

Synchronous Motors

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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 $n_m = \frac{120f_e}{P}$

- Electrical frequency for the rotating magnetic field
- When the N-S poles couple 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 (Squirrel cage)
- Speed of motor is constant only if load is very high and motor will be over loaded

Squirrel cage will have no effect because when rotor and stator have same 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

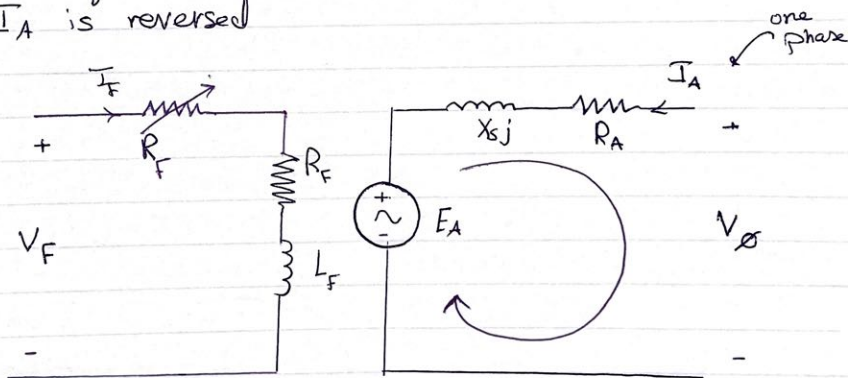
Synchronous motors: Synchronous machines used to convert electrical power to mechanical power

- I_F (field current) $\rightarrow B_R$ (Steady state magnetic field)
- 3phase I (on stator) $\rightarrow B_S$ (rotating)

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

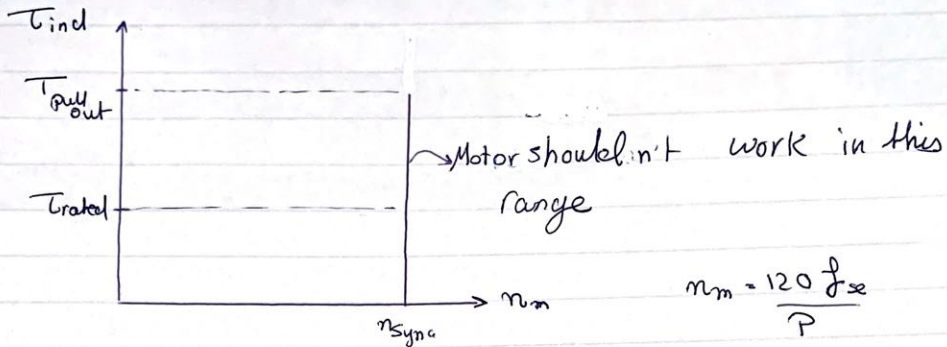
Single phase circuit

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



$$\text{KVL: } V_\phi = E_A + I_A (R_A + X_{sj})$$

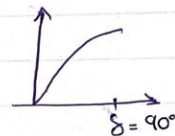
Torque Speed characteristics curve



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

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

increase gradually



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

$$E_A = |E_A| \angle -\delta$$

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

- At no load
- with load
- Higher load

$$E_A = \underbrace{K \phi}_{\text{constant}} \omega_{syn}$$

$$I_A \uparrow \text{ and so } I_A X_s \uparrow$$

$$15 < \delta < 35 \text{ for rated}$$

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

