Problem #7.1 : Induction Motor:

- $V_T = V_L = 208V$; $f_e = 60Hz$, 3-ϕ stator winding, Y-connected
- Rated $P_{out} = 10hp$
- No of poles, $P = 4$
- Full-load slip, $s = 5\% = 0.05$

$$s = \frac{n_{sync} - n_m}{n_{sync}}$$

$$n_m = (1-s) n_{sync}$$

a) find n_{sync}:

$$n_{sync} = \frac{120 f_e}{P} = \frac{120 \times 60}{4}$$

$$= 1800 rpm$$

b) n_m at rated load:

$$n_m = (1-s) n_{sync}$$

$$n_m = 1710 rpm$$

c) Find out the frequency of emf induced in rotor.

$$f_r = s f_e = 0.05 \times 60\,Hz = 3\,Hz$$

d) What is the shaft torque (mechanical) at the rated load?

n_m (rev/min)

ω_m (rad/s)

at rated load; $P_{mech} = 10\,hp = 10 \times 746\,W = 7460\,W$

$$\tau \omega_m = P_{mech} = 7460\,W$$

$$\Rightarrow \tau = \frac{7460\,W}{\omega_m} = (\quad)\,N\text{-}m$$

Problem 7.2: Induction Motor:

$P_{in(Elec)} = \sqrt{3} V_L I_L \cos\theta$

- $V_T = V_L = 480V, 60Hz$, # poles & connection type → Not provided
- It draws current from the supply line = 60A at 0.85 pf (lagging)

$I_L = 60A$ and $pf = 0.85 = \cos\theta$ (lagging)

$\Rightarrow I_L$ lags behind V_L by an angle $\cos^{-1}(0.85)$ degree.

- Power losses: $P_{SCL} = 2kW$; $P_{RSL} = 700W$; $P_{Core} = 1.8kW$; $P_{fric+Windage} = 600W$

$P_{out(mech)} = P_{in(elec)} - \text{Power losses}$

a) Determine the power in air-gap; ie, P_{AG}

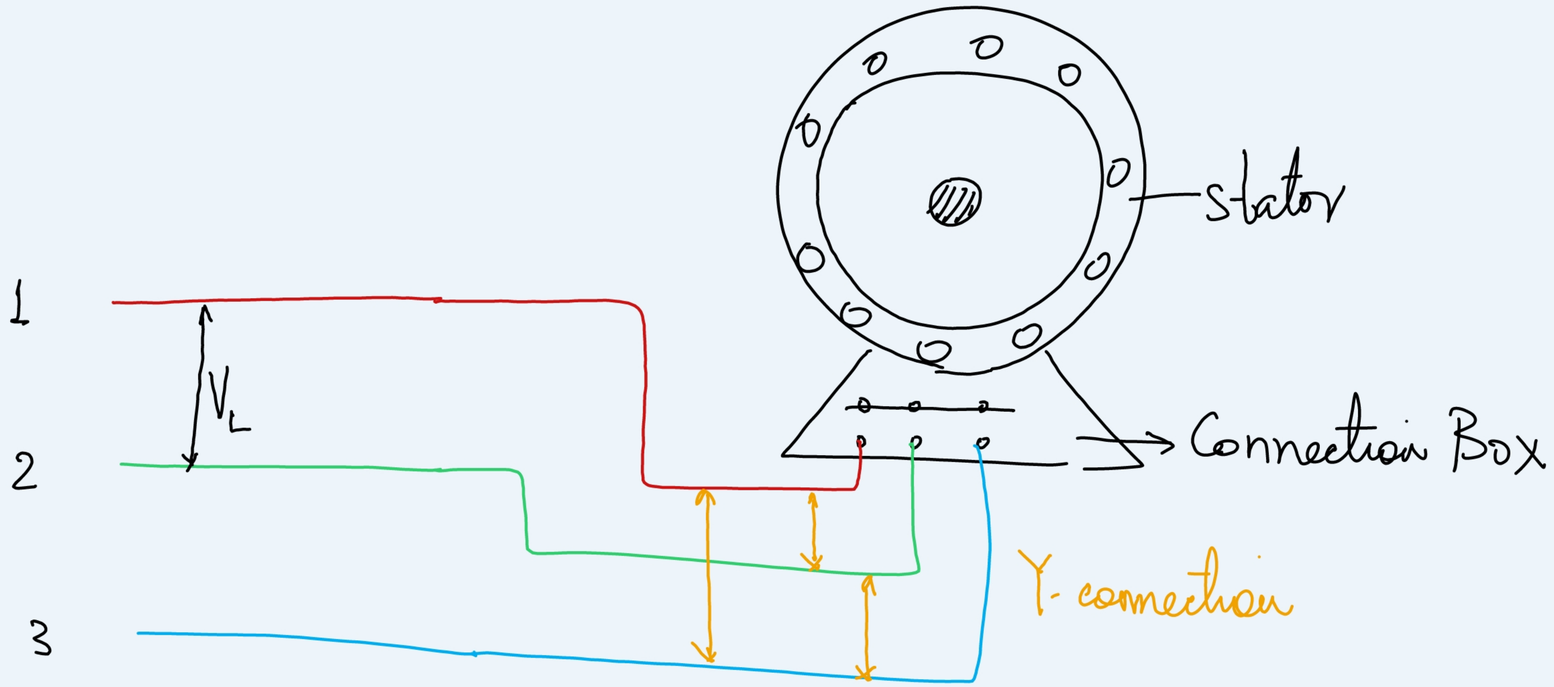
$$P_{AG} = \underbrace{P_{in(Elec.)}}_{\sqrt{3}V_L I_L \cos\theta} - \underbrace{P_{SCL}}_{\text{given}} - \underbrace{P_{Core}}_{} =$$

b) How much electrical power is converted into mechanical power.

this includes the mechanical power losses.

$$P_{Conversion} = P_{AG} - P_{RCL} = \text{Available as mechanical power.}$$

c) $P_{out} = P_{conversion} - P_{frict+Windage} = \text{Actual mech. power avaible at the shaft.}$


1
2
3
V_L
Stator
Connection Box
Y- connection

d) $$\eta_{I.M.} = \frac{P_{out\ (mech.)}}{P_{in\ (Elect.)}} \times 100\%$$