DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

POWER SYSTEM ANALYSIS
UNIT – II
Permanent Magnet Synchronous Motor

② 3 ϕ, 400 V, 50 Hz, 4 pole star connected synchronous reluctance motor has $X_d = 8\,\Omega$ and $X_q = 2\,\Omega$ and load torque $T_L = 80$ Nm. Calculate i) load angle which is torque angle ii) armature current iii) Input power factor

Sol//

$V_L = 400$ V

$V_p = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}}$

$= 230.94$ V

$X_d = 8\,\Omega$

$X_q = 2\,\Omega$.

$$\omega_s = \frac{2\omega}{P} = \frac{4\pi f}{P} = \frac{4\pi \times 80}{P}$$

$$\omega_s = 157.07 \text{ rad/sec}$$

$$T_L = T_{ph} = \frac{3}{2} \times \frac{V_A^2}{\omega_s} \times \left(\frac{X_d - X_q}{X_d X_q} \sin 2\delta \right)$$

$$80 = \frac{-3}{2} \times \frac{(400)^2}{157.07} \times \left(\frac{8-2}{16} \sin 2\delta \right)$$

$$80 = -572.99 \sin 2\delta$$

$$\sin 2\delta = -0.13$$

$$2\delta = \sin^{-1}\left(\frac{-0.13}{7.46}\right)$$

$$2\delta = -7.46$$

$$\delta = -3.73$$

ii) $I_a = \sqrt{I_d^2 + I_q^2}$

$$I_d = \frac{V \cos\delta}{X_d}$$

$$I_q = \frac{V \sin\delta}{X_q}$$

$$I_d = \frac{400 \cos(-3.73)}{8}$$

$$I_d = 49.89 \text{ A}$$

$$I_q = \frac{400 \sin(-3.73)}{2}$$

$$I_q = -13.01 \text{ A}$$

$$I_a = \sqrt{(49.89)^2 + (-13.01)^2}$$

$I_a = 51.55\ A.$

iii) $P = \sqrt{3}\, VI \cos\phi.$

$T_L \times \omega_s = \sqrt{3}\, VI \cos\phi.$

$$\cos\phi = \frac{T_L \times \omega_s}{\sqrt{3}\, VI}$$

$$= \frac{80 \times 157.07}{\sqrt{3} \times 400 \times 51.55}$$

$\cos\phi = 0.35.$