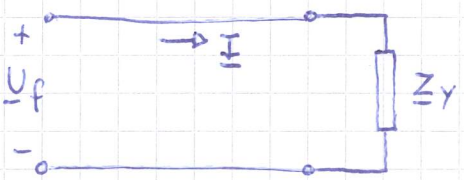
1/1

$\underline{Z}_\Delta = (15 + j9)\ \Omega$; $U = 400\ V$

a) Ekv. Y- fas kvrets:



$\underline{Z}_Y = \frac{1}{3}\underline{Z}_\Delta = (5 + j3)\ \Omega/fas$

$\underline{U}_f = \frac{400}{\sqrt{3}}\angle 0^\circ = 230{,}94\angle 0^\circ\ V$

referens

$\underline{Z}_Y = 5 + j3 = 5{,}83\angle 31^\circ\ \Omega/fas \Rightarrow \cos\varphi = 0{,}857$

$\underline{I} = \frac{\underline{U}_f}{\underline{Z}_Y} = \frac{230{,}94\angle 0^\circ}{5{,}83\angle 31^\circ} = 39{,}6\angle -31^\circ\ A$

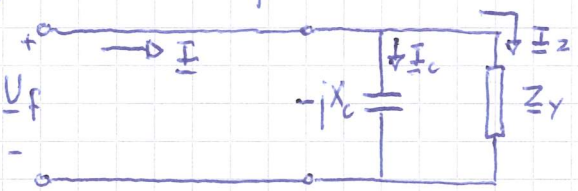
$I_\Delta = \frac{I}{\sqrt{3}} = 22{,}87\ A$

$\underline{S} = 3\underline{U}_f \underline{I}^* = 3 \cdot 230{,}94\angle 0^\circ \cdot 39{,}6\angle 31^\circ =$

$= 27{,}44 \cdot 10^3\angle 31^\circ = (23{,}52 \cdot 10^3 + j14{,}13 \cdot 10^3)\ VA$

$P = 23{,}52\ kW$; $Q = 14{,}13\ kVAr$

b) Ekv. Y- fas kvrets:



$X_c = 20\ \Omega$

$\underline{I}_z = 39{,}6\angle -31^\circ = (33{,}94 - j20{,}4)\ A$ enl. a)

$\underline{I}_c = \frac{\underline{U}_f}{-jX_c} = j\frac{230{,}94\angle 0^\circ}{20} = j11{,}55\ A$

$\underline{I} = \underline{I}_c + \underline{I}_z = 33{,}94 - j20{,}4 + j11{,}55 = 33{,}94 - j8{,}85 =$

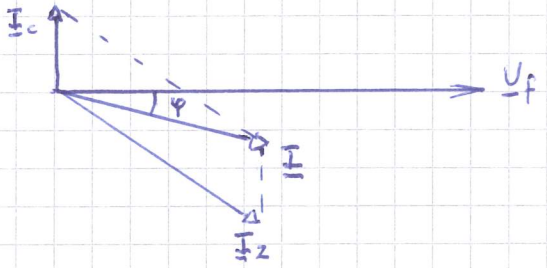
$= 35{,}1\angle -14{,}61^\circ\ A \Rightarrow \cos\varphi = 0{,}968$

$\underline{S} = 3\underline{U}_f \underline{I}^* = 24{,}32 \cdot 10^3\angle 14{,}61^\circ = (23{,}52 \cdot 10^3 + j6{,}13 \cdot 10^3)\ VA$

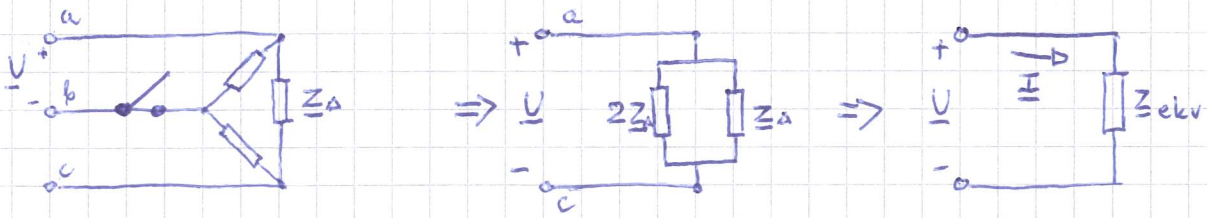
$P = 23{,}52\ kW$; $Q = 6{,}13\ kVAr$

1/2

a) Visardiagram:



b) Anta att säkringen i fas b löser ut:



$$\underline{Z}_{ekv} = 2\underline{Z}_\Delta // \underline{Z}_\Delta = \frac{2}{3}\underline{Z}_\Delta = 11{,}66\angle 31^\circ \ \Omega$$

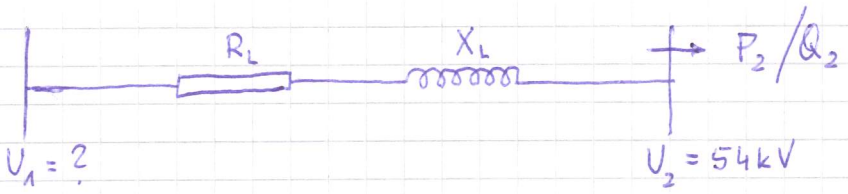
$$\underline{I} = \frac{\underline{U}}{\underline{Z}_{ekv}} = \frac{400\angle 30^\circ}{11{,}66\angle 31^\circ} = \underline{34{,}3\angle -1^\circ} \ \text{A}$$

$$\underline{S} = \underline{U}\,\underline{I}^* = 400\angle 30^\circ \cdot 34{,}3\angle 1^\circ = 13{,}72\cdot 10^3\angle 31^\circ =$$

$$= (11{,}76\cdot 10^3 + j\,7{,}07\cdot 10^3)\ \text{VA}$$

P Q

2.



$P_2 = 12\ MW\ ;\ \cos\varphi = 0{,}6 \Rightarrow Q_2 = 16\ MVAr$

$\Rightarrow S_2 = 20\ MVA$

Luftledning: $l = 50\,km\ ;\ A = 200\,mm^2$

$$R_L = \rho \frac{l}{A} = 28{,}2 \cdot \frac{50}{200} = 7{,}05\ \Omega/fas$$

$$X_L = 0{,}4 \cdot 50 = 20{,}0\ \Omega/fas$$

a) $U_1 = ?$ visardiagramberäkningar; tvärsp. fallet försummas

$$U_{längs} = \frac{R_L \cdot P_2 + X_L Q_2}{U_2} = \frac{7{,}05 \cdot 12 + 20 \cdot 16}{54} = 7{,}5\ kV$$

$$\underline{U_1 \approx U_2 + U_{längs} \approx 61{,}5\ kV}$$

b) förluster:

$$\underline{P_f = 3 R_L I^2 = 3 \cdot R \left(\frac{S_2}{\sqrt{3} U_2}\right)^2 = 3 \cdot 7{,}05 \cdot \left(\frac{20 \cdot 10^6}{\sqrt{3} \cdot 54 \cdot 10^3}\right)^2 = 967{,}1\ kW}$$

$$\underline{Q_f = 3 X_L I^2 = 3 \cdot 20 \left(\frac{20 \cdot 10^6}{\sqrt{3} \cdot 54 \cdot 10^3}\right)^2 = 2{,}74\ MVAr}$$

3

En 3-fas trafo: 690/400 V; $S_n = 2400$ VA; $f = 50$ Hz; $P_0 = 20$ W

$r_k = 1{,}5\%$; $z_k = 6{,}6\%$

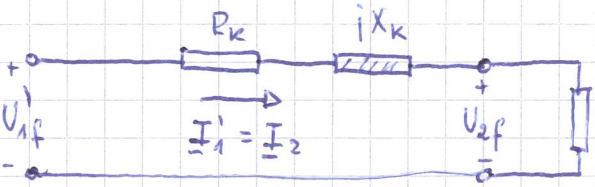
a) R_k och X_k hänförda till 400 V-sidan?

$$R_k = r_k \cdot Z_{bas} = 0{,}015 \frac{400^2}{2400} = 1{,}0 \ \Omega/\text{fas}$$

$$Z_k = z_k \cdot Z_{bas} = 0{,}066 \frac{400^2}{2400} = 4{,}4 \ \Omega/\text{fas}$$

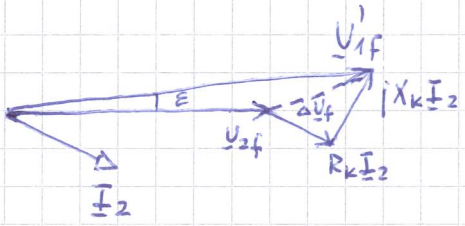
$$X_k = 4{,}28 \ \Omega/\text{fas}$$

b)



$\underline{Z} = 70 + j25 = 74{,}33 \angle 19{,}65^\circ \ \Omega/\text{fas}$

$\underline{U}'_{1f} = \frac{400}{\sqrt{3}} = 230{,}94$ V



c)

$$\underline{I}_2 = \frac{\underline{U}'_{1f}}{R_k + jX_k + \underline{Z}} = \frac{230{,}94\angle 0^\circ}{71 + j29{,}4} = \frac{230{,}94\angle 0^\circ}{76{,}85\angle 22{,}49^\circ} = \underline{3{,}0\angle -22{,}49^\circ \ \text{A}}$$

$$\underline{U}_{2f} = \underline{Z} \cdot \underline{I}_2 = 74{,}33\angle 19{,}65^\circ \cdot 3{,}0\angle -22{,}49^\circ = 223{,}0\angle -2{,}84^\circ \ \text{V}$$

$$\underline{U_2 = 386{,}25 \ \text{V}}$$

d) Förluster:

$$P_{cu} = 3 R_k I_2^2 = 3 \cdot 1 \cdot 3^2 = 27{,}0 \ \text{W} \ ; \ P_0 = 20{,}0 \ \text{W}$$

$$P_2 = \sqrt{3}\, U_2 I_2 \cos\varphi_2 = \sqrt{3} \cdot 386{,}25 \cdot 3 \cdot \cos 19{,}65^\circ = 1890 \ \text{W}$$

$$\eta = \frac{P_2}{P_2 + P_{cu} + P_0} = \frac{1890}{1890 + 27 + 20} = 0{,}9757$$

$$\underline{\eta = 97{,}57\%}$$

4/1

AM : $P_n = 15\,kW$; $U_n = 400\,V$; $f = 50\,Hz$

$I_n = 32\,A$; $n_n = 970\,rpm$; $\cos\varphi = 0{,}81$

Lasten :

70 Nm vid 750 rpm

145 Nm vid 1250 rpm

a) $n = ?$

Lastens momentkaraktäristik kan approximeras med en rät linje

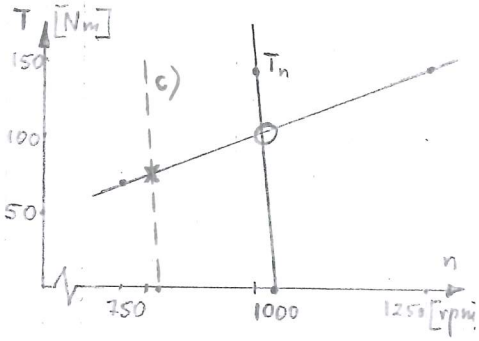
även AM-s momentkaraktäristik mellan tomgång och märkdrift kan approximeras med en rät linje

AM $T_n = \dfrac{P_n}{\omega_n} = \dfrac{15 \cdot 10^3}{\frac{2\pi\,970}{60}} = 147{,}7\,Nm$

vid $n_s = 1000\,rpm$ är $T = 0$

$T_{AM} - 0 = \dfrac{147{,}7 - 0}{970 - 1000}(n - 1000)$

$T_{AM} = 4920 - 4{,}92n$



Lasten

$T_L - 70 = \dfrac{145 - 70}{1250 - 750}(n - 750)$

$T_L = -42{,}5 + 0{,}15n$

Vid drift gäller : $T_{AM} = T_L$

$4920 - 4{,}92n = -42{,}5 + 0{,}15n$

$\underline{n = 978{,}8\,rpm}$

b) $T = ?$

$\underline{T = 4920 - 4{,}92 \cdot 978{,}8 = 104{,}3\,Nm}$

c) d) Lutningen på AM-s momentkurva i båda driftsfall skall vara lika

AM skall skapa vridmoment:

enl. a): $T_L = -42{,}5 + 0{,}15n = -42{,}5 + 0{,}15 \cdot 800 = \underline{\underline{77{,}5\ \text{Nm}}}$

$$\frac{T_b}{n_a - n_{sa}} = \frac{T_d}{n_c - n_{sc}} \Rightarrow \frac{104{,}3}{978{,}8 - 1000} = \frac{77{,}5}{800 - n_{sc}}$$

$n_{sc} = 815{,}75$ rpm $\qquad p = 3$

$$n_{sc} = 60 \cdot \frac{f_c}{p} \Rightarrow \underline{\underline{f_c}} = \frac{p \cdot n_{sc}}{60} = \frac{3 \cdot 815{,}75}{60} = \underline{\underline{40{,}79\ \text{Hz}}}$$

För att AM-s luftgapsflöde skall hållas konstant:

$$\Rightarrow \frac{U}{f} = \text{konst} \qquad \frac{400}{50} = 8 \Rightarrow U_c = 40{,}79 \cdot 8 = \underline{\underline{326{,}3\ \text{V}}}$$

e) $f_r = ?$

$$f_r = s_c \cdot f_c = \frac{815{,}75 - 800}{815{,}75} \cdot 40{,}79 = \underline{\underline{0{,}79\ \text{Hz}}}$$