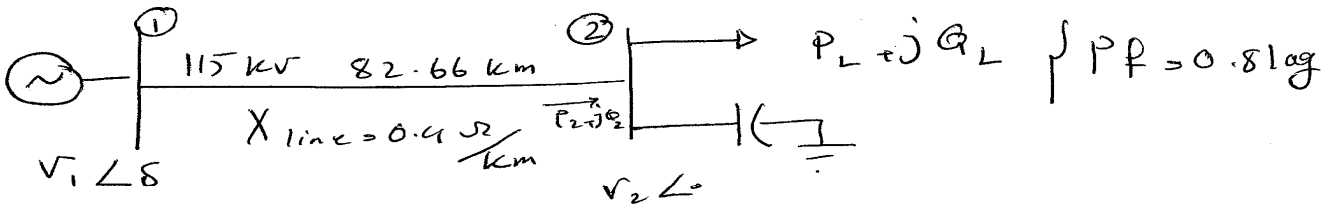
EECE 458 Fall 2012 Solution Exercise 7

IRFAN



$S_{base_{3\phi}} = 100\ MVA \qquad V_{base_{l-l}} = 115\ kV$

$$S_{base_{3\phi}} = \frac{(V_{base\ l-l})^2}{Z_{base}} \Rightarrow Z_{base} = \frac{(115\times 10^3)^2}{100\ 10^6}$$

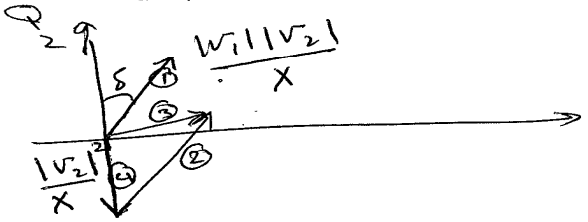
$$\Rightarrow Z_{base} = 132.25\ \Omega$$

$$X_{line} = 0.4\ \frac{\Omega}{km} \cdot 82.66 = 33.064\ \Omega$$

$$\Rightarrow X_{p.u} = \frac{33.064}{132.25} = 0.25\ p.u$$

$$P_2 + jQ_2 = V_2\left(\frac{V_1 - V_2}{Z}\right)^* = \frac{V_2 V_1^*}{(jX)^*} - \frac{|V_2|^2}{(jX)^*}$$

$$P_2 + jQ_2 = \underbrace{\frac{|V_1||V_2|\angle 90-\delta}{X}}_{\text{contribute to } P_2 \text{ and } Q_2} + \underbrace{\frac{|V_2|^2\angle -90}{X}}_{\text{only contribute to } Q_2}$$



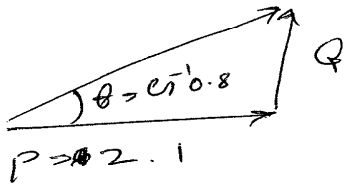
① and ② are the same vec
③ is the addition of ① and ②

$$\Rightarrow P_2 + jQ_2 = \frac{1.05}{0.25}\angle\delta + \frac{1}{0.25}\angle -90$$

Max power $\delta = 30^\circ \Rightarrow P = 1.05 * 4 \sin 30^\circ = 2.1$ p.u

$= 210$ Mwatt

② $P_L = 2.1$ p.u Load is inductive $\Rightarrow$ Consumes Q



$$1 + \tan^2\theta = \frac{1}{\cos^2\theta} \Rightarrow$$

$$\tan\theta = \sqrt{\frac{1}{\mu^2} - 1} = \sqrt{\frac{36}{64}}$$

$$= \frac{6}{8} = \frac{3}{4}$$

$$Q_{Load} = P \tan\theta = 2.1 \frac{3}{4} = 1.575 \text{ p.u}$$

Q_{bus} @ $\delta = 30^\circ$: $Q_2 = \frac{1.05}{1} * 4^2 \frac{\sqrt{3}}{2} - 4 = 3.63 - 4$

$$Q_2 = -0.362 \text{ p.u}$$

$$Q_2 = Q_L + Q_C \Rightarrow Q_C = -0.362 - 1.575 =$$

$$-1.937 \text{ pu}$$

$1 + \tan^2$

$Q_c = 193\ MVAr \Rightarrow Q_{per\_cap} = \frac{193}{3}\ MVAr$

$Q_c = \frac{V_{cap}^2}{X_c} \Rightarrow X_c = \frac{V_{cap}^2}{Q_c} \Rightarrow$

$X_c = \frac{(115/\sqrt{3})^2}{193/3} = 68.27$, $X_c = \frac{1}{2\pi f_c} \Rightarrow$

$C = 38.8\ \mu F$

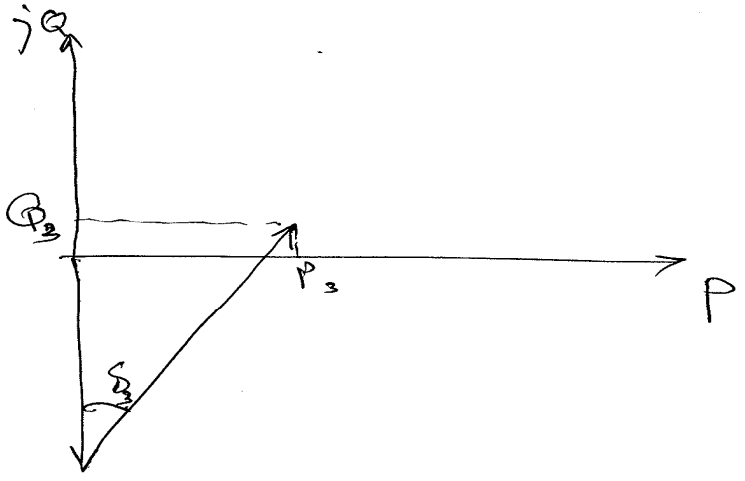
③ $Q_c = \frac{1.937}{2}$ $Q_L = 1.575 \Rightarrow$

$Q_3 = 1.575 - 0.9685 = 0.606$

$P_3 = 2.1$

$\delta_3 = \tan^{-1} \frac{P_3}{Q_3 + \frac{V_2^2}{X}} =$

$\tan^{-1} \frac{2.1}{4.6075} = 24.5°$



$P_L = \frac{V_1 V_2 \sin\delta}{X} \Rightarrow$

$V_1 = \frac{P_L \cdot X}{V_2 \sin\delta} = \frac{2.1 \angle 0.25}{1.8 \angle 24.5} = 1.266\ pu$