1) State and explain Kirchoff's voltage and current law.

Ans) Kirchoff's laws : 1) Kirchof's current law (KCL)

2) Kirchoff's voltage law (KVL)

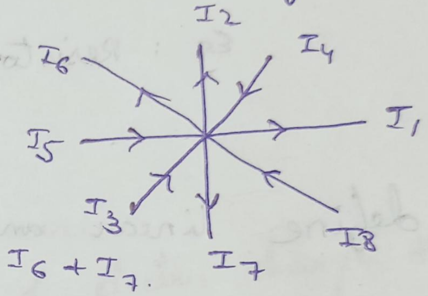
KCL: The algebraic sum of currents at that node is '0'

(or)

The sum of currents entering a node = sum of currents leaving a node

Entering currents : $+I_5, I_4, I_3, I_8$

leaving currents : $-I_1, I_2, I_6\ I_7$



$$I_3 + I_4 + I_5 + I_8 = I_1 + I_2 + I_6 + I_7.$$

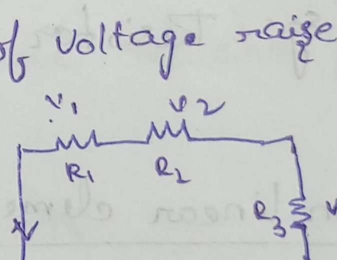
KVL: The algebraic sum of all voltages around a closed path is zero

(or)

The sum of voltage drop = Sum of voltage raise

$$V_1 + V_2 + V_3 = e$$

$$V_1 + V_2 + V_3 - E = 0$$



2) (i) define active and passive elements

Ans: Active elements: The elements which deliver the power in the circuit are known as active elements

Eg: All sources

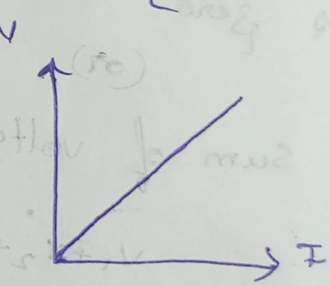
Passive elements: The elements which takes the power from the sources are known as passive elements

Eg: Resistor, Inductor, capacitor.

(ii) define linear and non linear elements

Ans: Linear elements: The elements which are having the [V-I] linear voltage current relationship passing through origin are known as linear elements

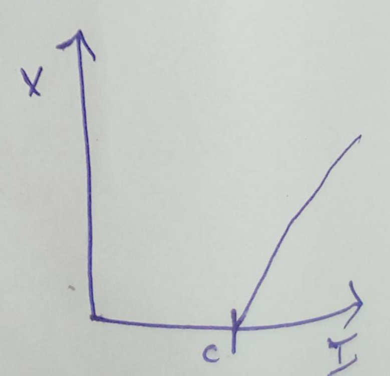
Eg: Resistor



Non linear elements

The elements which are having non linear volt current relationship are known as linear elements

Eg: All semiconductor devices



(ii) Unilateral Elements: The elements which allows the current in one direction. those elements are called as unilateral elements

Eg: ~~Resistor, Inductor, capacitor~~
Diode, silicon control rectifier

Bilateral Elements

The elements which allows the current in both the directions those elements are called Bilateral elements

Eg: Resistor, Inductor, capacitor.

3) Define current, voltage and Power.

i) current :- The rate of change of flow of electric charge through a conductor or circuit element.

Deloted by 'I' (or) 'i'

UNITS: AMPERES $1A = 1C/sec$

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

ii) Voltage :- The energy required to move the charge through a conductor or circuit elements

UNITS: VOLTS

$$V = \frac{dw}{dq}$$

Denoted by v (or) V

$$1V = 1J/1C$$

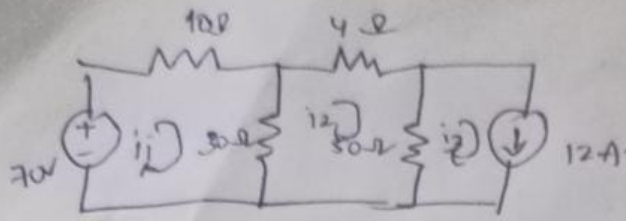
iii) Power :- The time rate of expending or absorbing energy

UNITS : watts Denoted as P

$$P = \frac{dw}{dt} \Rightarrow P = \frac{dw}{dq} \times \frac{dq}{dt} \Rightarrow \text{voltage} \times \text{current}$$

$$\boxed{P = VI}$$

4)



$\boxed{i_3 = 12A}$

Apply mesh analysis for mesh (1)

$$-70 + 10i_1 + (i_1 - i_2)30 = 0$$

$$40i_1 - 30i_2 = 70 \longrightarrow (1)$$

Apply mesh analysis for mesh (2)

$$30(i_2 - i_1) + 4i_2 + 50(i_2 - i_3) = 0.$$

$$-30i_1 + 84i_2 = 600 \rightarrow (2)$$

solving eqn (1) & (2)

$$\boxed{i_1 = 9.7A, \; i_2 = 10.6A.}$$

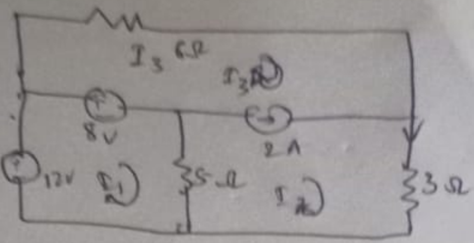
For 50Ω,

$$I_{50\Omega} = I_2 - I_3 = 10.6 - 12 = -1.4A.$$

or

$$I_{50\Omega} = I_3 - I_2 = 12 - 10.6 = 1.4A.$$

5)



Apply mesh analysis for mesh ② & ③ at a time

$$5(I_2-I_1)-8+6I_3+3I_2=0$$

$$-5I_1+8I_2+6I_3=8 \rightarrow ①$$

from 2A current source

$$I_2-I_3=2 \rightarrow ②$$

Apply mesh and mesh ①

$$-12+8+5(I_1-I_2)=0$$

$$5I_1-5I_2=4 \rightarrow ③$$

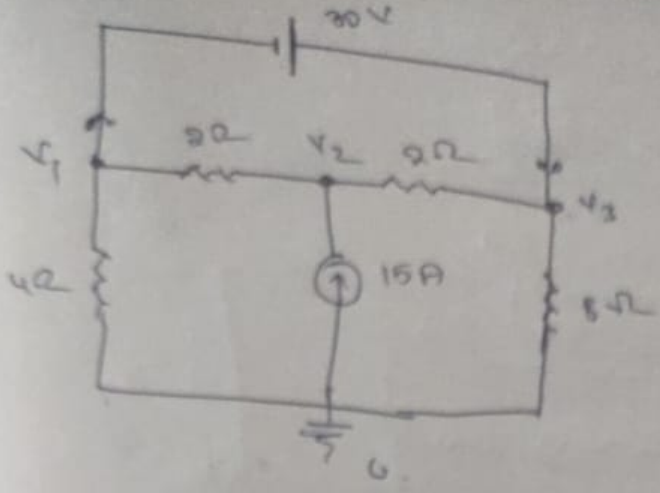
By solving eq ①, ②, ③

$$I_1=3.4A, \quad I_2=2.6A, \quad I_3=0.6A.$$

Current flowing through 3Ω resistor is.

$$\boxed{I_{3\Omega}=I_2=2.6A}$$

(7)



$-V_1 + V_3 = 30V$

$\boxed{V_3 = V_1 + 30}$ — (1)

Apply KCL for Node (1) and (3)

$$\frac{V_1 - V_2}{2} + \frac{V_1}{4} + \frac{V_3}{5} + \frac{V_3 - V_2}{2} = 0$$

solving

$6V_1 - 8V_2 + 5V_3 = 0$ — (2)

Apply KCL for Node (2)

$$\frac{V_2 - V_1}{2} + \frac{V_2 - V_3}{2} = 15A$$

$2V_2 - V_1 - V_3 = 30A$ — (3)

Sub Eq (1) in Eq (2) and Eq (3)

the solve.

$11V_1 - 8V_2 = -150$

$-8V_1 + 8V_2 = 240$

$3V_1 = 90 \Rightarrow \boxed{V_1 = 30V}$

$-60 + 2V_2 = 60$

$\boxed{V_2 = 60\,V}$

$V_3 - V_1 = 20$

$\boxed{V_3 = 60}$

current
~~voltage~~ across $8\,\Omega$

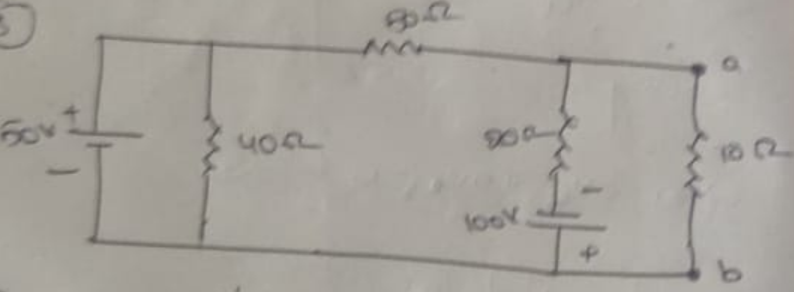
$V = iR$

$i = V/R$

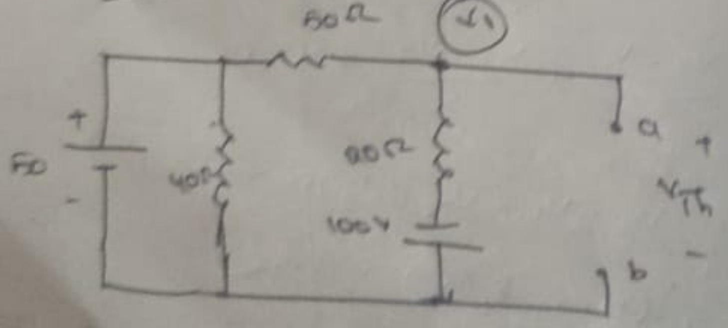
$i = V_3/R_8 = \frac{60}{8}$

$\boxed{i = 7.5\,A}$

(8)



By Thevenin's



Voltage at $20\,\Omega$ = V_{Th}

$\boxed{V_{Th} = 100.64\,V}$

By Nodal analysis

$$\frac{V_1 - 100}{20} + \frac{V_1 - 50}{50} = 0$$

$$50V_1 - 5000 + 20V_1 - 1000 = 0$$

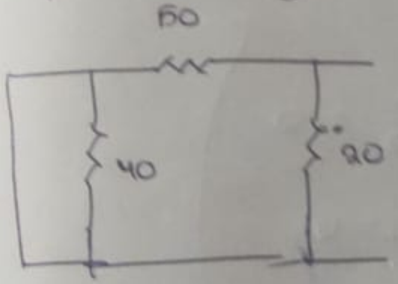
$$70V_1 = 6000$$

$$\boxed{V_1 = 85.71\,V}$$

where $\boxed{V_{Th} = 85.71\,V}$

Now find R_{Th}

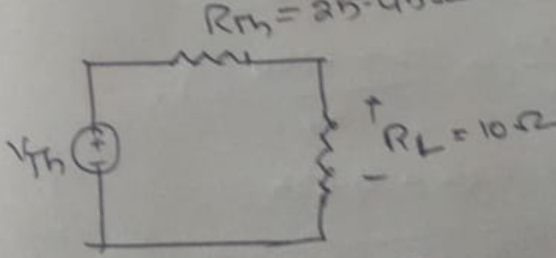
By considering all voltages in to closed circuit



=>

$$R_{Th} = \frac{40(70)}{110} \Rightarrow 25.45\Omega$$

then

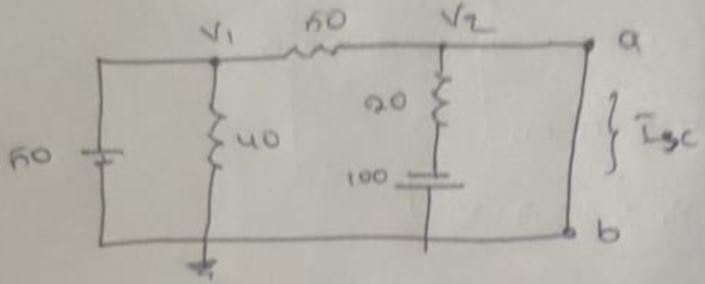


$$V_{10\Omega} = 85.71 \times \frac{10}{10 + 25.45}$$

$$\boxed{V_{10\Omega} = 24.177\ \text{Volts}}$$

(ii) By Norton's theorem

Note:- Make R_L in to short circuit



Now Find I_{sc} value

$$\underline{V_1 = 50}$$

$$\frac{V_2 - 50}{50} + \frac{V_2 - 100}{20} = I_s$$

for $\underline{V_1}$

$$\frac{50 - V_2}{50} + \frac{50}{40} = 0$$

$$200 - 4V_2 + 250 = 0$$

$$V_2 = \frac{450}{4}$$

$$\boxed{V_2 = 112.5}$$

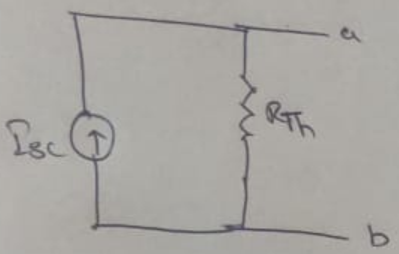
$$\frac{112.5 - 50}{50} + \frac{112.5 - 100}{20} = I_s$$

$\Rightarrow I_s = 1.25 + 0.625$

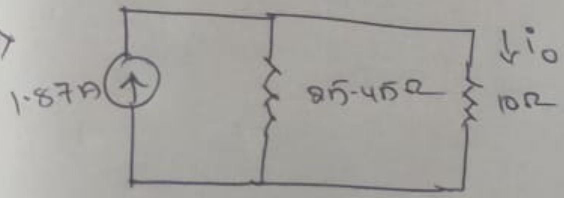
$$\boxed{I_s = 1.87A}$$

Now $R_{Th} = 25.45\,\Omega$

then



$\Rightarrow$



$$i_0 = 1.87 \times \frac{25.45}{10 + 25.45}$$

$$i_0 = 1.34\,A$$

$$V_{10} = i_0 (R_{10})$$

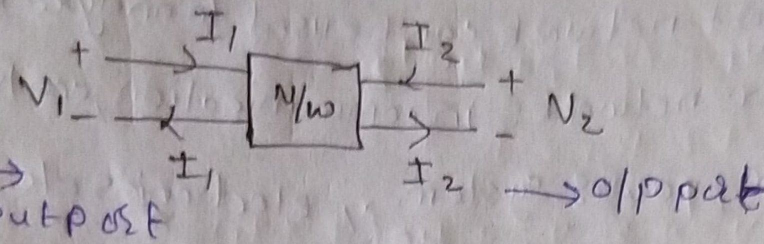
$$= (1.34)(10)$$

$$\boxed{V_0 = 13.4 \text{ volts}}$$

UNIT-3

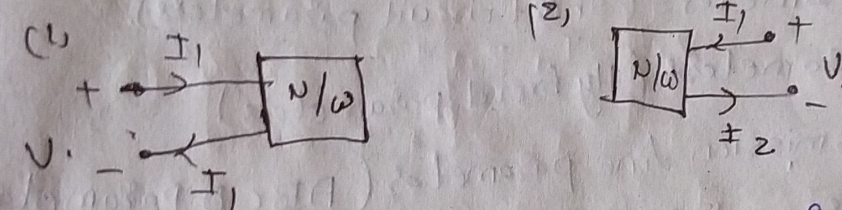
Two port Network

(1) A pair of terminals at which signal (current) may enter (or) leave from the network is called as "port"

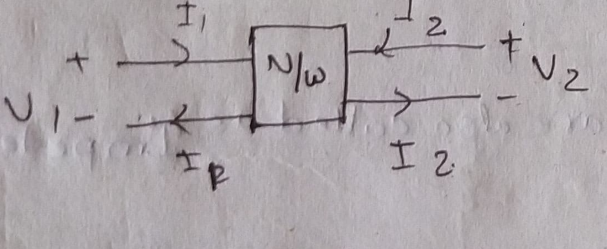


(2) when the network is having only one pair of terminals then the network is called single port network

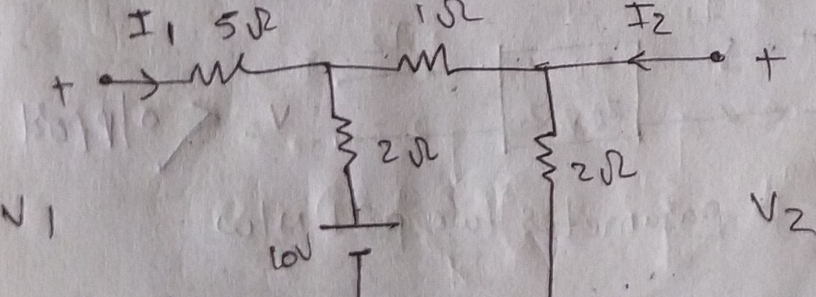
Ex:



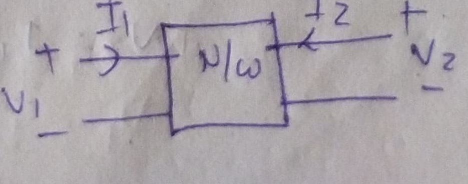
(3) when the network is having two pair of terminals then the network is called as two port network



Eg:



This is two port Network



(4) from the two port network, we can observe that there are '4' variables

i.e. $V_1, I_1; V_2, I_2$.

Out of which two variables are independent & two variables are dependent

(5) Two port network can be used to analyze the complex networks in communication, control system, power system, electronics etc.

Classification of Parameters

(1) z parameters (open circuit parameter)
(2) Y parameters (short circuit parameters).
(3) H parameters (Hybreid parameters)
(4) Transmission line parameter (ABCD parameters)
(5) g parameters (Inverse hybrid parameters)
(6) abcd parameters (Inverse transmission line parameter)

Z-Parameters

(1) z-parameters are also called as Impedence parameters

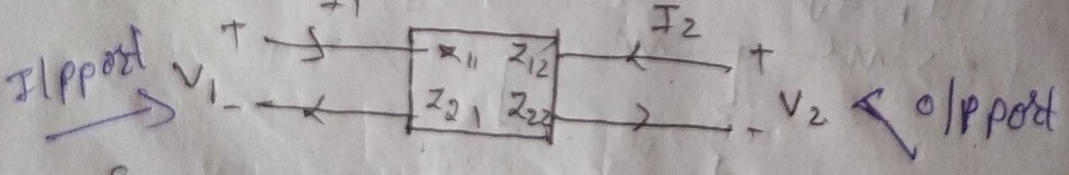


fig.1:- z-parameter two port N/w

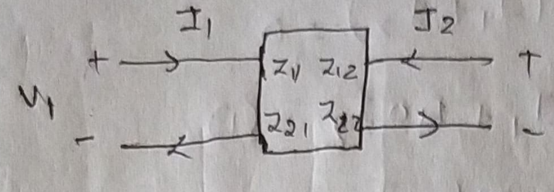
(2) By using KVL we will get $V_1 = I_1 z_{11} + I_2 z_{12}$ —(1)

$V_2 = I_1 z_{21} + I_2 z_{22}$ —(2)

The eq ① & ② can be written in matrix form

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} \quad — ③$$

Determination of Z_{11}, Z_{12}, Z_{21} & Z_{22}



Case (i): o/p port is open circuited

put $I_2 = 0$ in Eq ① & ②

① ⇒ $V_1 = I_1 Z_{11} \Rightarrow Z_{11} = \dfrac{V_1}{I_1}\Big|_{I_2=0}$.

② ⇒ $V_2 = I_1 Z_{21} \Rightarrow Z_{21} = \dfrac{V_2}{I_1}\Big|_{I_2=0}$

where Z_{11} = open circuit I/p impedence.

where Z_{21} = open circuit Transfer impedence

case (ii): I/p port is open circuited

put $I_1 = 0$ in Eq ① & ②

① ⇒ $V_1 = I_2 Z_{12} \Rightarrow Z_{12} = \dfrac{V_1}{I_2}\Big|_{I_1=0}$.

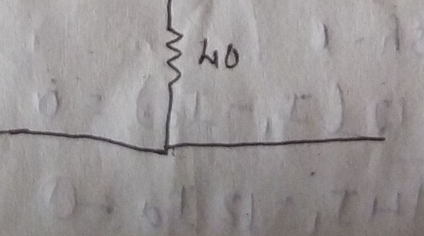
② ⇒ $V_2 = I_2 Z_{22} \Rightarrow Z_{22} = \dfrac{V_2}{I_2}\Big|_{I_1=0}$

where Z_{12} = open circuit Transfer impedence

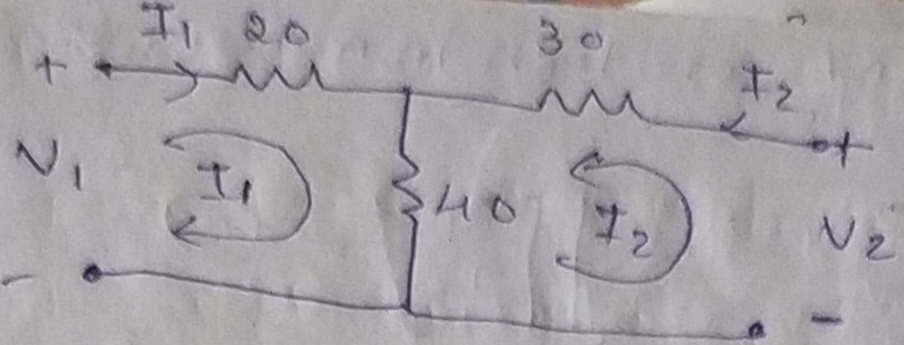
where Z_{22} = open circuit o/p impedence

Units: Ohms.

Eg:



find Z-parameters



Apply KVL to mesh-1

$$-V_1 + 20I_1 + 40(I_1 + I_2) = 0$$

$$V_1 = 60I_1 + 40I_2 \quad -(1)$$

Apply KVL to mesh-2

$$-V_2 + 30I_2 + 40(I_2 + I_1) = 0$$

$$V_2 = 70I_2 + 40I_1 \quad -(2)$$

The standart eqns for z-parameters

$$\left.\begin{aligned} V_1 &= I_1 z_{11} + I_2 z_{12} \\ V_2 &= I_1 z_{21} + I_2 z_{22} \end{aligned}\right\} -(3)$$

compare (1) & (2) with (3)

$$z_{11} = 60,\ z_{12} = 40\,\Omega$$

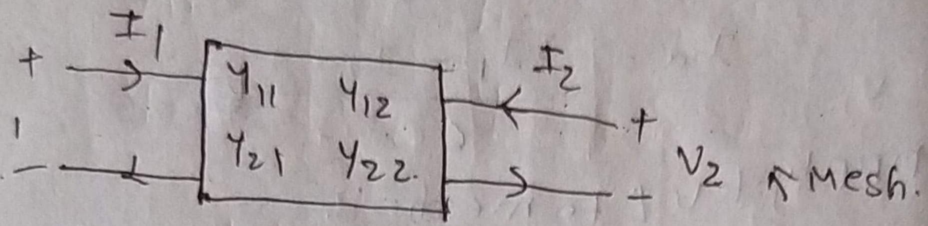
$$z_{21} = 40,\ z_{22} = 70\,\Omega$$

Y-parameters

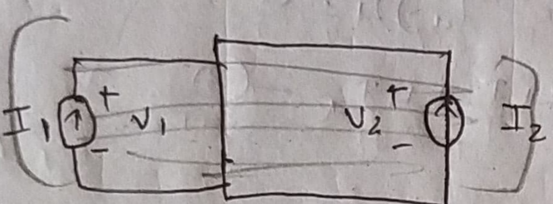
(1) Y-parameters are also called admittance parameters

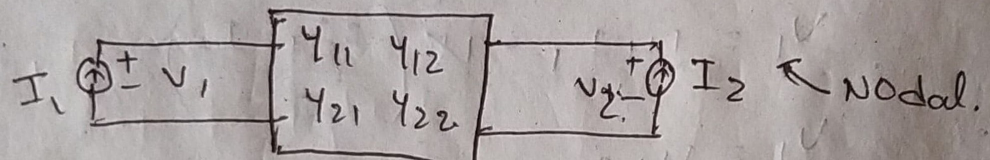
(2) Y-parameters units are mhos ($\mho$) or siemens

$$Y = \frac{1}{Z} = \frac{I}{V} \ \mho \text{ (or) siemens.}$$



(or)





(3) Terminal currents (I_1 & I_2) can be expressed as

$$I_1 = Y_{11}V_1 + Y_{12}V_2 \quad \text{—} (1)$$

$$I_2 = Y_{21}V_1 + Y_{22}V_2 \quad \text{—} (2)$$

The equation (1) & (2) can be written in matrix form

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} \quad \text{—} (3)$$

(4) Determination of Y-parameters :-

Case :- 1 $V_2 = 0$ (o/p port short circuited)

put $V_2 = 0$ in Eq (1) & (2)

(1) ⇒ $I_1 = Y_{11}V_1 \Rightarrow Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$

(2) ⇒ $I_2 = Y_{21}V_1 \Rightarrow Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$

where y_{11} = short circuit I/p admitten

where y_{21} = short circuit transfer admitten

case (ii) $V_1 = 0$ (I/p port short circuited)

put $V_1 = 0$ in Eq ① & ②

① ⇒ $I_1 = y_{12} V_2 \Rightarrow y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1 = 0}$

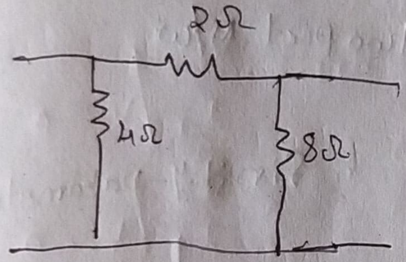
② ⇒ $I_2 = y_{22} V_2 \Rightarrow y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1 = 0}$

where

y_{12} = short circuit Transfer admittance

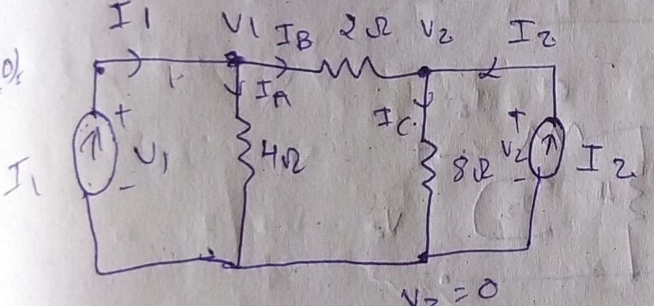
y_{22} = short circuit o/p admittance

Eg:



find 'y' parameters?

Sol:



Apply KCL at V_1

$I_1 = I_A + I_B$

$I_1 = \frac{V_1}{4} + \frac{V_1 - V_2}{2}$

$I_1 = \frac{V_1 + 2V_1 - 2V_2}{4}$

$4 I_1 = 3V_1 - 2V_2$

$I_1 = \frac{3}{4} V_1 - \frac{1 V_2}{2}$ — ①

Apply KCL at V_2

$I_B + I_2 = I_C$

$\frac{V_1 - V_2}{2} + I_2 = \frac{V_2}{8}$

$I_2 = \frac{V_2}{8} - \frac{V_1 - V_2}{2}$

$8 I_2 = V_2 - 4V_1 + 4V_2$

$I_2 = \frac{-1}{2} V_1 + \frac{5}{8} V_2$ — ②

The standard Y-parameters eqⁿ are

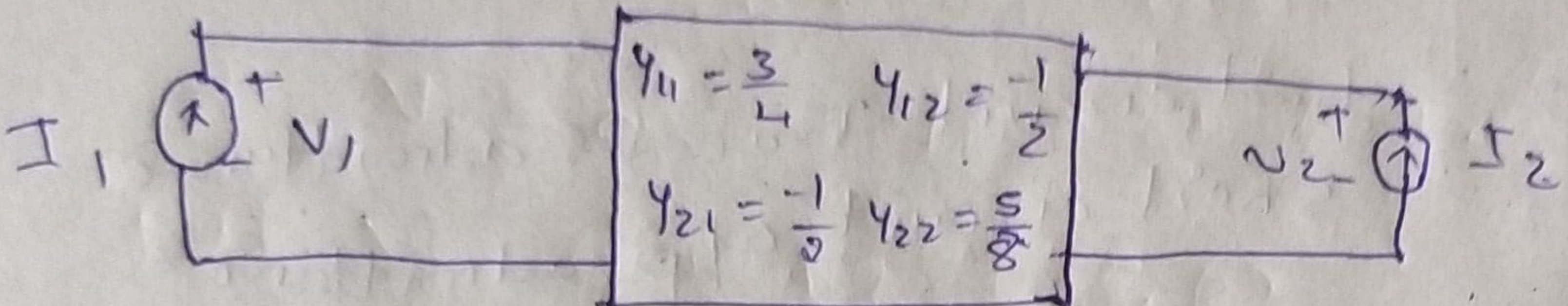
$$I_1 = Y_{11} V_1 + Y_{12} V_2 \quad \text{--- (3)}$$

$$I_2 = Y_{21} V_1 + Y_{22} V_2 \quad \text{--- (4)}$$

compare (1) & (2) with (3) & (4)

$$Y_{11} = \frac{3}{4} \mho \qquad Y_{12} = -\frac{1}{2} \mho$$

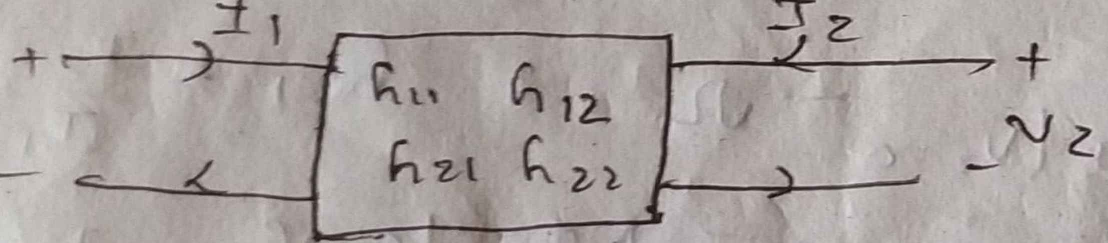
$$Y_{21} = -\frac{1}{2} \mho \qquad Y_{22} = \frac{5}{8} \mho$$



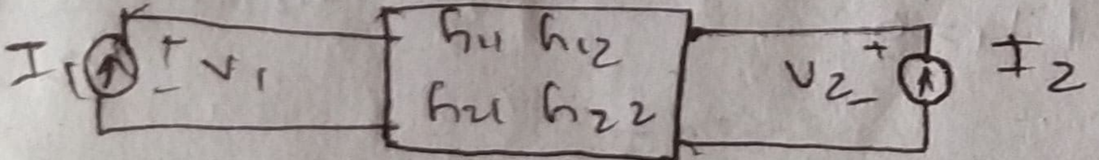
Y-parameters two port N/w

h-parameters:

(1) h-parameters are called hybrid parameters



(or)



2) The standard h-parameter equations are

$$V_1 = h_{11} I_1 + h_{12} V_2 \quad \text{--- (1)}$$

$$I_2 = h_{21} I_1 + h_{22} V_2 \quad \text{--- (2)}$$

Eq (1) & (2) can be written in matrix form

$$\begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix} \quad \text{--- (3)}$$

Eg:

Sol:

Determination of h-parameters:

Case (i) $V_2 = 0$. o/p port short-circuted

put $V_2 = 0$, in Eq (1) & (2)

$$(1) \Rightarrow V_1 = h_{11} I_1 \Rightarrow h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0}$$

$$(2) \Rightarrow I_2 = h_{21} I_1 \Rightarrow h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0}$$

Case (ii)

$I_1 = 0$ (I/p port open circutated)

put $I_1 = 0$ in Eq (1) & (2)

$$(1) \Rightarrow V_1 = h_{12} V_2 \Rightarrow h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0}$$

$$(2) \Rightarrow I_2 = h_{22} V_2 \Rightarrow h_{22} = \left.\frac{I_2}{V_2}\right|_{I_1=0}$$

where h_{11} - short circuit I/p impedence $\{z = \frac{V}{I}\}$

h_{22} - open circuit o/p admitance $\{y = \frac{I}{V}\}$

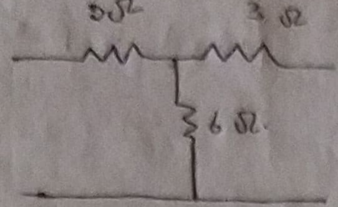
h_{12} - open circuit reverse voltage gain

h_{21} - Short circuit forward current gain

units: $h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0}$ - Ω $\quad h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0}$ - No

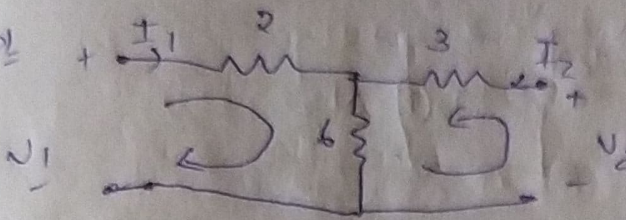
$h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0}$ - No units $\quad h_{22} = \left.\frac{I_2}{V_2}\right|_{I_1=0}$ - $\mho$

Eg:



find h-parameter

Sol:



apply KVL to mesh-1

$$-V_1 + 2I_1 + 6(I_1 + I_2) = 0$$

$$8I_1 + 6I_2 = V_1 \quad \text{— (1)}$$

apply KVL to mesh-2

$$-V_2 + 3I_2 + 6(I_2 + I_1) = 0$$

$$6I_1 + 9I_2 = V_2 \quad \text{— (2)}$$

$$I_2 = \frac{V_2 - 6I_1}{9}$$

$$\boxed{I_2 = \frac{1}{9}V_2 - \frac{2}{3}I_1}$$

sub Eq (2) in (1)

$$V_1 = 8I_1 + 6\left(\frac{1}{9}V_2 - \frac{2}{3}I_1\right)$$

$$V_1 = 8I_1 + \frac{2}{3}V_2 - 4I_1$$

$$V_1 = 4I_1 + \frac{2}{3}V_2 \quad \text{— (3)}$$

compare Eq (1) & (3) with standart h-parameter

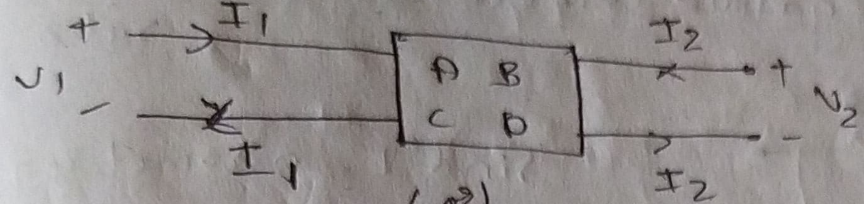
$h_{11} = 4\,\Omega$ $\quad h_{12} = \frac{2}{3}$

$h_{21} = -\frac{2}{3}$ $\quad h_{22} = \frac{1}{9}\,℧$

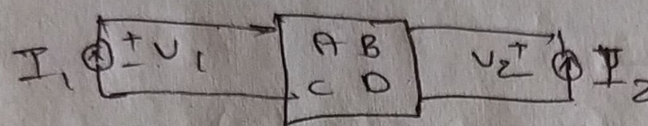
$$\begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 4 & 2/3 \\ -2/3 & 1/9 \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix}$$

Transmission parameters: (T-parameters)

1) These parameters are also called ABCD parameters
2) These parameters are useful in the analysis of transmission line.



(or)



3) The standard T-parameter equations are

$$V_1 = AV_2 - BI_2 \quad \text{--- (1)}$$

$$I_1 = CV_2 - DI_2 \quad \text{--- (2)}$$

4) The equation (1) & (2) can be written in matrix form

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix} \quad \text{--- (3)}$$

Determination of T-parameters

case-1: $V_2 = 0$ (o/p port short circuited)

put $V_2 = 0$ in Eq (1) & (2)

(1) $\Rightarrow V_1 = -BI_2 \Rightarrow B = +\frac{V_1}{I_2}\Big|_{V_2=0}$ (Ω

(2) $\Rightarrow I_1 = -DI_2 \Rightarrow D = +\frac{I_1}{I_2}\Big|_{V_2=0}$ (No units)

case-2: $I_2 = 0$ (o/p port open circuited)

put $I_2 = 0$ in Eq (1) & (2)

① ⇒ $V_1 = AV_2$ ⇒ $A = \frac{V_1}{V_2} \Big|_{I_2=0}$ (No units)

② ⇒ $I_1 = CV_2$ ⇒ $C = \frac{I_1}{V_2} \Big|_{I_2=0}$ (℧)

where,

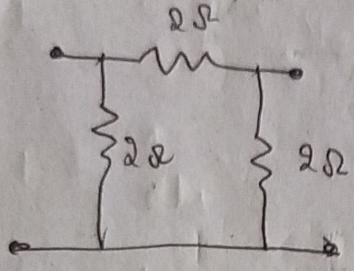
A = open circuit voltage gain (or) ratio

B = negative short circuit transfer impedance

C = open circuit Transfer admittance

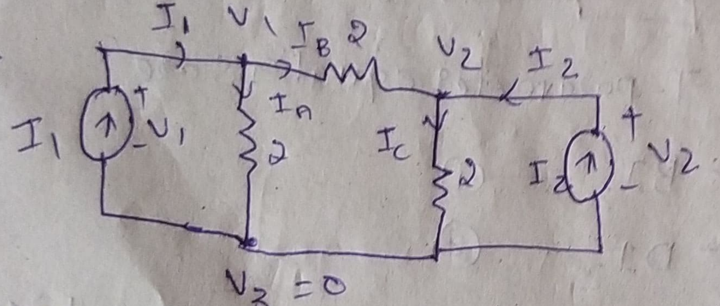
D = negative short circuit current gain (or) ratio

Eg:-



find T - parameters?

Sol



Apply KCL at V_1

$$I_1 = I_A + I_B$$

$$= \frac{V_1}{2} + \frac{V_1 - V_2}{2}$$

$$2I_1 = 2V_1 - V_2$$

$$I_1 = V_1 - \frac{V_2}{2} \quad — ①$$

Apply KCL at V_2

$$I_B + I_2 = I_C$$

$$\frac{V_1 - V_2}{2} + I_2 = \frac{V_2}{2}$$

$$I_2 = \frac{V_2}{2} - \frac{V_1 - V_2}{2}$$

$$V_1 = 2V_2 - 2I_2 \quad — ②$$

sub Eq (2) in (1)

$$I_1 = 2V_2 - 2I_2 - \frac{V_2}{2}$$

$$2I_1 = 4V_2 - 4I_2 - V_2$$

$$I_1 = 1.5V_2 - 2I_2 \quad (3)$$

compare Eq (2) & (3) with standard h-parameters

$A = 2$. $B = 2\,\Omega$

$C = 1.5\,℧$ $D = 2$.

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} 2 & 2 \\ 1.5 & 2 \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

UNIT-IV

DC Machines

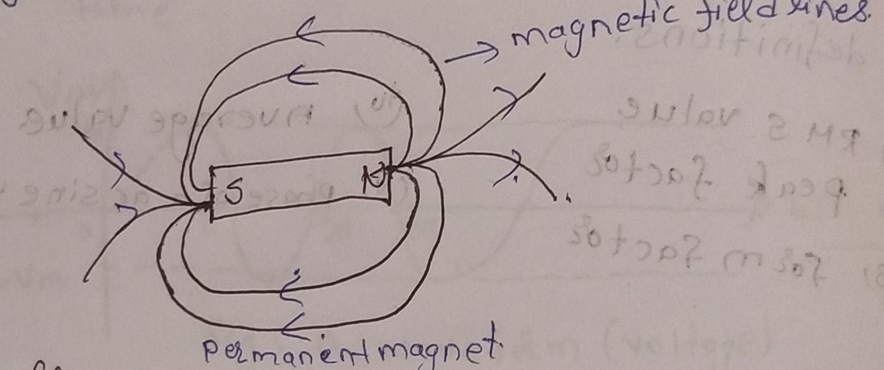
→ DC Generator

→ DC Motor

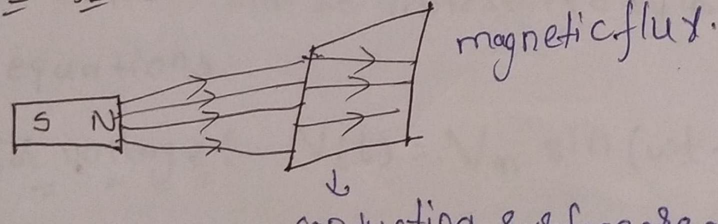
DC-Generator

I/P			O/P
Mech energy	⟶	(G)	⟶ electrical energy
↓			↓
(Torque).			(V, I)

* The function of generator is to convert mechanical energy in to electrical energy.



Magnetic flux



The quantity magnetic field lines linked to conducting surface area is called magnetic flux.

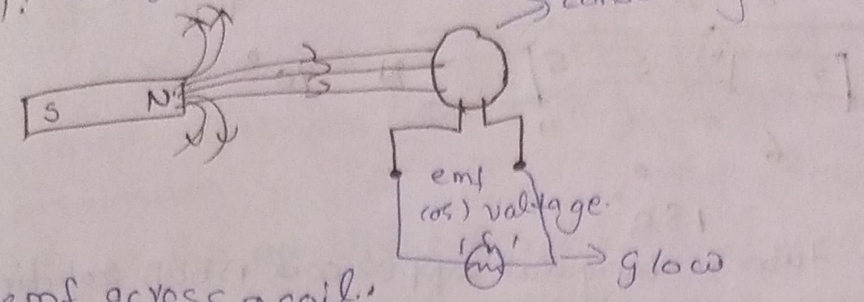
→ Denoted by $\phi = B \cdot A$

{ A = surface area }

→ units are weber (wb)

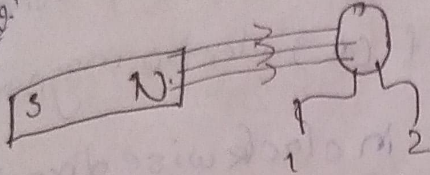
Faraday's Laws

Law1: Change of magnetic flux linked to a coil generates



an emf across a coil.

Law2:



The emf generated across the coil is equal to the rate of change of flux in the coil.

$$emf \; e = -\frac{d\phi}{dt}$$

- = indicates emf generated always oppose the change in flux.

*Dc Generator Principle:

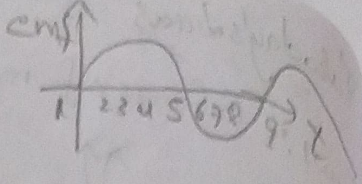
(1) An electrical generator is a machine which converts mechical energy into electrical energy

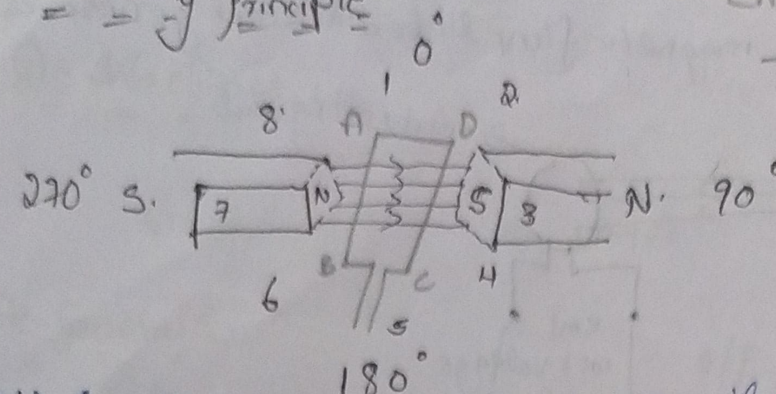
(2) The energy conversion is based on the principle of faraday's laws. whenever a conductor cuts magnetic flux, a dynamical induced emf is generated in it according to faraday's laws.

(3) This emf (or) voltage causes a current to flow if the conductor is closed.

(4) Basic ~~electri~~ essential parts of an electrical generator are (1) magnetic field (2) conductor

Working Principle





(1) Single turn rectangular copper coil ABCD rotating about its own axis in a magnetic field provided by either permanet magnet (or) electro magnet

(2) Assume coil is rotating in clockwise direction

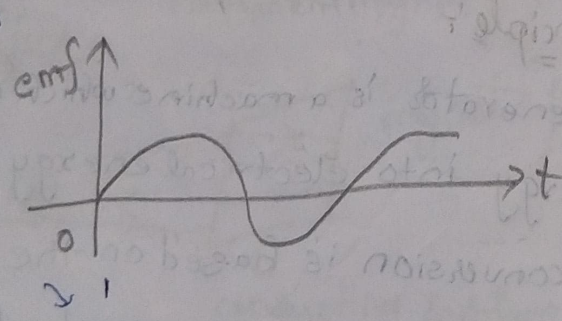
(3) As the coil rotates in clockwise direction, magnetic flux linked with rectangular copper coil will change

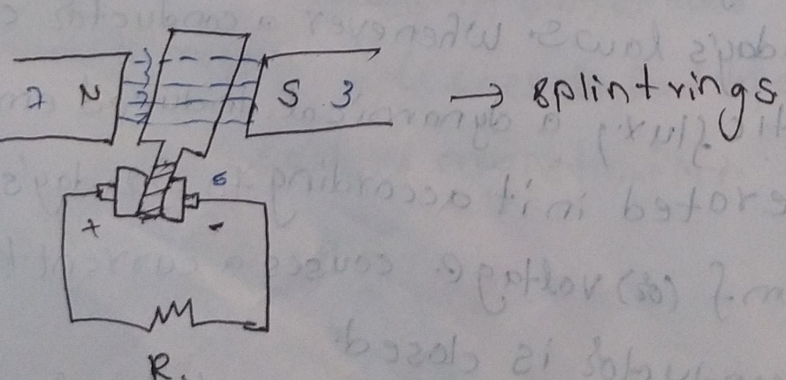
(4) Hence an emf is generated across the coil

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

$n \to$ no. of turns. {single turn coil $N=1$}

Wave form





R.

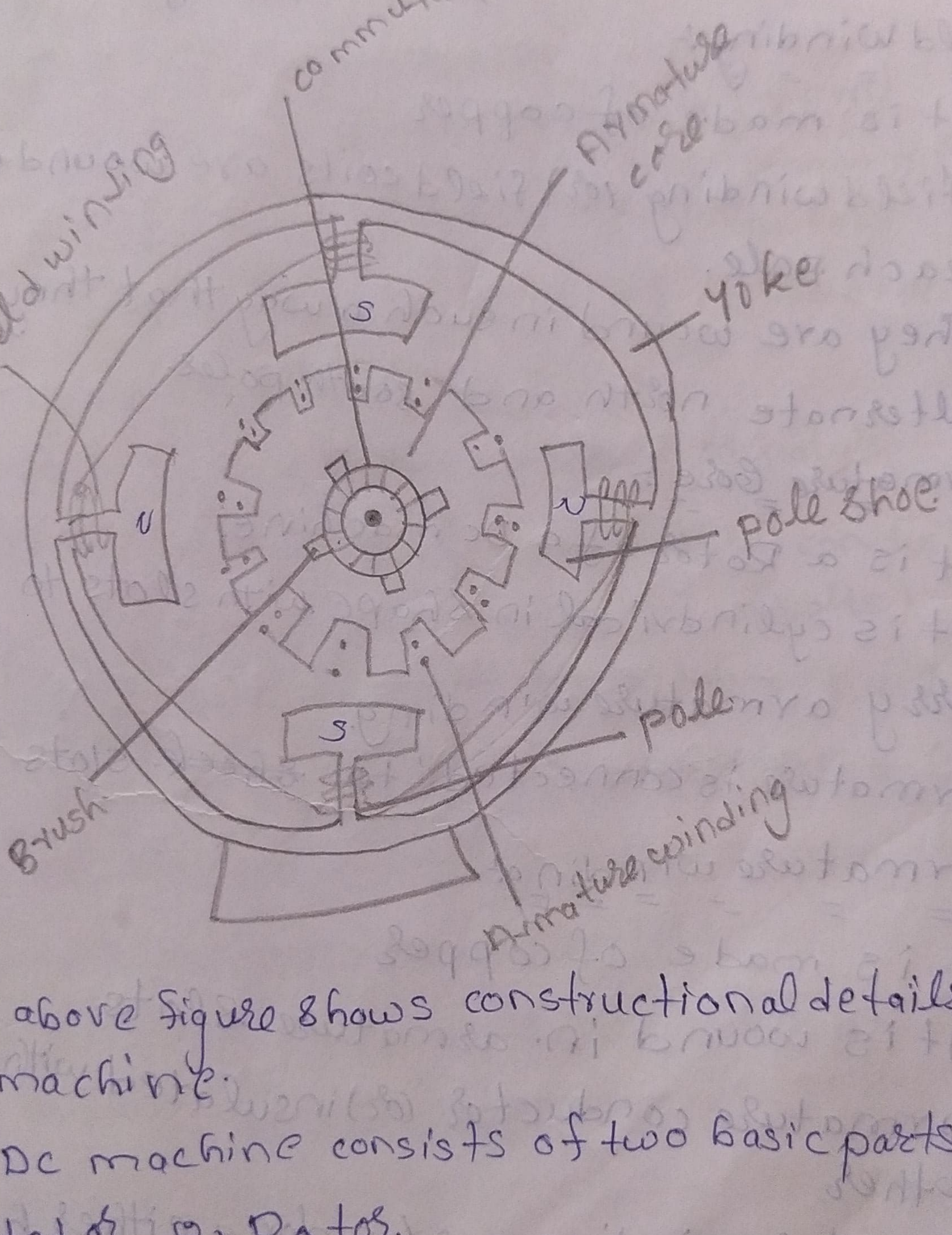
(1) When coil is in position 1, the flux linked with it is maximum but rate of change of flux is

minimum, Therefore, emf generated at position1 is minimum.

(2) when coil is in position 3, the flux linked with its is minimum but rate of change of flux is maximum. Therefore, emf induced at position 3 is maximum.

(3) For making unidirectional emf (or) voltage in the external circuit, splint rings are used.

Construction of DC Machine



(1) The above figure shows constructional details a dc machine.

(2) A DC machine consists of two basic parts
(1) stator (2) Rotor.

(3) Different parts DC machine are.
(i) Yoke (ii) pole and pole shoe (iii) field winding
(iv) Armature core (v) Armature winding (vi) commutator & Brushes

(i) Yoke :- (1) The outer frame of DC machine is called Yoke.
(2) It is made up of cast iron (or) steel.
(3) It provides mechanical strength to the whole assembly (or) whole parts

(ii) pole and pole shoe :-
(1) Poles are joined to the joke.
(2) They carry field winding.
(3) Pole shoe support field winding
(4) Pole shoes spread flux uniformly.

(iii) Field winding :-
(1) It is made of copper
(2) Field winding (or) field coils are wound on each pole.
(3) They are wound in such a way that they form alternate north and south poles.

(iv) Armature Core :-
(1) It is a Rotor of a DC machine.
(2) It is cylindrical in shape with slots to carry armature winding.
(3) Armature is connected to ~~shock~~ slots

(v) Armature winding :-
(1) It is made of copper
(2) It is wound in armature slots
(3) Armature conductor (or) insulated with each other
(4) Armature winding can be done either by lap winding (or) wave winding

Commutator and Brushes:-

(ii) Commutator

(1) It converts Ac into DC in a dc generator.

(2) The AC generated in the armature winding gets converted to DC after it passes through commutator and brushes

(3) The brushes are made of carbon (or) graphite.

E.M.F Equation of a D.C. Generator

let ϕ = flux per pole (wb)

P = no. of poles = 2.

N = speed of the armature (r.p.m) revolution per minute.

Z = Total No. of armature conductors.

= no. of slots ~~x~~ no. of conductor.

(~~= 16 x 32~~ = 512)

A = no. of parallel paths in armature.

E = Induced emf in armature conductors (volts)

Total flux produced by all the poles = $P \times \phi$.

Time taken to complete one revalution = $\frac{60}{N}$

According faraday's 2nd law

induced emf of one conductor.

$$e = \frac{d\phi}{dt} = \frac{\text{Total flux}}{\text{time taken}} = \frac{P\phi}{\frac{60}{N}}$$

$$\boxed{e = \frac{\phi P N}{60}}$$

Induced emf of DC Generator

E = emf of one conductor x no. of conductors.

connected in series

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

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

* Lap winding

$A = P$

* wave winding

$A = 2$

Problem 1: A 4 pole generator, having wave wound armature winding has 51 slots, each slot containing 20 conductors. What will be the voltage generated in the machine when driven at 1500 rpm assuming the flux per pole is 7 mWb?

Solution

$P = 4$

wave winding $A = 2$

51 slots,

$\phi = 7 \text{ mWb}$

$= 7 \times 10^{-3}$

$Z = 51 \times 20$

$= 1020$

$N = 1500 \text{ rpm}$

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

$$E = \frac{7 \times 10^{-3} \times 1020 \times 4 \times 1500}{120} = \cancel{178.5 \text{ V}}$$

$= \cancel{178.5 \text{ V}}$ 357 V

Problem 2: An 8-pole DC generator, has 500 armature conductors and a useful flux of 0.05 Wb per pole. What will be the emf generated if it is lap winding and runs at 1200 rpm? What must be the speed at which it is driven to produce the same emf if it is wave winding.

Solution

$P = 8$

$N = 1200$

$Z = 500$ $\phi = 0.05$

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

$$= \frac{0.05 \times 500 \times 1200 \times 8}{60 \times 8}$$

$$\boxed{E = 500V}$$

$$E = \frac{\phi Z n P}{60 A}$$

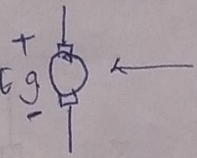
$$N = \frac{60 E A}{\phi Z P}$$

$$N = \frac{60 \times 2 \times 500}{0.05 \times 500 \times 8}$$

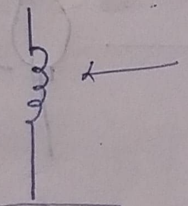
$$= 300 \text{ rmp}$$

Basic essential parts of DC g/r

1) Armature →

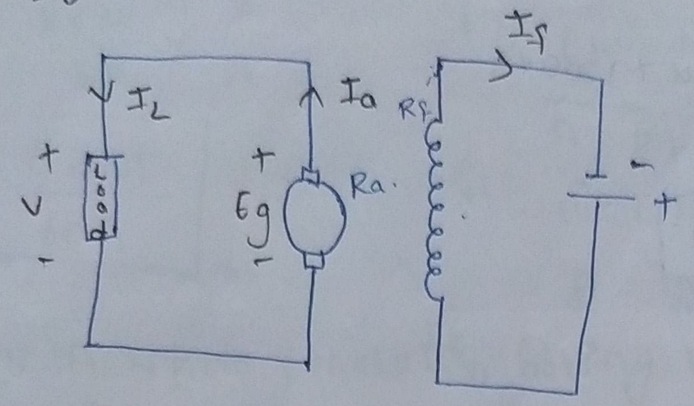


2) field winding —



DC g/r
- Separately excited DC generator
- self excited DC generator
  - Series DC generator
  - Shunt DC generator
  - Compound DC generator
    - Short Shunt Compound DC g/r.
    - Long shunt Compound DC g/r

Separately Excited DC Generator



(i) I_a = Armature current

I_L = Load current

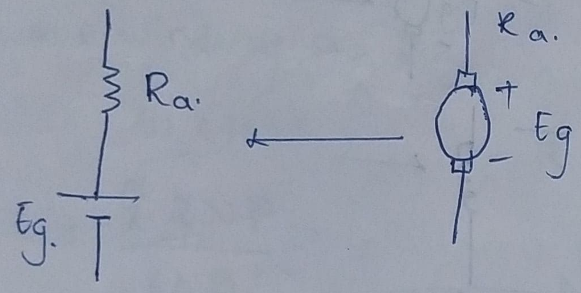
V = Terminal voltage.

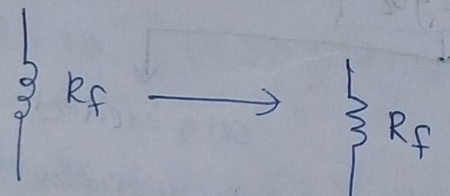
E_g = Generated EMF

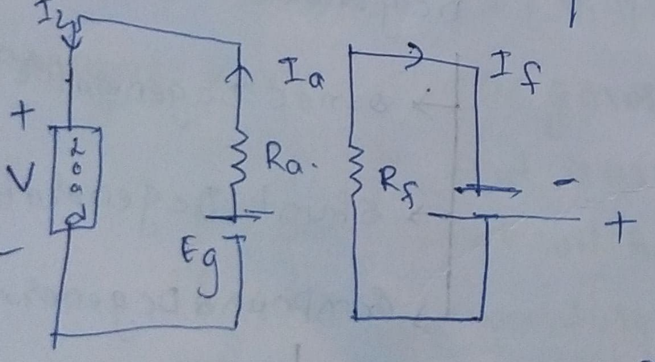
R_a = Armature resistance

R_f = field resistance

I_f = field current







$I_a = I_L$

P = voltage × current

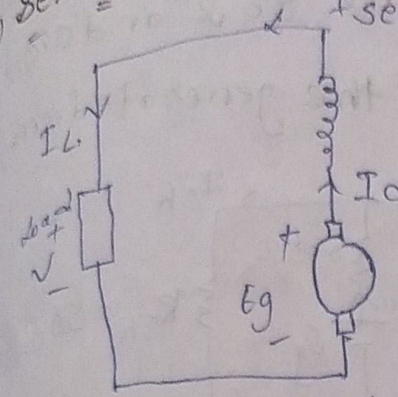
$\boxed{P = VI_L}$

power observed

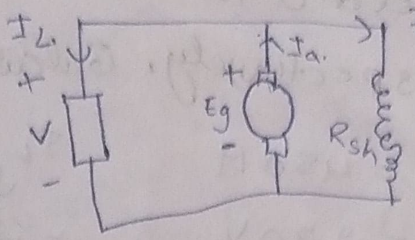
$\boxed{P_{delivered} = E_g \times I_a}$

Self Excited DC Generator

(1) Series DC Generator

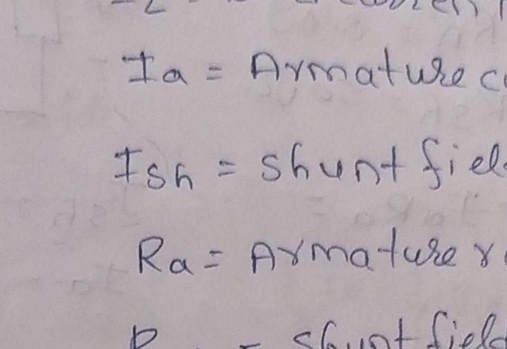


(2) Shunt DC Generator



I_L = Load current
I_a = Armature current
I_{sh} = shunt field current
R_a = Armature resistance
R_{sh} = shunt field resistance
V = Terminal voltage
E_g = Generated EMF

R_{se} = series field winding resistance
I_{se} = field current
I_a = Armature current
R_a = Armature resistance
V = Terminal voltage
E_g = Generated EMF
I_L = Load current



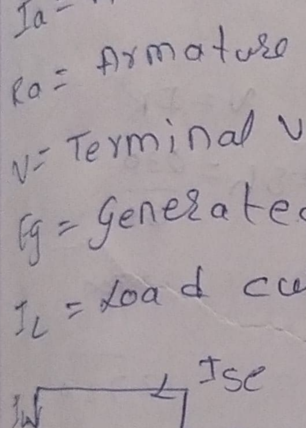
$$-E_g + I_a R_a + V = 0$$

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

According to KCL

$$\boxed{I_a = I_L + I_{sh}}$$

$$P_g = E_g I_a$$
$$P_L = V \times I_L$$



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

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

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

$$\boxed{\begin{aligned} P_h &= E_g \times I_a \\ P_L &= V \times I_L \end{aligned}}$$

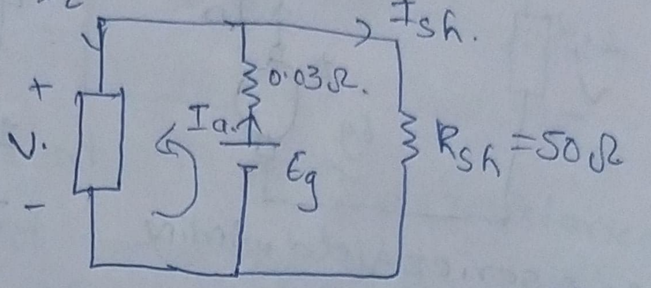
Eg: A shunt Generator delivers 450 Amp at 230 volts and the resistance of the shunt field and armature are 50 Ω and 0.03 Ω respectively. Calculate the generated emf

Sol:- $I_L = 450A$

$V = 230V$

$R_A = 0.03$

$R_{sh} = 50\Omega$



$V = IR$

~~$V + I_a R_a =$~~

~~$I_{sh} = 4.6$~~

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

$-E_g + (I_a \times 0.03) + 230 E_g = 0$

$E_g = [0.03 I_a \times 230)$

$V = IR$

$I_a = I_L + I_{sh}$

$I_{sh} = \frac{230}{50}$

$= 450 + \frac{230}{50}$

22500

$= 454.6$

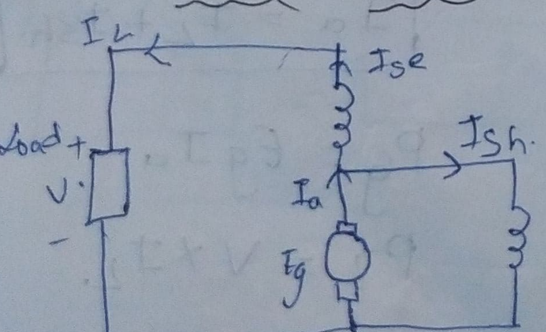
22730

$E_g = 0.03 \times 454.6 \cancel{\times} 230$

$= 243.6$ V.

Compound D/c Generator : combination of series & shunt oc gln

(1) Short Shunt D/c Generator



V = Terminal voltage

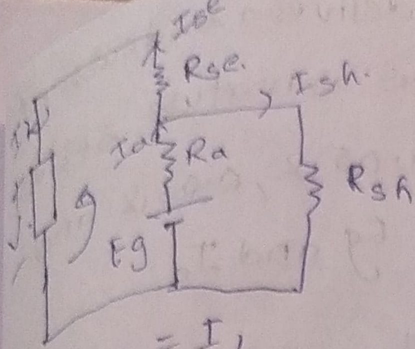
I_L = Load current

I_{sh} = Shunt field wedg curr

I_{se} = seriesfieldcurr

E_g = genera emf

I_a = Arma current



R_{se} = series field resis

R_{sh} = shunt field resis

R_a = armature resis.

$I_{sc} = I_L$

$I_a = I_{se} + I_{sh}$

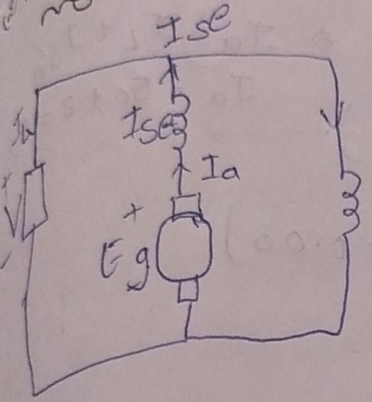
$-E_g + I_a R_a + I_{se} R_{se} + V = 0$

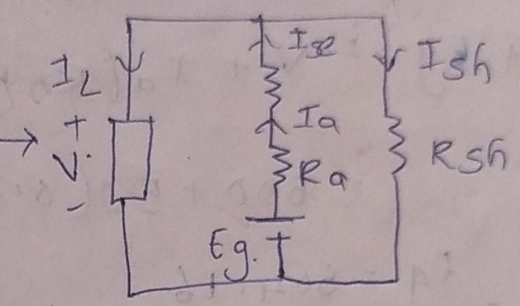
$P_g = E_g \times I_a$

$V = E_g - (I_a R_a + I_{se} R_{se})$

$P_{obs} = V \times I_L$

Long Shunt D/c Generator.





E_g = generated emf

I_{se} = series field

I_{sh} = shunt field

R_a = armature resistance

I_L = load current

V = internal valtage

$I_a = I_{se}$

$I_a = I_L + I_{sh}$

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

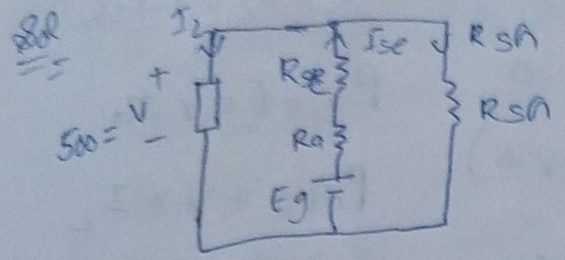
$V = E_g - I_a(R_a + R_{se})$

$P_g = E_g I_a$

$P_L = V I_L$

Eg :- Long shunt Compound dc g/r delivers a load current of 50A at 500V and has armature, series & shunt field resis of 0.05 Ω, 0.03 Ω and 250 Ω respec. Calculate Eg and Ia.

Sol



$I_L = 50A$

$V = 500$

$R_a = 0.05$

$R_{se} = 0.03$

$R_{sh} = 250 Ω$

$I_a = 52A$ $\quad I_{sh} = \frac{500}{250} = 2A \Rightarrow I_a = I_L + I_{sh}$

$I_a = 50 + 2 = 52$

$E_g = V + I_a(R_a + R_{se})$

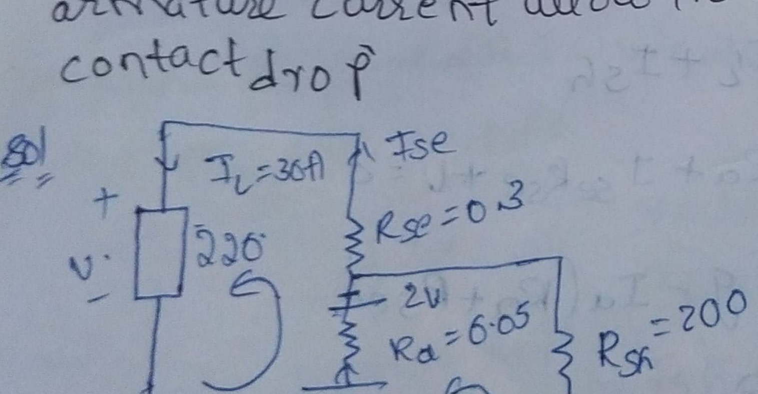
$= 500 + 52(0.05 + 0.03)$

$E_g = 504.16$

Eg 2: A short shunt DC g/r delivers a load current of 30A at 220V, and has armature, series field, shunt field resistance of 0.05 Ω, 0.3 Ω and 200 Ω respec. Calculate the induced emf and armature current allow 1.0V for brush for contact drop

$I_{se} = I_L$

Sol



Apply mesh for loop

$-E_g + I_a R_a + 2 + I_L R_{se} + 220 = 0$

$-E_g + 0.05 I_a + 2 + 9 + 220 = 0$

$-E_g + 0.05 I_a = -231$ — (1)

Apply mech for loop 2

$-E_g + 0.05 I_a + 2 + 200 I_{sh} = 0$

$-E_g + 0.05 I_a + 200 I_{sh} = -2$

$I_a = I_{sh} + I_L$

$I_a = I_{sh} + 30$

$I_{sh} = I_a - 30$

$-E_g + 0.05 I_a + 200(I_a - 30) = -2$ — ②

solve Eq ① & ②

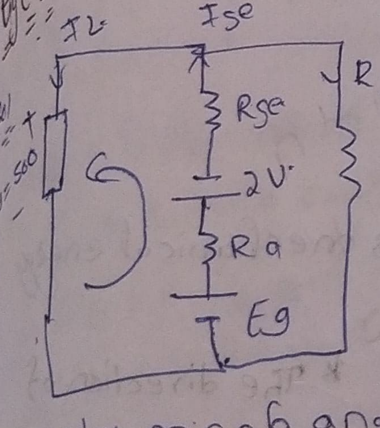
we get $I_a = 31.145$

from Eq ①

$-E_g = -231 - 1.555$

$$\boxed{E_g = 232.55}$$

Eg(1): Same -- Allow 1V per brush for contact drop



$I_L = 50\,A$, $V = 500$

$R_a = 0.05$, $R_{se} = 0.03$

$R_{sh} = 250\,\Omega$

$I_{sh} = \frac{500}{250} = 2A$

$I_a = I_L + I_{sh}$

$= 50 + 2 = 52\,A$

Apply mech analysis

$-E_g + I_a(R_a + R_{se}) + 2 + 500 = 0$

$-E_g + 52(0.05 + 0.03) = -502$

$-E_g = -502 - \cancel{2.6}\ -1.56$

$-E_g = -506.16$

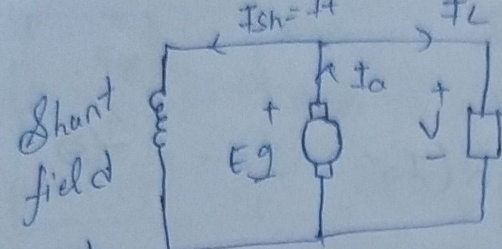
$E_g = 506.16\ V.$

Magnitization characteristics of Dc Shunt Generator (or).

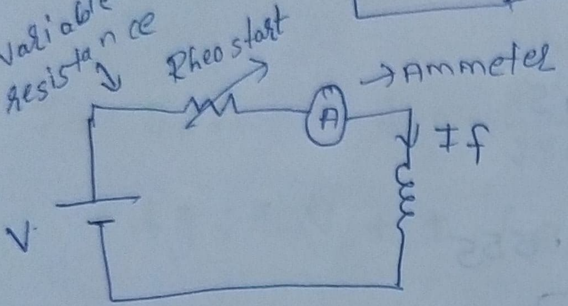
No-load characteristics of Dc Shunt Generator :-

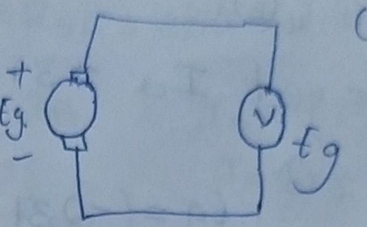
(or)

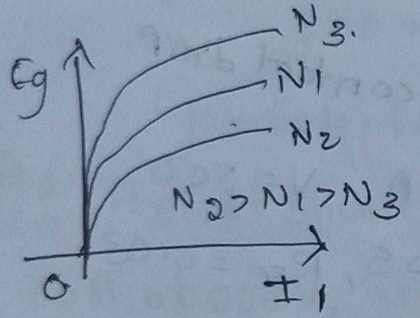
Open Circuit characteristics of Dc Shunt Generator:-



{Take Rheostart value Read current in I_f (Ammeter) and Read voltage in E_g (voltmeter)







$I_{f_1} = E_{g_1}$

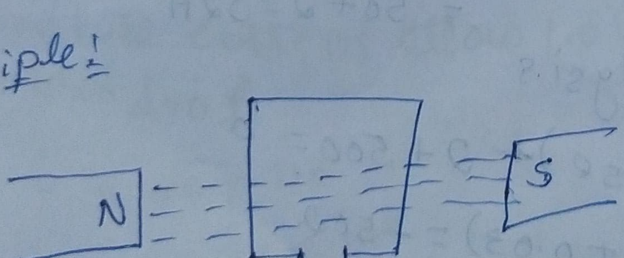
$I_{f_2} = E_{g_2}$

- - - - - -

Dc Motor principle:-

It Converts electrical energy into mechanical energy

principle:-



* The direction of rotation is followed by flemming left hand rule

Thumb → force direction

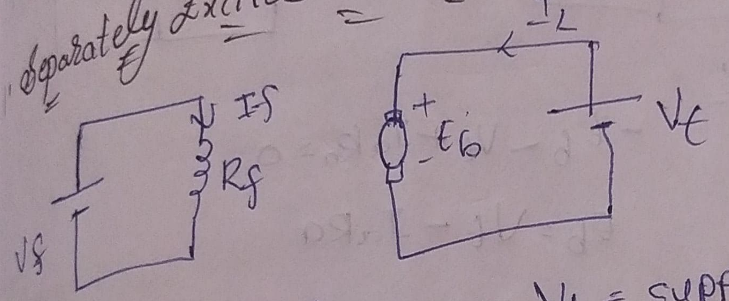
fore → field direction

Middle → direction of current

Classification of Dc Motor:

- Separately excited Dc motor
- Self-excited Dc Motor
  - Dc Series
  - Dc shunt
  - Dc Compound
    - Short shunt
    - Compound motor long shunt DC
    - Compound motor

Separately Excited Dc Motor:



V_t = supply voltage

I_f = field current

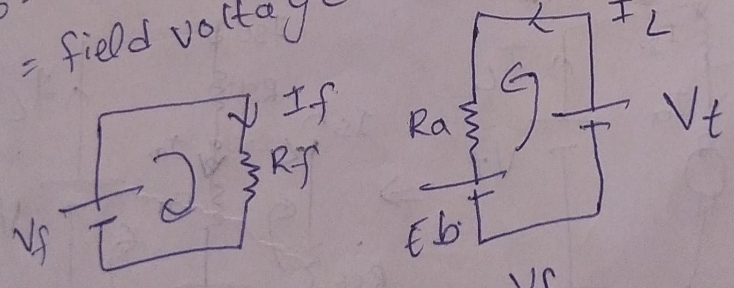
I_L = supply current

R_a = Armature Resistance

R_f = field resistance

E_b = back emf

V_f = field voltage

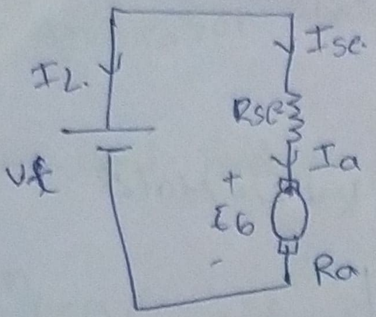


$$-V_f + I_f R_f = 0 \Rightarrow I_f = \frac{V_f}{R_f}$$

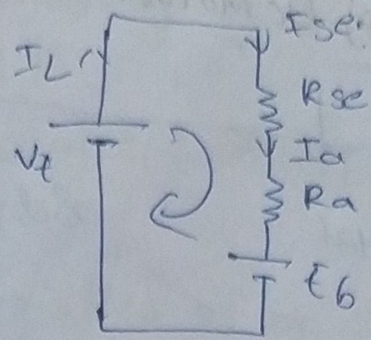
$$-V_t + I_L R_a + E_b = 0$$

$$E_b = V_t - I_L R_a$$

Dc Series Motor



⇒

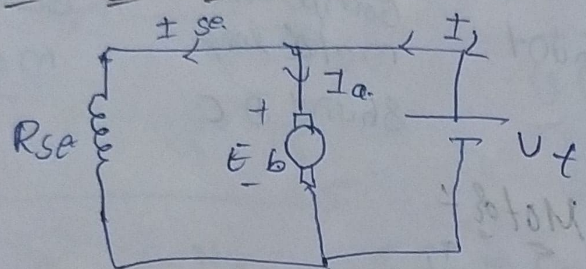


$$\therefore I_L = I_{se} = I_a$$

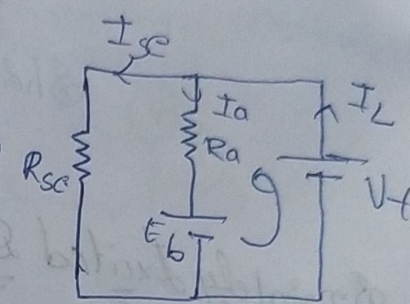
$$-V_t + I_a R_{se} + I_a R_a + E_b = 0$$

$$E_b = V_t - I_a(R_a + R_{se})$$

Dc Shunt Motor:



⇒



Apply KVL:

$$-E_b - V_t + I_a R_a = 0$$

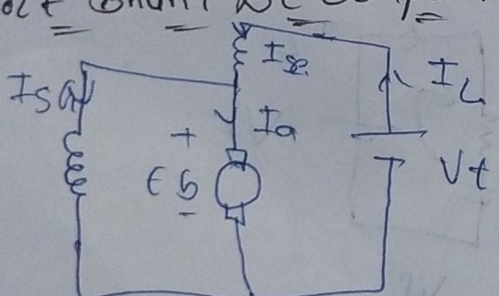
$$E_b = V_t - I_a R_a$$

Apply KCL:

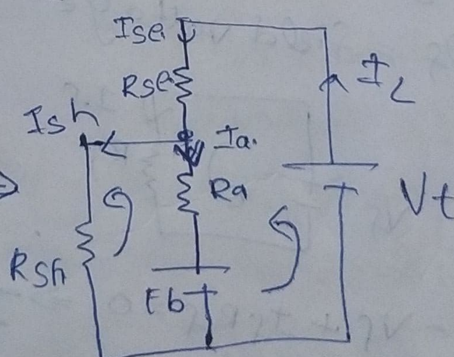
$$I_{se} = \frac{V_t}{R_{se}}$$

Dc Compound motor:

Short Shunt Dc Compound motor:



⇒



Apply KVL:

$$-V_t + I_{se}R_{se} + I_a R_a + E_b = 0$$

$$E_b = V_t - I_{se}R_{se} - I_a R_a$$

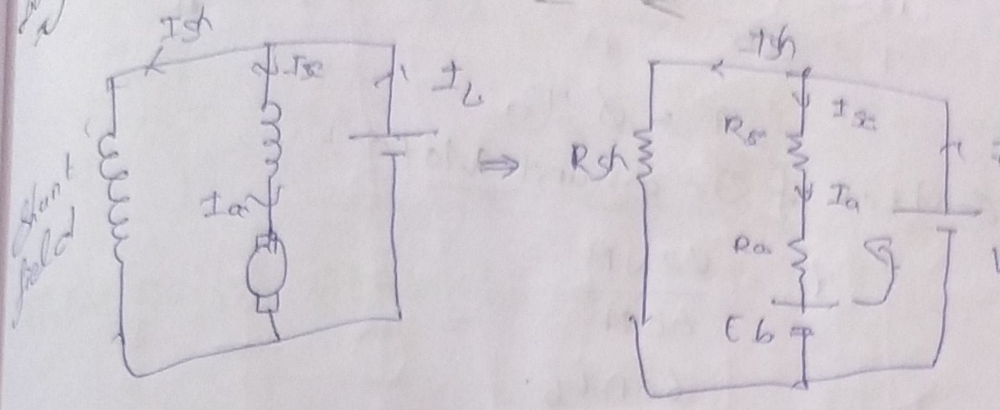
KVL:

$$-E_b - I_a R_a + I_{sh} R_{sh} = 0$$

$$I_{sh} = \frac{E_b + I_a R_a}{R_{sh}}$$

Apply KCL: $I_{se} = I_a + I_{sh}$

Long Shunt D.C Compound motor:



$I_{se} = I_a.$

$I_L = I_{sh} + I_{se}$

Apply KVL: $-E_b - V_t + I_a R_{se} + I_a R_a = 0$

$E_b = V_t - I_a(R_{se} + R_a)$

$\therefore I_{sh} = \frac{V_t}{R_{sh}}$

Torque equation:-

power developed by armature $P_a = E_b \times I_a.$

(or)

input power.

Mechanical power $= T \times \omega$ → angular velocity

(or) Torque

output power $= T \times \frac{2\pi N}{60}$

Assume losses in motor = 0

$P_{in} = P_{out} - \text{losses}$

$E_b I_a = T \times \frac{2\pi N}{60}$

$\left(\frac{\phi Z N P}{60 A}\right) I_a = T \times \frac{2\pi N}{60}$

$$\frac{\phi Z P I_a}{A} = 2\pi T$$

$$T = \frac{1}{2\pi} \frac{\phi Z P I_a}{A} = 0.159 \frac{\phi Z P I_a}{A}$$

$$\therefore T \propto \phi I_a$$

Speed Control of DC Shunt Motor:

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

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

Assume A, Z, P are constant

case (i):

$$\uparrow N \propto \frac{E_b}{\phi} \uparrow$$

[By variaing E_b &
ϕ = constant]

This method is called armature valtege control method.

case (ii)

$$\uparrow N \propto \frac{E_b}{\phi} \downarrow$$

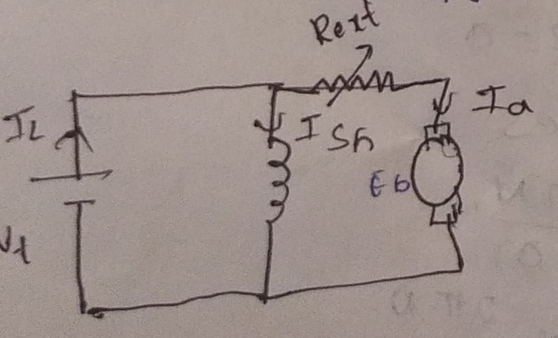
[E_b = constant &
ϕ = varying]

Method is called flux (or) field control method

Armature Voltage Control method

$$N \propto \frac{E_b}{\phi = \text{constant}}$$

$$\therefore \uparrow N \propto \uparrow E_b$$

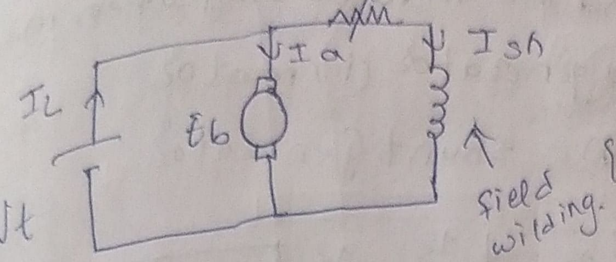


By varying Rext
↓
$I_a \rightarrow E_b$
↓
N

* Metho dalso called below rated speed control method

Flux (or) field Control method:

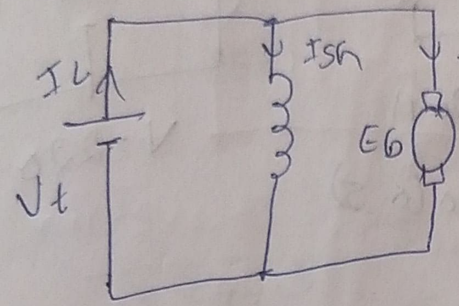
$$N \propto \frac{E_b = \text{constant}}{\uparrow \phi}$$



$\{\phi\}$

R_{ext}
↓
I_{sh}
↓
$\phi \rightarrow N.$

Three point starter



$$V_t = E_b + I_a R_a.$$

$$I_a = \frac{V_t - E_b}{R_a} \quad \text{--- (1)}$$

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

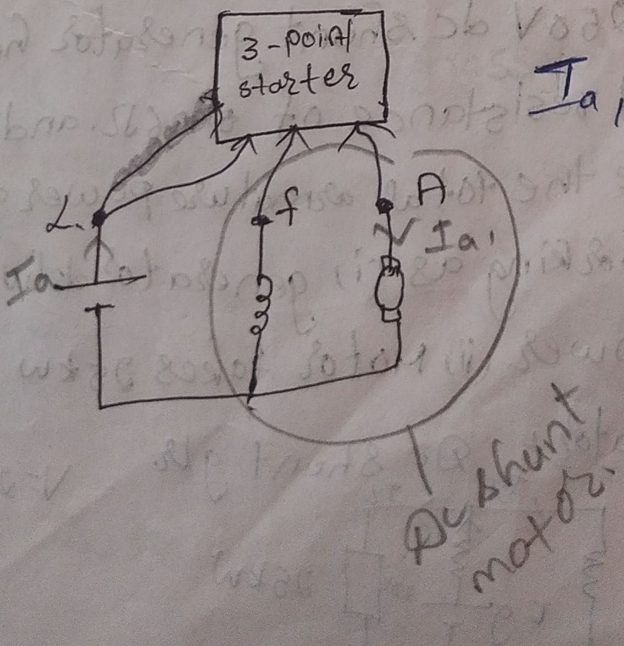
At starting, $N = 0 \rightarrow E_b = 0\,V.$

from (1) $I_a = \frac{V_t}{R_a}$ $[\because V_t = 220]$

$[\because R_a \leq 1\Omega]$.

$$I_a = \frac{220}{1} = 220\,A$$

* using three point starter we will overcome the problem [we will limiat the starting current]

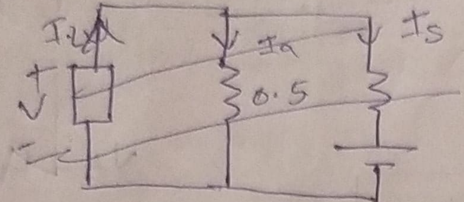


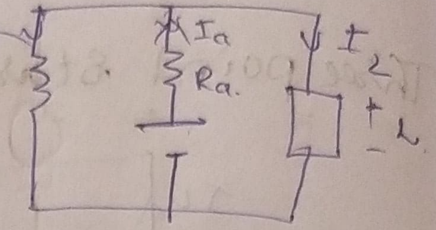
$$I_{a_1} = \frac{V_t - E_b}{R_a + R_1 + R_2 + R_3 + R_4 + R_5}$$

Problem: A 220V dc machine has an armature resistance 0.5 Ω. If the full load armature current is 20 A, find the induced emf when machine acts as (i) generator (ii) motor.

Sol

(i) Generator :- DC Shunt Generator.



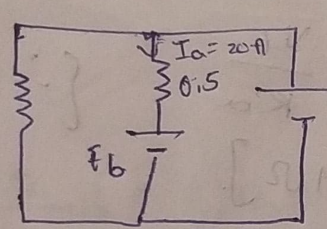


$R_a = 0.5$, $I_a = 20\,A$ $\qquad V = 220$

$$E_g = 220 + 20(0.5)$$

$$= 230V$$

(ii) Motor: DC shunt Motor



$V = 220\,V$

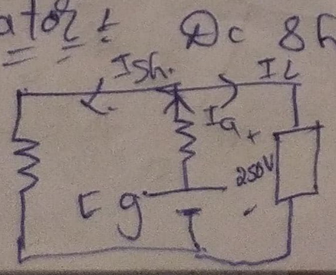
$$E_b = V_t - I_a R_a$$

$$= 220 - 20(0.5)$$

$$E_b = 210\,V$$

(2) A 25kW, 250V dc shunt generator has armature and field resistance of 0.06 Ω and 100 Ω respec. Determine the total armature power developed by when working as (i) generator delivering 25 kW output power. (ii) Motor takes 25 kW I/p power

Sol (i) Generator: Dc Shunt glr. $\qquad V = 250\,V$



25 kW

$P_0 = E_g \times I_a$

$= 256.15 \times 102.5$

$= 26.25\,KW$

$E_g = V + I_a R_a$

$= 250 + (102.5)(0.06)$

$= 256.15V$

power $= V \times I$

$25 \times 10^3 = 250 \times I_L$

$I_L = 100A$

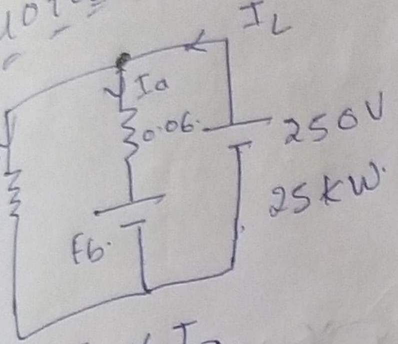
$V = IR$

$I_{sh} = \frac{250}{100} = 2.5A$

$I_a = I_{sh} + I_L$

$= 100 + 2.5 = 102.5A$

Motor!



$P = V \times I$

$I_L = 100A$

$I_{sh} = \frac{250}{100} = 2.5A$

$I_L = I_{sh} + I_a$

$I_a = 100 - 2.5 = 97.5$

$P_0 = E_b \times I_a$

$= 244.15 \times 97.5$

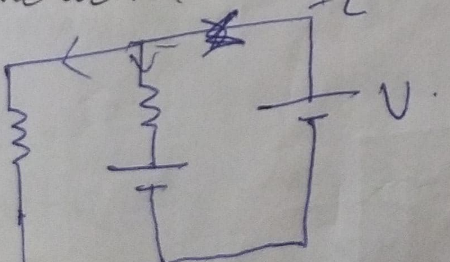
$= 23.8\,kW$

$E_b = V_t - I_a R_a$

$= 250 - 97.5 \times 0.06$

$= 244.15$

3) A DC Motor takes an armature current of 110A at 480 volts. The armature resistance is 0.2Ω. The machine has 6 poles and armature is lap connected with 864 conductor. $\phi = 0.05wb$ Calculate (i) speed, (ii) gross torque developed by the armature



$I_a = 110A$

$V = 480$

$R_a = 0.2\Omega$

$P = 6,\ Z = 864$

$\phi = 0.05wb$

Lap $A = P = 6$.

(i) speed N:

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

$$E_b = V - I_a R_a$$

$$= -(110 \times 0.2) + 480$$

$$= 458 V.$$

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

$$N = \frac{60 \times 6 \times 458}{0.05 \times 864 \times 6}$$

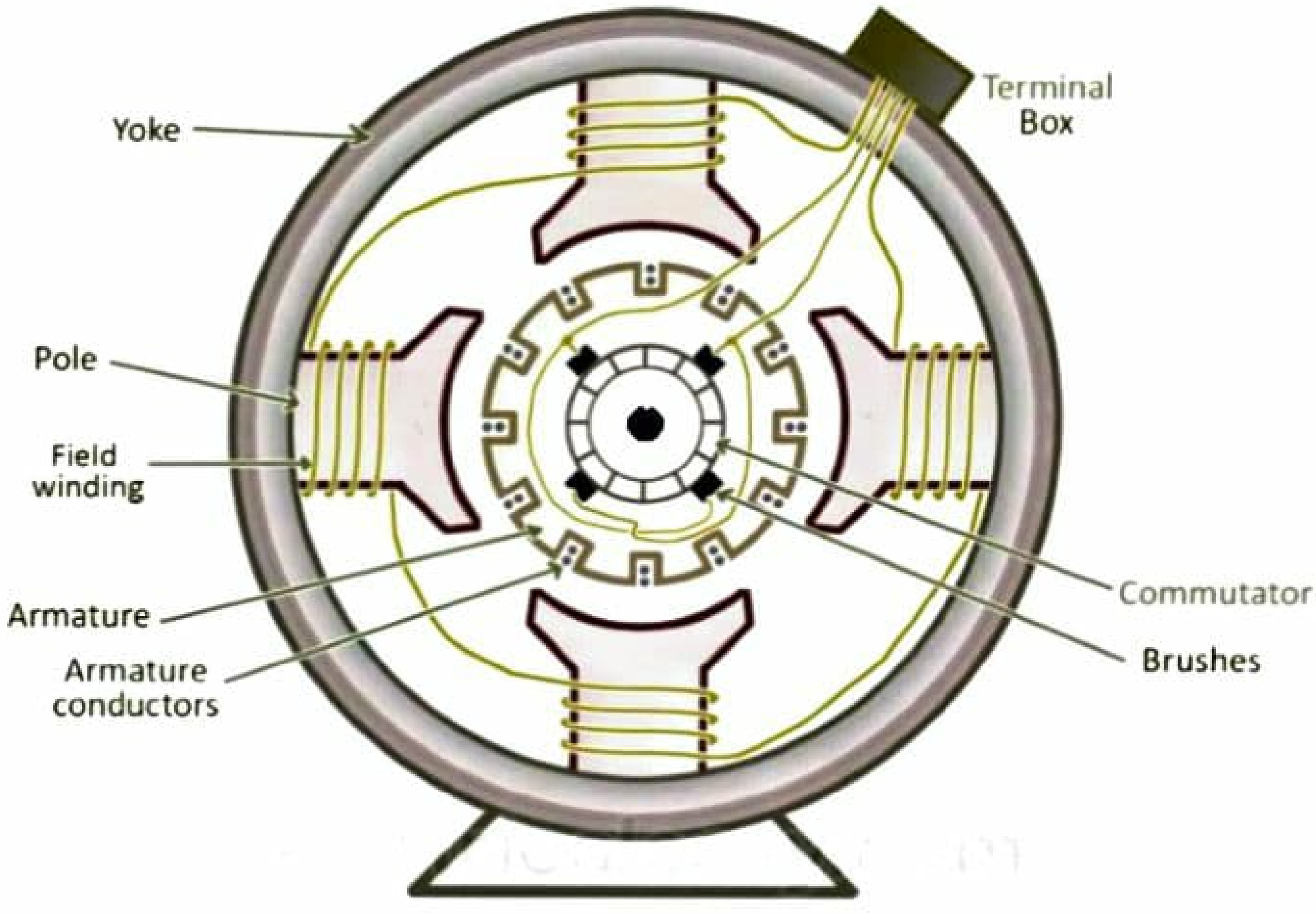
$$= 636 \text{ rpm}$$

(ii) Torque $= 0.159 \frac{\phi Z P I_a}{A}$

$$= 0.159 \times \frac{0.05 \times 864 \times 6 \times 110}{6}$$

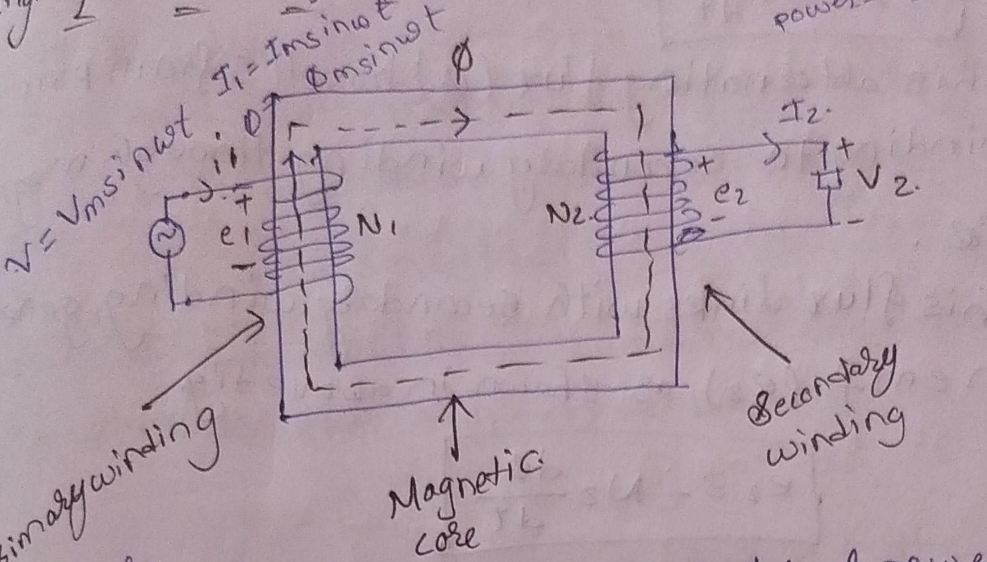
$$= 756.3 \text{ N-m}$$

construction of a DC machine instead of just 'construction of a dc generator'.



UNIT-5

1) Single phase Transformer



Transformer

1) It is a static device which transfers electrical power/energy from one electrical circuit to another electrical circuit with same frequency.

static device - It doesn't have any rotating parts

$$e_1 = -N_1 \frac{d\phi}{dt} \qquad e_2 = -N_2 \frac{d\phi}{dt}$$

2) A single phase [1-ϕ] transformer works on the faraday's law of electromagnetic induction.

3) 1-ϕ transformer consists of two windings, wounded on magnetic core.

4) The two windings are primary and secondary winding

5) The AC source. ($v = V_m \sin\omega t$) supplies current to primary winding as shown in above fig: $i = I_m \sin\omega t$

6) This current produces magnetic flux in the magnetic core i.e; $\phi = \phi_m \sin\omega t$.

7) The direction of magnetic flux can be determined using right hand thumb rule.

8) According to faraday first law, an emf (e_1)

generates across primary winding due to changing magnetic flux.

$$\boxed{e_1 = -N_1 \frac{d\phi}{dt}} \quad \text{--- (1)}$$

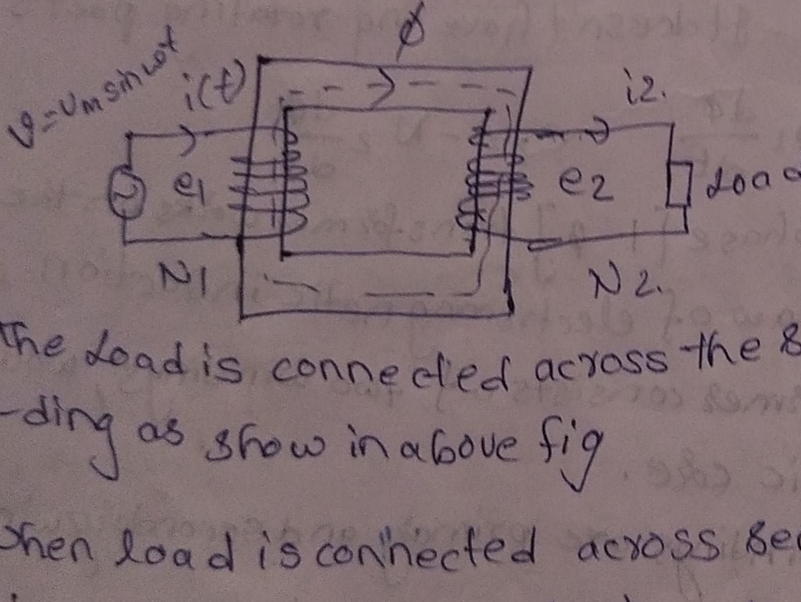
(9) This alternating flux (ϕ) travells from primary winding to secondary winding through magnetic core.

(10) This flux links with secondary winding, generates an emf (e_2) as shown in above fig.

$$\boxed{e_2 = -N_2 \frac{d\phi}{dt}}$$

(11) According to faradays second law we will get

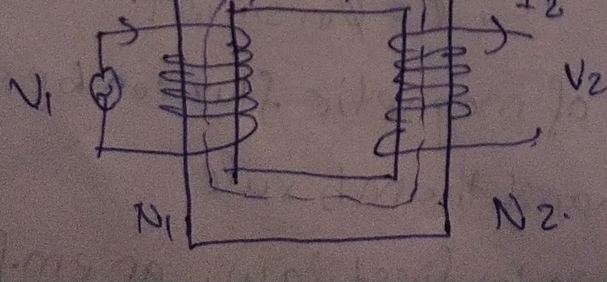
$$e_2 = -N_1 \frac{d\phi}{dt} \quad \text{--- (2)}$$



(12) The load is connected across the secondary win-ding as show in above fig

(13) When load is connected across secondary winding, it carries a current (i_2), called load current

EMf Equation of a Single phase Transformer



The single phase transformer is shown in above fig.
Consider an alternating voltage (V_1) of frequency (f) is applied to the primary winding

$$V_1 = V_m \sin \omega t \quad \text{—— (1)}$$

Due to this alternating voltage current I_1 will flow in the primary winding.

$$I_1 = I_m \sin \omega t \quad \text{—— (2)}$$

According to right hand thumb rule the direction of flux is shown in above fig.

$$\phi = \phi_m \sin \omega t \quad \text{—— (3)}$$

The instantaneous emf e_1 induced in the primary winding is.

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

from (3)

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

$$e_1 = -N_1 \phi_m \omega \cos \omega t \quad \{\omega = 2\pi f\}$$

$$\left[\begin{matrix} -\cos \omega t \\ \sin(\omega t - 90^\circ) \end{matrix}\right] \quad e_1 = -N_1 \phi_m 2\pi f \cos \omega t$$

$$\boxed{e_1 = 2\pi f N_1 \phi_m \sin(\omega t - 90^\circ).} \quad \text{—— (4)}$$

from (4) the maximum value of e_1

$$E_{m1} = 2\pi f N_1 \phi_m \quad \text{—— (5)}$$

The rms value of E_{m1} is.

$$E_1 = \frac{E_{m1}}{\sqrt{2}} = \frac{2\pi f N_1 \phi_m}{\sqrt{2}} \qquad E_{rms} = \frac{E_{max}}{\sqrt{2}}$$

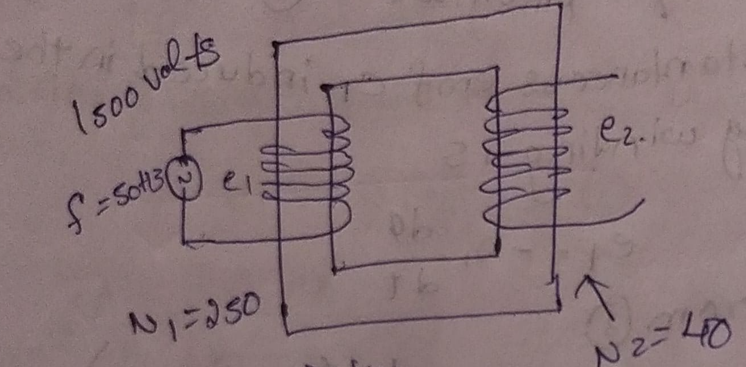
$$E_1 = 4.44 f N_1 \phi_m \quad \text{—— (6)}$$

ϕ_m = mass (or) peak flux. ; f = frequency
N_1 = primary turns

$Ily, \; E_2 = 4.44 f N_2 \phi_m$ — (7)

Eg: A 25kVA, single phase transformer has 250 turns on the primary and 40 turns on the secondary winding. The primary is connected to 1500 volts, 50 Hz mains. Calculate (i) primary & secondary currents on full load (ii) secondary emf (iii) max flux in the core.

Sol



25kVa, rating

(i) $I_1 = \frac{25 \times 10^3}{1500} = 16.67 A$

$\boxed{\frac{I_2}{I_1} = \frac{V_1}{V_2} = \frac{E_1}{E_2}} = \frac{N_1}{N_2}$

(ii) $\frac{I_2}{I_1} = \frac{N_1}{N_2} \Rightarrow \frac{I_2}{16.67} = \frac{250}{40}$

$I_2 = 104.1 A$

(iii) $\frac{E_1}{E_2} = \frac{N_1}{N_2}$ $\quad \frac{1500}{E_2} = \frac{250}{40}$ $\quad \{E_1 = 1500\}$

$E_2 = 240$

(iv) we know that $E_1 = 4.44 f N_1 \phi_m$

$1500 = 4.44 \times 50 \times 250 \times \phi_m$

$\phi_m = 0.027 \Rightarrow 27 mWb$

Transformation Ratio's

Voltage transformation ratio :- It can be defined as the ratio of the secondary voltage to the primary voltage.

It is denoted by 'K'

$$K = \frac{\text{secondary voltage}}{\text{primary voltage}}$$

$$= \frac{V_2}{V_1} = \frac{E_2}{E_1} = \frac{N_2\,\cancel{4.44 f \phi_m}}{N_1\,\cancel{4.44 f \phi_m}}$$

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

Current transformation ratio :-

for ideal transformer input volt ampere = o/p volt ampere.

$$V_1 I_1 = V_2 I_2.$$

$$\frac{I_1}{I_2} = \frac{V_2}{V_1} = k$$

$$\boxed{k = \frac{I_1}{I_2} = \frac{V_2}{V_1} = \frac{E_2}{E_1} = \frac{N_2}{N_1}}$$

Efficiency of 1-ϕ :- It is the ratio of o/p power to the I/p power of a 1-ϕ transformer.

$$\therefore \text{Efficiency } (\eta) = \frac{\text{o/p power}}{\text{I/p power}}$$

$$\boxed{\eta = \frac{\text{o/p power}}{\text{o/p power + losses}}}$$

Voltage Regulation: The voltage regulation of a 1-Ø transformer is defined as the ratio of change in secondary terminal voltage b/w no-load and full load to full load to terminal voltage.

$$\text{Voltage Regulation} = \frac{\text{no load voltage} - \text{full load voltage}}{\text{full load voltage}}$$

$$= \frac{V_0 - V_{FL}}{V_{FL}}$$

Types of losses in Transformer:

Iron (or) Core Losses (magnetic core)

Copper losses (winding)

Iron Losses:

(1) The Iron (or) core losses occur through the alternating flux with in the transformer magnetic core.

(2) This kind of losses mainly depends on the material of the magnetic core

(3) This type of losses can be categorized into two types (1) Hysteries loses:

$$\boxed{P_h = K_h f B_m^x V} \quad \text{—} (1)$$

where K_h = constant that depends on the quality and volume of the magnetic material.

f → frequency

Bm = Highest fluxdensity.

v = volume of the magnetic core

x = constant = 1.5 to 2.5

2) Eddy Current losses:

1) The circulating current in the magnetic core is called eddy current losses.

2) It is denoted by T_E

$$T_E = K_E B_m f V.$$

where, K_E = constant that depends on quality and volume of the material.

Bm = max flux density

f = frequency

V = volume of the magnetic core.

Copper losses:

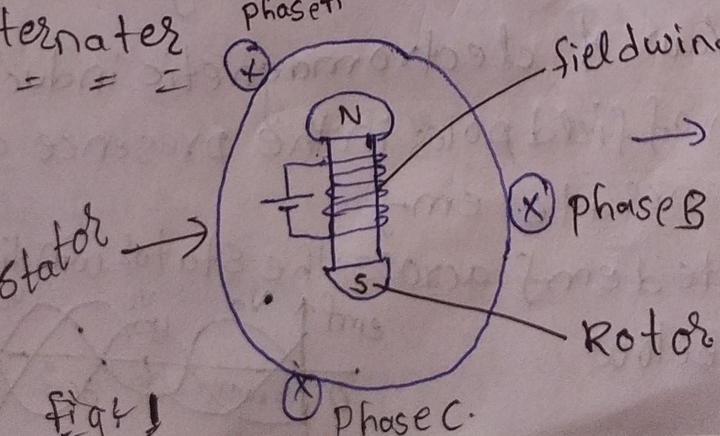
1) Copper losses due to resistance in primary and secondary winding.

2) It is denoted by P_{cu}. { power loss $P = I^2 R$ }

$$\therefore P_{cu} = I_1^2 R_1 + I_2^2 R_2.$$

4 Principle and Operation of 3-ϕ Synchronous Generator

(or) Alternater



→ 2 pole synchronous generator

fig 1

(1) An electrical generator can be defined as.
electrical machine, changes the ~~electrical~~ mechanical energy into ~~mechanical~~ electrical energy

(2) An electrical generator typically consists of two parts (1) Stator (2) Rotor

(3) The rotating and stationary parts of an electrical machince can be called as rotor and stator respectively.

(4) The Rotor part consisting of fieldwinding (or) field poles

(5) Stator part consisting of armature conductors (phase A, phase B and phase C).

(6) Stator winding are physically 120° apart

(7) The rotor part is magnetically coupled with turbine with the help of shock

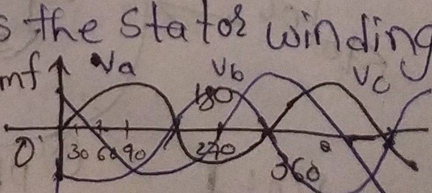
(8) The speed of field poles is synchronous speed and is given by $N_S = \frac{120f}{P}$

where, f = frequency $\quad$ $[f = 50\,Hz$
P = No. of poles $\quad$ $P = 2]$.

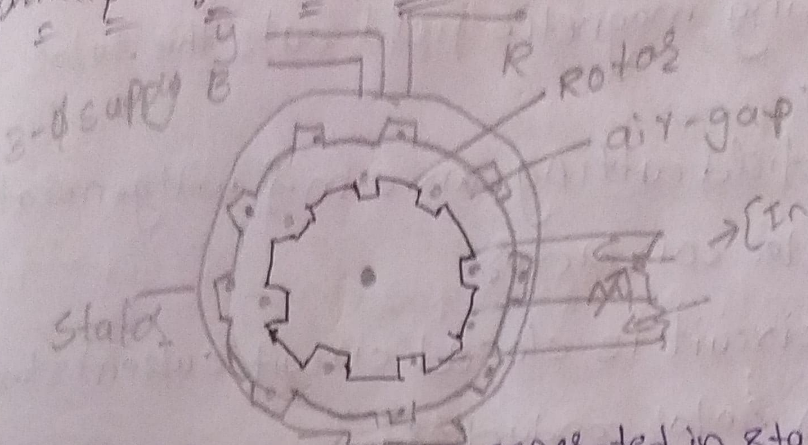
(9) The principle of operation of synchronous generator is faradays law of electromagnetic induction.

(10) The rotation of field poles in the presence armature conductor generate emf

(11) The Generated emf across the Stator winding is as shown in below



principle of Operation of 3-Phase Induction Motor:-



(12) The E.M.f (or) voltage generated in stator winding are 120° apart in time

(13) Types of rotor are.
(1) Salient pole rotor
(2) Cylindrical rotor.

3ϕ Induction Motor

(1) An electrical motor is an electro mechanical device that converts electrical energy into mechanical energy.
(2) The mostly used motor is a 3-ϕ Induction motor
(3) A 3-ϕ induction motor is having 2-major parts
(1) Stator (2) Rotor
(4) The stator of 3-ϕ Induction motor is having No-of slots to construct a 3-ϕ winding
(5) This 3-ϕ winding is connected to the 3-ϕ supply.
(6) The rotor of 3-ϕ induction motor is having cylindrical cone with slots that carriers an conductors
(7) The conductors are made of copper (or) aluminium bars fitted in each slot.
(8) when 3-ϕ stator winding is energised from the 3-ϕ supply, a rotating magnetic field is generated

across the stator winding

(9) This rotating magnetic field cuts the rotor conductor.

(10) Due this field cutting an e.m.f will generate in the rotor conductor.

(11) As rotor circuit is closed circuit current starts flowing in rotor conductors.

(12) According to Lorentz ~~pri~~ force principle, current carrying conductor in a magnetic field experience a force

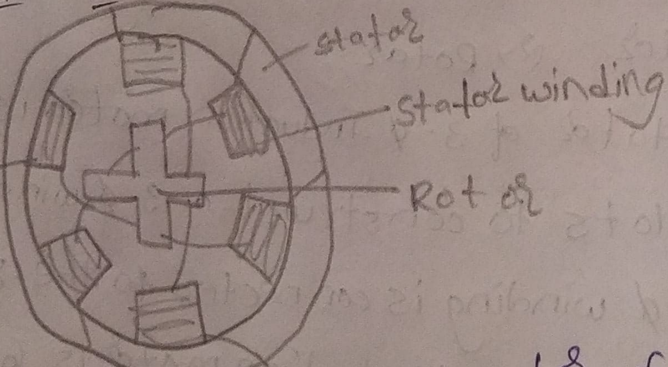
(13) Due to this force the rotor starts rotating in the field direction.

(14) Types of induction motors are.

(1) Squirrel cage I.M

(2) Slipring I.M.

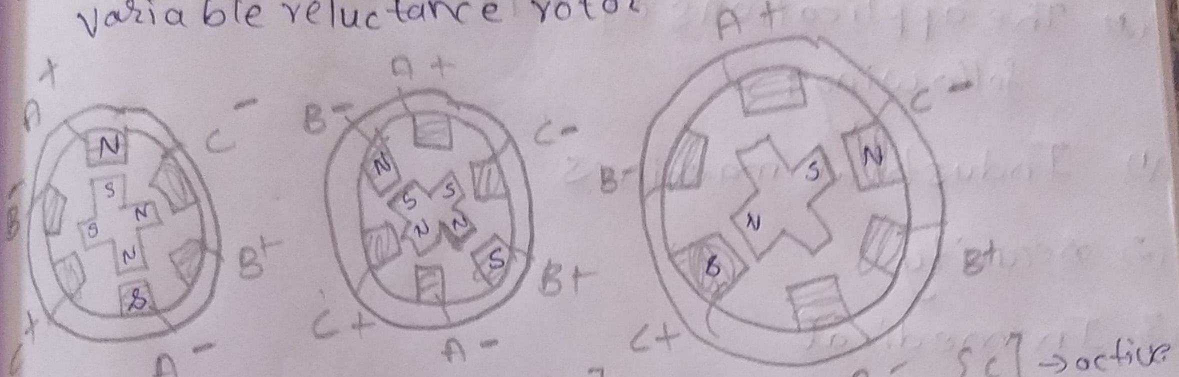
Principle of Operation of Stepper Motor



(1) A stepper motor is an electric motor whose main feature is that its rotor rotates at a particular (or) fixed amount of step

(2) Stepper motor is having 2 major parts (1) Stator (2) Rotor

3) Stationary part is called stator and moving part is called as a rotor.
4) On the stator there are teeths on which coils are wounded.
5) The Rotor is either permanent magnet rotor (or) variable reluctance rotor



{A} → active fig: 2. [B] → active {C} → active

6) The Basic working principle of the stepper motor is the by energising one or more of the stator phase/coils, a active magnetic field are generated in the coil and the rotor alligned with the poles.
7) By supplying different phases in sequence, the rotor can be rotated by a specific degree or step.
8) fig 2 shows a representation of the stepper motor working principle.
9) At the beginning coil A is energised/active. and the rotor is alligned with the coil A magnetic force.
10) when coil B is active, the rotor rotates in clock wise direction by paticular step/degree to allign with coil B magnetic force
11) The same happens when coil c is active.
12) The types of stepper motor (1) permanent

magnet rotor

(2) Variable reluctance stepper motor

(3) Hybrid stepper motor

Applications

(1) The applications of stepper motor includes the following:

(1) Industrial machines

(2) Security

(3) In medical

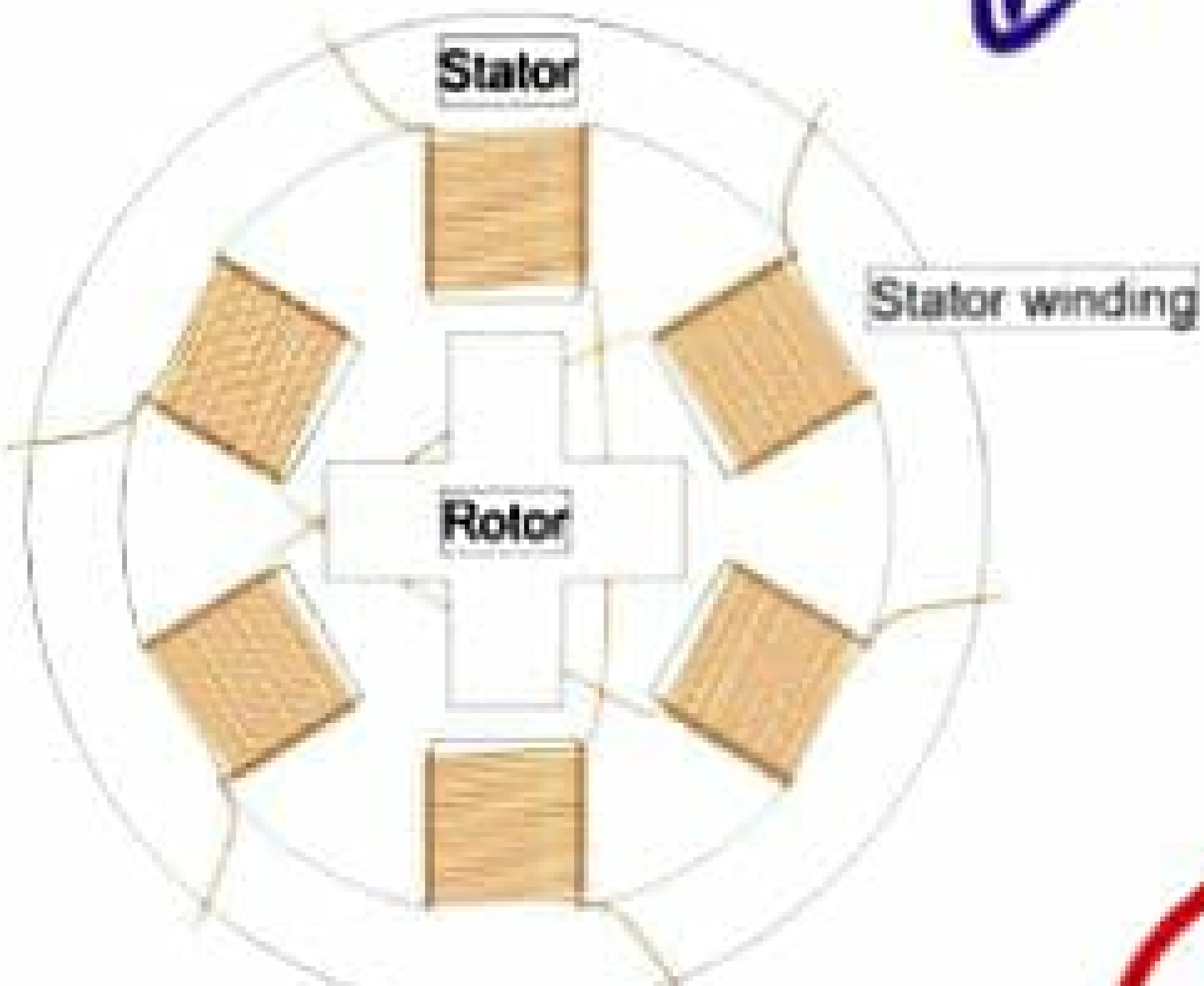
(4) consumer electronics

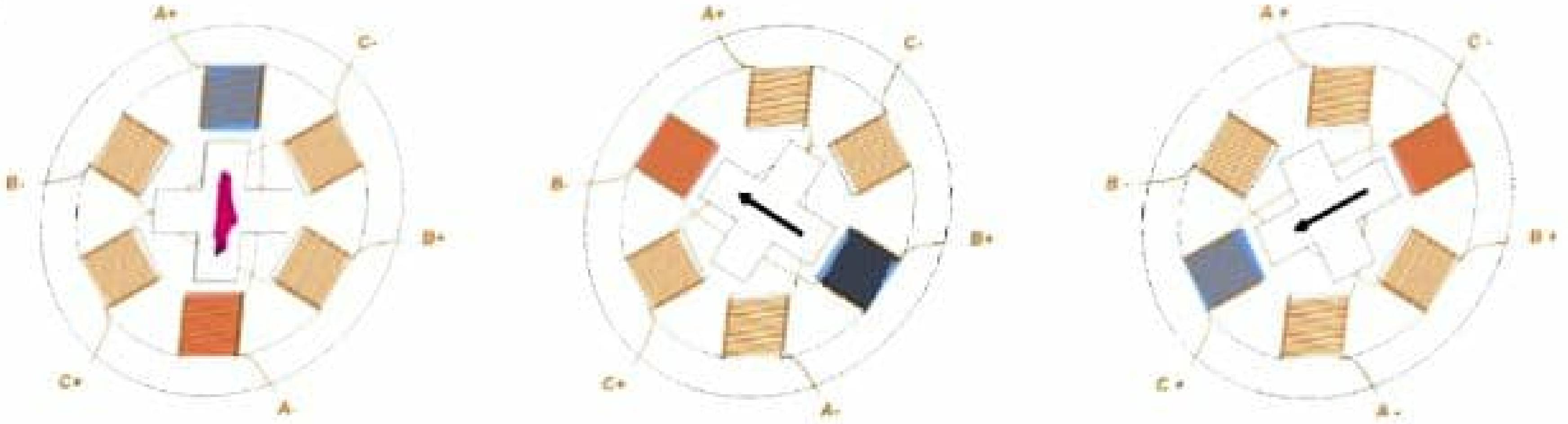
(5) computer peripherals

Permanent Magnet Brushless Dc Motor

prepare ppt

Microsoft Whiteboard




A+
C-
B-
B+
C+
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A+
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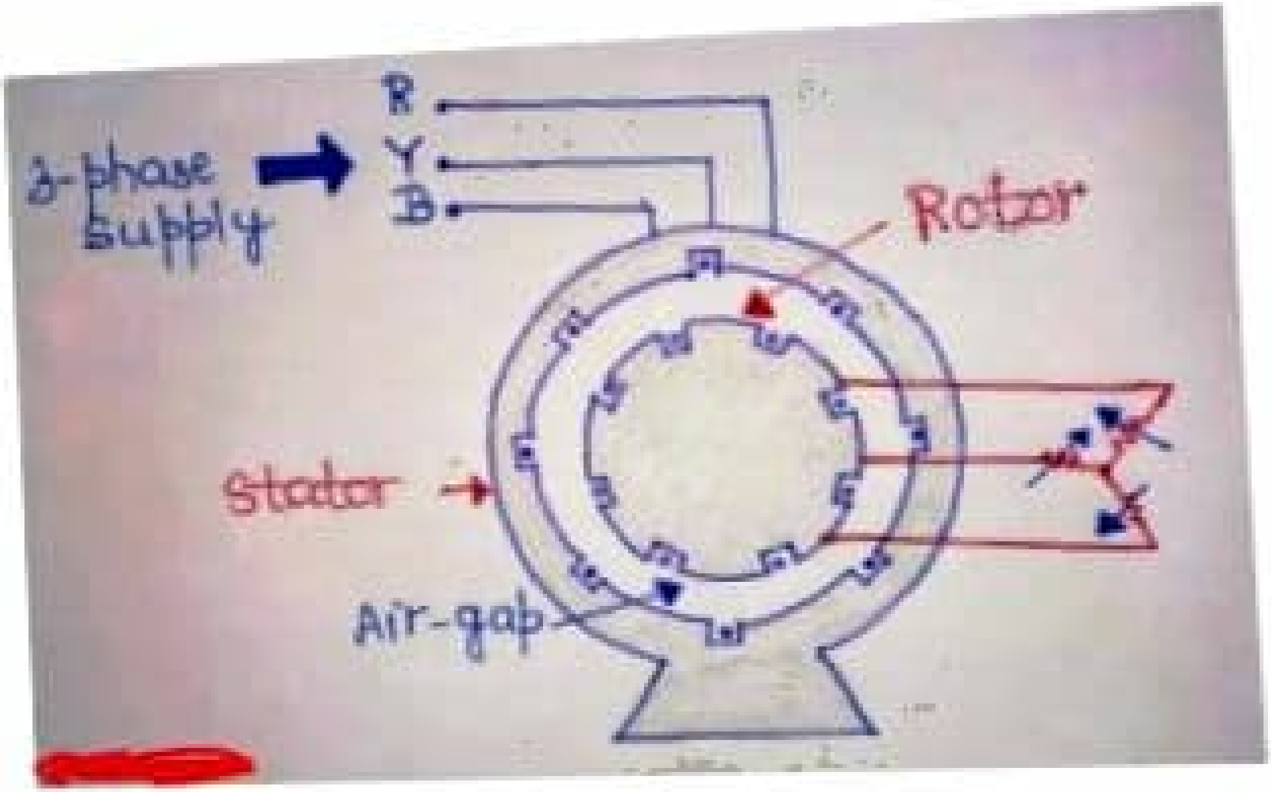

Fig.1 3-ϕ Induction motor