Synchronous Motors

Video

In a Synchronous machine :-

- Rotor: Dc power source will produce fixed (constant) magnetic field (slip rings & Brushes)

- Stator: 3 phase current source will produce Rotating magnetic field (In Synchronous speed)

→ Coupling occurs between the Stator and Rotor
we Know that $n_m = \frac{120 f_e}{P}$

- Electrical frequency for the rotating magnetic field
→ when the N-S poles couples with N-S poles on rotor and coupling occurs, then the rotor will try to rotate with the speed of the Stator in the Synchronous Speed

Add Note → Frequency can be controlled using an inverter

- We need a pushing force for the rotor to ease coupling (Not self started)
Force is obtained from induced electricity in the bars (Squirell cage)

▶ Speed of motor is constant only if load is very high and motor will be over loaded

Squirl cage will have no effect because when rotor and stator have save speed the bars will have the same speed as Magnetic field and the lines will not be cut so no induced voltage on bars

Slides

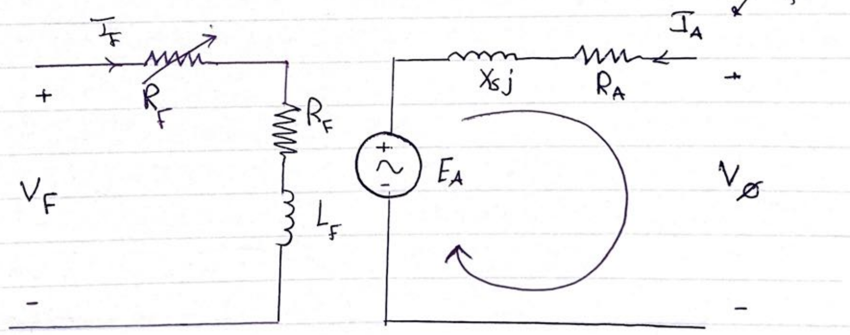
Synchronous motors : Synchronous machines used to convert electrical power to mechanical power

- I_F (field current) → B_R (steady state magnetic field)
- 3phase I (on stator) → B_s (rotating

→ Rotor field will line up with stator field and the rotor will try to catch up with stator

Single phase circuit

Same as generator but power flow is reversed and I_A is reversed



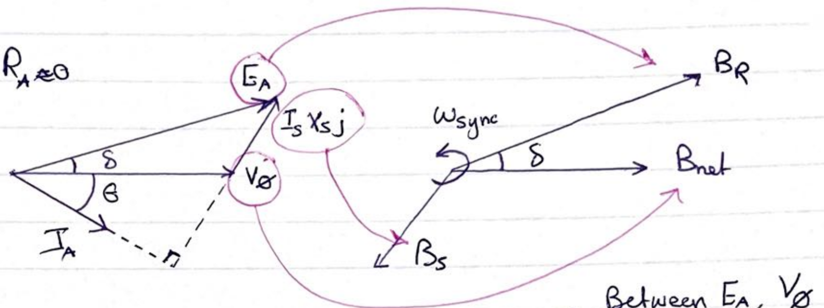
KVL: $V_\phi = E_A + I_A (R_A + X_s j)$

Difference between motor and generator

- **Generator**

B_R produces E_A , B_{net} produces V_ϕ , B_s produces E_{stat}

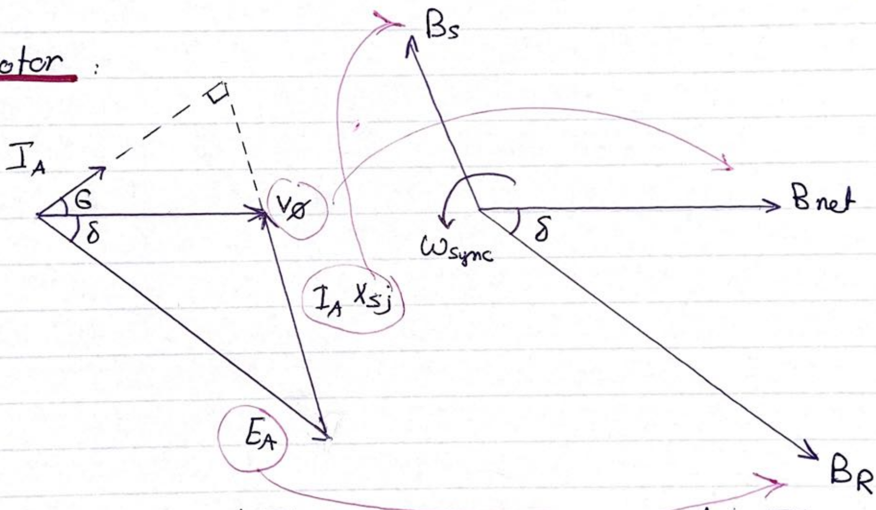
Assuming $R_A \approx 0$



Between E_A, V_ϕ

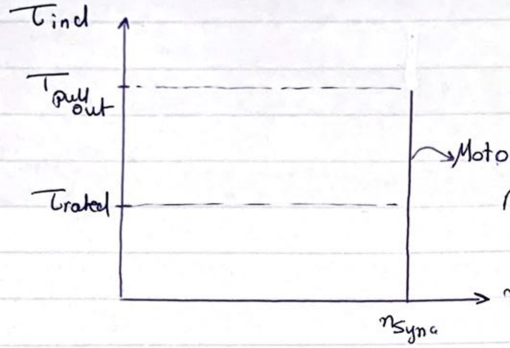
$\tau_{ind} = K B_R \times B_{net} = K B_R B_{net} \sin \delta$ (δ: Torque angle)

- **Motor** :



- δ increases and Torque is higher until $\tau_{ind} = \tau_{load}$ at this point: machine operates at steady state and synchronous speed again

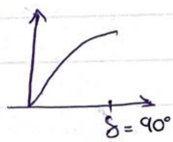
Torque Speed characteristics curve



$$n_m = \frac{120 f_{se}}{P}$$

increase gradually

$$\tau_{ind} = \frac{3 E_A V_\phi \sin\delta}{\omega X_s}$$



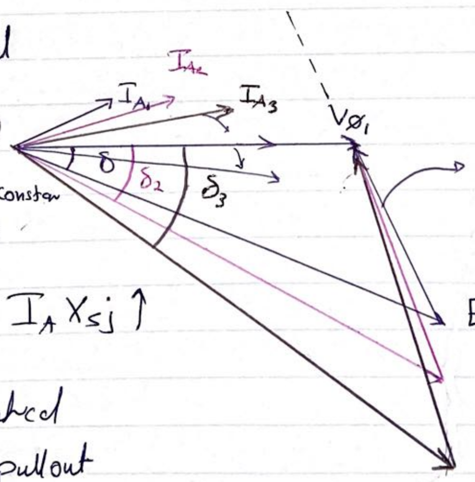
$$P = \frac{3 E_A V_\phi \sin\delta}{X_s}$$

Not
$E_A = |E_A| \angle -\delta$

$\tau_{pull\ out} = 3\ \tau_{rated}$ (full load)

- What happens when load is changed on a Synchronous machine?

- : At no load
- : with load
- : Higher load



$E_A = K \phi \omega_{syn}$ (Kø constant; ω constant)

$I_A \uparrow$ and so $I_A X_s j \uparrow$

$15 < \delta < 35$ for rated

$\delta = 90 \rightarrow \tau_{pullout}$