Lecture-30

On

INTRODUCTION TO ELECTRICAL ENGINEERING (ESO203)

- DC generator.

Armature and Field Connections

❑ Excitation:

1. Permanent magnet.
2. Separate excitation (separately excited machine).
3. Shunt excitation (Self excited machine).
4. Compound excitation.

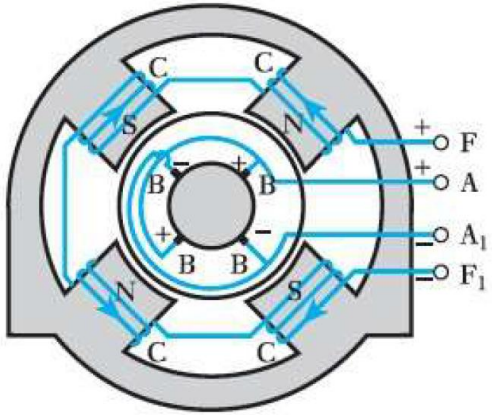
Armature and Field Connections (cont...)

1. Separately excited machines –the field winding being connected to a source of supply other than the armature of its own machine.
2. Self-excited machines, which may be subdivided into:

   a) Shunt-wound machines –the field winding being connected across the armature terminals

   b) Series-wound machines –the field winding being connected in series with the armature winding

   c) Compound-wound machines –a combination of shunt and series windings



Armature and Field Connections (cont...)

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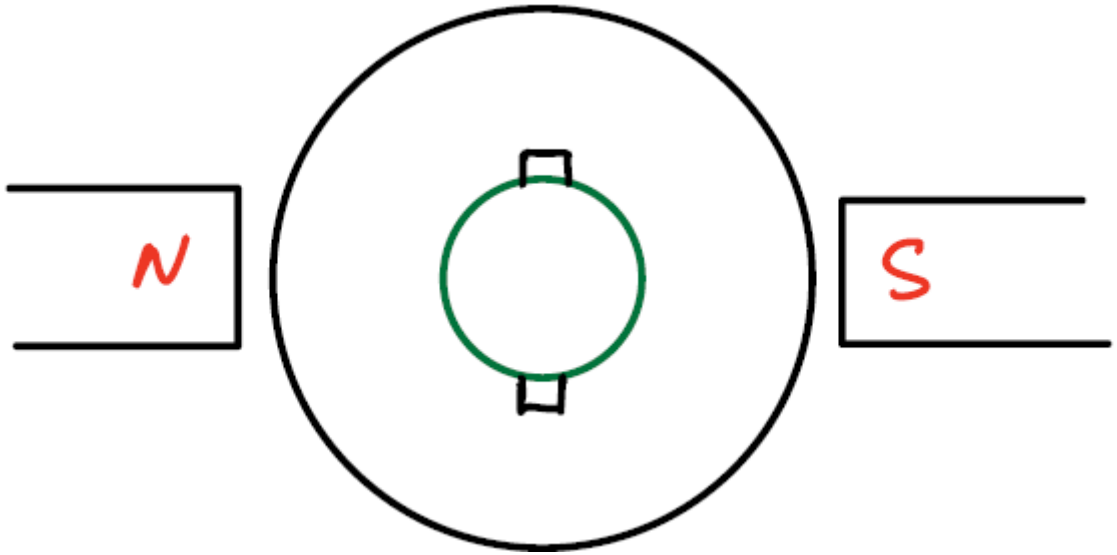
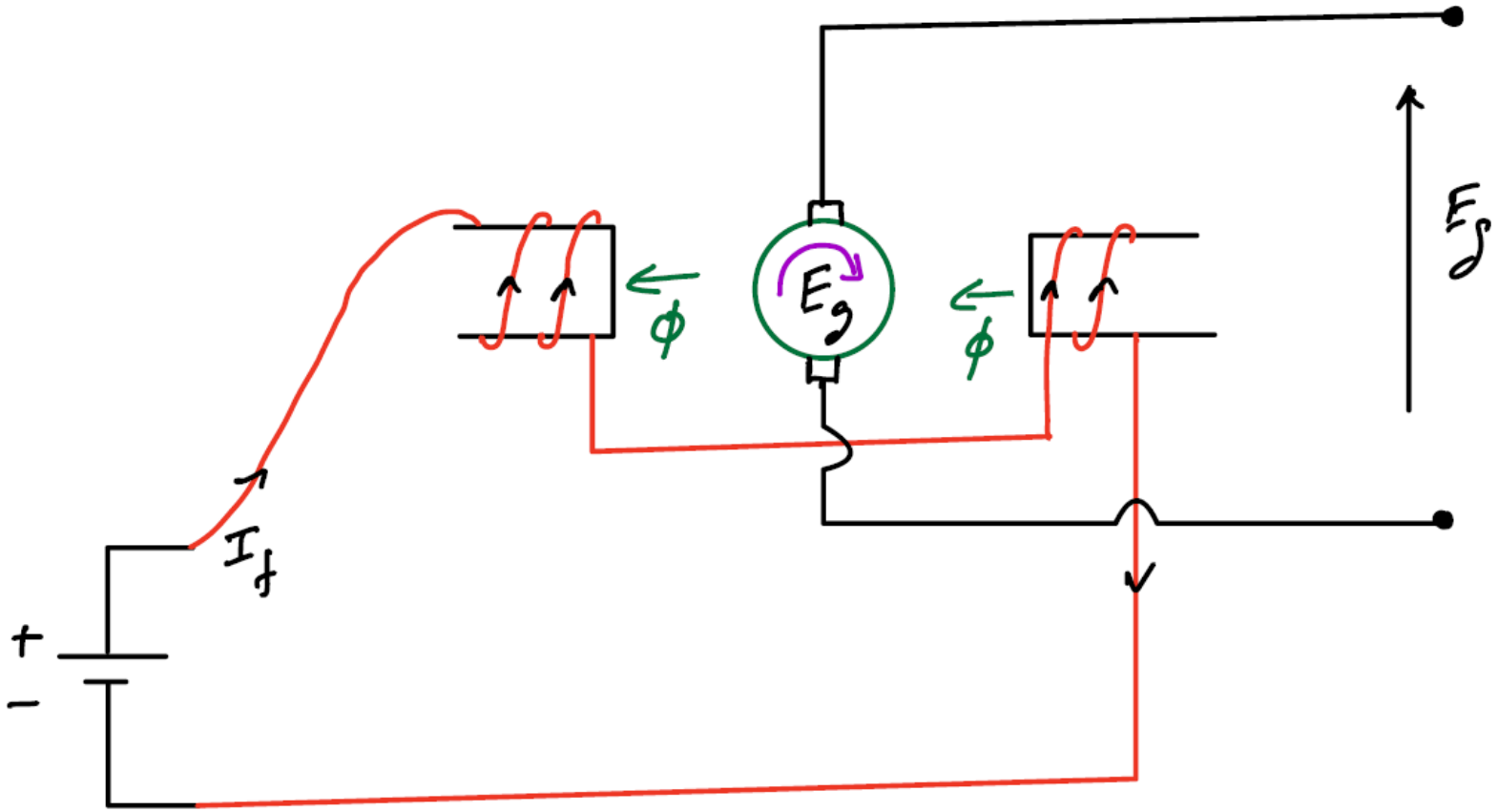
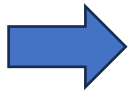


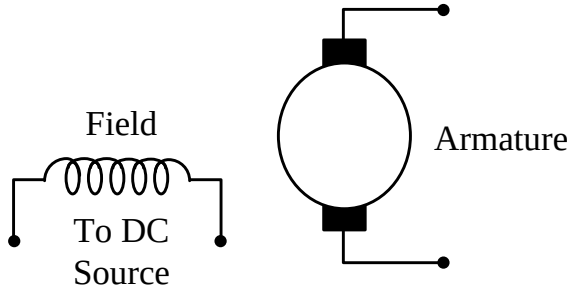
Armature and Field Connections (cont...)

❑ Excitation:

1. Separate excitation (separately excited machine).



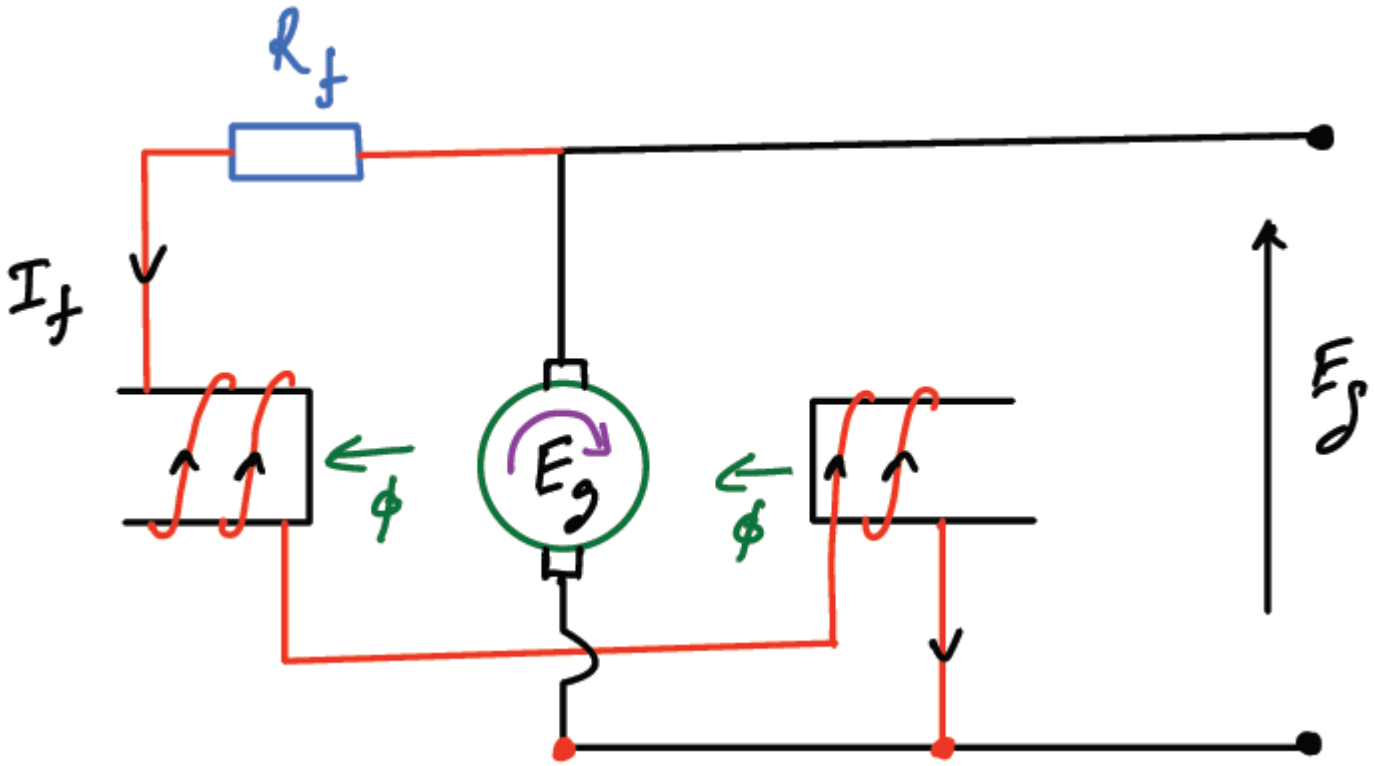


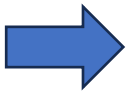


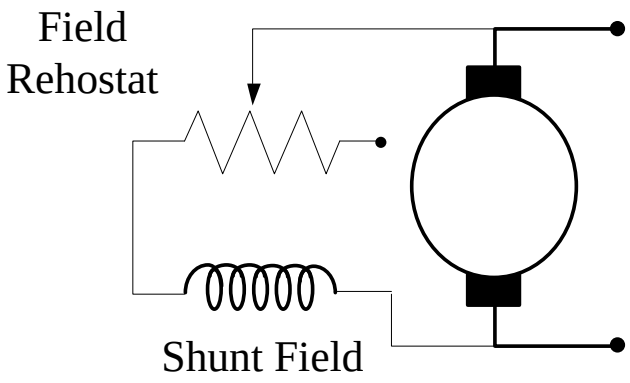
Armature and Field Connections (cont...)

❑ Excitation:

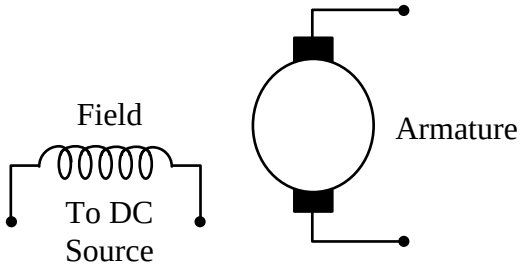
1. Shunt excitation (Self excited machine).



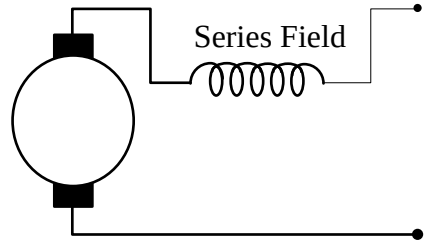




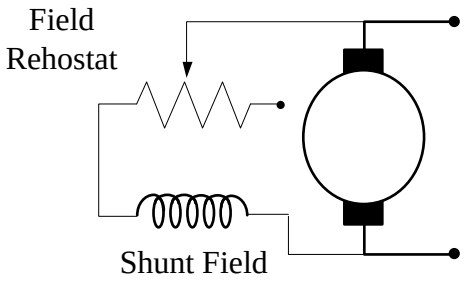
Armature and Field Connections (cont...)



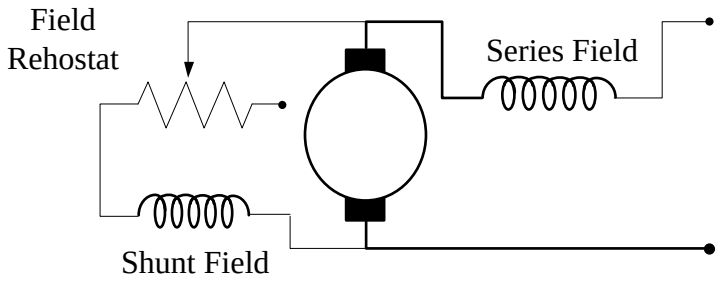
Separate Excitation



Series



Shunt

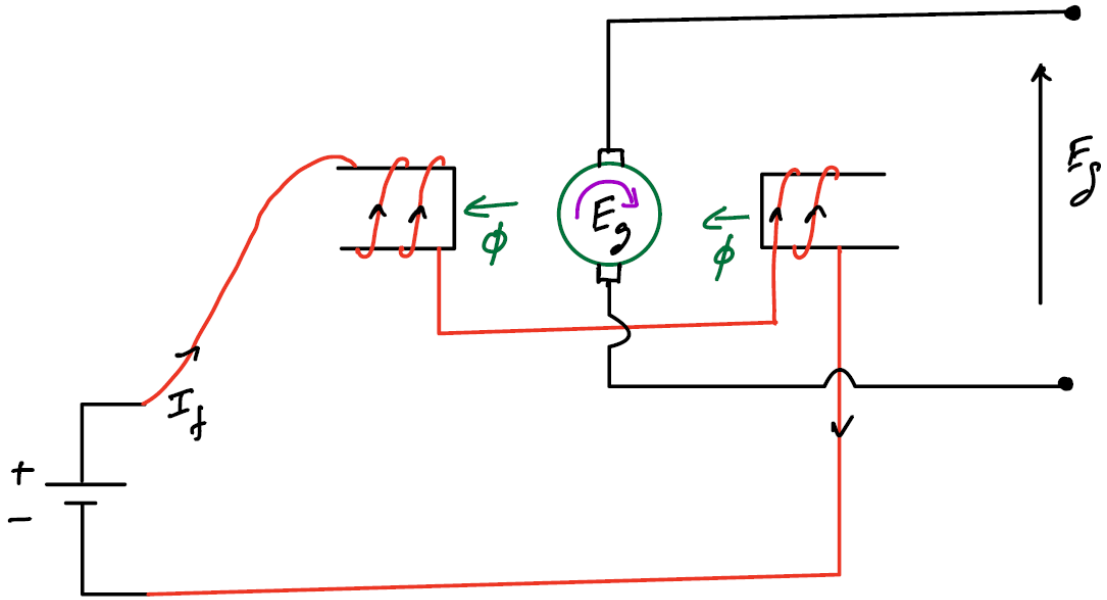


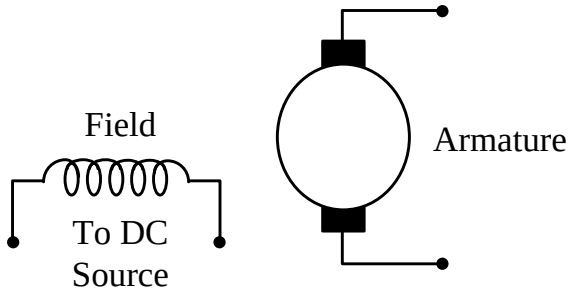
Compound

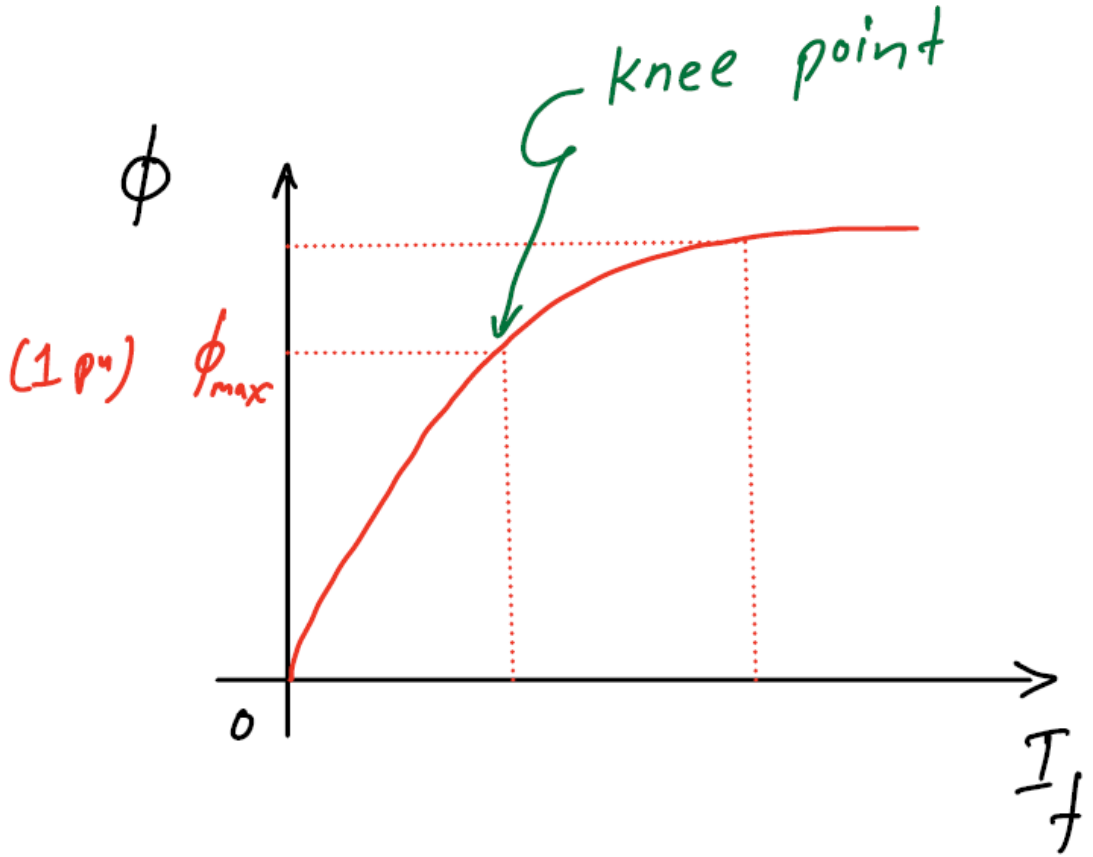
Armature and Field Connections (cont...)

❑ Excitation:

1. Separate excitation (separately excited machine).







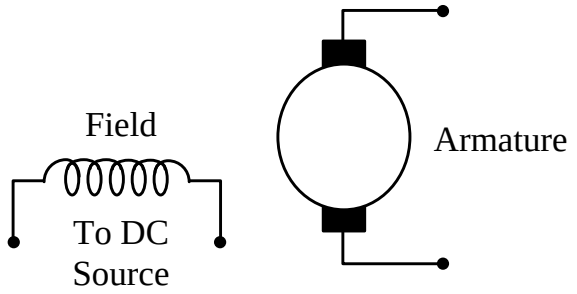
Armature and Field Connections (cont...)

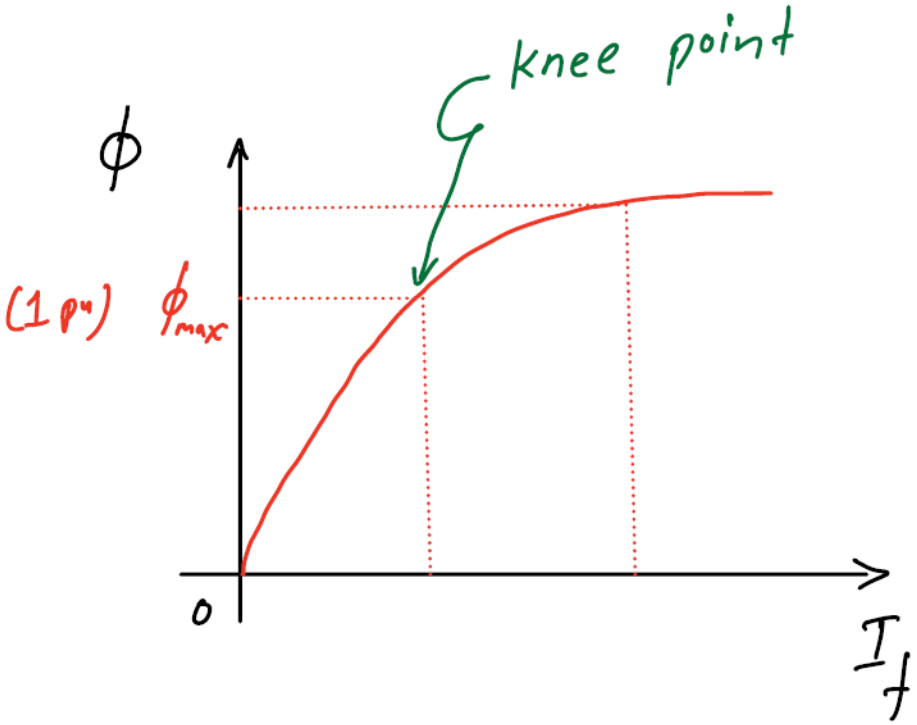
❑ Excitation:

1. Separate excitation (separately excited machine).

$$E = \frac{\phi Z n p}{60 a}$$

$$E \propto \phi$$





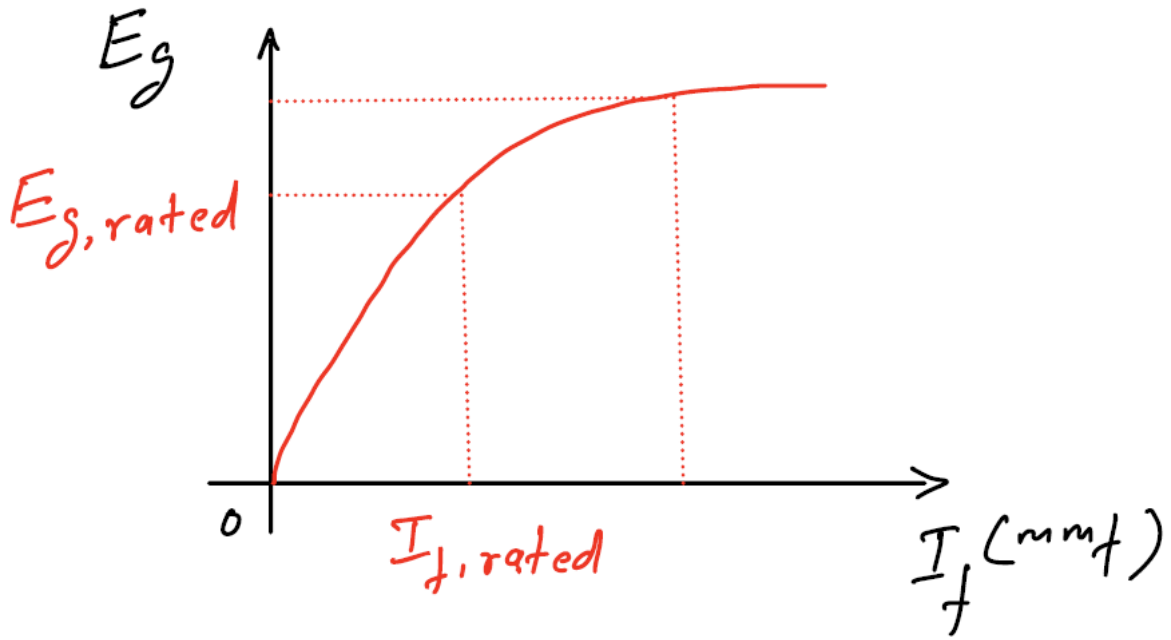


Fig. Voltage saturation curve.

Armature and Field Connections (cont...)

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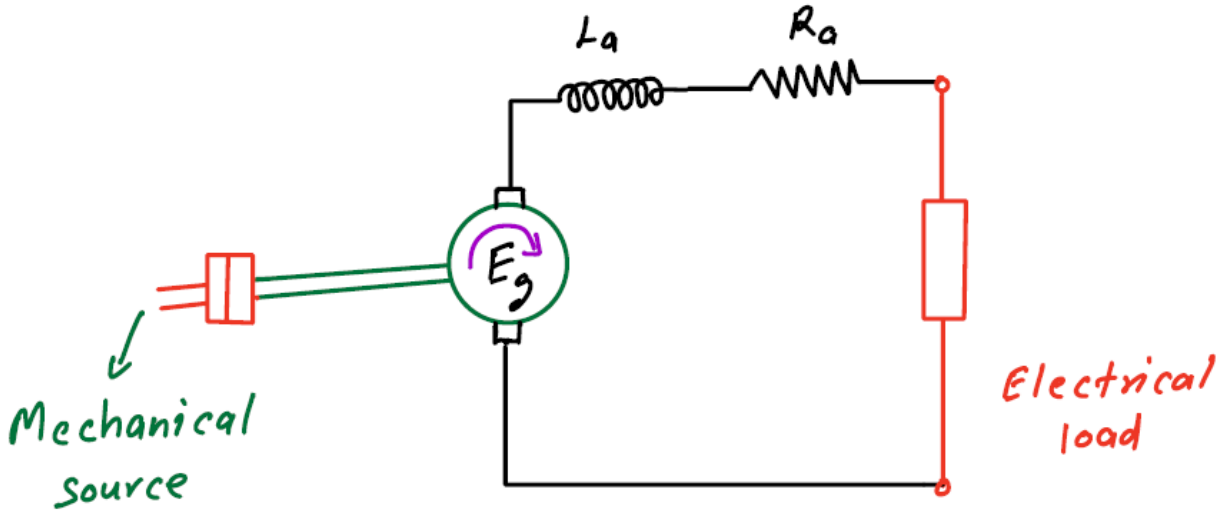

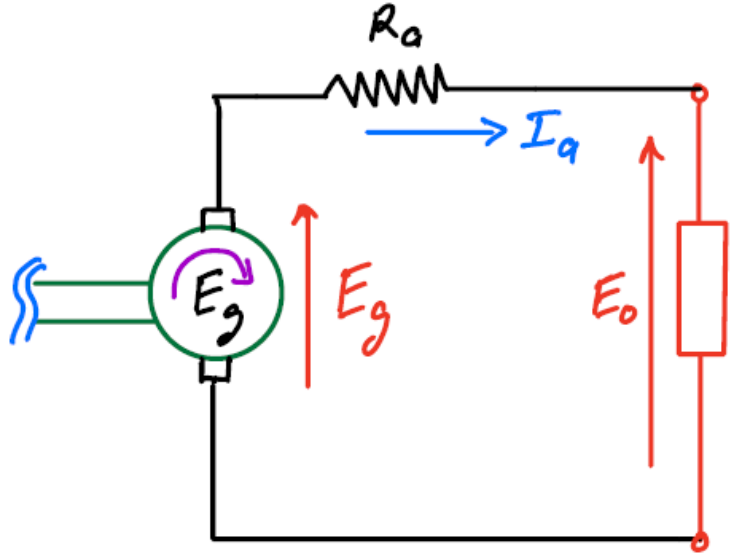

1. Armature winding resistance, R_a.
2. Armature winding reactance, L_a.

$$-E_g + I_a R_a + E_o = 0$$

$$\boxed{E_o = E_g - I_a R_a}$$

Armature and Field Connections (cont...)

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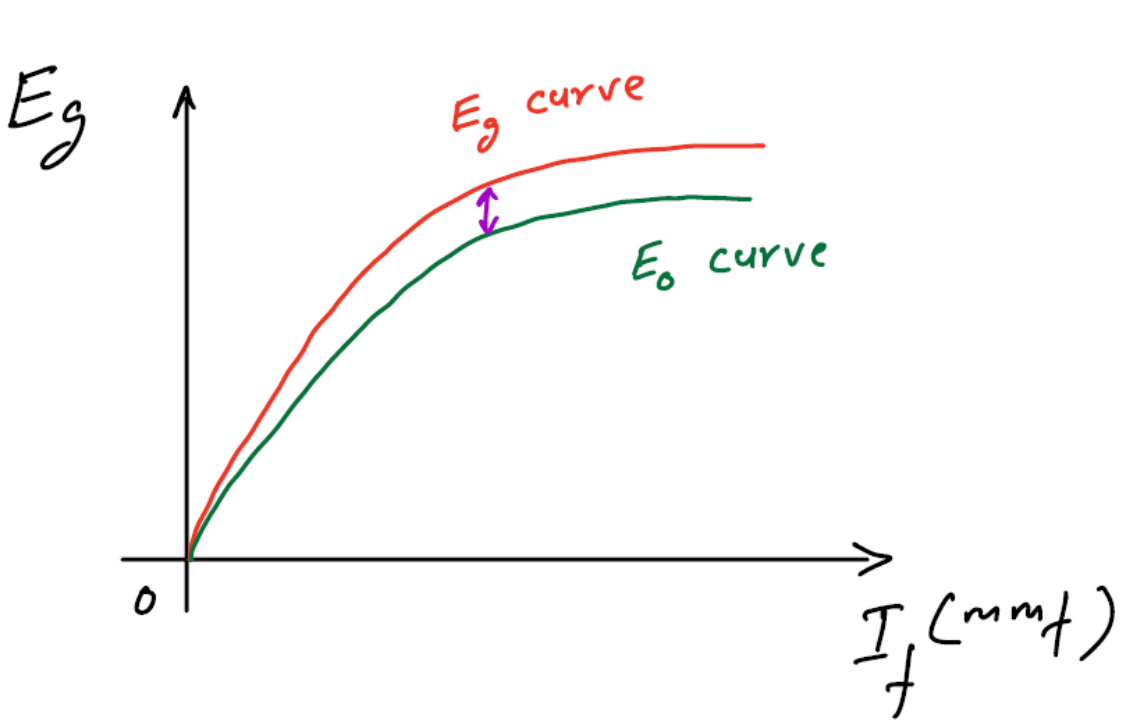

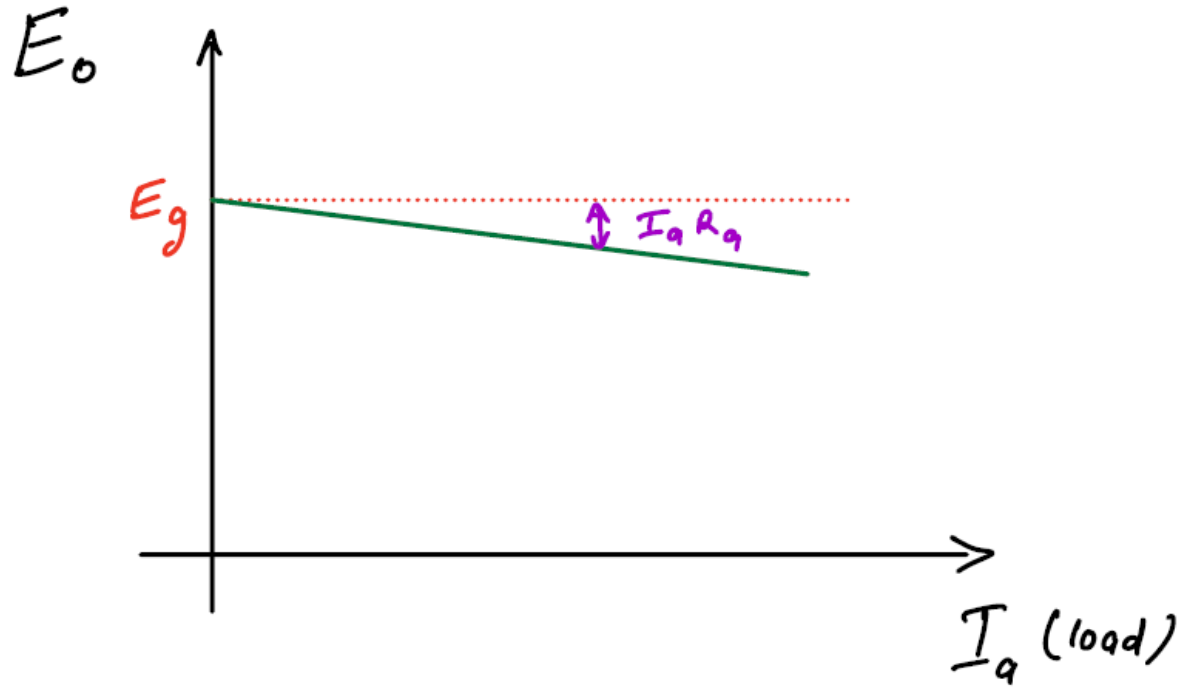

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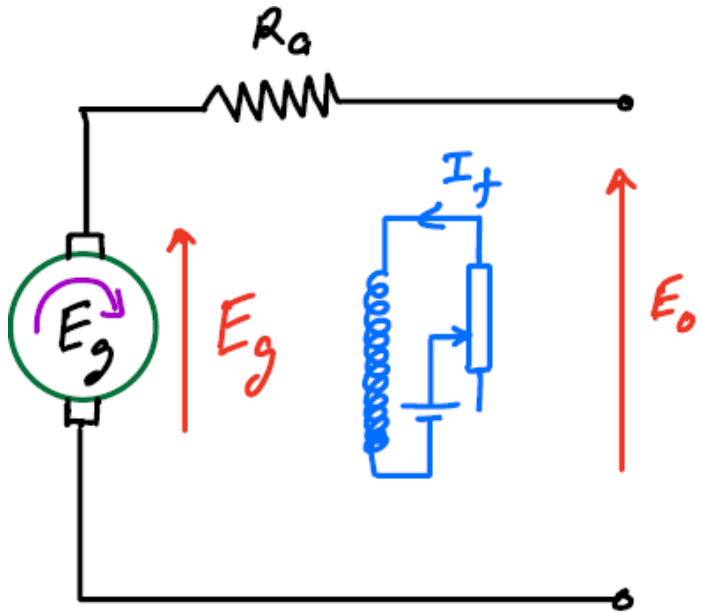
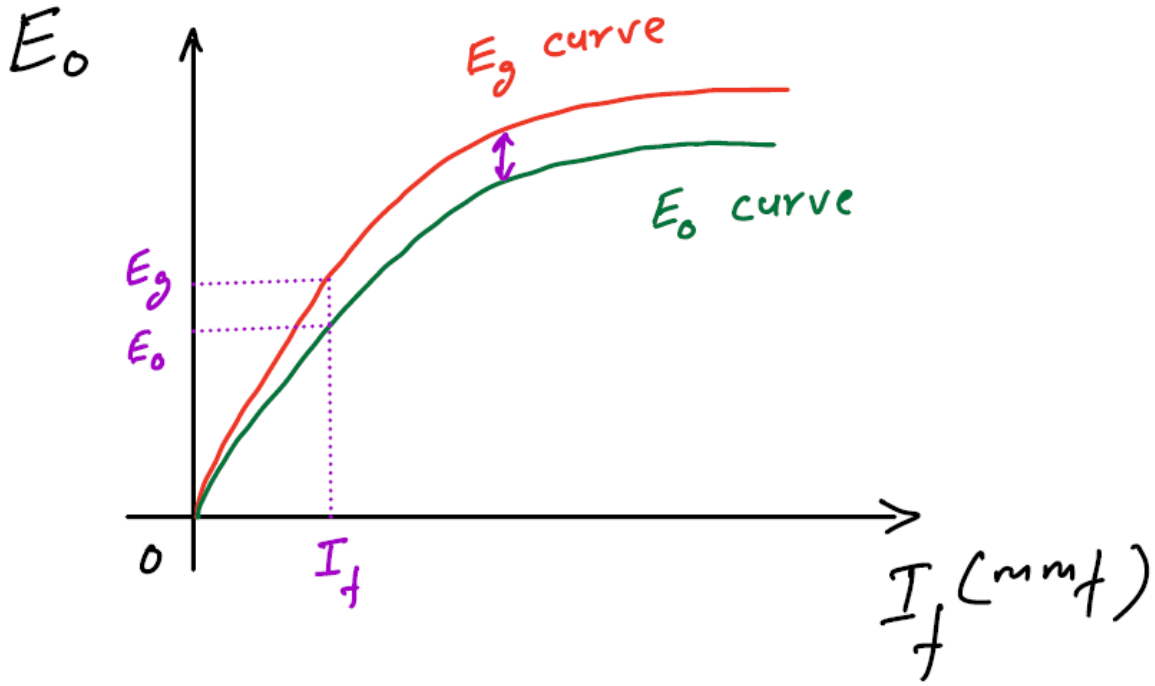
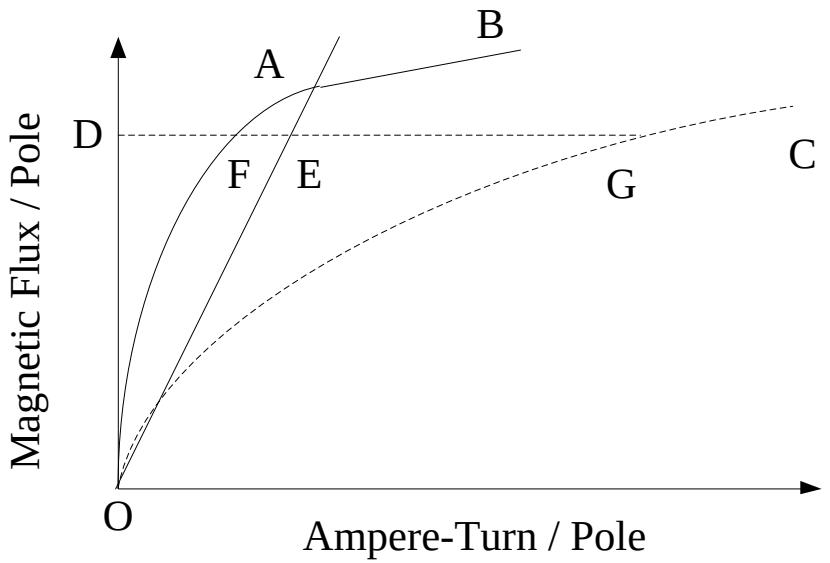




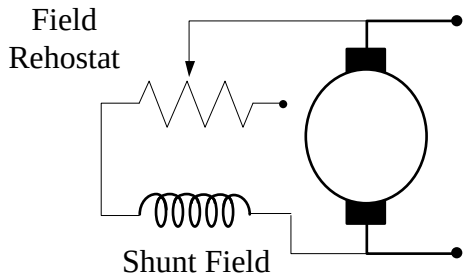
Magnetization Curve

- The number of ampere-turns required for the airgap is directly proportional to the flux and is represented by the straight-line OA.

- For low values of the flux, the number of ampere-turns required to send the flux through the ferromagnetic portion of the magnetic circuit is very small, but when the flux exceeds a certain value, some parts – especially the teeth– begin to get saturated and the number of ampere-turns increase.



Equivalent Circuit



Generator $E = V + I_a R_a$

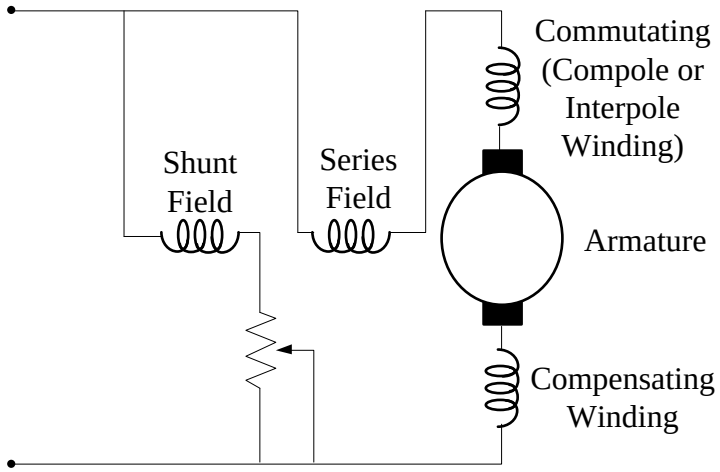
Motor $E = V - I_a R_a$

Power (P)=Torque (T) × Speed (ω)

$V_f = I_f R_f$

$V_t = E_a \pm I_a R_a$

Where +ve for Generator and –ve for Motor.



DC Generator Characteristics

1. The open-circuit characteristic (OCC, no-load magnetization curve), gives the relationship between generated emf and field current at constant speed.

2. The external characteristic, which gives the relationship between terminal voltage and load current at constant speed.

3. The load characteristic, which gives the relationship between terminal voltage and field current, with constant armature current and speed.

Separately Excited Generator

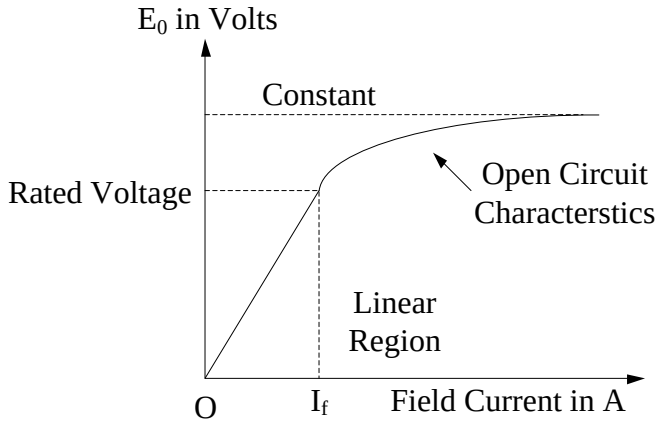
E_O = NO LOAD INDUCED E.M.F.

$E_a = K_a \phi \omega_m$

$E \alpha \phi$

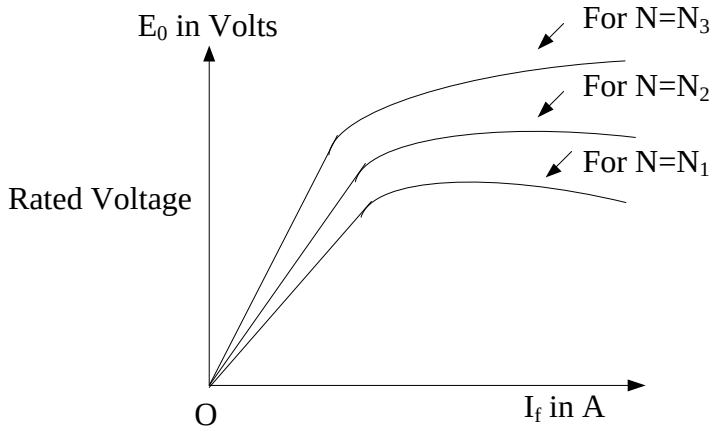
$E \alpha I_F$

$\phi \alpha I_F$



- Thus, characteristics is linear till saturation and after that bends such that voltage remains constant though I_f increases.

$$E_a = K_a \phi N_r$$



Separately Excited Generator

- $V_t = E_a - I_a R_a$
- Voltage Regulation = $\frac{E_a - Vt}{V_t} \times 100\%$
- Separately excited generator requires a separate DC field supply, its use is limited to applications in which a wide range of controlled voltage is essential.
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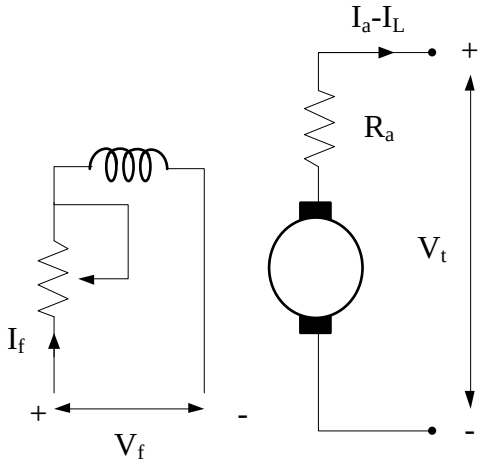
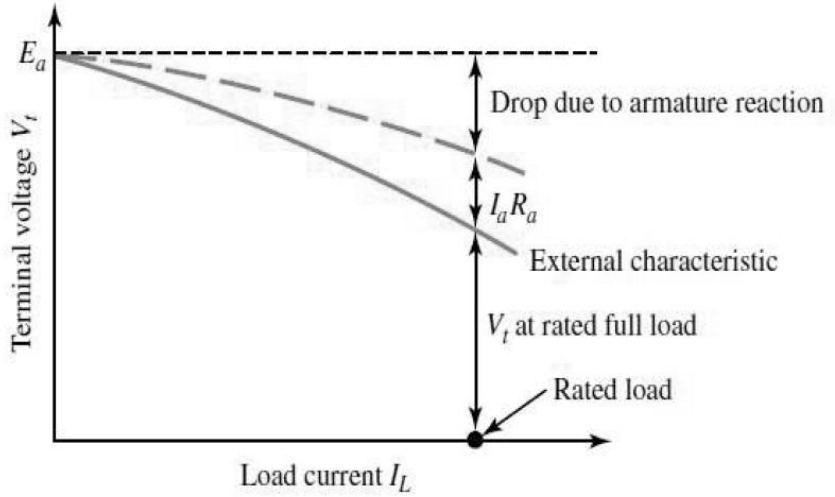
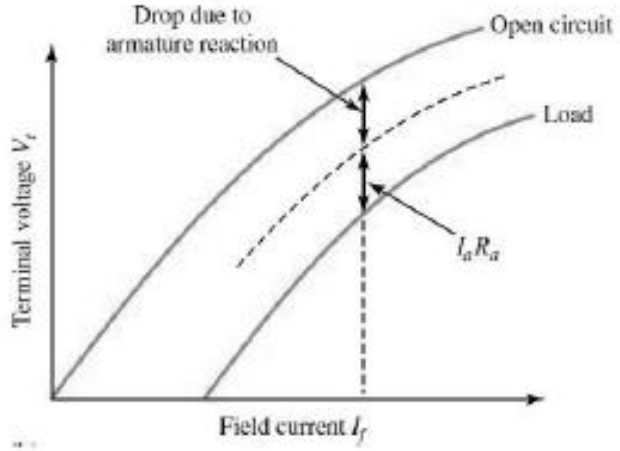






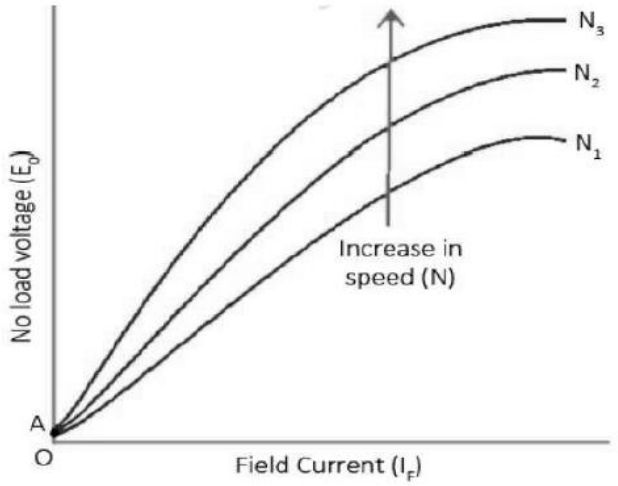
Self Excited DC Generator

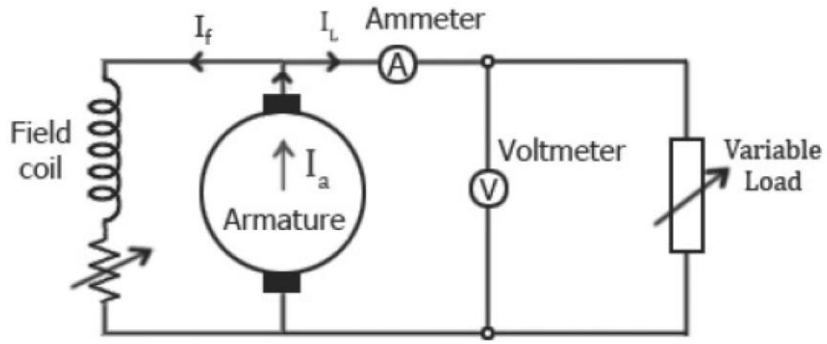
- A self excited dc generator dc generator supplies its own field excitation.
- The armature voltage supplies the field current.
- Even when the field current is zero, some amount of emf is generated.
- This initially induced emf is due to the fact that there exists some residual magnetism in the field poles.

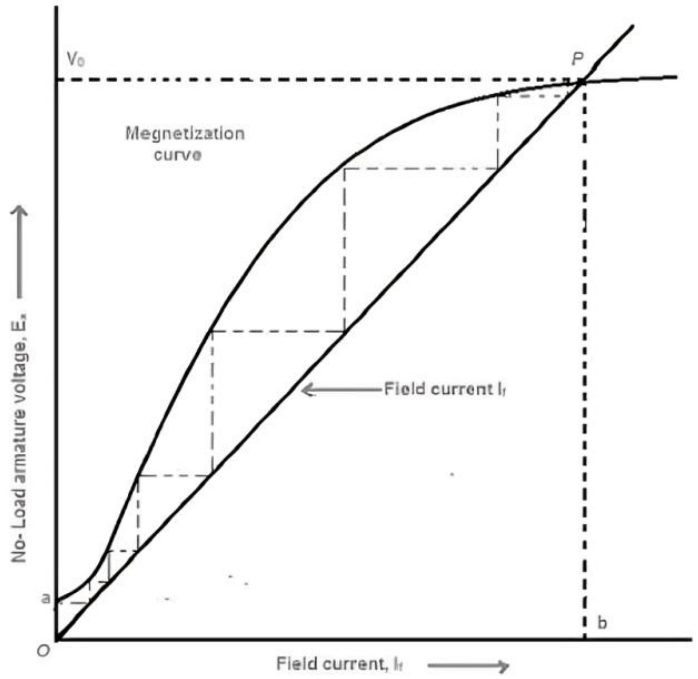
$$I_f = \frac{V}{R_f}$$

$$E_{ar} = K\phi_{res}\omega$$

Approx.1V or 2V



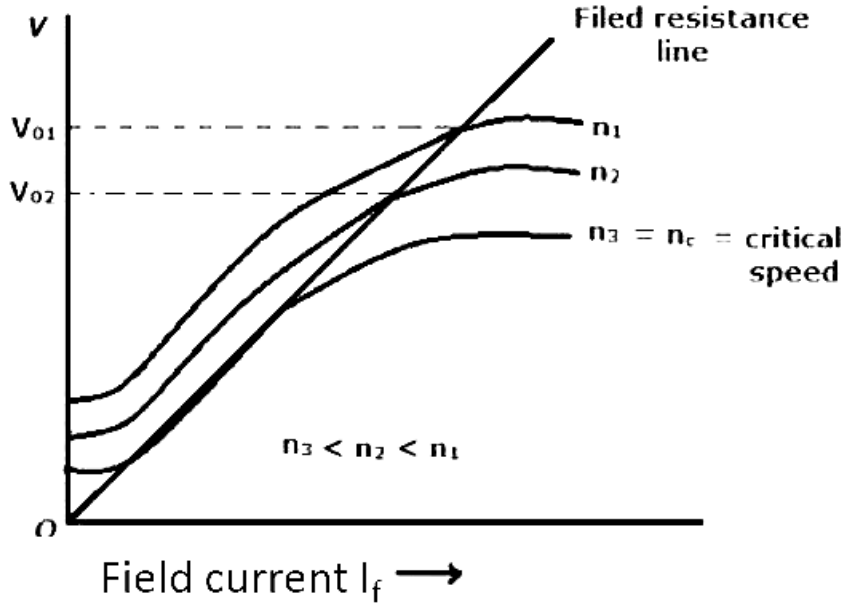




No-load Voltage With Fixed R_f and Variable Speed of the Armature

At a particular speed, called the critical speed, the field resistance line becomes tangential to the magnetization curve. Below the critical speed the voltage will not build up.

1. The following conditions must be satisfied for voltage buildup in a self-excited generator. There must be sufficient residual flux in the field poles.
2. The field terminal should be connected such a way that the field current increases flux in the direction of residual flux.
3. The field circuit resistance should be less than the critical field circuit resistance.

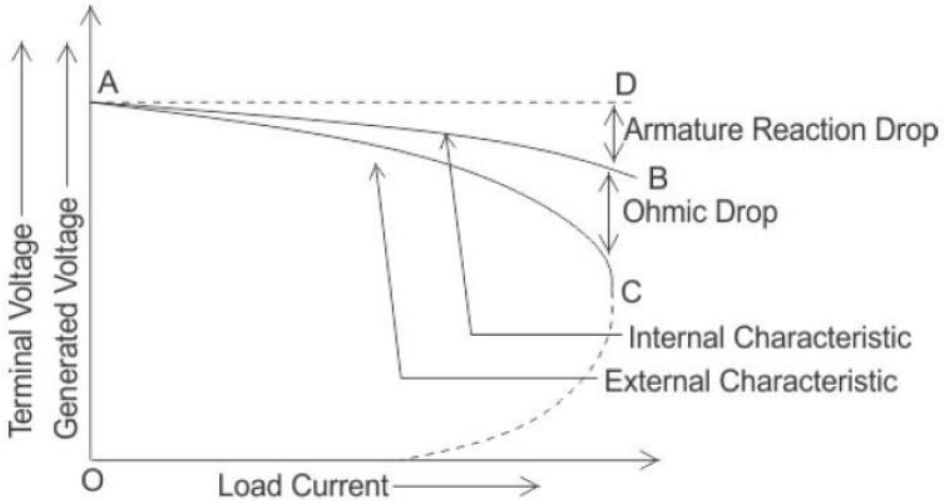


No-load Voltage With Fixed R_f and Variable Speed of the Armature.

During a normal running condition, when load resistance is decreased, the load current increases → armature reaction increases, increased I^2R losses →Terminal voltage decreases.

Hence, beyond this limit any further decrease in load resistance results in decreasing load current.

A shunt generator maintains approximately constant voltage on load. It finds wide application as an exciter for the field circuit of large AC generators. The shunt generator is also sometimes used as a techo generator.



$I_a = I_L + I_F$


THANKS
FOR YOUR
ATTENTION