Tentamen Elkraftssystem
070528

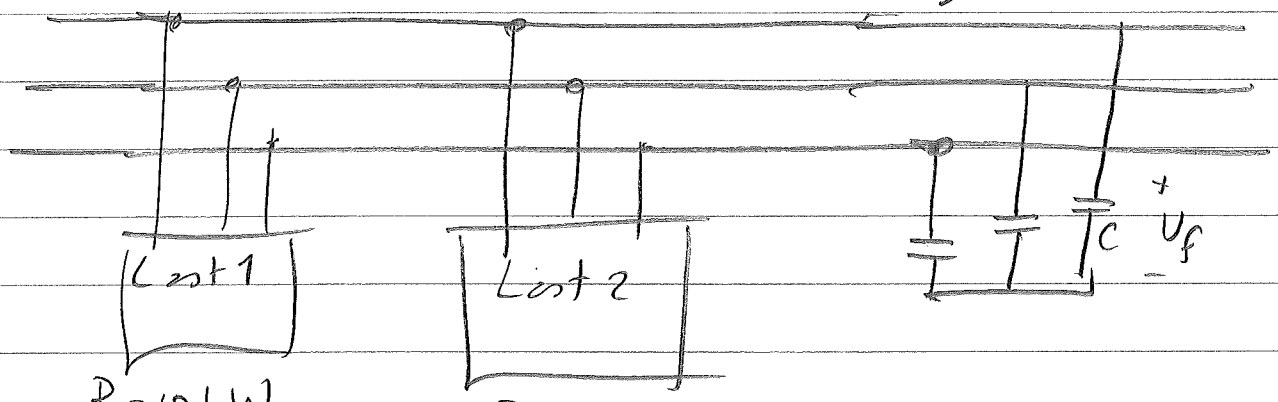
Lösningsförslag här

Uppgifter 9-13.

Uppgifter 1-8 se kursbok.

9.

c)



$P_1 = 10\,kW$

$\cos\varphi = 0.75$

$\Downarrow$

$\tan\varphi = 0.882$

$Q_1 = 8,82\,kVAr$

$P_2 = 18\,kW$

$Q_2 = 10\,kVAr$

$\Downarrow$

a) $P_{tot} = P_1 + P_2 = 28\,kW$ $\quad Q_{tot} = Q_1 + Q_2 = 18,82\,kVAr$

$|S_{tot}| = \sqrt{P_{tot}^2 + Q_{tot}^2} = \sqrt{3} \cdot U_h \cdot I_{hres} \Rightarrow I_{hres} = 48,7\,A$

$33,737\,kVA = \sqrt{3} \cdot 400 \cdot I_{hres}$

$\cos\varphi_{res} = \frac{P_{tot}}{|S_{tot}|} = 0,83$

b) Szimmetrikus!

c) $\cos\varphi_{tot} = 0,97 = \frac{P_{tot}}{|S_{tot}^{ny}|}$ $\quad |S_{tot}^{ny}| = 28,87\,kVA$

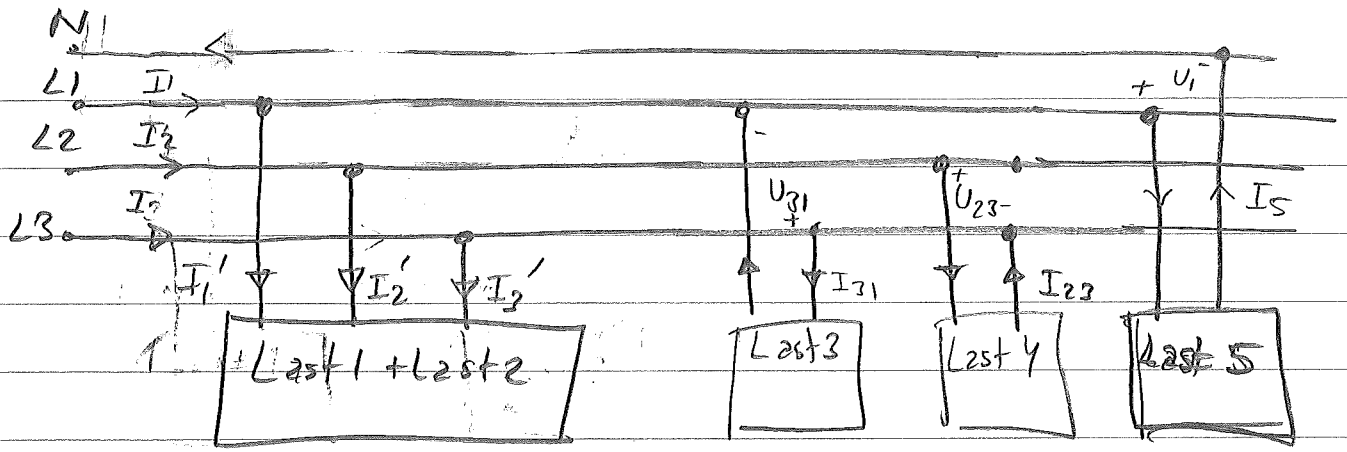
$|Q_{tot}^{ny}| = 7,02\,kVAr$

Skillnaden = $7,02 - 18,82\,kVAr = -11,8\,kVAr = Q_c$

reaktiv effekt

$Q_c = -3 \cdot \omega C U_f^2 \Rightarrow C = \frac{Q_c}{3\omega \cdot U_f^2} = \underline{\underline{237\,\mu F}}$

10.



$P_{hf} = 28\,kW$, $\cos\varphi = 0{,}82$

Last 5:

$$\tan\varphi = \frac{Q_5}{P_5} = 1 \Rightarrow \varphi = 45° \qquad U_1 = 230\,e^{j0°}$$

$$P_5 = U_f \cdot I_5 \cdot \cos\varphi \rightarrow I_5 = \frac{P_5}{U_f \cdot \cos\varphi} = \frac{4000}{230 \cdot \cos 45°} \approx 24{,}6\,A$$

$$I_5 = 24{,}6\,e^{-j45°} = I_N$$

Genom att summera strömmar för de olika faserna.

$$I_1 = I_1' - I_{31} + I_5 \quad , \quad I_2 = I_2' + I_{23} \quad , \quad I_3 = I_3' + I_{31} - I_{23}$$

Last 4:

$Q_4 = 3\,kVAr$, $\sin\varphi = 0{,}72$

$\varphi = 46{,}1°$

$U_{23} = 400\,e^{-j90°}$

$P_4 = 2{,}89\,kW = U_{23} \cdot I_{23} \cdot \cos\varphi \Rightarrow I_{23} = 10{,}41\,A$

$$I_{23} = 10.41\,e^{-j136{,}1°}$$

Last 3:

$$P_3 = \underbrace{U_{31}}_{400} \cdot I_{31} \cdot \underbrace{\cos\varphi}_{0{,}72} = 5\,kW \rightarrow I_{31} = 17{,}36\,A$$

$\varphi = 44°$

$U_{31} = 400\,e^{-j210°}$ V

$I_{31} = 17{,}36\,e^{-j254°}$

Last 1+2: $P_{hf} = \sqrt{3} \cdot \underbrace{U_h}_{400} \cdot I_1' \cdot \underbrace{\cos\varphi}_{0{,}83} = 28\,kW \rightarrow I_1' = 48{,}7\,A = I_2' = I_3'$

$\varphi = 33{,}9°$

10 forts

$$I_1' = 48{,}7\, e^{-j33{,}9^\circ}\ A$$
$$I_2' = 48{,}7\, e^{-j153{,}9^\circ}\ A$$
$$I_3' = 48{,}7\, e^{-j273{,}9^\circ}\ A$$

$$I_1 = I_1' - I_{31} + I_5$$

$$I_1 = 48{,}7\left(\cos 33{,}9^\circ + j\sin(-33{,}9^\circ)\right) - 17{,}36\left(\cos(-254^\circ) + j\sin(-254^\circ)\right)$$

$$+ 24{,}6\left(\cos(-45^\circ) + j\sin(-45^\circ)\right) \simeq 87{,}6\, e^{-j44{,}4^\circ}\ [A]$$

$=$

$$I_2 = I_2' + I_{23} = 48{,}7\left(\cos 153{,}9^\circ + j\sin(-153{,}9^\circ)\right) + 10{,}41\left(\cos 136{,}1^\circ + j\sin(-136{,}1^\circ)\right)$$

$$= -43{,}73 - j\,21{,}42 - 7{,}50 - j\,7{,}22 \simeq -51{,}23 - j\,28{,}64$$

$$I_2 = 58{,}7\, e^{-j150{,}8^\circ}$$

$$I_3 = I_3' + I_{31} - I_{23} = 48{,}7\left(\cos 273{,}9^\circ + j\sin(-273{,}9^\circ)\right) +$$
$$+ 17{,}36\left(\cos 254^\circ + j\sin(-254^\circ)\right) - 10{,}41\left(\cos(-136{,}1^\circ) + j\sin(-136{,}1^\circ)\right)$$

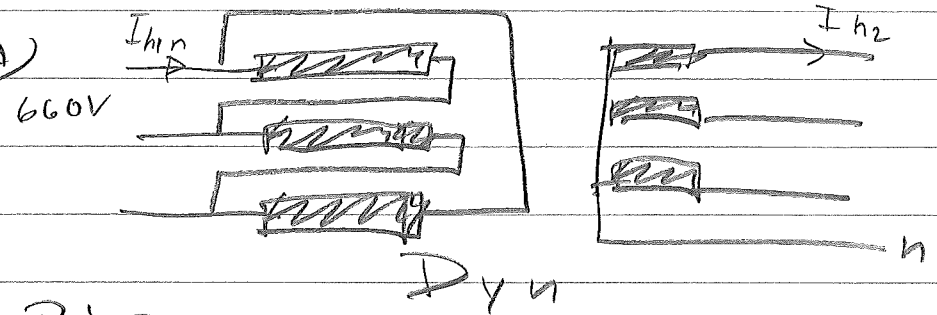
$$\simeq 3{,}31 + j\,48{,}59 - 4{,}79 + j\,16{,}69 + 7{,}50 + j\,7{,}22 =$$

$$= 6{,}02 + j\,72{,}5 \simeq 72{,}7\, e^{j85{,}3^\circ}$$

11. $S_n = 6\,kVA$, 660V/191V Dyn, $f = 50Hz$

Kortsluttn.prøv: $U_k = 15{,}7V$, $I_k = 5A$, $P_k = 131W$

a)



Primær:

$S_n = \sqrt{3} \cdot U_{h1n} \cdot I_{h1n} \rightarrow I_{h1n} = 5{,}25\,A$

$I_{f1} = I_{h1}/\sqrt{3} = 3{,}00\,A$

Sek.side:

$S_n = \sqrt{3} \cdot U_{h2n} \cdot I_{h2} \rightarrow I_{h2} = 18{,}14\,A$

Kortsluttn.prøv indikerer at strømmen måtte være på primærsiden.

$P_k = 3 \cdot R_{1k} \cdot I_{k1}^2 \Rightarrow R_{1k} = 1{,}75\,\Omega$

$3 \cdot R_{2k} \cdot I_{k2}^2 \Rightarrow R_{2k} = 0{,}177\,\Omega$

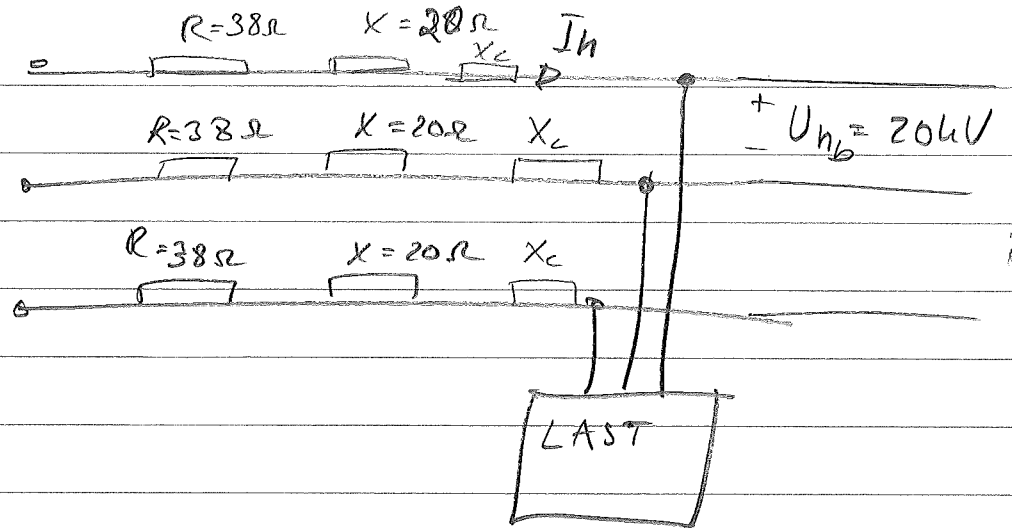
$R_{1k} = \frac{r_k}{100} \cdot \frac{U_{h1n}^2}{S_n} \rightarrow r_k = 2{,}4\ \%$

$\frac{U_k}{\sqrt{3} I_k} = Z_{1k} = 1{,}81\,\Omega \rightarrow Z_k = \frac{z_k}{100} \cdot \frac{U_{h1n}^2}{S_n} \rightarrow z_k = 2{,}5\ \%$

$x_k = \sqrt{z_k^2 - r_k^2} = 0{,}69\ \%$

b) $P_b = 3 \cdot R_{1k} \cdot I_{h1n}^2 = 3 \cdot 1{,}75 \cdot 5{,}25^2 \approx 145\,W$

12.



$S = 1500kVA = \sqrt{3} \cdot U_{hb} \cdot I_h \rightarrow I_h = 43,3A$

$\cos\varphi_b = 0,75$

$\sin\varphi_b = 0,66$

$$\frac{U_h - U_{hb}}{U_h} \cdot 100 = 8 \quad (=) \quad 0,92\, U_h = U_{hb}$$

$$U_h = \frac{U_{hb}}{0,92} = 21739\,Volt$$

(i meth. änden)

Impedansen pr ledning blir: $R + j(X - X_c)$

$\Delta U = 1739\,Volt$

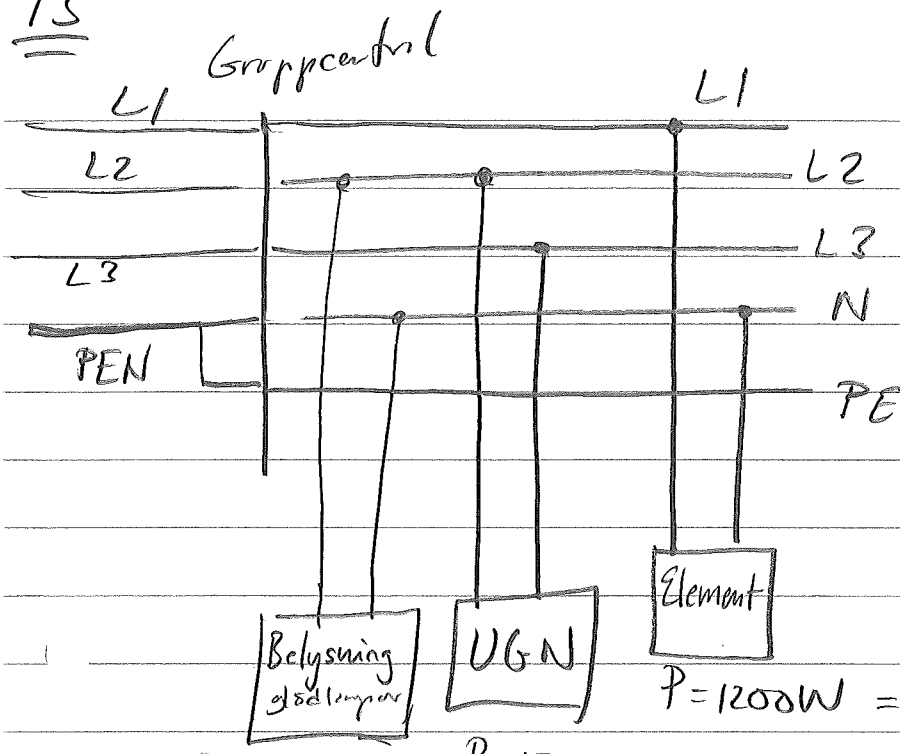
$$\Delta U = \sqrt{3}\, I_h \cdot \left(R \cdot \cos\varphi_b + (X - X_c) \cdot \sin\varphi_b \right)$$

$$\left(\frac{\Delta U}{\sqrt{3} \cdot I_h} - R\cos\varphi_b \right) / \sin\varphi_b = X - X_c$$

$$X_c = X - \left(\frac{\Delta U}{\sqrt{3} \cdot I_h} - R\cos\varphi_b \right) / \sin\varphi_b = 20 - \left(\frac{1739}{\sqrt{3} \cdot 43,3} - 38 \cdot 0,75 \right) / 0,66$$

$$X_c \approx 20 \div (-8,05) = \frac{1}{\omega C} = \frac{1}{2\pi f \cdot C} \Rightarrow C = \frac{1}{2\pi f \cdot X_c} \approx 113\,\mu F$$

13



$P = 1200W = \frac{U_f^2}{R_{element}} \rightarrow R_{element} = 44{,}1\ \Omega$

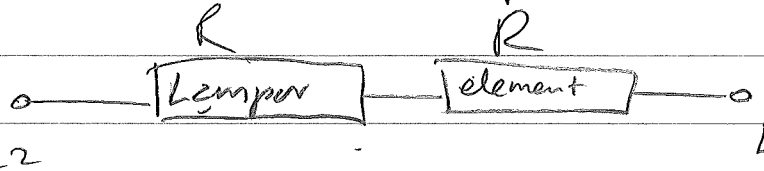
$P = 400W$ $P = 1500W$

$P = \frac{U_f^2}{R_{lampa}} \rightarrow R_{lampa} \approx 132\ \Omega$

a) Bestäm spänningarna över lasterna efter felet med nollskruven!

U_{gn} för fortfarande 400V.

Element och glödlampor är resistiva belastningar.



$U_n = 400$

300V över lampor och 100Volt över elementet.

b) Effekt hos ugn oförändrad

$P_{lampa} \approx \frac{300^2}{R_{lampor}} \approx 681W$

$P_{element} \approx \frac{100^2}{R_{element}} \approx 227W$

Notera att resistansen hos dessa sällanligen varierar med temperaturen, men vi har inte uppgifter på temp. beroende.