Lösning tentamen i EEK 140 2015 08 25

1.

$U = 690\,V$; tre symmetriska belastningar:

a) b)

	P (kW)	$\cos\varphi$	Q (kVAr)
I	78	0,64 kap	-93,65
II	95	0,90	46,00
III	22	1,0	0,00
Σ	195		-47,65

$\underline{S} = 195,0 - j47,65 = 200,74 \angle -13,73^\circ$ (kVA)

$\underline{I}^* = \frac{\underline{S}}{3\,\underline{U}_f} = 167,97 \angle -13,73^\circ \Rightarrow \underline{I} = 167,97 \angle 13,73^\circ$ (A)

c)

$\cos 13,73^\circ = 0,971$

$\cos\varphi = 0,971$ kapacitiv karaktär

d) $\underline{Z} = \frac{\underline{U}_f}{\underline{I}} = \frac{\frac{690}{\sqrt{3}} \angle 0^\circ}{167,97 \angle 13,73^\circ} = 2,37 \angle -13,73^\circ = 2,3 - j0,56$ (Ω/fas)

$S_n = 100\,kVA$; $6,6/0,4\,kV$

a) Kortslutningsprov utfört från uppspänningssidan gav följande resultat: $U_k = 265\,V$; $P_k = 1,0\,kW$; $I_k = I_{1n}$

$$I_{1n} = \frac{S_n}{\sqrt{3}\,U_{1n}} = \frac{100\cdot 10^3}{\sqrt{3}\cdot 6,6\cdot 10^3} = 8,75\,A$$

$$P_k = 3\cdot R_k I_k^2 \Rightarrow R_k = \frac{1000}{3\cdot 8,75^2} = 4,35\,\Omega/fas$$

$$U_k = \sqrt{3}\,I_k Z_k \Rightarrow Z_k = \frac{265}{\sqrt{3}\cdot 8,75} = 17,5\,\Omega/fas$$

$$X_k = \sqrt{Z_k^2 - R_k^2} = \sqrt{17,5^2 - 4,35^2} = 16,95\,\Omega/fas$$

Uppspänningssida: $R_k = 4,35\,\Omega/fas$; $X_k = 16,95\,\Omega/fas$

$$\underline{Z}_k = (4,35 + j\,16,95)\,\Omega/fas$$

Nedspänningssida:

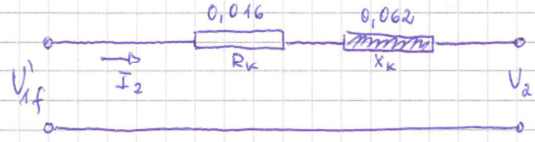
$$\underline{Z}_k = (4,35 + j\,16,95)\left(\frac{0,4}{6,6}\right)^2 = (0,016 + j\,0,062)\,\Omega/fas$$

$R_k = 0,016\,\Omega/fas$; $X_k = 0,062\,\Omega/fas$

$z_k = ?$

$$z_k = \frac{Z_k}{Z_{bas}} = \frac{Z_k}{\frac{U_n^2}{S_n}} = \frac{17,5}{\frac{(6,6\cdot 10^3)^2}{100\cdot 10^3}} = 0,04 \Rightarrow z_k = 4\%$$

b) $I_2 = 100\,A$; $\cos\varphi_2 = 0,8$; $U_1 = 6,6\,kV$; $U_2 = ?$



$U'_{1f} = 400\,V$

$$\Delta U = \sqrt{3}\,I_2\left(R_k\cos\varphi_2 + X_k\sin\varphi_2\right) = \sqrt{3}\cdot 100\left(0,016\cdot 0,8 + 0,062\cdot 0,6\right) =$$

$$= 8,66\,V$$

$$U_2 = 400 - 8,66 = 391,34\,V$$

c) $P_0 = 800\ W$; $\eta = ?$

$$P_2 = \sqrt{3} \cdot U_2 \cdot I_2 \cdot \cos\varphi_2 = \sqrt{3} \cdot 391{,}34 \cdot 100 \cdot 0{,}8 =$$
$$= 54230\ W$$

$$P_{cu} = 3 R_k I_2^2 = 3 \cdot 0{,}016 \cdot 100^2 = 480\ W$$

$$\eta = \frac{P_2}{P_2 + P_0 + P_{cu}} = \frac{54230}{54230 + 800 + 480} = 0{,}977$$

$$\eta = 97{,}7\ \%$$

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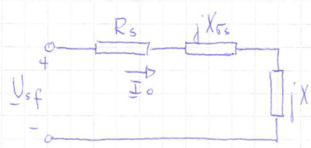
AM; $U_n = 690\ V$; $P_n = 500\ kW$; $\cos\varphi = 0{,}92$; $\eta = 0{,}$

a) Tomgång: $s \approx 0 \Rightarrow$



$R_s = 0{,}004\ \Omega/fas$

$X_{\sigma s} = 0{,}12\ \Omega/fas$

$X_m = 2{,}5\ \Omega/fas$

b) $$\underline{I}_0 = \frac{\underline{U}_{sf}}{R_s + j(X_{\sigma s} + X_m)} = \frac{\frac{690}{\sqrt{3}} \angle 0^\circ}{0{,}004 + j\,2{,}62} = 152{,}05 \angle -89{,}9$$

$\cos(-89{,}91^\circ) = 0{,}0016 = \cos\varphi_0$

c) $$P_0 = 3 U_{sf} I_0 \cos\varphi_0 = 285{,}44\ W$$

$$Q_0 = 3 U_{sf} I_0 \sin\varphi_0 = 181{,}72\ kVAr$$

$$P_s = \frac{P_n}{\eta} = \frac{500}{0{,}95} = 526{,}32\ kW$$

$\cos\varphi = 0{,}92 \Rightarrow Q_s = 224{,}21\ kVAr$

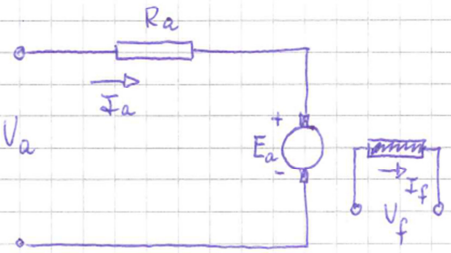
d) $Q_c = Q_0$ (för att undvika överkompensering

$$X_c = \frac{3U_c^2}{Q_c}$$ om Y-kopplad $U_c = U_{sf}$

$X_c = 2{,}62\ \Omega/fas$

LM - separatmagnetiserad ; $R_a = 0{,}5\,\Omega$

$U_a = ?$ vid 500 rpm



$U_{a1} = 440$ V ; $I_{a1} = 40$ A ; $n_1 = 1500$ rpm

$U_{a2} = ?$ då $n_2 = 500$ rpm ; T = konst ; I_f = konst

$$U_{a1} = E_{a1} + R_a I_{a1} \Rightarrow E_{a1} = 440 - 0{,}5 \cdot 40 = 420\ \text{V}$$

$$E_a = k \omega I_f \Rightarrow$$

$$\frac{E_{a1}}{E_{a2}} = \frac{\omega_1}{\omega_2} = \frac{n_1}{n_2} \Rightarrow E_{a2} = E_{a1} \frac{n_2}{n_1} = 420 \frac{500}{1500} = 140\ \text{V}$$

Då T och I_f konst $\Rightarrow I_a$ = konst $\Rightarrow I_{a1} = I_{a2}$

$$U_{a2} = E_{a2} + R_a I_{a2} = 140 + 0{,}5 \cdot 40 = 160\ \text{V}$$

$$\underline{\underline{U_{a2} = 160\ \text{V}}}$$

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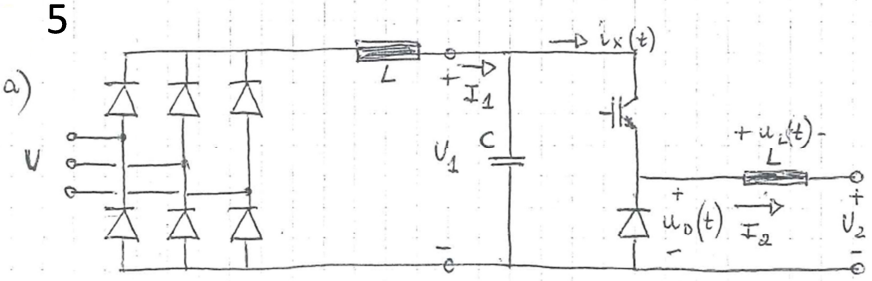
a)



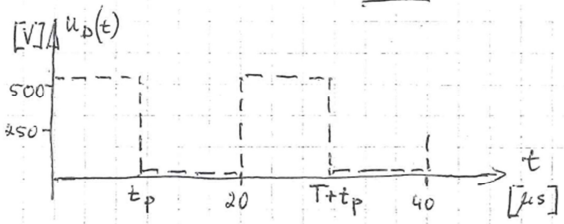
3-fas diodliktave LS-omvriktaren

$U = 400\,V \Rightarrow U_1 = 1{,}35\,U = 540\,V$

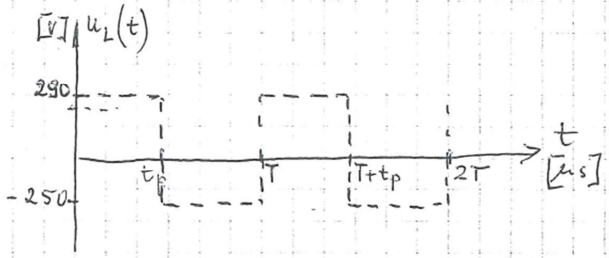
$f = 50\,kHz \qquad U_2 = 250\,V\,;\ I_2 = 10\,A$

b) $\dfrac{U_2}{U_1} = \dfrac{t_p}{T} \qquad T = \dfrac{1}{f} = 20\cdot10^{-6}\,s\,;\ t_p = \dfrac{U_2}{U_1}T = \dfrac{250}{540}\cdot 20\cdot10^{-6} = 9\,\mu s$

$u_D(t) = ?$

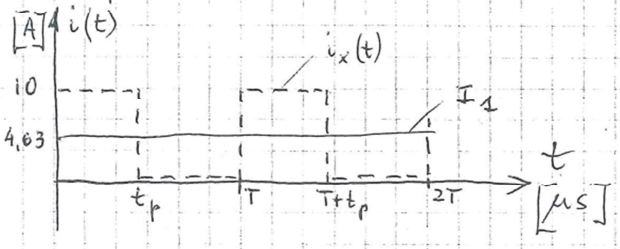


c) $u_L(t) = ?$



d) $U_1 I_1 = U_2 I_2$

$I_1 = \dfrac{U_2}{U_1} I_2 = \dfrac{250}{540}\cdot 10 = 4{,}63\,A$



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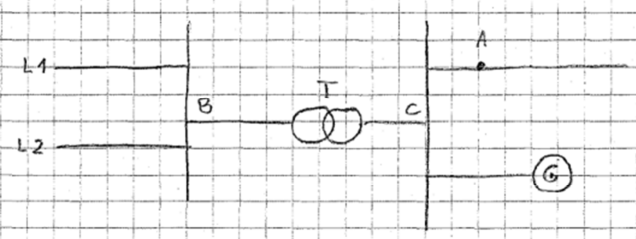

a) $S_{kL1} = 300\ MVA$

$S_{kL2} = 200\ MVA$

$$S_{kT} = \frac{S_n}{z_k} = \frac{20}{0,1} = 200\ MVA$$

$$S_{kG} = \frac{S_n}{x'_d} = \frac{5}{0,25} = 20\ MVA$$

$$S_{kB} = S_{kL1} + S_{kL2} = 500\ MVA$$

$$S_{kC} = \frac{S_{kB} \cdot S_{kT}}{S_{kB} + S_{kT}} = \frac{500 \cdot 200}{700} = 142,86\ MVA$$

$$S_{kA} = S_{kC} + S_{kG} = 142,86 + 20 = 162,86\ MVA$$

b)

$$I_{kA} = \frac{S_{kA}}{\sqrt{3} \cdot U} = \frac{162,86}{\sqrt{3} \cdot 10} = 9,4\ kA$$

$$I_s = 2,5 \cdot I_{kA} = 23,5\ kA$$