8.0 FLERFASET VEKSELSTRØM
8.1 TREFASET VEKSELSTRØM I SYMMETRI

8.1.1

a) Stjernekopling
$U = 230V, 50Hz$
$I = 10A$

$I_f = I = \underline{10A}$

$U_f = \frac{U}{\sqrt{3}} = \frac{230V}{\sqrt{3}} = \underline{132,8V}$

b)

$P = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi = \sqrt{3} \cdot 230V \cdot 10A \cdot \cos 0° = \underline{3984W}$

8.1.2

a) Trekantkopling
$U = 400V, 50Hz$
$I = 5A$

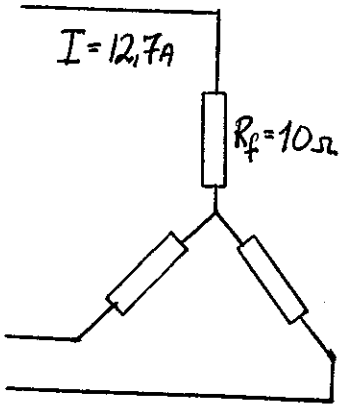
$I_f = \frac{I}{\sqrt{3}} = \frac{5A}{\sqrt{3}} = \underline{2,89A}$

$U_f = U = \underline{400V}$

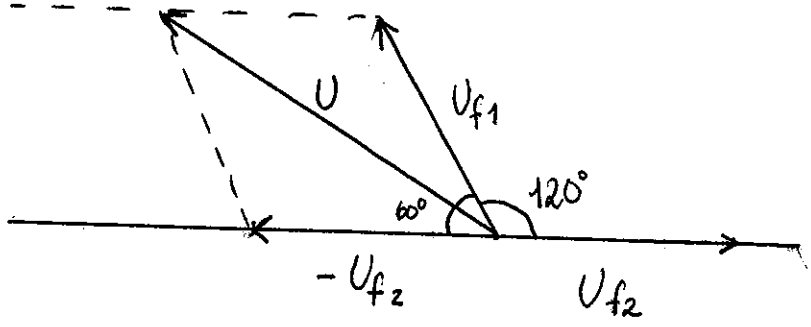
b)

$P = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi = \sqrt{3} \cdot 400V \cdot 5A = \underline{3464W}$

8.1.4



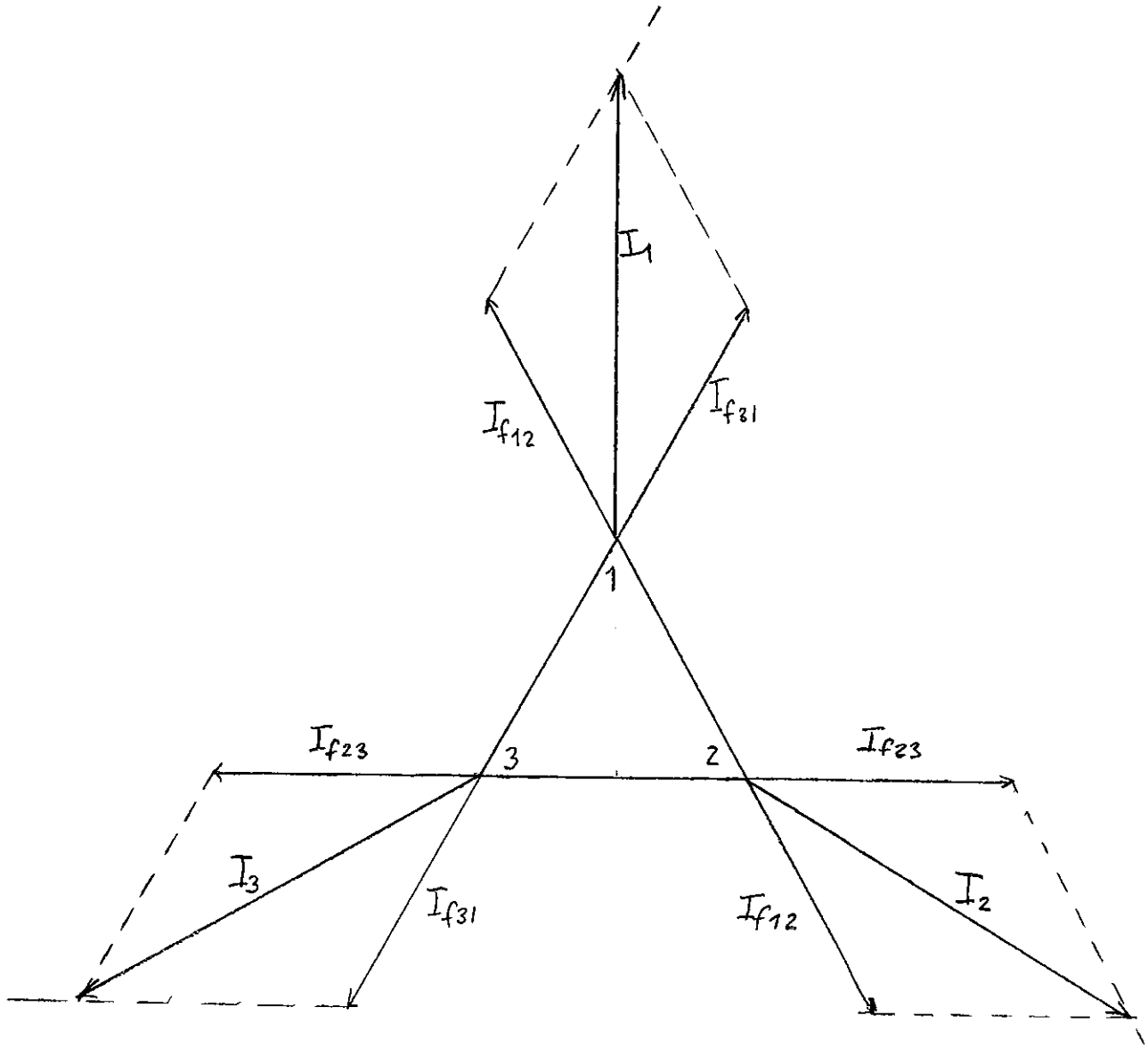
a) $U_f = I_f \cdot R_f = 12,7A \cdot 10\Omega = \underline{127V}$



b) $U = U_f \cdot \sqrt{3} = 127V \cdot \sqrt{3} = \underline{220V}$

8.1.5

a) $I_f = \frac{U_f}{R_f} = \frac{400V}{20\Omega} = \underline{20A}$



b) $I_1 = I_f \cdot \sqrt{3} = 20A \cdot \sqrt{3} = \underline{\underline{34,64A}}$

8.1.6

$U = 240\,V,\ 50\,Hz$
$\cos\varphi = 0{,}85$
$I = 7\,A$
Stjernekopling

a) $U_f = \frac{U}{\sqrt{3}} = \frac{240\,V}{\sqrt{3}} = \underline{\underline{138{,}6\,V}}$

b) $S = \sqrt{3} \cdot U \cdot I = \sqrt{3} \cdot 240\,V \cdot 7\,A = \underline{\underline{2910\,VA}}$

$P = S \cdot \cos\varphi = 2910\,VA \cdot 0{,}85 = \underline{\underline{2473\,W}}$

$Q = \sqrt{S^2 - P^2} = \sqrt{2910\,VA^2 - 2473\,W^2} = \underline{\underline{1533\,VAr}}$

c) Stjernekopling:

$Z_f = \frac{U_f}{I_f} = \frac{138{,}6\,V}{7\,A} = \underline{\underline{19{,}8\,\Omega}}$

Trekantkopling:

$U_f = U_H = \underline{\underline{240\,V}}$

$I_f = \frac{U_f}{Z_f} = \frac{240\,V}{19{,}8\,\Omega} = \underline{\underline{12{,}12\,A}}$

d) $I = I_f \cdot \sqrt{3} = 12{,}12\,A \cdot \sqrt{3} = \underline{\underline{21{,}0\,A}}$

$S = \sqrt{3} \cdot U \cdot I = \sqrt{3} \cdot 240\,V \cdot 21{,}0\,A = \underline{\underline{8729{,}5\,VA}}$

$P = S \cdot \cos\varphi = 8729{,}5\,VA \cdot 0{,}85 = \underline{\underline{7420{,}1\,W}}$

$Q = \sqrt{S^2 - P^2} = \sqrt{8729{,}5\,VA^2 - 7420{,}1\,W^2} = \underline{\underline{4598{,}5\,VAr}}$

e)

$\frac{S_\Delta}{S_Y} = \frac{8729{,}5\,VA}{2910{,}0\,VA} = 3$ $\qquad$ $\frac{I_\Delta}{I_Y} = \frac{21{,}0\,A}{7{,}0\,A} = 3$

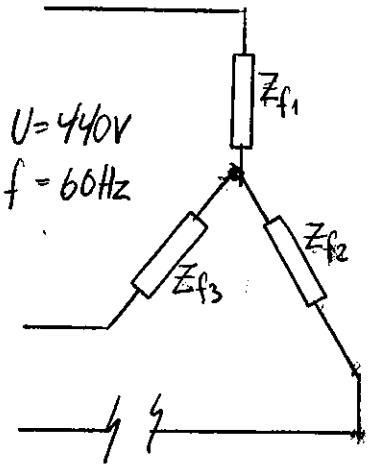
Effektene og Hovedstrømmen er tre ganger så stor i trekant som i stjerne.

8.1.7

a) $S = \sqrt{3} \cdot U \cdot I = \sqrt{3} \cdot 440V \cdot 7A = \underline{5334,7VA}$

$P = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi = \sqrt{3} \cdot 440V \cdot 7A \cdot 0,7 = \underline{3734,3W}$

$Q = \sqrt{S^2 - P^2} = \sqrt{5334,7VA^2 - 3734,3W^2} = \underline{3809,7VAr}$



b) Hel stjernekopling:

$Z_f = \frac{U_f}{I_f} = \frac{\frac{U}{\sqrt{3}}}{I_f} = \frac{\frac{440V}{\sqrt{3}}}{12A} = \underline{21,17\Omega}$

$I = \frac{U}{Z_{f1} + Z_{f2}} = \frac{440V}{21,17\Omega + 21,17\Omega} = \underline{10,3A}$

$S = U \cdot I = 440V \cdot 10,3A = \underline{4572,6VA}$

$P = U \cdot I \cdot \cos\varphi = 440V \cdot 10,3A \cdot 0,7 = \underline{3200,8W}$

$Q = \sqrt{S^2 - P^2} = \sqrt{4572,6VA^2 - 3200,8W^2} = \underline{3265,5VAr}$

c) Trekant

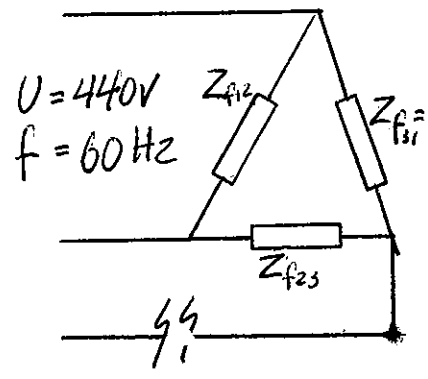
$I_f = \frac{U_f}{Z_f} = \frac{440V}{21,17\Omega} = \underline{20,78A}$ $I = I_f \cdot \sqrt{3} = 20,78A \cdot \sqrt{3} = \underline{36,0A}$

$S = \sqrt{3} \cdot U \cdot I = \sqrt{3} \cdot 440V \cdot 36,0A = \underline{27,44kVA}$

$P = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi = \sqrt{3} \cdot 440V \cdot 36,0A \cdot 0,7 = \underline{19,21kW}$

$Q = \sqrt{S^2 - P^2} = \sqrt{27,44 \cdot 10^3 VA^2 - 19,21 \cdot 10^3 W^2} = \underline{19,59kVAr}$

d)



$\frac{1}{Z} = \frac{1}{Z_{f12}} + \frac{1}{Z_{f23} + Z_{f31}} =$

$= \frac{1}{21,17\Omega} + \frac{1}{21,17\Omega + 21,17\Omega}$ $Z = \underline{14,1\Omega}$

$I = \frac{U}{Z} = \frac{440V}{14,1\Omega} = \underline{31,18A}$

$S = U \cdot I = 440V \cdot 31,18A = \underline{13,72kVA}$

$P = U \cdot I \cdot \cos\varphi = 440V \cdot 31,18A \cdot 0,7 = \underline{9,60kW}$

$Q = \sqrt{S^2 - P^2} = \sqrt{13,72 \cdot 10^3 VA^2 - 9,60 \cdot 10^3 W^2} = \underline{9,80kVAr}$

8.1.8

STJERNEKOPLING:

a) $S = \sqrt{3} \cdot U \cdot I = \sqrt{3} \cdot 200V \cdot 12A = \underline{4157\,VA}$ $\quad \cos\varphi = 0{,}85 \Rightarrow \angle\varphi = 31{,}79°$

$\bar{S} = S\angle\varphi = 4157VA\angle 31{,}79° = \underline{3533W + j2190VAr}$

b) $Z_f = \frac{U_f}{I_f} = \frac{\frac{U}{\sqrt{3}}}{I_f} = \frac{\frac{200V}{\sqrt{3}}}{12A} = \underline{9{,}62\,\Omega}$

$I = \frac{U}{Z_f + Z_f} = \frac{200V}{9{,}62\Omega + 9{,}62\Omega} = \underline{10{,}39\,A}$

c) TREKANTKOPLING:

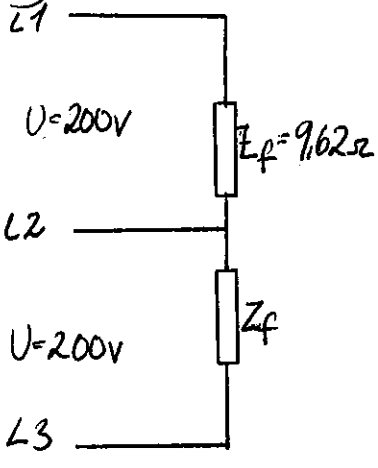
$I_f = \frac{U_f}{f} = \frac{200V}{9{,}62\Omega} = \underline{20{,}78A}$

$I = I_f \cdot \sqrt{3} = 20{,}78A \cdot \sqrt{3} = \underline{36A}$

$S = \sqrt{3} \cdot U \cdot I = \sqrt{3} \cdot 200V \cdot 36A = \underline{12470{,}8VA}$

$\bar{S} = S\angle\varphi = 12470{,}8VA\angle 31{,}79° = \underline{10560W + j6570VAr}$

d)



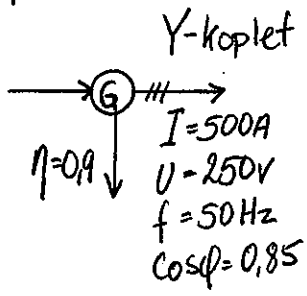
strømmen i fasene L1 og L3:

$I_f = \frac{U_f}{Z_f} = \frac{200V}{9{,}62\Omega} = \underline{20{,}79A}$

strømmen i fasen L2

$I_f = I_f \cdot 2 = \underline{41{,}58A}$

8.1.9



a) $U_f = \frac{U}{\sqrt{3}} = \frac{250V}{\sqrt{3}} = 144{,}3V$

b) $S = \sqrt{3} \cdot U \cdot I = \sqrt{3} \cdot 250V \cdot 500A = 216{,}5\,kVA$

c) $\cos\varphi = 0{,}85 \Rightarrow \angle\varphi = 31{,}79°$

$\underline{S} = S \angle\varphi = 216{,}5 \cdot 10^3 VA \angle 31{,}79° = 184{,}0\,kW + j\,114{,}0\,kVAr$

d) $P_{tilf} = P_{avg} + \Delta P = 184{,}0 \cdot 10^3 W + 12{,}0 \cdot 10^3 W = 196{,}0\,kW$

$\eta = \frac{P_{avg}}{P_{tilf}} = \frac{184{,}0 \cdot 10^3 W}{196{,}0 \cdot 10^3 W} = 0{,}939$