1.

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

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

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

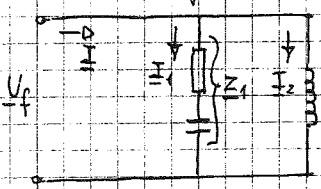
$$\underline{Z}_1 = (20 - j\,31{,}83)\ \Omega/fas$$

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

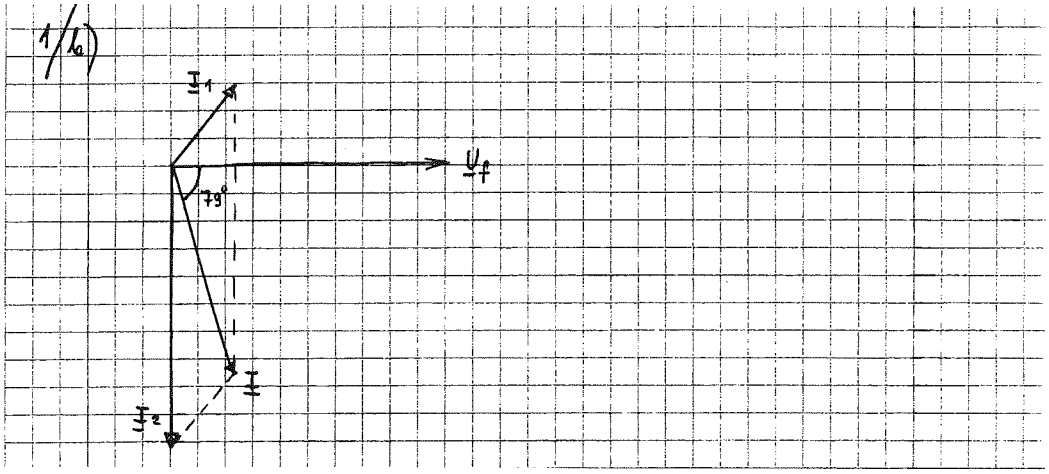
Totala lasten – ind. karaktär

d)

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

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

1/4)



2 a)

1. Före inkoppling av AM och C:

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

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

$$I = \frac{S_i}{\sqrt{3}\,U} = \frac{\sqrt{2} \cdot 140 \cdot 10^3}{\sqrt{3} \cdot 400} = 285{,}8\,A$$

2. Efter inkoppling av AM och C:

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

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

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

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

Från nätet:

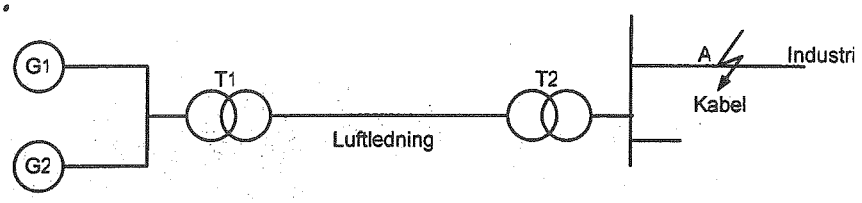
$P = P_i + P_m = 140 + 15 = 155\,kW$

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

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

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

4.



a) Imp.sum.metoden: $U_e = 20\,kV$

Gen 1 och Gen 2 $\Rightarrow X_d = x_d \frac{U_e^2}{S_n} = 0{,}2 \frac{20^2}{25} = 3{,}2\ \Omega/fas$

$\Rightarrow X_G = \frac{X_d}{2} = 1{,}6\ \Omega/fas$

Trafo T1:

$R_{T1} = r_k \frac{U_e^2}{S_n} = 0{,}02 \frac{20^2}{50} = 0{,}16\ \Omega/fas$

$Z_{T1} = z_k \frac{U_e^2}{S_n} = 0{,}12 \frac{20^2}{50} = 0{,}96\ \Omega/fas$

$X_{T1} = \sqrt{Z_{T1}^2 - R_{T1}^2} = 0{,}947\ \Omega/fas$

Trafo T2:

$R_{T2} = 0{,}01 \frac{20^2}{50} = 0{,}08\ \Omega/fas$

$Z_{T2} = 0{,}1 \frac{20^2}{50} = 0{,}8\ \Omega/fas$

$X_{T2} = 0{,}796\ \Omega/fas$

Luftledning 130 kV: 40 km $R_L = 0{,}15 \cdot 40 \cdot \left(\frac{20}{130}\right)^2 = 0{,}142\ \Omega/fas$

$X_L = 0{,}4 \cdot 40 \left(\frac{20}{130}\right)^2 = 0{,}379\ \Omega/fas$

Kabel 20 kV: 1 km $R_K = 0{,}05\ \Omega/fas$; $X_K = 0{,}1\ \Omega/fas$

$\sum R = 0{,}16 + 0{,}08 + 0{,}142 + 0{,}05 = 0{,}432\ \Omega/fas$

$\sum X = 1{,}6 + 0{,}947 + 0{,}796 + 0{,}379 + 0{,}1 = 3{,}82\ \Omega/fas$

$Z = \sqrt{R^2 + X^2} = 3{,}846\ \Omega/fas$

$I_k = \frac{U_f}{Z} = \frac{20 \cdot 10^3}{\sqrt{3} \cdot 3{,}846} = 3002\ A$

46)

$I = 650\ A \quad ; \quad \cos\varphi = 0{,}8$

T2 $R_k = 0{,}08\ \Omega/\text{fas}$ } hänförda
$X_k = 0{,}796\ \Omega/\text{fas}$ } till 20 kV-sidan

$\Delta U = \sqrt{3}\, I \left(R_k \cos\varphi + X_2 \sin\varphi\right) =$

$= \sqrt{3} \cdot 650 \left(0{,}08 \cdot 0{,}8 + 0{,}796 \cdot 0{,}6\right) = 609{,}75\ V$

$U_2 = 20000 - 609{,}75 = 19390{,}25\ V$

6.

3-fas AM: 150 kW ; 3,3 kV ; 36 A ; $\cos\varphi = 0{,}8$

965 rpm ; 50 Hz ; $R_s = 1{,}5\ \Omega$/fas

$P_{sstart} = 345$ kW ; $I_{sstart} = 200$ A

a) $T_{start} = ?$

Vid start gäller $s = 1$

P_M och P_{Fes} kan försummas $\Rightarrow$

$P_m = P = 0 \Rightarrow P_s = P_\delta + P_{cus}$

$P_{cus} = 3 R_s I_{sstart}^2 = 3 \cdot 1{,}5 \cdot 200^2 = 180$ kW

$P_\delta = P_{sstart} - P_{cus} = 345 - 180 = 165$ kW

$$T_{start} = \frac{P_\delta}{\omega_s} = \frac{165 \cdot 10^3}{\frac{2\pi \cdot 1000}{60}} = 1575{,}6 \text{ Nm}$$

b) $T_n = ?$

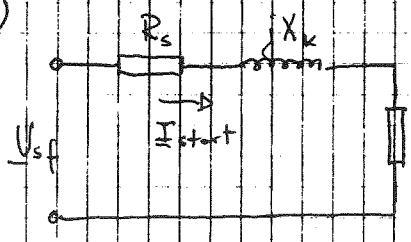
$$T_n = \frac{P_n}{\omega_n} = \frac{150 \cdot 10^3}{\frac{2\pi \cdot 965}{60}} = 1484{,}3 \text{ Nm}$$

$$\frac{T_{start}}{T_n} = \frac{1575{,}6}{1484{,}3} = 1{,}06$$

c) $P_{cusn} = 3 \cdot 1{,}5 \cdot 36^2 = 5832$ W

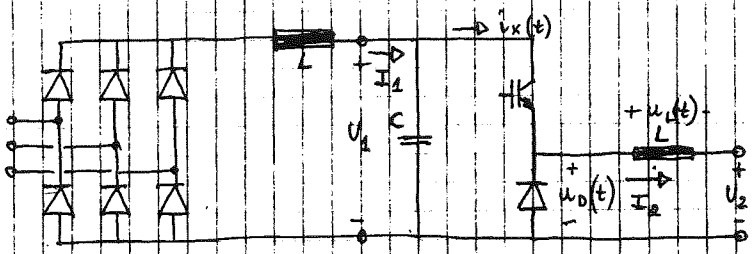
$$\frac{P_{cusstart}}{P_{cusn}} = \frac{180000}{5832} = 30{,}86 \text{ ggr}$$

d)



8

a)



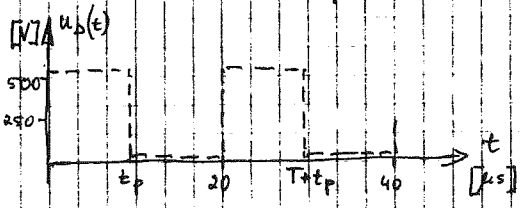
3-fas diodlikriktare 4S-omvriktaren

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

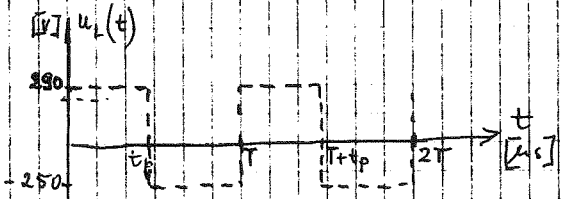
$f = 50\,kHz \qquad U_2 = 250\,V\,;\; I_2 = 10\,A$

b) $\frac{U_2}{U_1} = \frac{t_p}{T} \qquad T = \frac{1}{f} = 20\cdot10^{-6}\,s\,;\; t_p = \frac{U_2}{U_1}T = \frac{250}{540}\cdot 20\cdot10^{-6} = 9{,}26\,\mu s$

$u_D(t) = ?$



c) $u_L(t) = ?$



d) $U_1 I_1 = U_2 I_2$

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