Chapter 7 DC Machines fundementals

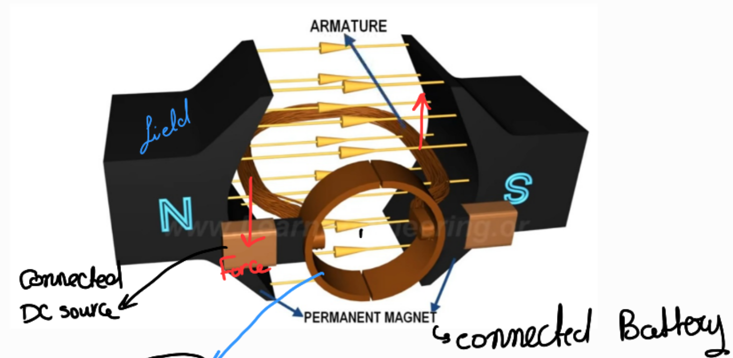
Video

- Efficiency and control of DC machines is much simpler than AC machines
- Sometimes we need DC Battery when we have no AC source for example: vehicles
- Electrical drive of AC machines are not stable

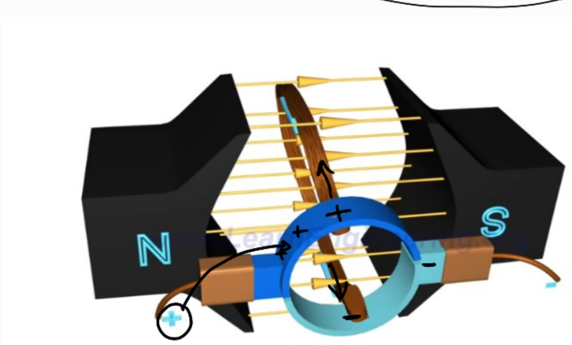
Construction of DC-Machine

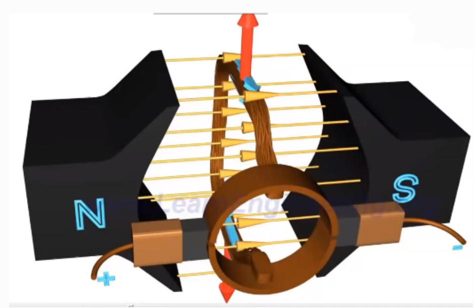
- Shape of N, S
- Naming of Armeture and field (العكس)
- Comutator assures that current is always in the same Direction

How?



Comutator ring: current is Always in same Direction

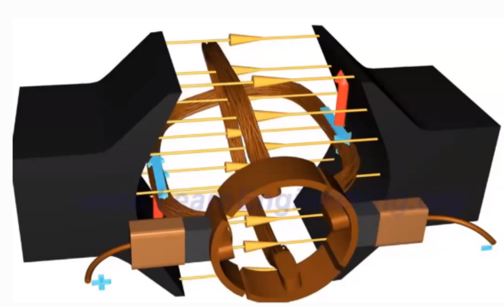




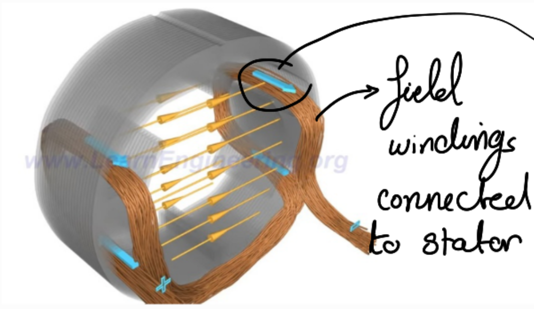
- At this moment $\Sigma F = 0$ and so no torque exists
- 4 rings are used to solve this problem (more is used now)

Types of DC motors:

1. Permanent magnet → for small devices
2. Separately excited
3. Shunt
4. Series
5. Compound



Instead of using permanent magnet, electrical magnet is used



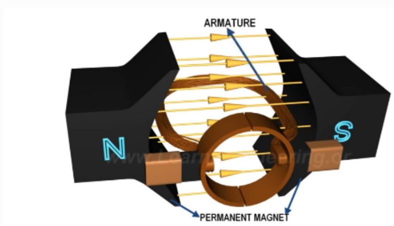
from Dc source

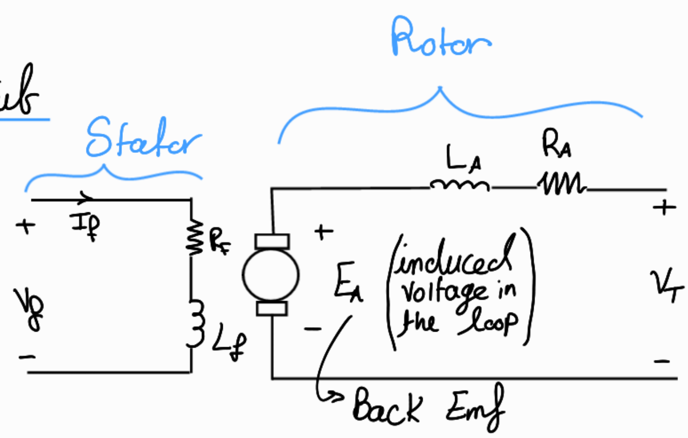
Rotor
→ Armature

Stator
→ field

- we use an electromagnet
- we need a DC source

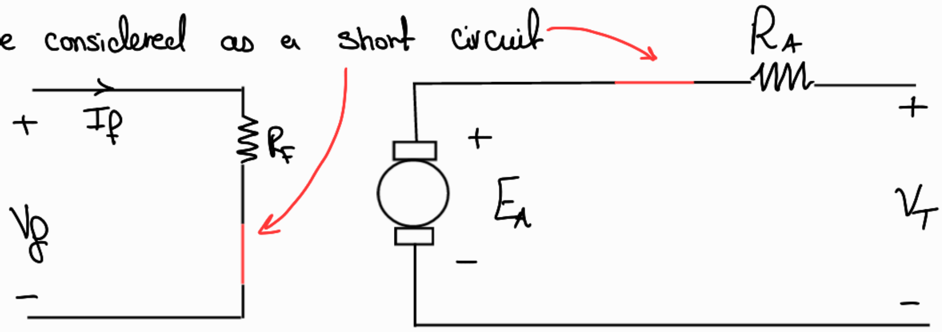
Modeling of Motor circuit



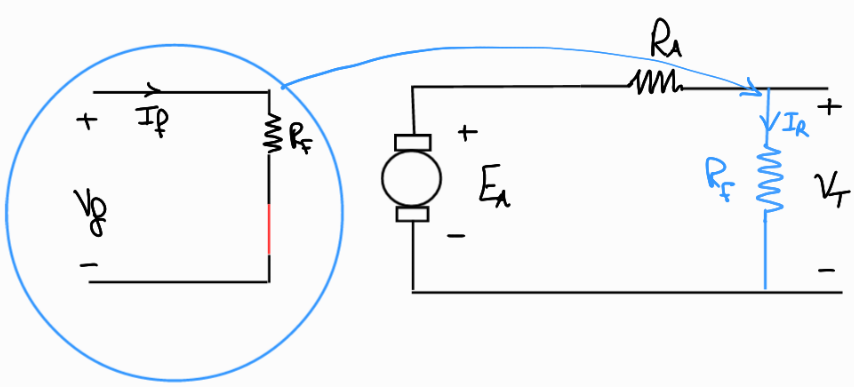


For DC: $Z_L = j\omega L \Rightarrow \omega = 0$ (DC)

so can be considered as a short circuit

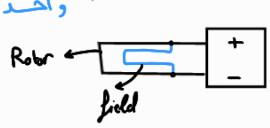


- It is called separately excited because we have two Dc source: one for stator and other one for rotor

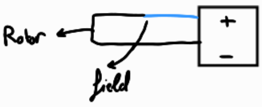


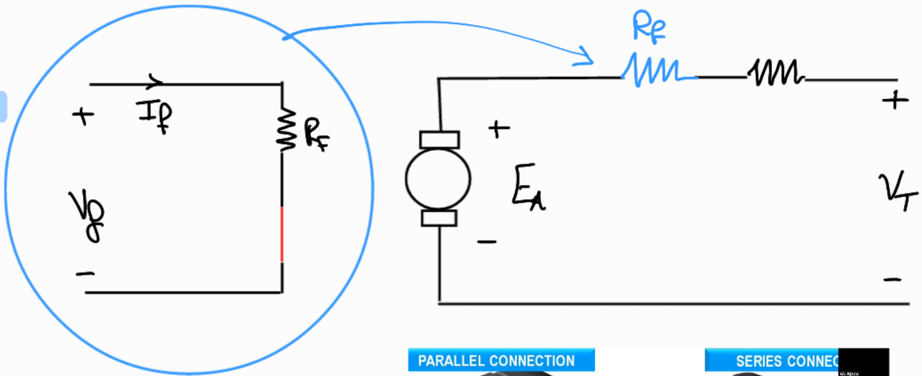
It is called shunt (Parallel)

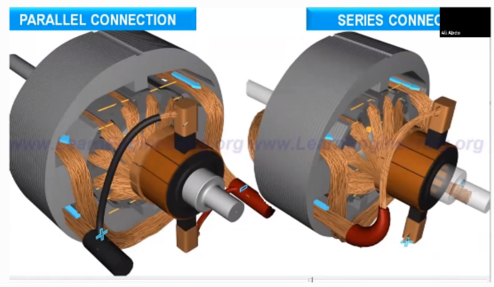
جمعنا ال sources
يعني بنستخدم source واحد



It is called series

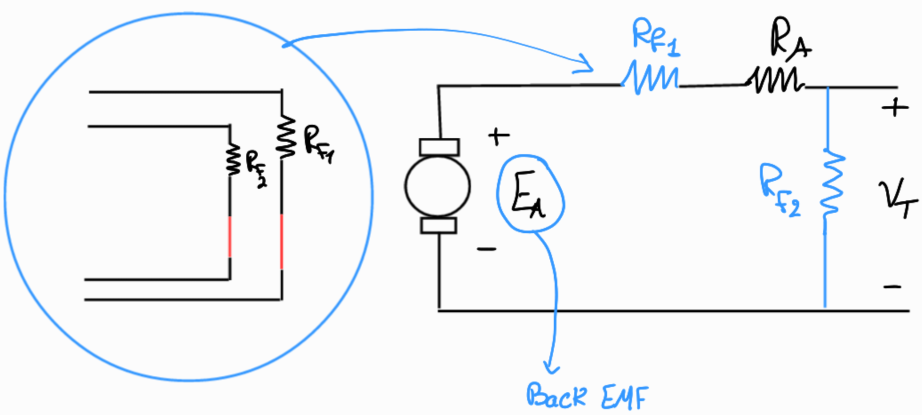






It is called compound

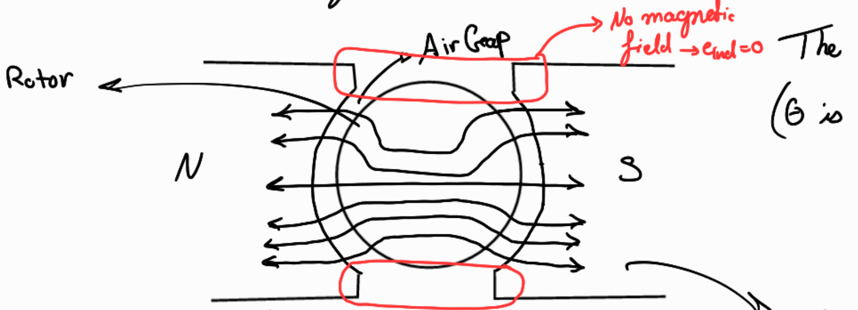
يعني كأني جبت لفتين



Universal motor is a series motor but It works if given AC or DC, this is done by physical modifications

Slides

DC machinary fundementals

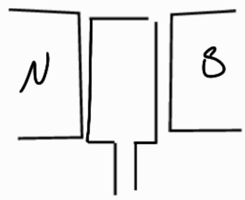


The Arc shape is important to assure that value of magnetic field is constant (θ is always 90°)

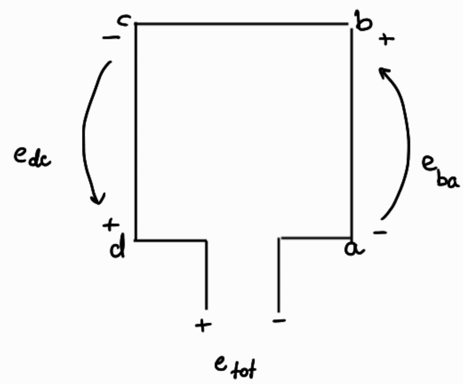
خطوط المجال تختار الطريق الأقصر
يعني الطريق العمودية على ال Rotor face

AC Machines

Shape:



- Magnetic field is supplied by the stator
- when the rotor rotates a voltage will be enduced in the wire loop



$e_{ind} = (V \times B) l = vBl$

At ab, cd $= vBl$

At cb, da $= 0$

$$e_{ind} = \begin{cases} 2vBl & : \text{under pole face} \\ 0 & : \text{beyond pole faces} \end{cases}$$

$e = 2vBl = 2 r \omega B l$

$V_{cylinder} = r^2 \pi l$

$\frac{dV_c}{dr} = A = 2 r \pi l$ ← Rotor surface area

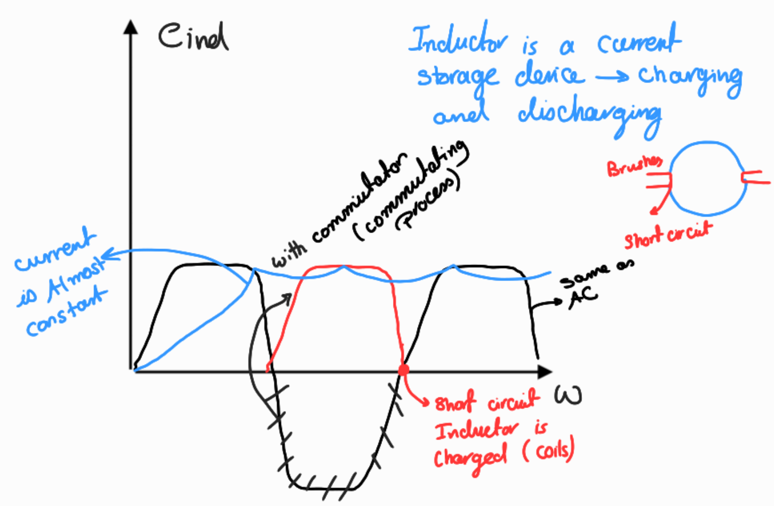
Pole surface area $= A_p = \frac{1}{2} A = r \pi l$

$e_{ind} = \frac{2 \omega B A_p}{\pi}$

$\phi = B A_p$

$$e_{ind} = \frac{2\omega \phi}{\pi}$$

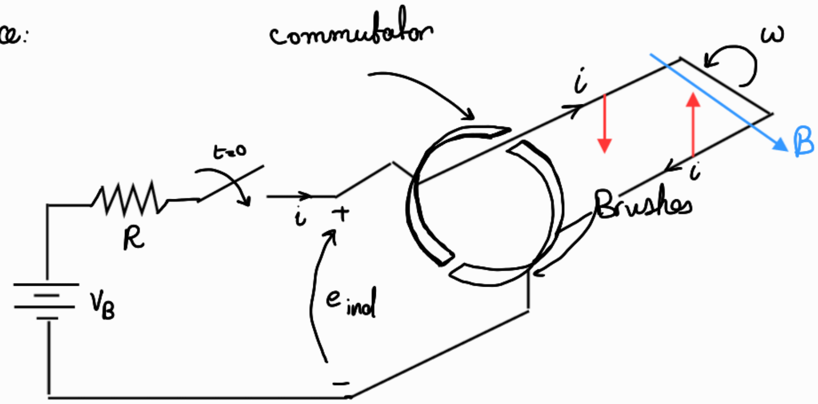
$\frac{2}{\pi} = K$



Torque induced in rotating loop

Each segment is subjected to a force:

$F = i(l \times B)$ → ab, cd $= ilB$; bc, ad $= 0$



$\tau = r \times F = rF\sin\theta$

$$\tau_{ind} = \begin{cases} 2rilB & \text{under pole faces} \quad \text{CCW} \\ 0 & \text{beyond pole edges} \end{cases}$$

Simplifying:

$\tau_{ind} = \dfrac{2 A_p B i}{\pi} = \dfrac{2}{\pi}\phi i$ → Rotor current (i)

$$\tau_{ind} = \begin{cases} \frac{2}{\pi}\phi i & \text{under pole faces} \quad \text{CCW} \\ 0 & \text{beyond pole edges} \end{cases}$$