یا لطیف

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تمرین سری ۱ تحلیل سیستم انرژی

3

$$\begin{cases} V_a = 120 \angle 45^\circ \ V \\ V_b = 100 \angle -15^\circ \ V \\ V_{ba} = ? \end{cases} \longrightarrow V_{ba} = V_b - V_a = (100 \angle -15^\circ) - (120 \angle 45^\circ)$$

$$= 100 e^{-j15} - 120 e^{j45} = 100(\cos(-15) + j\sin(-15)) - (120(\cos(45) + j\sin(45)))$$

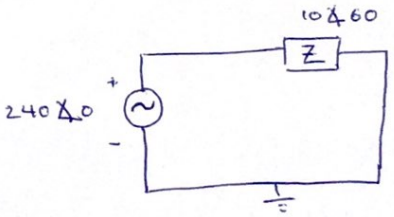
$$= 100(0.96 - 0.25j) - 120(0.7 + 0.7j)$$

$$= 96 - 25j - 84 - 84j = 12 - 109j \longrightarrow \begin{cases} |r| = \sqrt{12^2 + 109^2} = 109 \\ \theta = \tan^{-1}\left(\frac{-109}{12}\right) \approx -83.72^\circ \end{cases}$$

$$\Rightarrow 109 e^{-83.72j} = 109 \angle -83.72^\circ$$

4

$$\begin{cases} V_{ac} = 240 \ V \\ Z = 10 \angle 60^\circ \ \Omega \\ R, X, P, Q = ? \text{ and } PF = ? \end{cases}$$



$Z = R + jX \Rightarrow R + jX = 10 \angle 60^\circ$

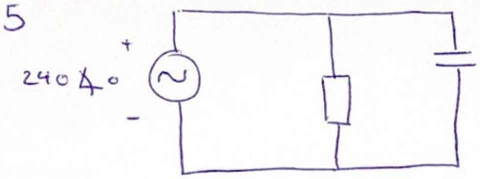
$= 10 e^{j60} = 10(\cos 60 + j\sin 60) = 5 + 8.6j$ → $R = 5 \ \Omega$, $X = 8.6 \ \Omega$

$V = iR \rightarrow i = \frac{V}{R} = \frac{240 \angle 0^\circ}{10 \angle 60} = 24 \angle -60 \ A$

$P = |I|^2 R = (24)^2 \times 5 = 2.88 \ kW$, $Q = |X||I|^2 = (24)^2 \times 8.6 = 4953.6 \ VAR$

$PF = \cos\theta$; $\cos\left[\tan^{-1}\left(\frac{Q}{P}\right)\right] = \cos\left(\tan^{-1}\left(\frac{4953.6}{2880}\right)\right) = \cos(45.72) = 0.69^\circ$

5



$Q_T = Q_{\text{تبی}} - Q_{\text{خازن}}$

$Q_T =$ ~~[illegible]~~ $4953.6 - 1250 = 3703.6$ VAR

$PF = \cos\theta = \cos\left[\tan^{-1}\left(\frac{3703.6}{2880}\right)\right] = \cos(52.13^\circ) \simeq 0.61$

15

$V_L = 440\,v$
$P = 15\,hp$
بازده → 90% : راندمان
$\cos\varphi = 80\%$ پس فاز

$P, Q = ?$

$P = 15\,hp \times 746 = 11190 \quad \Rightarrow \quad |I| = \frac{11190}{\sqrt{3} \times 440 \times \frac{90}{100} \times \frac{80}{100}} = 20.39\,A$

$P = \sqrt{3} \times 440 \times 20.39^A \times 0.8 = 12431\,W \quad , \quad Q = \sqrt{3} \times 440 \times 20.39 \times 0.6 = 9324\,VAR$

16

$Z = 0.3 + j1\,\Omega$
$V_{L-L} = ?$

$I = 20.39\,(0.8 - j0.6) = 16.31 - j12.23\,A$

$v_{\text{خط}} = 440\,v \longrightarrow v_{\text{فاز}} = \frac{440}{\sqrt{3}} = 254\angle 0$

$\Rightarrow 254 + 0j + (0.3 + 1j)(16.31 - j12.23) = 271.1 + j12.64$

$V_{L-L} = \sqrt{3}\,(271.1 + j12.64) = 470\angle 2.67^\circ$

21

$S_{base} = 500\,MVA$
$V_b = 22\,kv$
$X = 1.1\,pu$

$Z_{base} = \frac{V_b^2}{S_{base}} = \frac{22^2}{500} = 0.986\,\Omega$

$X_{(pu)} = \frac{X}{Z_{base}} \Rightarrow X = Z_{base} X_{(pu)} = 0.986 \times 1.1$

$\simeq 1.065\,\Omega$

22

$V_o = 22\,kv$ $\quad X_o = 1.1\,pu$
$V_n = 20\,kv$ $\quad X_n = ?$
$S_o = 500\,MVA$
$S_n = 100\,MVA$

$X_n = X_o \left(\frac{V_o}{V_n}\right)^2 \cdot \left(\frac{S_n}{S_o}\right)^2$

$= 1.1 \left(\frac{22}{20}\right)^2 \times \left(\frac{100}{500}\right) \simeq 0.2662\,(pu)$