Basic Electrical Engineering (TEE 101)

Unit-I.

Electrical Circuit Theory → Mast Fundamental branch of EE.

DC Network Theory.

→ KCL, KVL, Mesh Analysis, Modal Analysis
N/w Theorems →
Source Conversion.
Type of Circuit Elements & their properties.
Delta to Star Conversion.

We will also discuss the different laws which are required to analyze an electrical Circuit

Basic Terminologyies of Electrical Circuits.

Minimum

Concept of Electric charge

SI Unit → Coulomb (C)

1 electron = 1.602×10^{-19} C

∴ 1 Coulomb charge = $\left(\frac{1}{1.602 \times 10^{-19}}\right)$ electrons.

1 Coulomb charge = charge of 6.2×10^{18} electrons

The motion of charged particles (e.g., of electrons in metal) in a particular direction is said to Constitude an electric current. (Tensor quantity).

The phenomenon of transferring electric charge from one point in a Circuit to another is described by the term electric Current.

Electric Current is defined as the rate of flow of electric charges or electrons through a Cross-Sectional area.

By Convention, the electric current flows in the opposite direction to the electrons.

$$I = \frac{\text{charge}}{\text{Time}} = \frac{Q}{T} = \frac{C}{\text{sec}} = C/\text{sec or Ampere (A)}$$

1 Ampere Current = flow of 6.24×10^{18} electrons per second through an area

$$i_{inst} = \frac{dq}{dt}$$

charge transferred b/w time t_0 & t is given by

$$q = \int_{t_0}^{t} i\,dt$$

Ques) If n, electrons flows from A to B in 't' sec find I.

$$I = \frac{Q}{T}$$

$1e = 1.602 \times 10^{-19}$

n electrons $= 1.602 \times 10^{-19} \times n$

$$I = \frac{n \times 1.602 \times 10^{-19}}{t}$$

Ques) $q = t^2 + 4t + 5$; Find i_{inst} at $t = 3$ sec
also Find i_{avg} from 0sec to 2sec

$$i_{ins} = \frac{dq}{dt} = 2t + 4\Big|_{t=3se} = 6 + 4 = 10\,A$$

$$i_{avrg} = \frac{\Delta Q}{\Delta t} = \frac{Q|_{2sec} - Q|_{0sec}}{t_2 - t_1} = \frac{(4+8+5) - 5}{2} = 6A$$

Ques) $i = t^2 + 1$

Find q, flown through a cross section b/w 0 to 3sec.
Also, Find the number of electrons that flows in this time.

Sol) $q = \int_{t_0}^{t_1} i\,dt$ $\qquad dI = \frac{dq}{dt}$

$$q = \int_0^3 (t^2+1)\,dt$$

$$= \left[\frac{t^3}{2} + t\right]_0^3 = 12\,C$$

$Q = 12C$; $1\,C = 1.602 \times 10^{-19}$

$\therefore$ $12C = 12 \times 1.602 \times 10^{-19}$ elect

(II) Concept of Electric Potential or potential Difference

To move an electron in a Conductor in a particular direction, as to Create a Current, requires Some Work or energy.

This work is done by the potential or the potential difference. This is also known as Voltage difference or Voltage.

Unit → Volt (V)

The potential of a point is 1 volt if 1 Joule of work is done in bringing a Coulomb charge from infinity to that point.

The voltage V_{ab} between two points a & b is the energy (or work) W, required to move a Unit positive charge from a to b.

$$V_{ab} = \frac{dW}{dq}$$

$$\Delta V = \frac{\text{Work done}}{\text{Unit Charge.}} = \frac{J}{C} = J/C$$

$$1\ J/C = 1V = \frac{1J}{1C}$$

the P.D b/w two points is 1V if 1 Joule of work is done to displace 1 Coulomb of charge from one point to another.

(III) Concept of Electromotive Force (EMF)

The phenomenon of electric Current depends on the presence of free electrons.

If a material has a large number of free electrons, these elect will always move in a random directions as shown be

Typical path of an electron

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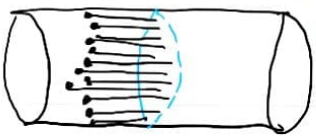
If a material has a large number of free electrons, these electrons will always move in a random directions as shown bellow

Typical path of an electron

If an external effort is applied to the material, it is possible to drift all the electrons in a definite direction as shown below.



A high Current results from many charge Carriers passing through a given Cross-Section of wire on a Ckt

Such an external factor is known as electromotive Force (emf).

In other words, the Voltage or potential of an electrical energy Source is known as emf.

* emf is not a force, but it is the energy or work done.

(IV) Electric Circuits and Networks

Any Combinations and interconnection of network elements (like: resistors, or inductors, Capacitors or electrical energy sources) are known as a "NETWORK".

However, a closed energized N/w is known as a "Circuit".

A N/w need not Contain an energy Source, but a Circuit must Contain an energy Source.

Therefore, it Can be stated that all Circuits are N/w, but all N/w are not Circuits.

Basic Circuit Elements

I Electrical Resistance (R)

It is a measure of the degree to which an object opposes an electric Current through it.

Unit → ohm (Ω)

$\frac{1}{R}$ = electrical Conductance = mho (Ω^{-1})

The resistance of an object determines the amount of current through the object for a given voltage across the object.

$I = \frac{V}{R}$ → Voltage across the object (V)
→ Resistance of the object (Ω)

I → Current through the object (A)

The DC resistance, R of a Conductor of Regular Cross-Section can be Computed as

$R = \rho \frac{l}{A}$ → length of the Conductor (m)
ρ → Electrical Resistivity (ohm-meter)
A → Cross-sectional Area (m^2)

Minimum

$R \propto l$

$R \propto \frac{1}{A}$

R of a typical metal Conductor increases linearly with the temp.

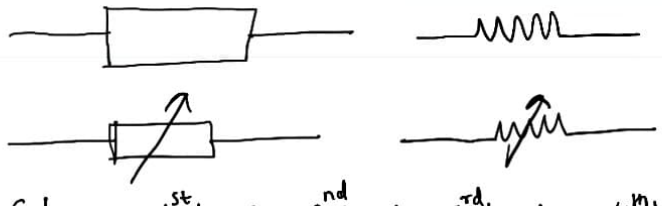
The AC Resistance :- If a wire Conducts high-freq alternative current then the effective Cross-Sectional area of the wire is reduced. This is because of the skin effect.

Also, In a Conductor close to others, the actual resistance is higher because of the proximity effect.

Property of Resistor

A resistor is a two-terminal electrical Component that resists an electric current by producing a voltage drop b/w its terminals in accordance with Ohm's Law.

(i) Non-dynamic Component (No memory)
(ii) Passive element
(iii) Dissipative → loss in the form of heat.



Carbon Composition type
Metal Film type
Wire Wound type

Color	1st band	2nd band	3rd band (Multiplier)	4th band tolerance
B - Black	0	0	10^0	
B - Brown	1	1	10^1	± 1%
R - Red	2	2	10^2	± 2%
O - Orange	3	3	10^3	