TTK4240 - Øving 6
Høst 2016
Vsevolod Karpov - vsevolok

Oppgave 1 a)

$V_L = 132\,KV, \quad S_L = 50 \cdot e^{j\,36.87^0}\,MVA$

$R_{Line} = 10\,\Omega, \quad X_{Line} = 35\,\Omega$

$\Rightarrow Z_{Line} = R_{Line} + j X_{Line} = 10 + j \cdot 35$

$S_L = P_L + j Q_L = V \cdot \bar{I} = Z_L \cdot I \cdot \bar{I}$

$$\Rightarrow S_L = \frac{V^2}{Z_L} \Rightarrow Z_L = \frac{V^2}{\bar{S}_L} = 348.48\,e^{j\,36.87^0}\,\Omega$$

b) $S_L = V_L \cdot \bar{I}_L \Rightarrow I_L = \frac{V_L}{S_L}$

$V = I(Z_{Line} + Z_L)$

$\Rightarrow I = \frac{V}{Z_{Line} + Z_L} =$

$$Z_L = \frac{V_L^2}{S_L} = \frac{V_L}{I_L} \Rightarrow I_L = \frac{\bar{S}_L}{V_L} = 378.78\,e^{-j\,36.87^0}$$

c) $V_s = I_L(Z_{Line} + Z_L)$

$Z_{Line} = R_{Line} + jX_{Line}$

$$\Rightarrow V_s = I_L\left(10 + j \cdot 35 + 348.8\left(\cos(36.87^0) + \sin(36.87^0)\right)\right)$$

$$= I_L\,(288.78 + j \cdot 244.08)$$

$$= I_L \cdot 378.112 \cdot e^{j\,40.20^0}$$

$$= 143221 \cdot e^{j \cdot 3.33^0}$$

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d) $S = \frac{V^2}{\bar{Z}}, Z = \frac{V}{I} \Rightarrow S = V \cdot \bar{I}$

$\Rightarrow S_s = V_s \cdot \bar{I} = 143221 \cdot 378.78 \cdot e^{j(3.33^\circ + 36.87^\circ)}$

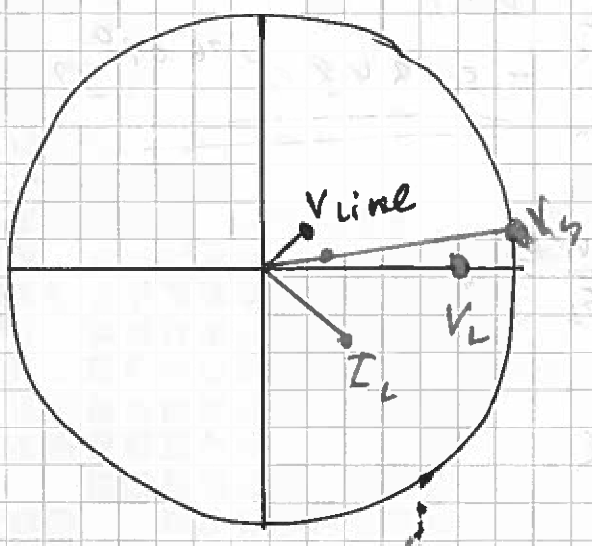
$= 54249350\, e^{j40.20^\circ}$

$= 54.25 \cdot 10^6 (\cos(40.2^\circ) + j \sin(40.20^\circ))$

$\Rightarrow S_s = 54.25$ MVA, $P = 41.44$ MW.

$Q = 35$ MVar

e)



Oppgave 2

a) $V_s = 22 \cdot 10^3$ V RMS, $X_{line} = 10\,\Omega$

$V_L = 22 \cdot 10^3$ V, ~~$S_L = 5 \cdot 10^6 \cdot e^{j\phi}$~~ $P_L = 5 \cdot 10^6$ W

$\cos(\phi) = 0.9 \Rightarrow \phi = -25.84^\circ$ (induktiv)

$Z_L = \infty \Rightarrow \underline{V_L = V_s}$ (nåå ut på havet)

b) $S = V \cdot \bar{I}, \quad \bar{I} = \left(\frac{V}{Z}\right) \Rightarrow \bar{Z} = \frac{V^2}{S}$

~~$\Rightarrow Z_{tot} = \frac{V_L^2}{S_L} = Z_L + Z_{Line}$~~

~~$\Rightarrow Z_L = \frac{V_L^2}{S_L} - Z_{Line}$~~

$$\Rightarrow \bar{Z}_L = \frac{V_L^2}{S_L}, \quad S_L = P + jQ = A \cdot e^{j\phi}$$

$$P_L = A \cdot \cos(\phi) \Rightarrow A = \frac{P_L}{0.9}$$

$$\Rightarrow S_L = \frac{5 \cdot 10^6}{0.9} \cdot e^{j\phi}$$

$$\Rightarrow \bar{Z}_L = \frac{(22 \cdot 10^3)^2}{5 \cdot 10^6} \cdot 0.9 \cdot e^{-j\phi}$$

$$= \underline{\underline{Z_L = 87.12 e^{j \cdot 25.84^\circ}}}$$

c) Before $= V_s$

After $= Z_L \cdot I = \frac{V_s \cdot Z_L}{Z_L + jX}$

$$\Delta = |V_s| - \left|\frac{V_s \cdot Z_L}{\bar{Z}_L + jx}\right| = |V_s| - |V_s| \cdot \frac{87.12}{91.91}$$

$$= V_s \cdot 0.0521 \Rightarrow \underline{\underline{\Delta = 5.21\,\%}}$$

d) Hvis kondensatoren blir satt på kaia, vil den mate reaktiv effekt mot nettet når ferja ~~ikke~~ er ut på vannet. Spenningen på kaia blir da null.
→ Enorm spenningsfall.

e) $Z_L = A + Bj$, $Z_c = Dj$

$$Z_{tot} = \frac{Z_L \cdot Z_c}{Z_L + Z_c} = \frac{-ABD + j(A^2D + B^2D + BD^2)}{A^2 + (B+D)^2}$$

$\Rightarrow A^2D + B^2D + BD^2 = 0$ (imaginærdel $= 0 \Rightarrow 0$ reaktiv effekt)

$$\Rightarrow \underline{D = \left(\frac{-B}{A^2+B^2}\right)^{-1}} \quad D = -\frac{1}{\omega C} \Rightarrow C = \frac{-1}{\omega D}, \quad \omega = 2 \cdot 50 \cdot \pi$$

$$\Rightarrow \underline{\underline{C = 15.9\,\mu F}}$$

f) Ny impedans $Z_{tot} = \frac{Z_L \cdot Z_c}{Z_L + Z_c} = \cancel{9.48\,\Omega}\ \cancel{18.56\,\Omega}$
$= 0.\cancel{00496}\,\Omega$
$= \underline{96.71\,\Omega}$

$$\Rightarrow \Delta = \frac{\left(|V_s| - \left|\frac{V_s \cdot Z_{tot}}{Z_{tot} + jX}\right|\right) \cdot 100}{|V_s|} = \underline{\underline{0{,}53\,\%}}$$

Oppgave 3

a) $Z_L = 90 - j30\,\Omega$

$V_{th} = V_{ab}(\cancel{no}\ load) + I_L(R_{th} + jX_{th})$

$V_{ab}(no\text{-}load) = 240\,V\ (rms)$

$V_{ab}(load) = 175.2 - j86.4\,V$

$$\underline{\underline{V_{th} = V_{ab}(no\text{-}load) = 240\,V}}$$

$$I_L = \frac{V_{ab}(load)}{Z_L} = \frac{144 \cdot e^{-j36.86}}{94{,}86 \cdot e^{-j18.43}} = \underline{\underline{1.51^{-j18.43}\,A}}$$

$$\frac{V_{th} - V_{ab}(load)}{I_L} = Z_{th} = \frac{151.789 \cdot e^{34.6052^\circ}}{1.51 \cdot e^{-j18.43}} = \underline{100 \cdot e^{j\cancel{16.26}\,53.12}}$$

$$= R_{th} + X_{th} = 100 \cdot \cos(53.12^\circ) + j100 \cdot \sin(53.12^\circ)$$

$\Rightarrow R_{th} = 60.014\,\Omega$

$\underline{\underline{X_{th} = 79.98\,\Omega}}$

b) $P_L = Z_L \cdot I_L^2 \quad , \quad I_L = \frac{V_{th}}{Z_L + Z_{th}}$

$$\Rightarrow P_L = \frac{Z_L \cdot (V_{th})^2}{(Z_L + Z_{th})^2}$$

$$P_L'(Z_L) = \frac{(V_{th})^2 - 2(Z_L + Z_{th})}{(Z_L + Z_{th})^4} = 0$$

$\Rightarrow 2(Z_L + Z_{th}) = V_{th}^2$

$$\underline{\underline{Z_L = \frac{V_{th}^2}{2} - Z_{th}}}$$

$$P = |I^2| \cdot R_L$$

$$I = \frac{V_{th}}{Z_L + Z_{th}} = \frac{V_{th}}{R_{th} + R_L + j(X_{th} + X_L)}$$

$$\Rightarrow |I| = \frac{|V_{th}|}{\sqrt{(R_{th}+R_L)^2 + (X_{th}+X_L)^2}}$$

$$\Rightarrow P = \frac{|V_{th}| \cdot R_L}{(R_{th}+R_L)^2 + (X_{th}+X_L)^2}$$

$$\Rightarrow \frac{\partial P}{\partial R_L} = 0 \quad \text{og} \quad \frac{\partial P}{\partial X_L} = 0$$

$$\Rightarrow X_L = -X_{th}$$

$$R_L = \sqrt{R_{th}^2 + (X_L + X_{Th})^2} = R_L = R_{th}$$

$$\Rightarrow \underline{\underline{Z_L \text{ (top effekt)} = R_{th} - j X_{th}}}$$

c) $\underline{\underline{Z_L = 60.014 - j\,79.98}}$

$$S_L = V_L \cdot \bar{I} \quad , \quad I = \frac{V_{th}}{2 \cdot R_{th}} \quad , \quad V_L = I_L \cdot Z_L$$

$$\Rightarrow S_L = Z_L \cdot \frac{V_{th}^2}{4 \cdot R_{th}^2} = \underline{\underline{(240 - 320 \cdot j)\,VA}}$$