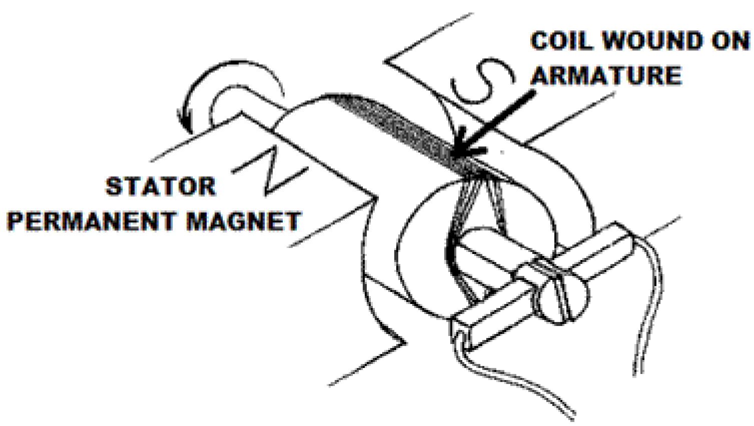
## TYPES OF DC GENERATORS

Generally DC generators are classified according to the ways of excitation of their fields. There are three methods of excitation.

1. Field coils excited by permanent magnets – Permanent magnet DC generators.
2. Field coils excited by some external source – Separately excited DC generators.
3. Field coils excited by the generator itself – Self excited DC generators.

A brief description of these **type of generators** are given below.

**Permanent Magnet DC Generator**




PERMANENT MAGNET DC GENERATOR

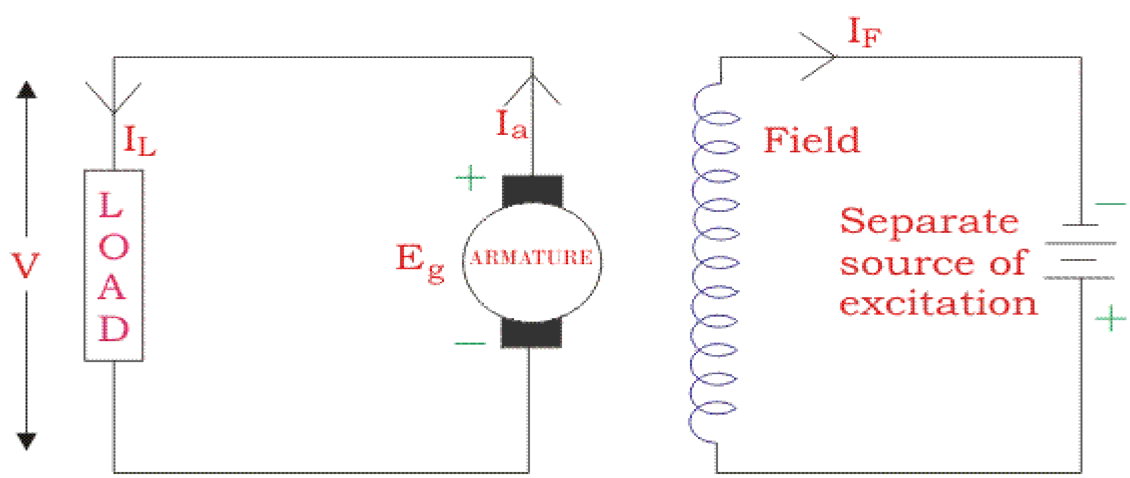
When the flux in the magnetic circuit is established by the help of permanent magnets then it is known as Permanent magnet DC generator.

It consists of an armature and one or several permanent magnets situated around the armature. This **type of DC generators** generates very low power. So, they are rarely found in industrial applications. They are normally used in small applications like dynamos in motorcycles.

**Separately Excited DC Generator**

These are the generators whose field magnets are energized by some external DC source such as battery.

A circuit diagram of separately excited DC generator is shown in the figure. $I_a$ = Armature current $I_L$ = Load current V = Terminal voltage $E_g$ = Generated emf Voltage drop in the armature = $I_a \times R_a$ (R/sub>a is the armature resistance) Let, $I_a = I_L = I\ (say)$




Separately Excited DC Generator

Then, $voltage\ across\ the\ load, V = IR_a$ Power generated, $P_g = E_g \times I$ Power delivered to the external load, $P_L = V \times I$

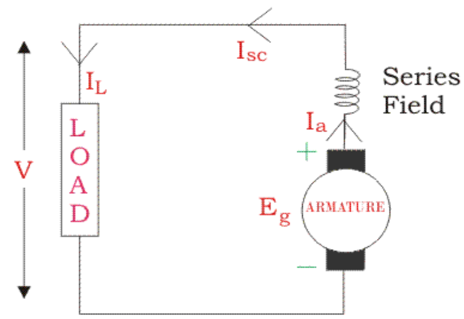
**Self-excited DC Generators**

These are the generators whose field magnets are energized by the current supplied by themselves. In these type of machines, field coils are internally connected with the armature. Due to residual magnetism some flux is always present in the poles. When the armature is rotated, some emf is induced. Hence some induced current is produced. This small current flows through the field coil as well as the load and thereby strengthening the pole flux. As the pole flux strengthened, it will produce more armature emf, which cause the further increase of current through the field. This increased field current further raises armature emf, and this cumulative phenomenon continues until the excitation reaches to the rated value. According to the position of the field coils the self-excited DC generators may be classified as…

1. Series wound generators
2. Shunt wound generators
3. Compound wound generators

***Series Wound Generator***

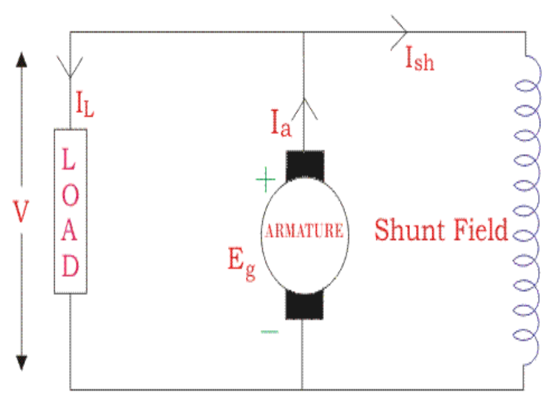
In these type of generators, the field windings are connected in series with armature conductors as shown in figure below. So, whole current flows through the field coils as well as the load. As series field winding carries full load current it is designed with relatively few turns of thick wire. The electrical resistance of series field winding is therefore very low (nearly 0.5Ω ). Let, $R_{sc}$ = Series winding resistance $I_{sc}$ = Current flowing through the series field $R_a$ = Armature resistance $I_a$ = Armature current $I_L$ = Load current V = Terminal voltage $E_g$ = Generated emf Then, $I_a = I_{sc} = I_L = I \ (say)$ Voltage across the load, $V = E_g - I(I_a \times R_a)$ Power generated, $P_g = E_g \times I$ Power delivered to the load, $P_L = V \times I$




Series Wound Generator

### *Shunt Wound DC Generators*

In these **type of DC generators** the field windings are connected in parallel with armature conductors as shown in figure below. In shunt wound generators the voltage in the field winding is same as the voltage across the terminal. Let, $R_{sh}$ = Shunt winding resistance $I_{sh}$ = Current flowing through the shunt field $R_a$ = Armature resistance $I_a$ = Armature current $I_L$ = Load current V = Terminal voltage $E_g$ = Generated emf




Shunt Wound Generator

Here armature current $I_a$ is dividing in two parts, one is shunt field current $I_{sh}$ and another is load current $I_L$. So, $I_a = I_{sh} + I_L$The effective power across the load will be maximum when $I_L$

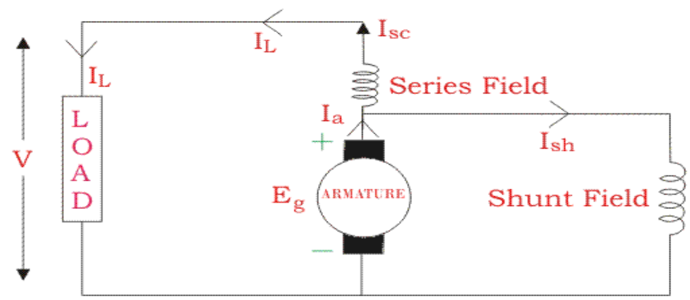
will be maximum. So, it is required to keep shunt field current as small as possible. For this purpose the resistance of the shunt field winding generally kept high (100 Ω) and large no of turns are used for the desired emf. Shunt field current, $I_{sh} = \frac{V}{R_{sh}}$ Voltage across the load, $V = E_g - I_a R_a$ Power generated, $P_g = E_g \times I_a$ Power delivered to the load, $P_L = V \times I_L$

***Compound Wound DC Generator***

In series wound generators, the output voltage is directly proportional with load current. In shunt wound generators, output voltage is inversely proportional with load current. A combination of these two types of generators can overcome the disadvantages of both. This combination of windings is called compound wound DC generator. Compound wound generators have both series field winding and shunt field winding. One winding is placed in series with the armature, and the other is placed in parallel with the armature. This **type of DC generators** may be of two types- short shunt compound-wound generator and long shunt compound-wound generator.

**Short Shunt Compound Wound DC Generator**

The generators in which only shunt field winding is in parallel with the armature winding as shown in figure.

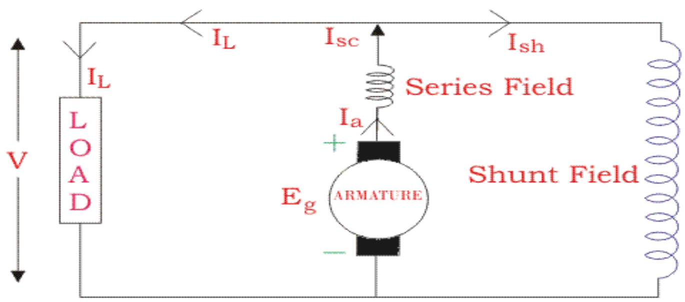



Short Shunt Compound Wound Generator

Series field current, $I_{sc} = I_L$ Shunt field current, $I_{sh} = \dfrac{(V + I_{sc}R_{sc})}{R_{sh}}$ Armature current, $I_a = I_{sh} + I_L$ Voltage across the load, $V = E_g - I_aR_a - I_{sc}R_{sc}$ Power generated, $P_g = E_g \times I_a$ Power delivered to the load, $P_L = V \times I_L$

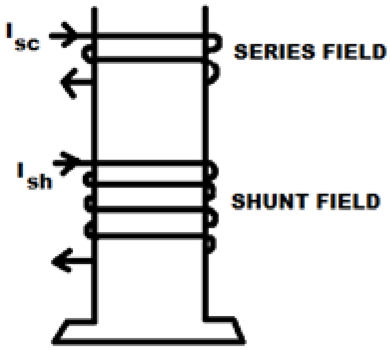
**Long Shunt Compound Wound DC Generator**

The generators in which shunt field winding is in parallel with both series field and armature winding as shown in figure.

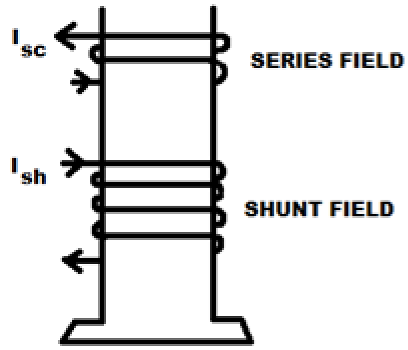



Long Shunt Compound Wound Generator

Shunt field current, $I_{sh} = \dfrac{V}{R_{sh}}$ Armature current, $I_a$ = series field current, $I_{sc} = I_L + I_{sh}$ Voltage across the load, $V = E_g - I_aR_a - I_{sc}R_{sc} = E_g - I_a(R_a + R_{sc})$ $[\therefore I_a = I_{cs}]$ Power generated, $P_g = E_g \times I_a$ Power delivered to the load, $P_L = V \times I_L$ In a compound wound generator, the shunt field is stronger than the series field. When the series field assists the shunt field, generator is said to be commutatively compound wound. On the other hand if series field opposes the shunt field, the generator is said to be differentially compound wound.




CUMULATIVE COMPOUNDING




DIFFERENTIAL COMPOUNDING