Assignment on Power factor correction

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Course code: EEE326

(A) $E_A = V_t - jI_2X_1$:

$V_L = 415V$, $S = 25KVA = 25000VA$

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

$X_1 = 1.5\Omega$, $pf = 0.8$ lagging

$\therefore \theta = \cos^{-1}(-0.8) = 143.13°$

$I_2 = \frac{S}{V_L\sqrt{3}} = \frac{25000}{415\sqrt{3}}$

$34.78A \angle 143.13°$

$\therefore E_2 = 239.6 - j[(34.78\angle 143.13)(1.5)]$

$E_2 = 270.90 + j41.74$

$E_2 = 274.098V \angle 8.76°$

(B) 20% increase $= 1.2$

$\theta = 8.76°$

$E_2' = 1.2 \times 274.098 = 328.92V$

$\frac{V_t E_2 \sin\theta}{X_1} = \frac{V_t E_2' \sin\theta'}{X_1}$ $\therefore \sin\theta' = \frac{E_2 \sin\theta}{E_2'} = \frac{274.098}{328.92} \times \sin 8.76$

$\sin\theta' = 0.1269$

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

$\therefore \theta' = 7.29°$

$I_A' = \frac{E_2' - V_t}{jX_B} = \frac{328.92\angle 7.29° - 239.6\angle 0}{j1.5} = 27.82 - j57.77$

$I_A' = 64.13A \angle -64.28°$

(C) $P_f = \cos(-64.28) = 0.434$ lagging

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(b) $Q = 3V_t I_2 \sin\theta = 3 \times 239.6 \times 64.13 \times \sin(64.28) = 41529.65$ VAR

(c) At maximum power, $\delta = 90°$

$$P_{max} = \frac{3E_2 V_t}{X_s} = \frac{3 \times 274.098 \times 239.6}{1.05} = 131347.76\,W = 131.35\,KW$$

$$I_{max} = \frac{E_2 - V_t}{jX_s} = \frac{274.098 \angle 90 - 239.6 \angle 0}{1.05j} = 242.71A \angle 41.16°$$

$P_f = \cos(41.16) = 0.7529$ leading

$Q_{max} = 3V_t I_{2max} \sin(41.16°)$

$= 3 \times 239.6 \times 242.71 \times 0.6532 = 114829.54\,VAR = 114.83\,KVAR$

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