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17/ENG06/024
Mechanical Engineering
Electrical Machines

ASSIGNMENT

1a $E_a = V_t - jI_aX_s$; $V_L = 415V$, $S = 25KVA = 25000$

$$V_t = \frac{V_L}{\sqrt{3}} = \frac{415}{\sqrt{3}} = 239.6V$$

$X_s = 1.5\Omega$; $P_F = 0.8$ lagging ; $\therefore \theta = \cos^{-1}(-0.8) = 143.1$

$$I_a = \frac{S}{V_L\sqrt{3}} = \frac{25000}{415.\sqrt{3}} = 34.78A \angle 143.13°$$

$\therefore E_a = 239.6 - j[(34.78\angle 143.13°)(1.5)]$

$E_a = 270.90 + j41.74$

$E_a = 274.098V \angle 8.76°$

(b) 20% increase $= 1 + 0.2 = 1.2$

$S = 8.76°$

$E_a' = 1.2 \times 274.098 = 328.92V$

$\therefore \frac{V_t E_a \sin S}{X_s} = \frac{V_t E_a' \sin S^{-1}}{X_s}$ $\therefore \sin S^{-1} = \frac{E_a}{E_a'} \sin S$

$$= \frac{274.098}{328.92V} \times \sin 8.76°$$

$\sin S^{-1} = 0.1269$ $\therefore S = \sin^{-1}(0.1269)$

$S' = 7.29°$

(i) $I_A' = \frac{E_a' - V_t}{jX_s} = \frac{328.92\angle 7.29° - 239.6\angle 0}{j1.5}$

$= 27.82 - j57.77$

$I_A' = 64.13A\angle -64.28°$

(ii) Power factor $= \cos(-64.28°) = 0.434$ lagging

(iii) $Q = 3V_tI_a\sin\theta = 3 \times 239.6 \times 64.13 \times \sin(64.28)$

$= 41529.65VAR$

(c) At max power $\delta = 90°$

$$P_{max} = \frac{3 E_a V_t}{X_s} = \frac{3 \times 274.098 \times 239.6}{1.5}$$

$$= 131347.76\,W = 131.347\,KW$$

$$I_{max} = \frac{\bar{E}_a - \bar{V}_t}{jX_s} = \frac{274.098 \angle 90° - 239.6 \angle 0}{1.5j}$$

$$= 242.71\,A \angle 41.16°$$

Power factor $= \cos(41.16°) = 0.7529$ leading

$$Q_{max} = 3 V_t I_a^{max} \sin(41.16°)$$

$$3 \times 239.6 \times 242.71 \times 0.6582$$

$$= 1148.29.54\,VAR = 114.829\,KVAR$$