SNS COLLEGE OF TECHNOLOGY

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Coimbatore-35

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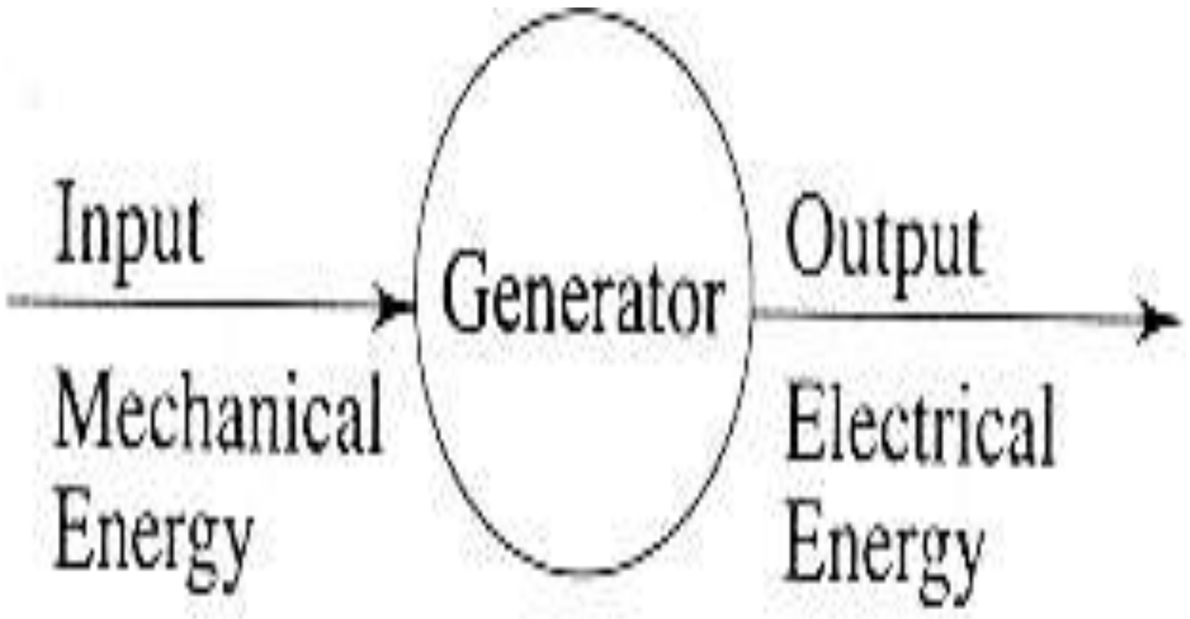
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

IIYEAR/ III SEMESTER

19ECT201 Electrical Engineering and Instrumentation

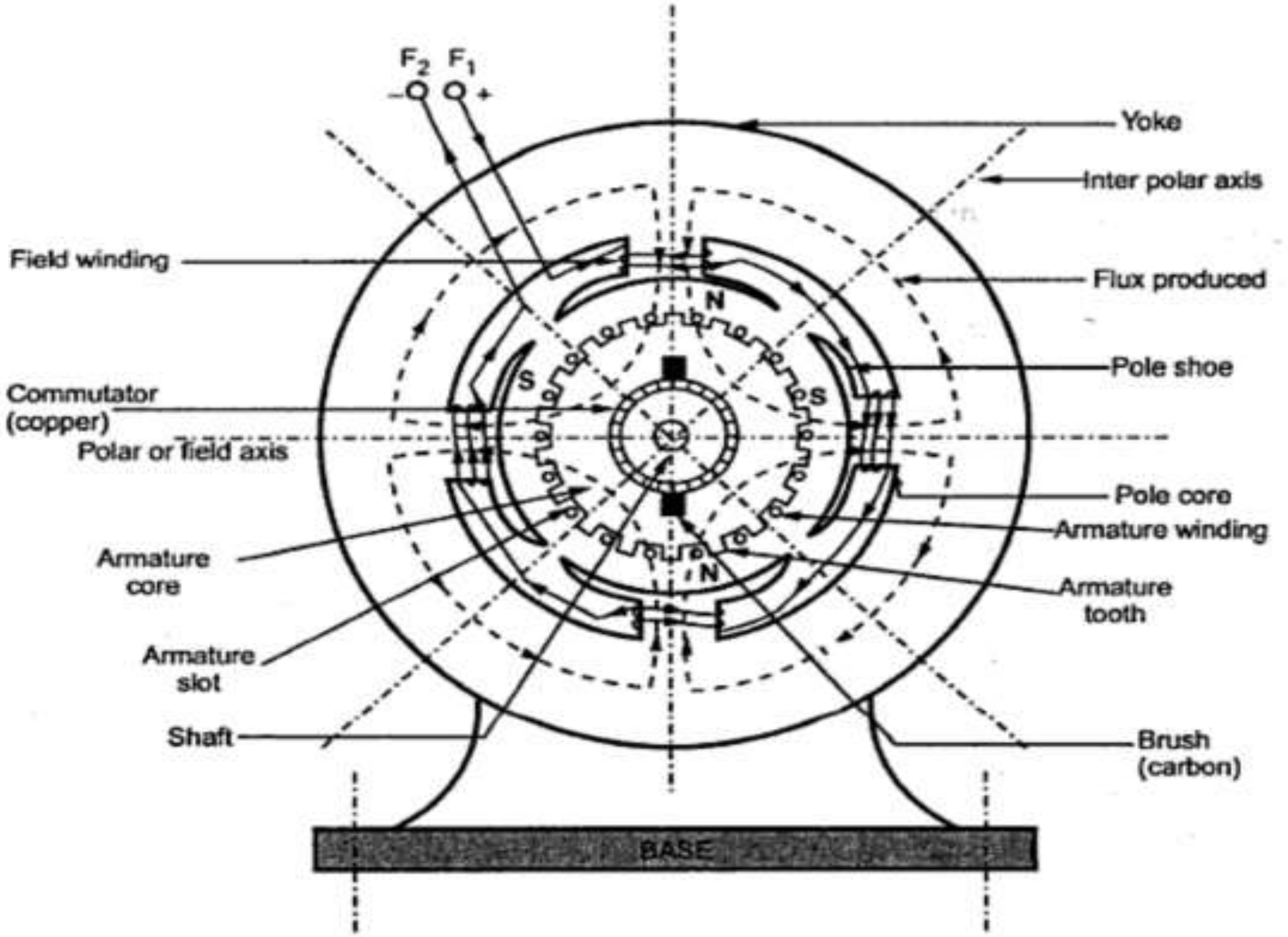
TOPIC – DC GENERATOR

DC GENERATOR



Constructional Details

- Yoke:
- Pole core and pole shoe:
- Field windings
- Armature:
- Commutator:
- Brushes

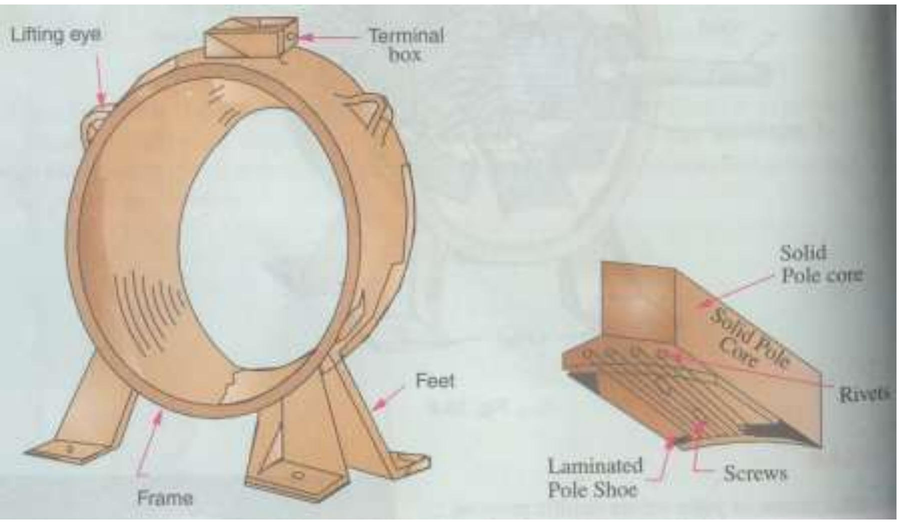

F2
F1
Yoke
Inter polar axis
Field winding
Flux produced
N
Pole shoe
S
S
Commutator
(copper)
Polar or field axis
Pole core
Armature winding
Armature
core
N
Armature
tooth
Armature
slot
Shaft
Brush
(carbon)
BASE

1)Yoke

1)Yoke:-

- Acts as a outermost cover of the machine
- Mechanical support
- path for low reluctance for magnetic flux
- High Permeability
  - -- For Small machines -- Cast iron—low cost
  - -- For Large Machines -- Cast Steel (Rolled steel)

large DC machine



small
DC machine

2)Field Magnets:-

a) Pole core (Pole body) :- --Carry the field winding
--directs flux
-- Laminated to reduce heat losses
--Fitted to yoke through bolts

b) Pole shoe:- Acts as support to field poles and spreads out flux

materials: cast iron or steel

3. Field windings:

• wound on pole core
• carry current ,due to this pole behaves as electromagnet
• material :Aluminium or copper

4.Armature

- **Armature core**

    cylindrical in shape mounted on shaft
    slots and air ducts permits air flow for cooling purpose
    house for armature winding
    path for low reluctance to the magnetic flux produced by field winding
    material:cast iron or steel

- **Armature winding**

    Interconnection of armature conductors placed in slots
    when armature is rotated magnetic flux gets cuts by armature conductor and e.m.f gets induced in them
    material:copper

5.Commutator

It converts Alternating e.m.f generated in armature conductor to direct e.m.f
collects current from armature conductor convert to d.c
Material:copper

6.Brushes

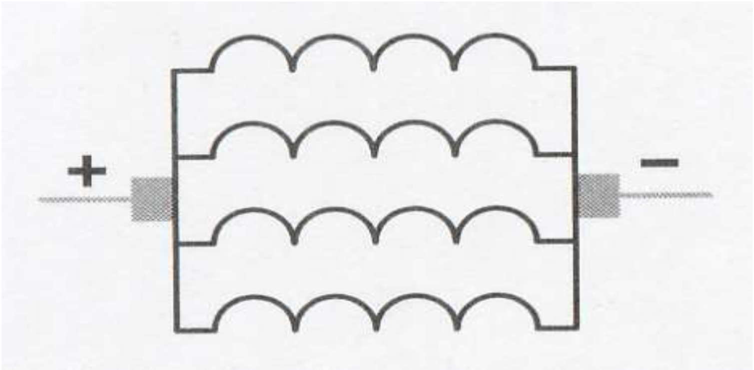
brushes are stationary, rest on surface of commutator
collect current from commutator and make it available to stationary external circuit
material:carbon

Armature Winding is classified into two types:

- Lap winding
- Wave windings

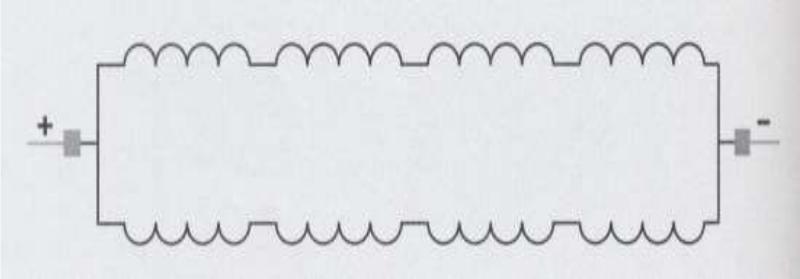
Lap Winding:

- are used in machines designed for low voltage and high current
- armatures are constructed with large wire because of high current
- Eg: - are used is in the starter motor of almost all automobiles
- The windings of a lap wound armature are connected in parallel. This permits the current capacity of each winding to be added and provides a higher operating current.
- No of parallel path, A=P ; P = no. of poles



Wave winding:

- ➢are used in machines designed for high voltage and low current
- ➢their windings connected in series
- ➢When the windings are connected in series, the voltage of each winding adds, but the current capacity remains the same
- ➢are used is in the small generator.
- ➢No of parallel path, A=2,



D.C. GENERATORS PRINCIPLE OF OPERATION

•**Principle: Faraday law of electromagnetic induction**
• whenever number of magnetic lines of force (FLUX) linking with conductor or coil changes an EMF sets up in conductor or coil
• Magnitude is directly proportional to rate of change of flux
• Relative motion is achieved by rotating conductor w.r.t flux or vice versa
• voltage generated as long as relative motion exists
• induced e.m.f is called dynamically induced emf

To have large voltage as output number of conductors connected together to form winding called armature winding placed on armature on machine

prime movers: rotate conductors placed on armature.

Field winding: current carrying winding, produce necessary magnetic flux

Generated EMF or EMF Equation of a generator

Let Φ = flux produced by each pole in Weber

Z = Total number of armature conductors

= No. of slot × No. of conductors/slot

P = No. of generator poles

A = No. of parallel paths in armature

N = speed of armature (r. p. m)

E = e.m.f induced in any parallel path in armature

Average e.m.f generated/conductor = $\frac{d\Phi}{dt}$ volt

Now, flux cut/conductor in one revolution $d\Phi = \Phi P$ wb

No. of revolutions/sec=N/ 60

$\therefore$ Time for one revolution , dt= 60 /N sec

According to Faraday's Law of electro magnetic induction

E.M.F generated/conductor = $\frac{d\Phi}{dt} = \frac{\Phi PN}{60}$ volts

No. of conductors (in series) in one parallel path= Z / A

$\therefore$ E.M.F generated/path= $\frac{\Phi PN}{60} \times \frac{Z}{A}$ Volts

$\therefore$ Generate E.M.F, $E_g = \frac{\Phi Z N}{60} \times \frac{P}{A}$ Volts

For

i) Wave winding A = 2

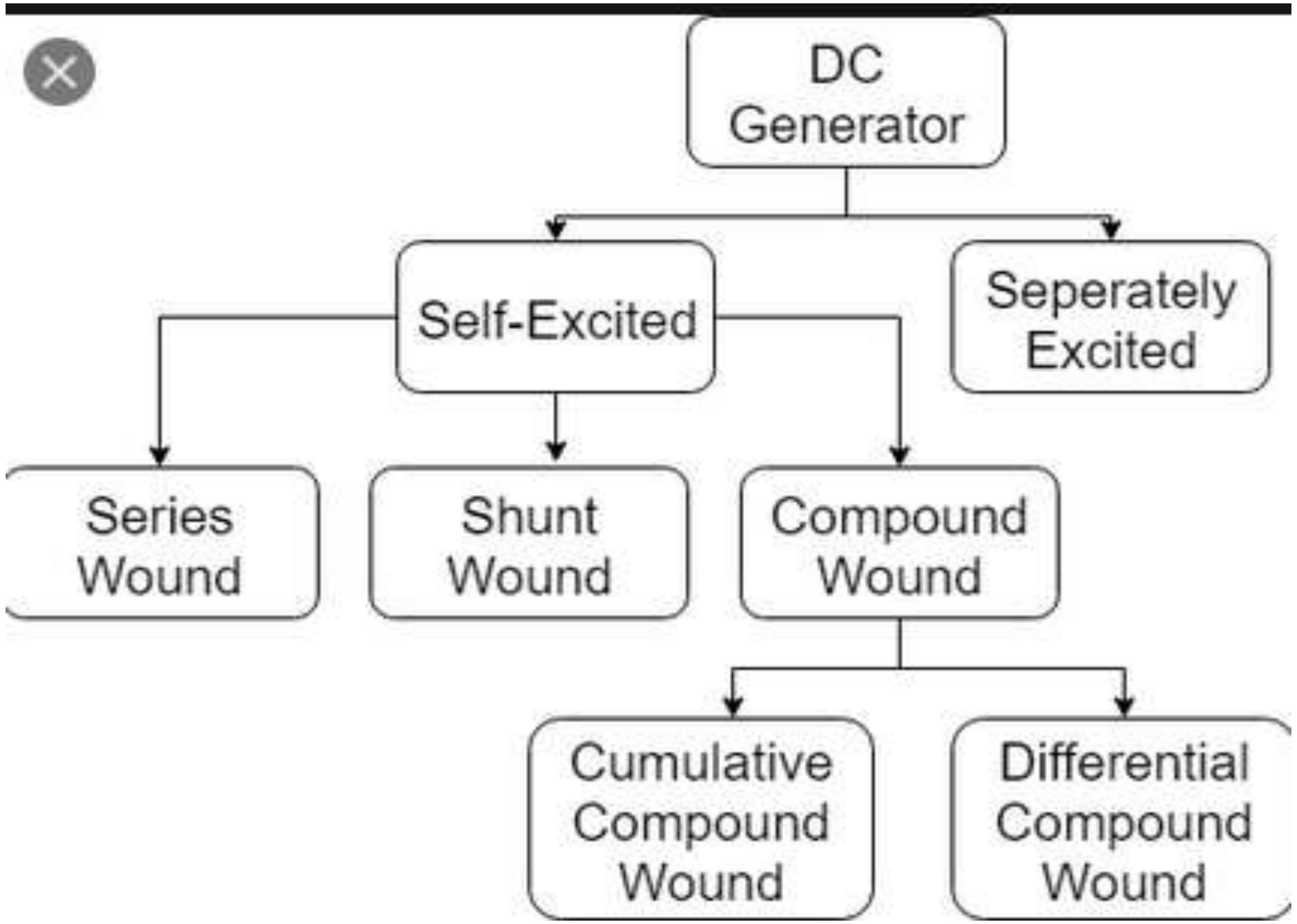
ii) Lap winding A = P

Types of Generators

1)Separately excited generators

2)Self excited generators

- i) shunt wound
- ii) series wound
- iii) compound wound
  - a) long shunt
  - b) short shunt


DC Generator
Self-Excited
Seperately Excited
Series Wound
Shunt Wound
Compound Wound
Cumulative Compound Wound
Differential Compound Wound

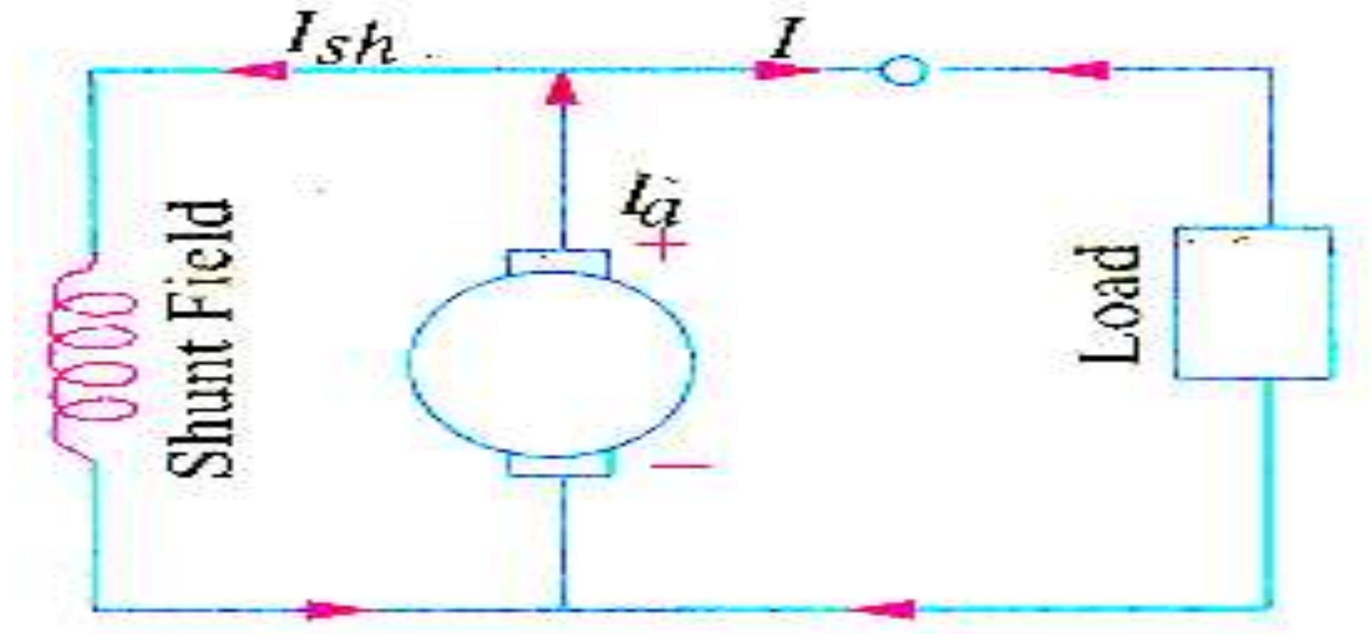
Separately excited

field winding is supplied from external dc supply
It has large number of turns
Ia is armature current I_L load current I_f is field current
field current depends on supply voltage and resistance of field winding
Voltage drop across armature winding is IaRa
voltage drop across brushes is Vbrush
armature carries current and produces its own flux which distorts main flux voltage drop due to this is armature reaction drop which is neglected
E=Vt+IaRa+Vbrush+Armature reaction drop

Self excited

field winding is supplied from armature of generator
Based on how field winding connected to armature to derive excitation it is classified in to 3 types
shunt series and compound

Shunt



A field winding connected parallel with armature

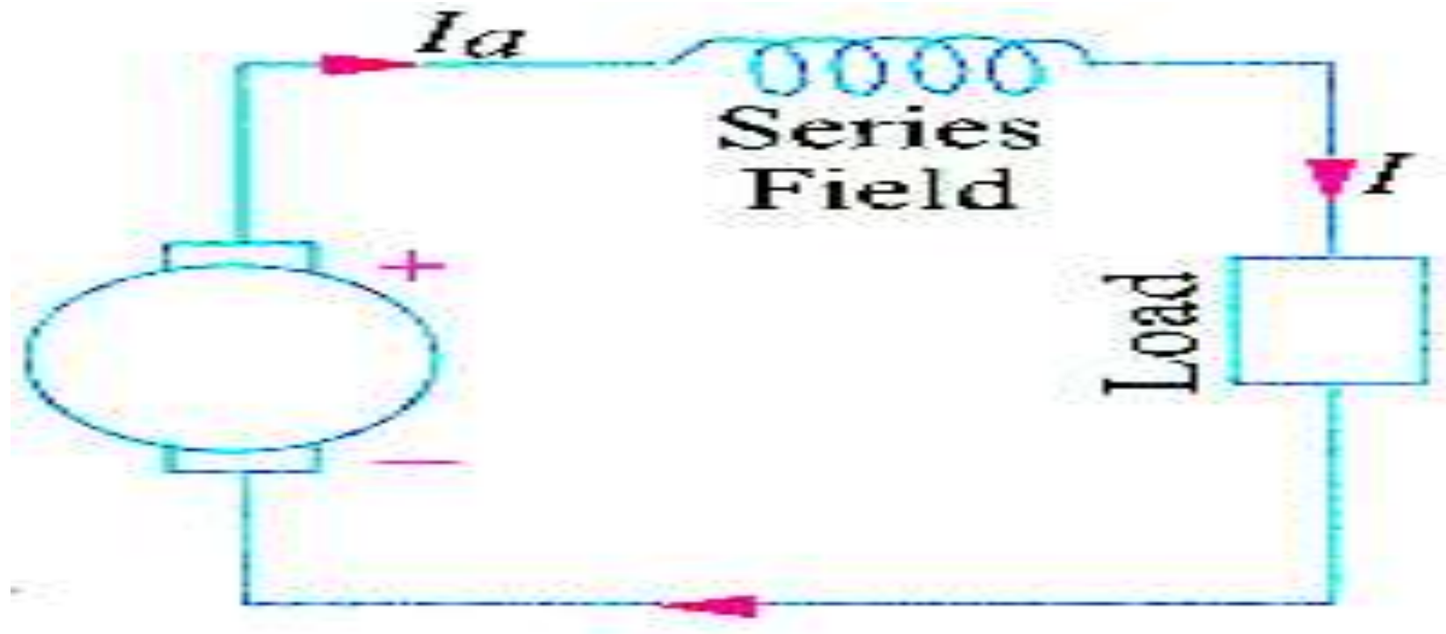
field winding has large number of turns and high resistance Rsh

$Ia = I_L + Ish$

$Ish = Vt/Rsh$

$E = Vt + IaRa + Vbrush$

Series



Field winding connected in series with armature winding

Rse is very small and less number of turns

$Ia=Ise=I_L$

E=vt+IseRse+Vbrush

Compound generator

• part of winding connected parallel to armature and remaining part in series with armature

classified as long shunt and short shunt

Long shunt

shunt field winding connected across entire series combination of armature and series field winding

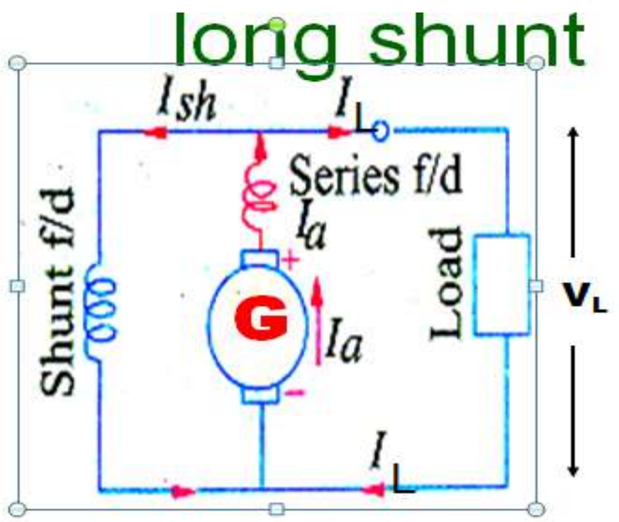
$Ia=Ish+I_L$

$Ish=Vt/Rsh$

Vt is voltage across shunt field winding

$E=Vt+IaRa+IaRse+Vbrush$

Rse resistance of series winding



Short shunt

shunt fields winding is connected only across armature excluding series field winding

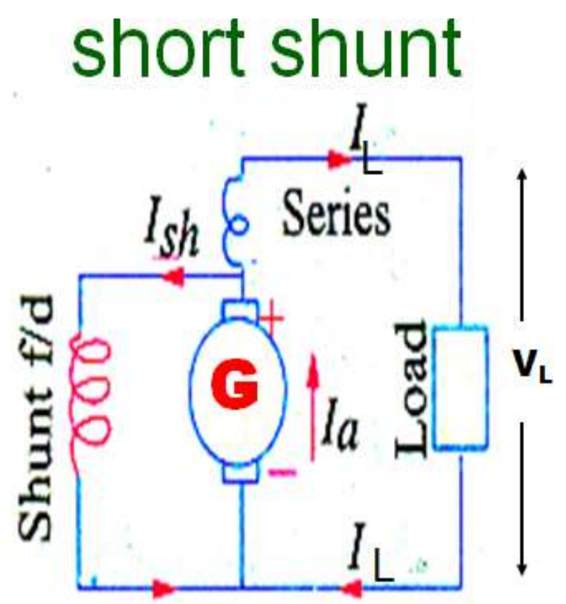
$Ia=Ise+Ish$

$Ise=I_L$

$Ia=I_L+Ish$

$E=Vt+IaRa+IseRse+Vbrush$

$Ise=I_L$ hence $E=Vt+IaRa+I_L Rse+Vbrush$

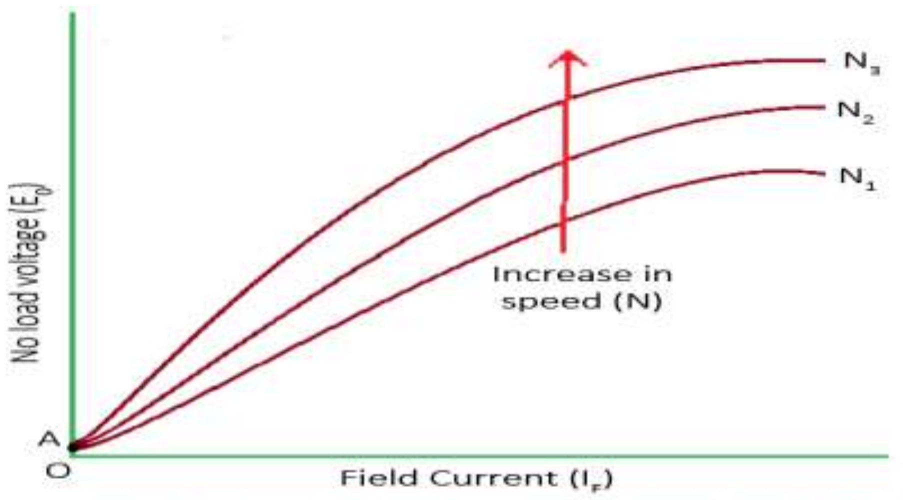


Characteristics of DC generator

(i) Open Circuit Characteristic (O.C.C.),
(ii) Internal or Total Characteristic
(iii) External Characteristic.

Open Circuit Characteristic (O.C.C.),

- This characteristic shows the relation between generated emf at no load (E_0) and the field current (I_f) at a given fixed speed.



Open Circuit Characteristic (O.C.C.)

The data for O.C.C. curve is obtained by operating the generator at no load and keeping a constant speed.

Field current is gradually increased and the corresponding terminal voltage is recorded.

2. Internal Or Total Characteristic (E/I_a)

- An internal characteristic curve shows the relation between the on-load generated emf (Eg) and the armature current (I_a).
- The on-load generated emf Eg is always less than E_0 due to the armature reaction.

3. External Characteristic. (V/I_L)

- An external characteristic curve shows the relation between terminal voltage (V) and the load current (I_L).
- Terminal voltage V is less than the generated emf Eg due to voltage drop in the armature circuit.

Applications of D.C Generators

Separately excited generators

i) These are used for speed control of D.C motors over a large range.

ii) These are used in areas where a wide range of terminal voltage is required

Self excited generators

i) shunt generators :-

i) These are used as exciters for exciting the field of synchronous machines and separately excited D.C generators

ii) These are used for battery charging

iii) Commonly used in ordinary lighting purposes and power supply purposes.

ii) series generators:-

i) These are used for series arc lighting

ii) Series incandescent lighting

iii) Special purposes such as supplying the field current for regenerative breaking of D.C locomotives (railway service).

iv) Constant current for welding.

iii) compound generators:-

i) Compound generators are used where constant terminal voltages have to be maintained for different loading conditions.

ii) Cumulatively compound generators:-These are for domestic lighting purposes and to transmit energy over long distance and for heavy power service such as electric railways.

iii) Differential compound generator:- The use of this type of generators is very rare and it is used for special application like arc welding.

THANK YOU