

### **Charge :**

The characteristic property of any elementary particles of matter is called as charge. Coulomb is the unit of charge and it is denoted by C. An atom consists of positively charged nucleus and negatively charged electrons.

One coulomb of charge is equal to the charge of  $6.24 \times 10^{18}$  electrons. The symbol of charge is Q or q.

### **Current :**

The rate of flow of electrons is known as current. It is also defined as the rate of change of charge at a particular point. The symbol of current is I or i. The unit of current is Ampere (A)

$$I = \frac{Q}{t} \quad (\text{or}) \quad I = \frac{dQ}{dt}$$

where,  $dQ$  → small change in charge  
 $dt$  → small change in time  
 $I$  → current in Ampere  
 $Q$  → charge in coulomb  
 $t$  → time in seconds

Both the current direction and charge flow are same.

### **Ampere :**

The current is said to be one ampere if one coulomb of charge is transferred in one second.

## Voltage :

The voltage is defined as the ability of the charged body to do work, in moving a coulomb of charge between the two points. Voltage is also known as potential difference. Its unit is volts (V).

$$V = \frac{W}{Q}$$

|          |   |  |
|----------|---|--|
| Where, V | → | voltage or potential difference in volts |
| W        | → | workdone or energy measured in joules    |
| Q        | → | charge in coulombs                       |
| dW       | → | small change in energy                   |
| dQ       | → | small change in charge                   |
| one volt | → | one Joule / one coulomb                  |

## Power :

The power is defined as the ratio of workdone to the time taken (or) the product of current and potential difference. It is denoted by P.

$$P = \frac{dW}{dQ} \times \frac{dQ}{dt} = V \times I \quad (\text{Or}) \quad \frac{dW}{dt}$$

Power is also defined as the rate of change of energy. Its unit is watts (W).

|          |   |                        |
|----------|---|------------------------|
| Where, P | → | Power in watts         |
| W        | → | Energy in Joules       |
| t        | → | time in seconds        |
| dW       | → | small change in energy |
| dQ       | → | small change in charge |

## Work Done (Or) Energy :

Work done is defined as the capacity to do work. It is the resultant of force acting over a distance. The unit of energy is joules or Newtonmeter. It is given by,

$$W = F \times d \text{ Joules or Newton - meter.}$$

where,  $W$  → workdone or energy in Joules

$F$  → Force acting in Newton

$d$  → Distance in metres

Energy is the product of power and time.

$$W = P \times t \text{ watt - sec}$$

## Active Elements :

The sources of energy are called active elements. They are voltage and current source.

Eg. Generator, Transistors, Vacuum tubes, etc.,

## Elements :

Electrical devices or elements are two terminal devices which are the basic building blocks of the electrical circuit. The general form of two terminal device is shown in the figure (1.2) where A and B forms the terminals.



*Two terminal device*

The elements are classified into two types. They are :

- (i) Active Elements
- (ii) Passive Elements

## Passive Elements :

Passive elements stores energy or dissipates energy in the form of heat.

Eg. Resistor, Inductor, capacitor.

## Resistance (R) :

It is the property of a material to oppose the flow of electrical current. The unit of resistance is ohm. Resistance depends on the material of the conductor, length of the conductor, cross sectional area of the conductor and temperature.

If  $\rho$  is the resistivity of the material,  $l$  is the length of the conductor and  $a$  is the area of cross section of the conductor then the resistance (R) offered by the conductor is given by,

$$R = \frac{\rho l}{a}$$



Where,  $\rho$  is measured in  $\Omega\text{m}$

$l$  is measured in m

$a$  is measured in  $\text{m}^2$

$R$  is measured in  $\Omega$

## Inductance (L) :

It is the property of a material that stores energy in magnetic field. The unit of inductance is Henry and is denoted by H.

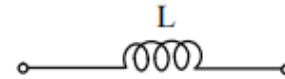
$$\text{Flux linkage} = N\phi$$

where,  $N \rightarrow$  No. of turns

$\phi \rightarrow$  flux in weber

$$L = \frac{N\phi}{i} \Rightarrow Li = N\phi$$

$$\Rightarrow L \frac{di}{dt} = N \frac{d\phi}{dt}$$



The voltage across an inductance when current  $i$  flow through it, is given by,

$$V \propto \frac{di}{dt} \Rightarrow V = L \frac{di}{dt}$$

$$\therefore \frac{V}{L} = \frac{di}{dt} \Rightarrow di = \frac{V}{L} dt = \int_0^t di = \frac{1}{L} \int_0^t V dt$$

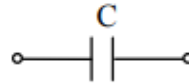
$$\therefore i(t) = \frac{1}{L} \int_0^t V dt + i(0)$$

The current through an inductor  $L$  depends on the integral of voltage across it and the initial current in the coil.

## Capacitance (C) :

It is the property of an element to store electric charge within it. Capacitor stores the energy in the form of electric field. It can be measured as charge per unit voltage. The unit of capacitance is Farad (F).

$$C = \frac{q}{v}$$



Where,  $q \rightarrow$  charge in coulomb

$V \rightarrow$  voltage in volts

$$q = CV$$

$$\frac{dq}{dt} = C \frac{dv}{dt}$$

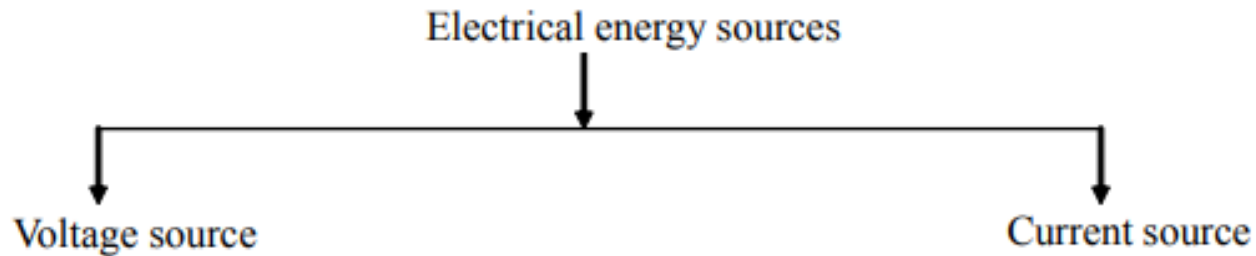
$$\therefore i = C \frac{dv}{dt}$$

$$\frac{i}{c} = \frac{dv}{dt} \Rightarrow dv = \frac{1}{c} i dt = \int_0^t dv = \frac{1}{c} \int_0^t i dt$$

$$V(t) = \frac{1}{c} \int_0^t i dt + v(0)$$

$\therefore$  The voltage across the capacitor depends on the integral of current through it & initial voltage across it.

## Electrical Energy Sources :

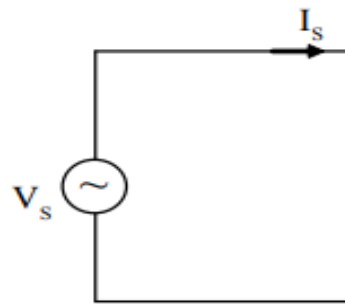


### Voltage Source :

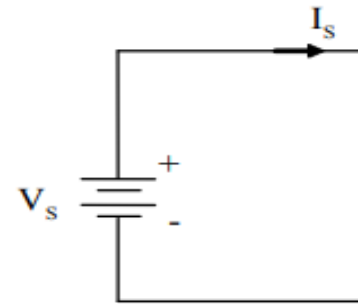
If the voltage across the terminals remains constant irrespective of load changes than the active element is said to be an ideal voltage source. Its internal resistance is zero.

Independent of current flowing through the terminal, if a source is able to produce constant specified voltage across its terminals, then it is called as voltage source.

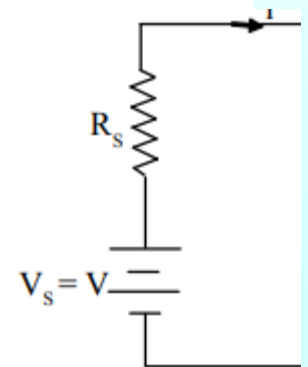
Figure shows the AC and DC voltage source.



*AC Voltage source*



*DC Voltage source*





## Current Source :

Irrespective of input voltage, if a current source can be able to give specified magnitude of current across its output terminal then, it is called as independent current source.

