1.

$U = 400\ V$; $f = 50\ Hz$

Belastning I : Y-kopplad ; $R = 20\ \Omega$; $C = 100\ \mu F$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi \cdot 50 \cdot 100 \cdot 10^{-6}} = 31{,}83\ \Omega/fas$$

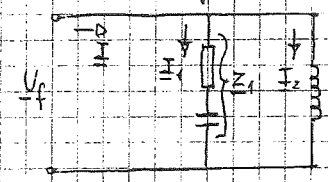
$$\underline{Z}_1 = (20 - j\,31{,}83)\ \Omega/fas$$

Belastning II : Δ-kopplad ; $L = 100\ mH$

$$X_L = \omega L = 2\pi \cdot 50 \cdot 100 \cdot 10^{-3} = 31{,}42\ \Omega$$

$$\underline{Z}_\Delta = j\,31{,}42$$

Ekv. Y-fas:



$$\underline{Z}_2 = \frac{\underline{Z}_\Delta}{3} = j\,10{,}47\ \Omega/fas$$

a)
$$\underline{I}_1 = \frac{\underline{U}_f}{\underline{Z}_1} = \frac{\frac{400}{\sqrt{3}}\angle 0^\circ}{20 - j\,31{,}83} = \frac{\frac{400}{\sqrt{3}}\angle 0^\circ}{37{,}59\angle -57{,}86^\circ} = 6{,}14\angle 57{,}86^\circ = (3{,}27 + j\,5{,}2)\ A$$

$$\underline{I}_2 = \frac{\underline{U}_f}{\underline{Z}_2} = \frac{\frac{400}{\sqrt{3}}\angle 0^\circ}{j\,10{,}47} = 22{,}05\angle -90^\circ\ A$$

$$\underline{I} = \underline{I}_1 + \underline{I}_2 = 3{,}27 + j\,5{,}2 - j\,22{,}05 = 3{,}27 - j\,16{,}85 = 17{,}16\angle -79^\circ\ A$$

$$|I_\Delta| = \frac{|I_2|}{\sqrt{3}} \Rightarrow |I_\Delta| = 12{,}73\ A$$

c) Belastning I – kap. karaktär

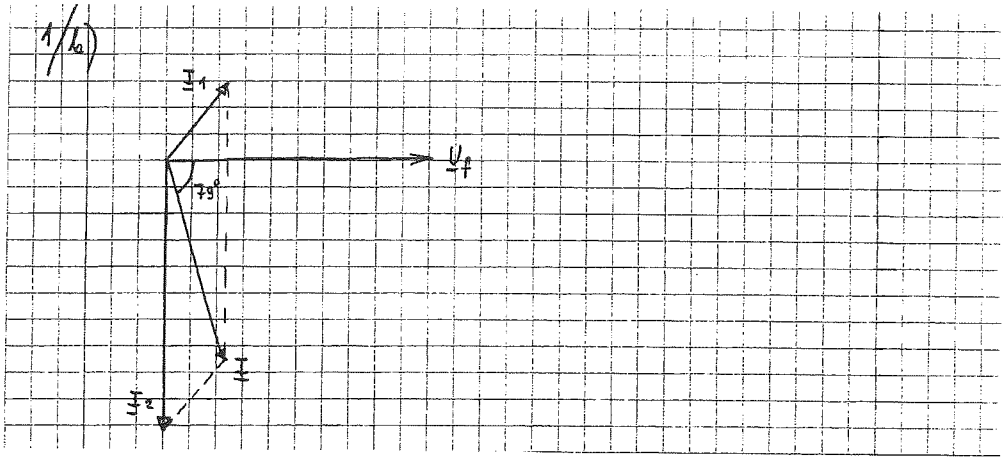
Belastning II – ind. karaktär

Totala lasten – ind karaktär

d)
$$\underline{S} = 3\,\underline{U}_f\,\underline{I}^* = 3 \cdot \frac{400}{\sqrt{3}}\angle 0^\circ \cdot 17{,}16\angle 79^\circ = 11{,}89 \cdot 10^3\angle 79^\circ =$$

$$= (2269 + j\,11672)\ VA$$

1/b)



2 a)

1. Före inkoppling av AM och C:

$U = 400\,V$; $f = 50\,Hz$; $P_i = 140\,kW$; $\cos\varphi_i = 0{,}707$

$\Rightarrow Q_i = 140\,kVAr \Rightarrow S_i = \sqrt{P_i^2 + Q_i^2} = \sqrt{2}\cdot 140\,kVA$

$$I = \frac{S_i}{\sqrt{3}\,U} = \frac{\sqrt{2}\cdot 140\cdot 10^3}{\sqrt{3}\cdot 400} = 285{,}3\,A$$

2. Efter inkoppling av AM och C:

$Q_c = 3\omega C U_f^2$; $U_c = U = 400\,V$; $C = 1\cdot 10^{-3}\,F$

$Q_c = 3\cdot 100\pi\cdot 1\cdot 10^{-3}\cdot 400^2 = 150{,}8\,kVAr$

$P_m = 15\,kW$; $I_m = 28{,}5\,A \Rightarrow S_m = \sqrt{3}\cdot 400\cdot 28{,}5 = 19{,}75\,kVA$

$Q_m = \sqrt{S_m^2 - P_m^2} = 12{,}84\,kVAr$

Från nätet:

$P = P_i + P_m = 140 + 15 = 155\,kW$

$Q = Q_i + Q_m - Q_c = 140 + 12{,}84 - 150{,}8 = 2{,}04\,kVAr$

$$I = \frac{S}{\sqrt{3}\cdot U} = \frac{\sqrt{155^2 + 2{,}04^2}\cdot 10^3}{\sqrt{3}\cdot 400} = 223{,}7\,A$$

$$\cos\varphi = \frac{P}{S} = \frac{155}{155{,}01} \approx 1$$

3. En 3-fas trafo: $S_n = 100\,kVA$; $6{,}6/0{,}4\,kV$

$z_k = 5{,}5\%$, $r_k = 1{,}0\%$

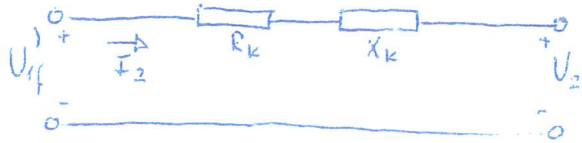
a) $I_2 = 125\,A$; $\cos\varphi_2 = 0{,}8$; $U_1 = 6{,}6\,kV$; $U_2 = ?$

Beräkningar på nedsp sidan:

$$Z_k = z_k Z_{bas} = 0{,}055 \cdot \frac{400^2}{100 \cdot 10^3} = 88 \cdot 10^{-3}\ \Omega/fas$$

$$R_k = r_k Z_{bas} = 0{,}01 \cdot \frac{400^2}{100 \cdot 10^3} = 16 \cdot 10^{-3}\ \Omega/fas$$

$$X_k = \sqrt{Z_k^2 - R_k^2} = 86{,}5 \cdot 10^{-3}\ \Omega/fas$$



$$U_{1f}' = \frac{400}{\sqrt{3}}\ V$$

$$\Delta U = \sqrt{3}\, I_2 (R_k \cos\varphi_2 + X_k \sin\varphi_2) = \sqrt{3} \cdot 125 (16\,10^{-3} \cdot 0{,}8 + 86{,}5 \cdot 10^{-3} \cdot 0{,}6) =$$

$$= 14\,V$$

$$\underline{\underline{U_2 = 400 - 14 = 386\,V}}$$

b) $P_0 = 800\,W$; $\eta = ?$ $\qquad \eta = \frac{P_2}{P_1} = \frac{P_2}{P_2 + P_{cu} + P_0}$

$$P_2 = \sqrt{3} \cdot U_2 \cdot I_2 \cos\varphi_2 = \sqrt{3} \cdot 386 \cdot 125 \cdot 0{,}8 = 66857\,W$$

$$P_{cu} = 3 R_k I_2^2 = 3 \cdot 16\,10^{-3}\, 125^2 = 750\,W$$

$$\eta = \frac{66857}{66857 + 750 + 800} = 0{,}977 \Rightarrow \underline{\underline{\eta = 97{,}7\%}}$$

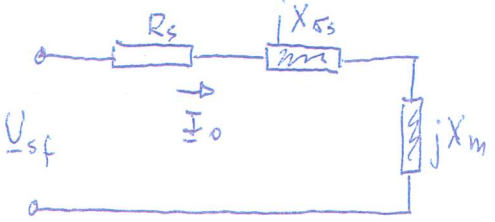
4.

a) Eul. märkdata: $P_n = 2{,}2\ kW$

$P_s = \sqrt{3} \cdot U_n \cdot I_n \cdot \cos\varphi = \sqrt{3} \cdot 400 \cdot 4{,}9 \cdot 0{,}7 = 2376{,}4\ W$

$Q_s = \sqrt{3} \cdot U_n \cdot I_n \cdot \sin\varphi = \sqrt{3} \cdot 400 \cdot 4{,}9 \cdot 0{,}714 = 2424{,}4\ VAr$

b) $Q_0 = ?$ $\quad s = 0 \Rightarrow$ ekv. schemat:



$$\underline{I}_0 = \frac{\underline{U}_{sf}}{R_s + j(X_{\sigma s} + X_m)} = \frac{\frac{400}{\sqrt{3}} \angle 0^\circ}{1{,}1 + j\,67{,}9} =$$

$$= 3{,}4 \angle -89{,}1^\circ\ A$$

$Q_0 = \sqrt{3} \cdot U_n \cdot I_0 \cdot \sin\varphi_0 = \sqrt{3} \cdot 400 \cdot 3{,}4 \cdot \sin 89{,}1^\circ = 2355\ VAr$

$Q_c = Q_0$

c) Vattenpumpen: 12 Nm vid 2500 rpm och 6 Nm vid 1000 rpm

$$T - 6 = \frac{12 - 6}{2500 - 1000}(n - 1000)$$

$T_p = 2 + 0{,}004n$

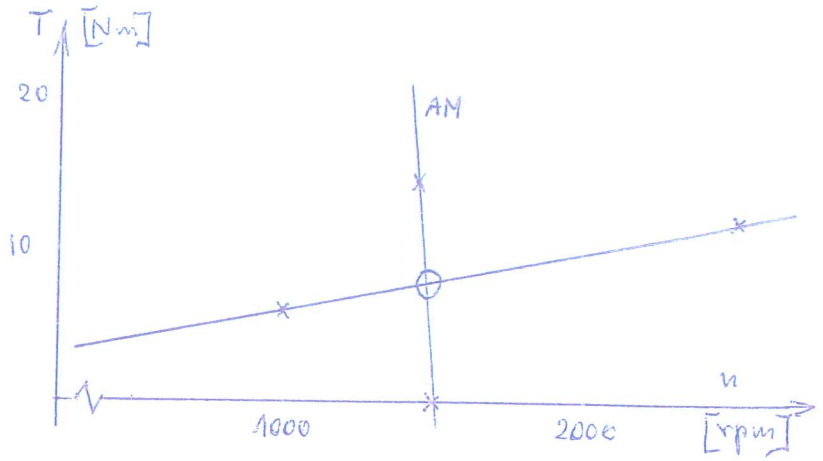
AM: $T_n = \frac{P_n}{\omega_n} = \frac{2200}{\frac{2\pi 1437}{60}} = 14{,}62\ Nm$

0 Nm vid 1500 rpm och 14,62 Nm vid 1437 rpm

$T_{AM} = 348{,}1 - 0{,}232n$

$T_p = T_{AM}$

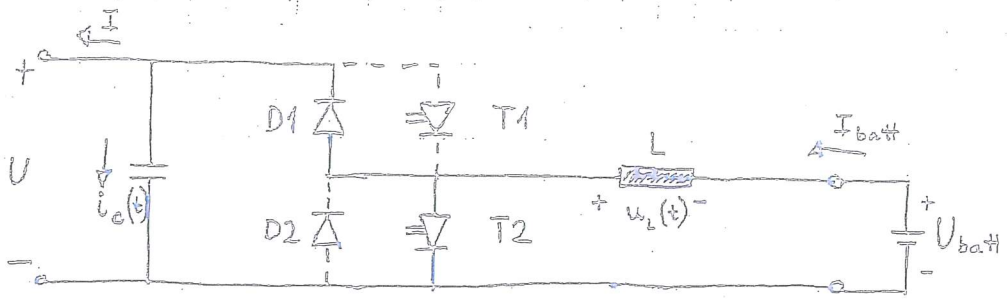
$n = 1466{,}5\ rpm$



6.

$U_{batt} = 96\,V$; $I = 10\,A$; $U = 300\,V$; $T = 0{,}1\,ms$

L och C mycket stora



a) $\frac{t_p}{T} = ?$

$0 \le t < t_p$ D1

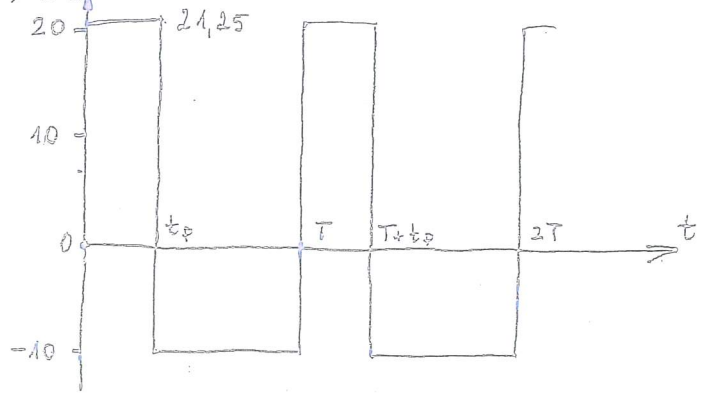
$t_p < t < T$ T2

$U_{batt} = \frac{t_p}{T} U$

$\frac{t_p}{T} = \frac{96}{300} = 0{,}32$

$t_p = 0{,}32 \cdot 0{,}1 = 0{,}032\,ms$

b) $[A]$ $i_c(t)$

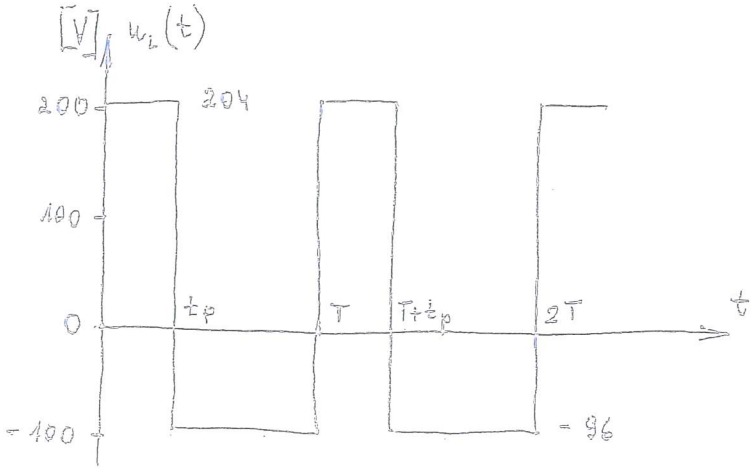


$U_{batt} \cdot I_{batt} = UI$

$I_{batt} = \frac{300}{96} \cdot 10 = 31{,}25\,A$

$i_c(t) = 31{,}25 - 10 = 21{,}25\,A$

$[V]$ $u_L(t)$



$u_L = U - U_{batt} =$

$= 300 - 96 = 204\,V \rightarrow (t_p)$

$u_L = -96\,V \rightarrow (T - t_p)$

7. $I_k = ?$ / $I_s = ?$ vid trefasig kortslutning

$$S_{KT} = \frac{S_n}{z_k} = \frac{63 \cdot 10^6}{0{,}12} = 525\ \text{MVA}$$

$$S_{vänster} = \frac{S_{nät\,v} \cdot S_{KT}}{S_{nät\,v} + S_{KT}} = \frac{5000 \cdot 525}{5525} = 475{,}1\ \text{MVA}$$

S_k på 50 kV sekundär: $S_k = S_{vänster} + S_{höger} = 2475{,}1\ \text{MVA}$

$$I_k = \frac{S_k}{\sqrt{3} \cdot U_k} = \frac{2475{,}1 \cdot 10^6}{\sqrt{3} \cdot 50 \cdot 10^3} = 28{,}58\ \text{kA}$$

$$I_s = 2{,}55 \cdot I_k = 72{,}88\ \text{kA}$$