit) + I(enter) = 0.
- In the above figure, the currents I_1, I_2 and I_3 entering the node is considered positive, likewise, the currents I_4 and I_5 exiting the nodes is considered negative in values. This can be expressed in the form of an equation:
- **I1 + I2 + I3 – I4 – I5 = 0**

Kirchhoff’s Current Law (First)



Kirchhoff’s Voltage Law

The voltage around a loop equals to the sum of every voltage drop in the same loop for any closed network and also equals to zero.



E_1 = 10 V
R_1
R_2
E_2 = 5 V
R_3

Solution:

Following are the things that you should keep in mind while approaching the problem:

- You need to choose the direction of the current. In this problem, let us choose the clockwise direction.
- When the current flows across the resistor, there is a potential decrease. Hence, V = IR is signed negative.
- If the current moves from low to high then the source of emf (E) signed positive because of the charging of energy at the emf source. Likewise, if the current moves from high to low voltage (+ to -) then the source of emf (E) signed negative because of the emptying of energy at the emf source.

  In this solution, the direction of the current is the same as the direction of clockwise rotation.

  $– IR_1 + E_1 – IR_2 – IR_3 – E_2 = 0$

  Substituting the values in the equation, we get

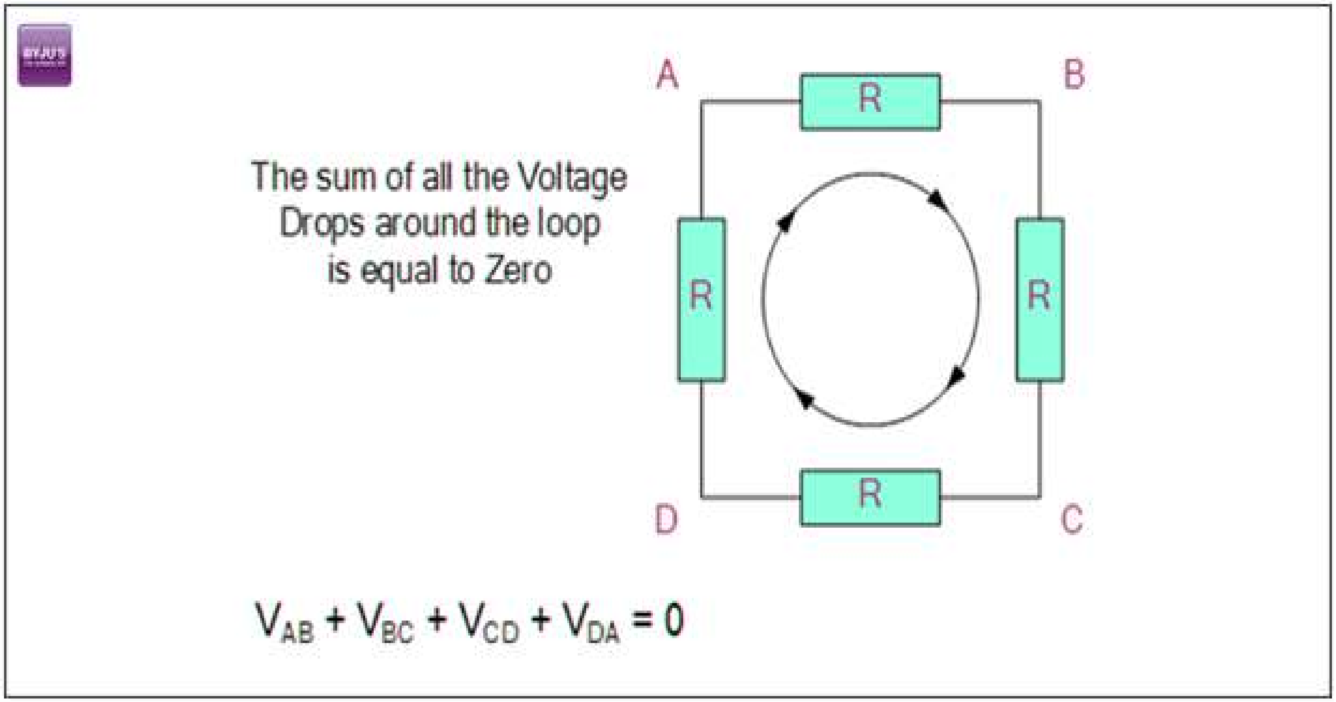
  $–2I + 10 – 4I – 6I – 5 = 0$

  $-12I + 5 = 0$

  $I = -5/-12$

  $I = 0.416$ A
- The electric current that flows in the circuit is 0.416 A. The electric current is signed positive which means that the direction of the electric current is the same as the direction of clockwise rotation. If the electric current is negative then the direction of the current would be in anti-clockwise direction.

Kirchhoff’s voltage Law (Second Law)



Calculation of Internal resistance of Supply

- Internal resistance usually means the electrical resistance inside batteries and power supplies that can limit the potential difference that can be supplied to an external load.
- For example, a battery might have an EMF (Electromotive force - badly named term for the amount of potential difference that could be supplied under ideal conditions) of 1.60 volts, but not all of this will end up across an external load.