## Types of DC Generators :-

The magnetic field in a d.c. generator is normally produced by electromagnets rather than permanent magnets.

→ Generally, generators are classified according to their methods of field Excitation. On this basis, D.C generators are divided into the following two classes.

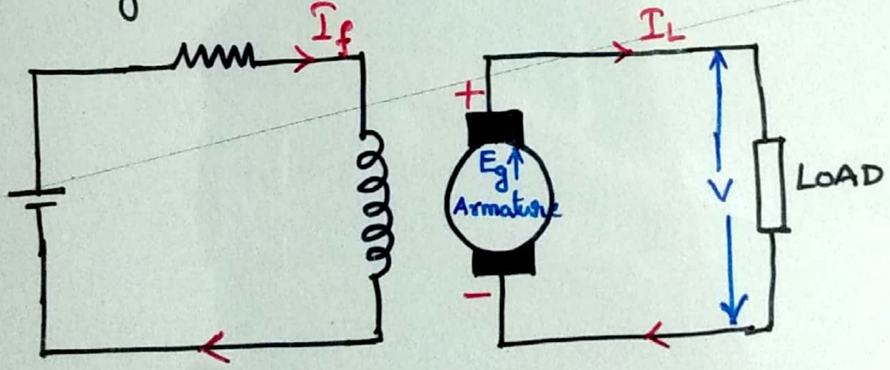
(i) Separately Excited D.C. generators

(ii) Self - Excited D.C generators

## Separately Excited D.C. generator :-

→ A D.C generator whose field winding is excited from an Independent external D.C Source, such as a battery, the generator is called a Separately Excited generator.

→ Separately Excited d.c generators are rarely used in practic[e]. The D.C generators are normally of self-Excited type.




Armature current, $I_a = I_L$

terminal voltage $V = E_g - I_a R_a$.

Electrical power developed $= E_g \cdot I_a$

power delivered to load $= E_g \cdot I_a - I_a^2 R_a$

$= I_a (E_g - I_a R_a)$

$= V \cdot I_a$.

## Self - Excited D.C. generators :-

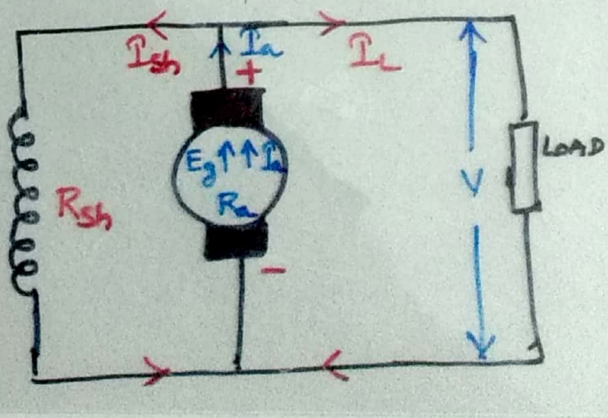
→ A DC generator whose field winding is excited by the current supplied by the generator itself, is called a self - excited generator.

→ Self excited generators are classified as
(i) Shunt wound generators
(ii) Series wound generators
(iii) Compound wound generators.

Due to residual magnetism, some flux is always present in the poles of such machines. when the armature is rotated, a small voltage is induced in the armature winding owing to residual flux. This induced voltage causes a small current to flow in the field coils and thus increase in flux per pole. The increase in flux causes increase in induced voltage which further increases the field current and so flux per pole. These events take place rapidly and the generator builds up to the rated voltage.

## Shunt wound generator :-

In a shunt generator, the field winding is connected in parallel with the armature winding so that terminal voltage of the generator is applied across it. The shunt field winding has many turns of fine wire having high resistance. Therefore, only a part of armature current flows through shunt field winding and rest flows through the load.



Shunt field current, $I_{sh} = V/R_{sh}$

Armature current, $I_a = I_L + I_{sh}$

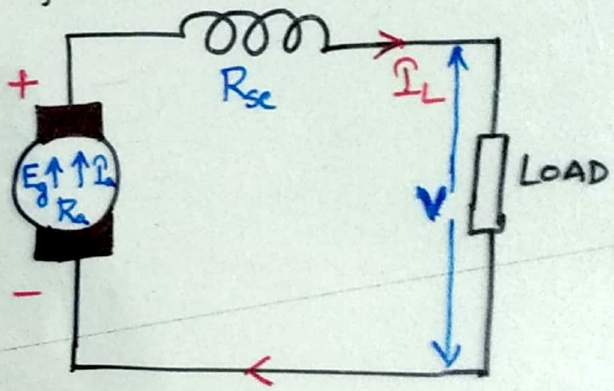
terminal Voltage, $V = E_g - I_a R_a$.

Power developed in armature $= E_g \cdot I_a$.

Power delivered to load $= V \cdot I_L$

## Series wound generator :-

→ In a series-wound generator, the field winding is connected in series with armature winding so that whole armature current flows through the field winding as well as the load. Since the field winding carries the whole of load current, it has a few turns of thick wire having low resistance.




Armature current $= I_a = I_{se} = I_L$

terminal Voltage $V = E_g - I\,(R_a + R_{se})$

Power developed in Armature $= E_g \cdot I_a$

Power developed to load $= E_g \cdot I_a - I_a^2 (R_a + R_{se})$

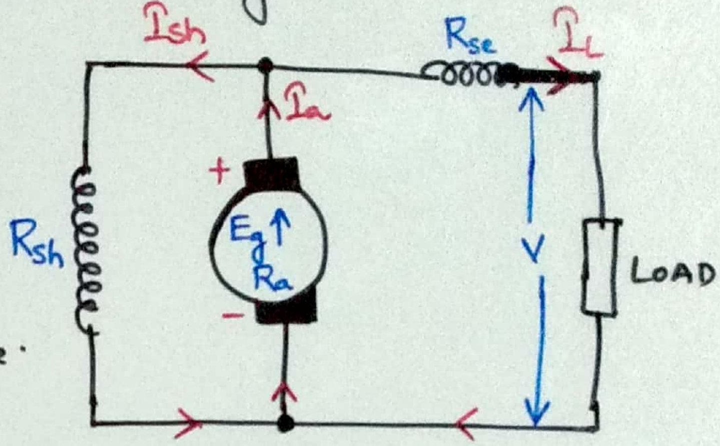
$= I_a \left[E_g - I_a (R_a + R_{se})\right]$

$= V \cdot I_a = V \cdot I_L$

## Compound wound generators :-

In a compound wound generators, there are two sets of field windings on each pole — one is in series and the other in parallel with the armature. A compound wound generator may be : ⓐ Short shunt ⓑ Long shunt.

**Short Shunt generator :-** in which only shunt field winding is in parallel with the armature winding.




Series field Current, $I_{se} = I_L$

Shunt field Current $I_{sh} = \frac{V + I_{se} R_{se}}{R_{sh}}$

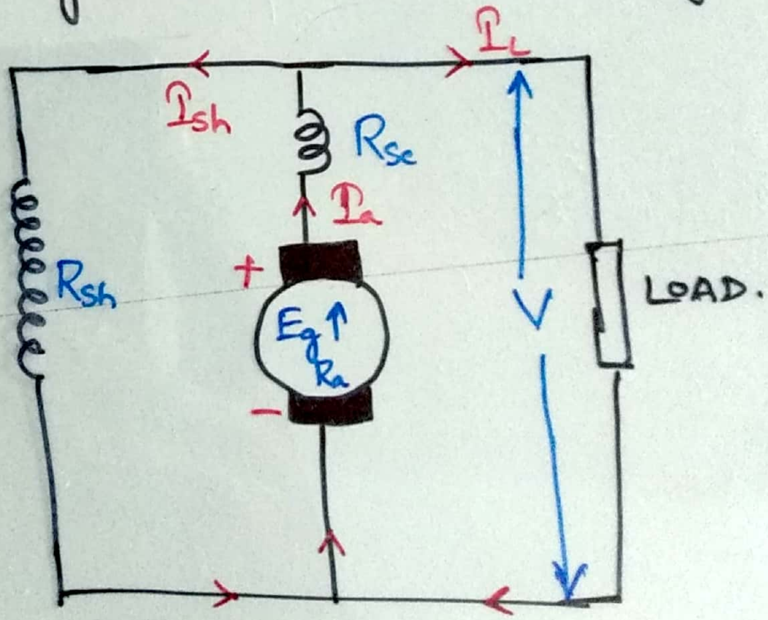
terminal Voltage $V = E_g - I_a R_a - I_{se} R_{se}$.

power developed in Armature

$= E_g \cdot I_a$.

power delivered to load $= V \cdot I_L$.

**Long Shunt generator :-** in which field winding is in parallel with both Series winding (field) and armature winding.




Shunt field Current $I_{sh} = \frac{V}{R_{sh}}$

Series field Current $I_{se} = I_a = I_L + I_{sh}$

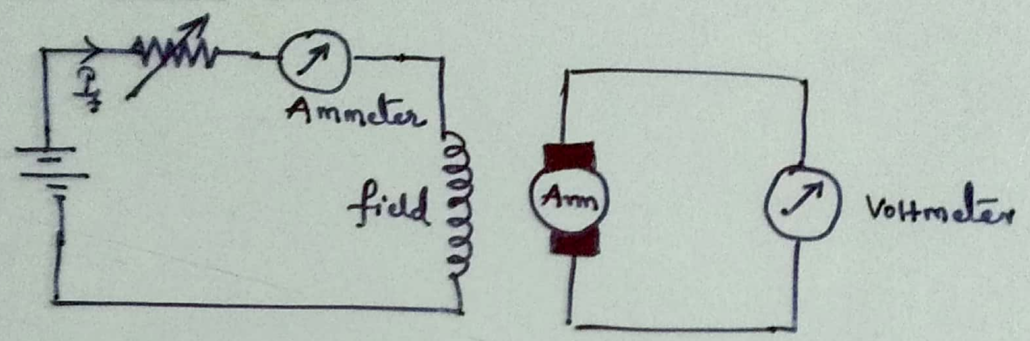
terminal Voltage, $V = E_g - I_a (R_a + R_{se})$

Power developed in Armature $= E_g \cdot I_a$

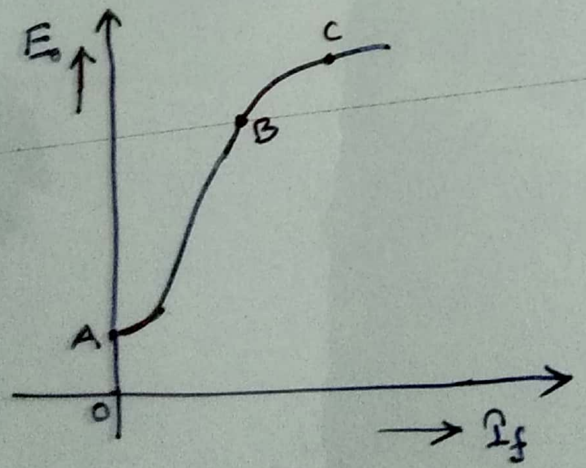
Power delivered to load $= V \cdot I_L$.

## Open circuit characteristic :—

The arrangement for obtaining necessary data to plot this curve is shown below.




The field winding of the d.c. generator (series or shunt) is separately excited from an external DC source. The field current ($I_f$) is varied from zero in steps and the corresponding values of generated emf ($E_0$) read off on a voltmeter ~~from~~ across the armature terminals on plotting the relation between $E_0$ and $I_f$, we get open circuit characteristic.




The following points may be noted from O.C.C

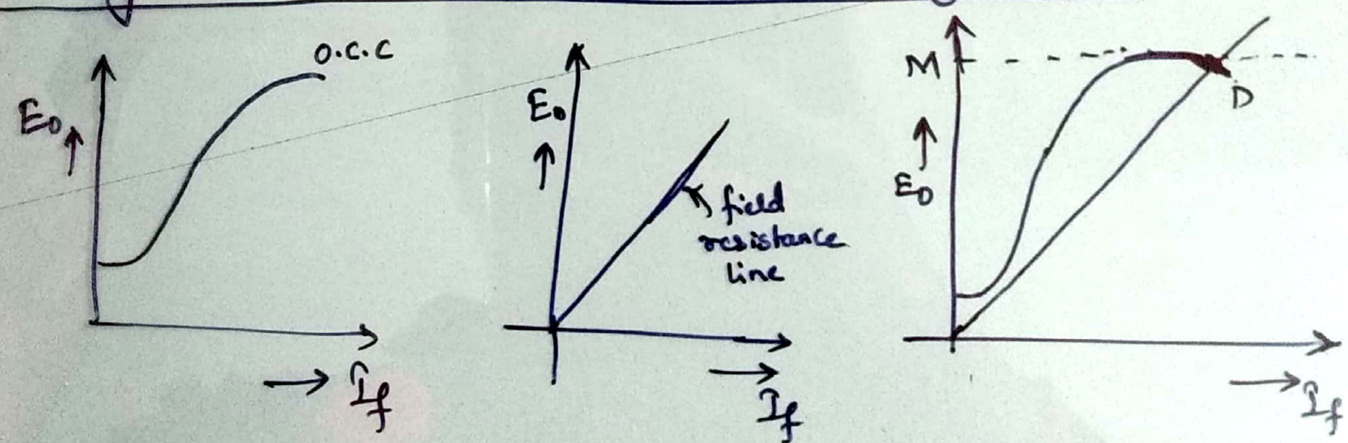
(i) when $I_f = 0$, there is some generated emf OA. This is due to residual magnetism in the field poles

(ii) over a fairly wide range of field current (upto point B in the curve), The current is linear. It is because in this range, reluctance of iron is negligible as compared with that of air gap. The air gap reluctance is constant and hence linear relationship.

(iii) After point B on the curve, the reluctance of iron also comes into picture. It is because at higher flux density, $\mu_r$ for iron decreases and reluctance of iron is no longer negligible. Consequently, the curve deviates from linear relationship.

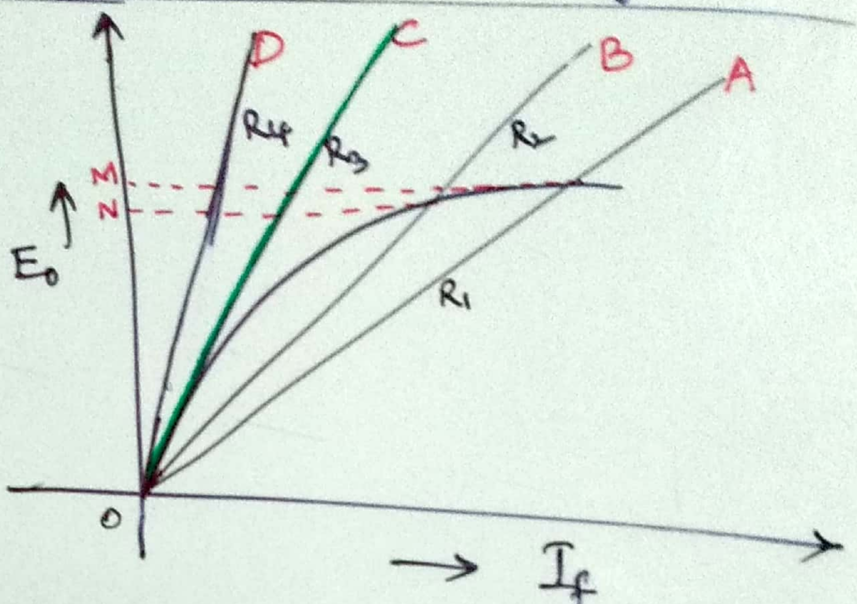
(iv) After point C on the curve, the magnetic saturation of poles begins and $E_0$ tends to level off.

## Voltage Build-up of a Shunt generator :-




Conclusion : The voltage build up of the generator is given by the point of intersection of O.C.C and field resistance line. Thus in above figure D is the point of intersection of O.C.C and field resistance line. Hence generator will build up a voltage OM.

## Critical field Resistance for a Shunt generator 




- When the field resistance ~~line~~ is Increased, the slop of resistance line also ↑.
- When field resistance line becomes tangent (line OC) to O.c.c the generator would just excite.
- If the field circuit resistance is Increased beyond this point (say line OD). The generator will fail to Excite.

**Critical field Resistance:** The maximum field circuit resistance (for a given speed) with which the shunt generator would just excite is known as critical field resistance