I Unit D.C. Generator E&E III sem

Machine 1

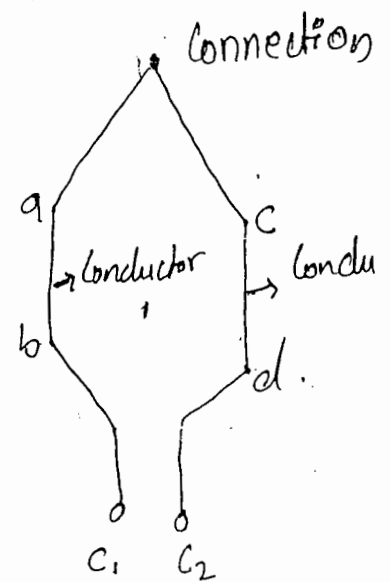Que 6) Explain the principle of D.c. generator works.

The Dc generator works on the principle of Faraday's Law of electromagnetic induction.

Faraday's law states that whenever a Conductor cuts the magnetic lines of force an Emf is Induced in the Conductor. This Emf causes to flow if Conductor Circuit is Closed.

The relative motion can be achieved by rotating Conductor w.r.t flux. This principle is nothing but dynamically Emf induced.

Simple Loop Generator :-

It consist of permanent magnet with two poles. The Coil is made up of Conducting material like Copper or aluminium. The Coil is made up of two Conductor a-b and c-d such Conductor are Connected at one end to form a Coil as. shown in figure. The remaining two ends are Connected to ring Mounted on Shaft called slip rings C_1 & C_2. Slip rings rotates along with armature of a Machine. Two brush... P... I...

Connection

a

C

Conductor 1

Condu

b

d

C_1 C_2

on one slip rings. The brushes f and d are stationary. The slip ring and brush is required to collect the emf induced in the rotating coil. The overall figure is as shown below
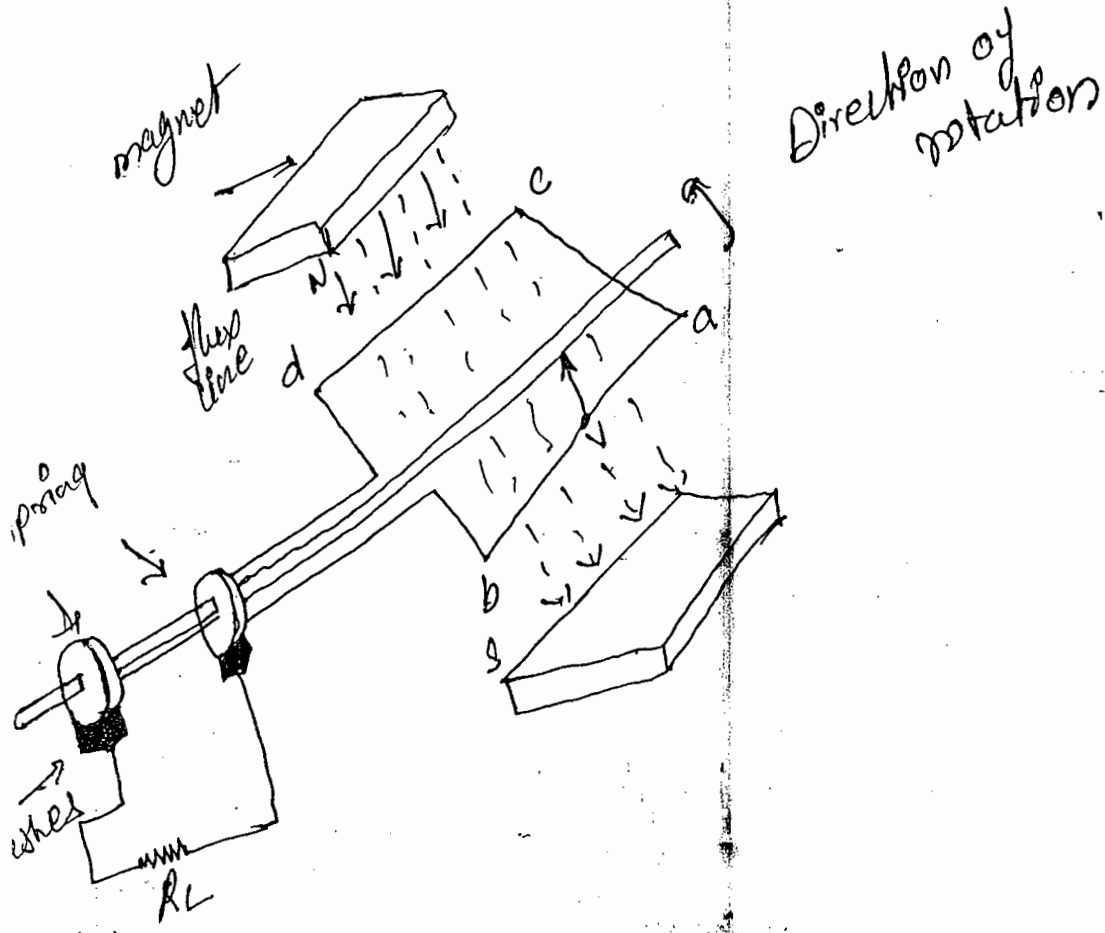

If coil is rotated in an anticlockwise direction while rotating the conductor cuts the magnetic lines of force. Hence emf is induced in the conductor. This emf drive a current through Resistance.
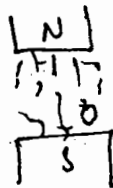
Sinwave

conductor Perpendicular at ∠90°
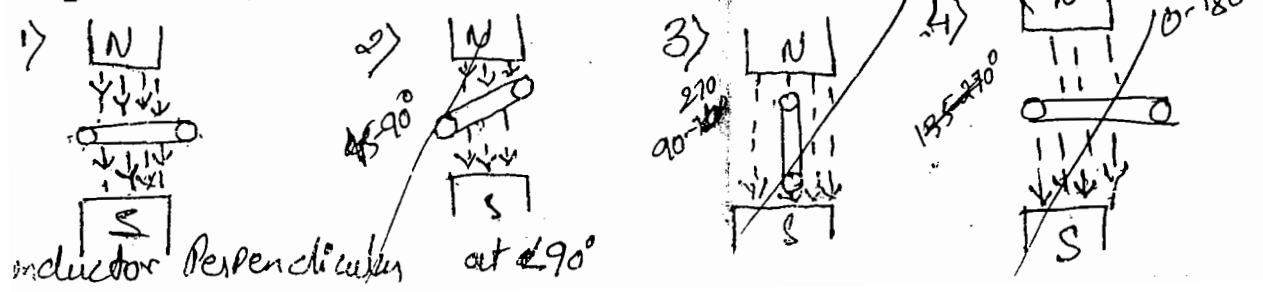
1) The conductor is placed 0-180° as shown in figure The conductor is parallel to flux. Hence conductor does not cuts the flux, no EmF induced. In the conductor
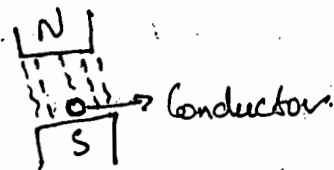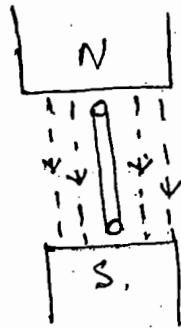
→ Conductor.

2) The conductor is placed as shown in fig. The conductor cuts the magnetic lines of force hence Emf induced in the conductor

3) The conductor is placed as shown in figure. The conductor is parallel to flux hence maximum flux cuts by the conductor and emf induced in the conductor
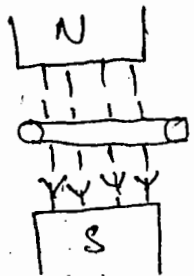
4) The conductor is placed as shown in figure the conductor rotates at an angle Hence the flux links with the conductor and Emf is induced in the conductor.
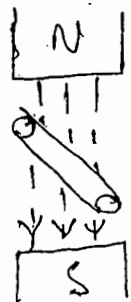
Construction of Dc machine :-

1) **Yoke :-** * **Function.**
   1) It serves as outermost cover of Dc machine
   2) It protect harmful atmospheric element like moisture, dust, and various gases. etc
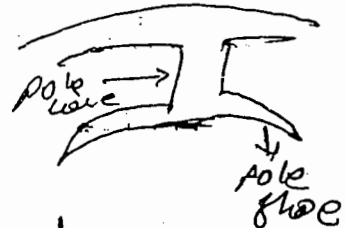   3) It provide mechanical support to the poles.

   ## choice of materials
   1) To provide low reluctance path.
   2) It should made up of magnetic material
   3) It should made up of cast iron

2) **Poles :-** ~~function~~
   1) Each pole divided into two parts.
      a) Pole core   b) pole shoe.

   ## Functions
   1) Pole core carries a field winding to produce flux.
   2) Pole shoe enlarges the area of armature core to come across the flux which is necessary to produce larger flux.

   ## Choice of material.
   1) It is made up of cast iron or cast steel
   2) It should carry low reluctance path.

3) **Field winding** :- The field winding is wound on the pole core.

Function :
1) It is used to carry current which produces necessary flux.
2) It helps to produce magnetic field.

Choice of material
1) It should made up of conducting material. Such as copper. etc.
2) It should take any shape and bend easily.

4) **Armature** - It is divided into two parts- namely
   Armature core   2) Armature winding.

1) **Armature core** :- Armature core is cylindrical shape mounted on shaft.

Function :- 1) It consist of slots in which winding are placed.
2) It provide low reluctance path. to magnetic field.

Choice of material :-
1) To provide low reluctance path.
2) material should made up of cast Iron cast steel.
3) core should be laminated.

+ armature winding :- The interconnection of the armature conductors placed in the slots.

function :- 1) Generation of emf in case of generator.

2) To carry current supplied in case of DC motor

choice of material :-

1) It should carry current depend upon load
2) It should be conducting material.

5) **commutator** :- Commutator produced AC. Hence in case of DC generator rectification is required. which is possible by use of commutator.

function :- 1) It should collect the current from armature conductors.

2) Convert AC to DC supply internally

3)

choice of material :-

1) It should made up of copper segment
2) This segments are insulated from each other
3) mica sheets are used to seperate segments -

6) Brushes :-

function :- To collect current from commutator and made t available to stationary.

It supplies current in case of motor.

Choice of material :-

1) rushes are made up of carbon or graphite.

2) Brushes are rectangular in shape

3) To collect current from commutator.

7) Bearing :

> Ball Bearing are generally used for more reliable.

> For heavy duty machines. roller bearing's are prefered.

Properties : materials used for D.C machine

1) Winding. sistivity. of a material. used for winding s low.

2) The resis we temperature co-efficient is low.

3) The mater l have high magnetic permeability

4) Hysteresis oop is narrow. and having small a a.

5) The magnetic material have high saturation limits.

6) Low reluctance

7) The resistivity of the material used for yoke and cores is high.

Properties of Slot Insulation materials

1) Very high Insulation resistance

2) High dielectric strength

3) Low dielectric loss

4) No attraction of moisture

5) Good heat conductivity

6) High melting point.

7) Sufficient mechanical strength to withstand bending & vibration.

Types of Armature winding :-

A number of armature conductors are connected in specific manner as per requirements.

✳. There are two types. Armature winding.
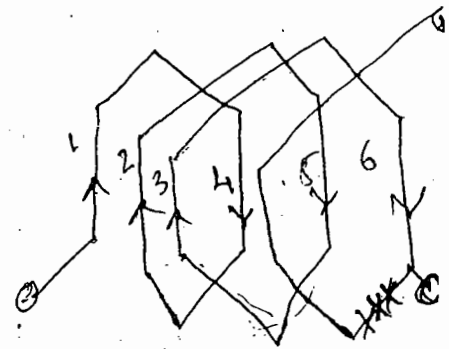   a) lap winding   b). Wave winding.

Lap
wave
simplex
duplex

a) lap winding.

In this case if connection is started from conductor in slot 1 then connection overlap each other as winding proceeds. till starting point reached again.

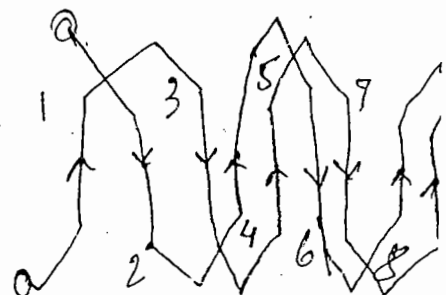Developed view of part of the armature winding is ashown in figure

The total number of conductors get divided into "P" number of parallel path

where
   P = number of poles in machine

Wave Winding. :-

In this type of connection, winding always travels ahead avoiding overlapping

① It travels like a progressive wave hence it is called wave winding

④ The total number of conductor's get divided into two number of parallel path always, irrespective of number of poles (P) of the machine.

④
so A = P for lap connection
& A = 2 for wave connection

Rules for the winding

1) Both winding are full pitch. both back pitch & front pitch are each almost equal to the pole pitch.
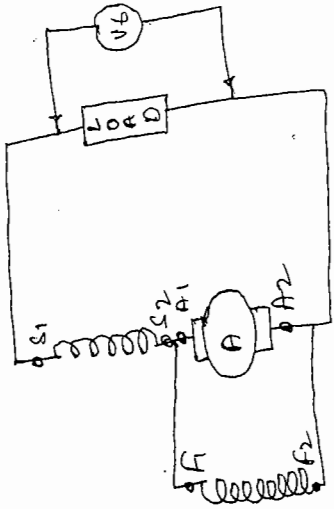Due to this there is increase in emf induced around coil.

2) Both back pitch and front pitch must be odd number which helps to design the winding easily

3) The front ends of the conductor's are joined to the commutator segments in pairs hence number of commutator segments is always equal to the number of slots

4) The entire winding must be closed path.

5) The average pitch for the lap winding is z/p while that for the wave winding is $\dfrac{z \pm 2}{P}$

Vinayak

Performance of DC Generator

Armature Reaction :- The effect of magnetic field setup by the armature current on distribution of the flux under main poles is called as Armature Reaction

F_m = main field mmf or flux.

Consider an armature rotating in clockwise direction. When field winding energised, the field flux is distributed as shown in figure. Assume the generator is on no load.

The brushes will make contact with conductors lying on magnetic neutral (axis) plane (MNP) which coincide with (GNP) Geometric neutral plane.; No emf induced in armature conductor is known as MNP.

Shunt compound generator :-

- In this type of generator The field winding is connected across armature winding alone.

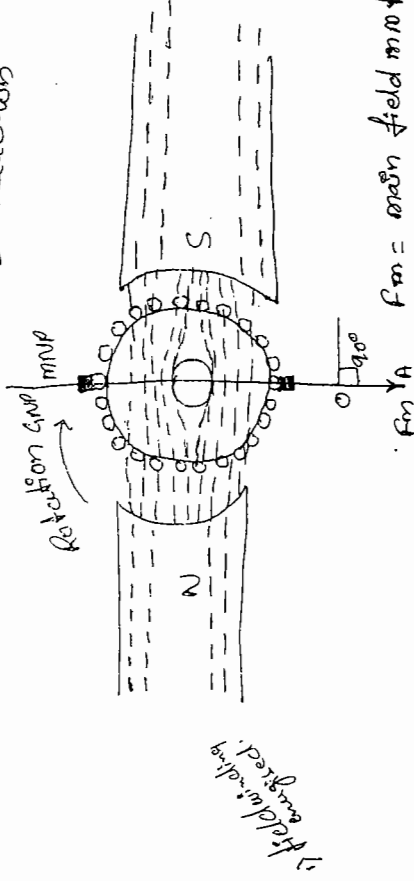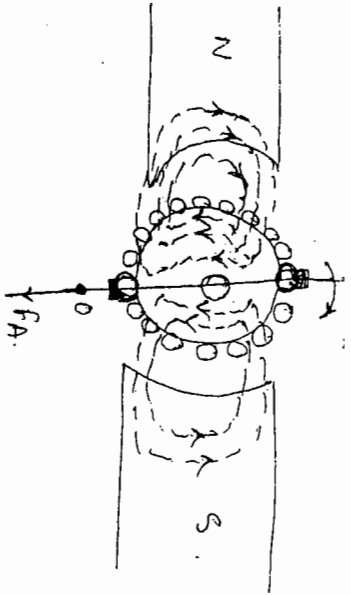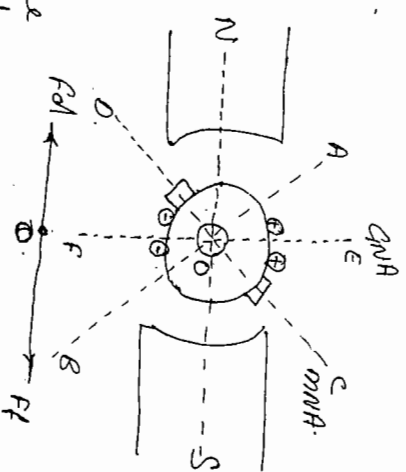This type of generator is called Short Shunt compound generator.

Now we consider that field coils are unexcited, whereas armature conductors are carrying current. Under this case field set up armature conductors is shown in figure. The direction of current in armature conductors is alternate by flemings right rule. The current carrying armature conductor try to magnetise the armature core along with brushes axis.

vector OFA shows in figure represents the armature mmf both in magnitude & direction.
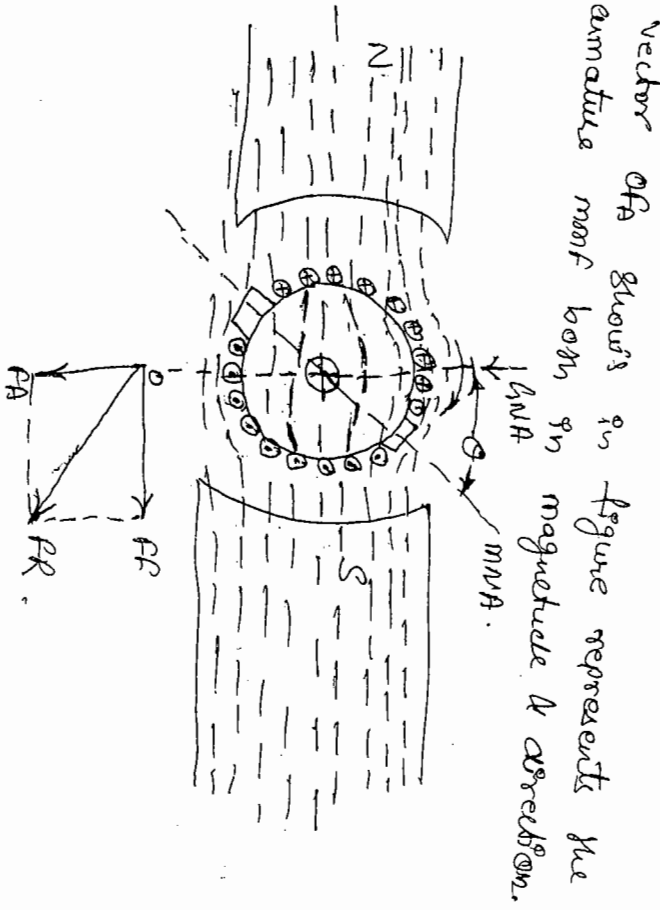
* Due to interaction of two fluxes the resultant distribution flux is changed as shown in fig.

* The pole tip which met first during rotation by armature conductors is known as trailing pole tip and others is known as leading pole tip.

* The Resultant field OFR is perpendicular to new MMA. The new MMA is shifted through an angle α so that brushes are also shifted.

* Due to brush shift the armature conductors and armature current is redistributed as shown in figure

(12) <u>Demagnetising Effect</u>

* In the figure it is clear that the new mmf is shifted the new position of mmf is at angle α from MMA due to armature reaction.

* The armature are carrying the current in such direction that from right to left.

* Thus these conductors are in direct opposition to main field and is called as demagnetising effect.

Characteristics of Seperately Excited Dc Generator.

Open cct characteristics

Saturation — A — constant

* The above figure shows, the characteristics of seperately excited Dc generator.

* The Rheostat is used used to control the field current and flux.

* If is varied from zero and measured by ammeter connected. $\left[E_0 = \dfrac{\Phi P N Z}{60 \times A} \right]$.

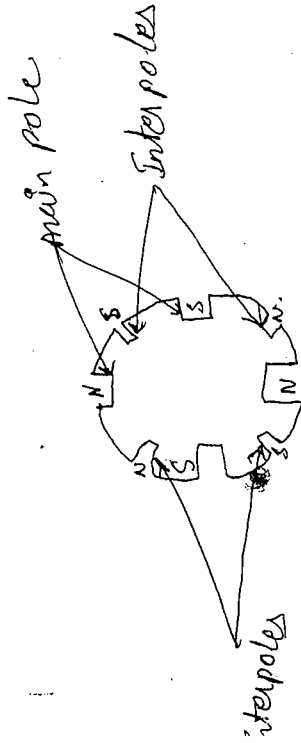† As If varied, the flux changes and Emf induce across armature.
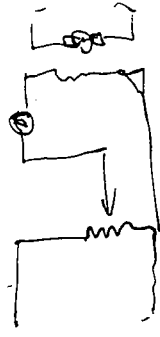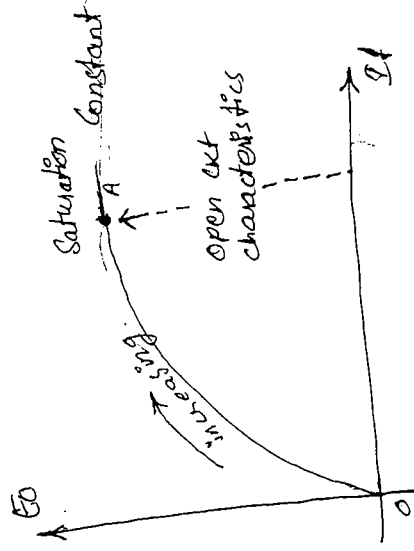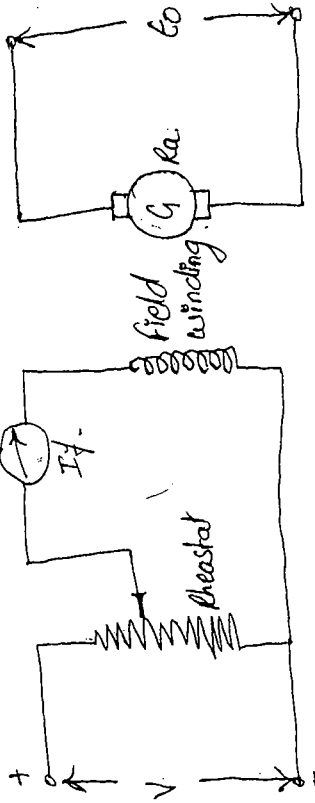

Brush Shift :-

If the brushes are ex-shifted forward or backward depends on generator or motor.

The short circuit coil will come under influence of main pole of opposite polarity.

Interpoles :-

By using small poles fixed to the yoke and placed in between the main poles. along with GNA, these poles are called as interpoles. This interpoles are used to neutralize reactance voltage

main pole

Interpoles

interpoles

No load is connected to machine hence characteristics is also called as No. load characteristics.

→ IF Emf increases, (flux) φ increases.

→ IF φ increases, Eo increases.

After a point A saturation occurs when φ becomes constant and hence Eo saturates.

Internal & External Characteristics of Separately excited Dc generator.

- voltage
- No load.
- Armature reaction drop
- Internal
- External
- Armature Resistance drop
- Vt
- Es
- IL current
- (IL = Ia for separately excited).
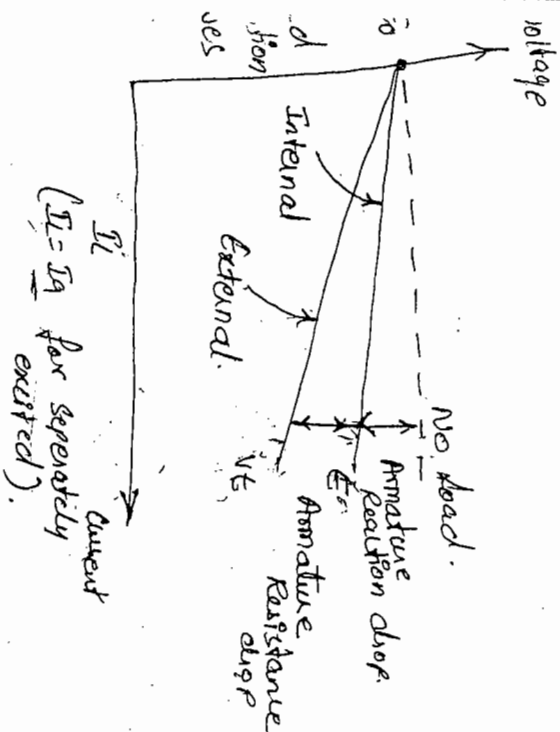
(⊛) Let Eo be the no load rated voltage which drop to E due to armature reaction on and further drops due to Vt due to armature resistance drop Iaka on load.
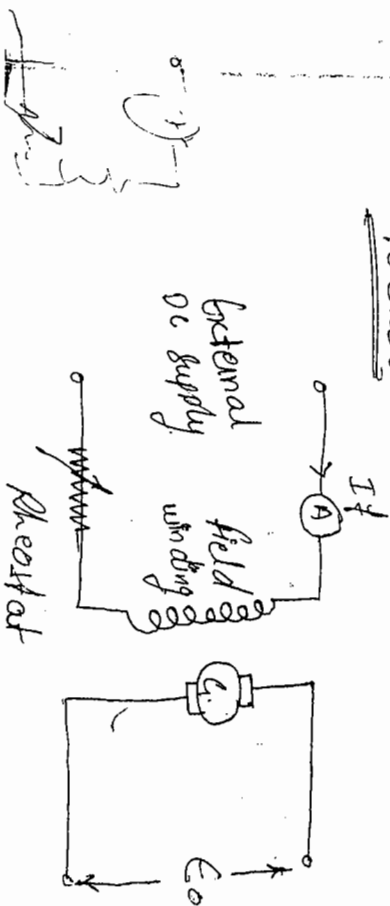
$$E_o = V_t + I_a R_a.$$

(⊛) The graph of Vt against load current IL is called External characteristics.

(⊛) The graph of Vt & E against load current IL is called internal characteristics.

(⊛) The figure shows the separately excited Dc generator characteristics.

(⊛) The Emf induced is totally dependent on the flux hence to control over field current the field regulator is necessary.

(ie If) flux

Open circuit characteristics of Dc shunt Generator

- External Dc supply.
- field winding
- G
- Eo
- If
- A
- Rheostat

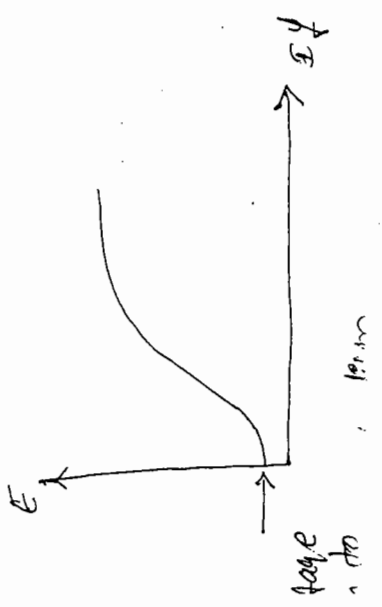↑ **Voltage Building in Self Excited Shunt Generator**

The open ckt characteristics of self excited shunt is similar to separately excited DC generator.

The machine is driven at constant speed.

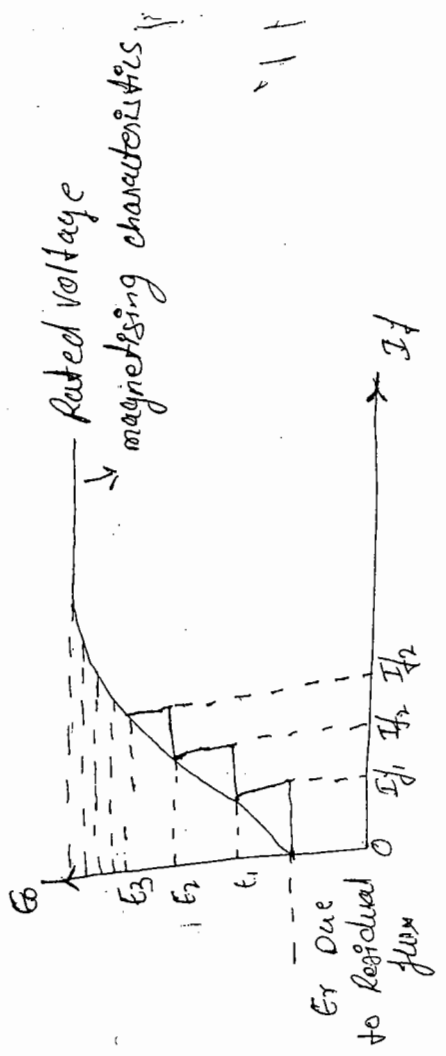The field current (If) is varied by using Rheostat and measured by ammeter.

The open ckt emf generated is measured by Voltmeter.

The graph against $(E_0 \propto If)$ is called OCC (open circuit characteristics).

Due to residual magnetism there is small voltage present $If = 0\,Amp$ Hence graph does not pass through origin

(*) For every self excited generator there must be existance of Residual magnetism.

(*) when armature Rotates, conductor cut this small residual flux to produce emf.

(*) Thus field current produce more current which is greater than residual flux Hence more emf is induced.

(*) This process continues and get build up. as shown in figure.

Conditions to Build up Voltage in Shunt Generator :-

Residual magnetism must be present

The field connection should be proper

Inter change of connection may cancel the Residual magnetism.

The field resistance must be less than the Critical Resistance value

The generator must be driven in the proper direction by prime mover.

External Characteristics of DC Shunt Generator

(*) The graph of Vt (terminal voltage) against field current (If) is called external characteristics.

(*) In DC generator there are three reasons to reduce Vt as I_L increases.

1) As I_L increases, armature current Ia increases due to this voltage drops by $I_a R_a$.

2) As Ia increases, armature reaction increases which weakens the main flux. Hence emf induced decreased.

3) As Vt decreases by above two reasons (If) decreases, hence flux decreases which decreases in the induced emf.

B. — Vt voltage in Vt

If