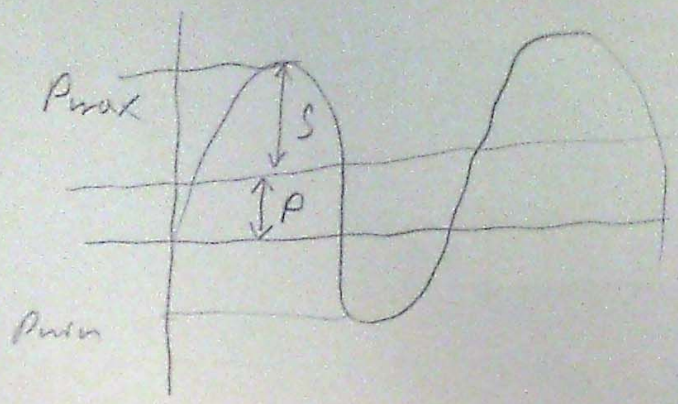
IX. 1-2

$P_{max} = 1600\,VA$

$P_{min} = -400\,VA$

$Q = ?$

$\cos\varphi = ?$



$$P = \frac{P_{min} + P_{max}}{2} = \frac{1200}{2} = 600\,W$$

$$S = 1600 - 600 = 1000\,VA$$

$$Q = \sqrt{1000^2 - 600^2} = 800\,VAr$$

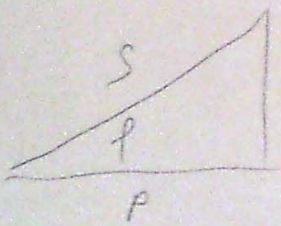
$$\cos\varphi = \frac{P}{S} = \frac{600}{1000} = 0.6$$

IX. 1-4 S se ne zbraja po elementima kao Q i P. Rješava se preko trokuta snage

$S_1 = 250\,VA$, $\cos\varphi_1 = 0,5\ (ind)$

$P_2 = 180\,W$, $\cos\varphi_2 = 0,8\ (kap)$

$S_3 = 300\,VA$, $Q_3 = 100\,VAr$



$\cos\varphi = \frac{P}{S}$

$P_3 = \sqrt{300^2 - 100^2} = 282,8\,W$

$P_1 = \cos\varphi_1 \cdot S_1 = 125\,W$

$Q_1 = \sqrt{250^2 - 125^2} = 216,5\,VAr$

$S_2 = \frac{P_2}{\cos\varphi_2} = 225\,VA$

$Q_2 = \sqrt{225^2 - 180^2} = 135\,VAr$

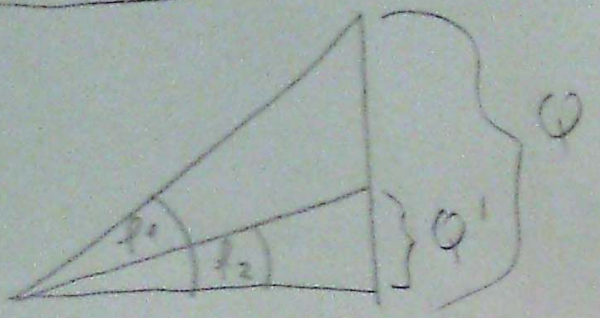
$= -135$ (jer je $\cos\varphi$ kap)

$P_{uk} = 125 + 180 + 282,8 = 588\,W$

$Q_{uk} = 216,5 - 135 + 100 = 182\,VAr$

$S_{uk} = \sqrt{588^2 + 182^2} = 615,52\,VA$

IX. 1-3



$Q_k = Q - Q'$

$U_n = 220\,V$

$I_n = 4.5\,A$

$\cos\varphi_1 = 0.866$

$\cos\varphi_2 = 0.95$

→ maksimalno opterećenje

$S = U_n \cdot I_n = 990\,VA$

→ radna snaga, jalova pri φ_1

$\cos\varphi_1 = \frac{P}{S} \Rightarrow P = 857.34$

$Q = \sqrt{990^2 - 857.34^2} = 495.04\,VAr$

→ radna, jalova pri φ_2

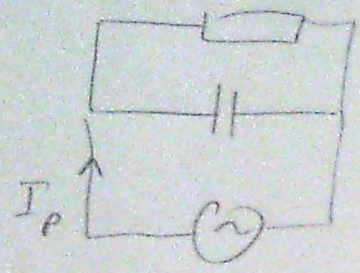
$\cos\varphi_2 = \frac{P'}{S} \Rightarrow P' = 990 \cdot 0.95 = 940.5$

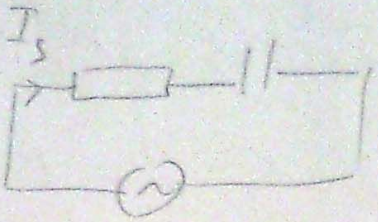
$Q' = \sqrt{990^2 - 940.5^2} = 309.127\,VAr$

$Q_r = 495.04 - 309.127 = 185.91\,VAr$

$C = \frac{Q_r}{\omega \cdot U^2} = \frac{185.91}{100\pi \cdot 220^2} = 12.2\,\mu F$

IX. 1-5





$\cos\varphi = 0.5$

$\cos\varphi' = ?$

$$Z_p = \frac{R-(-jX_c)}{R-jX_c} \cdot \frac{R+jX_c}{R+jX_c} = \frac{-R^2X_cj + RX_c^2}{R^2+X_c^2}$$

$$S_p = I_p^2 \cdot Z_p = I_p^2 \cdot \frac{RX_c^2}{R^2+X_c^2} - I_p^2 \cdot \frac{R^2X_c}{R^2+X_c^2} \cdot j = P + Qj$$

$\downarrow P$

$$\cos\varphi = \frac{P}{S}$$

$$\frac{1}{2} = 0{,}5 = \frac{I_p^2 \cdot \frac{RX_c^2}{R^2+X_c^2}}{|S_p|} = \frac{I_p^2 \cdot \frac{RX_c^2}{R^2+X_c^2}}{\sqrt{I_p^4 \cdot \frac{R^2X_c^4}{(R^2+X_c^2)^2} + I_p^4 \cdot \frac{R^4X_c^2}{(R^2+X_c^2)^2}}}^2$$

$$\frac{1}{4} = \frac{I_p^4 \cdot \frac{R^2X_c^4}{(R^2+X_c^2)^2}}{\frac{I_p^4R^2X_c^2(X_c^2+R^2)}{(R^2+X_c^2)^2}} = \frac{X_c^2}{X_c^2+R^2} \Rightarrow X_c^2+R^2 = 4X_c^2$$

$$3X_c^2 = R^2$$

$$Z_s = R - jX_c$$

$$S_s = I_s^2 \cdot Z_s = I_s^2 \cdot (R - jX_c)$$

$$= (I_s^2 \cdot R) - I_s^2 \cdot X_c \cdot j = P + Qj$$

$\downarrow P$

$$\cos\varphi' = \frac{P}{|S_s|} = \frac{I_s^2 \cdot R}{\sqrt{I_s^4 \cdot R^2 + I_s^4 \cdot X_c^2}} \Big/^2$$

$$\cos^2\varphi' = \frac{I_s^4 \cdot R^2}{I_s^4 (R^2 + X_c^2)} \Rightarrow \frac{R^2}{X_c^2 + R^2}$$

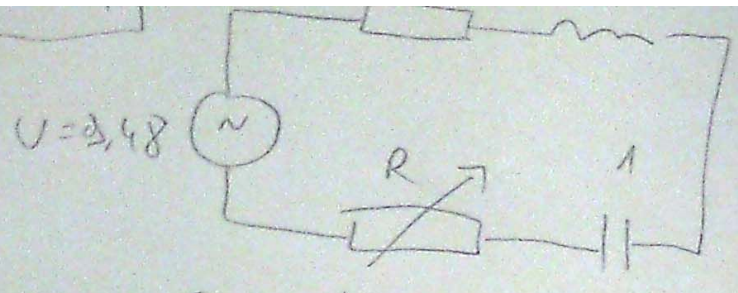
Sada vidimo da smo dobili isti izraz kao za $\cos\varphi$, samo što u brojniku imamo R^2 umjesto X_c^2. Zato izbacujemo odnos:

$3X_c^2 = R^2$ $\quad \Rightarrow \frac{1}{4}$ (iz prošlog izraza)

$$\cos^2\varphi' = \frac{3X_c^2}{X_c^2 + R^2} = 3 \cdot \frac{1}{4} \Big/ \sqrt{\ }$$

$$\cos\varphi' = \frac{\sqrt{3}}{2} = 0{,}5 \cdot \sqrt{3}$$

NAPOMENA - nisam pisao induktivne otpornike i kapacitete ; radnim snagama, no očito je da se rješiti u serijskom i paralelnom spoju



$P_{RMAX} = ?$ Ako se samo R može mijenjati,
$R = ?$ tada je (primjer IX. 1 - P7)

$$R = \sqrt{R_x^2 + (X_L - X_C)^2} = \sqrt{16 + 9}$$

$$= \boxed{5\ \Omega}$$

$$Z = 4 + 4j + 5 - j = 9 + 3j$$

$$\underline{I} = \frac{9,48}{9 + 3j} = \frac{237}{250} - \frac{79}{250}j$$

$$P_{RMAX} = \underline{I}^2 \cdot R = \left(\frac{237}{250} - \frac{79}{250}j\right)^2 \cdot 5 = \underline{4,99\ \angle -36\ W}$$

IX. 1-8

$P = 30\ W \quad U = 220\ V \quad I = 300\ mA \quad f = 50\ Hz$

$$P = U \cdot I \cdot \cos\varphi$$

$$\cos\varphi = \frac{P}{U \cdot I} = \frac{30}{220 \cdot 300 \cdot 10^{-3}} = 0,4545 \Rightarrow \boxed{\varphi = 63^\circ}$$

$$S = \underline{I}^2 \cdot Z = \underline{I}^2 \cdot (R + jX_L) = P + Qj$$

$$= R \cdot I^2 + X_L \cdot I^2 j$$

$$P = R \cdot \underline{I}^2$$

$$30 = R \cdot (300 \cdot 10^{-3})^2$$

$$R = \boxed{333,3\ \Omega}$$

$$U^2 = U_R^2 + U_L^2$$

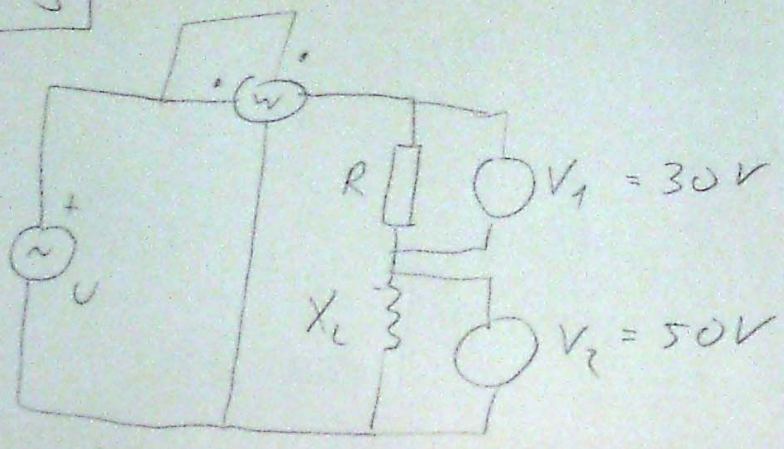
$$X_L = \sqrt{\frac{220^2 - I^2 \cdot R^2}{I^2}}$$

$$X_L = 653,2\ \Omega$$

$$X_L = \omega L = 100\pi \cdot L$$

$$L = \frac{653,2}{100\pi} = \boxed{2,07\ H}$$

IX. 1-9



$P_w = 30W$

$U = 30 + 50j = \boxed{58.3 \angle 59\ V}$

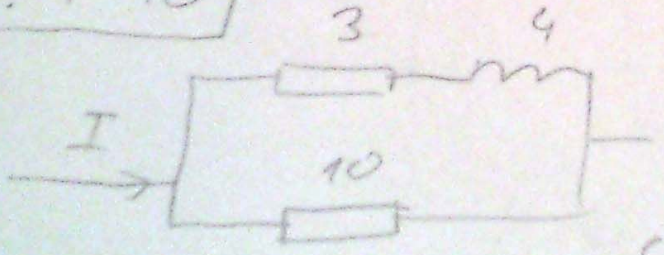
$P_w = \frac{U_{V1}^2}{R} \Rightarrow 30 = \frac{900}{R} \Rightarrow \boxed{R = 30\ \Omega}$

$I = \frac{U_{V1}}{R} = \frac{30}{30} = 1A$

$P_w = U \cdot I \cdot \cos\varphi$

$\cos\varphi = \frac{P_w}{U \cdot I} = \frac{30}{(30+50j)\cdot 1} = \boxed{0.514}$

X. 1-10



$Z = \frac{110}{37} + \frac{220}{37}j$

$P = 1100$

$S = I^2 \cdot Z$

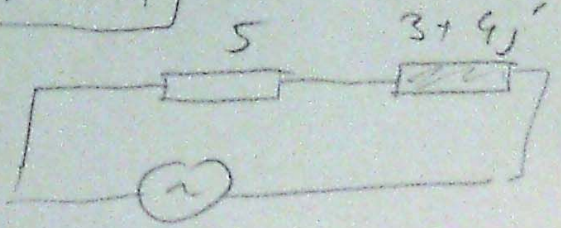
$= I^2 \cdot \frac{110}{37} + I^2 \cdot \frac{220}{37}j = P + Qj$

$P = I^2 \cdot \frac{110}{37}$

$1100 = I^2 \cdot \frac{110}{37}$

$\boxed{I = 19.24\ A}$

IX. 1-11



$Q = 100\ VAr$

$P = ?$

$$S = I^2 \cdot Z_{uk} = I^2 \cdot (5 + 3 + 4j)$$

$$= 8 \cdot I^2 + 4 I^2 j = P + Q j$$

$P = 8 I^2$

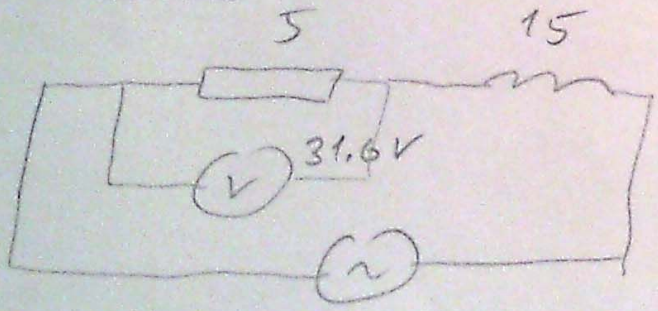
$P = 8 \cdot 5^2 = 200W$

$Q = 4 I^2$

$100 = 4 I^2$

$I = 5\ A$

IX. 1-12



$S = ?$

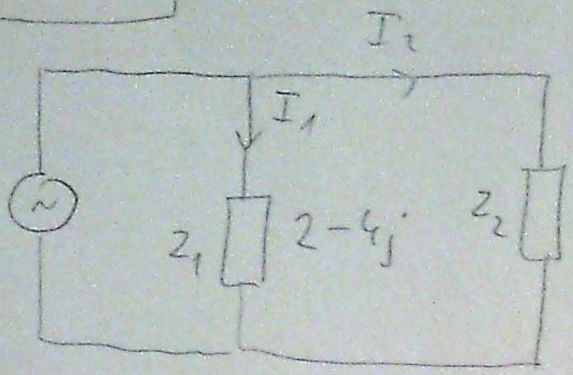
$S = I^2 \cdot Z$

$= 39.942 \cdot (5 + 15j)$

$= 199.712 + 599.136j\ VA$

$I = \frac{31.6}{5} = 6.32\ A$

IX. 1-13



Obje impedancije imaju isti ef. vrijednost otpora pa su i struje jednake.

$I_1 = I_2$

$P_{Z_2} = 20W$

$P, Q, S = ?$

$S_{Z_2} = I_2^2 \cdot Z_2$

$= 4 \cdot I_2^2 + 2 \cdot I_2^2 j = P + Qj$

$P_{Z_2} = 4 I_2^2$

$20 = 4 I_2^2$

$I_2 = \sqrt{5} = I_1$

$Q_{Z_2} = 2 \cdot I_2^2$

$Q_{Z_2} = 2 \cdot 5 = 10 VAr$

$S_{Z_1} = I_1^2 \cdot Z_1$

$= 10 - 20j$

$P_{Z_1} = 10W$

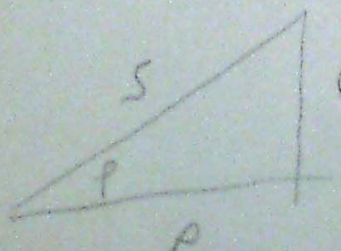
$Q_{Z_1} = -20 VAr$

$P_{uk} = P_{Z_1} + P_{Z_2} = 10 + 20 = 30W$

$Q_{uk} = Q_{Z_1} + Q_{Z_2} = -20 + 10 = -10 VAr = 10 VAr (kap)$

$S_{uk} = \sqrt{P_{uk}^2 + Q_{uk}^2} = \sqrt{1000} = 31.6 VA$

S se ne smije zbrajati po elementima, nego se dobiva iz trokuta snage

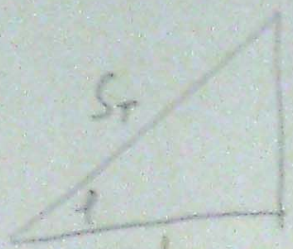


IX. 1-14

$S_n = 25\,kVA$

$P_T = 12\,kW$

$\cos\varphi = 0.6$



$\Rightarrow Q_T = \sqrt{S_T^2 - P_T^2}$

$= \sqrt{20k^2 - 12k^2}$

$= 16\,kVAr$

$\cos\varphi = \frac{12k}{S_T}$

$S_T = 20\,kVA$

a) opterećenost?

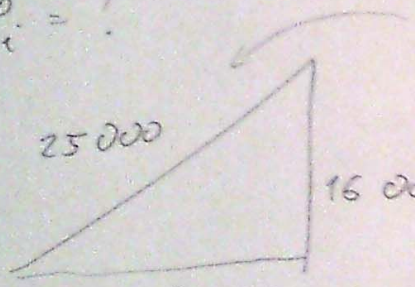
$\frac{S_T}{S_n} = \frac{20k}{25k} = 0.8 = 80\,\%$

b) Za ovo nisam siguran i ne znam objašnjenje, no rezultat je tu.
Dodatna radna snaga do full opterećenja?

$P_i = ?$

S treba biti 25k kako bi bila ista kao i nazivna

Ne znam zašto Q ostaje isti, vjerojatno zato što ne mijenjamo trošilo



$25k^2 = (12k + P_i)^2 + 16k^2$

$625k = 144k + 24k P_i + P_i^2 + 256k$

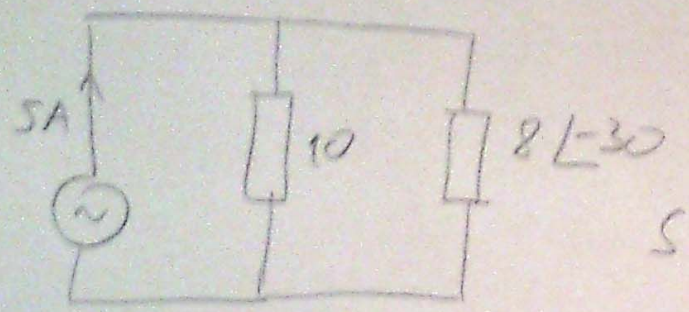
$P_i^2 + 24k P_i - 225k = 0$

$P_{i_1} = 7.2\,kW$

$P_{i_2} = -31.8\,kW$

Mislim da je $P > 0$

IX. 1 - 15



$P = ?$

$Q = ?$

$P_R = ?$

$Q_Z = ?$

$Z = 8\angle -30 = 4\sqrt{3} - 4j$

$Z_{ek} = 4.40508 - 1.322j$

$S = P + Qj = I^2 \cdot Z_{ek}$

$= 110.127 - 33.0508j$

$P = 110.127\ W$

$Q = -33.058\ VAr$

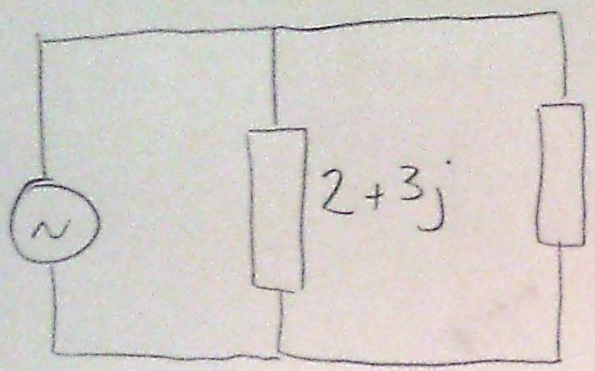
$= 33.058\ VAr$ (kap.)

$U = I \cdot Z_{ek} = 22.0254 - 6.61j$

$P_R = \frac{U^2}{10} = 52.88\angle -33\ W$

$Q_Z = \frac{U^2}{8\angle -30} = 66.101\angle -3.4\ VAr$

IX. 1-16



$$Z = \frac{129}{106} + \frac{213}{106} j$$

$P = 1500\ W$

$Q = ?$

$\cos\varphi = ?$

$$S = P + Qj = I^2 \cdot Z$$

$$= \underbrace{I^2 \cdot \frac{129}{106}}_{P} + \underbrace{I^2 \cdot \frac{213}{106}}_{Q} j =$$

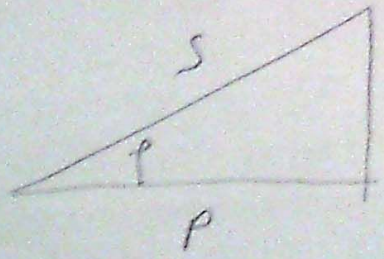
$$1500 = I^2 \cdot \frac{129}{106}$$

$$I = \sqrt{\frac{1500 \cdot 106}{129}} = 35.1098\ A$$

$$Q = 35.1098^2 \cdot \frac{213}{106}$$

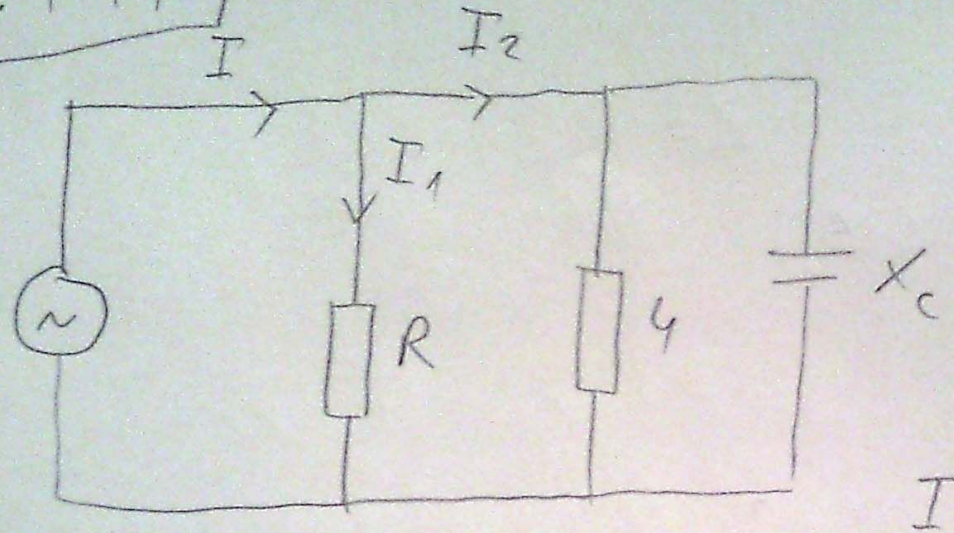
$$= 2476.743\ VAr$$

$$S = 2895.558 \angle 58.8$$



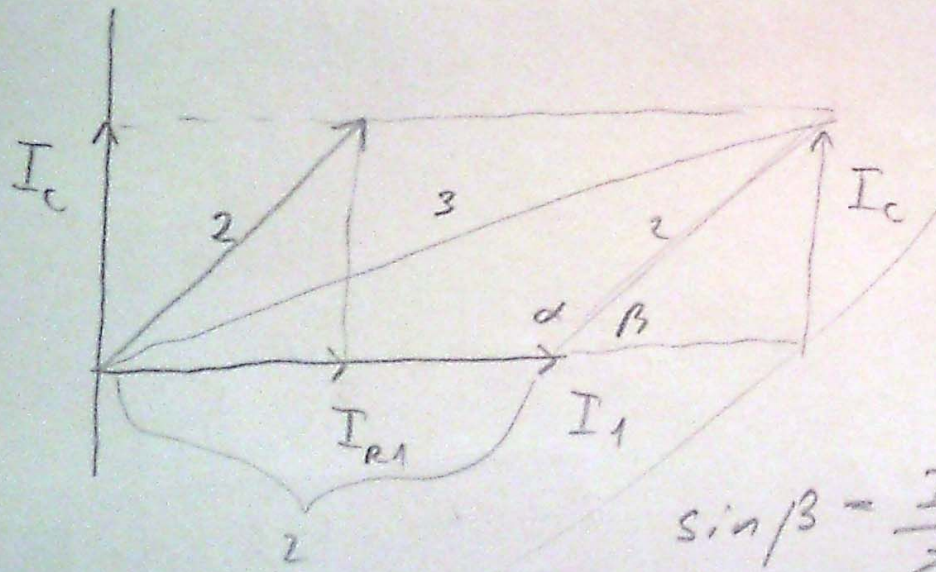
$$\cos\varphi = \frac{P}{S} = \frac{1500}{2895.558} = 0.518$$

IX. 1-17



$I = 3A$

$I_1 = 2A \quad I_2 = 2A$



$I_{R_1} = \sqrt{4 - I_c^2}$

$= 0,2501\ A$

$9 = 4 + 4 - 8\cos\alpha$

$\alpha = 97.18073°$

$\beta = 82.81925°$

$\sin\beta = \frac{I_c}{2} \quad I_c = 1.9843A$

$U = 0.2501 \cdot 4 = 1.0004\ V$

$X_c = \frac{U}{I_c} = \frac{1.0004}{1.9843} = 0.50416\ \Omega$

$Q = \frac{U^2}{X_c} = \frac{1.0004^2}{0.50416}$

$= 1.99\ VAr$