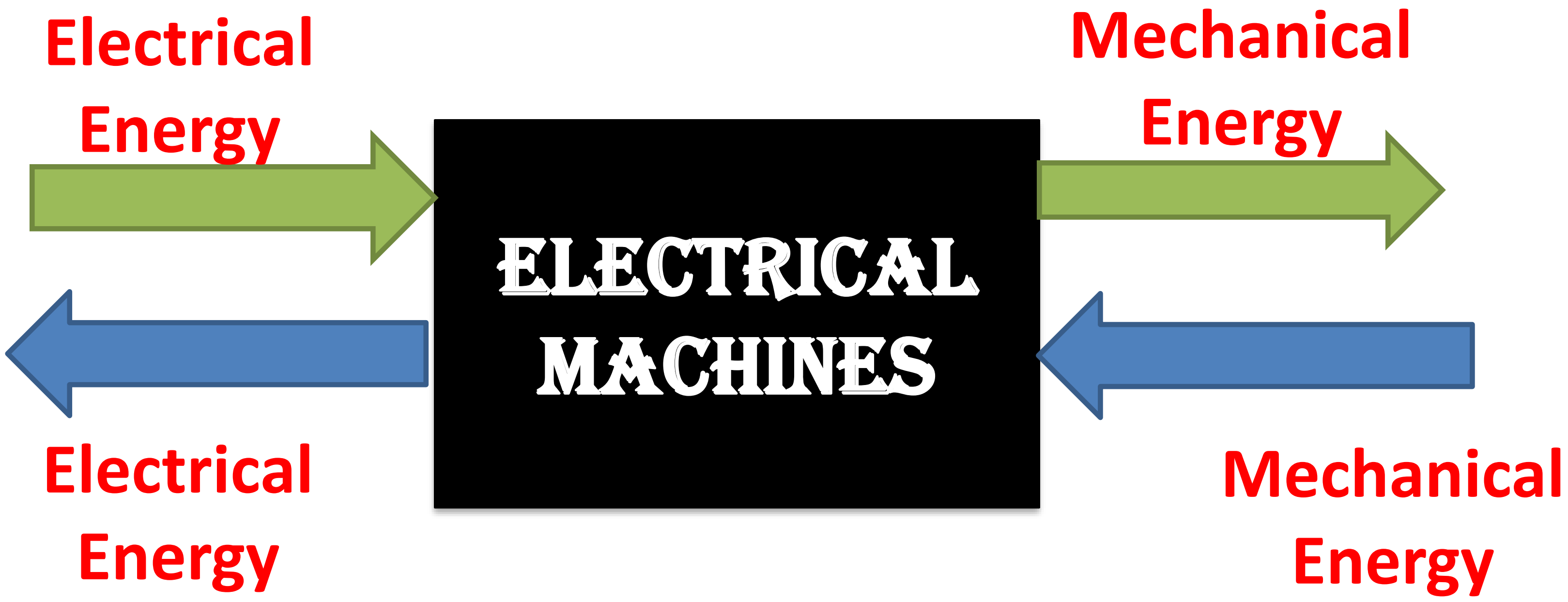
DC GENERATORS

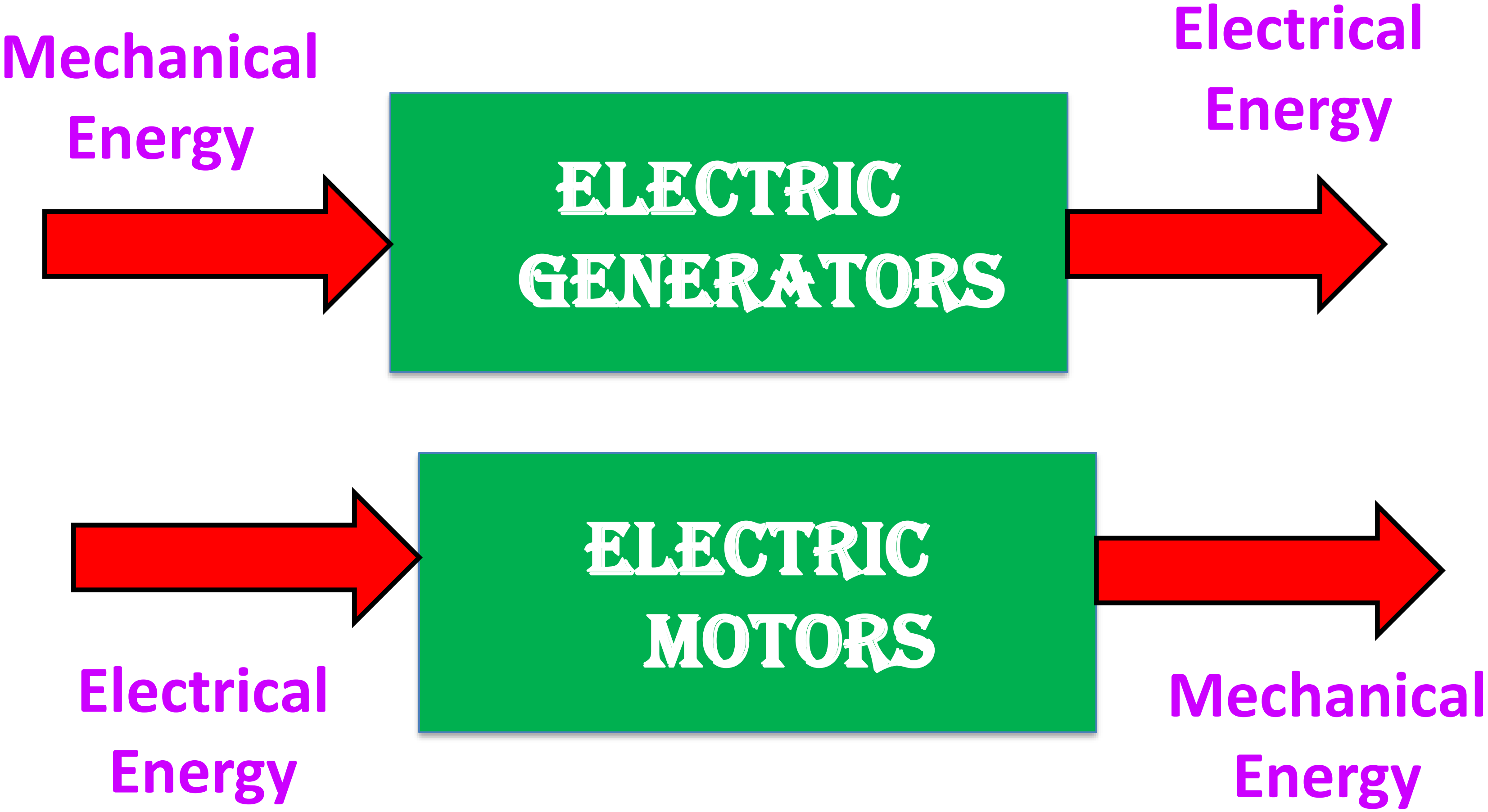
CONSTRUCTION & WORKING
ACTION OF COMMUTATOR
EMF EQUATION
TYPES OF DC GENERATOR

INTRODUCTION

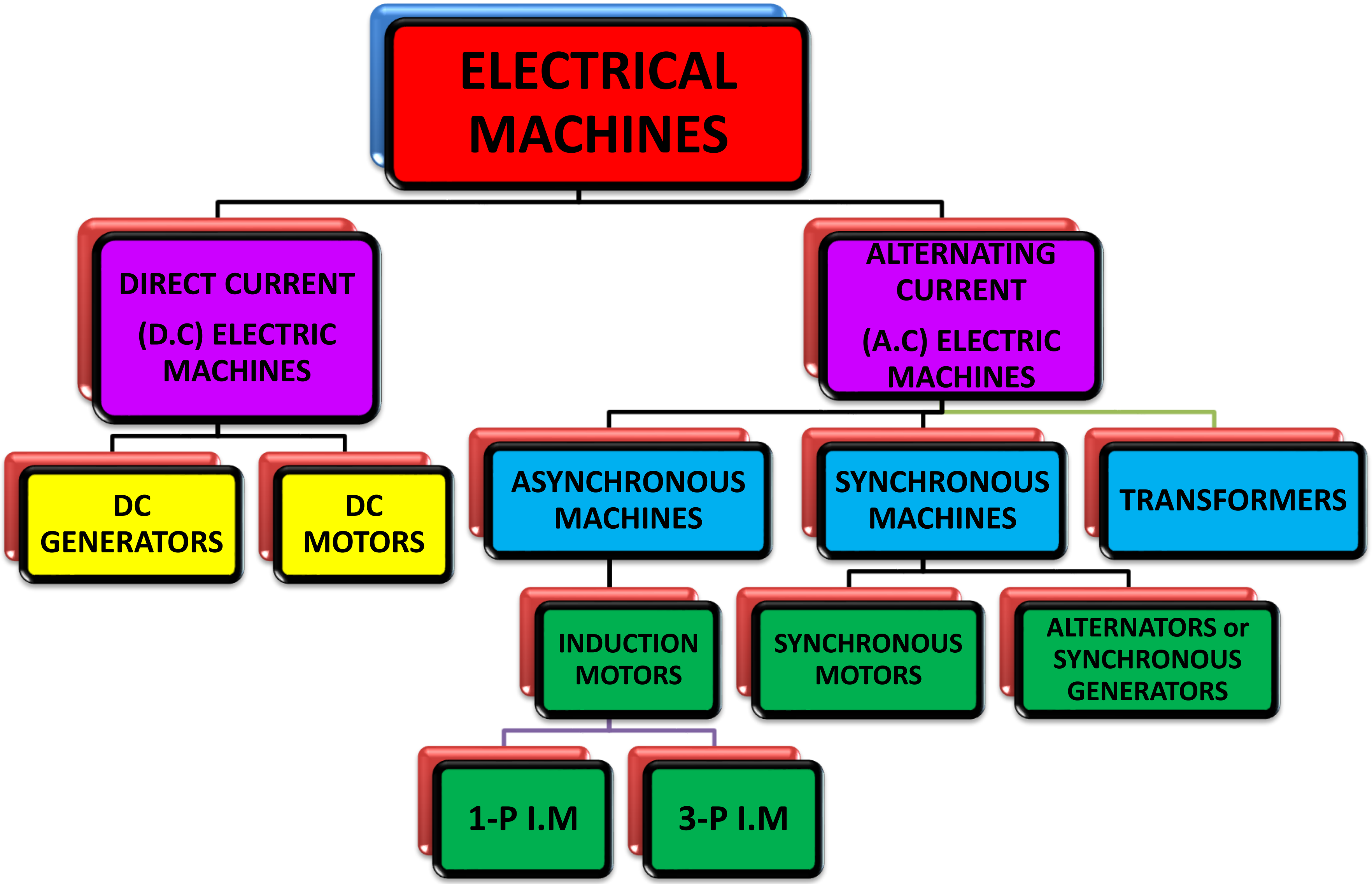
- **All Electrical Machines particularly Rotating Electrical Machines are basically "ELECTROMECHANICAL ENERGY CONVERSION DEVICES"**



GENERATOR & MOTOR



CLASSIFICATION OF ELECTRICAL MACHINES


ELECTRICAL MACHINES
DIRECT CURRENT (D.C) ELECTRIC MACHINES
ALTERNATING CURRENT (A.C) ELECTRIC MACHINES
DC GENERATORS
DC MOTORS
ASYNCHRONOUS MACHINES
SYNCHRONOUS MACHINES
TRANSFORMERS
INDUCTION MOTORS
SYNCHRONOUS MOTORS
ALTERNATORS or SYNCHRONOUS GENERATORS
1-P I.M
3-P I.M

GENERATOR PRINCIPLE

An electric generator is based on the principle of dynamically induced EMF.

This is nothing but FARADAY'S LAW OF ELECTROMAGNETIC INDUCTION

FARADAY'S LAW OF ELECTROMAGNETIC INDUCTION

FIRST LAW:

- Whenever a coil or conductor cuts magnetic field, an EMF is induced in that conductor or coil.

OR

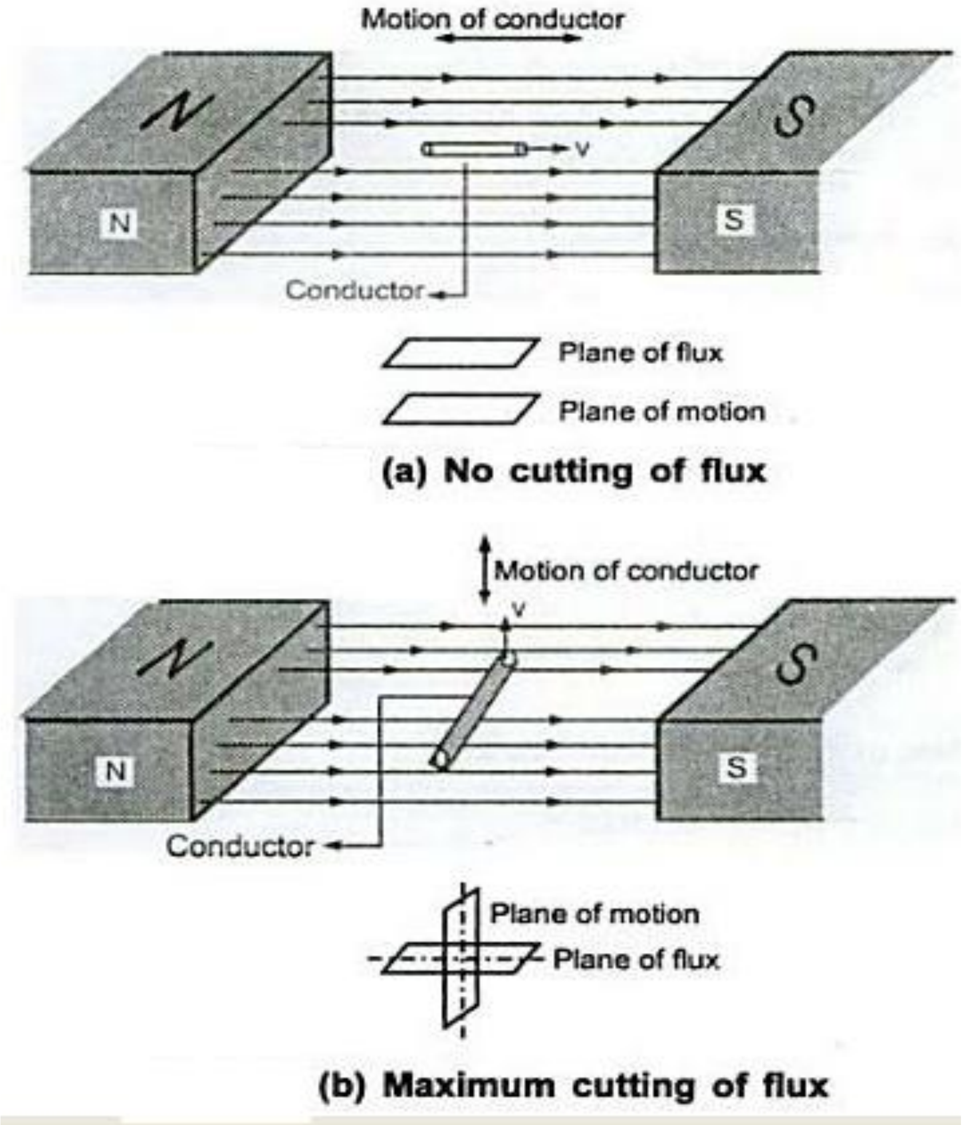
- Whenever magnetic flux linking a coil or conductor changes, an EMF is induced in it.

FARADAY'S LAW OF ELECTROMAGNETIC INDUCTION

SECOND LAW:

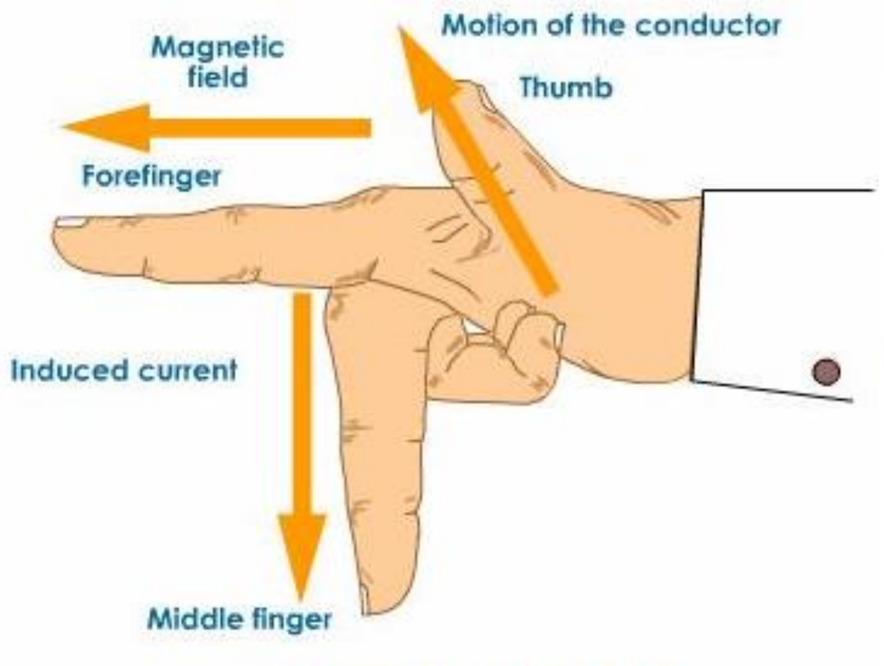
- It states that magnitude of induced EMF in a conductor or coil is equal to rate of change of flux linkages

DYNAMICALLY INDUCED EMF

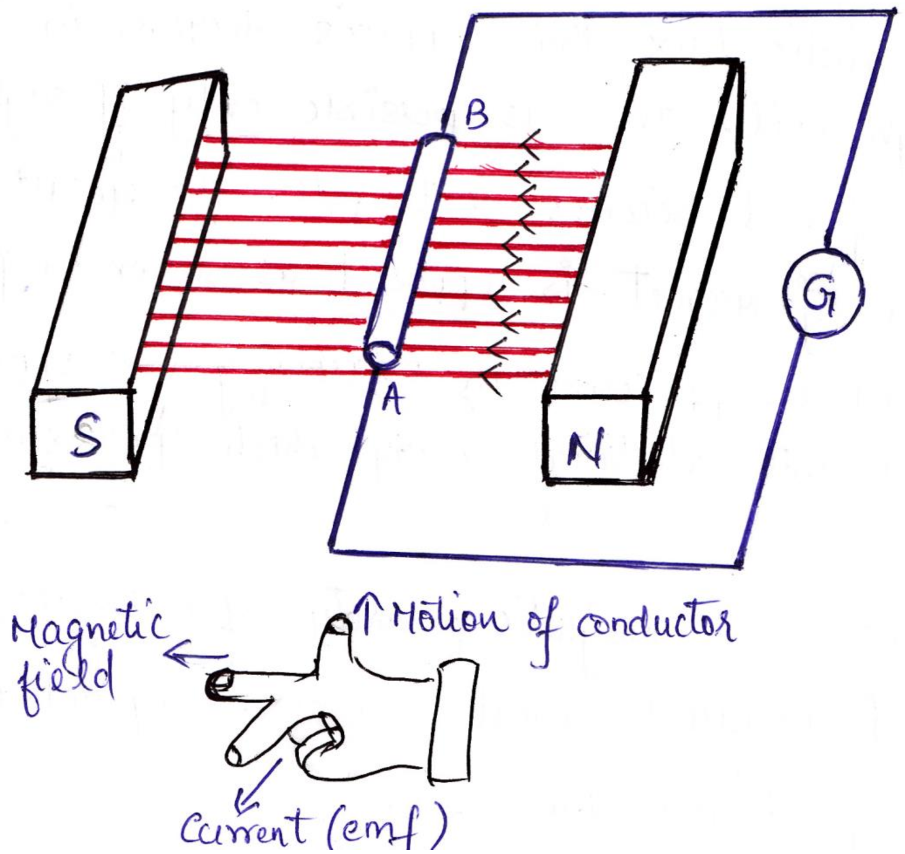


- When the conductor is parallel to direction of magnetic field, there is no cutting of flux. Hence no E.M.F is induced
- When the conductor is perpendicular to direction of magnetic field, there is max cutting of flux. Hence max E.M.F is induced

FLEMING'S RIGHT HAND RULE



Fleming's Right Hand Rule



ESSENTIAL REQUIREMENTS OF A GENERATING ACTION

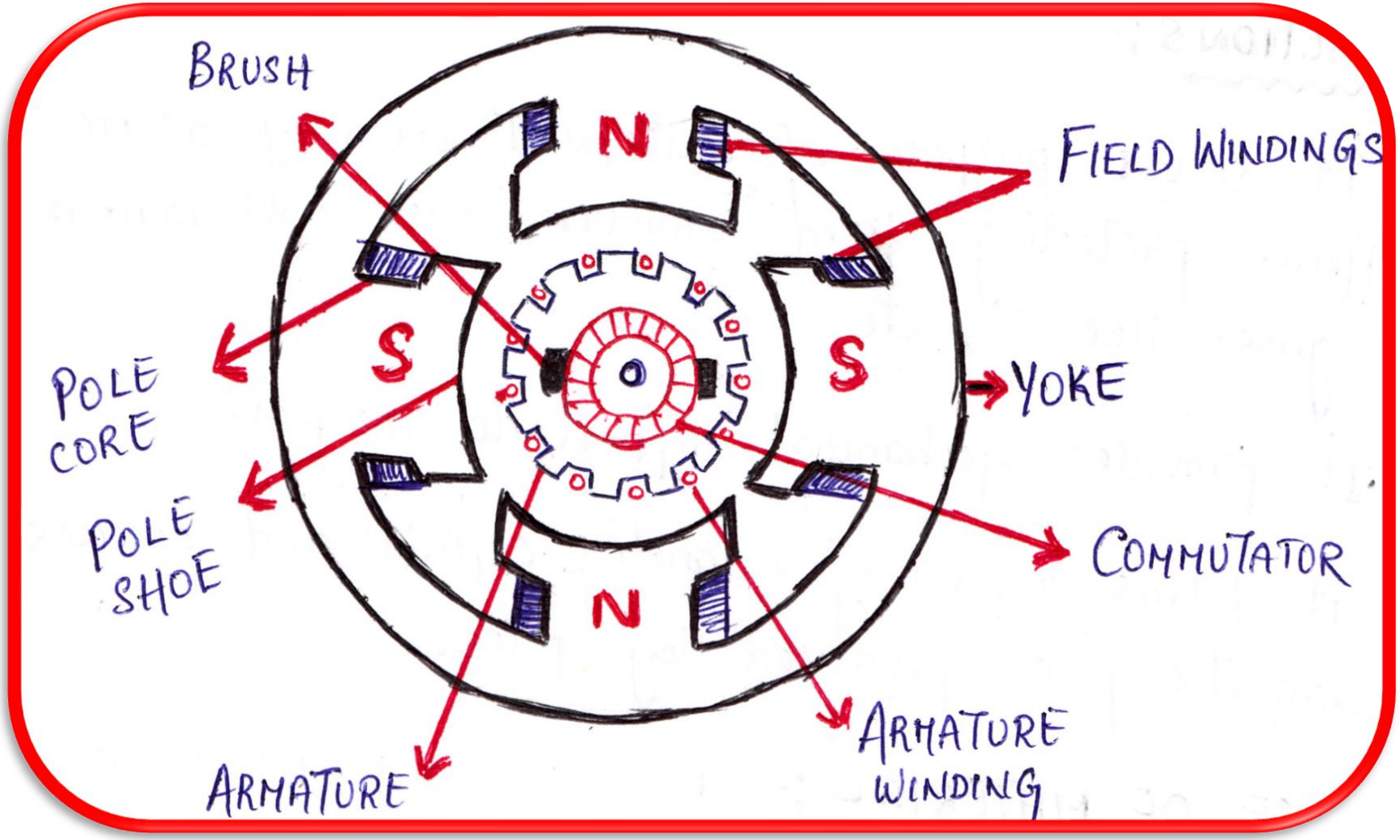
UNIFORM MAGNETIC FIELD

CONDUCTOR OR GROUP OF CONDUCTORS

RELATIVE MOTION OF CONDUCTOR W.R.T MAGNETIC FIELD

CONSTRUCTIONOF DC GENERATOR

CONSTRUCTION OF PRACTICAL DC GENERATOR



ESSENTIAL PARTS OF PRACTICAL GENERATOR

- YOKE
- POLES
- FIELD WINDING
- ARMATURE
- COMMUTATOR
- BRUSHES

YOKE

- **Serves outermost cover of dc machine protecting it from moisture, dust and harmful gases.**
- **Provides mechanical support**
- **Carries magnetic flux produced by poles**

- Material used is **CAST IRON or CAST STEEL**

POLES

- Every pole is divided into two parts namely
  - POLE CORE
  - POLE SHOE
- **Pole Core carries field winding which is necessary to produce flux.**
- **Pole Shoe spreads out flux in air-gap**
- **Pole Shoe reduces reluctance of magnetic path**

- Material used **is CAST IRON or CAST STEEL**

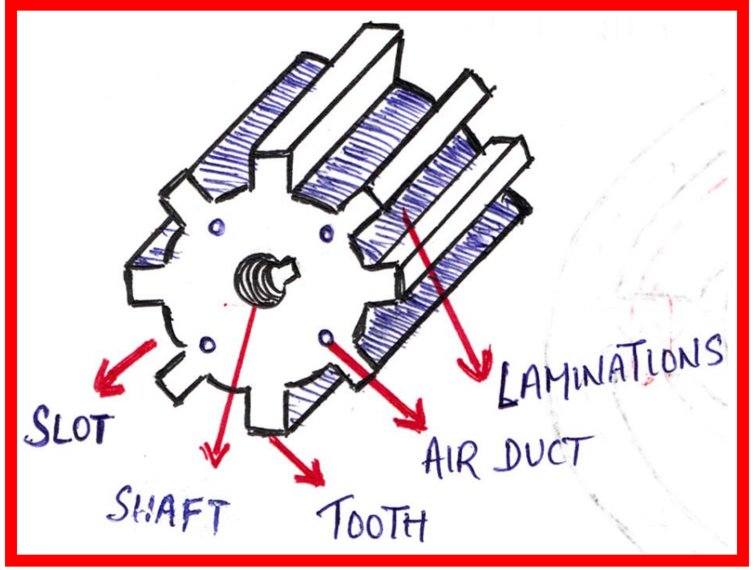
FIELD WINDING

- **To carry current due to which pole core behaves as Electromagnet.**
- **Helps in producing required flux**

- Since it has to carry current, it should be good conductor of Electricity.
- Also it should have property to bend easily.
- Material used is **COPPER**

ARMATURE

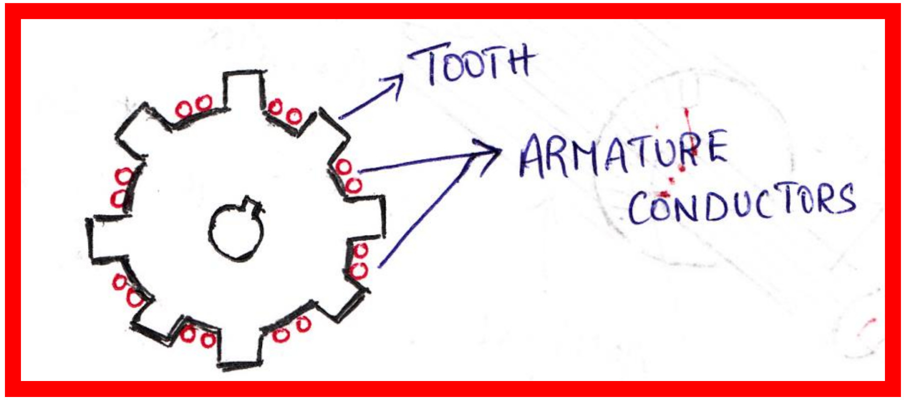
- Armature is divided into two parts
  - ARMATURE CORE
  - ARMATURE WINDING
- Armature core is cylindrical in shape mounted on the shaft.
- It consists of slots on its periphery.
- Laminations are provided to reduces eddy current losses.
- It contains air ducts to allow air flow through armature for cooling purposes.



ARMATURE CORE & ARMATURE WINDING

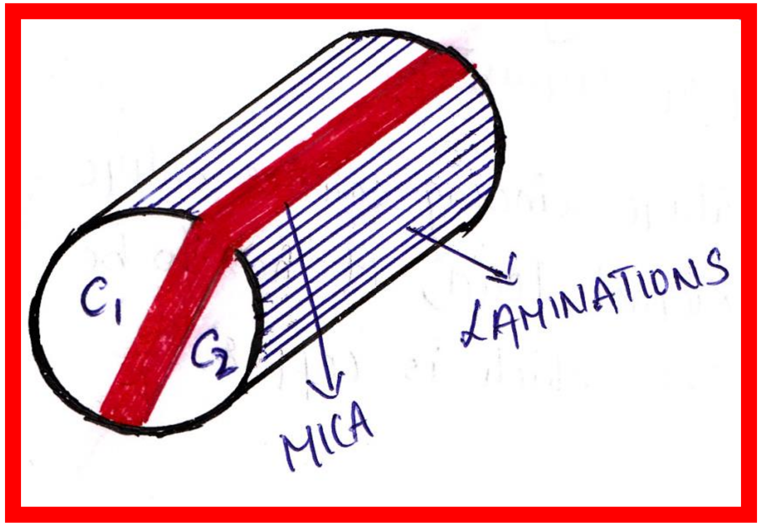
- **Armature Core holds the armature conductors**
- **It Provides low reluctance path to magnetic flux.**
- Armature Winding is interconnection of armature conductors, placed in slots provided in armature core.
- **In case of Generators, generation of EMF takes place in Armature Windings.**
- Material used is

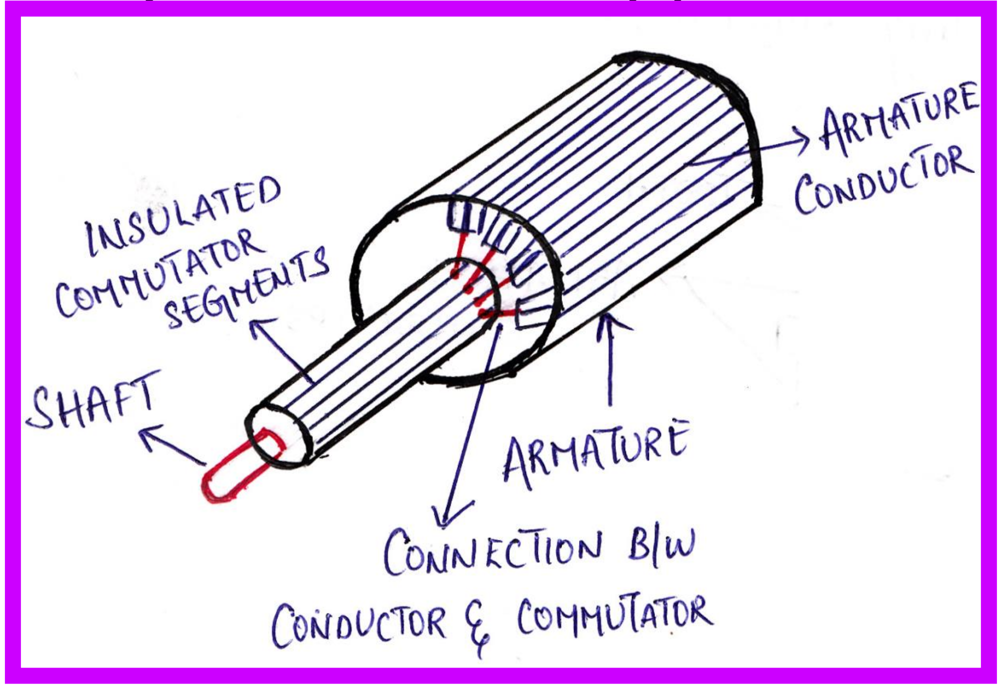
CAST IRON or CAST STEEL



COMMUTATOR

- Commutator is cylindrical in shape
- It consists of copper segments each insulated by thin layer of mica.
- Each commutator segment is connected to armature conductors by means of Copper strips.





COMMUTATOR

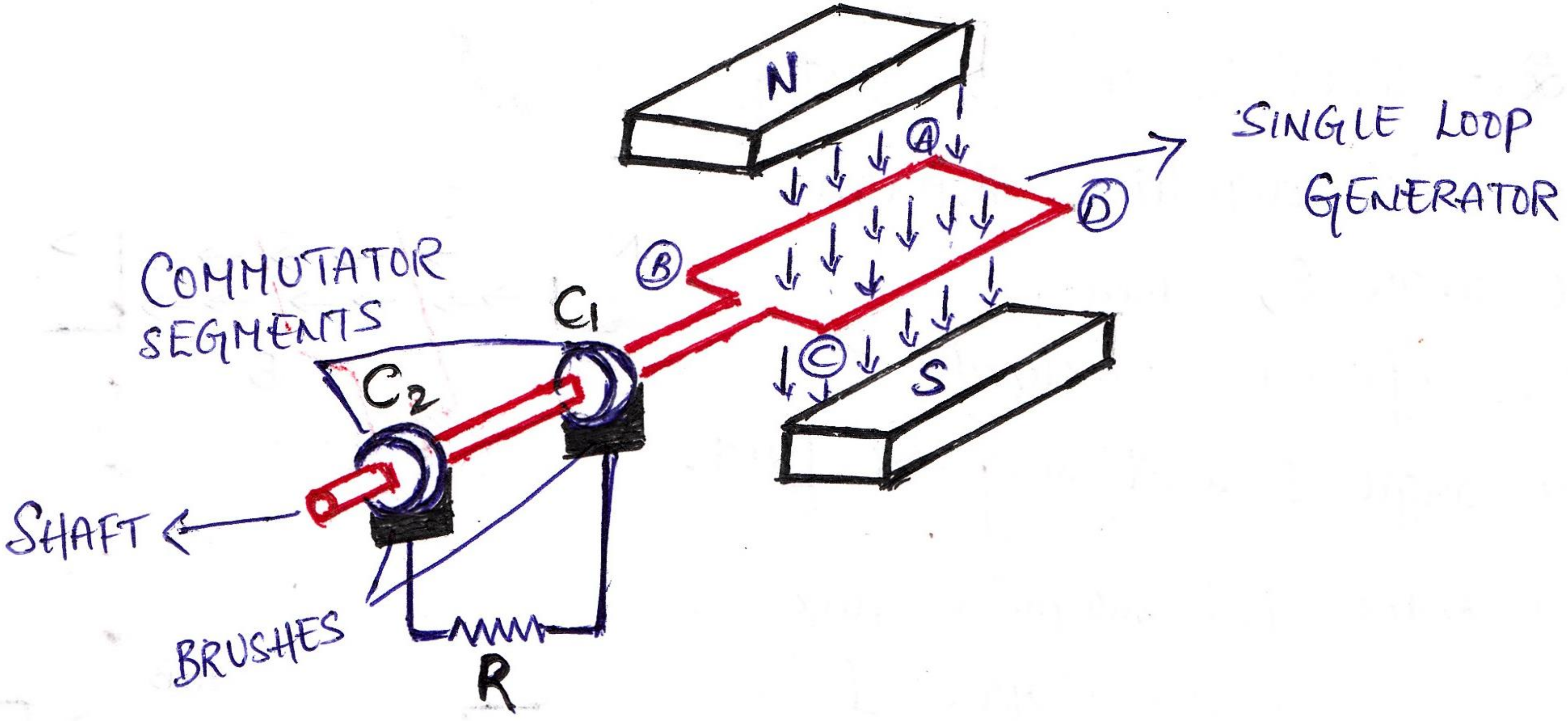
- **Converts Alternating EMF to unidirectional EMF**
- **Collects current from armature conductors**

- Since it carries current it should be made of conducting material
- Material used is COPPER.

BRUSHES

- **To collect current from commutator and make it available to external circuit.**
- Material used is **CARBON** to avoid wear and tear of commutator.

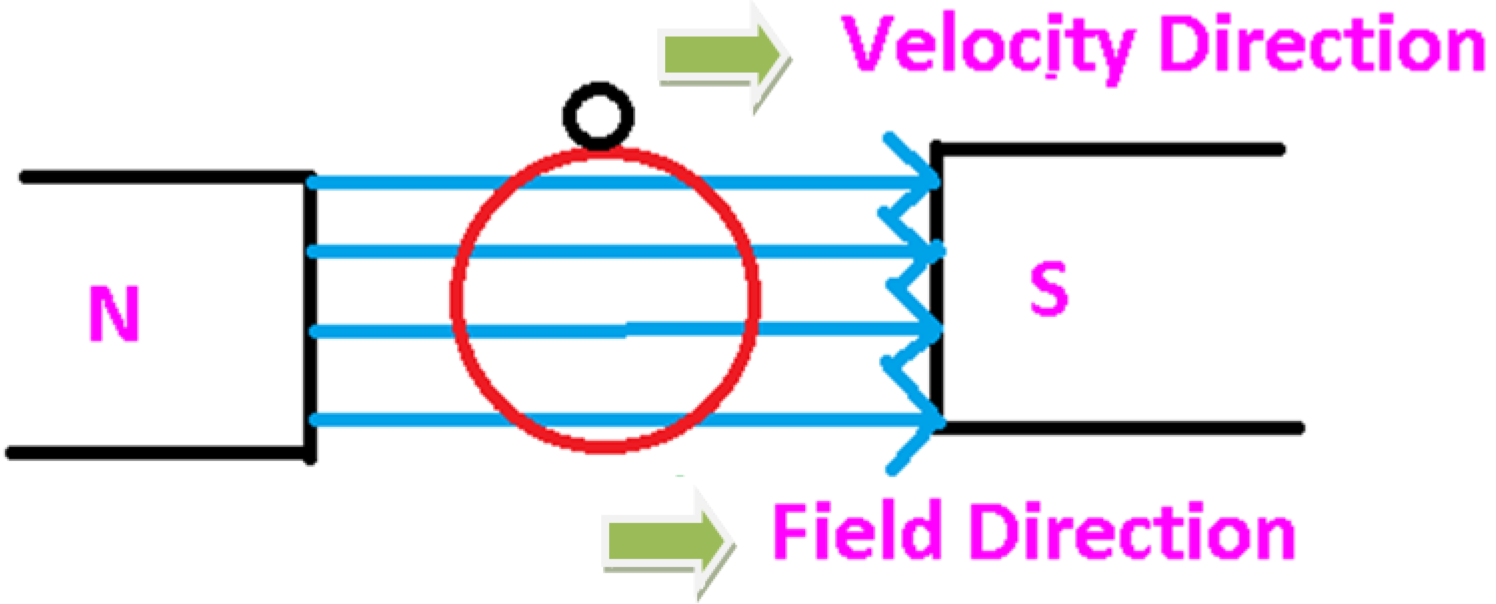
OVERALL CONSTRUCTION



WORKING OF DC GENERATOR

METHOD-1

POSITION-1

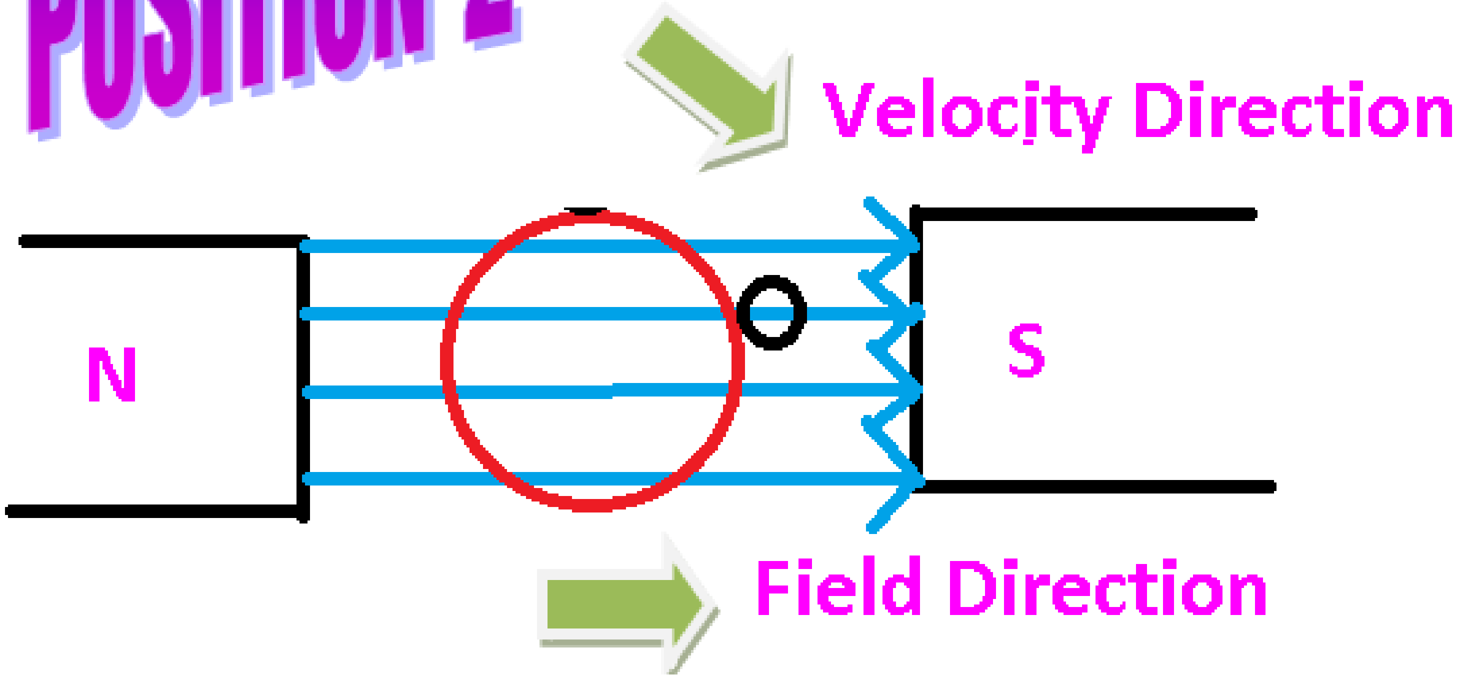


In this position,

θ is 0°, so According to EMF equation

$e = Blv \sin\theta \rightarrow \boxed{e = 0}$

POSITION-2

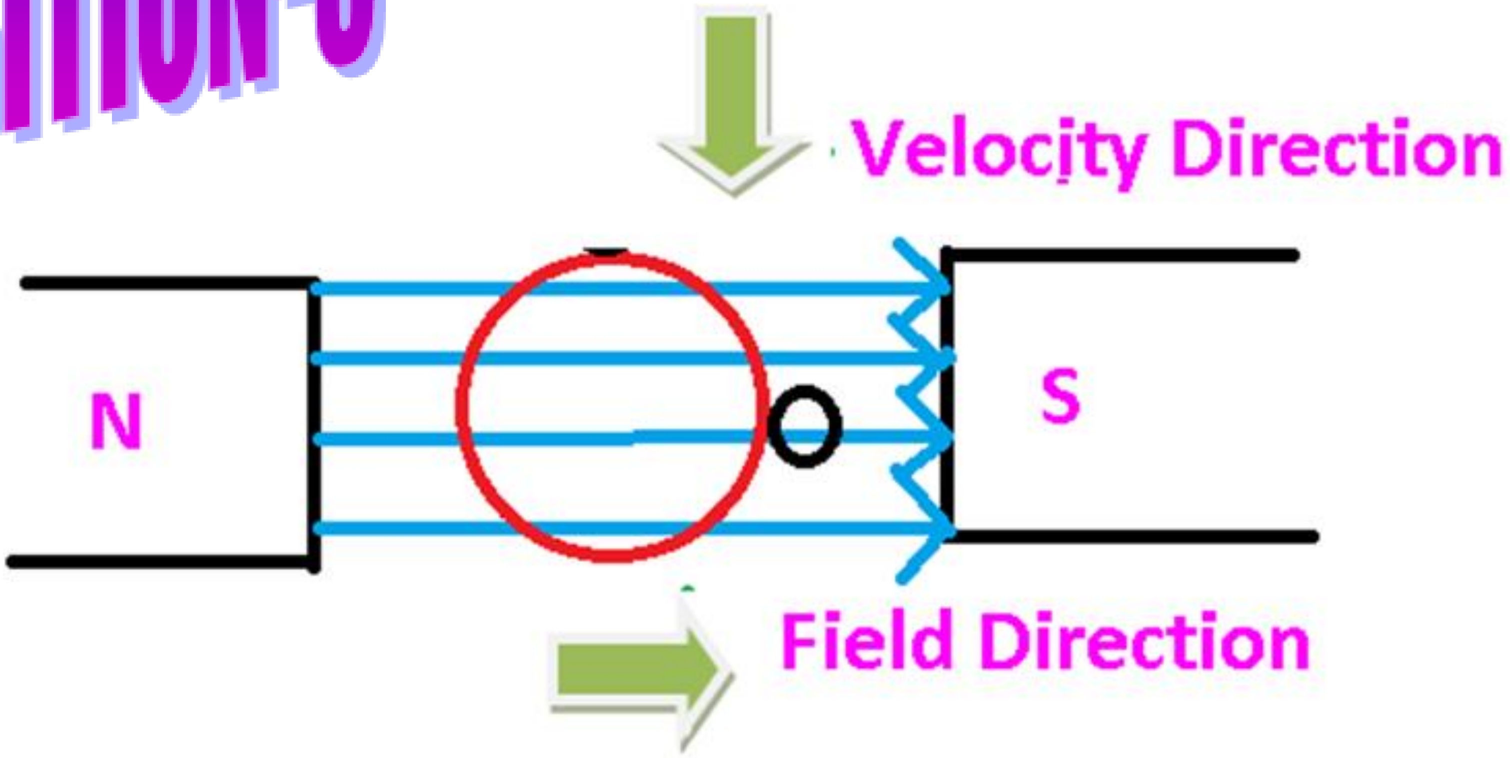


In this position,

θ is +ve value, so According to EMF equation

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

POSITION-3

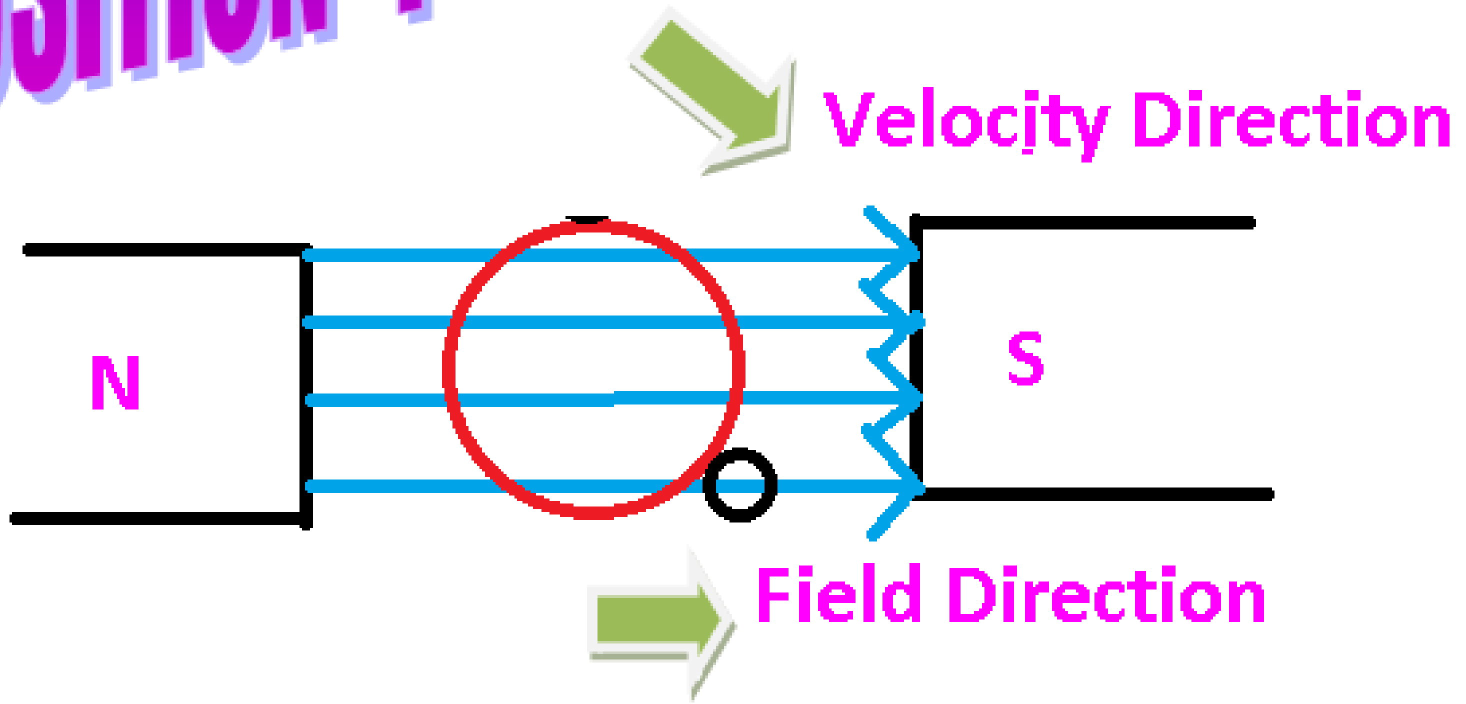


In this position,

θ is 90°, so According to EMF equation

$e = Blv \sin 90 \rightarrow \boxed{e = Blv}$ (+ve max)

POSITION-4

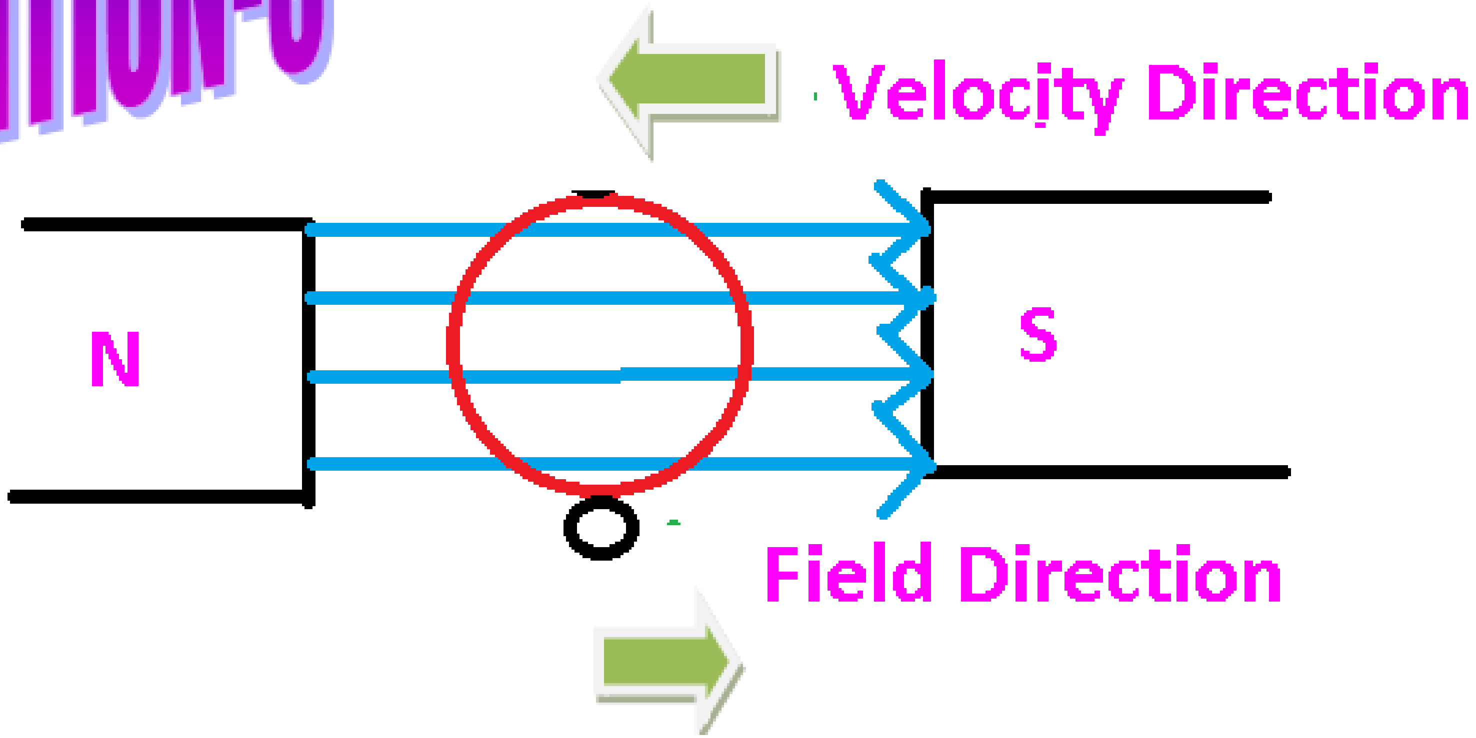


In this position,

θ is again +ve. So According to EMF equation

$e = Blv \sin \theta$

POSITION-5

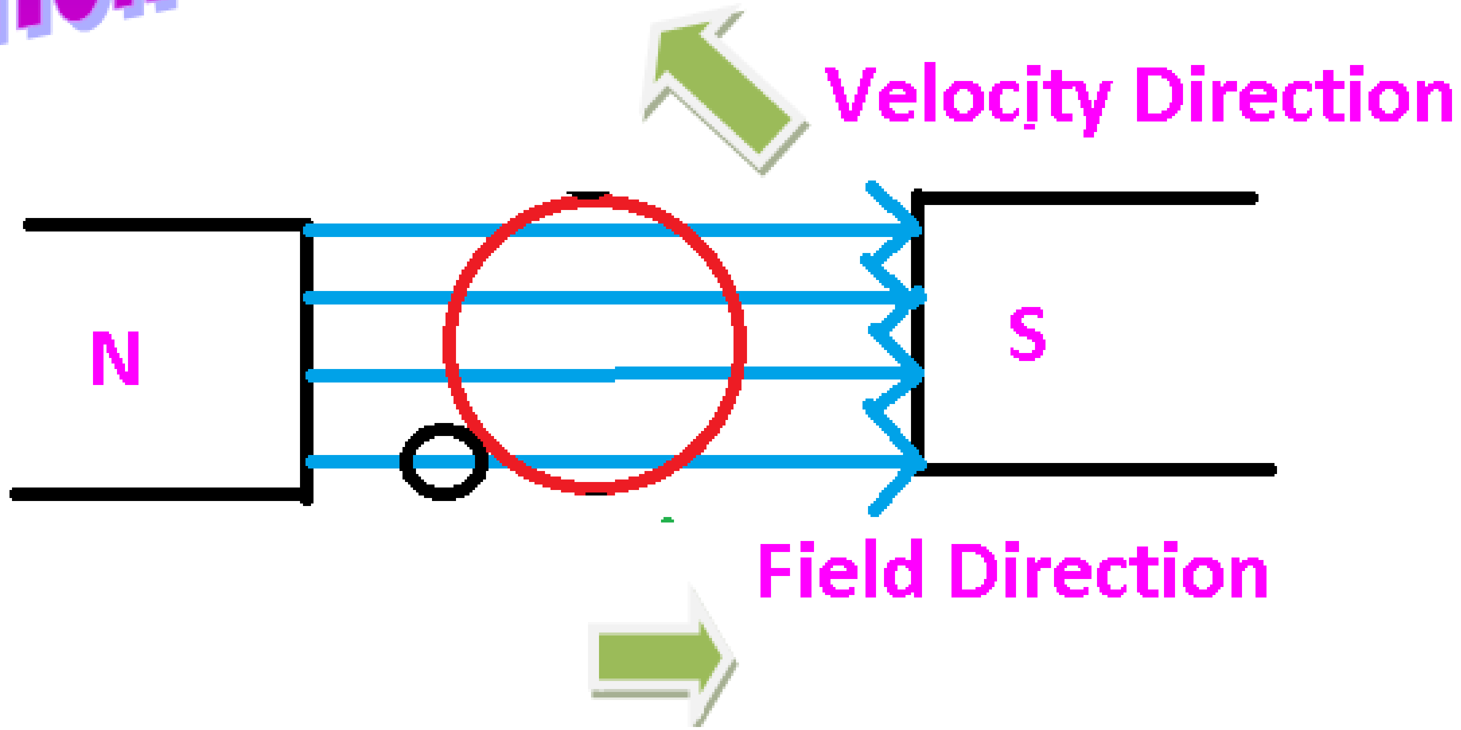


In this position,

θ is 180°. So According to EMF equation

$e = Blv \sin\theta \rightarrow \boxed{e = 0}$

POSITION-6

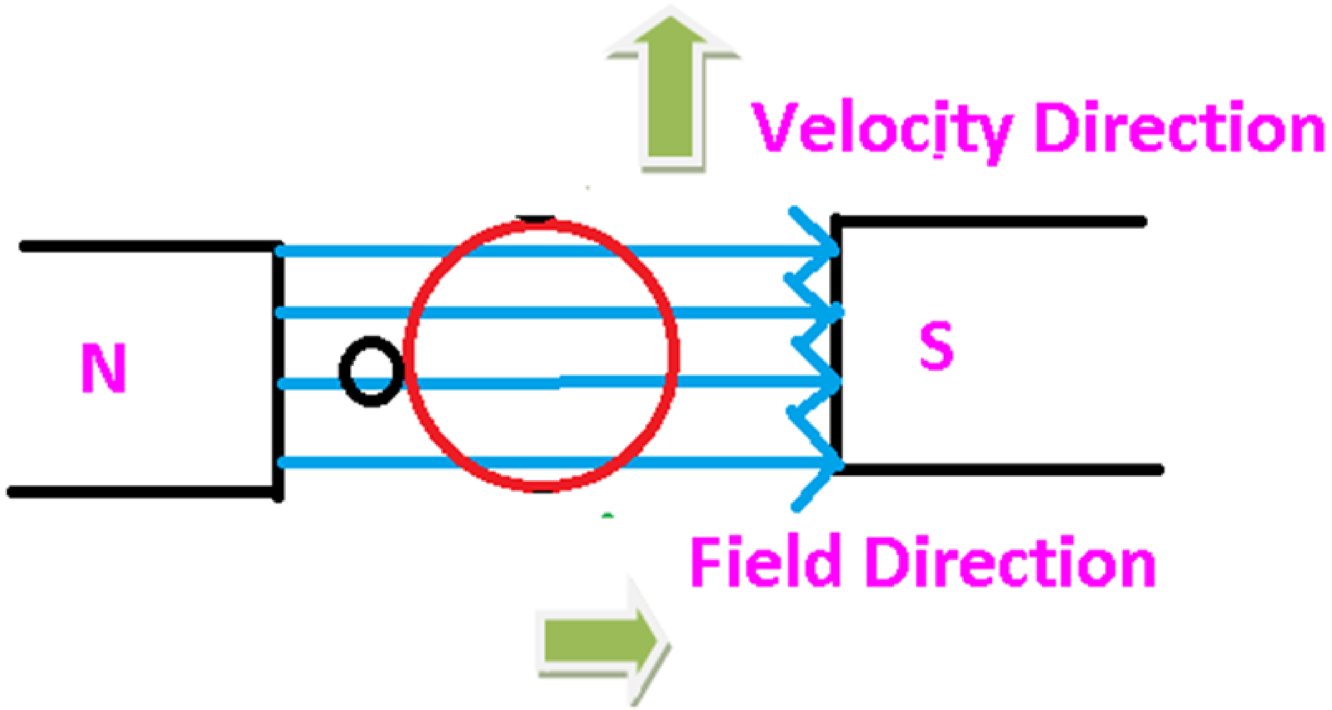


In this position,

θ is –ve value. So According to EMF equation

$e = Blv \sin\theta$ (-ve)

POSITION-7

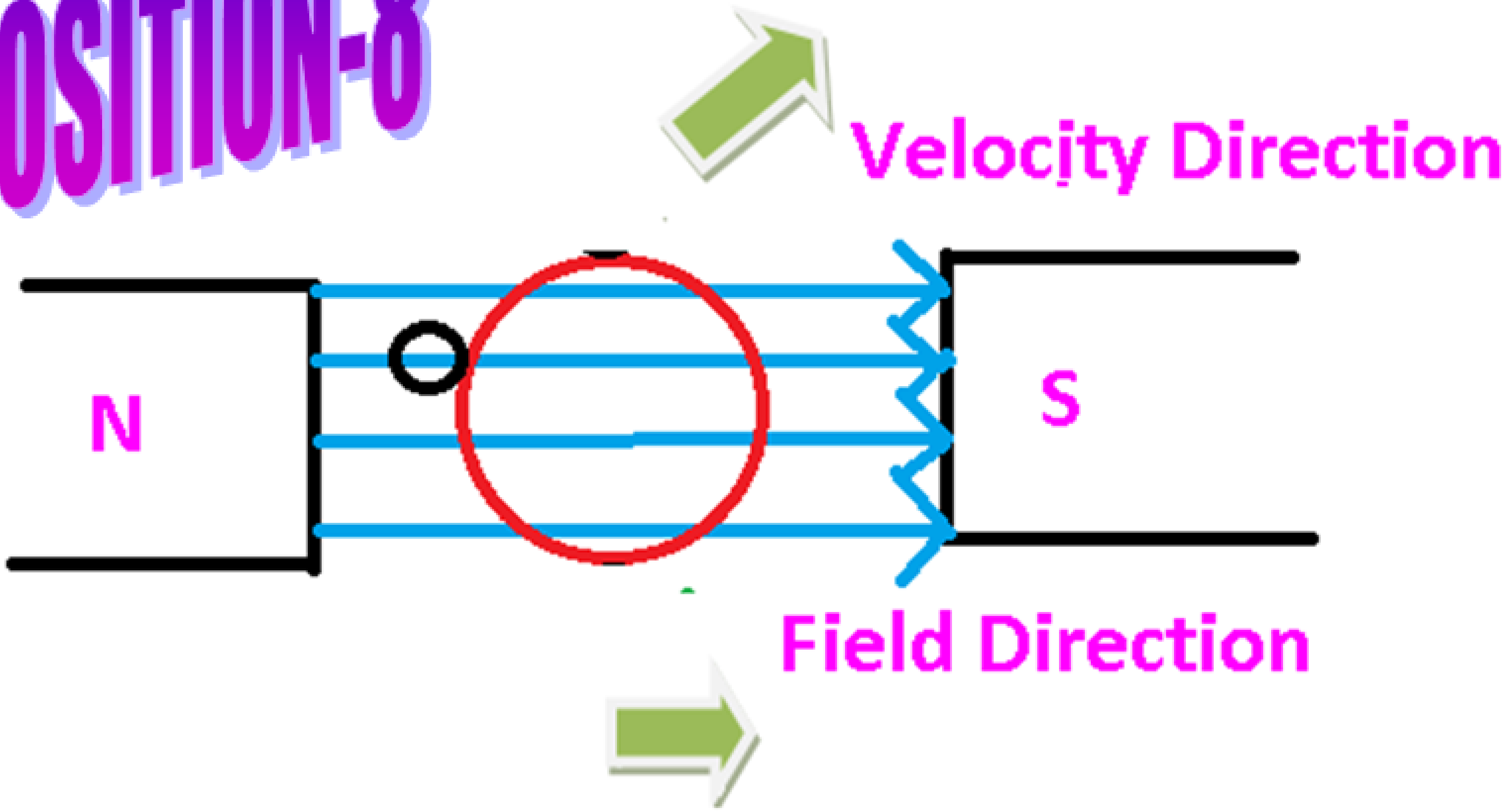


In this position,

θ is $270°$. So According to EMF equation

e= Blv (max -ve)

POSITION-8

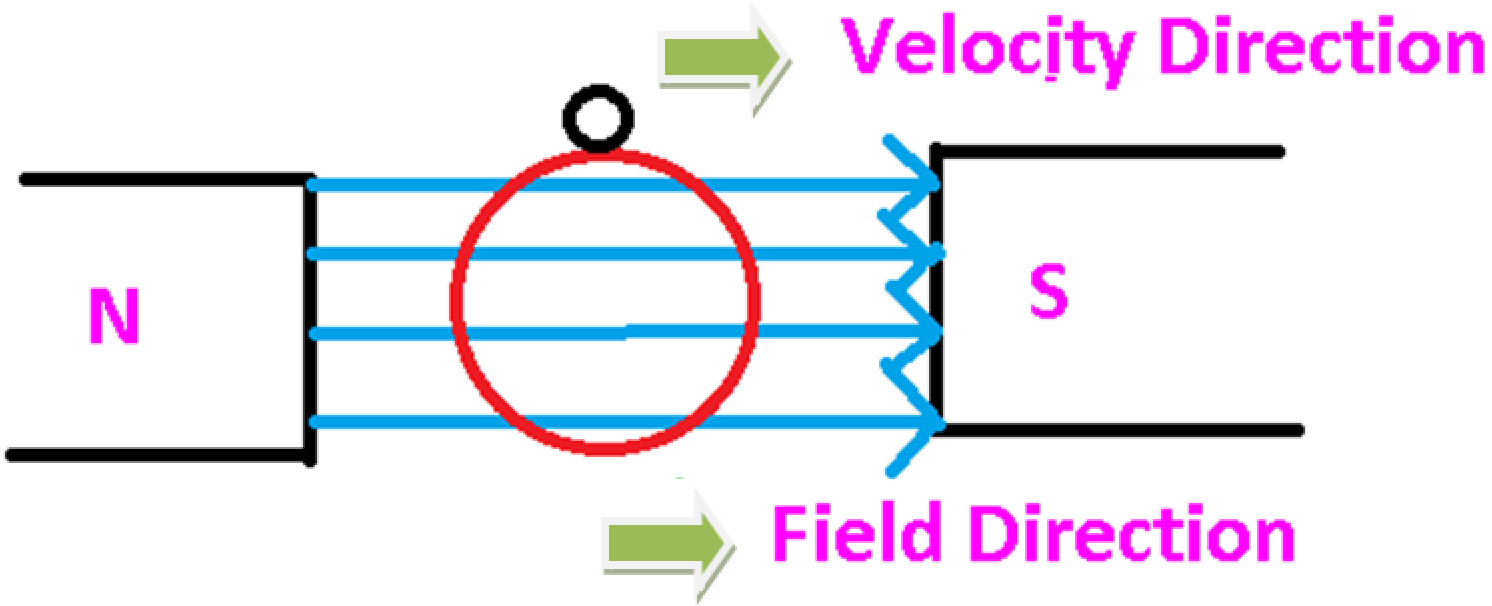


In this position,

θ is again finite value (-ve). So According to EMF equation

$e = Blv \sin\theta$ (-ve)

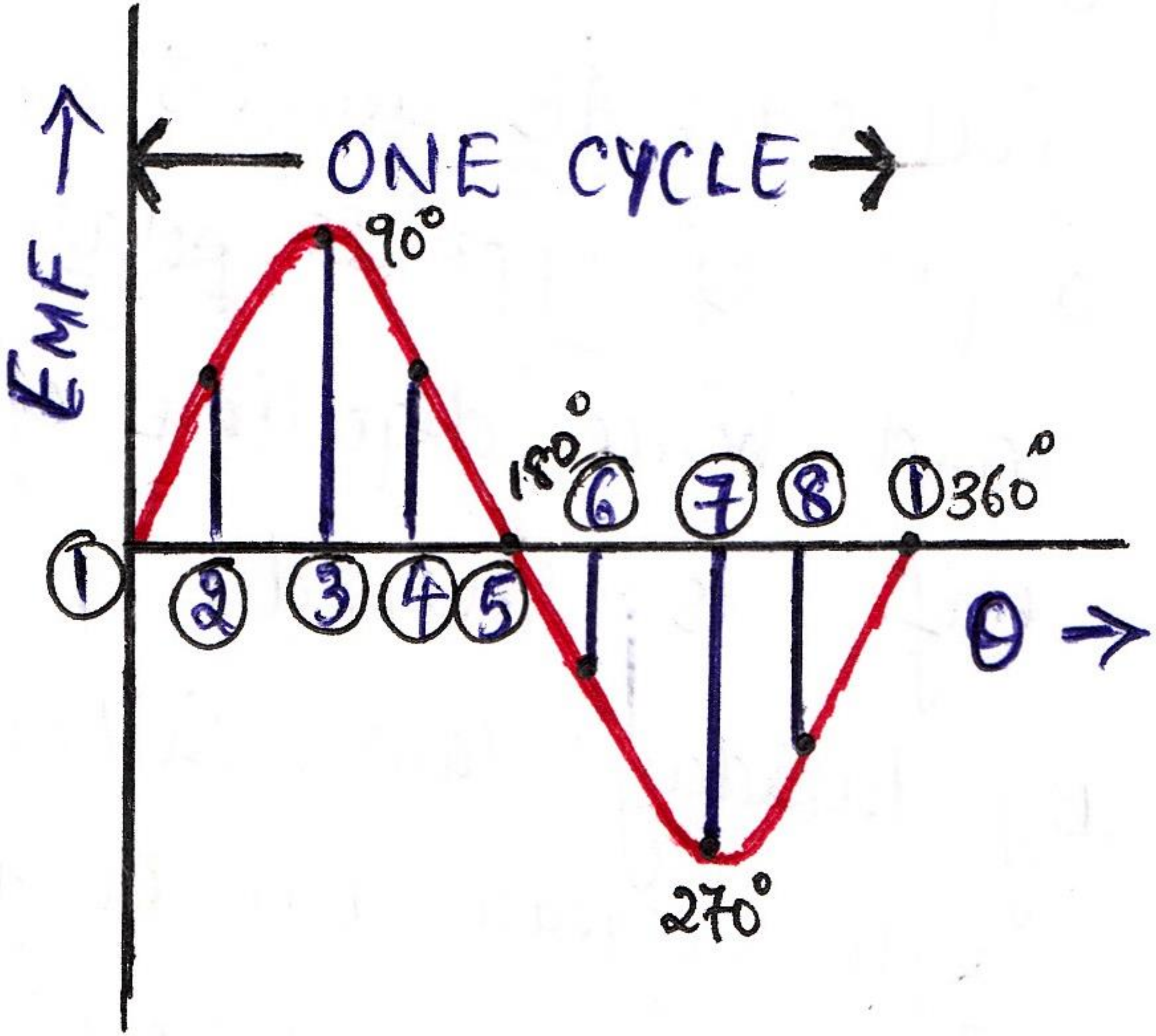
POSITION-1



In this position,

θ is 0°, so According to EMF equation

$e = Blv \sin\theta \rightarrow \boxed{e = 0}$

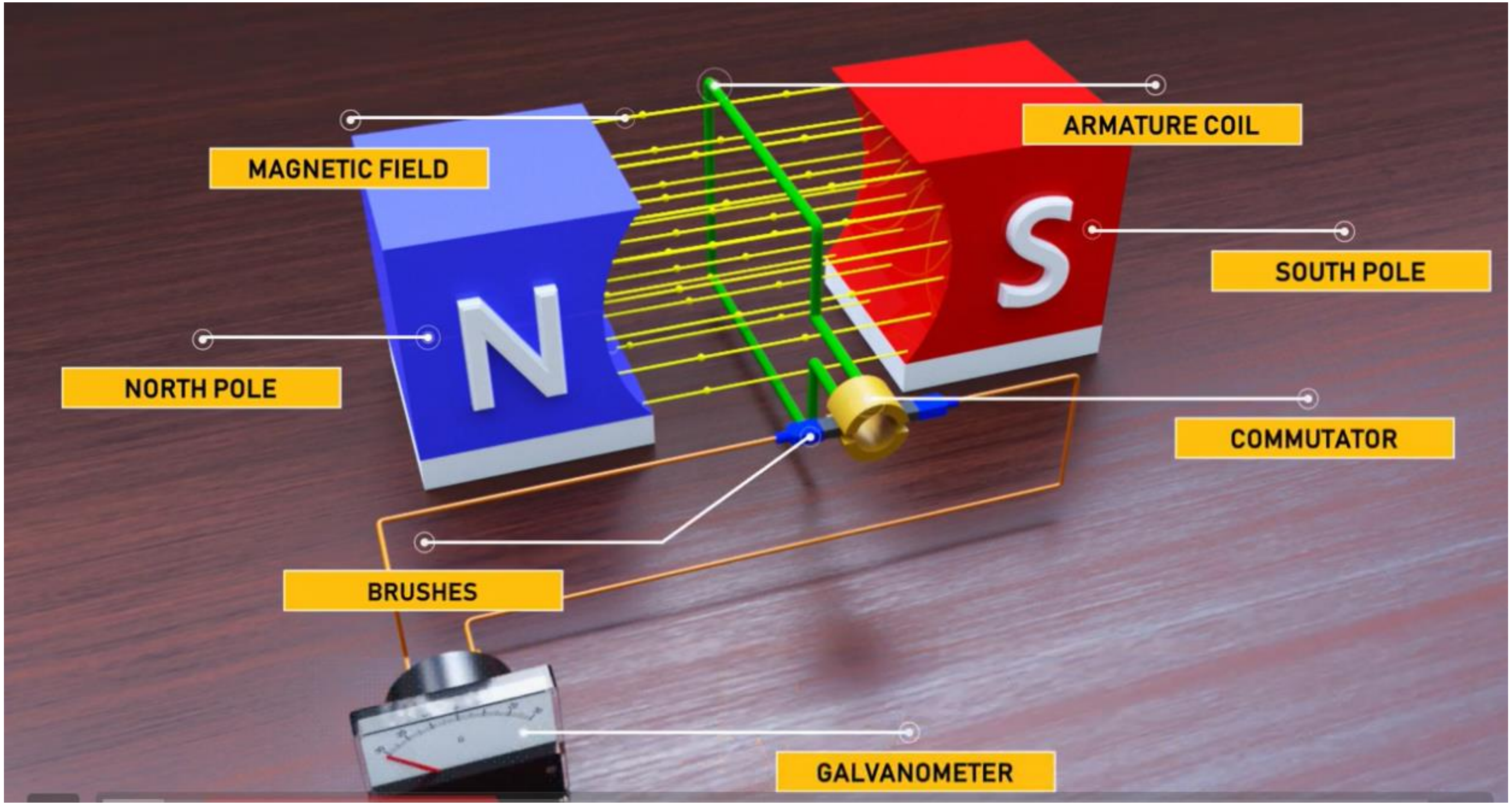

EMF
ONE CYCLE
90°
180°
270°
360°
1
2
3
4
5
6
7
8
1
θ

METHOD-2

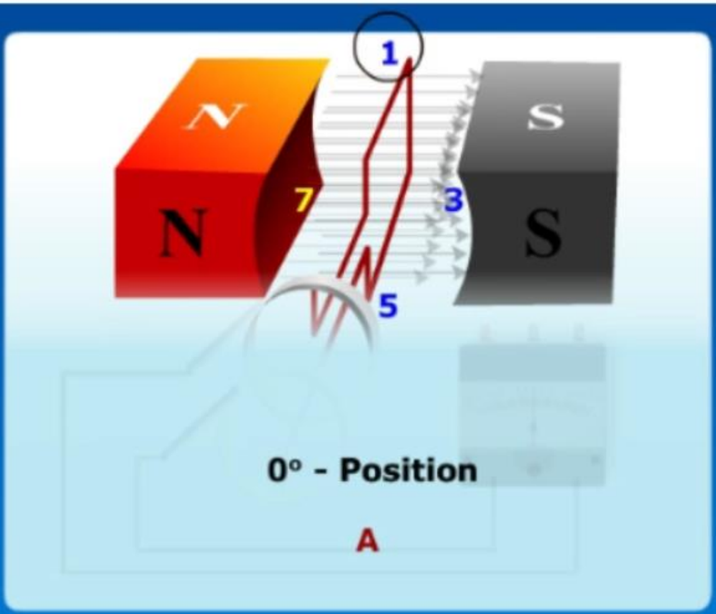
WORKING OF DC GENERATOR

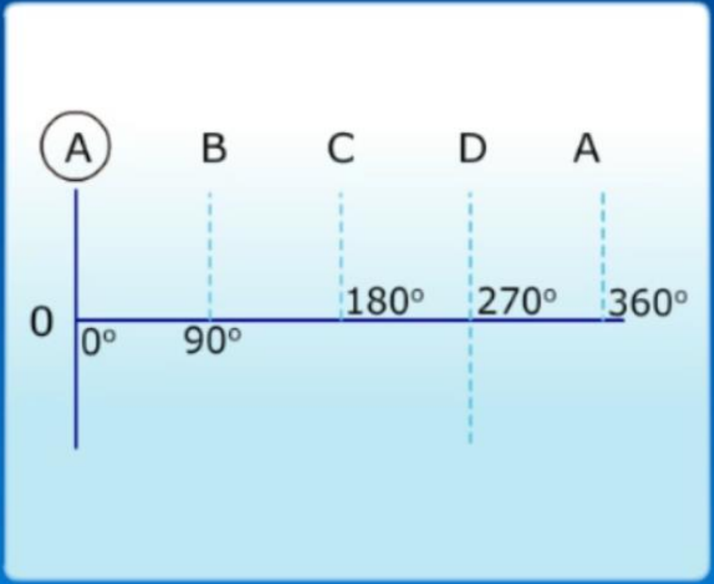
SIMPLE LOOP GENERATOR

SIMPLE LOOP GENERATOR



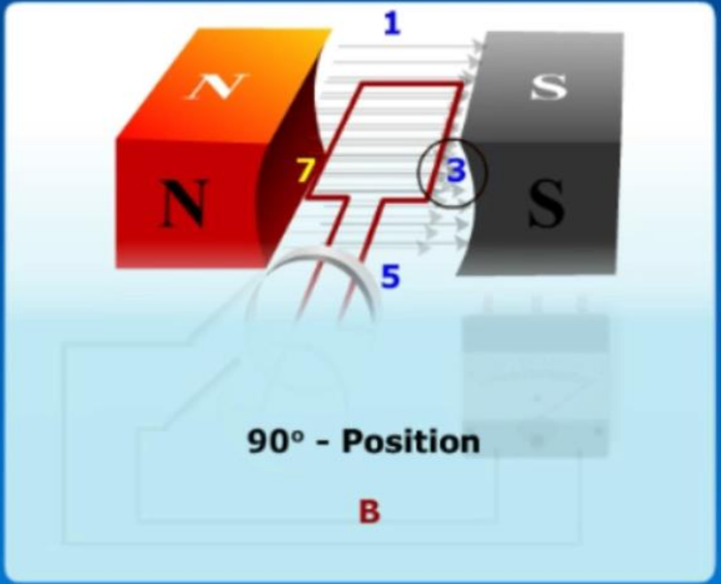
WORKING OF DC GENERATOR

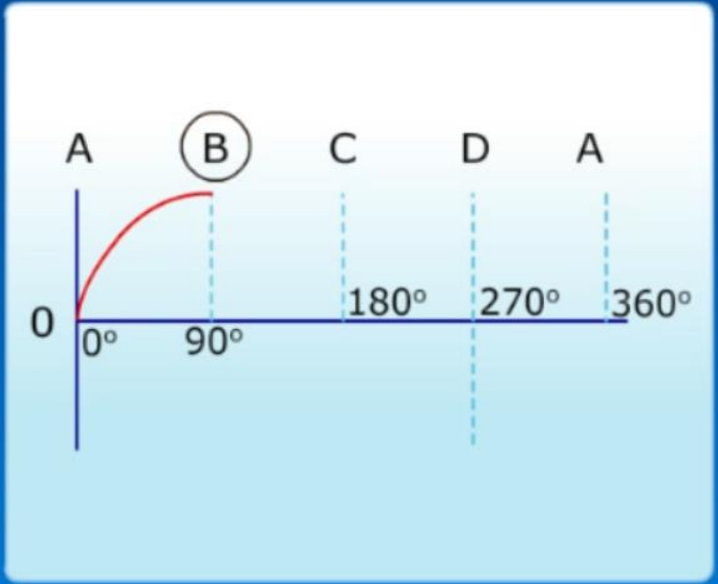




- When the plane of the coil is at right angles to the lines of flux i.e., when it is in position 1, then the flux linked with the coil is maximum, but the rate of change of flux linkages is minimum. Hence, there is no induced e.m.f in the coil.

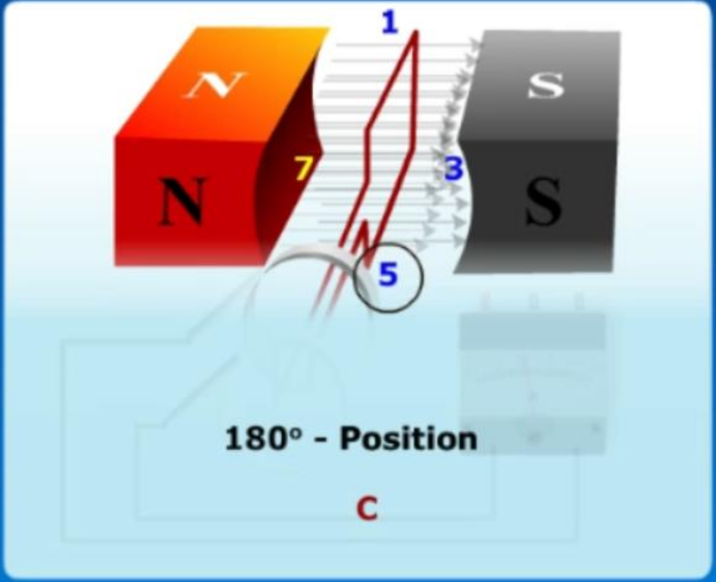
WORKING OF DC GENERATOR

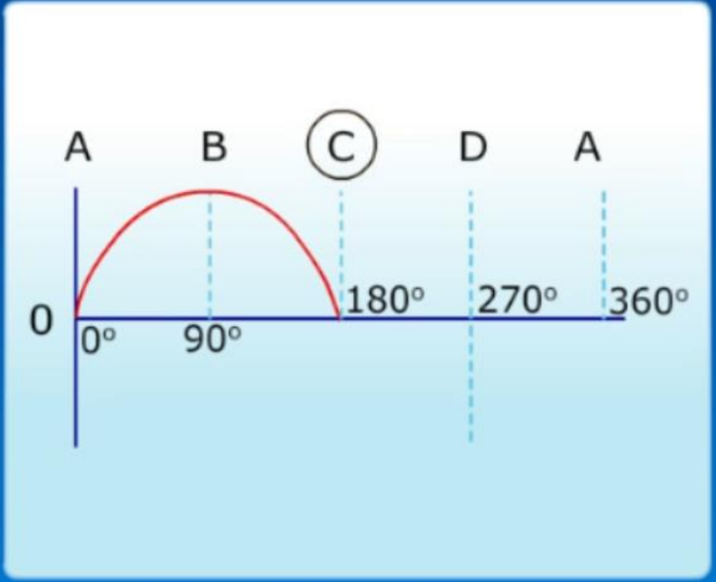




- As the coil continues to rotate further, the rate of change of the flux linkages (and hence induced e.m.f in it) increases, till position 3 is reached where θ= 90º, the coil plane is horizontal i.e. parallel to the lines of the flux. The flux linked with the coil is minimum but the rate of change of flux linkages is maximum. Hence, maximum e.m.f is induced in that position.

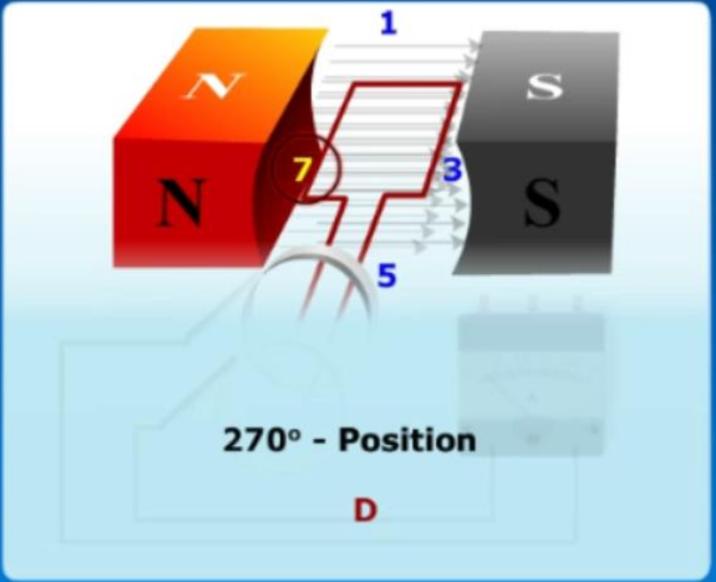
WORKING OF DC GENERATOR

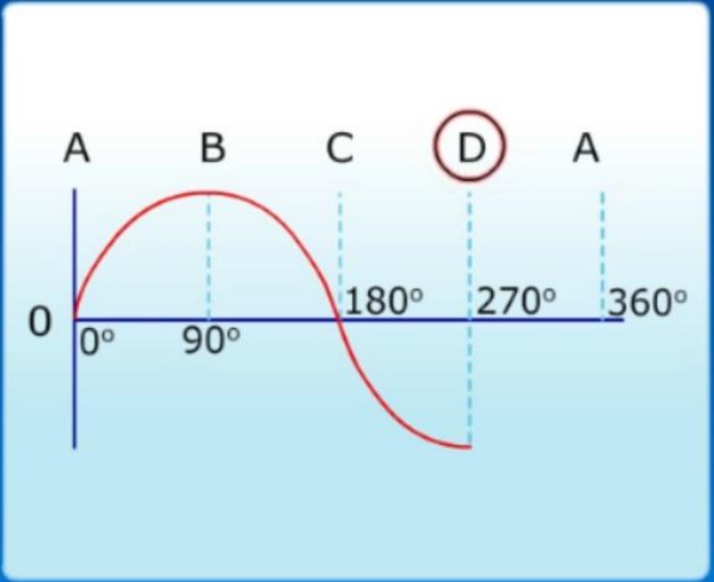




- From 90º to 180º, the flux linked with the coil gradually increases but the rate of change of flux linkages decreases. Hence, the induced e.m.f decreases gradually till in position 5 of the coil, it is reduced to zero value.

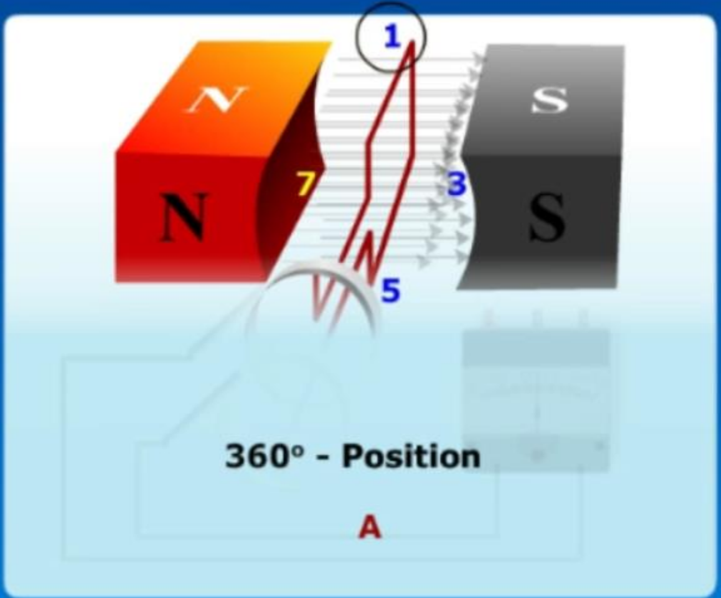
WORKING OF DC GENERATOR

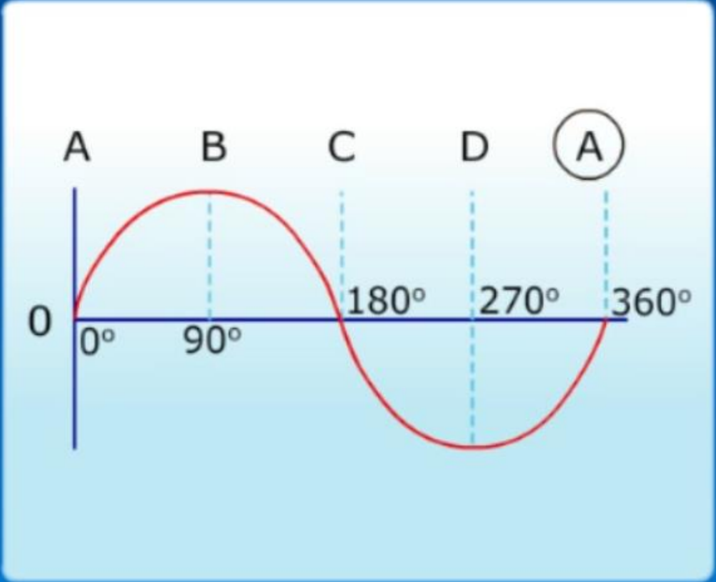




- From 180º to 360º, the variations in the magnitude of e.m.f are similar to those in the first half revolution. Its value is maximum when coil is in position 7 and minimum when in position 1. But the direction of the induced current is reverse of the previous direction of flow.

WORKING OF DC GENERATOR





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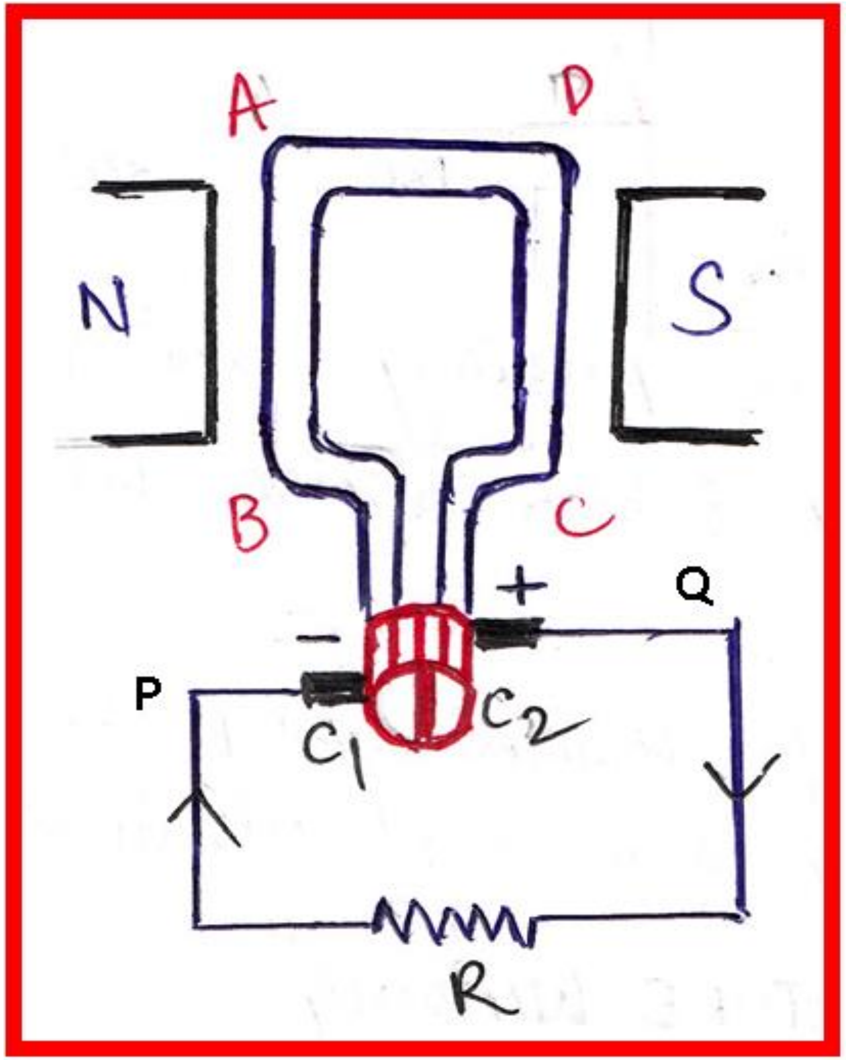
ACTION OF COMMUTATOR

ACTION OF COMMUTATOR

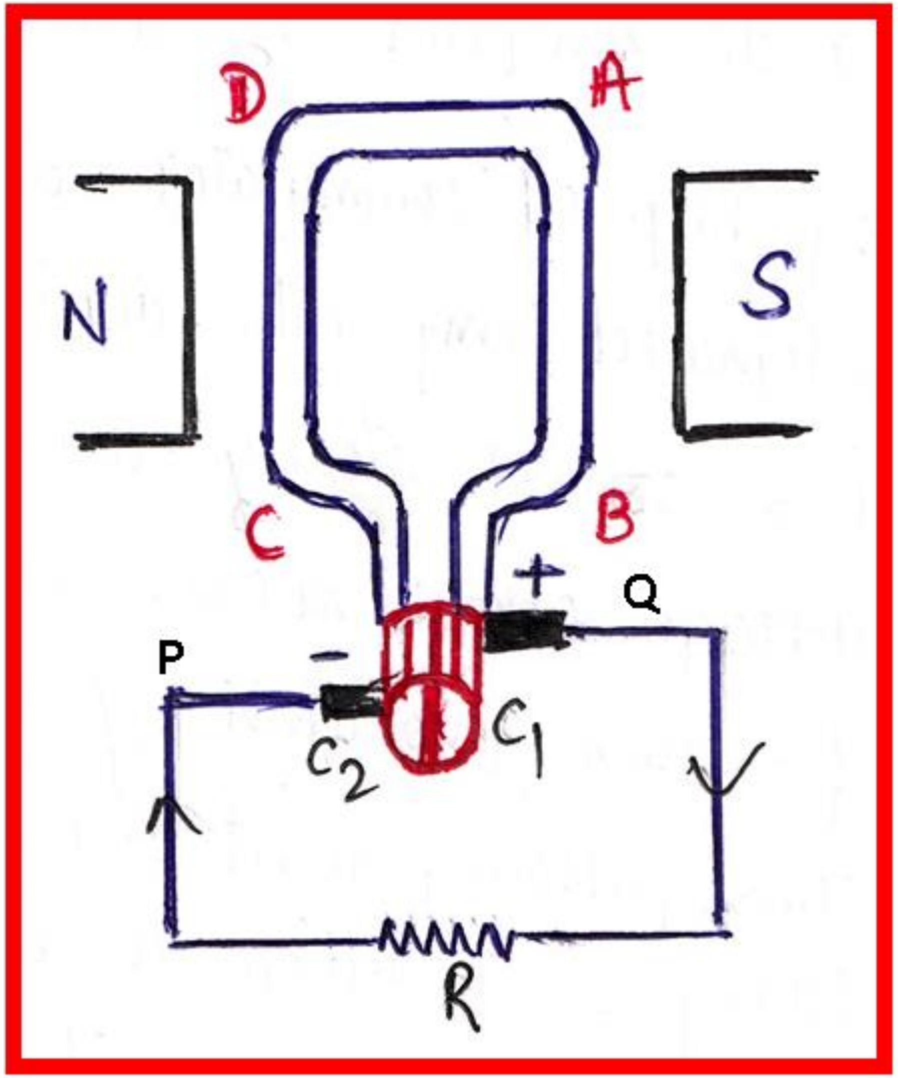
CASE-1



- Coil sides AB and CD are under N-pole & S-pole respectively.
- Segment C1 connects coil side AB to point P to load resistance R.
- Segment C2 connects coil side CD to point Q to load resistance R.
- Current direction is from Q to P.

ACTION OF COMMUTATOR

CASE-2

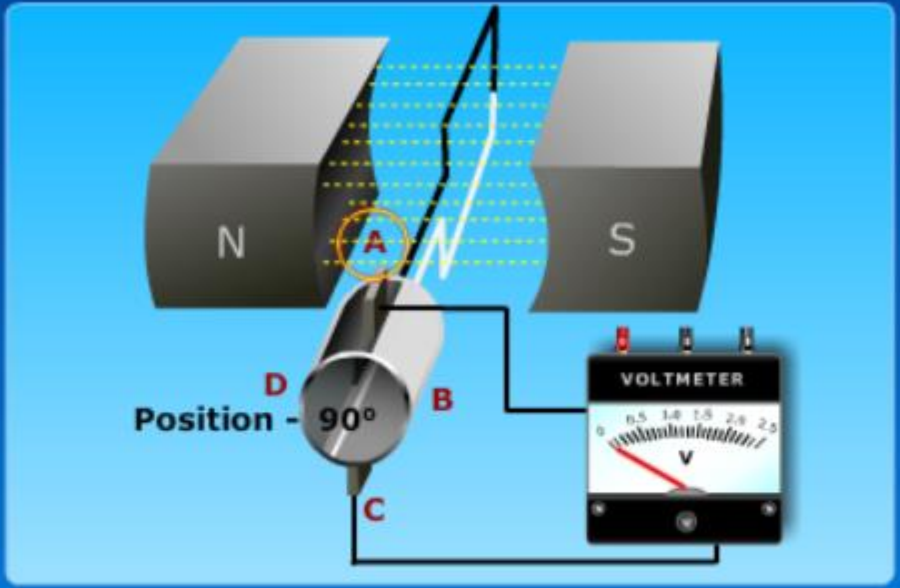


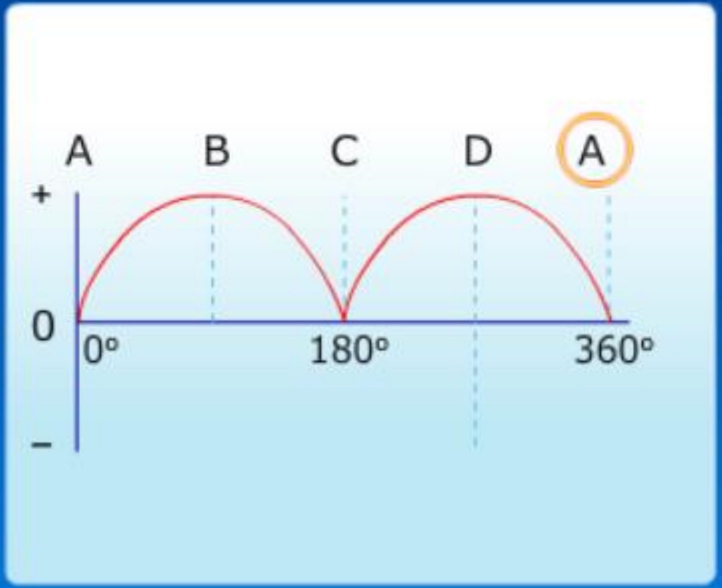
- After half a revolution of loop, coil side AB is under S-pole & CD under N-pole.
- Current in coil now has reversed but segments C1 and C2 have also moved through 180 degrees.
- Commutator has reversed the connections to the load. i.e Coil side AB is now connected to Q of load & Coil side CD is now connected to P of load.
- Direction of current through load is again same i.e Q to P

ACTION OF COMMUTATOR

- It should be noted that currents in coil sides are reversed but at the same time, connections of coil to external load are also reversed.
- Hence current will flow in same direction through the load.
- With the help of commutator, alternating EMF is converted into direct EMF as shown.

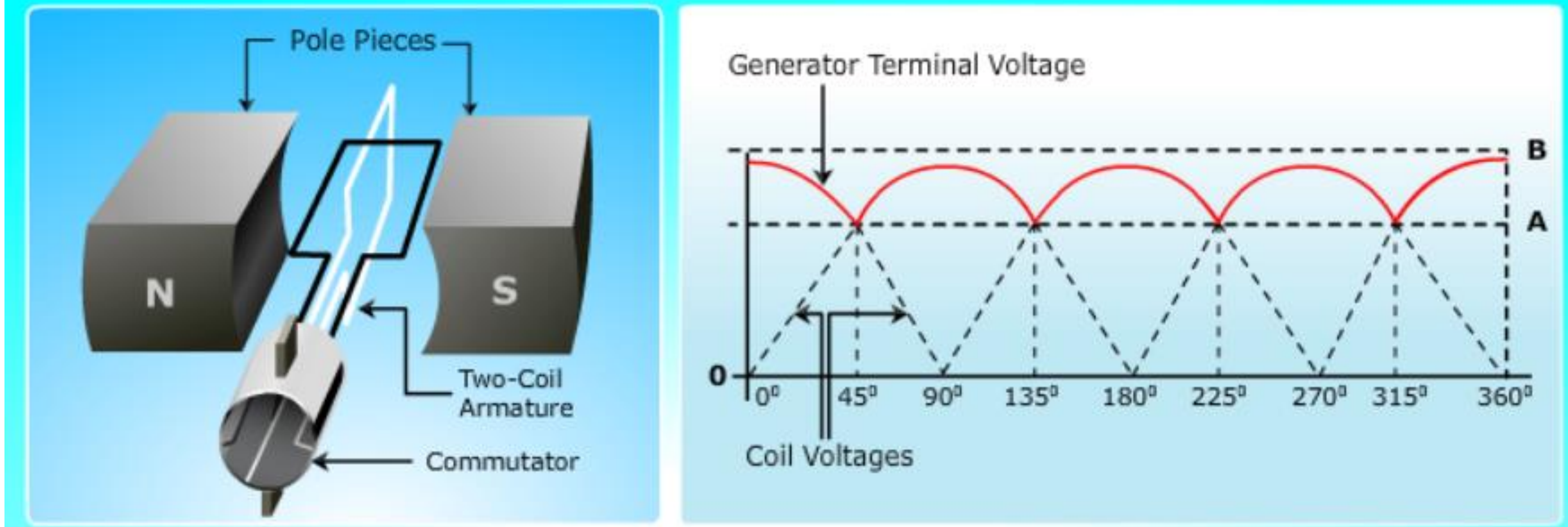
E.M.F Generation in D.C Generator





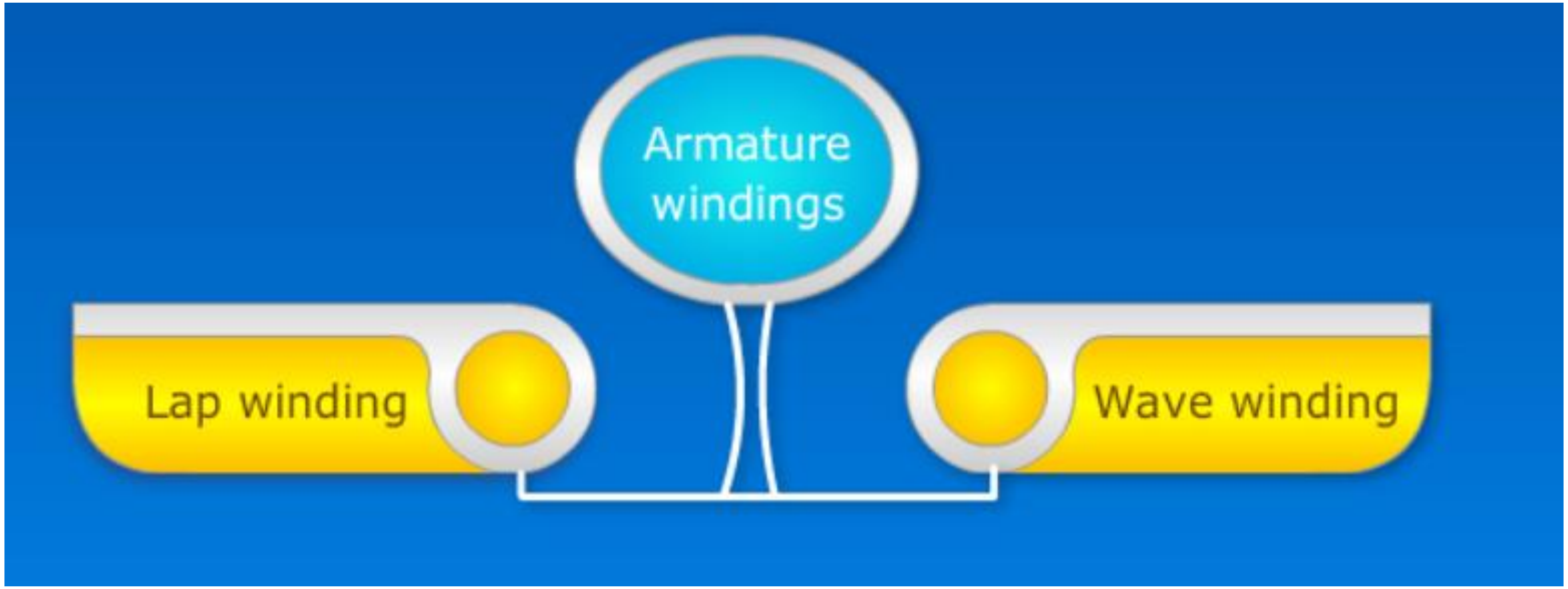
- A pulsating and unidirectional voltage (in one direction only)is developed across the brushes.This voltage varies twice during each revolution between zero and maximum. This variation is called ripple. The ripple voltage will reduce the average value. In order to eliminate this we may use more number of poles or conductors.

EMF GENERATED -TWO COILS



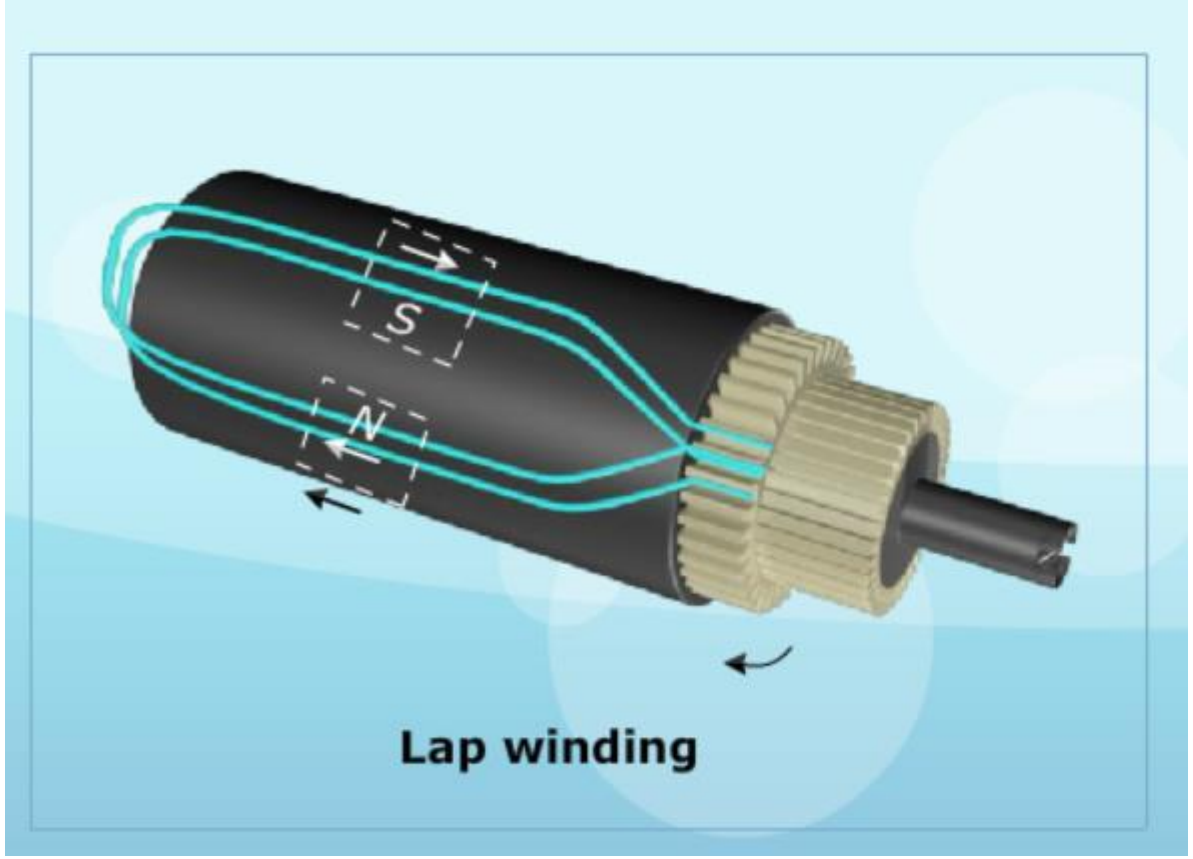
- Effective voltage is the equivalent level of d.c voltage, which will cause the same average current through a given resistance. By using additional armature coils, the voltage across the brushes is not allowed to fall to a low a level, between the peaks.

TYPES OF ARMATURE WINDINGS



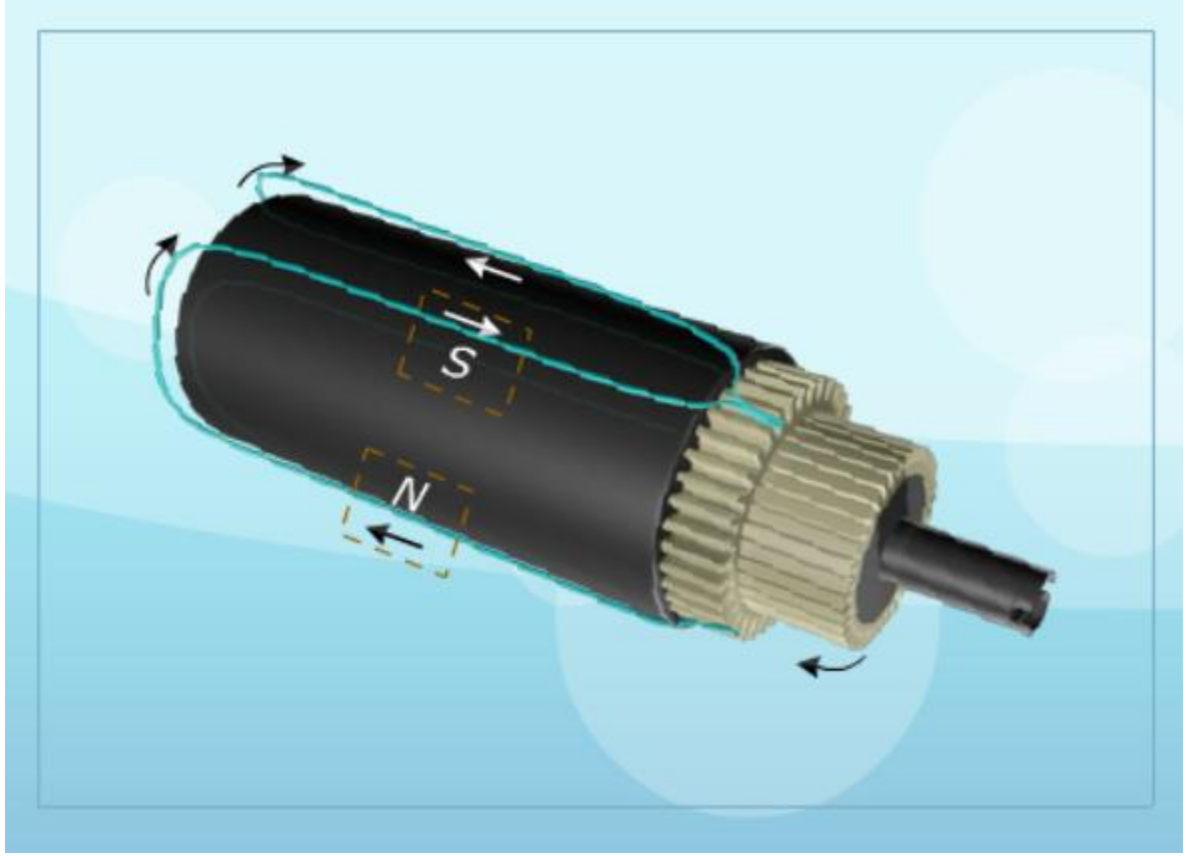
LAP WINDING

No. of Parallel paths = No. of Poles



WAVE WINDING

No. of Parallel Paths = 2



EMF EQUATION OF DC GENERATOR

EMF EQUATION OF GENERATOR

Let ø = Flux per pole in Weber

Z = Total number of conductors

= No. of Slots x No. of conductors/slot

P = No. of Poles

A = No. of Parallel paths

= P (Lap)

= 2 (Wave)

N = Speed of armature in r.p.m

Eg = Generated EMF

EMF generated in one conductor

$$e_g = \frac{Flux\ cut\ by\ a\ conductor\ in\ one\ revolution}{Time\ taken\ for\ 1\ complete\ revolution}$$

EMF EQUATION OF GENERATOR

Flux cut by a conductor in one revolution is Pø

In 60 seconds, it completes N revolutions

So,

Time taken for 1 complete revolution is $\frac{60}{N}$ sec

$$e_g = \frac{P\emptyset}{\frac{60}{N}} = \frac{P\emptyset N}{60}$$

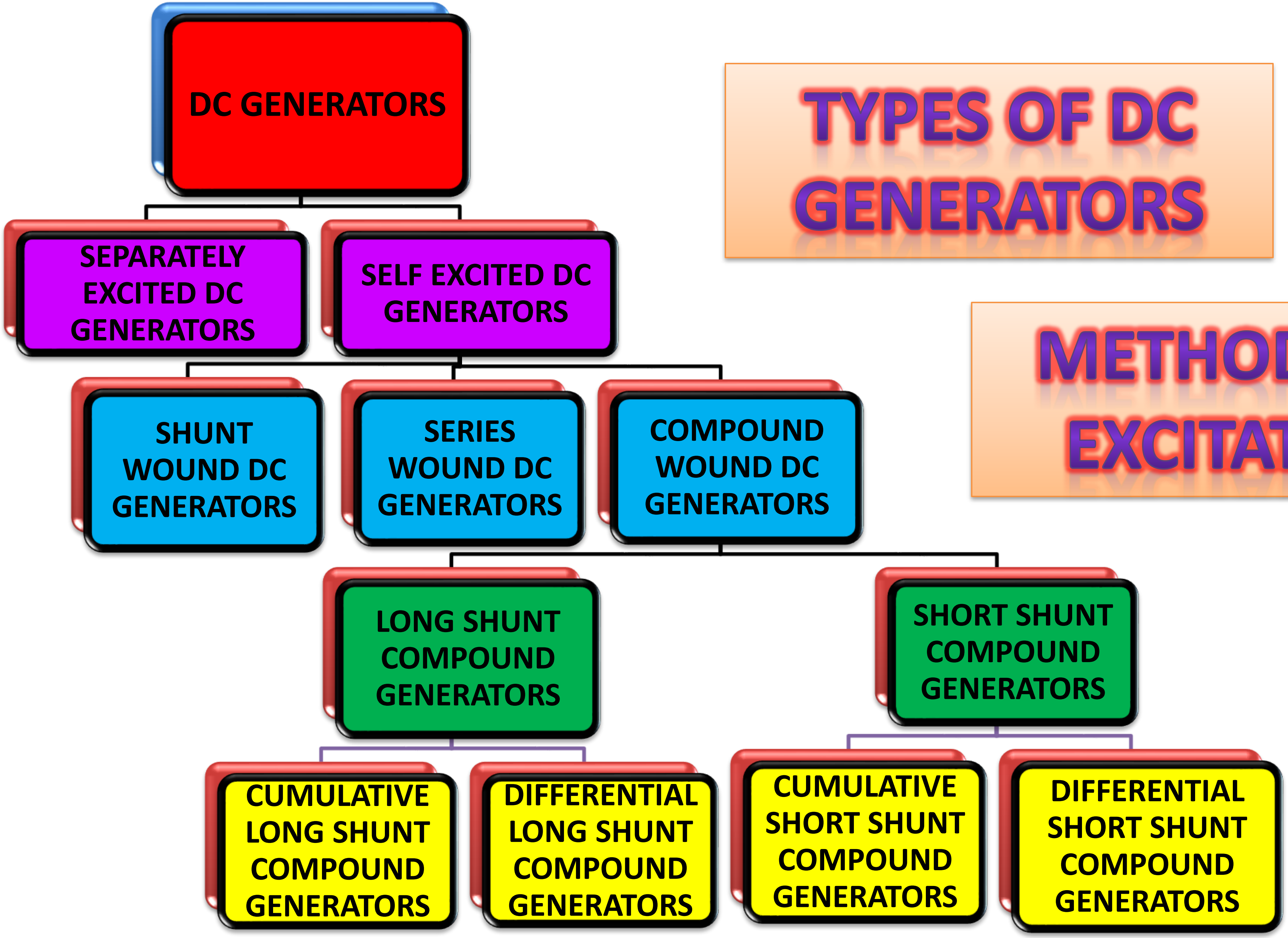
EMF of generator

Eg = (EMF/conductor) x (No. of conductors in series per parallel path)

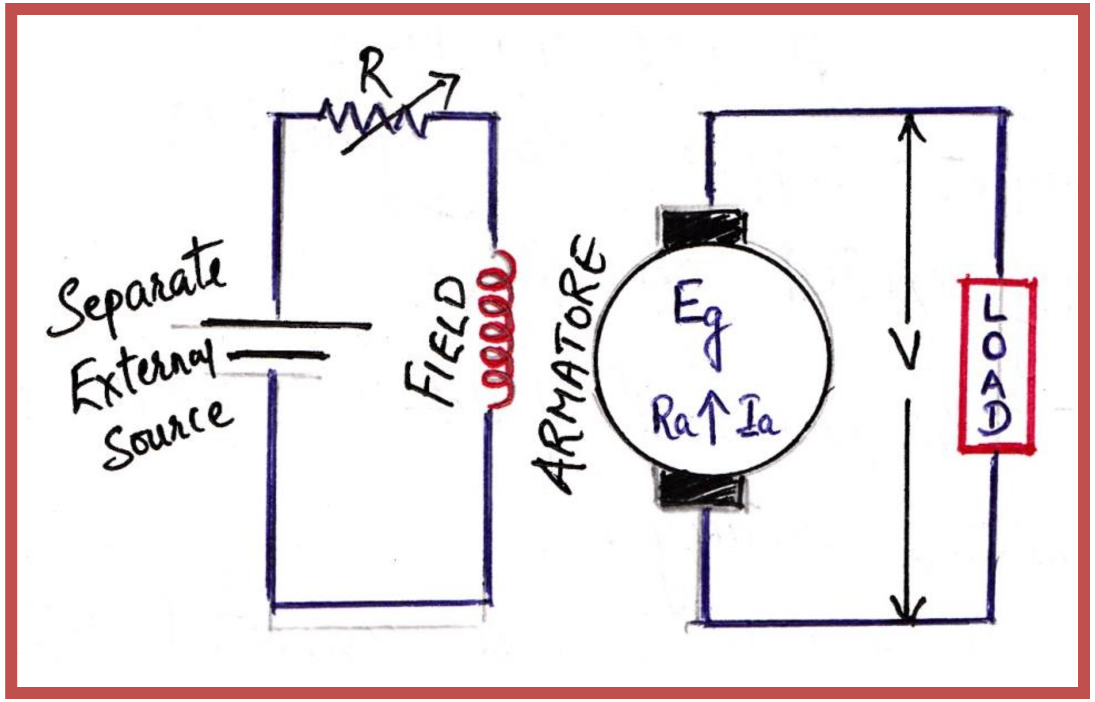
$$\boxed{E_g = \frac{P\emptyset \mathrm{N}}{60} \times \frac{\mathrm{Z}}{A}}$$

TYPES OF DC GENERATORS

METHODS OF EXCITATION



SEPARATELY EXCITED DC GENERATORS



Armature current (I_a) = Load current (I_L)

Generated EMF (E_G) = Terminal voltage (V) +Armature drop ($I_a R_a$)

Electric power developed (P_g) = $E_g I_a$

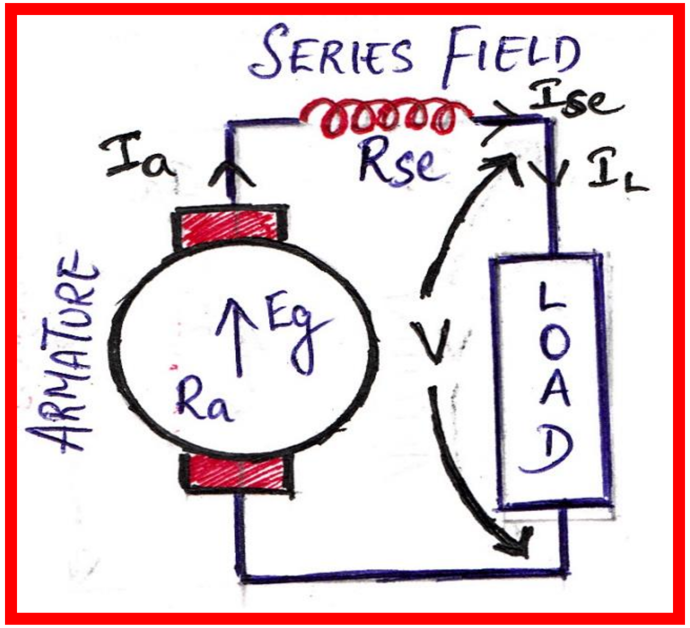
Power delivered to load (P_L) = $V I_L$

SELF EXCITED DC GENERATORS

- **A dc generator whose field winding is excited by current supplied by generator itself, is called**

  SELF EXCITED GENERATOR.
- **In such machines field coils are connected either "IN SERIES" with armature, "IN PARALLEL" with armature (or) "PARTLY IN SERIES & PARTLY IN PARALLEL" with armature.**
- **Accordingly self excited generators may be classified into**
  - **SERIES WOUND GENERATORS**
  - **SHUNT WOUND GENERATORS**
  - **COMPOUND WOUND GENERATORS**

SERIES WOUND GENERATORS



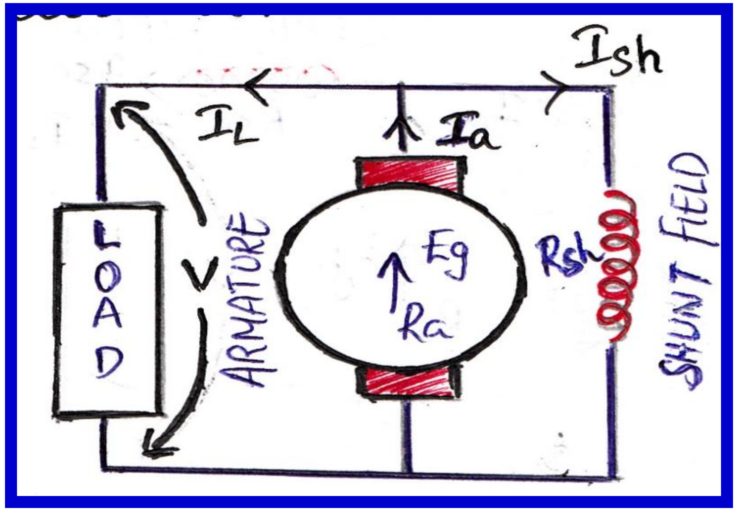
Armature Current (I_a) = *Series field current* (I_{se}) =*Load current* (I_L)

Generated EMF (E_G) = V +Armature drop ($I_a R_a$) + Series drop (Ise Rse)

Power developed in armature $= E_g I_a$

Power delivered to load $= \mathbf{V} I_L$

SHUNT WOUND GENERATORS



Armature Current (I_a) = *Shunt field current* (I_{sh}) + *Load current* (I_L)

Shunt field current $(I_{sh}) = \dfrac{V}{R_{sh}}$

Generated EMF (E_G) = Terminal voltage (V)+Armature drop ($I_a R_a$)

Power developed in armature $= E_g I_a$

Power delivered to load $= VI_L$

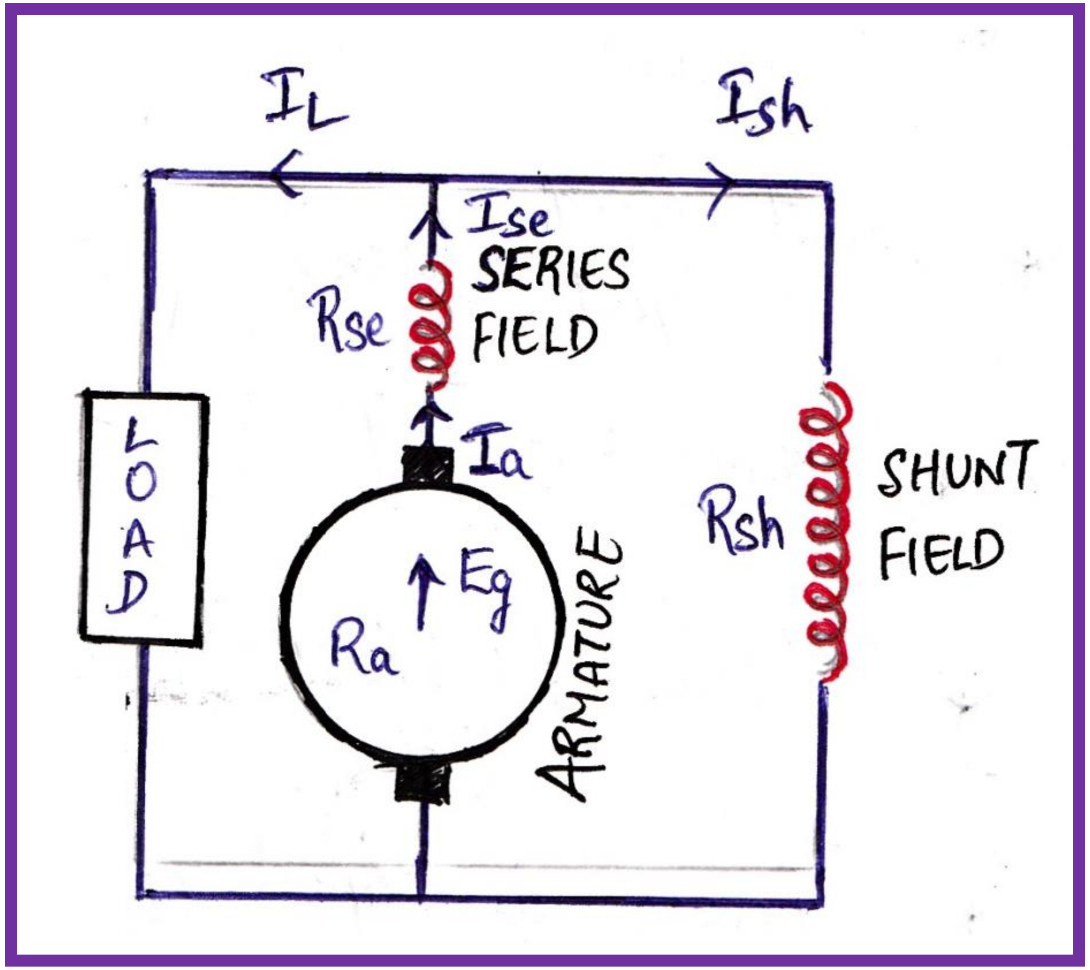
COMPOUND WOUND GENERATORS

- In compound wound generators, there are two field windings mounted on same poles i.e series & shunt field windings.
- In this type of generators, part of field is connected across armature and other part of field winding is connected in series with armature.
- Depending upon connection of shunt & series field winding, compound generators are further classified as

  1. LONG SHUNT COMPOUND WOUND GENERATORS

  2. SHORT SHUNT COMPOUND WOUND GENERATORS

LONG SHUNT COMPOUND WOUND GENERATORS



LONG SHUNT COMPOUND WOUND GENERATORS

$$\textit{Armature Current } (I_a) = \textit{Series field current } (I_{se})$$

$$\textit{Armature Current } (I_a) = \textit{Shunt field current } (I_{sh}) + \textit{Load current } (I_L)$$

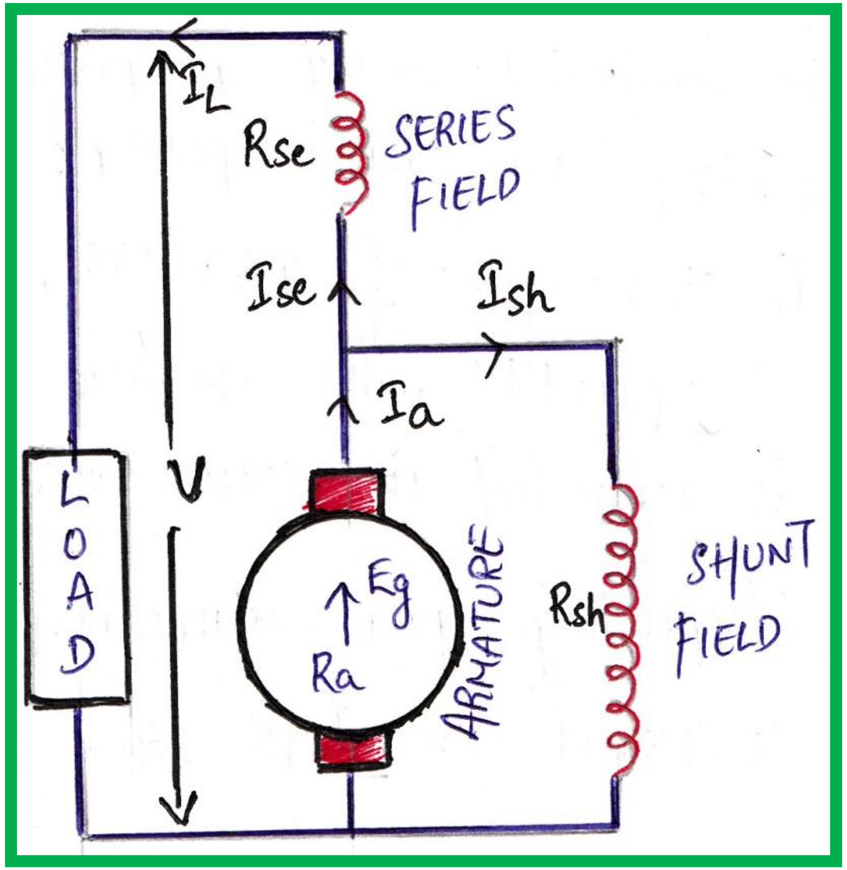
$$\textit{Shunt field current } (I_{sh}) = \frac{V}{R_{sh}}$$

Generated EMF (E_G) = V +Armature drop ($I_a R_a$) + Series drop ($I_{se} R_{se}$)

$$\textit{Power developed in armature} = E_g I_a$$

$$\textit{Power delivered to load} = V I_L$$

SHORT SHUNT
COMPOUND WOUND GENERATORS



SHORT SHUNT COMPOUND WOUND GENERATORS

Load Current (I_L) = *Series field current* (I_{se})

Armature Current (I_a) = *Shunt field current* (I_{sh}) + *Series field current* (I_{se})

Armature Current (I_a) = *Shunt field current* (I_{sh}) + *Load current* (I_L)

$$\text{Shunt field current } (I_{sh}) = \frac{V+I_{se}R_{se}}{R_{sh}}$$

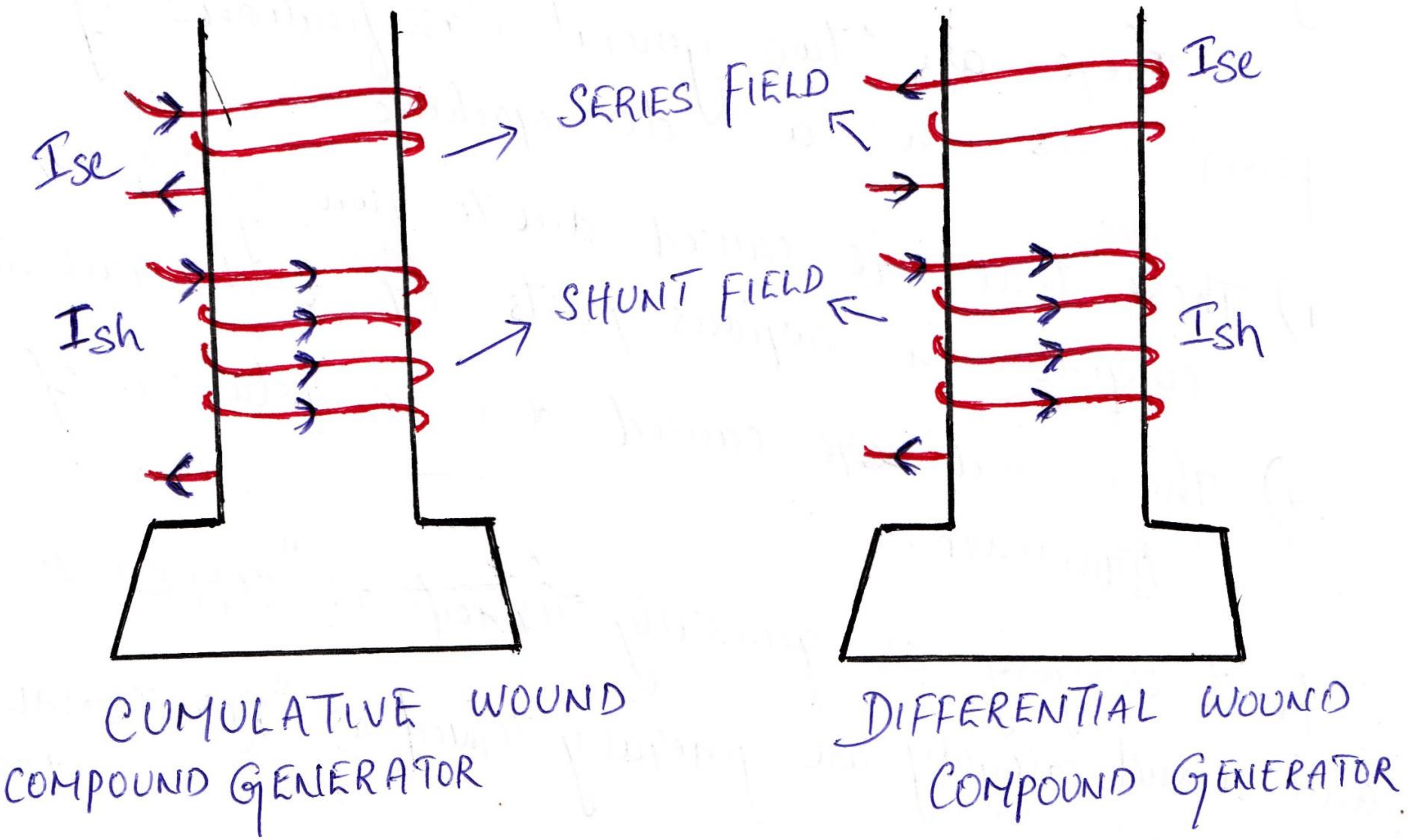
$$\text{Shunt field current } (I_{sh}) = \frac{E_g-I_aR_a}{R_{sh}}$$

Generated EMF (E_G) **= V +Armature drop** $(I_a R_a)$ **+ Series drop** $(I_{se} R_{se})$

Power developed in armature = $E_g I_a$

Power delivered to load = VI_L

CUMULATIVE & DIFFERENTIAL WOUND COMPOUND GENERATOR



TUTORIALS
EMF EQUATION & TYPES OF DC GENERATORS

TUTORIAL-1

- A 4-pole lap wound DC Generator running at 900 rpm has an armature resistance of 0.2 ohms and shunt field resistance of 200 ohms. There are 30 slots on armature & 15 conductors per slot. If the load resistance is 10 ohms, and terminal voltage is 230 V, find useful flux per pole Assume contact per brush to be 1 V.

SOLUTION: $Given\ P = 4$ $A = P = 4$

$N = 900\ rpm$ $R_a = 0.2\ \Omega$ $R_{sh} = 200\ \Omega$

$R_L = 10\ \Omega$ $V = 230\ V$ $Z = 30 * 15 = 450$

$$I_L = \frac{V}{R_L} = 23\ A$$

$$I_{sh} = \frac{V}{R_{sh}} = 1.15\ A$$

$$I_a = I_L + I_{sh} = 24.15\ A$$

$$E_g = V + I_a R_a + Total\ Brush\ Drop$$

$$E_g = 236.83\ V$$

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

$$\emptyset = 0.035\ Wb$$

TUTORIAL-2

- A 4-pole wave wound DC Generator consists of 51 slots and each slot contains 20 conductors. Find Generated EMF in the machine which is driven at 1500 rpm. Assume flux per pole is 0.7mWb.

SOLUTION:

$Given\ P = 4$

$Z = 51 * 20 = 1020$

$A = P = 4$

$N = 1500\ rpm$

$\emptyset = 0.7mWb$

$$E_g = \frac{\emptyset ZN}{60} * \frac{P}{A}$$

$$E_g = 35.7\ V$$

TUTORIAL-3

- A 8-pole DC generator has 500 armature conductors and useful flux of 0.05 Wb/pole. What will be the EMF generated if it is lap wound and runs at 1200 rpm. What must be its speed at which it must be driven so as to produce same EMF if it is wave wound

SOLUTION:

$Given\ P = 8$ $Z = 500$

$\varnothing = 0.05\ Wb$ $A_1 = P = 8$ $N_1 = 1200\ rpm$

$$E_g = \frac{\varnothing Z N_1}{60} * \frac{P}{A_1} \Rightarrow E_g = 500\ V$$

$A_2 = 2$ $Since\ E_g is\ same \Rightarrow \frac{N_1}{A_1} = \frac{N_2}{A_2}$

$$N_2 = 300\ rpm$$

TUTORIAL-4

- A 4-pole lap wound DC shunt generator has field resistance of 50 ohms & armature resistance of 0.1 ohms, which is supplying 60, 100V, 40 W lamps. Find armature current in each conductor and generated EMF. Assume 1 V per brush.

SOLUTION:

$Given\ P = 4$

$A = P = 4$

$R_a = 0.1\ \Omega$

$R_{sh} = 50\ \Omega$

$I_{sh} = \frac{V}{R_{sh}} = 2\ A$

$V = 100\ V$

$Power = 60 * 40 = 2400$ → $I_L = \frac{P}{V} = 24\ A$

$I_a = I_L + I_{sh} = 26\ A$

$E_g = V + I_a R_a + Total\ Brush\ Drop$ → $E_g = 104.6\ V$

TUTORIAL-5

- A long shunt compound generator, delivers a load of 50A at 500V. It has armature, series and shunt resistances of 0.05 ohms, 0.03 ohms and 250 ohms respectively. Assume 1V per brush. Calculate armature current & generated EMF.

SOLUTION:

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

$R_a = 0.05\ \Omega$ $R_{sh} = 250\ \Omega$ $R_{se} = 0.03\ \Omega$

$$I_a = I_{se} = I_L + I_{sh} = 52\ A$$

$$E_g = V + I_a R_a + Total\ Brush\ Drop$$

$$E_g = 506.16\ V$$

TUTORIAL-6

- A short shunt compound generator delivers a load of 30 A at 220 V. It has armature, series and shunt resistances of 0.05 ohms, 0.03 ohms and 200 ohms respectively. Assume 1V per brush. Calculate armature current & generated EMF.

SOLUTION:

$Given\ I_L = 30\ A$ $V = 220\ V$

$R_a = 0.05\ \Omega$ $R_{sh} = 200\ \Omega$ $R_{se} = 0.03\ \Omega$

$$I_{sh} = \frac{V + I_{se}R_{se}}{R_{sh}} = 1.1\ A$$

$$I_a = I_L + I_{sh} = 31.1\ A$$

$$E_g = V + I_aR_a + Total\ Brush\ Drop$$

$$E_g = 224.45\ V$$

TUTORIAL-7

- A series generator delivers a current of 100A at 250 V. Armature, Series field resistance are 0.1 ohms and 0.55 ohms respectively. Find generated EMF.

SOLUTION:

$$V = 250\ V$$

$$Given\ \ I_L = \ I_a = \ I_{se} = 100\ A$$

$$R_a = 0.1\ \Omega$$

$$R_{se} = 0.55\ \Omega$$

$$E_g = V + I_a\,(R_a + \ R_{se}) + Total\ Brush\ Drop$$

$$E_g = 315\ V$$

TUTORIAL-8

- A 120 V compound generator has armature, shunt and series resistances as 0.06 ohms, 25 ohms and 0.04 ohms respectively. Load current is 100A. Find induced EMF and armature current when it is connected as

(i) Long Shunt

(ii) Short Shunt

SOLUTION: $Given\ I_L = 100\ A$ $V = 120\ V$

$R_a = 0.06\ \Omega$ $R_{sh} = 25\ \Omega$ $R_{se} = 0.04\ \Omega$

$(i)\ Long\ Shunt\ Compound\ Generator$

$$I_{sh} = \frac{V}{R_{sh}} = 4.8\ A \Rightarrow I_a = I_{se} = I_L + I_{sh} = 104.8\ A$$

$$E_g = V + I_a\,(R_a + R_{se}) + Total\ Brush\ Drop$$

$$\Rightarrow E_g = 120.48\ V$$

$(ii)\ Short\ Shunt\ Compound\ Generator$

TUTORIAL-8

- A 120 V compound generator has armature, shunt and series resistances as 0.06 ohms, 25 ohms and 0.04 ohms respectively. Load current is 100A. Find induced EMF and armature current when it is connected as

(i) Long Shunt

(ii) Short Shunt

SOLUTION:

$(ii)\ Short\ Shunt\ Compound\ Generator$

$R_a = 0.06\ \Omega$ $R_{sh} = 25\ \Omega$ $R_{se} = 0.04\ \Omega$

$Given\ \ I_L = I_{se} = 100\ A$ $V = 120\ V$

$$I_{sh} = \frac{V + I_{se}R_{se}}{R_{sh}} = 4.96\ A$$

$$I_a = I_L + I_{sh} = 104.96\ A$$

$$E_g = V + I_a\,R_a + I_{se}\,R_{se} + Total\ Brush\ Drop$$

$$E_g = 130.29\ V$$

TUTORIAL-9

- A separately excited DC Generator has armature circuit resistance of 0.1 ohms and total brush drop of 2 V, while running at 1000 rpm, delivering a current of 100A at 250 V to a load of constant resistance. If generator speed drops to 700 rpm with field current unaltered, find current delivered to load.

SOLUTION:

$Given\ R_a = 0.1\ \Omega$ $\quad N_1 = 1000\ rpm$

$Given\ \ I_{L1} = \ 100\ A$ $\quad V_1 = 250\ V$ $\quad N_2 = 900\ rpm$

$Field\ curent\ unaltered\ \ \emptyset = constant$

$$\Rightarrow \frac{E_{g1}}{E_{g2}} = \frac{N_1}{N_2}$$

$$E_{g1} = V_1 + I_{L1}\, R_a + Total\ Brush\ Drop$$

$$E_{g1} = 262\ V$$

$$\frac{E_{g1}}{E_{g2}} = \frac{N_1}{N_2} \Rightarrow E_{g2} = 183.4\ V$$

$$E_{g2} = V_2 + I_{L2}\, R_a + Total\ Brush\ Drop$$

TUTORIAL-9

- A separately excited DC Generator has armature circuit resistance of 0.1 ohms and total brush drop of 2 V, while running at 1000 rpm, delivering a current of 100A at 250 V to a load of constant resistance. If generator speed drops to 700 rpm with field current unaltered, find current delivered to load.

SOLUTION:

Given constant load resistance, Hence R_L is constant

$$I_{L1} = \frac{V_1}{R_L} \Rightarrow R_L = 2.5\ ohms$$

$$I_{L2} = \frac{V_2}{R_L} \Rightarrow V_2 = 2.5\ I_{L2} \quad --1$$

$$E_{g2} = V_2 + I_{L2}\,R_a + Total\ Brush\ Drop$$

$$\Rightarrow 183.4 = (2.5\ I_{L2}) + 0.1 I_{L2} + Total\ Brush\ Drop$$

$$\Rightarrow I_{L2} = 69.76\ A$$

TUTORIAL-10

- A separately excited DC Generator has armature circuit resistance of 0.04 ohms and total brush drop of 2 V, while running at 1200 rpm, delivering a current of 200A at 125 V to a load of constant resistance. If generator speed drops to 1000 rpm with field current reduced to 80%, find current delivered to load.

SOLUTION:

$Given\ R_a = 0.04\ \Omega$ $N_1 = 1200\ rpm$

$N_2 = 1000\ rpm$ $V_1 = 125\ V$ $I_{L1} = 200\ A$

$E_{g1} = V_1 + I_{L1}\,R_a + Total\ Brush\ Drop$ → $E_{g1} = 135\ V$

$Given\ field\ current\ reduced\ to\ 80\%$

→ $\dfrac{E_{g1}}{E_{g2}} = \dfrac{N_1}{N_2} * \dfrac{\emptyset_1}{\emptyset_2}$ → $\dfrac{E_{g1}}{E_{g2}} = \dfrac{N_1}{N_2} * 0.8$

→ $E_{g2} = 90\ V$

→ $E_{g2} = V_2 + I_{L2}\,R_a + Total\ Brush\ Drop$

$Given\ constant\ load\ resistance, Hence\ R_L\ is\ constant$

TUTORIAL-10

- A separately excited DC Generator has armature circuit resistance of 0.04 ohms and total brush drop of 2 V, while running at 1200 rpm, delivering a current of 200A at 125 V to a load of constant resistance. If generator speed drops to 1000 rpm with field current reduced to 80%, find current delivered to load.

SOLUTION:

$$I_{L1} = \frac{V_1}{R_L} \rightarrow R_L = 0.62$$

$$I_{L2} = \frac{V_2}{R_L} \rightarrow V_2 = 0.62\, I_{L2}$$

$$E_{g2} = V_2 + I_{L2}\, R_a + Total\ Brush\ Drop$$

$$90 = (0.62\, I_{L2}) + 0.04 I_{L2} + 2$$

$$I_{L2} = 133.3\ A$$

TUTORIAL-11

- A 4-pole lap wound long shunt compound DC generator has useful flux of 0.07 Wb. The armature winding consists of 220 turns and resistance per turn is 0.004 ohms. Calculate terminal voltage if shunt, series field resistances are 100 ohms and 0.02 ohms respectively , while running at 900 rpm with armature current 50 A. Also calculate output power.

SOLUTION:

$$Armature\ resistance\ R_a = \frac{Each\ parallel\ path\ resistance}{No.\ of\ parallel\ paths}$$

$$4\ parallel\ path\ resistance = 220 * 0.004 = 0.88\ ohms$$

$$Each\ parallel\ path\ resistance = \frac{0.88}{4} = 0.22\ ohms$$

$$Armature\ resistance\ R_a = \frac{0.22}{4} = 0.055\ ohms$$

TUTORIAL-11

- A 4-pole lap wound long shunt compound DC generator has useful flux of 0.07 Wb. The armature winding consists of 220 turns and resistance per turn is 0.004 ohms. Calculate terminal voltage if shunt, series field resistances are 100 ohms and 0.02 ohms respectively , while running at 900 rpm with armature current 50 A. Also calculate output power.

SOLUTION:

$Given\ \emptyset = 0.07\ Wb$

$N = 900\ rpm$

$Z = 220 * 2 = 440$

$$E_g = \frac{\emptyset Z N}{60} * \frac{P}{A} = 462\ V$$

$$E_g = V + I_a\,(R_a + R_{se}) + Total\ Brush\ Drop$$

$$V = 458.5\ V$$

$Given\ I_a = 50\ A$

$$I_{sh} = \frac{V}{R_{sh}} = 4.58\ A$$

$$I_a = I_L + I_{sh} \rightarrow I_L = 45.4\ A$$

$$P_{out} = V\,I_L = 20.8\ kW$$