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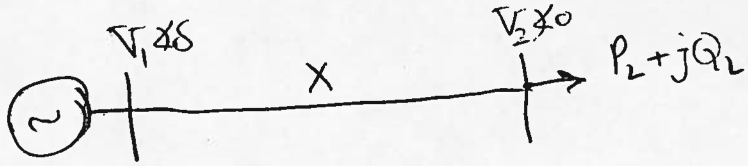
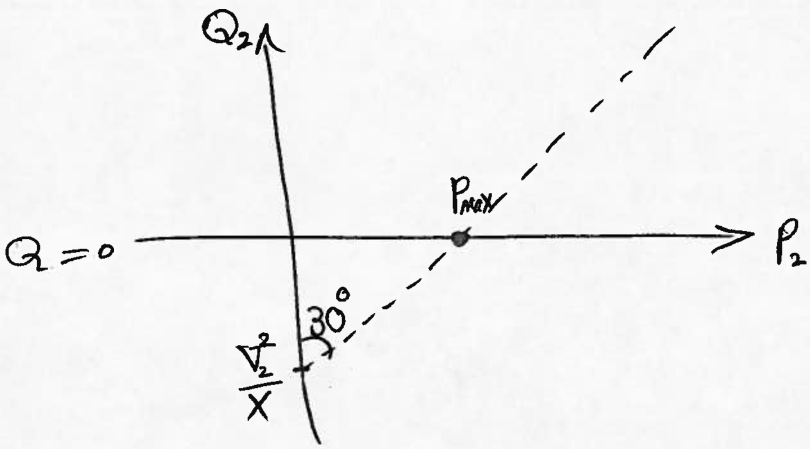


$$X = 82.66\,(\text{km}) \times 0.4\,(\Omega/\text{km}) = 33.064\ \Omega$$

$$Z_{base} = \frac{(115\times10^3)^2}{100\times10^6} = 132.25\ \Omega$$

$$X_{p.u.} = \frac{X}{Z_{base}} = \frac{33.064}{132.25} \simeq 0.25\ \text{p.u.}$$



$$\text{Power Factor} = 0 \Rightarrow Q_2 = 0$$

$$\tan(30^\circ) = \frac{P_{max}}{\frac{V_2^2}{X}} \Rightarrow P_{max} = \frac{V_2^2}{X}\tan(30^\circ)$$

$$P_{max} \simeq 2.31\ \text{p.u. or } 231\ \text{MW}$$

$$P_2 = \frac{V_1 V_2}{X}\sin\delta \Rightarrow V_1 = \frac{X P_2}{V_2 \sin\delta} = \frac{0.25 \times 2.31}{1.0 \times \sin(30)} \Rightarrow$$

$$V_1 = 1.155 \text{ p.u.}$$

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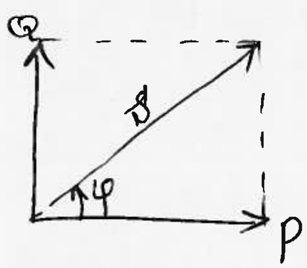
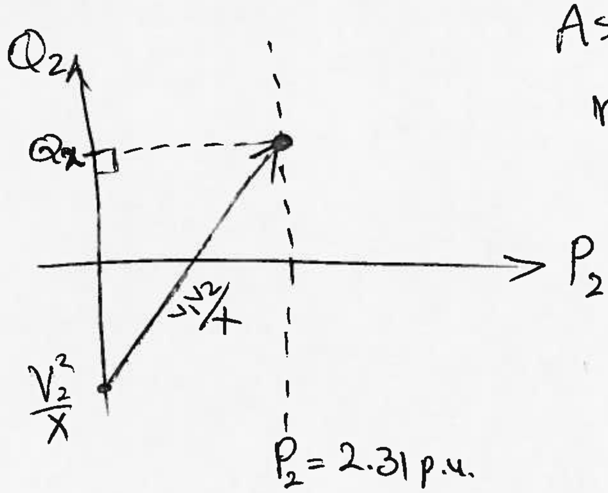
(2) Power Factor = 0.8 $\Rightarrow \cos\varphi = 0.8 \Rightarrow \tan\varphi = \frac{3}{4}$

$$Q = P\tan\varphi = 2.31 \times 0.75 = 1.7325 \text{ p.u}$$



We assume $V_2 = 1.0\angle 0$

Assume that we have a total reactive power consumption of $Q_x = Q_L - Q_c$



$$\left(\frac{V_2^2}{X} + Q_x\right)^2 + P_2^2 = \left(\frac{V_1 V_2}{X}\right)^2 \Rightarrow Q_x = \sqrt{\left(\frac{V_1 V_2}{X}\right)^2 - P_2^2} - \frac{V_2^2}{X}$$

$$Q_x = \sqrt{\left(\frac{1.05 \times 1.0}{0.25}\right)^2 - 2.31^2} - \frac{1.0^2}{0.25} \simeq -0.5$$

$$Q_c = Q_L - Q_x = 1.7325 + 0.5 = 2.2325 \text{ p.u.}$$

$$Q_{ph} = \frac{Q_c}{3} = 0.7442 \text{ p.u.}$$

$$Q_{ph} = \frac{V_{ph}^2}{X_c} = 2\pi f C V_{ph}^2 \Rightarrow C = \frac{Q_{ph}}{2\pi \times 60 \times (V_{Line}/\sqrt{3})^2}$$

$$C = \frac{\cancel{7}\, 4.42 \times 10^6}{120\pi \times (115)^2 \times (10^3/\sqrt{3})^2} = 4.4782 \times 10^{-5} \text{ F} = 44.78 \, \mu\text{F}$$

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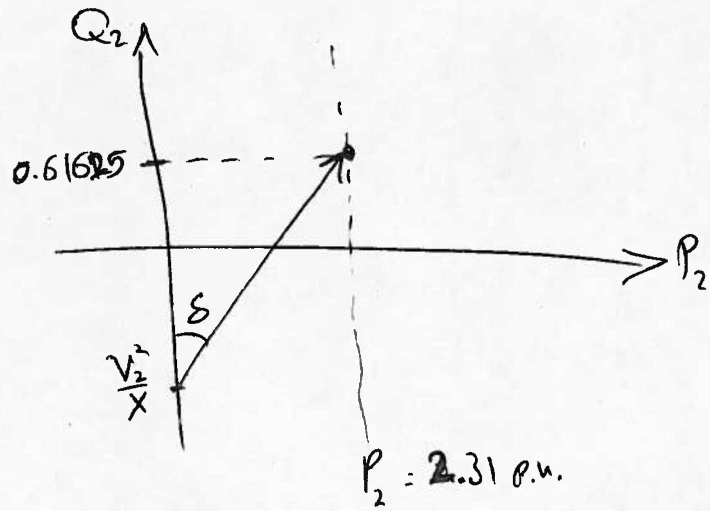
(3) $$\frac{Q_c}{2} = 1.11625 \text{ p.u.}$$

$$Q_2 = Q_L - \frac{Q_c}{2} = 0.61625 \text{ p.u}$$



$$\frac{V_2^2}{X} = \frac{1.0^2}{0.25} = 4 \text{ p.u.}$$

$$\tan(\delta) = \frac{P_2}{\frac{V_2^2}{X} + Q_2} = \frac{2.31}{4 + 0.61625}$$

$$\Rightarrow \delta = 26.58^\circ$$

$$V_1 = \frac{X P_1}{V_2 \sin\delta} = \frac{0.25 \times 2.31}{1 \times \sin(26.58^\circ)} = 1.2904 \text{ p.u.}$$