



# **SNS COLLEGE OF TECHNOLOGY**

**(An Autonomous Institution)**



**COIMBATORE-35**

**Accredited by NBA-AICTE and Accredited by NAAC – UGC with A++ Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai**

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS  
ENGINEERING**

**COURSE NAME: 23EET101/BASIC ELECTRICAL AND  
ELECTRONICS ENGINEERING**

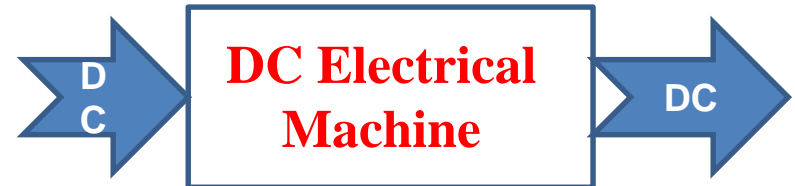
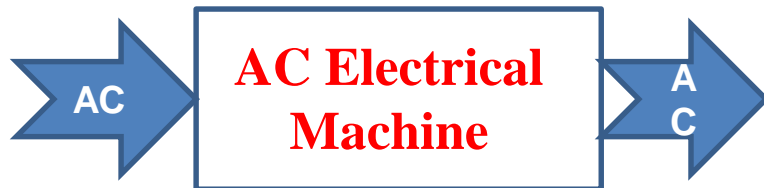
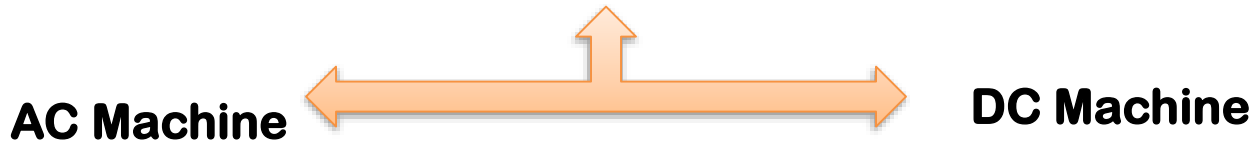
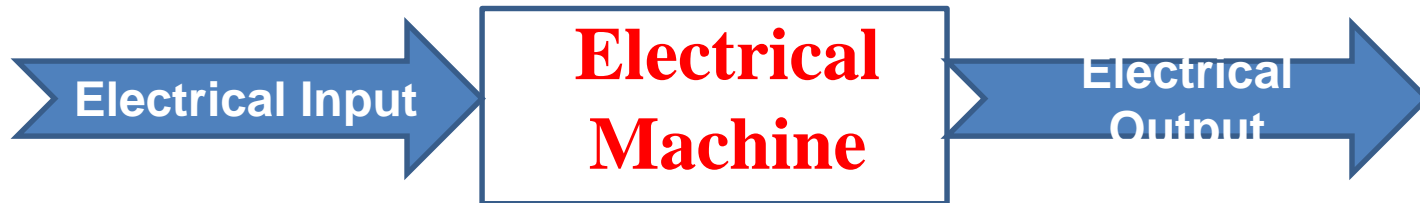
**I YEAR / I SEMESTER**

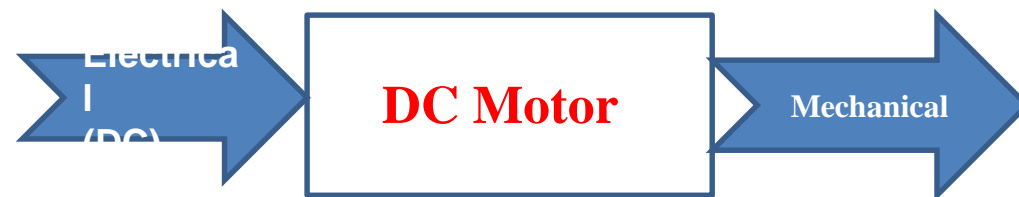
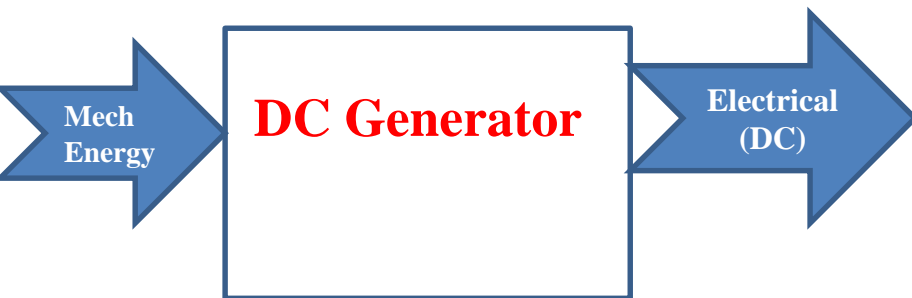
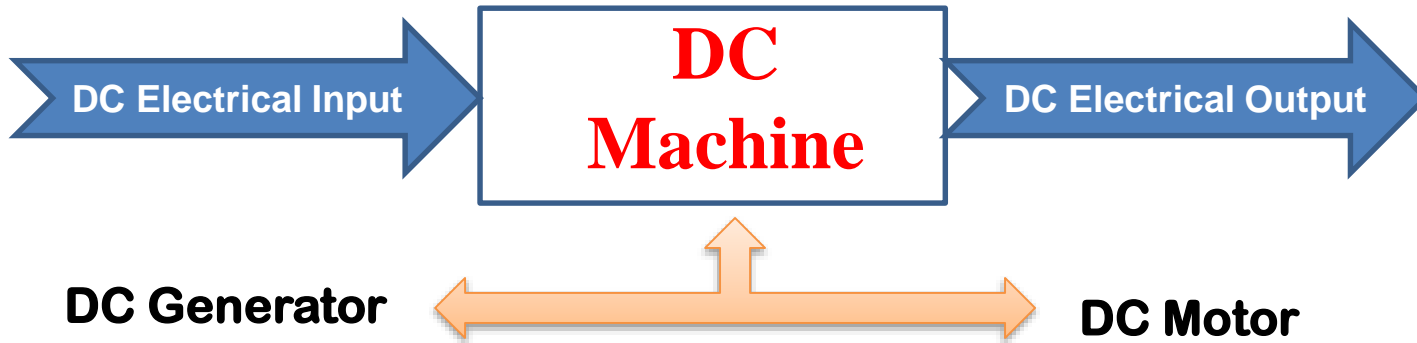
**Unit II – ELECTRICAL MACHINES**

**Topic : DC Generator**

# RECAP



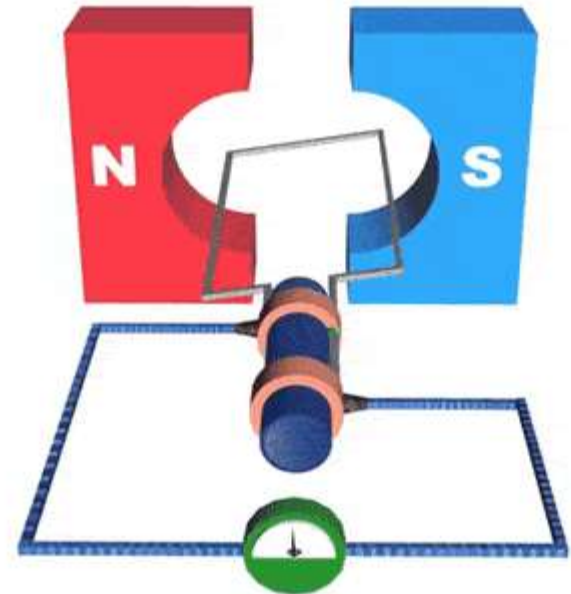
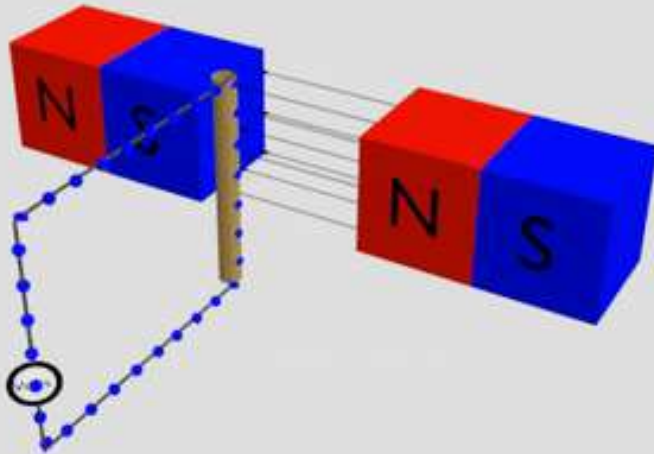






# DC Generator Principle

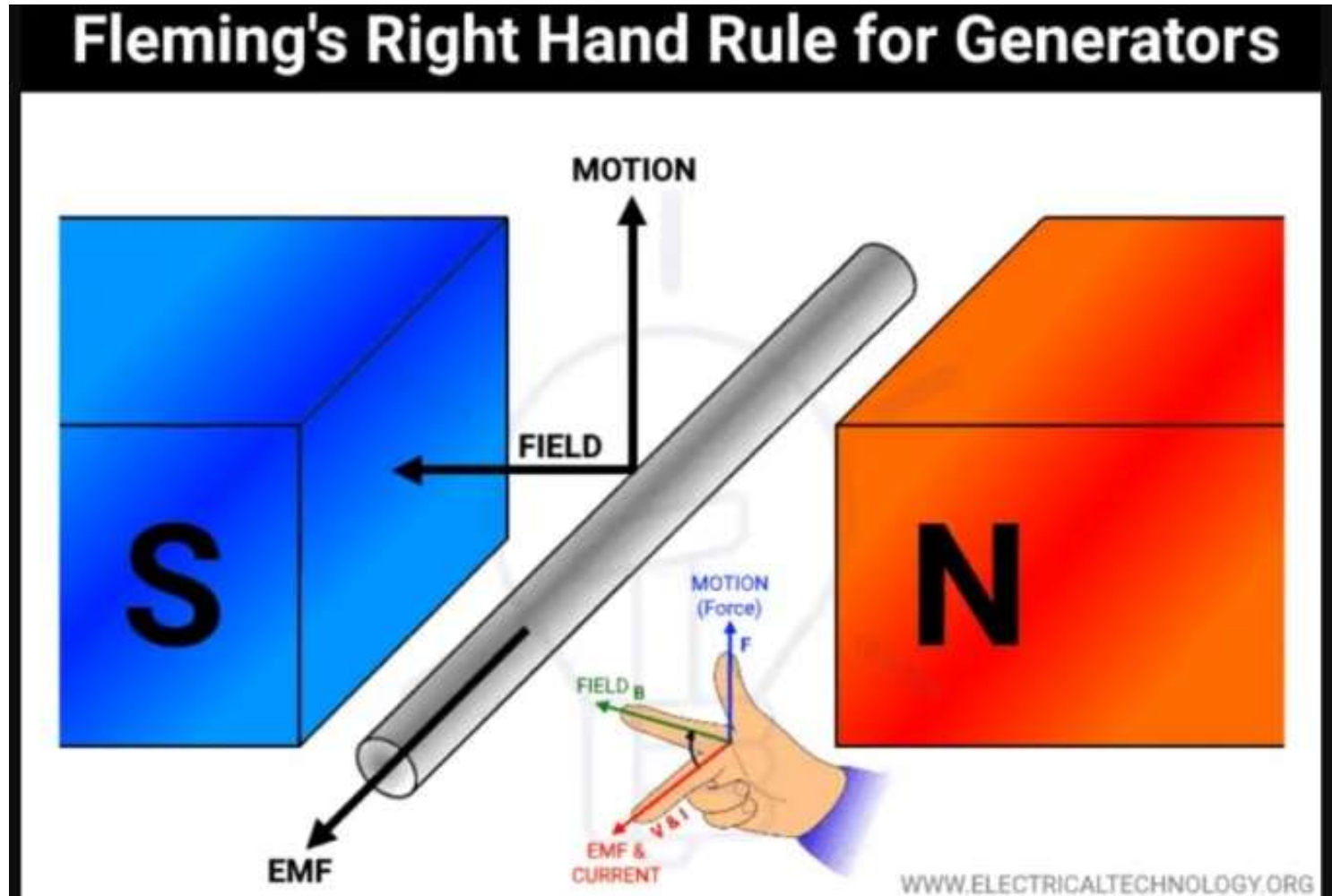
## 1. Faraday's first law of electromagnetic induction





# DC Generator Principle

## 2. Fleming Left Hand Rule





# DC Generator Principle

## 1. Faraday's first law of electromagnetic induction

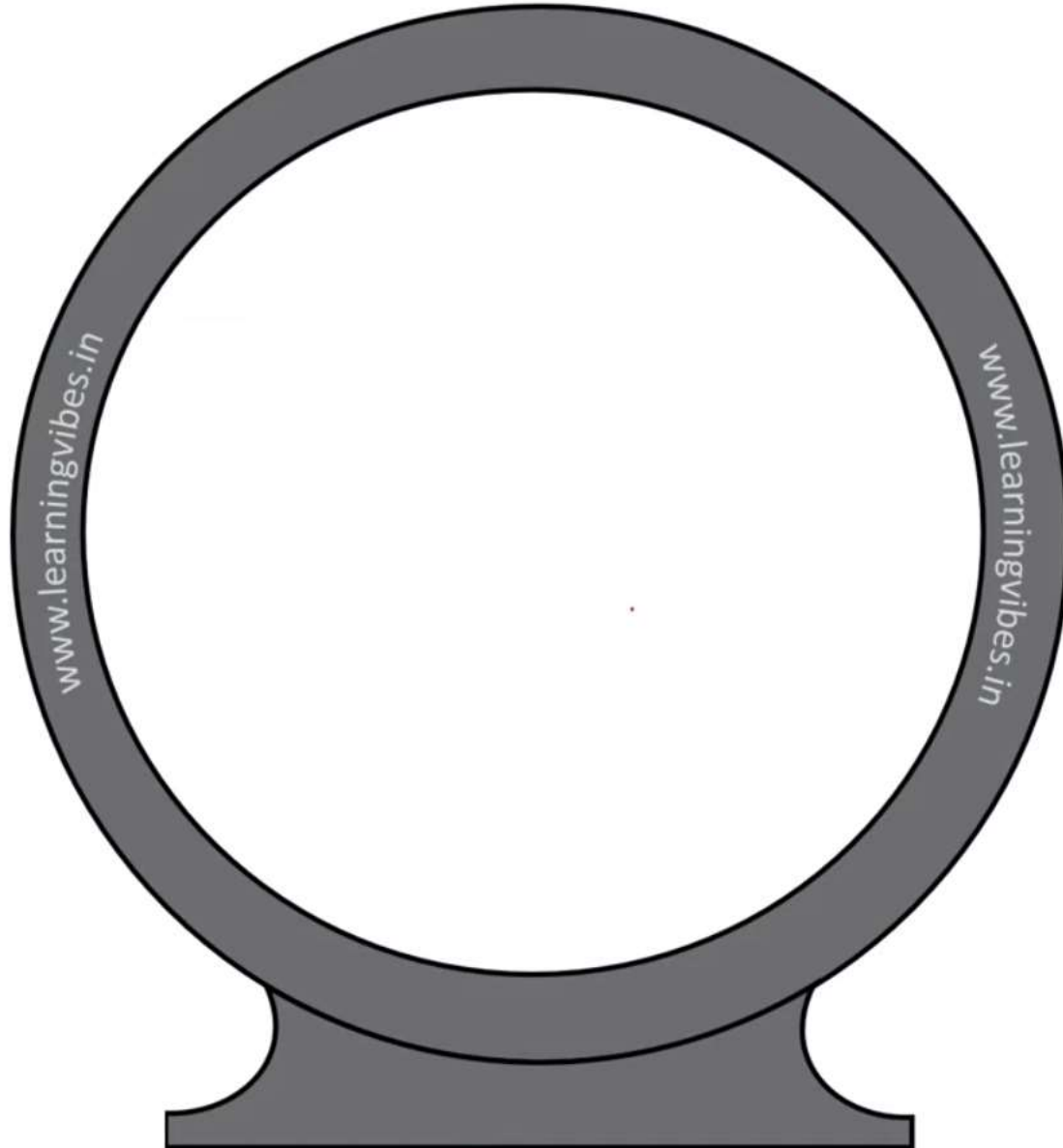
Faraday's first law of electromagnetic induction states the following: Whenever a **conductor** is placed in a **varying magnetic field**, an electromotive force is induced. If the conductor circuit is closed, a **current is induced**, which is called induced current.

## 2. Fleming Left Hand Rule

Whenever a **current carrying conductor moves** under a **magnetic field**, there will be a **induced current generated** from the conductor. The **direction of this current** can be found using Fleming's Right Hand Rule (also known as 'Flemings Right-hand rule for motors').



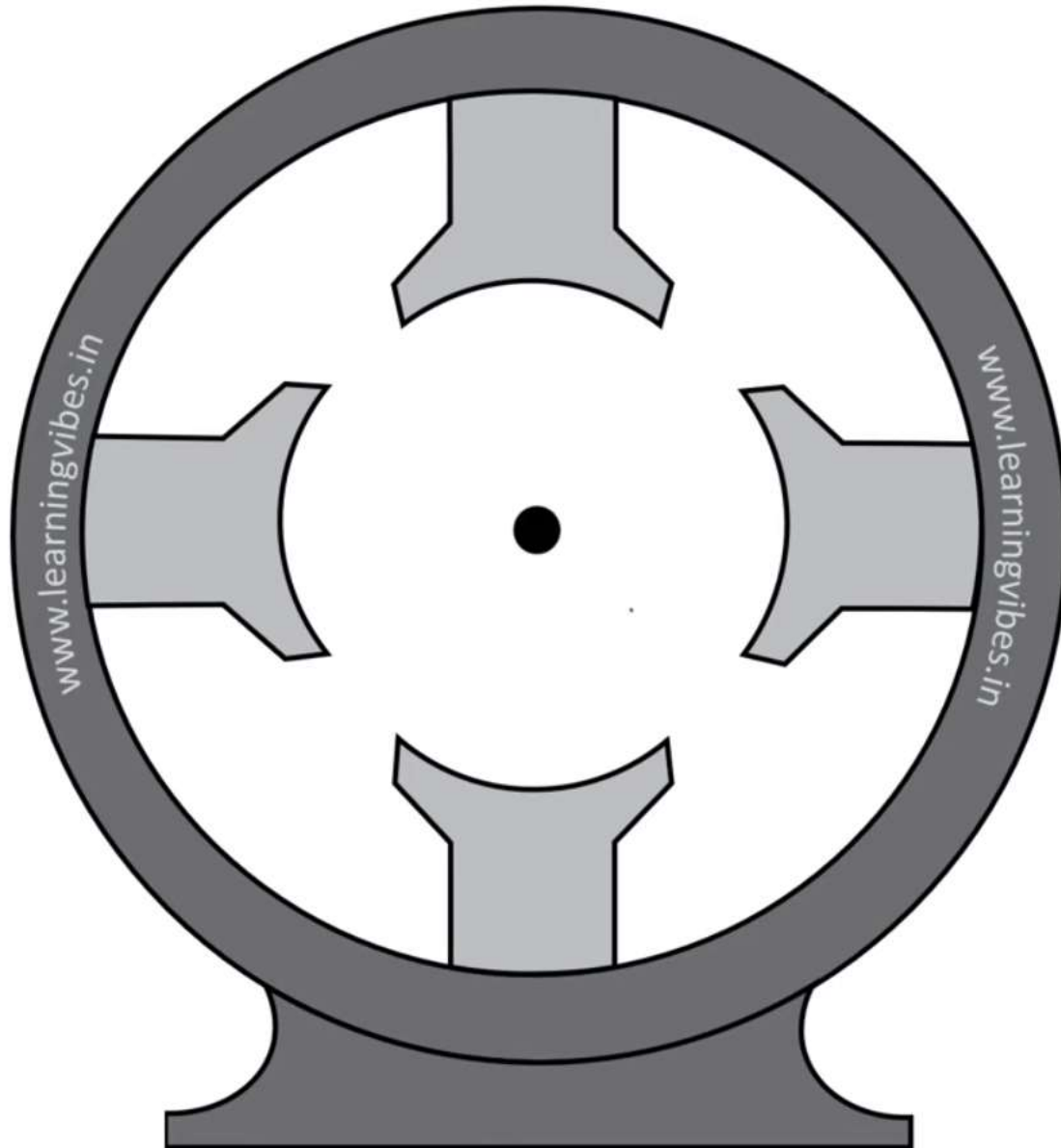
# DC Generator Construction





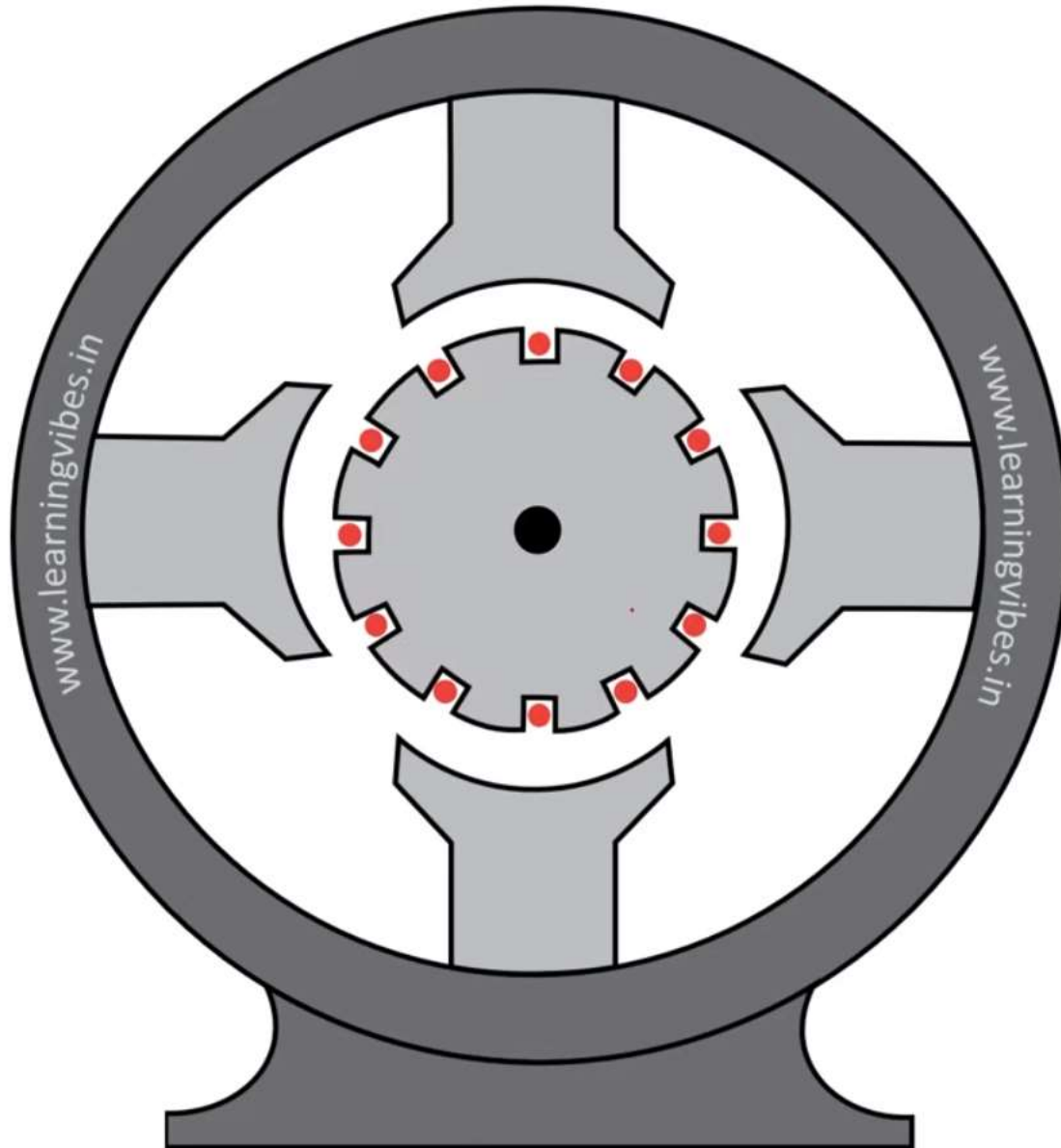


# DC Generator Construction



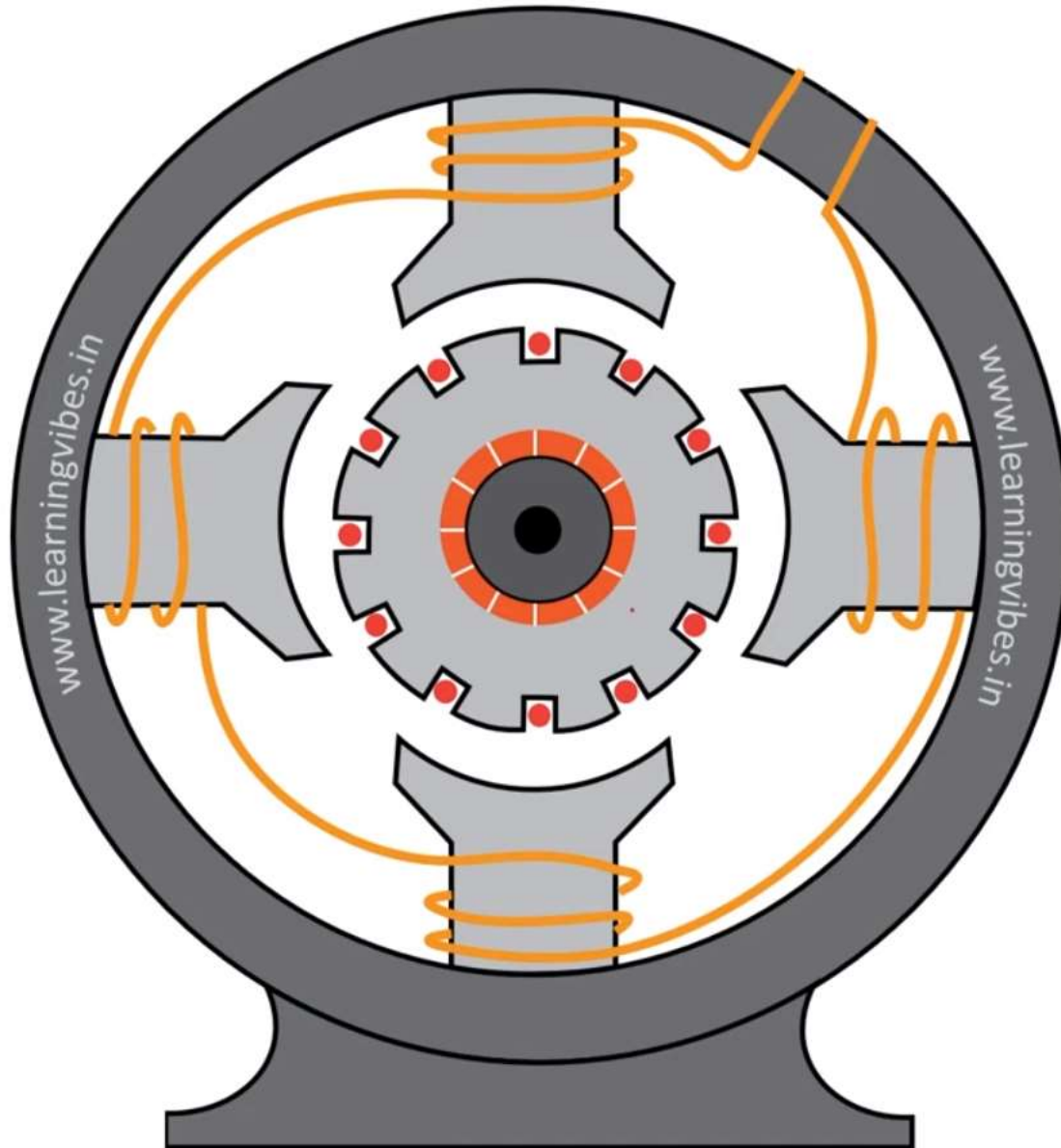


# DC Generator Construction



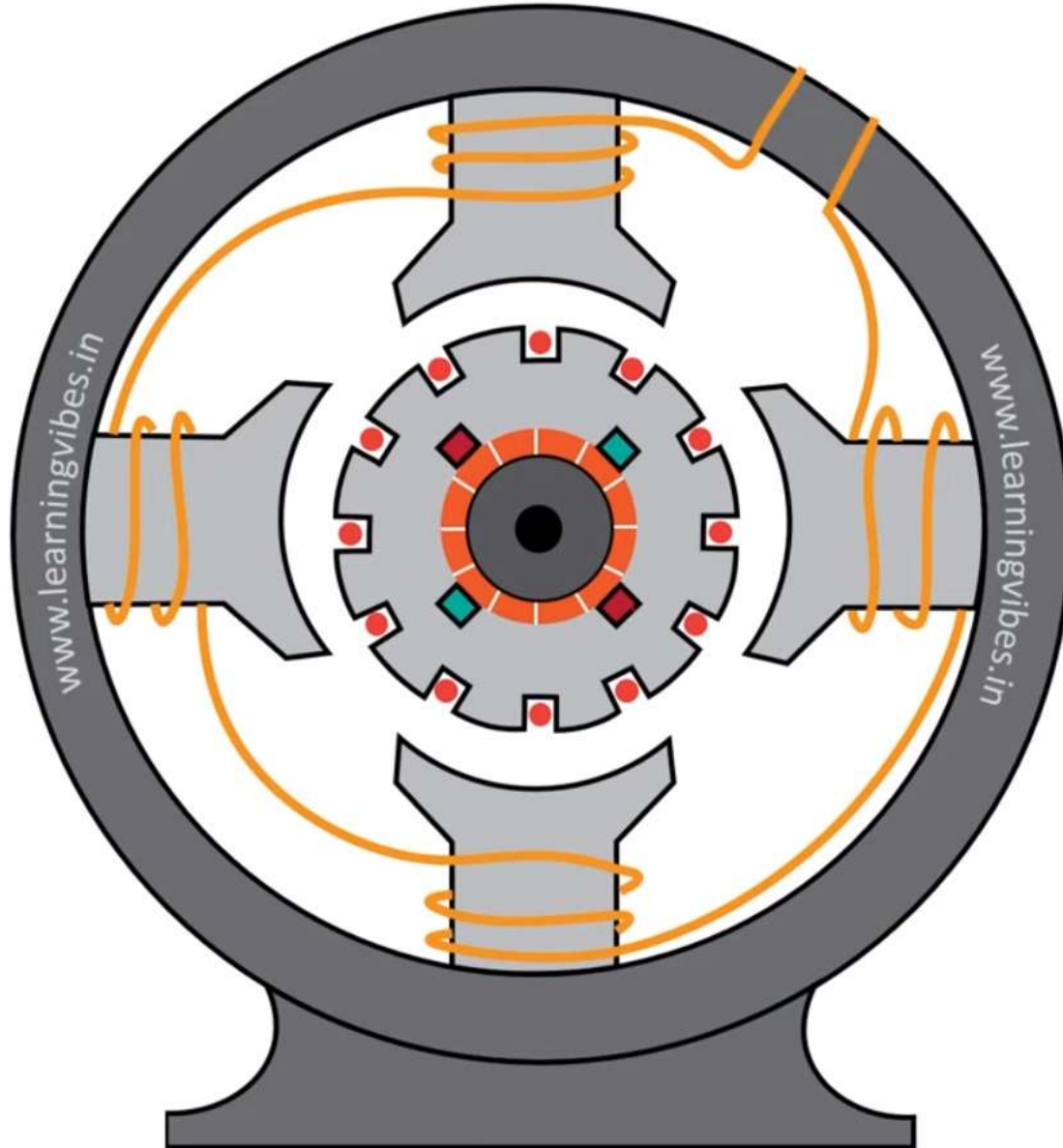


# DC Generator Principle



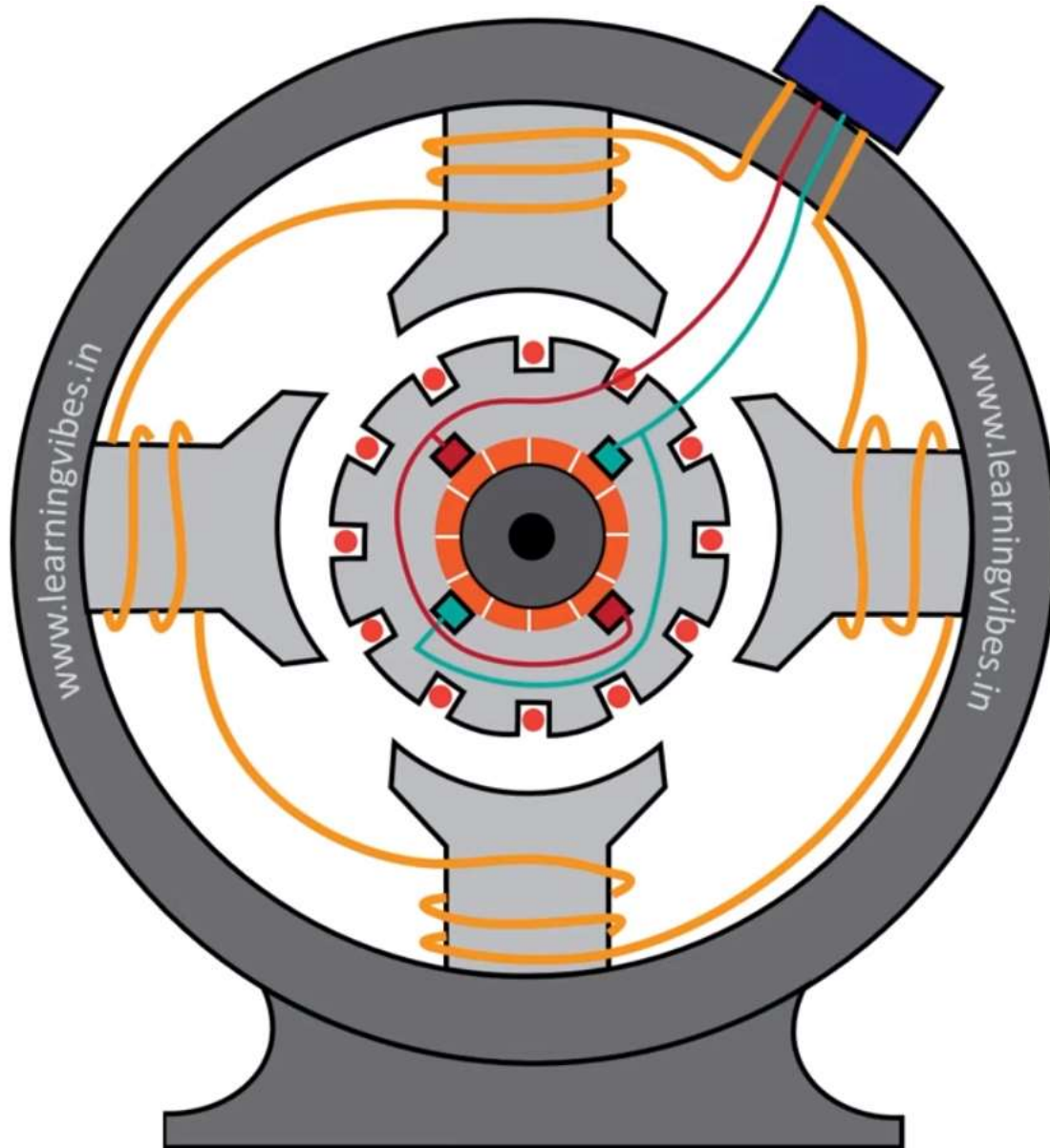


# DC Generator Principle





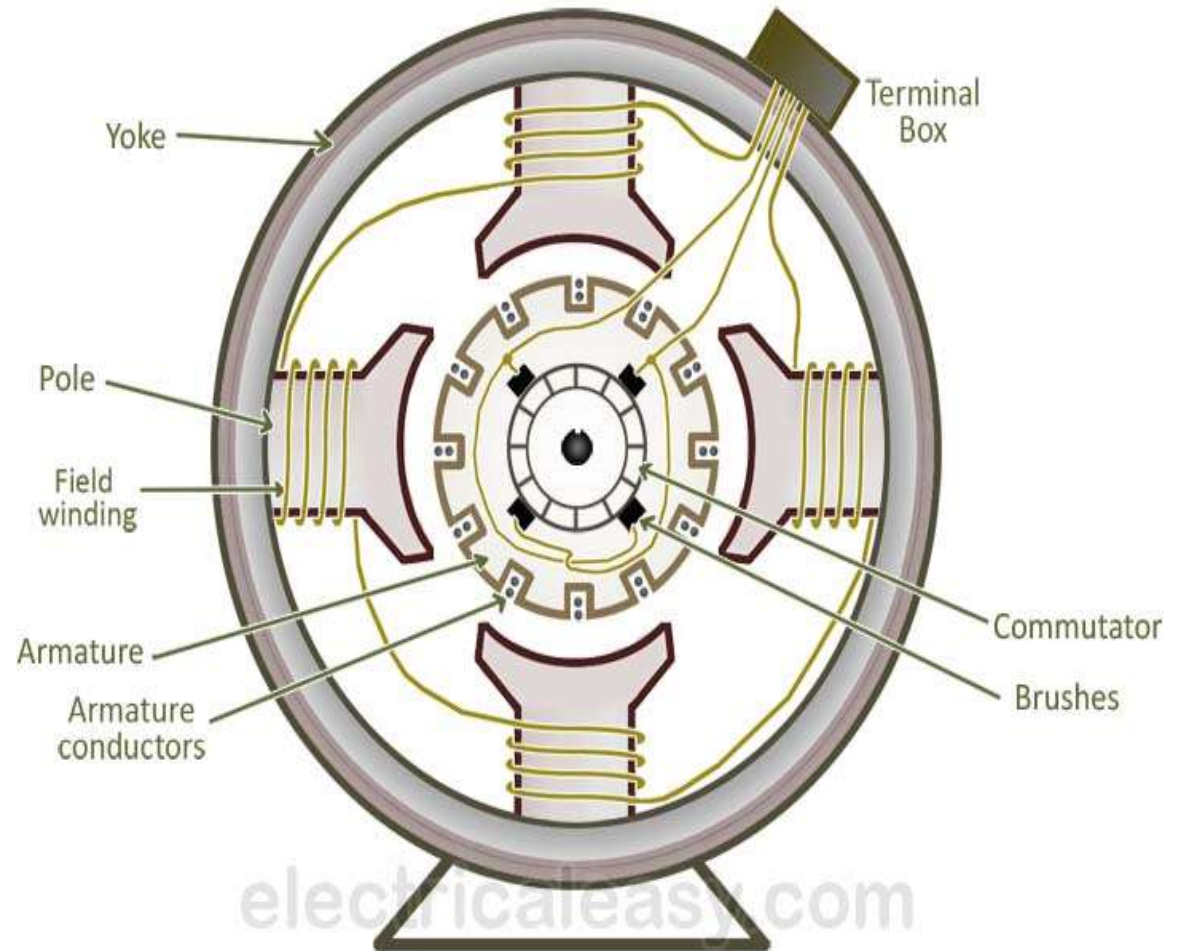
# DC Generator Principle





# CONSTRUCTION

- ▶ Field system
- ▶ Armature core
- ▶ Armature winding
- ▶ Commutator
- ▶ Brushes
- ▶ Yoke

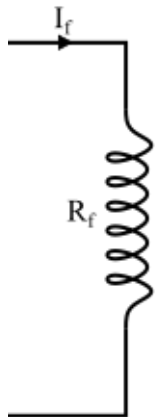




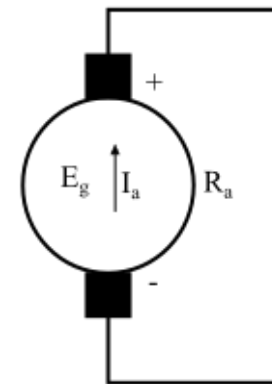
# DC GENERATOR



***FIELD WINDING***



***ARMATURE WINDING***





# DC GENERATOR

- It is an **electromechanical energy conversion device** that converts mechanical power into DC electrical power.
- It operates on the principle of **electromagnetic induction** i.e. when the magnetic flux linking a conductor changes, an EMF is induced in the conductor.
- A DC generator has a **field winding and an armature winding**.
- The armature winding of DC Generator is placed on the rotor whereas the field winding is placed on the stator.







# CONSTRUCTION

## Yoke

- The outer frame of a DC generator is a hollow cylinder made up of cast steel or rolled steel is known as yoke.
  - It supports the field pole core and acts as a protecting cover to the machine.
  - It provides a path for the magnetic flux produced by the field winding.

## Magnetic Field System

- It is the stationary part of the machine (STATOR)
- It produces the main magnetic flux in the generator.
- The field coils are connected in series with one another such that when the current flows through the coils, alternate north and south poles are produced in the direction of rotation.



# CONSTRUCTION

## Armature Core

- The armature core of DC generator is mounted on the shaft and rotates between the field poles.
- It has slots on its outer surface and the armature conductors are put in these slots.
- The armature core is made up of soft iron laminations which are insulated from each other and tightly clamped together.

## Armature Winding

- The insulated conductors are put into the slots of the armature core.
- The conductors are suitably connected. This connected arrangement of conductors is known as armature winding.
- There are two types of armature windings used – wave winding and lap winding.



# CONSTRUCTION



## Commutator

- A commutator is a mechanical rectifier which converts the alternating emf generated in the armature winding into the direct voltage across the load terminals.
- Each segment of commutator is connected to the ends of the armature coils.

## Brushes

- The brushes are mounted on the commutator and are used to collect the current from the armature winding.
- The current flows from the armature winding to the external circuit through the commutator and carbon brushes.



# WORKING

- As the armature rotates, the conductors cut through the magnetic field produced by the poles and field winding.
- According to **Faraday's law of electromagnetic induction**, an emf is induced in each conductor proportional to the rate of change of flux linkage.
- The direction of induced emf in each conductor can be determined by **Fleming's right-hand rule**. (Thumb finger - represents the direction of Motion of the conductor, First finger (four finger) - represents Field and Second finger (Middle finger) - represents Current).
- The induced emf in each conductor alternates as it passes under different poles.
- The induced emf in each coil is equal to the sum of EMFs induced in its conductors.
- The commutator segments connected to each coil end reverse their connections with the brushes every half revolution.
- This reverses the direction of current flow in each coil every half revolution.
- As a result, a unidirectional or **direct current flows** through the external circuit.



# EMF EQUATION

The **emf equation of dc generator** according to Faraday's Laws of Electromagnetic Induction is

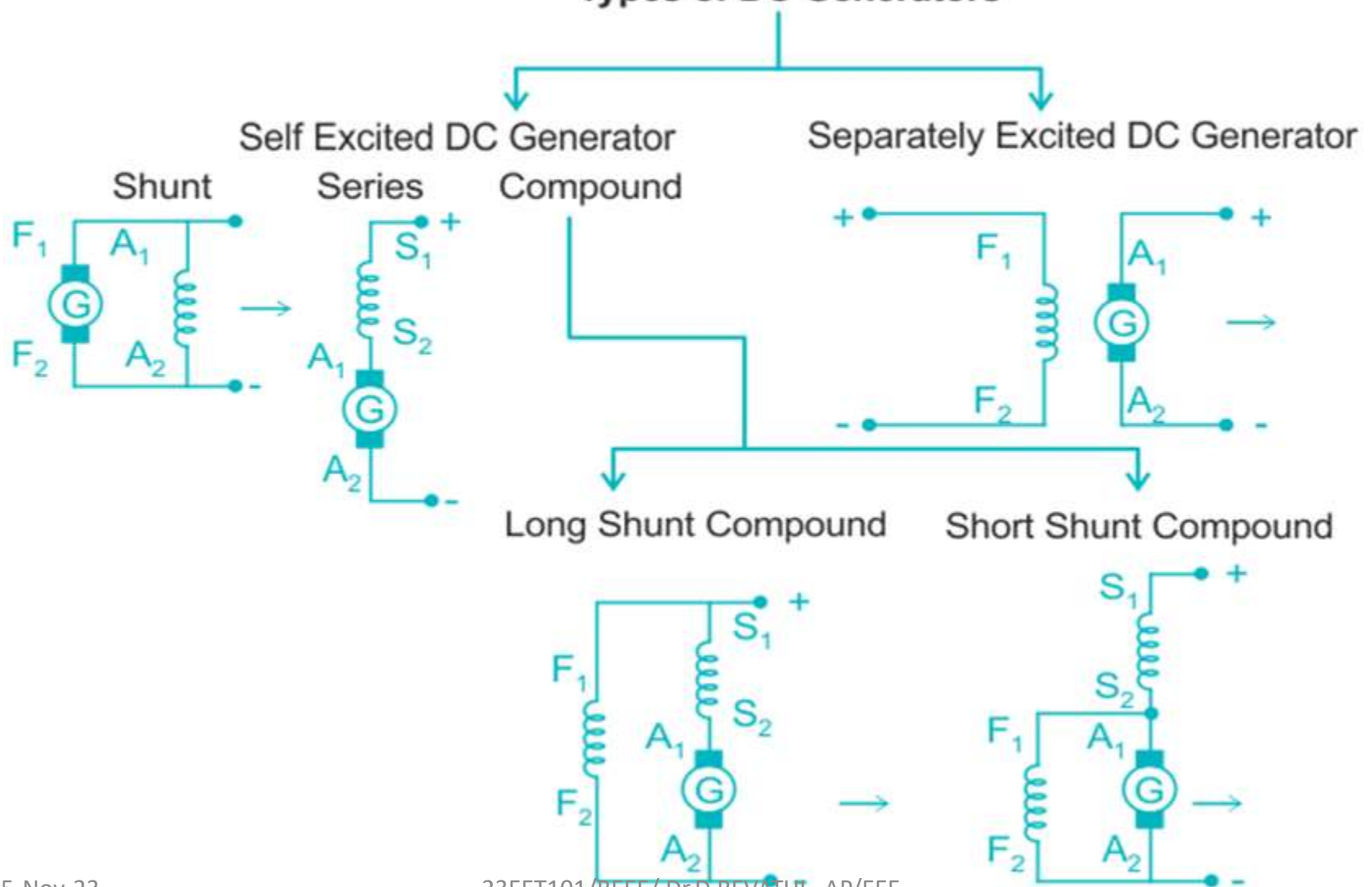
$$E_g = \frac{P\Phi ZN}{60} A$$

- Where  $\Phi$  is flux or pole within Webber
- 'Z' is a total no.of armature conductor
- 'P' is a number of poles in a generator
- 'A' is a number of parallel lanes within the armature
- 'N' is the rotation of armature in r.p.m (revolutions per minute)
- 'E<sub>g</sub>' is the generated e.m.f in any one of the parallel lanes
- 'N/60' is the number of turns per second
- Time for one turn will be  $dt = 60/N$  sec



# TYPES

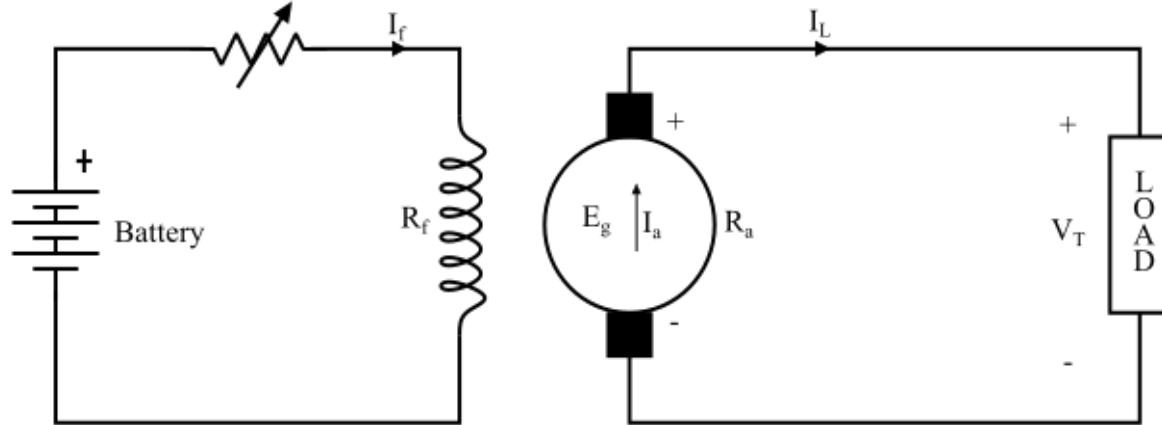
## Types of DC Generators





# SEPARATELY EXCITED DC GENERATOR AND ITS APPLICATIONS

- A *separately excited DC generator* is the one whose **field winding is supplied by an independent external DC source**



## APPLICATIONS

- These are able to produce a wide range of voltage output, they are primarily used in laboratory and commercial testing.
- These are used in speed regulation tests.
- These generators operate in a stable condition with any change in field excitation. Therefore, they are also used in supplying power to the DC motors, whose speed being to be controlled.



# SELF EXCITED DC GENERATOR AND ITS APPLICATIONS

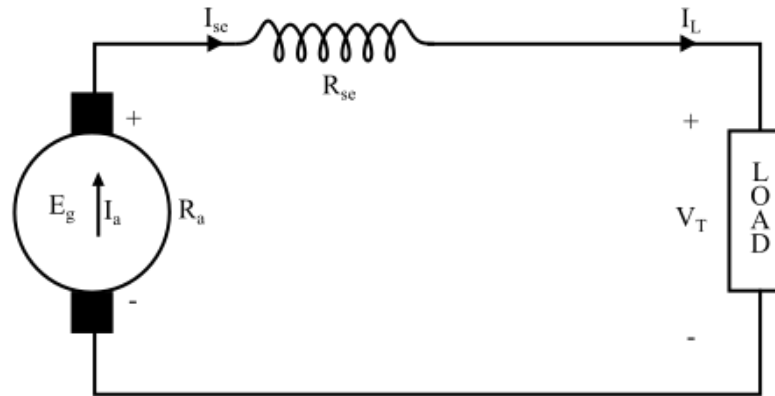
- A *self-excited DC generator* is the one whose **field winding is excited by the current from the output of the generator itself.**
- Depending upon the connection of field winding with the armature, the self-excited DC generators are of three types –
  - Series Generator
  - Shunt Generator
  - Compound Generator





# SERIES GENERATOR AND ITS APPLICATIONS

- The **field winding is connected in series with the armature of the generator** so that whole armature current would flow through the field winding as well as the load



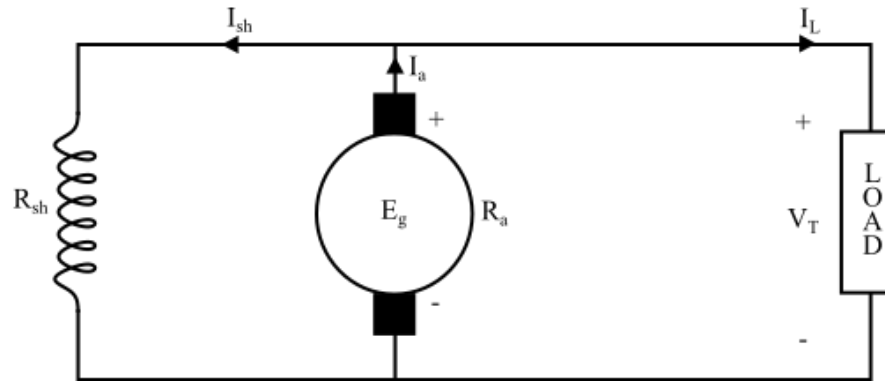
## APPLICATIONS

- The rising characteristics of a series DC generator makes it suitable for voltage boosting applications in the feeders in the various types of distribution systems.
- A series DC generator has the tendency to supply constant load current. Hence, several series generators can be connected in series to provide high voltage DC power transmission at constant load current.
- The series DC generators are also used in supplying field excitation current in DC locomotives for regenerative braking.
- The series generators also find applications in series arc lightening.



# SHUNT GENERATOR AND ITS APPLICATIONS

- The field winding is connected in parallel with the armature of the generator so that terminal voltage of the generator is applied across it.



## APPLICATIONS

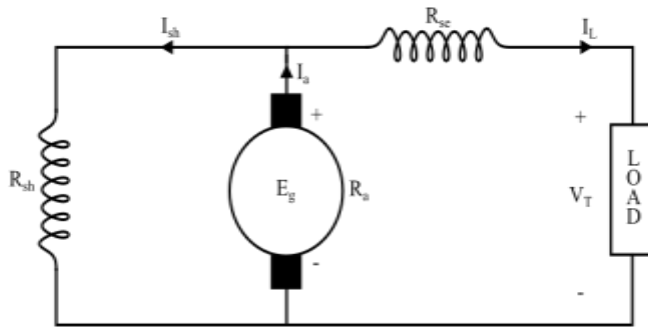
- They are used for battery charging applications.
- Shunt DC generators with field regulators are used for lighting and power supply purposes.
- Use for giving excitation to the alternators.



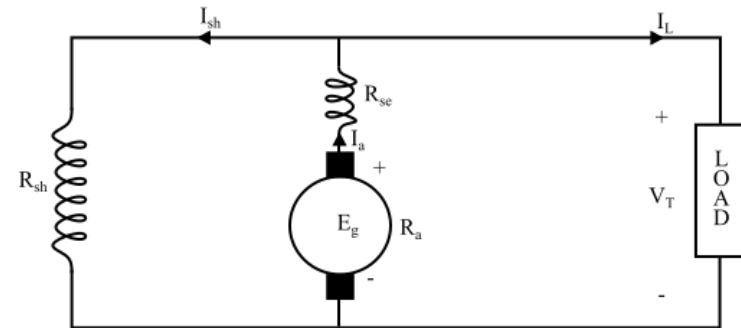
# COMPOUND GENERATOR AND ITS APPLICATIONS

- There are two field winding on each pole – one is in series and the other is in parallel with the armature.

## SHORT SHUNT COMPOUND GENERATOR



## LONG SHUNT COMPOUND GENERATOR



## APPLICATIONS

- The over compounded generators are used in supplying loads through long transmission lines.
- Cumulative compound generators are used for supplying power to DC motors.
- Cumulative compound generators are used for lighting, power supply purposes and for heavy power services, etc.
- The differential compound generators are used for arc welding purposes where a large voltage drop and constant current is required.



# LOSSES IN DC GENERATOR

- **Copper Loss-** These losses occur while current flows through windings and are of three types: armature copper loss, field copper winding loss and losses because of brush resistances.
- **Iron Losses-** Due to the induction of current in the armature, eddy current losses and hysteresis loss occur. These losses are also called Core losses or Magnetic losses.
- **Mechanical Losses-** Losses which occur because of friction between the parts of the generator are called mechanical losses.



# ADVANTAGES



- DC generators generate large output.
- The terminal load of these generators is high.
- The designing of dc generators are very simple
- These are used to generate uneven output power.
- These are extremely consistent with 85-95%.of efficiency ratings
- They give a reliable output.
- They are lightweight as well as compact.



# DISADVANTAGES

- DC generator cannot be used with a transformer
- The efficiency of this generator is low due to many losses like copper, mechanical, eddy, etc.
- A voltage drop can occur over long distances
- It uses a split ring commutator so it will complicate the machine design
- Expensive
- High maintenance
- The sparks will be generated while generating energy
- More energy will be lost while transmission



# APPLICATION

- The separately excited type DC generator is used for power and lighting purposes using the field regulators.
- The series DC generator is used in arc lamps for stable current generator, lighting and booster.
- Level compound DC generators are used to supply power to hostels, offices, lodges.
- Compound DC generators are used for supplying power to DC welding machines.
- A DC generator is used to compensate for the voltage drop in the feeders.



# VIDEOS



Construction –

<https://www.youtube.com/watch?v=gW45N2WpD64&t=109s>

Principle of Operation-

<https://www.youtube.com/watch?v=Jh167TEECBk>