BASIC ELECTRICAL & ELECTRONICS

Semester: 1st/2nd

STUDY MATERIAL

BASIC ELECTRICAL & ELECTRONICS

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Basic fundamental

Dt. 23.2.22

Electrical energy :-

-) It is a form of energy resulting from the flow of electric charge.

-) Energy is the ability to do work or apply force to move an object.

*Electrical energy is easy to use :-

convential form :-

It can be converted from one from of energy into another from.

Easy to control :-

It can be easily controlled by turning on/off through switch.

Greater flexibility :-

It can be transfered from one place to another place.

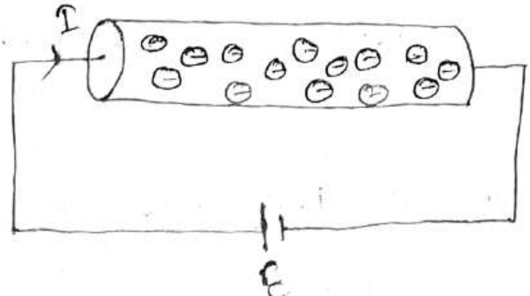
Cleanliness :-

It is not associated with any sources or any poisonous gasses.

High Transmission efficiency :-

It has highly transmission efficiency.

Electric current :-



Matter → Atoms → Electrons, protons, Neutrons.

$q_e = -1.607 \times 10^{-19} c.$

$q_p = 1.607 \times 10^{-19} c.$

The rate of flow of electric charges with respect to time is called electric current.

$$I = \frac{q}{t} \text{ or } \frac{dq}{dt}.$$

unit → Ampere.

Electric potential or voltages-

The ability or the capacity of the charged body to do work is called electric potential.

$$\text{voltage } (V) = \frac{\text{work done}}{\text{charge}} = \frac{w}{q}.$$

unit → volt.

→ The virtue by which work can possibily done due to accumulation of electric charges is called electric potential.

(i)- If two points donot have same potential, then the difference of potential exist betn the two points which is called potential difference.

Electric power:-

→ Power of device is defined as the rate of doing work.

→ Electric power refers to the rating of an electric device and is defined as the rate at which the device can transform electrical energy into other forms of energy, such as mechanical energy in heat energy and light energy.

$$P = \frac{W}{t}$$

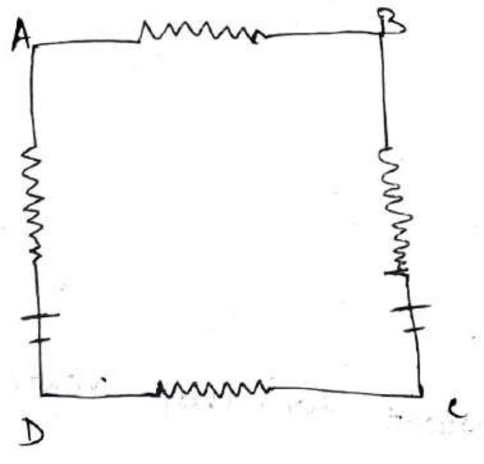
$$\Rightarrow \frac{dw}{dt}$$

$$P = VI.$$

for resistance circuit $P = I^2R$.

Circuit:-

Circuit is a closed conducting path through which an electric current flows.



Resistance (R) -

Inductance (L) -

capacitance (C) -

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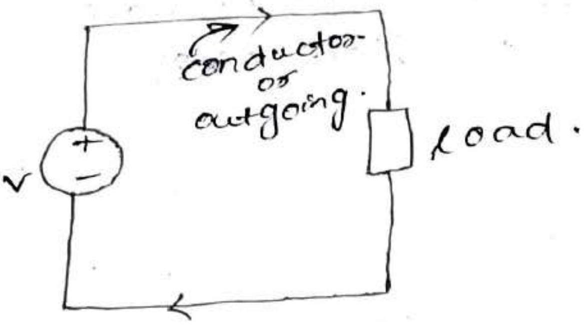
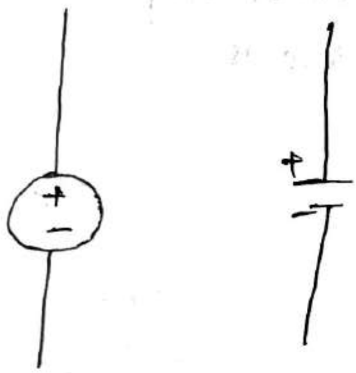
source and load:-



(1)- source → produ...
(2)- load - utilizes energy
(3)- conductors.

Ideal voltage source:-



(symbols).

It maintains constant terminal voltage irrespective of variations in load current.

Internal resistance is present.

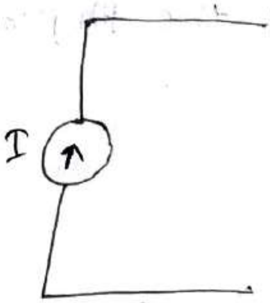
voltage source inwhich the internal resistance is not zero is treated as a practical voltage source.
...hen a load is connected across the voltage ...urce the terminal voltage doesn't remain ...ual to the emf of the source.

3.22

oduces.
es energy

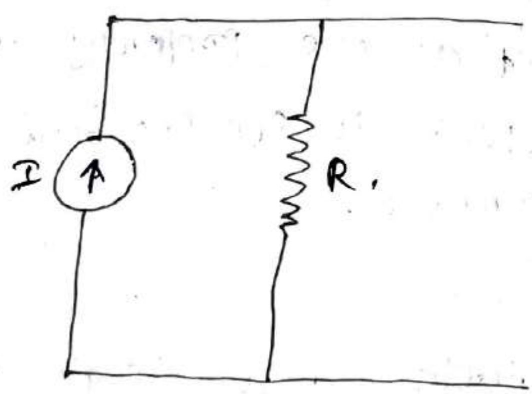
mathematically $V - iR = E$.

Ideal current source :-



(symbol).

Practical current source :-



(symbol).

⇒ A current source that maintains constant output current, irrespective of variations in load is called ideal current source.

⇒ A current source in which the internal resistance has a finite value is treated as practical current source.

⇒ In Practical current source output current may change with variations in load condition.

Ohm's law:

It states that the voltage across an element is directly proportional to the current flowing through it, provided the physical conditions remains the same.

mathematically

$$V \propto I$$

$$\boxed{V = IR}$$

Symbol of (R) =

R = Resistance.

Resistance:-

It may be defined as the property of a substance due to which it opposes the flow of electric current.

Property:-

(1)- It varies directly as its length of conductor.

(2)- It varies inversely as its crossectional area of conductor.

(3)- It depends on nature of material.

(4)- It also depends on the temperature of the conductor.

In mathematically,

$$R \propto l$$

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

$$R \propto \frac{l}{A}.$$

ρ = specific resistance or Resistivity.

$$\boxed{R = \rho \frac{l}{A}}.$$

$$\rho = \frac{AR}{l}$$

unit $= \frac{m^2 ohm}{m}$ = ohm m = Ωm.

Dt 26.3.22

Smaller l

~~(a) length.~~

(a)- larger area.

(i)- Low Resistance

Larger l,

(b). smaller area.

(ii)- high resistance.

$R \propto \frac{l}{A}$. $A\uparrow R\downarrow$

$A\downarrow R\uparrow$.

(iv)- R_0 at $0°C$.

$\downarrow$

R_t at $t°C$.

change in resistance = $R_t - R_0$.

$R_t - R_0 \propto R_0$

$R_t - R_0 \propto t$.

$R_t - R_0 \propto R_0 t$.

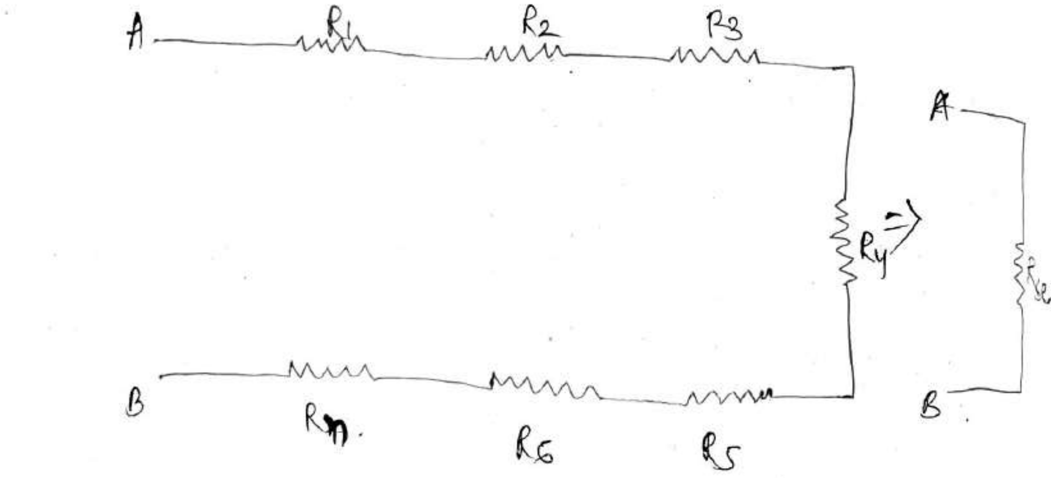
$R_t - R_0 = \alpha R_0 t$.

$R_t = R_0 + \alpha R_0 t$.

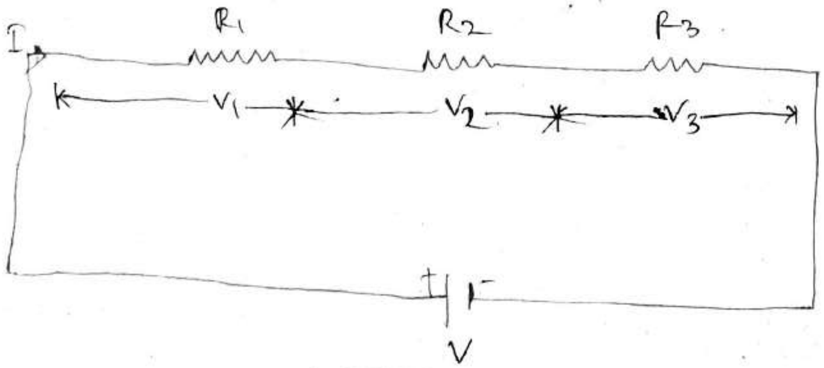
$\Rightarrow \boxed{R_t = R_0 (1 + \alpha t)}$.

α = temperature coefficient of resistance.

Resistance in series:-



$R_{se} = R_1 + R_2 + R_3 + \cdots + R_n$.



$\boxed{V = V_1 + V_2 + V_3}$.

$V = V_1 + V_2 + V_3$

$\Rightarrow IR = IR_1 + IR_2 + IR_3.$

$\Rightarrow IR = I(R_1 + R_2 + R_3)..$

$\Rightarrow \boxed{R = R_1 + R_2 + R_3}.$

Main characteristics of series circuit :-

(1)- same current flows through all the parts of a circuit.

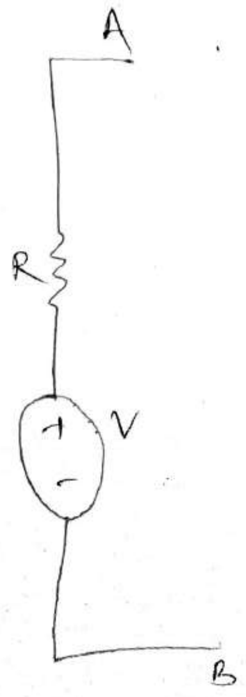
(2)- ~~diffe~~rents resistances have their individual voltage drop.

(3)- voltage drops are additive.

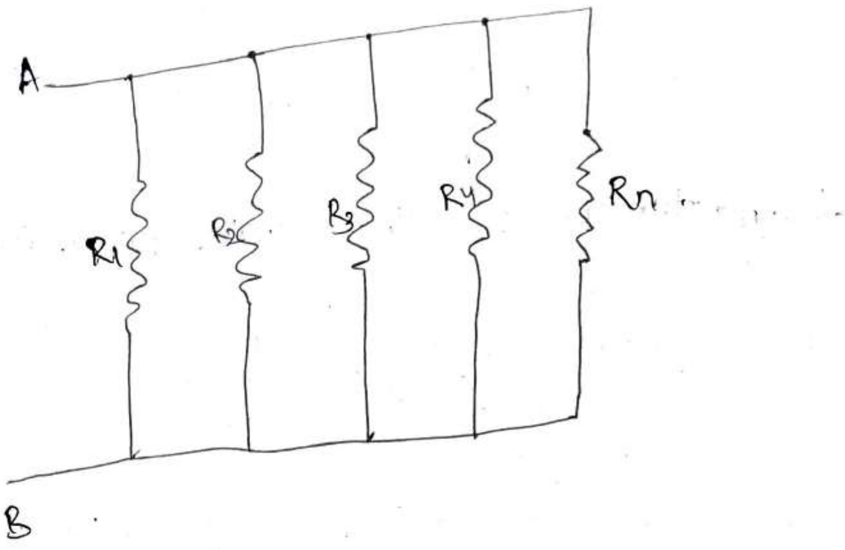
(4)- Resistances are additive.

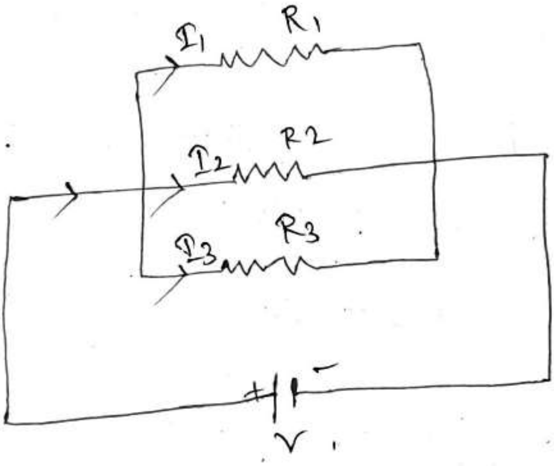
(5)- power are additive.

Practical voltage source



Parallel circuit :-





$$I = I_1 + I_2 + I_3.$$

$$V = IR.$$

$$I = \frac{V}{R}$$

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}.$$

$$\Rightarrow \frac{V}{R} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right).$$

$$\Rightarrow \boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$\boxed{G = G_1 + G_2 + G_3}$$

Characteristics of parallel circuit :-

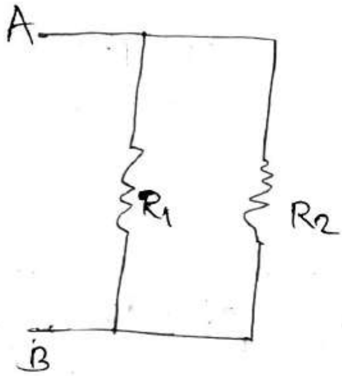
(1)- Same voltage acts through all the parts of a circuit

(2)- Different resistance have their individual current.

(3)- Currents are additive.

(4)- conductances are additive.

(5)- powers are additive.

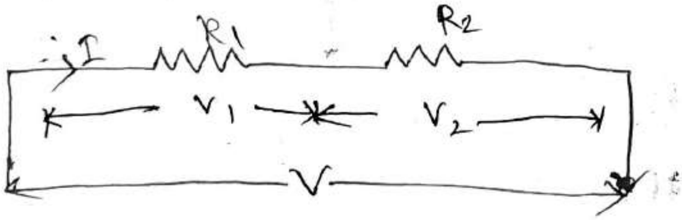


$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\Rightarrow \frac{1}{R_P} = \frac{R_2 + R_1}{R_1 R_2}$$

$$\Rightarrow \boxed{R_P = \frac{R_1 R_2}{R_1 + R_2}}$$

Voltage divider equation :-



V_{Eq} or $R_S = R_1 + R_2$

$$I = \frac{V}{R_S}$$

$$V = IR_1$$

$$= \frac{V}{R_1 + R_2} \times R_1 \qquad I = \frac{V}{R_1 + R_2} \quad \text{—(1)}.$$

$$\Rightarrow \boxed{V_1 = V \times \frac{R_1}{R_1 + R_2}}$$

Similarly

$$V_2 = I R_2$$

$$= \frac{V}{R_1 + R_2} \times R_2$$

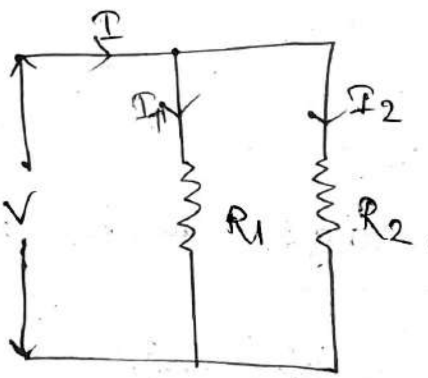
$$\boxed{V_2 = V \times \frac{R_2}{R_1 + R_2}}$$

Dt. 4. 4.

Current Divider equations:-

Let R_p = Total Resistance of the circuit.

I = Total current.



$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\Rightarrow \frac{1}{R_p} = \frac{R_2 + R_1}{R_1 R_2}$$

$$\Rightarrow R_p = \frac{R_1 R_2}{R_1 + R_2} \quad \text{— (1)}$$

$$\boxed{I = \frac{V}{R_p}}$$

Similarly $\boxed{I_1 = \frac{V}{R_1}}$ — (2)

$\boxed{I_2 = \frac{V}{R_2}}$ — (3)

eq^n (2) / eq^n (1).

$$\frac{I_1}{I} = \frac{\frac{V}{R_1}}{\frac{V}{R_p}}$$

$$\Rightarrow \frac{I_1}{I} = \frac{V}{R_1} \times \frac{R_p}{V}$$

$$\Rightarrow \frac{I_1}{I} = \frac{R_p}{R_1}$$

$$\Rightarrow \frac{I_1}{I} = \frac{\frac{R_1 R_2}{R_1+R_2}}{R_1}$$

$$\Rightarrow \boxed{\frac{I_1}{I} = \frac{R_2}{R_1+R_2}}$$

$$\Rightarrow \boxed{I_1 = \frac{I R_2}{R_1+R_2}}$$

similarly eq^n (3) / eq^n (1).

$$\frac{I_2}{I} = \frac{\frac{V}{R_2}}{\frac{V}{R_p}}$$

$$\Rightarrow \frac{I_2}{I} = \frac{R_p}{R_2}$$

$$\Rightarrow I_2 = I\,\frac{\frac{R_1 R_2}{R_1 R_2}}{R_2} \qquad \Rightarrow \boxed{I_2 = \frac{I R_1}{R_1+R_2}}$$

(Q):- 3 resistors of value 3Ω, 8Ω & 24Ω are connected in parallel across a 12 V DC supply. calculate

(i) - The total resistance of the combination

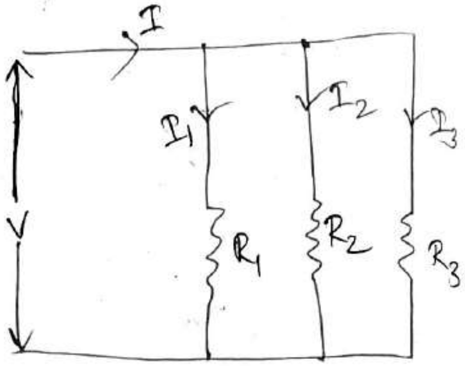
(ii) - The current in each branch.

(iii) - The total current.

Ans:-

~~Total resistance~~

Given, voltage = 12V,



$R_1 = 3\Omega$

$R_2 = 8\Omega$

$R_3 = 24\Omega$.

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}.$$

$$\Rightarrow \frac{1}{R_p} = \frac{1}{3} + \frac{1}{8} + \frac{1}{24}$$

$$\Rightarrow \frac{1}{R_p} = \frac{8+3+1}{24} = \frac{1}{2}$$

$$\Rightarrow R_p = 2\ \Omega,$$

$$I_1 = \frac{V}{R_1} = \frac{12}{3} = 4 \text{ Amp.}$$

$$I_2 = \frac{V}{R_2} = \frac{12}{8} = \frac{3}{2} = 1.5 \text{ Amp.}$$

$$I_3 = \frac{V}{R_3} = \frac{12}{24} = \frac{1}{2} = 0.5 \text{ Amp.}$$

$$I = I_1 + I_2 + I_3$$

$$= 4 + 1.5 + 0.5$$

$$= 4 + \frac{15}{10} + \frac{5}{10}$$

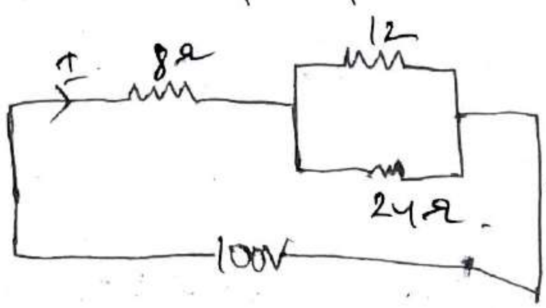
$$= \frac{40+15+5}{10} = \frac{60}{10} = 6 \text{ Amp.}$$

9) :- A Resistor of 8Ω is connected in series with a combination of 12Ω & 24Ω in parallel. The whole circuit is connected across 100V supply. Find

(i) – The current taken from the supply.

(ii) – The voltage across 8Ω ~~supp~~ resistor.

(iii) – current flowing in 12Ω & 24Ω resistor



Ans :-
$R_1 = 8\Omega$
$R_2 = 12\Omega$
$R_3 = 24\Omega$.

$$\frac{1}{R_P} = \frac{1}{R_2} + \frac{1}{R_3}$$

$$\Rightarrow \frac{1}{R_P} = \frac{1}{12} + \frac{1}{24}$$

$$= \frac{2+1}{24} = \frac{3}{24}$$

$$\Rightarrow R_P = 8\,\Omega.$$

$$R_{eq} = R_1 + R_P$$

$$\Rightarrow R_{eq} = 8 + 8$$

$$= 16\,\Omega.$$

~~The voltage across 8Ω~~

(ii) Current $I = \frac{V}{R_{eq}}$

$$= \frac{100}{16} = 6.25 \text{ Ampere}$$

i) The voltage across 8Ω

$$V_1 = IR_1$$

$$= \cancel{\ } 6.25 \times 8$$

$$= 50 \text{ volt.}$$

ii) current flowing in 12Ω & 24Ω

~~Req = 16Ω.~~

$$I_2 = \frac{V}{R_2} \text{ or } I \times \frac{R_3}{R_2+R_3}.$$

$$= \frac{50}{12} = 4.26 \text{ Amp.}$$

$$I_3 = \frac{V}{R_3} \text{ or } I \times \frac{R_2}{R_2+R_3}.$$

$$= \frac{50}{24} = 2.08 \text{ Amp.}$$

Kirchoff's laws :-

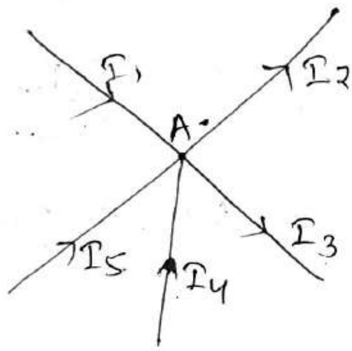
(1)- kirchoff's current law (KCL).

(2)- kirchoff's voltage law (KVL).

(1)- kirchoff's current law (KCL) :

-) It states that "In a circuit at any given junction the algebric sum of currents meeting at a point is zero".

$$\sum_{j=1}^{n} I_j = 0.$$



Incoming current (+ve)

outgoing current (-ve).

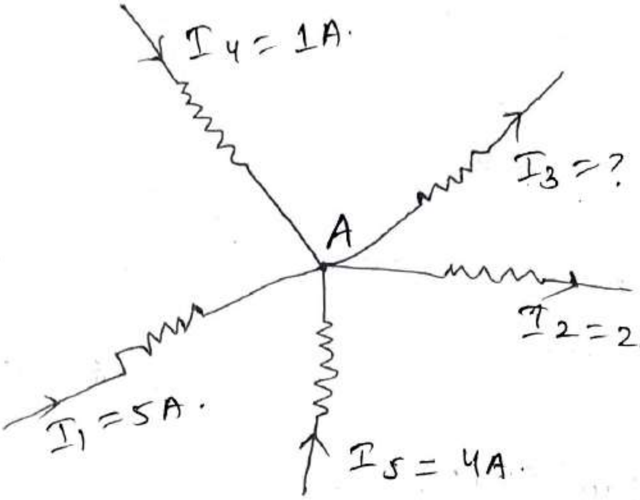
$$I_1 + (-I_2) + (-I_3) + I_4 + I_5 = 0.$$

$$\Rightarrow I_1 - I_2 - I_3 + I_4 + I_5 = 0.$$

$$\Rightarrow I_1 + I_4 + I_5 = I_2 + I_3.$$

$\boxed{\text{Total incoming current} = \text{Total outgoing current}}$.

(9):-



Find the value of I_3.

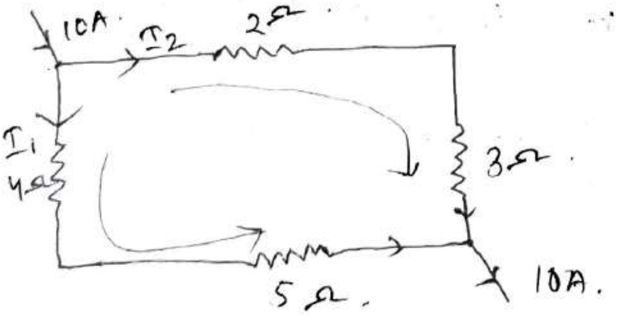
Applying KCL to node A.

$$I_1 + I_2 - I_3 + I_4 + I_5 = 0$$

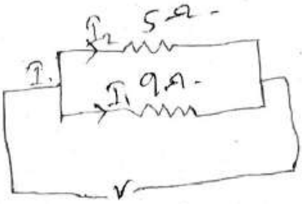
$$\Rightarrow 5A - 2A - I_3 + 1A + 4A = 0$$

$$\Rightarrow I_3 = 8A \quad \text{(Ans)}$$

3)-



Find the values of I_1 and I_2 shown in figure by applying KCL.



$$I_1 = I \times \frac{5}{9+5}$$

$$\Rightarrow I_1 = 10 \times \frac{5}{14}$$

$$\Rightarrow I_1 = 3.57\ A$$

$I = I_1 + I_2$.

$\Rightarrow 10 = 3.57 + I_2$

$\Rightarrow I_2 = 10 - 3.57$

$\Rightarrow I_2 = 6.43\ A$

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(2) Kirchoff's voltage law (KVL) :-

Statement:- It states that "the algebraic sum of Product of current and resistance in each of the conductor plus the algebric sum of EMF in that path is zero".

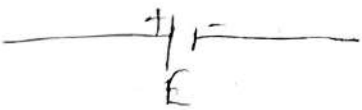
Mathematically $\Sigma IR + \Sigma EMF = 0$.

How to apply KVL in a circuit ?

Determination of voltage sign :-

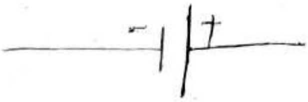
(1) Sign of Battery :-

(i)



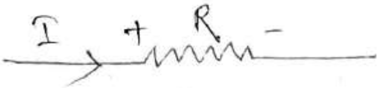
voltage drop $-E$.

ii)



voltage gain $+E$.

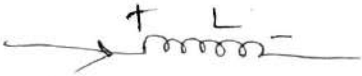
(2)- Sign of IR :-

(i)- 

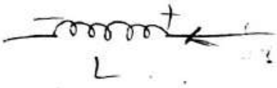
→ voltage drop $-IR$.

(ii)- 

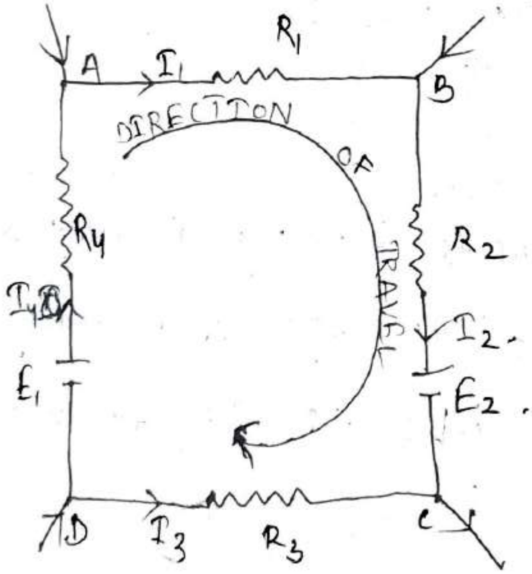
→ voltage gain $+IR$.

(iii)- 

$$V_L = -L\frac{dI}{dt}.$$ (Voltage drop).

(iv)- 

$$V_L = +L\frac{dI}{dt}$$ (voltage gain).



(1) - I_1R_1 (voltage drop).

(2) - $-I_2R_2$ (voltage drop).

(3) - $-E_2$ (voltage drop).

(4) - $+I_3R_3$. (Voltage gain).

(5) - $+E_1$ (voltage gain).

(6) - $-I_4R_4$ (Voltage drop).

According to KVL,

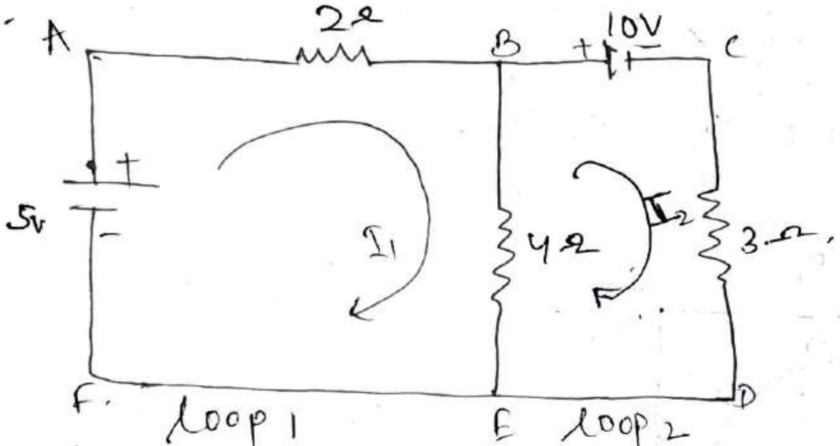
$\Sigma IR + \Sigma EMF = 0$.

$\Rightarrow -I_1 R_1 - I_2 R_2 - E_2 + I_3 R_3 + E_1 - I_4 R_4 = 0$.

$\Rightarrow I_3 R_3 + E_1 = I_1 R_1 + I_2 R_2 + I_4 R_4 + E_2$.

$\Rightarrow E_1 - E_2 = I_1 R_1 + I_2 R_2 + I_4 R_4 - I_3 R_3$.

(Q):



calculate the currents flowing in all the three resistances and voltage drop across 4Ω by applying KVL to the network?

In loop 1:

$-2I_1 - 4(I_1 - I_2) + 5 = 0$. $(I_1 > I_2)$.

$\Rightarrow -2I_1 - 4I_1 + 4I_2 + 5 = 0 \Rightarrow 4I_2 - 6I_1 + 5 = 0$.

In loop 2

$-10 - 3I_2 - 4(I_2 - I_1) = 0$.

$\Rightarrow -10 - 3I_2 - 4I_2 + 4I_1 = 0 \Rightarrow 4I_1 - 7I_2 - 10 = 0$.

According to KVL

$\cancel{-2I_1 - 4(I_1 - I_2) + 5 - 10 - 3I_2 - 4(I_2 - I)}$

$\Rightarrow 4I_2 - 6I_1 + 4I_1 - 7I_2 = 10 - 5$

$\Rightarrow -2I_1 - 3I_2 = 5 \Rightarrow 2I_1 + 3I_2 = -5$.

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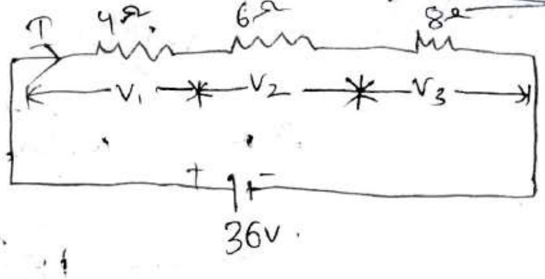
(a):



$R_1 = 4\Omega$, $R_2 = 6\Omega$,

$R_3 = 8\Omega$.

Total resistance of the circuit $R_{se} = 4+6+8 = 18\Omega$.

Total current $I = \frac{V}{R_{se}} = \frac{36}{18} = 2A$.

Voltage drop across 4Ω

$V_1 = IR_1$

$= 2 \times 4 = 8V$.

across $6\Omega \Rightarrow V_2 = IR_2 = 2\times 6 = 12V$.

across $8\Omega \Rightarrow V_3 = IR_3 = 2\times 8 = 16V$.

$V = V_1 + V_2 + V_3$

$= 8 + 12 + 16 = 36V$.

Power consumed in 4Ω

$P_1 = I^2 R_1 = 2^2 \times 4 = 16\,W$.

$P_2 = I^2 R_2 = 2^2 \times 6 = 24\,W$.

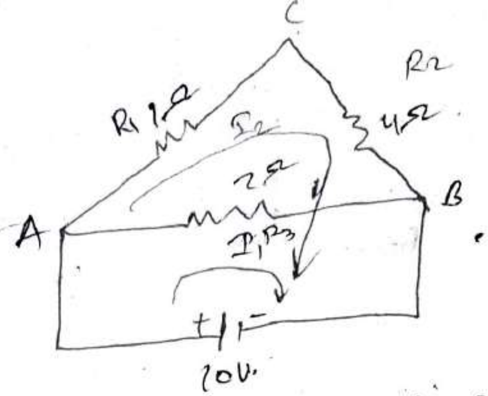
$P_3 = I^2 R_3 = 2^2 \times 8 = 32\,W$.

$P = P_1 + P_2 + P_3$

$= 16 + 24 + 32 = 72\,W$. (Ans)

Or $P = VI = 36 \times 2 = 72\,W$ (Ans).

(4) :



calculate the currents flowing in all the three resistances and total current supplied by the 10 V battery by applying KVL to the network.

Ans :- $\cancel{\Sigma IR =}$

$\cancel{\Sigma IR =}$

Loop - 1

$$10 - I_1 R_3 = 0$$
$$\Rightarrow 10 - I_1 \times 2 = 0$$
$$\Rightarrow -2I_1 = -10$$
$$\Rightarrow I_1 = 5A$$

Loop - 2

$\cancel{10 - I_2 = 0}$ $\qquad$ $10 - I_2 - 4I_2 = 0.$

$\cancel{\Rightarrow I_2 = 10}$ $\qquad$ $\Rightarrow 10 - 5I_2 = 0$

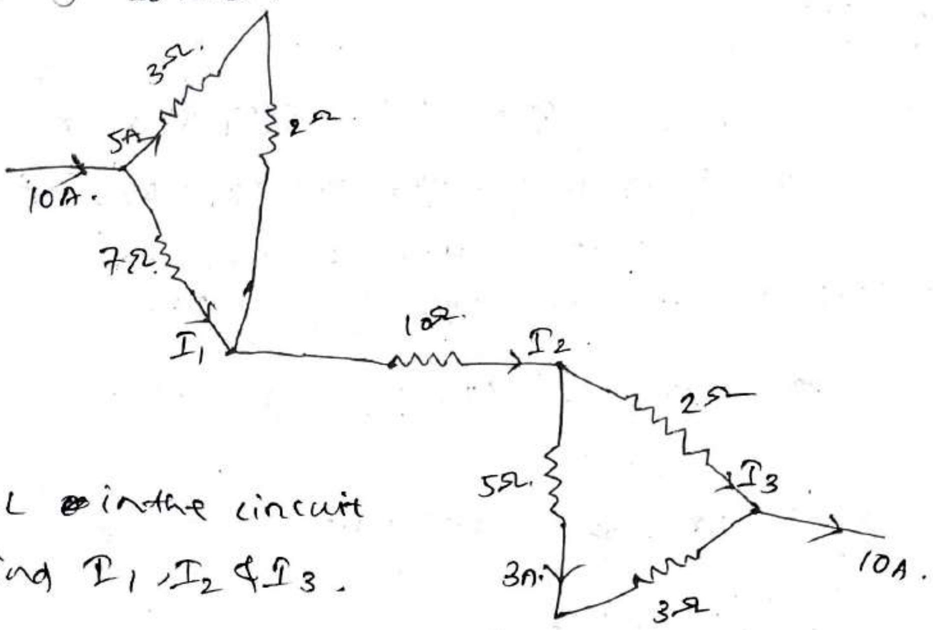
$\cancel{10 - I_2 \times 4 = 0}$ $\qquad$ $\Rightarrow -5I_2 = -10$

$\cancel{\Rightarrow 4I_2 = -10}$ $\qquad$ $\Rightarrow I_2 = 2A.$

$\cancel{\Rightarrow I_2 = \frac{5}{2}} = 2.5A.$

According ~~to KVL~~.

Q 1:-



Apply KCL in the circuit and find I_1, I_2 & I_3.

Ans:- $i = i_1 + i_2$

$\Rightarrow 10 = i_1 + 5$.

$\Rightarrow i_1 = 10 - 5 = 5A$.

$I_2 = 10A$.

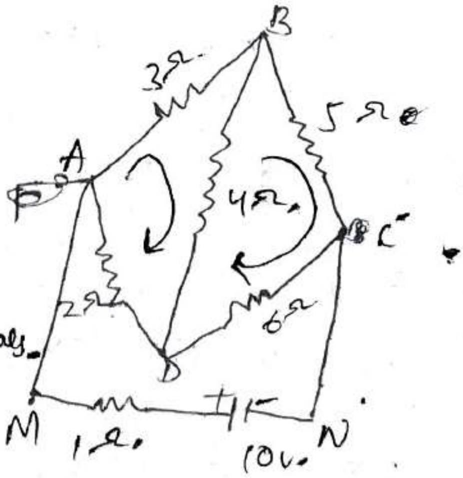
$I_2 = I_3 + 3A$

$I_3 = 10 - 3 = 7A$.

2):- Applied ~~KCL~~ KVL and determine.

(i)- current in each resistance.

(ii)- Voltage drop across terminals B and D.



Dt 25.4.

In loop-1

$10 - I_1 - 2(I_1 - I_2) - 6(I_1 - I_3) = 0.$

$\Rightarrow 10 - I_1 - 2I_1 + 2I_2 - 6I_1 + 6I_3 = 0$

$\Rightarrow 2I_2 + 6I_3 - 9I_1 + 10 = 0. \quad \text{---(1)}$

$\Rightarrow 9I_1 - 2I_2 - 6I_3 = -10.$

in loop-2

$10 - 3I_2 - 4(I_2 - I_3) - 2(I_2 - I_1) = 0.$

$\Rightarrow 10 - 3I_2 - 4I_2 + 4I_3 - 2I_2 + 2I_1 = 0.$

$\Rightarrow 2I_1 - 9I_2 + 4I_3 + 10 = 0.$

$\Rightarrow 2I_1 - 9I_2 - 4I_3 = 0 \quad \text{---(2)}.$

in loop-3

$10 - 5I_3 - 6(I_3 - I_1) - 4(I_3 - I_2) = 0.$

$\Rightarrow 10 - 5I_3 - 6I_3 + 6I_1 - 4I_3 + 4I_2 = 0.$

$\Rightarrow 6I_1 + 4I_2 - 15I_3 = 0. \quad \text{---(3)}.$

~~According to KVL~~ :

$\cancel{2I_2}$.

add eqn (1), (2) & (3).

$2I_2 + 6I_3 - 9I_1 + 10 + 2I_1 - 9I_2 - 4I_3 + 6I_1 + 4I_2 - 15I_3$

$\Rightarrow -3I_2 - 13I_3 - I_1 + 10 = 0.$

$$\Delta = \begin{vmatrix} 9 & -2 & -6 \\ 2 & -9 & 4 \\ 6 & 4 & -15 \end{vmatrix}$$

$$= 9(135 - 16) + 2(-30 - 24) - 6(8 + 54).$$

$$= 119 \times 9 + 2 \times (-54) - 62 \times 6.$$

$$= 1071 - 108 - 372$$

$$= 591.$$

$$\Delta_{I_1} = \begin{vmatrix} 10 & -2 & -6 \\ 0 & -9 & 4 \\ 0 & 4 & -15 \end{vmatrix} = 10 \times (135 - 16) = 10 \times 119 = 1190.$$

$$\Delta I_2 = \begin{vmatrix} 9 & 10 & -6 \\ 2 & 0 & 4 \\ 6 & 0 & -15 \end{vmatrix} = 10 \times (-30 - 24). = 10 \times (-54)$$

$$= 540.$$

$$\Delta I_3 = \begin{vmatrix} 9 & -2 & 10 \\ 2 & -9 & 0 \\ 6 & 4 & 0 \end{vmatrix} = 10 \times (8 + 54) = 620.$$

(1)

$$I_1 = \frac{\Delta I_1}{\Delta} = \frac{1190}{591} = 2.01 A.$$

$$I_2 = \frac{\Delta I_2}{\Delta} = \frac{540}{591} = 0.913 A.$$

$$I_3 = \frac{\Delta I_3}{\Delta} = \frac{620}{591} = 1.049 A.$$

(2) $V_{BD} = I_{BD} \cdot R_{BD}$ $\left(I_{BD} = I_3 - I_2 = 1.05 - 0.913 = 0.13 \right.$

$= 0.137 \times 4$

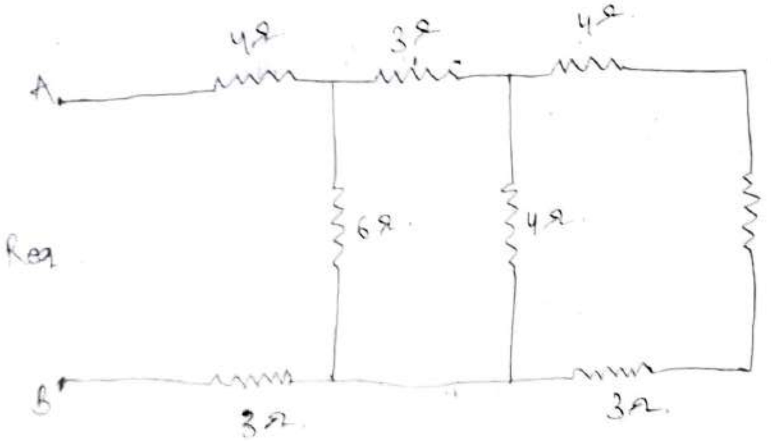
$= 0.548\,V$ (Ans).

Dt. 6.5.22

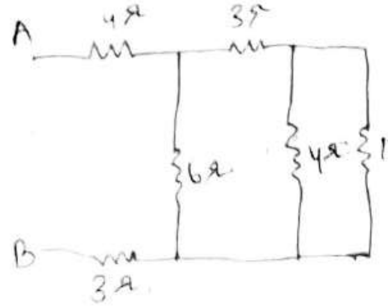
Equivalent Resistance:-

Equivalent resistance of a circuit or Network between its any two points given by that single resistance which can replace the entire circuit between that points.

(Q):



Ans: (1)-



$R_{eq} = 4+5+3 = 12\,\Omega$

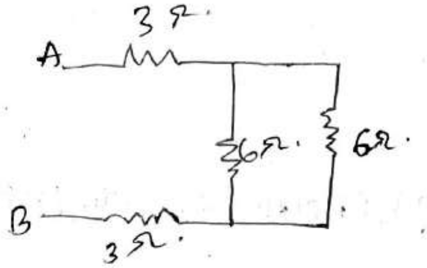
$R_P = \frac{R_1 R_2}{R_1+R_2} = \frac{4\times12}{4+12}$

$= \frac{48}{16} = 3\,\Omega$

(2)

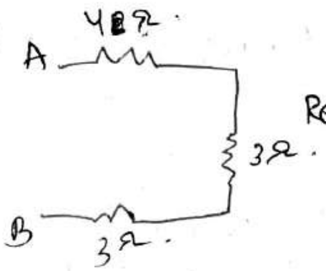
$3\Omega + 3\Omega = 6\Omega$

(3)



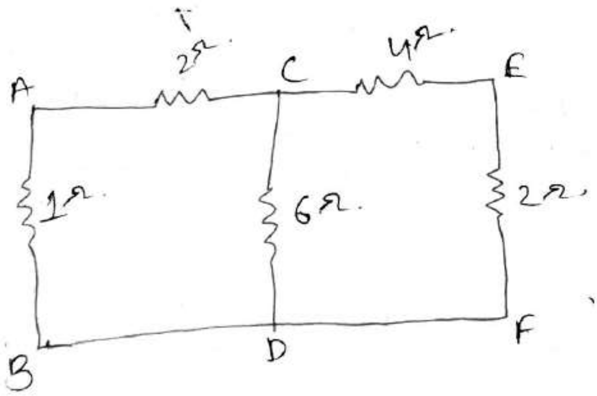
$$R_p = \frac{R_1 R_2}{R_1 + R_2} = \frac{6 \times 6}{6+6} = \frac{36}{12} = 3\Omega$$

(4)



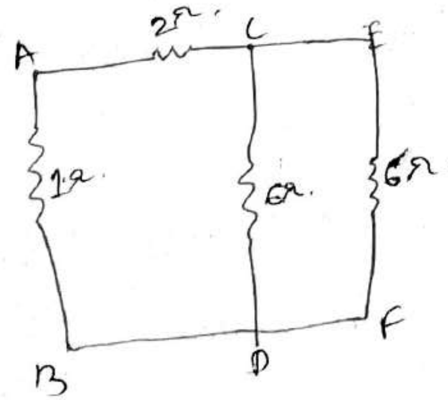
$$R_{eq} = 4 + 3 + 3 = 10\,\Omega$$

(Q.):-

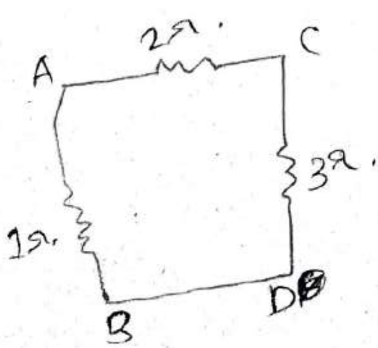


Ans:-

(1) $4\Omega + 2\Omega = 6\Omega$



$$R_p = \frac{6 \times 6}{6+6} = 3\Omega$$

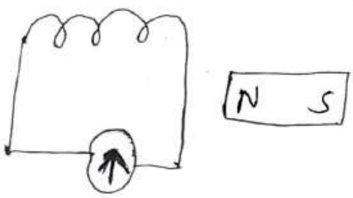


$$R_{eq} = 2 + 3 + 1 = 6\Omega$$

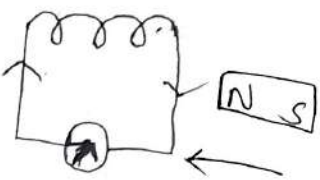
Dt 7.5.22

Electromagnetic Induction :-

Definition :- It is the phenomenon of producing induced current in a closed circuit due to change in magnetic field around it.



(Magnet is at rest)
(i).



(magnet is movin towards the coi
(ii).

Faraday's 1st law :-

It states that "whenever the magnetic flux linked with a circuit changes an emf is inclined in it".

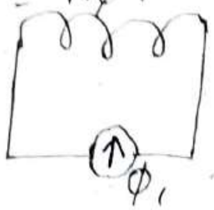
Or :- It states that "whenever a conductor cuts magnetic flux an emf is induced in it".

Faraday's 2nd law :-

It states that " The magnitude of the induced emf is equal to the rate of change of flux linkages.

→ Flux linkages = No. of turns × flux.

$= N\phi$



- Initial flux linkages $= N \times \phi_1$

$= N\phi_1$

Final flux linkages $= N\phi_2$.

Induced emf $(e) = \dfrac{N\phi_2 - N\phi_1}{t}$

$= N \dfrac{\phi_2 - \phi_1}{t}$.

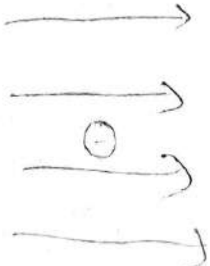
$$\boxed{e = -N\frac{d\phi}{dt}}$$

Induced EMF → Dynamically Induced Emf.

Induced EMF → Statically Induced Emf.

Dynamically Induced Emf :-

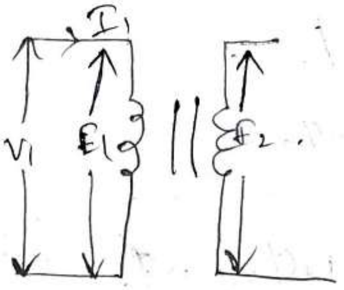
→ When the magnetic field remains stationary but the conductor moves across it, the it is known as Dinamically Induced Emf.



$$\boxed{e = Blv\sin\theta}$$

1- Statically Induced Emf :-

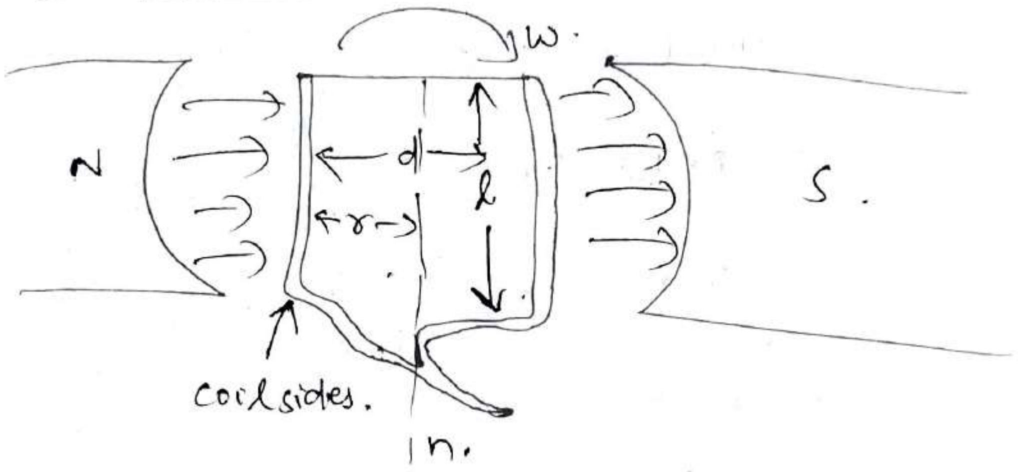
when the coils remains stationary, but flux through it ~~ex~~ are changes then it is known as statically Induced Emf.



As

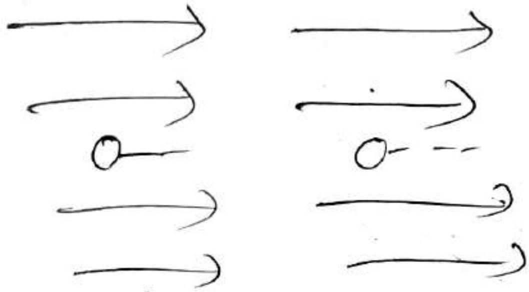
AC circuit

EMF Generation:



$e = Blv \sin\theta$.

B = magnetic flux density.
l = length of the conductor.
v = velocity of the conductor.



$e = 0$.

$0^\circ < \theta = 90^\circ$.

ω = Angular velocity = $2\pi n$.

$E = 2e$

$v = r\omega$

$\omega = 2\pi n$

$v = 2\pi r n$.

$E = 2e$

$e = 2Blv \sin\theta$

$= 2Bl\,(r\omega)\sin\theta$

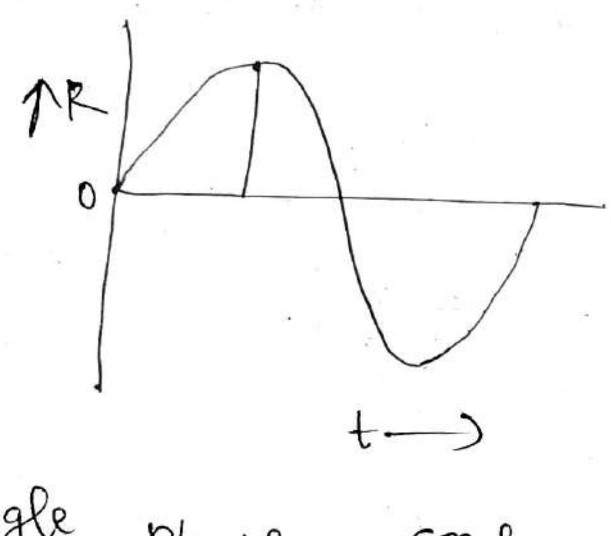
$= 2\pi n Bl\,(2r)\sin\theta$

$= 2\pi nB\,(lnd)\sin\theta$

$E = 2\pi n BA \sin\theta$

Or $\boxed{E = E_m \sin}$ Or $\boxed{E = E_m \sin\omega}$

where $E_m = 2\pi n BA$.



A single phase Emf generation is based on the principle of dynamical induced Emf According to this principle a conductor of length l while moving velocity v making an angle θ to a stedy magnetic field of a flux density (B) becomes the shaped of a dynamically induced emf (e) produced.

where $\boxed{e = Blv \sin\theta}$.

It consist of a pair of magnetic force designated as north pole and south pole in the form of a permanent magnet with a coil placed in beth which can freely rotate about an axis perpendicular to the dirn of the magnetic field produce by the magnet. The magnetic field ~~to~~ has a flux density B in (weber/m2) w/m2 in the space beth the two pole which is assume to be uniform through out the space. The coil is formed by use of two conductors as the coil size.

Each conductor has an effective length of (l) in m. The separation beth the conductor is taken as d. so the effictive area of the ~~coil~~ coil becomes

$A = l \times d$ in m2.

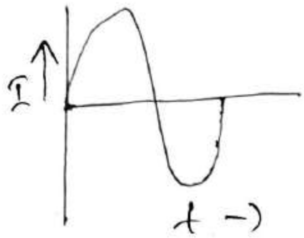
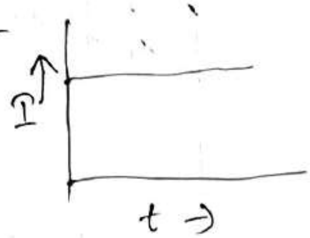
The coil is mounted on a shaft. When the shaft is mett to rotate at an revolution per second. It produces and angular speed of ω.

$$\omega = 2\pi n.$$

The e ends connected to a pair of isolated c- plings x and y, which form a kind of sliding contact with a pair of fixed carbon brushes (b_1, b_2) for collection of the emf induced in the coil per external induce.

Dt. 20.5.22

Difference betn AC & DC :-

AC (~)	DC
(1)- Alternating current changes its magnitude and direction periodically.	(1)- Direct current always flows in one dirn.
(2)- It is the graph betn current and time.	(2)- It is the graph betn current and time.
(3)- 	(3)- 
(4)- AC can be generated at high voltages.	(4)- DC cannot be generated at high voltages.
(5)- with the help of Transformer generated voltage can be ~~supplied~~ stepped up.	(5)- But in DC use of Transformer is not possible.

Values of Alternating quantity :-

(1)- Instantaneous value.

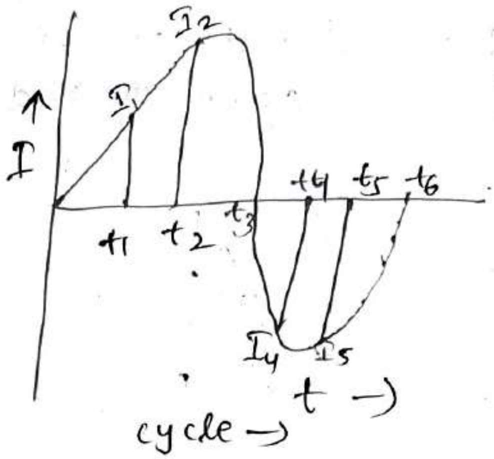
(2)- Maximum or Peak value.

(3)- Average or mean value.

(4)- Effective or Root mean square value (RMS).

(1)- Instantaneous value:-

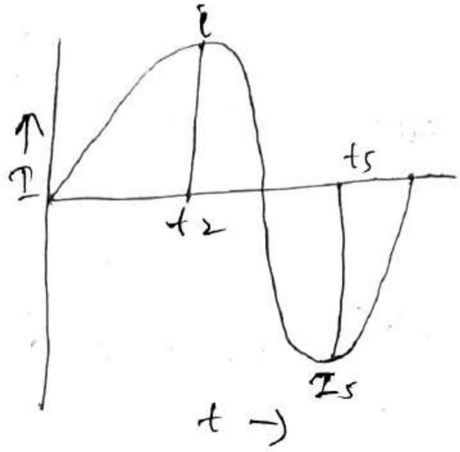
The value of alternating quantity at any given instant or time is called Instantaneous value.



Time (t)	current (I)
t = 0	0
t_1	i_1
t_2	i_2
t_3	0
t_4	$-i_4$
t_5	$-i_5$

2)- Maximum value or peak value:-

The maximum value attend by an ~~attim~~ alternating quantity is called maximum value or peak value.



(3)- Average value :-

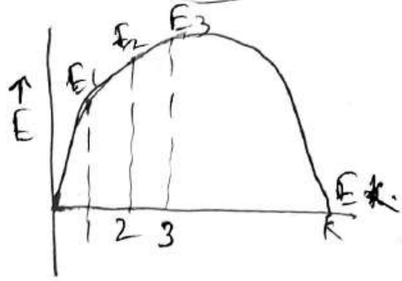
It gives the arithmetic mean of all instanteneous values over a given ~~peor~~ period of time.

method :-

(1)- Mid-ordinate method.

(2) - Integration method.

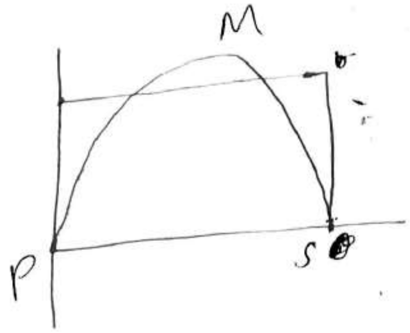
(1) Mid- ordinate method :-



$$\boxed{E_{av} = \frac{E_1 + E_2 + E_3 + \cdots + E_K}{K}}$$

Dt - 23.5.2[illegible]

(2) - Integration method:



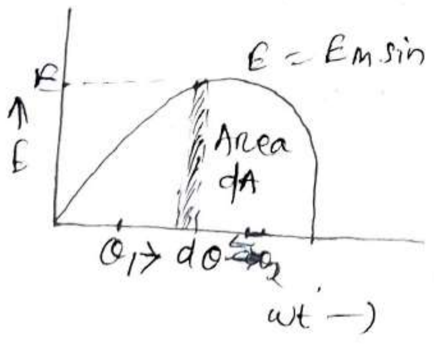
Rectangular Area = A

Average value = Height of rectangle.

Area of rectangle = Height × Base.

Average value = Height of rectangle = $\frac{\text{Area}}{\text{Base}}$

$$= \frac{A}{PS} \quad \text{--- (1).}$$



$dA = E d\theta$

$= E_m \sin\theta \, d\theta$.

$$A = \int_{\theta_1}^{\theta_2} dA = \int_{\theta_1}^{\theta_2} E_m \sin\theta \, d\theta.$$

$$= E_m \int_{\theta_1}^{\theta_2} \sin\theta \, d\theta$$

$$= E_m(-\cos\theta)$$

from eq^n (1).

$$\text{Avg value} = \frac{A}{PS}$$

$$= \frac{E_m[-\cos\theta]_{\theta_1}^{\theta_2}}{PS}$$

$$= \frac{E_m[-\cos\theta]_{\theta_1}^{\theta_2}}{\theta_2-\theta_1}$$

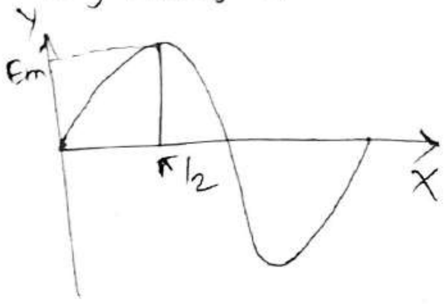
$$= \frac{E_m[-\cos\theta_2 + \cos\theta_1]}{\theta_2-\theta_1}$$

$$\boxed{E_{avg} = \frac{E_m[\cos\theta_1 - \cos\theta_2]}{\theta_2-\theta_1}}$$

$$\boxed{I_{avg} = \frac{I_m[\cos\theta_1 - \cos\theta_2]}{\theta_2-\theta_1}}$$

Q):- calculate the avarage value of an emf sinusoid over the period 0 to $\frac{\pi}{2}$ by integration method.

Ans:-



$\theta_1 = 0$

~~Eavg~~ $\theta_2 = \frac{\pi}{2}$

$$E_{avg} = \frac{E_m[\cos\theta_1 - \cos\theta_2]}{\theta_2 - \theta_1}$$

$$= \frac{E_m\{\cos 0^\circ - \cos\frac{\pi}{2}\}}{\cancel{0 - \frac{\pi}{2}}\ \frac{\pi}{2} - 0}$$

$$= \frac{E_m[1-0]}{\frac{\pi}{2}}$$

$$= \frac{E_m}{\frac{\pi}{2}}$$

$$= \cancel{2E_m}\ \frac{2E_m}{\pi}$$

$$= \frac{2E_m}{\frac{22}{7}}$$

$$= \frac{14}{22} E_m$$

$$= \frac{\cancel{7}E_m}{\cancel{11}}$$

0.63

$= 0.637\ E_m.$

(Q):- calculate the average value ~~of~~ sinosoid over the period $0 - 2\pi$.

Ans:- $\theta_1 = 0$
$\theta_2 = 2\pi$.

$$E_{avg} = \frac{E_m [\cos\theta_1 - \cos\theta_2]}{\theta_2 - \theta_1}$$

$$= \frac{E_m [\cos 0^\circ - \cos 2\pi]}{2\pi - 0}$$

$$= \frac{E_m [1 - 1]}{2\pi}$$

$$= \frac{0}{2\pi} = 0.$$

(Q):- calculate the average value of an emf ~~sin~~ sinosoid over the period $0 - 2\pi$ by the integration method.

Ans:- $\theta_1 = 0$
$\theta_2 = \pi$.

$$E_{avg} = \frac{E_m [\cos\theta_1 - \cos\theta_2]}{\theta_2 - \theta_1}$$

$$= \frac{E_m [\cos 0^\circ - \cos\pi]}{2\pi - 0}$$

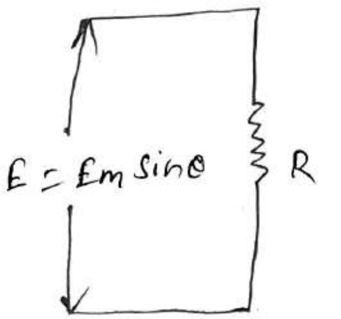
$$= \frac{E_m [1 + 1]}{2\pi} = \frac{2E_M}{2\pi} = \frac{E_m}{\pi}$$

$$= \frac{7}{22} E_m$$

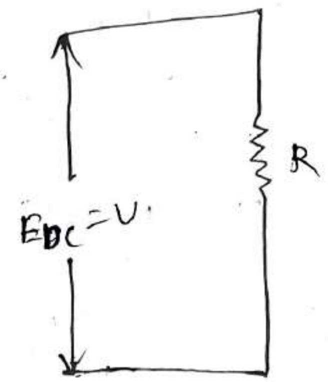
$$= 0.673 E_m.$$

(4) - Effective value or Root Mean Square (R.M.S) value:-

Effective value of alternating quantity means finding the Effectiveness of a given quantity over a specified period of time.



(i).



(ii).

in figure (i).

Power consumed over a period of time.

$$P = \frac{\omega}{t} \text{ or } \frac{d\omega}{dt}.$$

$$\text{or } d\omega = P\,dt.$$

$$\omega = \int_0^{\omega} P\,dt = \int_0^{t} \frac{E^2}{R}\,dt.$$

$$= \int_0^{t} \frac{(E_m \sin\theta)^2}{R}\,dt. \quad \text{---(1)}.$$

figure (ii)

$$\omega_{dc} = \int_0^{t} P\,dt = \int_0^{t} \frac{V^2}{R}\,dt = \frac{V^2}{R}\int_0^{t} dt.$$

$$= \frac{V^2}{R}t \quad \text{---(2)}.$$

$$\omega_{dc} = \omega_{ac}.$$

$$\Rightarrow \frac{V^2}{R} t = \int_0^t \frac{(E_m \sin\theta)^2}{R} dt.$$

$$\Rightarrow V^2 = \int_0^t \frac{(E_m \sin\theta)^2 dt}{t}.$$

$$\Rightarrow V = \sqrt{\int_0^t \frac{(E_m \sin\theta)^2}{t} dt}.$$

$$\Rightarrow V = \sqrt{\int_0^t \frac{E_m^2 \sin^2\theta}{t} dt}.$$

$$\Rightarrow V = E_m \sqrt{\int_0^t \frac{\sin^2 \omega t}{t} dt}$$

~~$\Rightarrow V = E_m$~~

$$\Rightarrow E_{eff} = E_m \sqrt{\int_0^t \frac{\sin^2 \omega t}{t} dt}.$$

$$\Rightarrow E_{eff} = E_m \sqrt{\int_0^t \frac{\frac{1-\cos 2\omega t}{2}}{t} dt}.$$

$$= \frac{E_m}{\sqrt{2}} \sqrt{\int_0^t \frac{1-\cos 2\omega t}{t} dt}.$$

$$= \frac{E_m}{\sqrt{2}} \sqrt{\int \frac{dt}{dt} - \int \frac{\cos 2\omega t \, dt}{t}}.$$

$$= \frac{E_m}{\sqrt{2}} \sqrt{\left[\frac{t - \frac{\sin 2\omega t}{2\omega}}{t} \right]_0^t}.$$

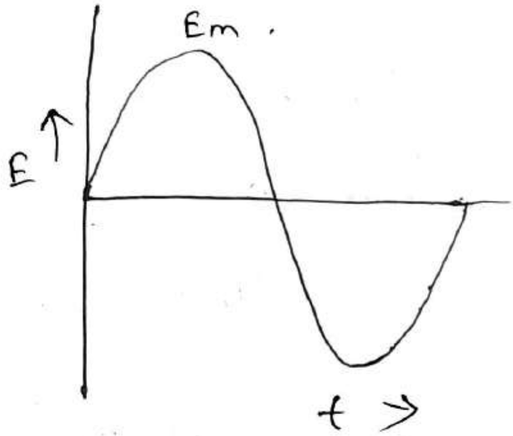
PEAK FACTOR :

Peak factor of alternating quantity is ~~def~~ defined as the ratio between peak value to the effective value of the alternating quantity.

$$\boxed{\text{Peak factor} = \frac{\text{peak Value}}{\text{Effective value}}}$$

$$\Rightarrow \text{Peak factor} = \frac{E_m}{\frac{E_m}{\sqrt{2}}}$$

$$\Rightarrow \sqrt{2} = 1.414$$



FORM Factor :

Form factor of alternating quantity is defined as the ratio between effective ~~value~~ value to the average value of the alternating quantity.

$$\boxed{\text{Form factor} = \frac{\text{Effective value}}{\text{Average value}}}$$

$$= \frac{\frac{E_m}{\sqrt{2}}}{\frac{2E_m}{\pi}}$$

$$= \frac{\pi}{2\sqrt{2}} = \frac{\frac{22}{7}}{2\sqrt{2}} = 1.111$$

Q9:- The instantenious value of current waveform is given by

$I = 25 \sin 314t\,A$. (i) calculate Peak current.

(ii) - ~~Anachnious~~ RMS current.

(iii) - Average current. Given that

Peak factor = 1.414

Form factor = 1.1.

Ans:-

$I = I_m \sin \omega t$.

(i) Peak current (I_m) = 25A.

$\omega = 314$ A.

~~(ii) Peak current I_m~~

(ii) Peak factor $= \dfrac{I_m}{I_{rms}}$

$\Rightarrow 1.414 = \dfrac{25}{I_{rms}}$

$\Rightarrow I_{rms} = \dfrac{25}{1.414} = 17.68\,A$.

(iii)- Form factor $= \dfrac{I_{rms}}{I_{avg}} = \dfrac{17.68}{I_{avg}}$

~~$\Rightarrow \dfrac{2E_m}{\pi} = \dfrac{17.68}{1.1}$~~

$\Rightarrow \cancel{\frac{2E_m}{\pi} = 15.92}$

$\Rightarrow \cancel{2E_m = 50.50}$

$\Rightarrow \cancel{E_m = \frac{50.50}{2} = 25.01}$

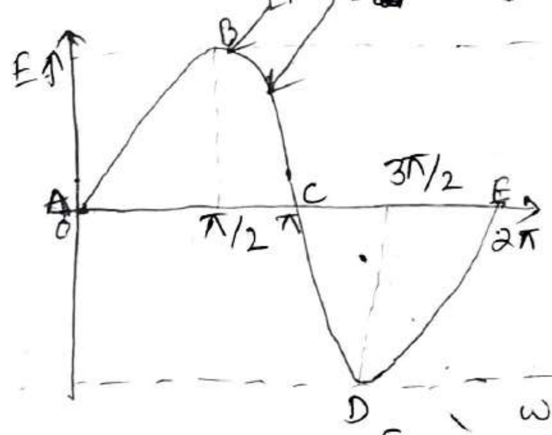
$\Rightarrow I_{avg} = \frac{17.68}{1.11}$

$\Rightarrow I_{avg} = 15.92$.

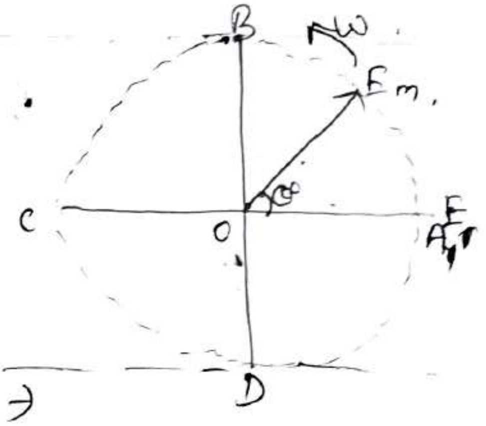
Dt. 4.6.22

Sinusoidal waveform and phasor representation of EMF :-

E_m ; $E = E_m \sin \omega t$.



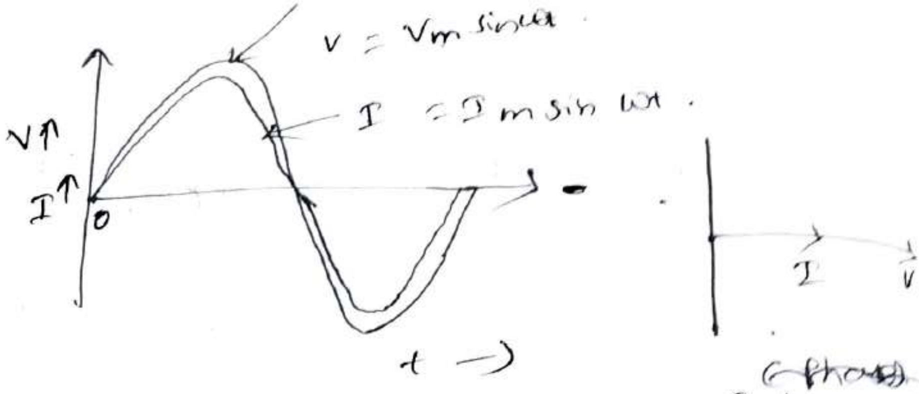
(waveform representation).



(Phasor Representation)

Distinct point on waveform	Angular position of coil.	Instantaneous EMF.
A	0	0
B	$\pi/2$	E_m.
C	π	0
D	$3\pi/2$	$-E_m$.
E	2π	0

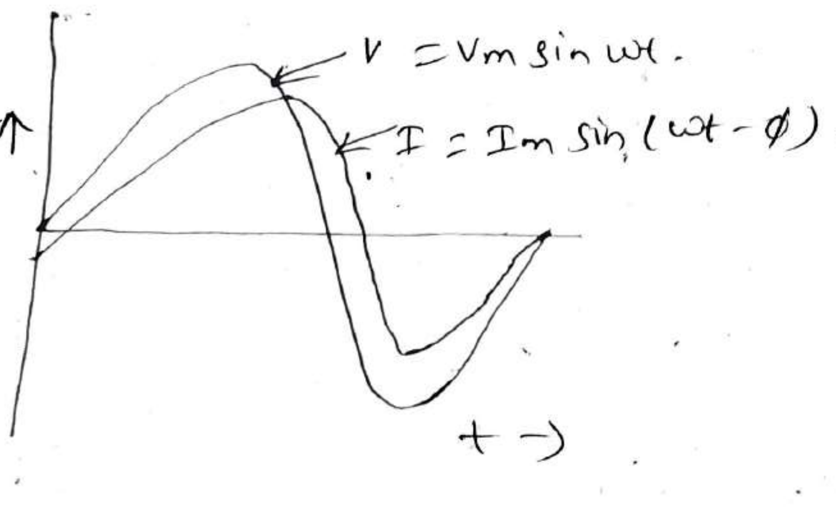
IN phase:-

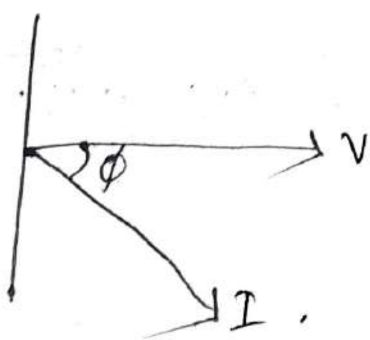


(phasor)

Two waveforms are said to be in ~~pha~~ phase if they begin simultaneously and end simultaneously.

Phase ~~dist~~ difference:-



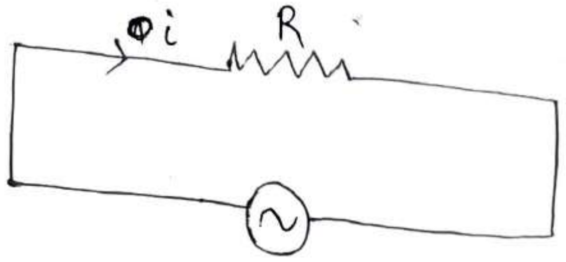


AC Theory

Dt. 26.6.22

~~current conta~~

Circuit containing pure Resistance :-



$V = V_m \sin\omega t.$

$V = V_m \sin\omega t$ — (1).

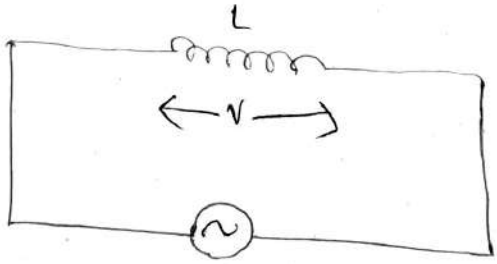
$I = \frac{V}{R} = \frac{V_m \sin\omega t}{R}.$

Or $i = \frac{V_m}{R} \sin\omega t.$

$\therefore I = I_{max} \cdot \sin\omega t.$ — (2).

where $I_{max} = \frac{V_m}{R}.$

Circuit containing pure Inductance :-



$V = V_m \sin\omega t.$

$$\boxed{V' = L\frac{dI}{dt}}.$$

$$V = V_m \sin \omega t \quad \text{--- (1).}$$

$$V - V' = 0$$

$$\Rightarrow V' = V$$

$$\Rightarrow V' = V_m \sin \omega t.$$

$$\Rightarrow L \frac{dI}{dt} = V_m \sin \omega t.$$

$$\Rightarrow \frac{dI}{dt} = \frac{V_m}{L} \sin \omega t.$$

$$\Rightarrow dI = \frac{V_m}{L} \sin \omega t \, dt.$$

$$\Rightarrow \int dI = \frac{V_m}{L} \int \sin \omega t \, dt.$$

$$\Rightarrow I = \frac{V_m}{L} \left\{ -\frac{\cos \omega t}{\omega} \right\}.$$

$$= \frac{V_m}{\omega L} \left[\sin\left(-\frac{\pi}{2} + \omega t\right) \right]$$

$$= \frac{W_m}{\omega L} \left[\sin\left(\omega t - \frac{\pi}{2}\right) \right].$$

$$= \omega L = 2\pi f L = X_L.$$

X_L = Inductive Reactance

unit - Ohm (Ω).

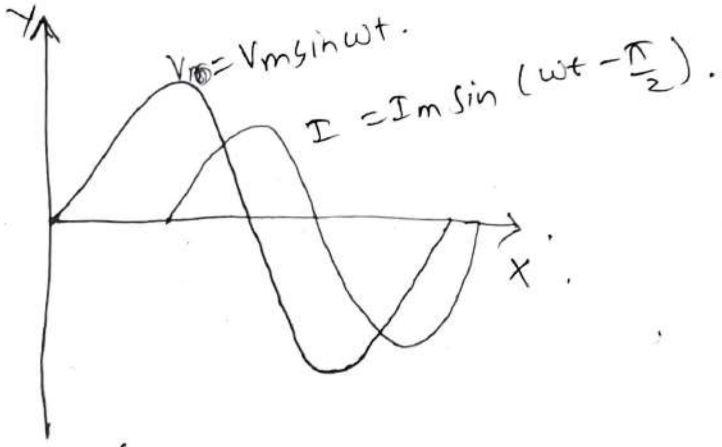
$$i = I_m \sin\left(\omega t - \frac{\pi}{2}\right) \quad \text{— (2)}.$$

where

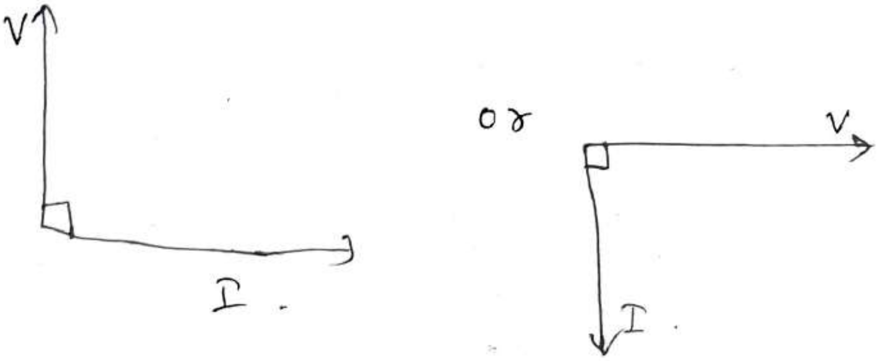
$$I_{max} = \frac{V_m}{\omega L} \quad \text{or} \quad \frac{V_m}{X_L}.$$

+ve sign → Leading quantity.

−ve sign → Lagging quantity.

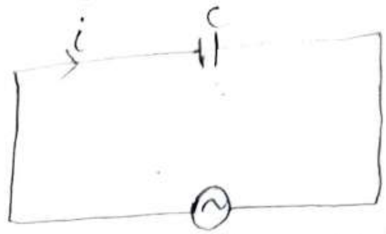


(Sinusoidal Representation or waveform).



(Phasor Representation).

circuit containing Pune capacitance:-



$V = V_m \sin\omega t$.

$C = \frac{q}{V}$.

unit = fanad.

$V = V_m \sin\omega t$ — (1).

$q = CV$

$i = \frac{dq}{dt} = \frac{d}{dt}(CV)$.

$i = C\frac{d}{dt}(V_m \sin\omega t)$.

$= C V_m \omega \cos\omega t$.

$i = C\omega V_m \cos\omega t$.

$= C\omega V_m \sin(\omega t + \frac{\pi}{2})$.

$i = I_{max} \sin(\omega t + \frac{\pi}{2})$ — (2).

whene $I_{max} = C\omega V_m$.

$I_{max} = C\omega V_{max}$.

$\Rightarrow \dfrac{I_{max}}{V_{max}} = C\omega$.

$\Rightarrow \dfrac{V_{max}}{I_{max}} = \dfrac{1}{C\omega}$.

$\Rightarrow \dfrac{\dfrac{V_{max}}{\sqrt{2}}}{\dfrac{I_{max}}{\sqrt{2}}} = \dfrac{1}{C\omega}$.

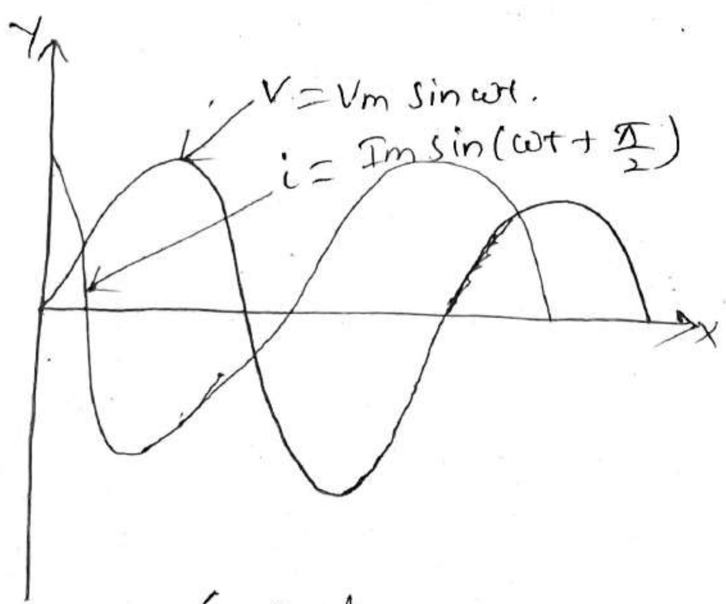
or $\dfrac{V}{I} = \dfrac{1}{C\omega} = X_C$.

$\Rightarrow \dfrac{V}{I} = \dfrac{1}{2\pi f C}$.

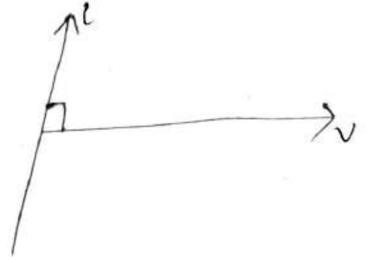
$X_C = \dfrac{1}{2\pi f C}$.

↓

capacitive Reactance.



(waveform Representation
(i)

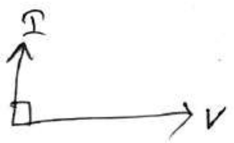


(Phasor Representation).

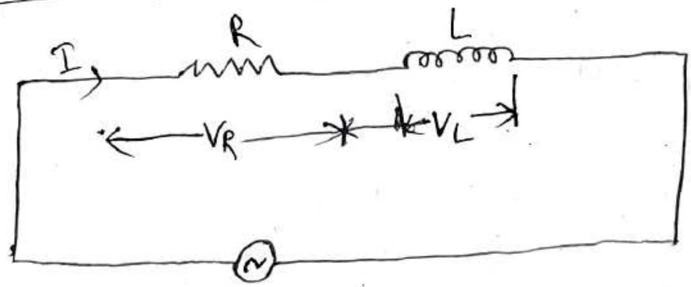
(ii).

R = 

L = 

C = 

R.L. Series ~~ciru~~ circuit :-



$V = V_m \sin \omega t$.

V_R = voltage across ~~Rea~~ Resistor. $= IR$.

V_L = voltage across Inductor. $= I X_L$.

I = current through the circuit.

Voltage Triangle

From voltage Triangle,

$$V^2 = V_R^2 + V_L^2$$

$$\Rightarrow V^2 = (IR)^2 + (IX_L)^2$$

$$= I^2R^2 + I^2X_L^2$$

$$\Rightarrow V^2 = I^2(R^2 + X_L^2)$$

or $$\frac{V^2}{I^2} = R^2 + X_L^2$$

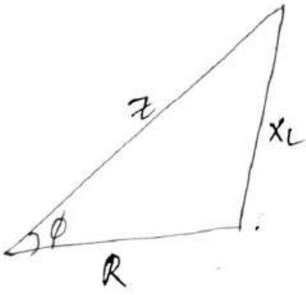
$$\Rightarrow \boxed{\frac{V}{I} = \sqrt{R^2 + X_L^2}}$$

$$\Rightarrow \boxed{Z = \sqrt{R^2 + X_L^2}}$$

$Z \rightarrow$ Impedence.

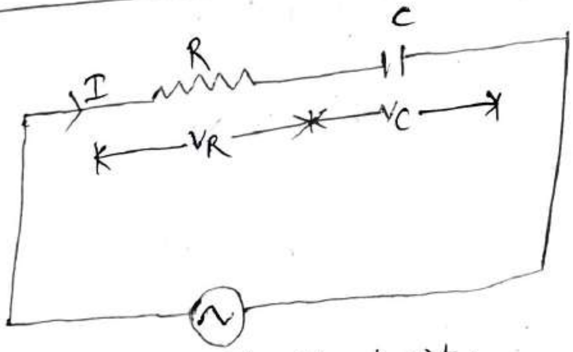
Unit = ohm (Ω).

Impedence Triang



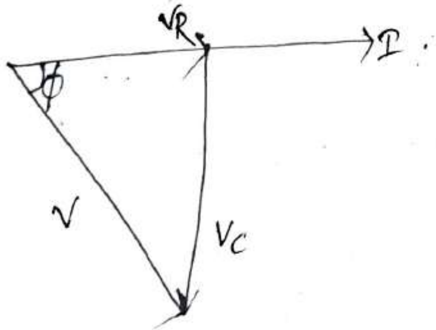
Dt. 28.6.2

RC series circuit :-



$V = V_m \sin \omega t$,

(circuit Diagram).



(Phasor Diagram).

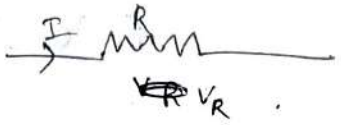
V_R = voltage drop across Resistor

$= IR$.

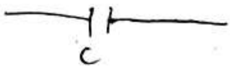
V_C = voltage across capacitor = IX_C

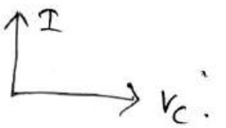
I = circuit current.

(1)-



(2)-





from the triangle.

$$V^2 = V_R^2 + V_C^2$$

$$\Rightarrow V^2 = (IR)^2 + (IX_C)^2$$

$$= I^2R^2 + I^2X_C^2$$

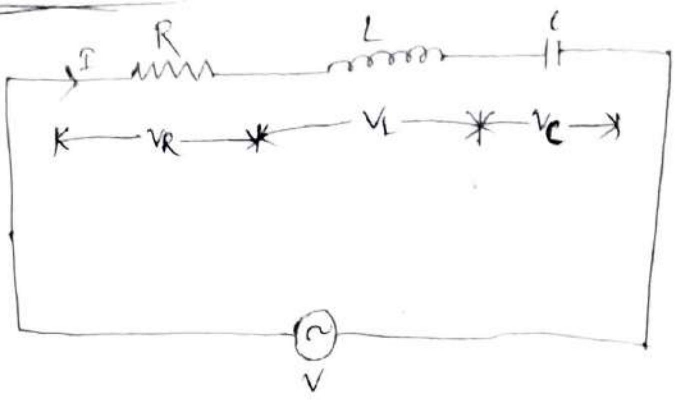
$$= I^2(R^2 + X_C^2)$$

$$\Rightarrow \frac{V^2}{I^2} = R^2 + X_C^2$$

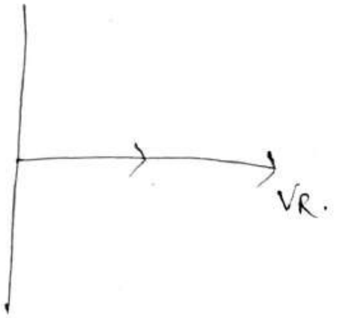
$$\Rightarrow \boxed{\frac{V}{I} = \sqrt{R^2 + X_C^2}}$$

or $\boxed{Z = \sqrt{R^2 + X_C^2}}$

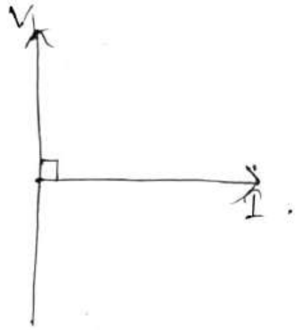
RLC series circuit:



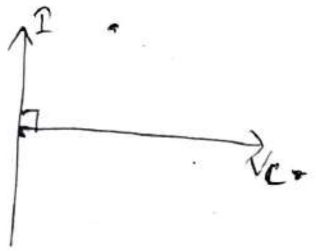
(Circuit diagram).



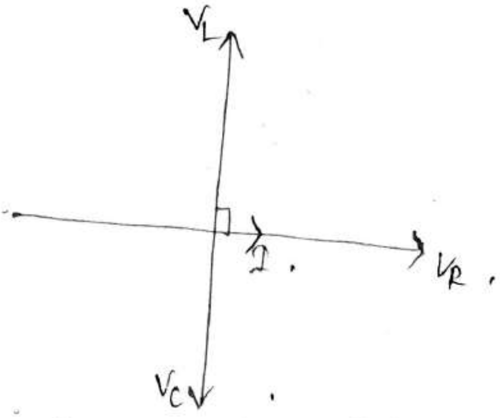
(V_R & I).
(i).



(V_L & I).
(ii).

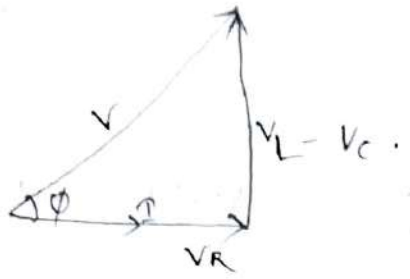


(V_C & I)
(iii).



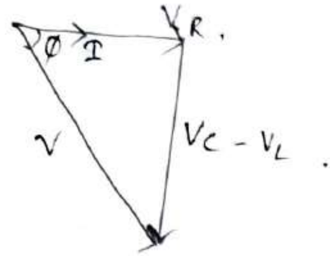
(V_R, V_L, V_C & I).

Voltage Triangle :-



$(X_L > X_C)$

(i)



$(X_L < X_C)$

(ii)

From triangle

$$V^2 = V_R^2 + (V_L - V_C)^2$$

$$= (IR)^2 + (IX_L - IX_C)^2$$

$$= I^2 [R^2 + (X_L - X_C)^2]$$

$$\Rightarrow \frac{V^2}{I^2} = R^2 + (X_L - X_C)^2$$

or $$\frac{V}{I} = \sqrt{R^2 + (X_L - X_C)^2}$$

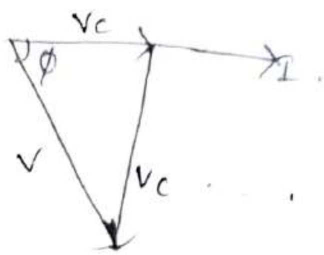
$$\boxed{Z = \sqrt{R^2 + (X_L - X_C)^2}}$$

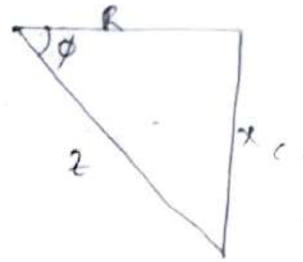
$(X_L > X_C)$.

$$\boxed{Z = \sqrt{R^2 + (X_C - X_L)^2}}$$

$(X_L < X_C)$

Impedance Triangle for RC circuit





(Impedence Triangle)

$V_R = IR / I = R$

$V_C = I X_C / I$

$= X_C$

$V/I = Z$

$$\boxed{Z = \sqrt{R^2 + X_C^2}}$$

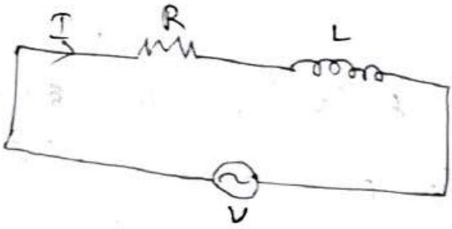
Dt. 2.7.22

(1) – A Series R.L. circuit having $R = 20\,\Omega$, $L = 0.05\,H$ is connected across 100V, 50Hz supply. Calculate circuit current and power consumed.

Ans:- $R = 20\,\Omega$.

$L = 0.05H$.

$V = 100V$, 50 Hz.



$I = \frac{V}{Z}$

Z = impedence.

$Z = \sqrt{R^2 + X_L^2}$.

$X_L = 2\pi f L$

$= 2 \times \frac{22}{7} \times 50 \times 0.05$

$= \frac{44}{7} \times 50 \times \frac{5}{100}$

$= 15.7\,\Omega$.

$\frac{110}{7}$

$Z = \sqrt{R^2 + (X_L)^2}$

$= \sqrt{20^2 + (15.7)^2}$

$= \sqrt{400 + 246.49}$

$= \sqrt{646.49}$

$= 25.4\,\Omega$

$I = \frac{V}{Z}$

$\Rightarrow I = \frac{100}{25.4} = \frac{1000}{254} = 3.93A$.

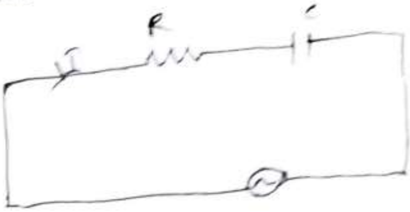
$P = VI \cos\phi$ $\cos\phi = \frac{R}{Z}$

$\Rightarrow P = 100 \times 3.93 \times \frac{R}{Z}$

$= 100 \times 3.93 \times \frac{20}{25.4}$

$= 309.4W$ (Ans)

(2) - A series RC circuit at resistance (R) = 20 Ω, C = 125 μf; a V = 200V, 50 Hz is applied in the circuit. calculate V_R and V_C.



Ans:- $R = 20\Omega$

$C = 125 \mu f$

$V = 200V, 50Hz$

$V_R, V_C = ?$

$V_R = IR$, $I = \frac{V}{Z}$

$\cancel{I = \frac{V}{R} = \frac{200}{20} = 10\ \Omega}$

~~$V_R = 10 \times 20 = 200\ \Omega$~~

$V_C = IX_C$

$X_C = \frac{1}{2\pi f c}$

$=$

$Z = \sqrt{R^2 + X_C^2}$

$X_C = \frac{1}{2\pi f c}$

$= \frac{1}{2 \times \frac{22}{7} \times 50 \times 125 \times 10^{-6}}$

$= 25.47$

$Z = \sqrt{R^2 + (25.47)^2}$

$I = \frac{V}{Z}$

$= \sqrt{20^2 + 648.72}$

$= \sqrt{400 + 648.72}$

$= \sqrt{1048.72} = 32.38$

$I = \frac{V}{Z} = \frac{200}{29.34}$

$= 6.817A$

$V_R = IR$

$= 6.17 \times 20$

$= 123.4$

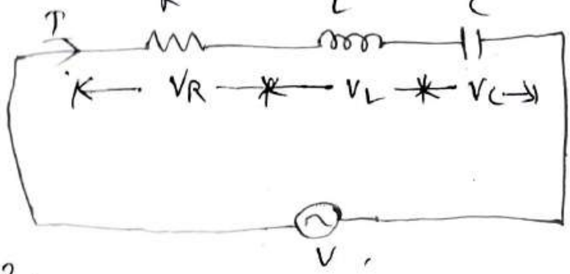
$V_C = IX_C$

$= 6.17 \times 25.47$

$= 157.4V$ (Ans)

(3) A series RLC circuit having resistance (R) = 10 Ω, L = 0.2 H, C = 100 µF is connected across 100 V, 50 Hz supply. Calculate current and power factor.

Ans:



$R = 10\Omega$

$L = 0.2H$

$C = 100 \mu F = 100 \times 10^{-6}$

$V = 100V, 50Hz$

$I = \frac{V}{Z}$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

$Z = \sqrt{R^2 + (X_C - X_L)^2}$

$X_L = 2\pi f L$

$= 2 \times \frac{22}{7} \times 50 \times 0.2$

$= 62.85\Omega$

$X_C = \frac{1}{2\pi f C}$

$= \frac{1}{2 \times \frac{22}{7} \times 50 \times 100 \times 10^{-6}}$

$= 31.8\Omega$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}.$$

$$= \sqrt{10^2 + (31)^2}$$

$$= 32.57\,\Omega.$$

~~I = V~~

$$I = \frac{V}{Z} = \frac{100}{32.57} = 3.07A.$$

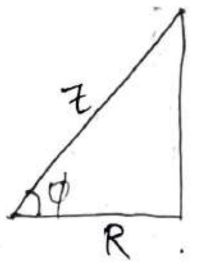
$$\text{Power factor } (P.F) = \cos\phi = \frac{R}{Z}.$$

$$= \frac{10}{32.57}$$

$$= 0.307. \quad \underline{\text{(Ans)}}.$$

Dt. 4.7.22

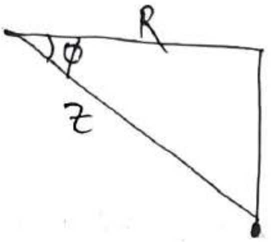
Impedence triangle for RLC series circuit :-



$X = X_L - X_C$.

$(X_L > X_C)$.

(i).



$X = X_C - X_L$.

$(X_L < X_C)$.

(ii).

X = Net reactance.

$Z = R \pm jX$.

R = Resistance.

$Z = R + jX$

$(X_L > X_C)$.

$Z = R - jX$

$(X_L < X_C)$.

Power and Power factor:-

Power

- Apparant power. (S)
- True power or Active power. (P)
- Reactive power. (Q)

Apparant power (S) :-

$$\boxed{S = VI}$$

unit = volt Ampere (VA) or KVA.

The product of RMS value of voltage and current is called apparant power and it measured in Volt Ampere or KVA.

True power (P) :-

$$\boxed{P = VI \cos\phi}$$

unit = watt or KW.

The true power is obtained by multiplying the apparant power by power factor. and it is measured in W or KW.

Reactive Power (Q):-

$$\boxed{Q = VI \sin\phi}$$

unit = Reactive volt Ampere (VAR).

The product of apparant power and sine of the angle beth voltage and current is called Reactive power and it is measured in Reactive volt Amp

$$P = VI\cos\phi$$

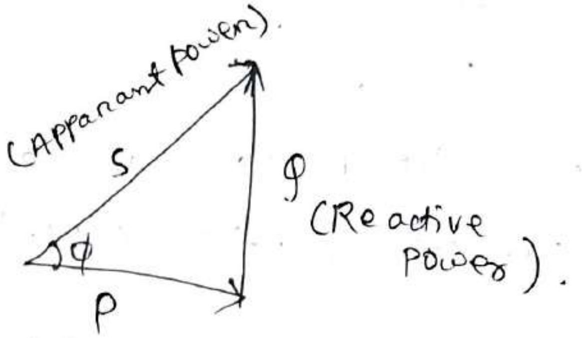
$$\cos\phi = \frac{P}{VI}$$

(1) - It is the cosine of the angle betn voltage and ~~to~~ current.

(2) - It is the ratio betn resistance and ~~Inductan~~ Impedence.

(3) - It is the ration betn true power and apparant ~~po~~ power.

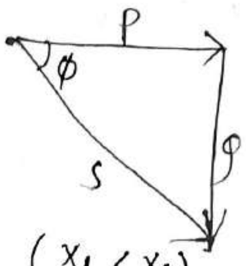
Powen triangle :-



True power

$(X_L > X_C)$.

(i).



$(X_L < X_C)$.

$$S = P \pm jQ.$$

S = Appanant power.

P = True power or ~~Act~~ Active power.

Q = Reactive power.

$S = P + jQ \quad (X_L > X_C)$

$S = P - jQ \quad (X_L < X_C)$.

$|S| = \sqrt{P^2 + Q^2}$

(Q): An RLC series circuit contain a ~~Res~~ $R = 5\Omega$, $L = 50\,mH$, $C = 400\,\mu F$. Draw the impedence triangle for the circuit when a sinusoidal voltage, 50Hz. (i) Express the impedence the complex form.

(ii) What is the phase angle betn the voltage and current for the circuit.

Ans:-

$R = 5\Omega$.

$L = 50mH$.

$C = 400\mu F = 4 \times 100 \times 10^{-6}$.

$\nu = 50\,Hz$.

$$X_C = \frac{1}{2\pi f C}$$

$$= \frac{1}{2 \times \frac{22}{7} \times 4 \times 100 \times 10^{-6} \times 50}$$

$$= 7.95\,\Omega$$

$X_L = 2\pi F L$

$= 2 \times \frac{22}{7} \times 50 \times 50 \times 10^{-3}$

$= 15.\cancel{0}9 \,\Omega$

$X_L > X_C$

$X = X_L - X_C = 15.9 - 7.9$

$= 7.8$

(i)- $Z = R + jX$

$= 5 + j \times 7.8$

$|Z| = \sqrt{5^2 + (7.8)^2} = 9.26$

(ii)- $\cos\phi = \frac{R}{Z}$ ~~57.34° (Aw)~~

$\phi = \cos^{-1}\left(\frac{R}{Z}\right)$

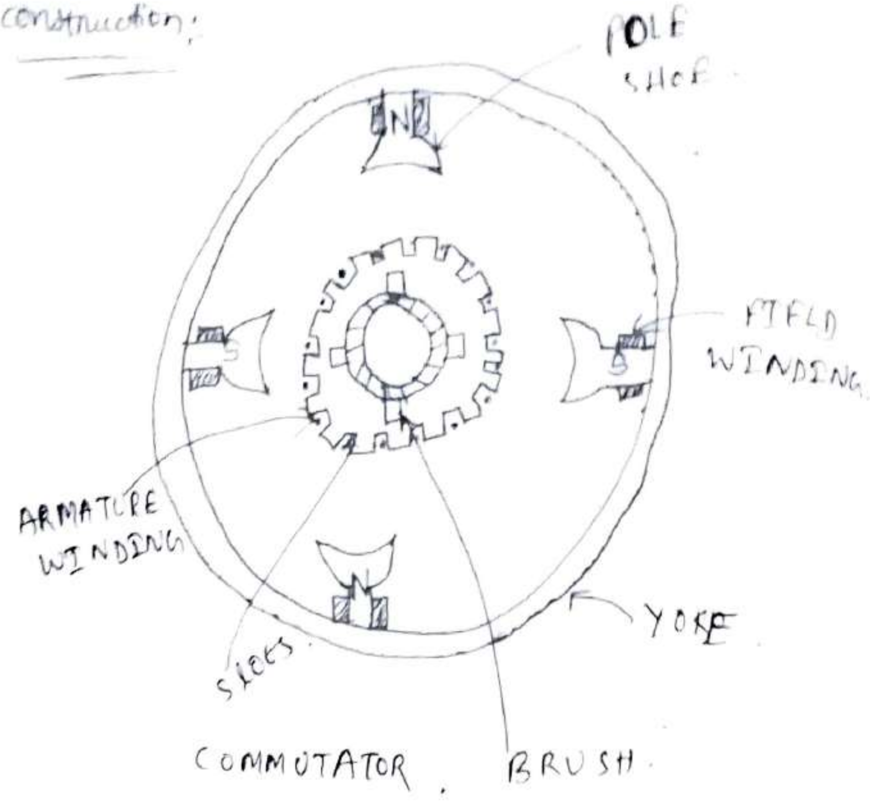
$\cancel{= \cos^{-1}\left(\frac{5}{57.34^\circ}\right)}$

$= \cos^{-1}\left(\frac{5}{9.26}\right)$

$= 57.34^\circ$ (Aw).

DC Generator

Construction:



DC Machine :-

DC Machine

- DC Generator.
- DC Motor.

Mechanical energy $\xrightarrow{I/P}$ DC Generator $\xrightarrow{O/P}$ Electrical energy construction:-

(1)- Yoke.

(2)- Field winding.

(3)- Pole core and pole shoe.

(4)- Armature core.

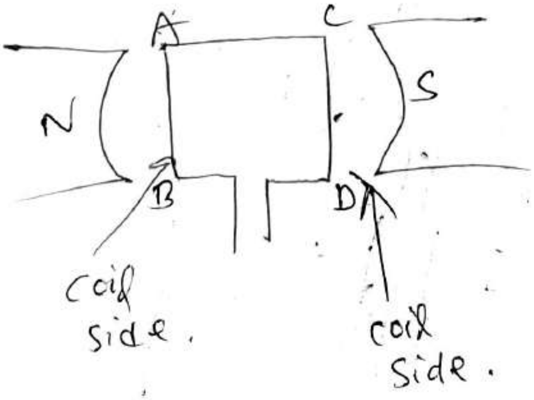
(5)- Armature winding

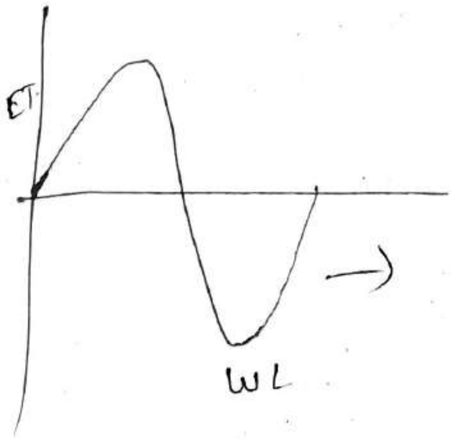
(6)- commutator.

(7)- Brush.

(1)- Lap winding.

(2)- wave winding.





EMF equation of DC Generator.

Let P = No. of poles.

ϕ = Flux per pole in weber.

Z = Total no. of armature conductor

N = No. of armature in r.p.m (revolution per minute)

A = No. of parallel paths.

$A = P$ --- for lap winding

$A = 2$ --- for wave winding.

Flux cut by one conductor in one revolution of armature.

$$d\phi = P\phi \text{ wb.}$$

Time taken to comple one revolution.

$$dt = \frac{60}{N} \text{ sec}$$

N rev = 60 s.
1 rev = $\frac{60}{N}$ sec.

EMF Generated Per conductor

$$e = \frac{d\phi}{dt}$$

$$= \frac{P\phi}{\frac{60}{N}} = \frac{P\phi N}{60} \text{ volt.}$$

EMF of Generator = Emf per conductor × No. of conductors in series per parallel paths

$$= \frac{P\phi N}{60} \times \frac{Z}{A}$$

$$\boxed{E_g = \frac{P\phi Z N}{60A}}$$

(Q) A 6 pole lap on DC Generator at 600 cond on its armature. The flux per pole is 0.02 wb calculate

(i) the speed at which the generator must be run to generate 300 volt.

(ii) what would be the speed if the generator ~~is~~ were ~~wt~~ wave wound

Ans: $P = 6 = A$

$Z = 600$

$\phi = 0.02 wb$

$E_g = 300 V$

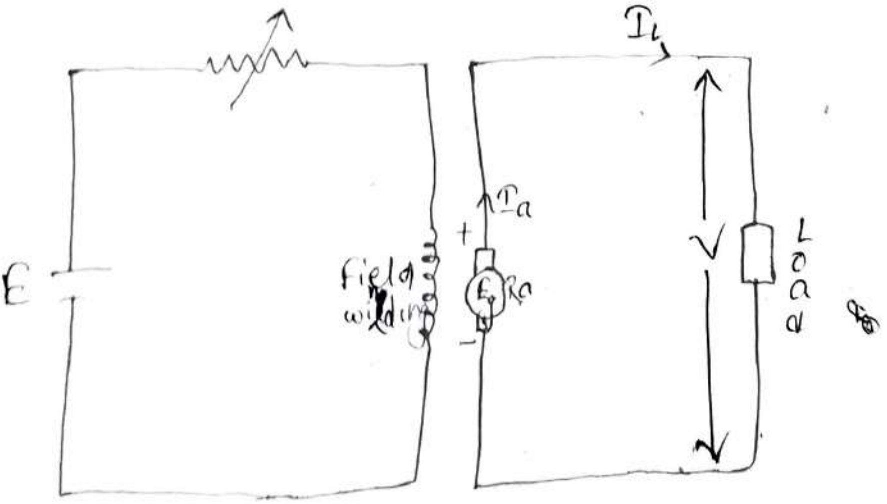
$$E_g = \frac{P\phi Z N}{60A}$$

Dt: 12.7.2

Types of DC Generator :

- Separately excited DC Generator.
- Self excited DC Generator.
  - Series Generator
  - Shunt Generation.
  - Compound Generator
    - Long Shunt.
    - Short Shunt

(1)- Separately excited DC Generator :-



$I_a = I_L$

$E_g - I_aR_a - V = 0$

$\Rightarrow \boxed{E_g = V + I_aR_a}$

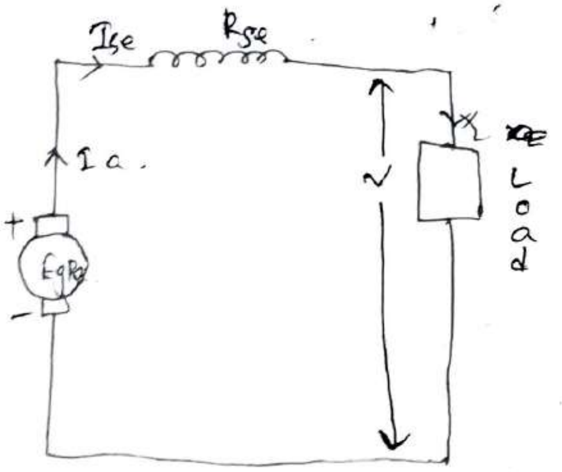
Power developed by the Armature.

$$E_g \times I_a = E_g I_a .$$

power developed to load $= V I_L$.

(2)- Self Excited DC Generator :-

(i)- series Generator :-



$$I_a = I_{se} = I_L$$
$$= I .$$

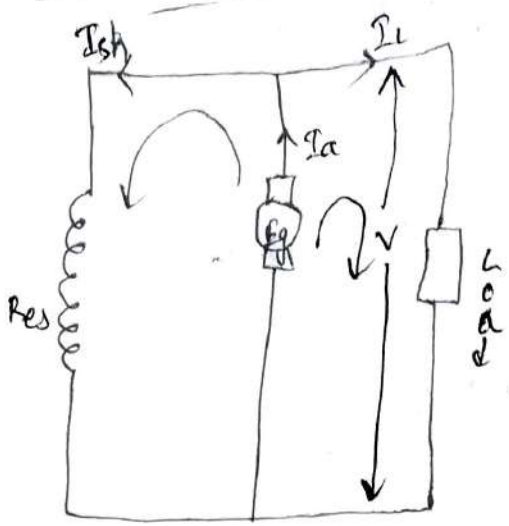
~~Eg~~

$$E_g - I_a R_a - V - I_{se} R_{se} = 0 .$$

$$\Rightarrow E_g - I (R_a - R_{se}) - V = 0 .$$

$$\Rightarrow \boxed{E_g = V + I (R_a - R_{se})}$$

(ii)- Shunt Generator:



$$I_a = I_L + I_{sh}.$$

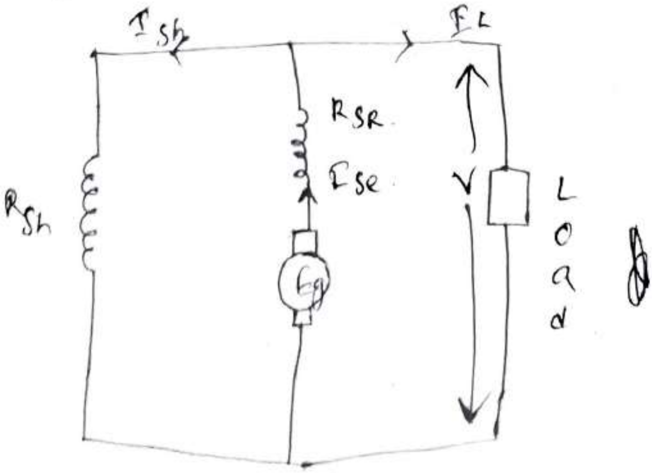
$$I_{sh} = \frac{V}{R_{sh}}$$

$$E_g - I_a R_a - V = 0.$$

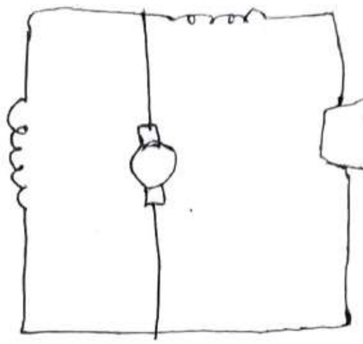
or $\boxed{E_g = V + I_a R_a}$.

Compound Generator:-

~~(iii)~~ (i) Long shunt:-



(ii)- Short Shunt :-



Principle of Generator :-

* An electric Generator is a Machine that convert mechanical energy to electrical energy.

* An electric Generator is based on the principle that whenever flux is cut by a conductor an emf is induced which will cause a current flow if the conductor circuit is closed.

* Consider a single turn loop ABCD rotating in clock wise in a uniform magnetic field with a constant speed. As the loop rotate, the flux ~~ting~~ linking the coil sides AB & ~~CD~~ CD changes continuously.

(i)- When the loop is in Position no-1 the generated emf is zero because the coil side AB & CD are cutting no flux but are moving parallel to it.

(ii)- When the loop is in position no-2 the coil sides ~~~~ ~~~~ are ~~~~ moving at an angle to the flux and therefore ~~~~ a low emf is generated.

(iii) - when the loop is in position no-3 the coilsides are right ~~anged~~ angle to the flux and therefore cutting the ~~ing~~ flux is at ~~an~~ a maximum rate. Hence at this ~~ista~~ instant the generated emf is maximum.

(iv) - At position - 4 the generated emf is less because the coil side are cutting the flux at an angle.

(v) - At position - 5 no magnetic lines are cut an hence induced emf is zero.

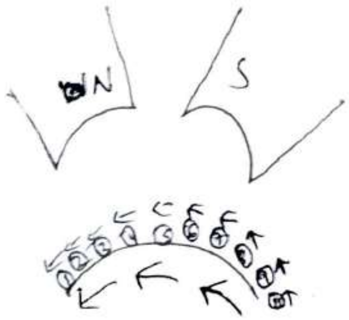
(vi) - At position - 6 the coil sides move under a pole of opposite polarity and hence the dirn of generated emf is reversed.

(vii) - The maxm emf in the reverse dirn will be when the loop is at position - 7. This cycle repeats with its revolution of the coil.

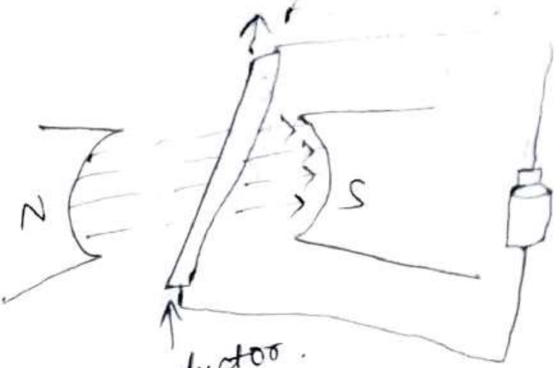
Dt 18.4.22

DC MOTOR

Principle :-



②.



①.

Electrical energy → DC Motor → mechanical energy.

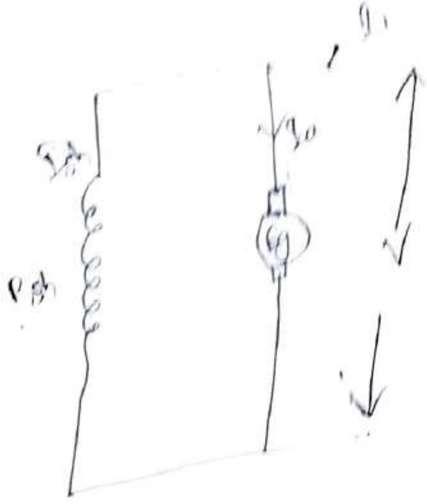
when a current carrying ~~con~~ conductor is placed in a magnetic field it will experience a mechanical force.

$$F = Bil \text{ Newton.}$$

B = Flux density.

i = current of the conductor.

L = length of the conductor.



$I_L = I_a + I_{sh}$

E_b = Back EMF.

Net voltage across armature circuit.

$= V - E_b$.

If R_a is Armature resistance.

$$I_a = \frac{V - E_b}{R_a}.$$

or $I_a R_a = V - E_b$.

$$\boxed{E_b = V - I_a R_a}.$$

$$\boxed{E_b = \frac{P\phi Z N}{60A}}.$$

Speed Equation of DC motor :

$$E_b = V - I_a R_a \quad -(1).$$

$$E_b = \frac{P\phi Z N}{60A} \quad -(2).$$

$$\frac{P\phi Z N}{60A} = V - I_a R_a .$$

$$N = \frac{V - I_a R_a \times 60A}{P\phi Z}$$

$$\Rightarrow N = \frac{V - I_a R_a}{\phi} \times \frac{60A}{PZ} .$$

$$\Rightarrow N = \frac{E_b}{\phi} K . \quad \left(\frac{60A}{PZ} = K\right).$$

$$\Rightarrow \boxed{N \propto \frac{E_b}{\phi}} .$$

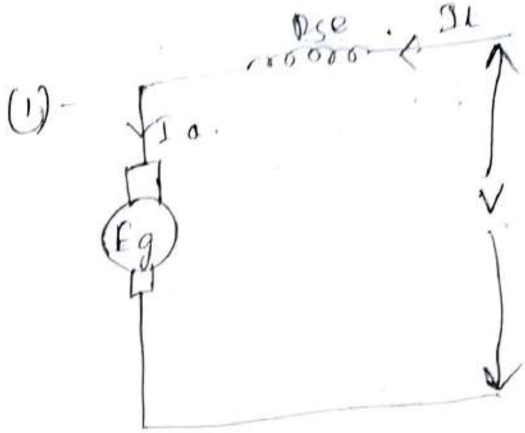
TYPES OF DC MOTOR:

(1) series motor.

(2) shunt motor.

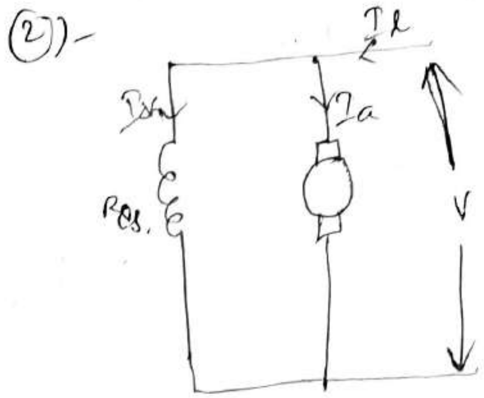
(3) compound motor.

(1)-



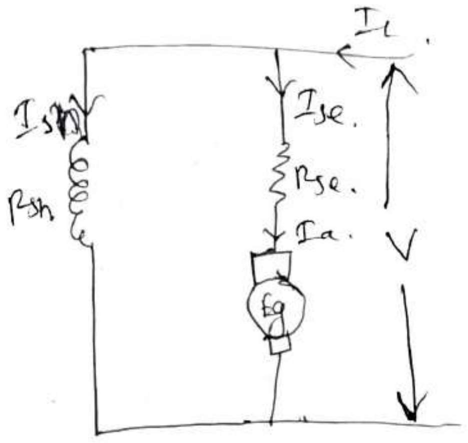
$I_L = I_{se} = I_a$.

(2)-

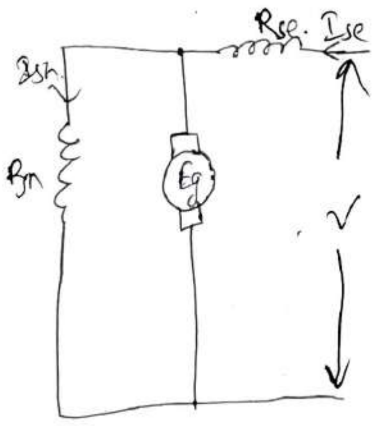


$I_L = I_a + I_{sh}$.

(i) Long Shunt :-

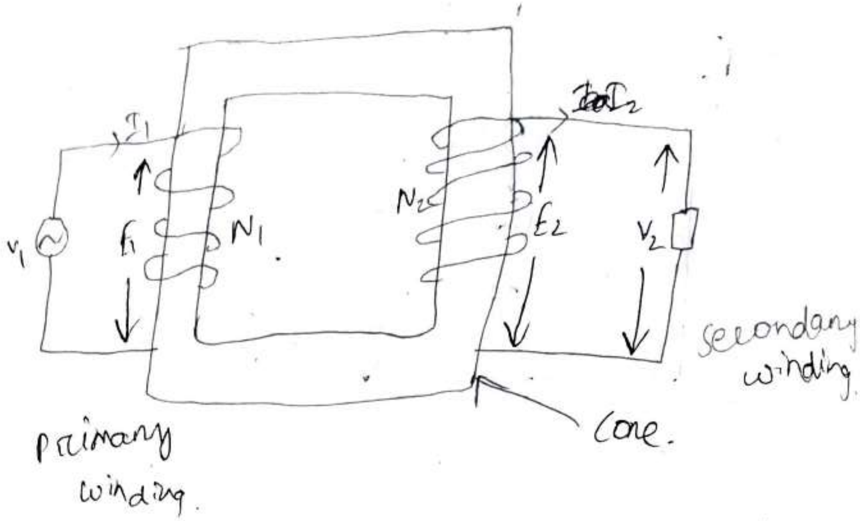


(ii) Short shunt :-



2022/09/26 17:31

Dt 22.2.22



$$E_1 = -N_1 \frac{d\phi}{dt}.$$

$$E_2 = -N_2 \frac{d\phi}{dt}.$$

$$\frac{E_2}{E_1} = \frac{N_2}{N_1}.$$

If $V_2 > V_1 \rightarrow$ step up Transformer.

$V_2 < V_1 \rightarrow$ step down Transformer.

Transformation Ratio(K) :-

$$\frac{V_2}{V_1} = \frac{N_2}{N_1} = K.$$

For Ideal Transformer.

$$\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{E_2}{E_1} = K.$$

Ideal transformer :-

(1)- No winding resistance.

(2)- No Ironloss.

(3)- No lekage reactance.

EMF eqn of Transformer :-

The sinusoidal flux produced in the primary.

$$\phi = \phi_m \sin\omega t.$$

The instantaneous emf produced in the primary.

$$e_1 = -N_1 \frac{d\phi}{dt}.$$

$$e_1 = -N_1 \frac{d}{dt}(\phi_m \sin \omega t)$$

$$= -\omega N_1 \phi_m \cos \omega t$$

$$\Rightarrow \omega = 2\pi$$

$$= -2\pi f N_1 \phi_m \cos \omega t$$

$$e_1 = 2\pi f N_1 \phi_m \sin\left(\omega t - \frac{\pi}{2}\right)$$

The maximum value of induced emf in the primary.

$$E_{max} = 2\pi f N_1 \phi_m$$

The r.m.s value of induced emf in the primary.

$$= \frac{E_m}{\sqrt{2}} = \frac{2\pi f N_1 \phi_m}{\sqrt{2}}$$

$$\boxed{E_2 = 4.44 f \phi_m N_2}$$

$$\boxed{E_1 = 4.44 f \phi_m N_1}$$

Construction of Transformer:-

Two main parts of a single phase Transformer are

(i)- A set of two isolated winding.
(ii)- A common magnetic ~~~~ core.

Depending on the wingding arrangement over the core.

Transformer may be classified ~~types~~ as

(i)- core type
(ii)- shell type.

- In core type transformer the winding surround the core.
- ~~The~~ In shell type transformer the core surround the winding.
- The core is provided to localize the magnetic flux for linking the two windings.
- Therefore the core is made up of highly permeable magnetic material.
- The core is also laminated to reduce Eddy current loss.
- The windings are made up of highly conducting material in the form of copper wire having an enamel coating on their surface which provides the necessary insulation for isolating of the winding form remaining conducting parts of the transformer.

-) Thus the two wingding remain electrically isolated from one another.

-) On the other hand both windings being placed on a common magnetic core established a mutual linkage with the common magnet flux.

-) Hence ~~the~~ the ~~two~~ two winding ~~are~~ remain magnetically coupled.

-) Among the Auxillary parts their is an enclosed ~~t~~ tank houses total core and winding assembly.

-) The core and winding Assembly remain completely built the immersed in a transformer ~~grade~~ grid mineral oil.

-) The free hand of the winding are ~~b~~ brought of the tank through a special type of insulation mounting called ~~the~~ bushing and terminals are ~~o~~ provided on the ~~d~~ top of ~~p~~ bushing to enable external connection.

Power Billing

Dt. 25.7.22

Q1:- A building has the following electrical

(i) - 1 H.P motor running for 5 Hours in a day.

(ii) - 3 fans ~~these~~ each of 80 watt running for 10 hours in a day.

(iii) 4 tube lights of 40 watt running for 15 hours per day.

Find the mothly bill for the month of November of 2021. If ~~indeed~~ unit cost of bill is Rs 2.50.

A:

Sl.No.	Name of Appliances	quantity	power rating	working hours in a day	Energy consumed in KWH.
1-	motor	1 NO	1 H.P = 746w.	5	$\frac{746\times5\times1}{1000} = 3.73$
2-	fans	3 NO	80w.	10	$\frac{80\times3\times10}{1000} = 2\cdot$
3	Tubelight	4 NO	40w	15	$\frac{15\times40\times4}{1000} = 2.4$

Total energy consumed perday

$= 3.73 + 2.4 + 2.4$

$= 8.53 KW$

In the month of November is 30 day.

So $30 \times 8.53 = 255.9$ KWH.

Total cost of energy

No. of units × cost per unit

= 255.9 × 2.5

= Rs 639.75. (Ans)

(Q): Find the cost of electrical energy in the month of January 2022 in operation of the following loads in a residential house, each unit of energy cost Rs 2.50

(i) - 5, 60w lamps for 8 hours.

(ii) - 3, 100w ceiling fans for 6 hours.

(iii) - 4, 40 watt florocent tubelight for 4 hours.

Sl No	Name of Appliences	Quantity	power rating	working hours in a day	Energy consume
1	lamps	5NO	60w	8	$\frac{60\times8\times5}{1000} = 2.4$
2	fans	3NO	100w	6	$\frac{100\times6\times3}{1000} = 1.8$
3	tubelight	4NO	40w	4	$\frac{40\times4\times4}{1000} = 0.64$

Total energy consumed per day.

$= 2.4 + 1.8 + 0.64$

$= 4.84$

In the month of January of 2022 is 31 day

So $= 31 \times 4.84$

$= 150.04$ KWH.

Total cost of Energy

= No. of units × cost per unit.

$= 150.04 \times 2.50$

= Rs 375.1. (Ans)