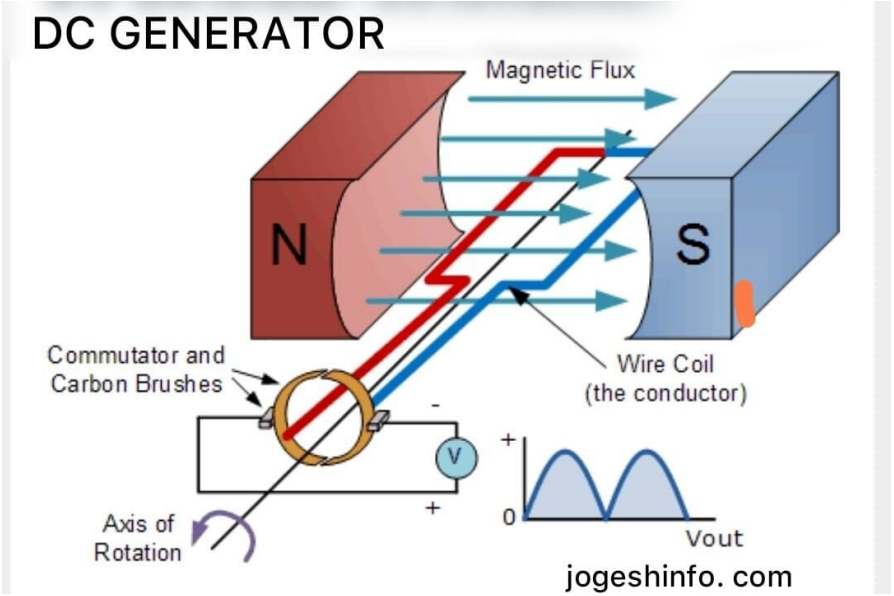
DC Generators

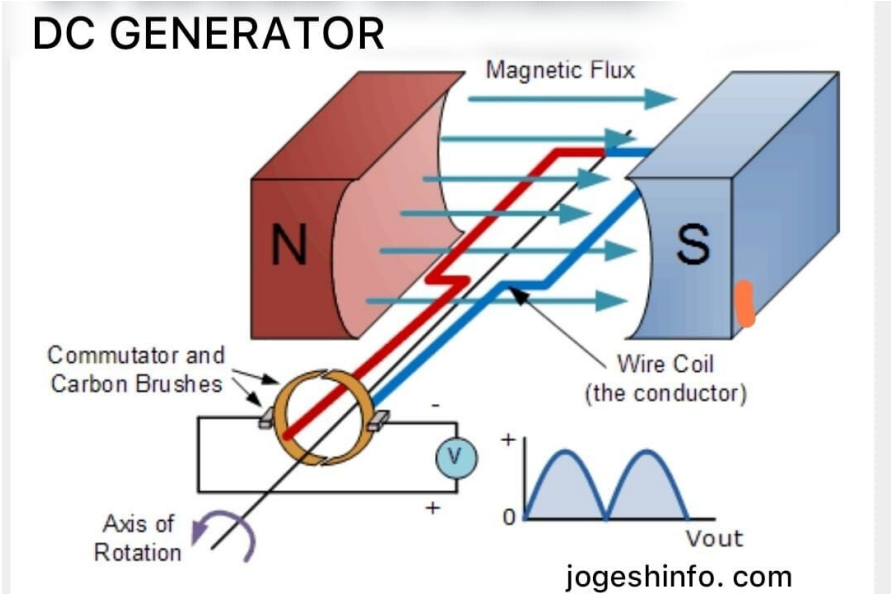
DC Generator Construction

- DC Generators are almost exactly the same as DC motors in terms of construction
- It contains the same items we've learnt about in motors;
  - Commutators/Split Ring
  - Brushes
  - Armature/Loop/Windings
  - Stators



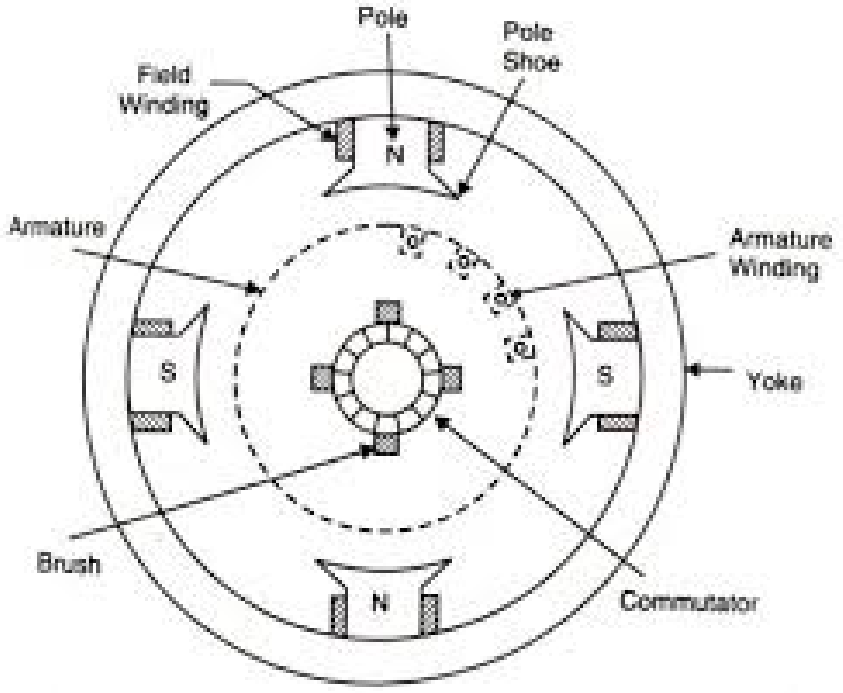
DC Generator Construction

- The commutator ensures that the current is always flowing the same way by swapping contacts
- The armature (windings) rotate because of some external force, they have the current induced in them
- The brushes ensure contact is always made with the split ring
- The stator creates the magnetic field to induce the current



Parts of a DC Generator Stator

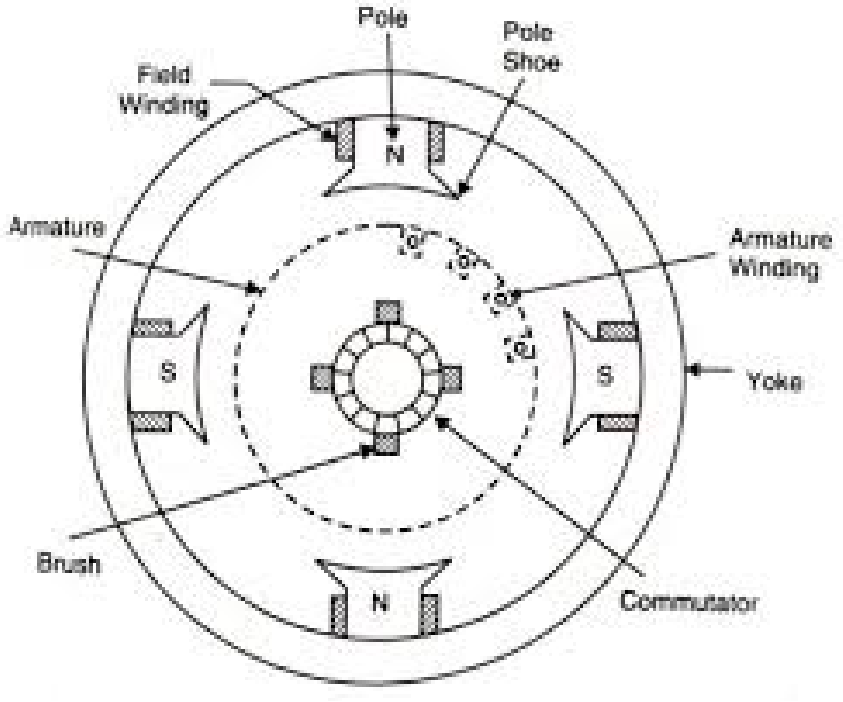
- The poles in a DC generator stator are what form the magnetic field
- They can either be PMDC (permanent magnet) or electromagnet (series or shunt)
- Often, they are electromagnets as they can produce a stronger field and can be controlled.



Parts of a DC Generator Stator

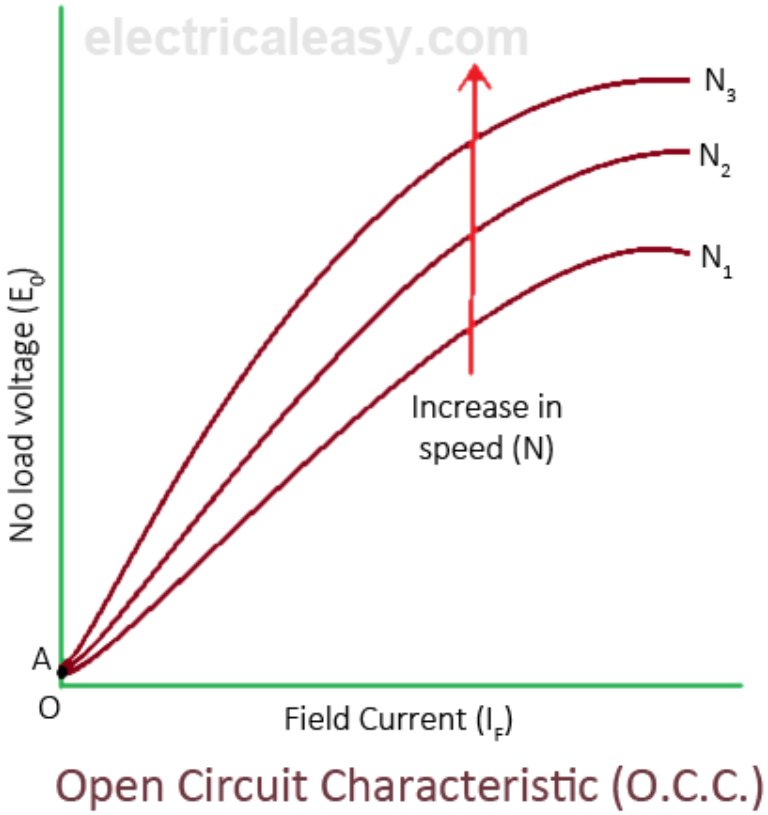
- The poles themselves are often chunks of metal formed to produce a wide field and then have field windings wrapped round making electromagnets

- The yoke holds the poles in place, acts as a strong outer shell to protect the motor and helps the magnetic field by acting as a good material to return the field.



Open Circuit (no load) Characteristics

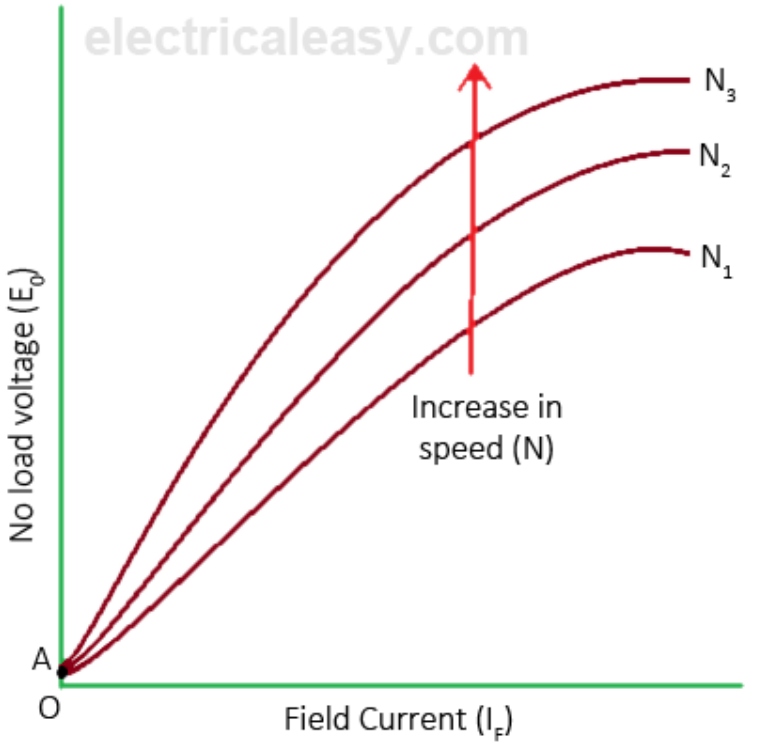
- The graph on this slide is only true when:
- There is no electrical device connected to the circuit to use the power generated (No Load)
- The generator is spinning at a constant speed



Open Circuit Characteristic (O.C.C.)

Open Circuit (no load) Characteristics

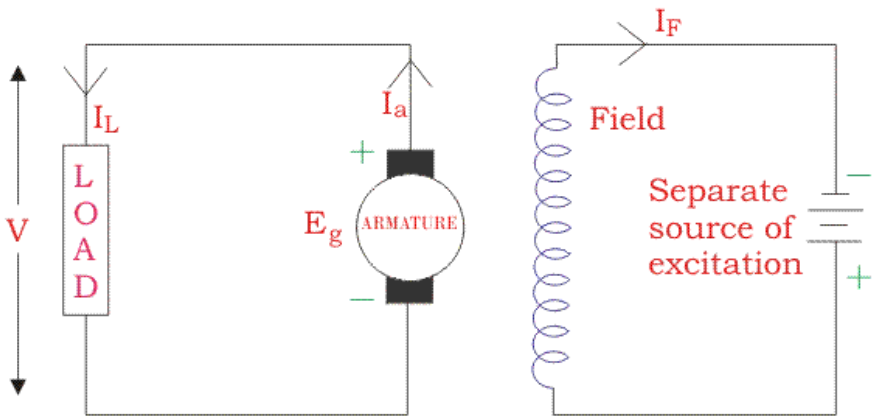
- As we can see from the graph as we increase the current going through the windings on the poles the voltage generated increases
- This is true until the poles are magnetically saturated at which point the voltage stops increasing gradually
- As you can see from the graph if we increase speed, we also get a higher voltage from field current values
- This is true of all types of DC generator



Open Circuit Characteristic (O.C.C.)

Separately Excited DC Generator

- A separately excited DC generator is a generator where the windings are powered by an external source
- This makes it easy to control the output voltage of the generator by adjusting the field strength using the external source (increasing or decreasing current)
- It also means the field is more consistent and doesn't vary with load

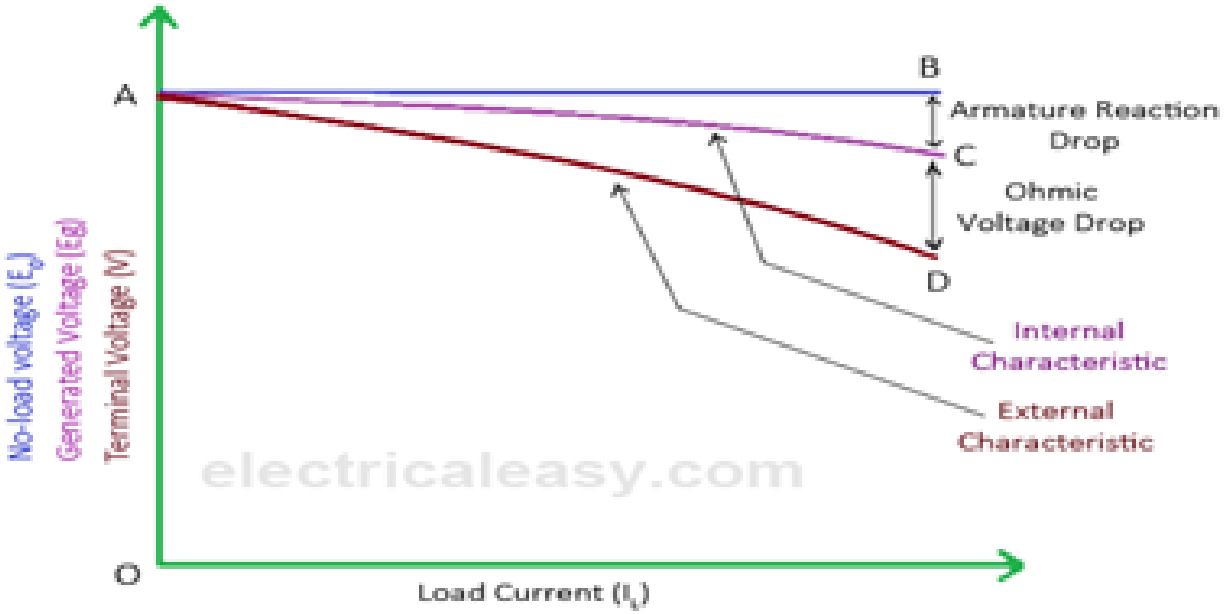


Separately Excited DC Generator

Separately Excited DC Generator

Advantages	Disadvantages
Output voltage can be **controlled independently** via the field current	Requires an **external DC power supply** for field excitation
Provides **very good voltage regulation** under varying load	More **complex and costly** than self-excited generators
Capable of producing **high and stable output voltages**	**Not self-starting** without external excitation
Field current is **stable and predictable**	Lower overall **system efficiency** due to extra power source
Suitable for **laboratory and test applications**	Less practical for **portable or standalone systems**

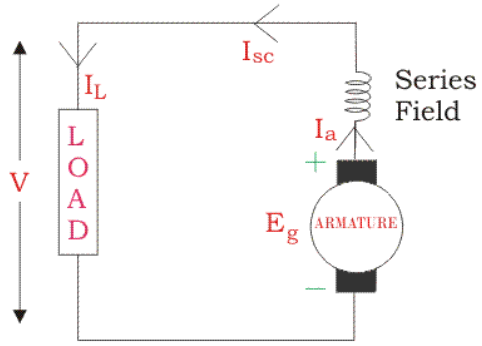
Separately Excited DC Generator - Load



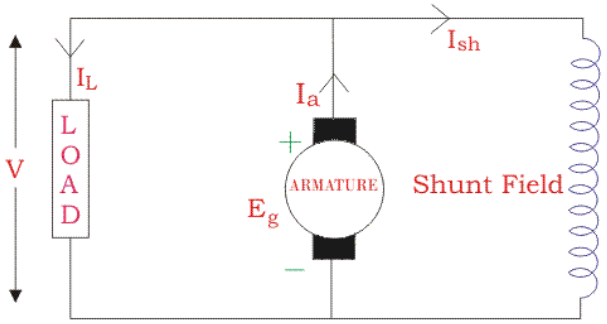
Characteristics of separately excited DC generator

Self Excited DC Generator

- A self excited DC generator is a generator where the windings are powered by an the current already being generated
- This makes them much easier to construct and repair and means you don't need an external source.
- It also means that its (often) self starting as residual magnetism is often left in field poles which allows it to be restarted



Series Wound Generator



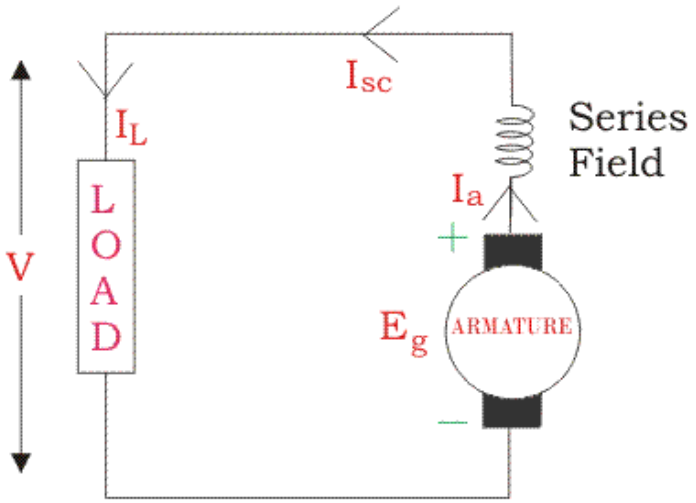
Shunt Wound Generator

Self Excited DC Generator

Advantages	Disadvantages
No external field supply required	Output voltage **depends on load and speed**
Simpler and cheaper than externally excited generators	**Poorer voltage regulation** (especially shunt and series)
Self-starting due to residual magnetism	Will **not build up voltage** if residual magnetism is lost
More **compact and practical** for standalone use	Voltage control is **less precise**
Suitable for **general industrial applications**	Performance varies significantly with **load changes**

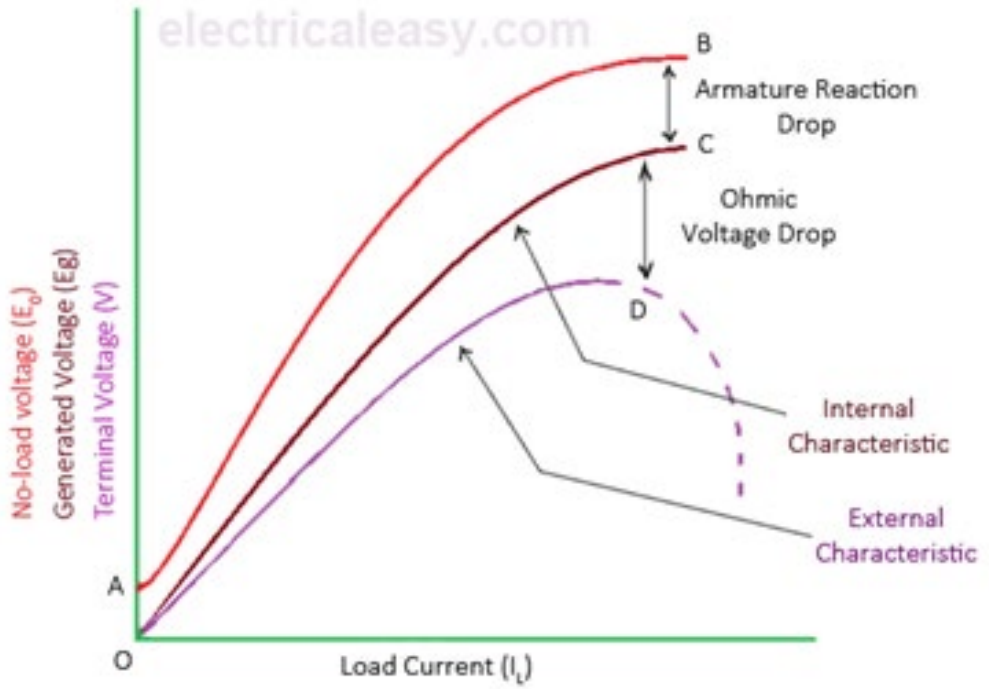
Series Wound DC Generator

- A series-wound DC Generator is similar in construction to a series-wound DC Motor
- This means that the armature and the windings are in series resulting in several things
- The current through the winding and thus the field strength varies based on the load
- This means that the voltage generated also varies with load, **rising as more load is added**
- Often used for very heavy or varying loads as the generator responds to load



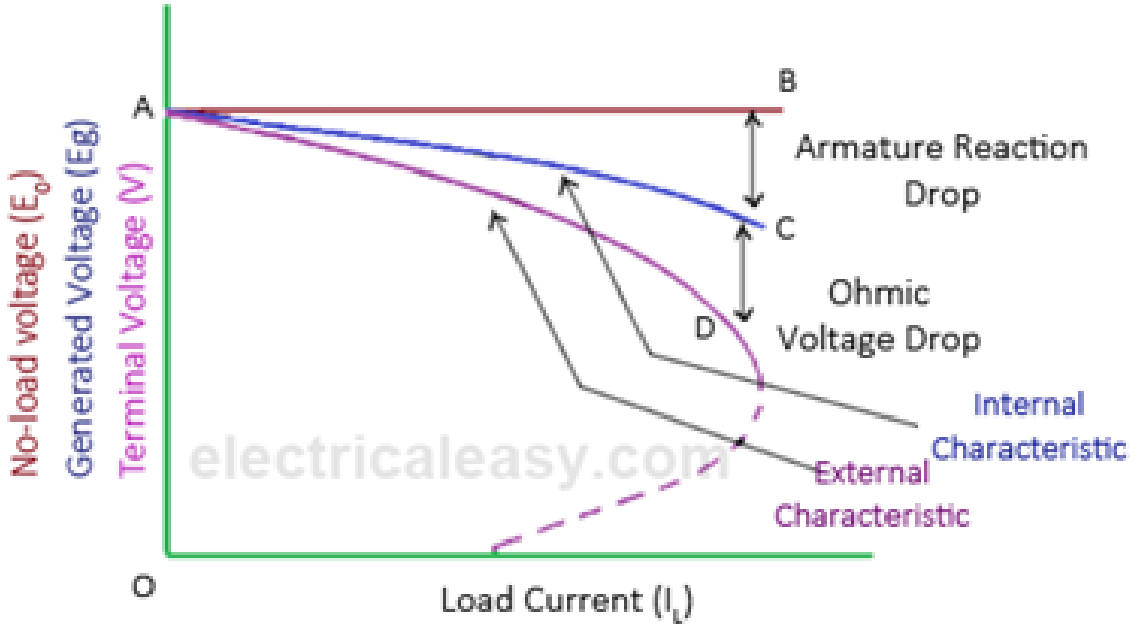
Series Wound Generator

Series Wound DC Generator - Load



Characteristics of DC series generator

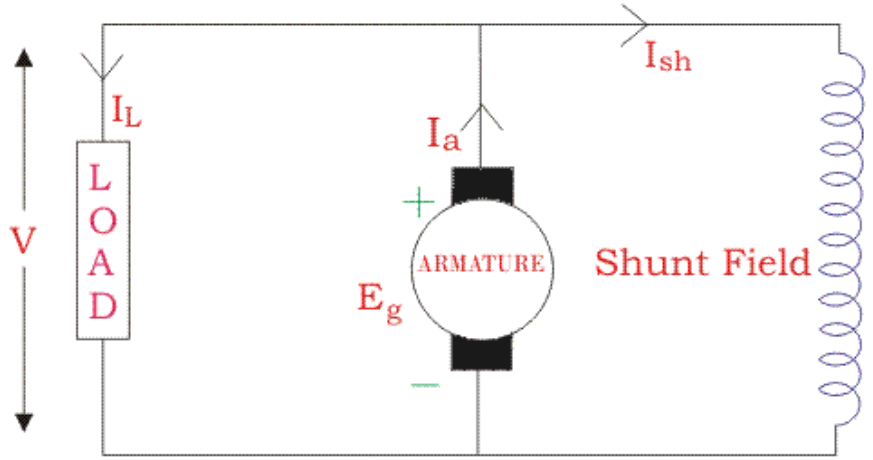
Series Wound DC Generator - Load



Characteristics of DC shunt generator

Shunt Wound DC Generator

- A shunt-wound DC Generator is similar in construction to a shunt-wound DC Motor
- This means that the armature and the windings are in parallel resulting in several things
- The current through the winding and thus the field strength stays consistent as it is independent of the load
- This means that the voltage generated stays mostly consistent, dropping slightly as load increases
- Often used for medium loads which don't vary alot



Shunt Wound Generator

Series vs Shunt Wound

Feature	Series-Wound DC Generator	Shunt-Wound DC Generator
Field winding connection	Field winding in **series with the load**	Field winding in **parallel (shunt) with the armature**
Field current	**Varies with load current**	**Nearly constant**, independent of load
Voltage regulation	**Poor** – voltage changes significantly with load	**Better** than series-wound
No-load operation	**Unsafe** (very low field current → low voltage)	**Safe** to run at no load
Output voltage behaviour	Voltage **rises with load** (up to saturation)	Voltage **drops slightly** as load increases
Load suitability	Best for **heavy, varying loads**	Best for **light to moderate, steady loads**
Typical applications	Boosters, traction, welding	Lighting, battery charging, general DC supply
Construction complexity	Simple field winding	Slightly more complex than series