LECTURE # 1

Course Title :- Electric Circuit Analysis-I

Course Code :- CPE121

Course outLine :-

→ CRT Analysis Techniques
→ Review of CRT Theorems
→ Transient and Steady Response.

Books :-

(i) Fundamentals of Electric Circuits by Charles K. Alexander

(ii) Engg circuit Analysis by William Hayt.

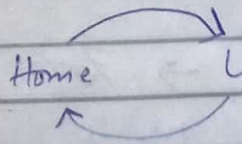
⇒ **What is Circuit & Network.**

Circuit :-

→ "Closed path"

Start from some point and then reach at that same point.

e.g Bus route

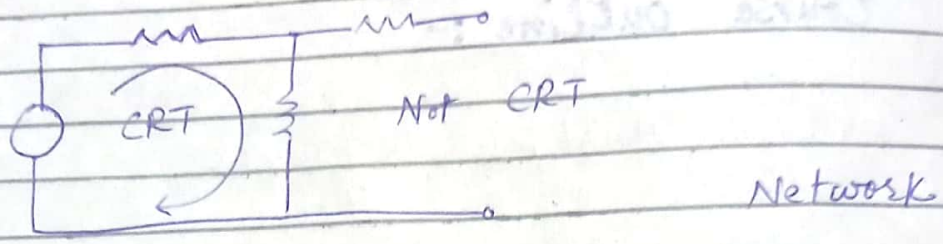


→ Closed loop that carries electricity.

→ Electric circuit is an interconnection of circuit elements

Network :-

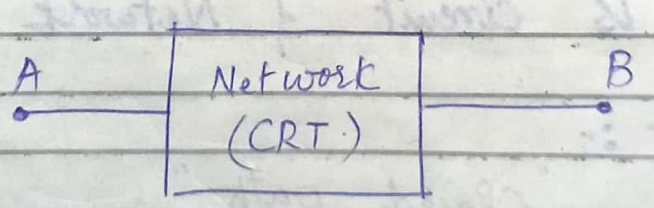
It may consists of closed as well as open path.



It is noted that all circuits are always network but vice versa is not always true.

Aspects of CRT Theory :-

(i) Analysis (ii) Synthesis

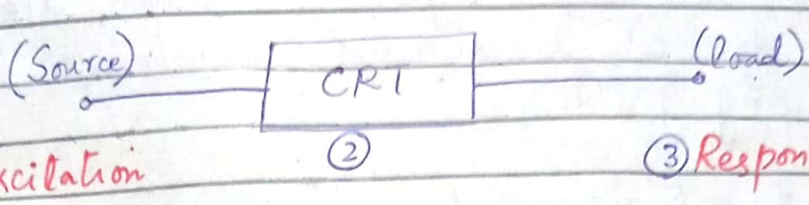


A & B points are terminals.

Terminals :-

→ Zero resistance points.
→ points used to connect source of energy to the CRT.

When a CRT is to be Useful ???



	1	2	3
Problem of Analysis	given	given	Unknown
Problem of Synthesis	given	Unknown	given

(i) **Analysis Problem** :-

Solution exists no matter how difficult it is ⟶ Unique Solution

(ii) **Synthesis Problem** :-

→ Solution may or may not exists
→ First check whether solution is realizable or not
→ Solution is not unique (Indefinite # of solutions can exist).
→ Which solution is convenient & economical.

(1) System of Units :-

⇒ As an electrical engr same units are used for all measurable quantities to avoid any problem.

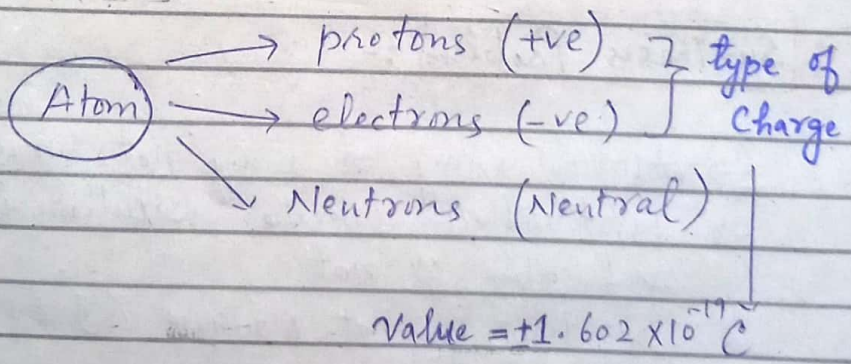
⇒ "International System of Units"

"Interoperatability"

(2) CHARGE :-

⇒ "Charge is the physical property of subatomic particles".

⇒ All matter is made up of fundamental building blocks known as atoms.



⇒ Law of Conservation of Charge:

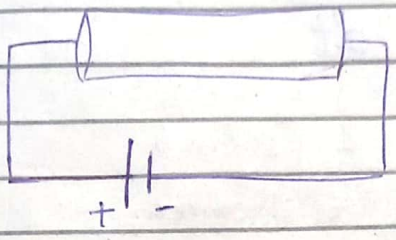
→ Charge can neither be created nor be destroyed only transferred.

→ Net quantity is always Consesved.

(3) CURRENT:- / Electric Current

⇒ A unique feature of charge is the fact that it is mobile, transferred from one place to another

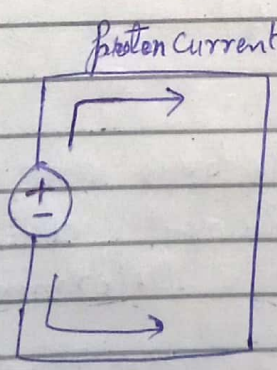
⇒ Charge in motion represents current.



Battery (electromotive force)

⇒ Electric current is due to flow of electrons.

+ve Charge → hole current
-ve Charge → electric/electron Current.



⇒ It is conventional to take the current flow as the movement of positive charges.

⇒ "Electric current is the time rate of change of charge, measured in Amperes (A)"

⇒ Mathematically;

$$i = \frac{dq}{dt}$$

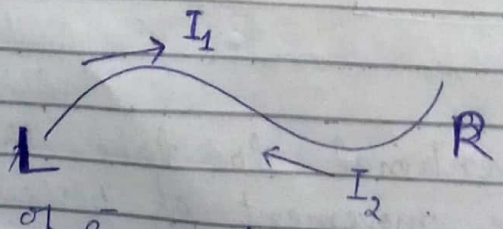
$$1\,A = \frac{1\ \text{Coulomb}}{1\ \text{second}}.$$

Charge transferred between t_0 and t is obtained by;

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

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

⇒ **Problem:-** In a wire electrons are moving from L to R. Current due to this movement is 2mA. Determine I_1 & I_2



I_1 → electron current

I_2 → Conventional current

↓

flow of e^- ⇒ L → R

I_1 ⇒ L → R

$\therefore I_2 = +2mA$ given

$I_1 = -I_2 = -2mA$.

Exp 1.1 :-

How much charge is represented by 4600 electrons ?

Solution

number of e^- = 4600

Total Q = ???

Charge on one e^- = -1.602×10^{-19} C.

$\therefore$ $Q = 4600 \times -1.602 \times 10^{-19}$

$$\boxed{Q = -7.369 \times 10^{-16} \text{ C}}$$

Exp 1.2 :-

Total charge entering a terminal is given by $q = 5t \sin 4\pi t$ mC
Calculate current i at $t = 0.5$ s

Solution :-

$$i = \frac{dq}{dt}$$

$$i = \frac{d}{dt}\left(5t \sin 4\pi t\right)$$

$$= 5 \sin 4\pi t + 5t \cos 4\pi t \,(4\pi)$$

$$= 5 \sin 4\pi t + 20\pi t \cos 4\pi t$$

At $t = 0.5$ sec.

$$i = 5 \sin 4\pi(0.5) + 20\pi(0.5)\cos 4\pi(0.5)$$

$$\boxed{i = 31.42 \text{ mA}}$$

Exp 1.3 :-

Determine the total charge entering a terminal between $t = 1s$ and $t = 2s$ if the current passing the terminal is $i = (3t^2 - t)\ A$.

Solution :-

$$Q = \int_{t=1}^{2} i\,dt = \int_{1}^{2} (3t^2 - t)\,dt$$

$$= \int_{1}^{2} 3t^2\,dt - \int_{1}^{2} t\,dt$$

$$= \frac{3t^3}{3}\Big|_1^2 - \frac{t^2}{2}\Big|_1^2$$

$$= t^3\Big|_1^2 - \frac{t^2}{2}\Big|_1^2$$

$$= (8 - 1) - \left(\frac{4}{2} - \frac{1}{2}\right)$$

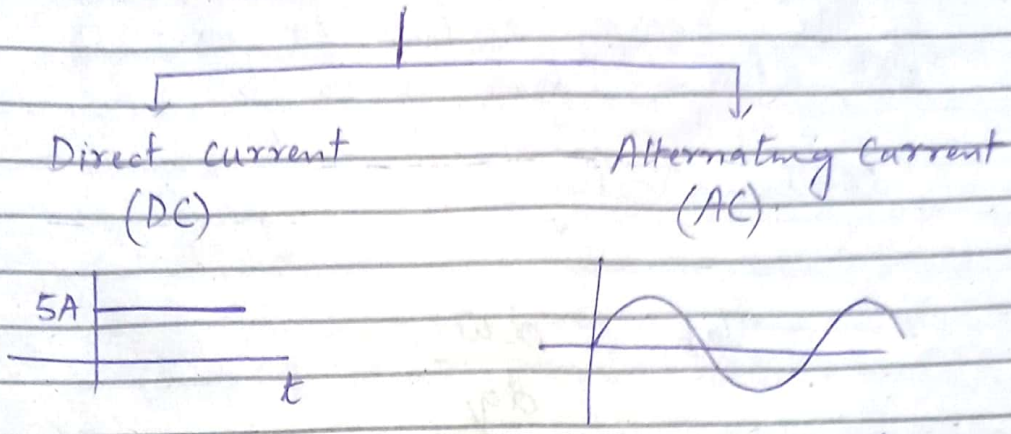
$$= 7 - 2 + \frac{1}{2}$$

$$= \frac{14 - 4 + 1}{2}$$

$$= \frac{11}{2} = 5.5\ C$$

$$\boxed{Q = 5.5\ C}$$

CURRENT TYPES :-



(4) VOLTAGE :- potential Difference

⇒ A "push" that causes the current to flow.

⇒ To move charge in a certain direction some work is done or energy is transferred.

⇒ This work is done by an external source electromotive force (emf). This emf is known as voltage or PD.

"Voltage (or PD) is the energy required to move a unit charge through an element, measured in volts (V)"

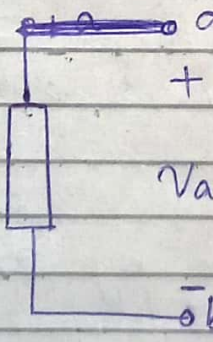
Voltage V_{ab} between two points 'a' and 'b' is the energy needed to move a unit charge from 'a' to 'b'.

Mathematically;

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

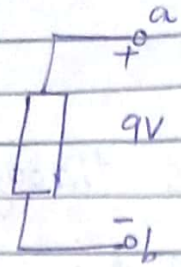
$w \longrightarrow$ energy in Joules (J)
$q \longrightarrow$ Charge in coulombs (C)

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



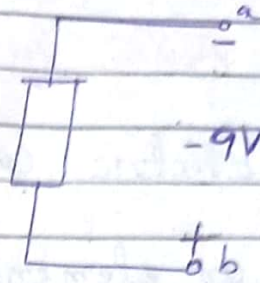
+ve sign shows point 'a' is at high potential

-ve sign shows point 'b' is at Low potential.



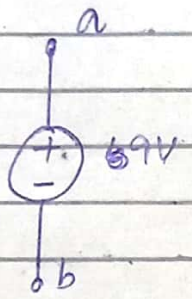
→ 'a' is 9V above 'b'

→ 9V voltage drop from a → b.

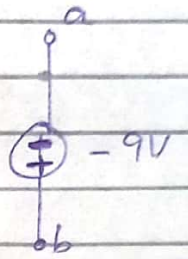


→ 'b' is -9V above 'a'

→ 9V rise from b → a

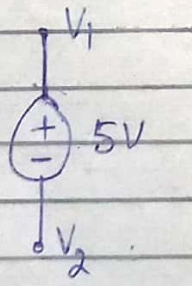


$V_a - 9V = V_b$



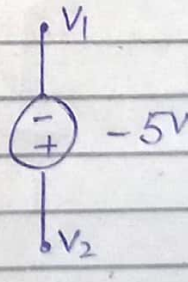
$V_a - (+9V) = V_b$

$V_a - 9V = V_b$



~~Voltage~~

$V_1 - 5V = V_2$



$V_1 + (-5V) = V_2$

$V_1 - 5V = V_2$

Always remember;

Electric current is always through an element and that electric voltage is always across or between two points.