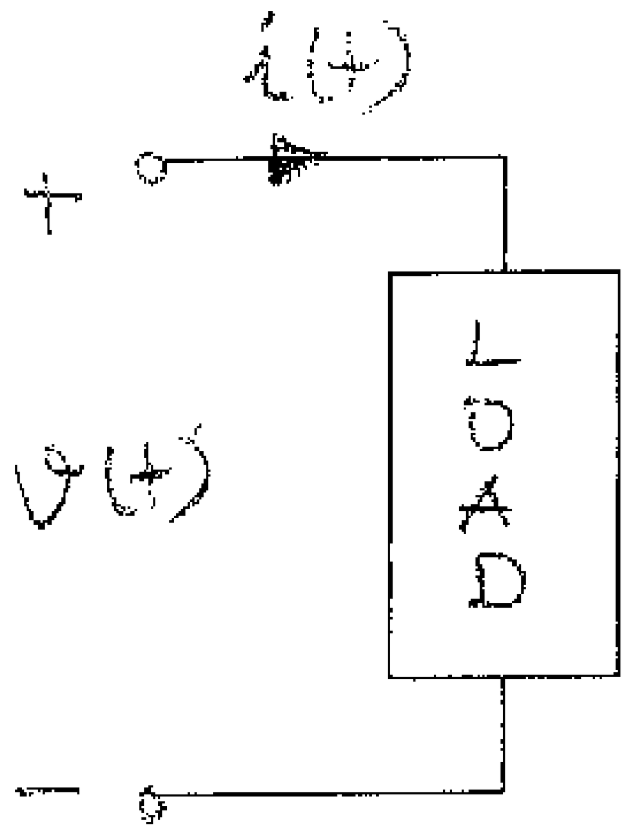
# POWER SYSTEM ANALYSIS – I FIRST MIDTERM EXAM

**Dr. Salih FADIL** **July 13, 2011**

**#1)** Consider a single phase load with an applied voltage $v(t) = 150\cos(\omega t + 10^\circ)$ volts and load current $i(t) = 5\cos(\omega t - 50^\circ)$ A.

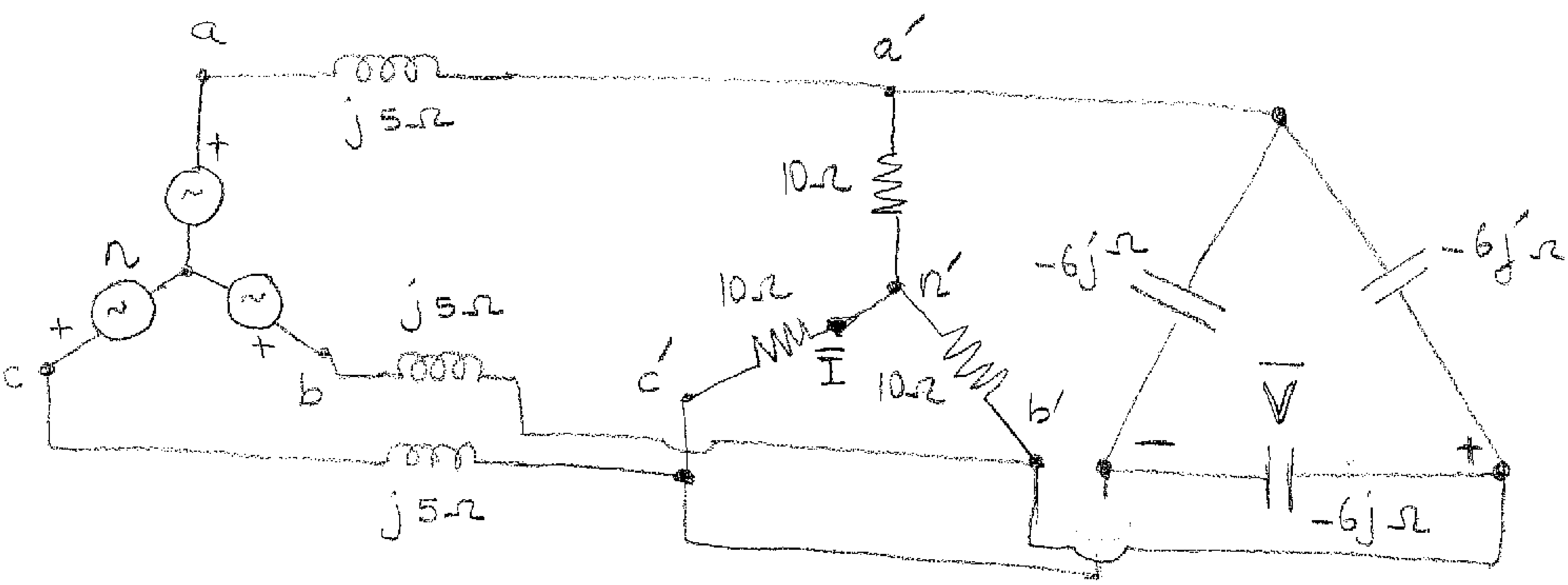



**a)** Find the power factor, specify whether it is lagging or leading.
**b)** Determine the active and reactive power absorbed by the load.
**c)** Calculate the reactive power supplied by the capacitor in parallel with the load that correct the power factor to 0.9 lagging.
**d)** Assume that the voltage across the load is kept constant. Calculate the capacitance value of the capacitor mentioned in part c. Take the frequency of the supply voltage as 50 *Hz*.

**#2)** The three phase system shown in the figure is balanced and $v_{bc}(t) = \sqrt{2}\,380\cos(\omega t + 90^\circ)$ volt. By using one line to neutral equivalent circuit, find;

**a)** $\overline{I}$ and $\overline{V}$ phasoral values shown in the figure ,

**b)** three phase complex power delivered by the source.




**#3)** The real power delivered by a source to two impedances $\overline{Z}_1 = 3 + j4\,\Omega$ and $\overline{Z}_2 = 10\,\Omega$ connected in parallel, is 1100 *W*. Determine

**a)** the real power absorbed by each of the impedances
**b)** the rms source current

**GOOD LUCK.....☺**

# POWER SYSTEM ANALYSIS FIRST MIDTERM EXAM SOLUTION MANUAL

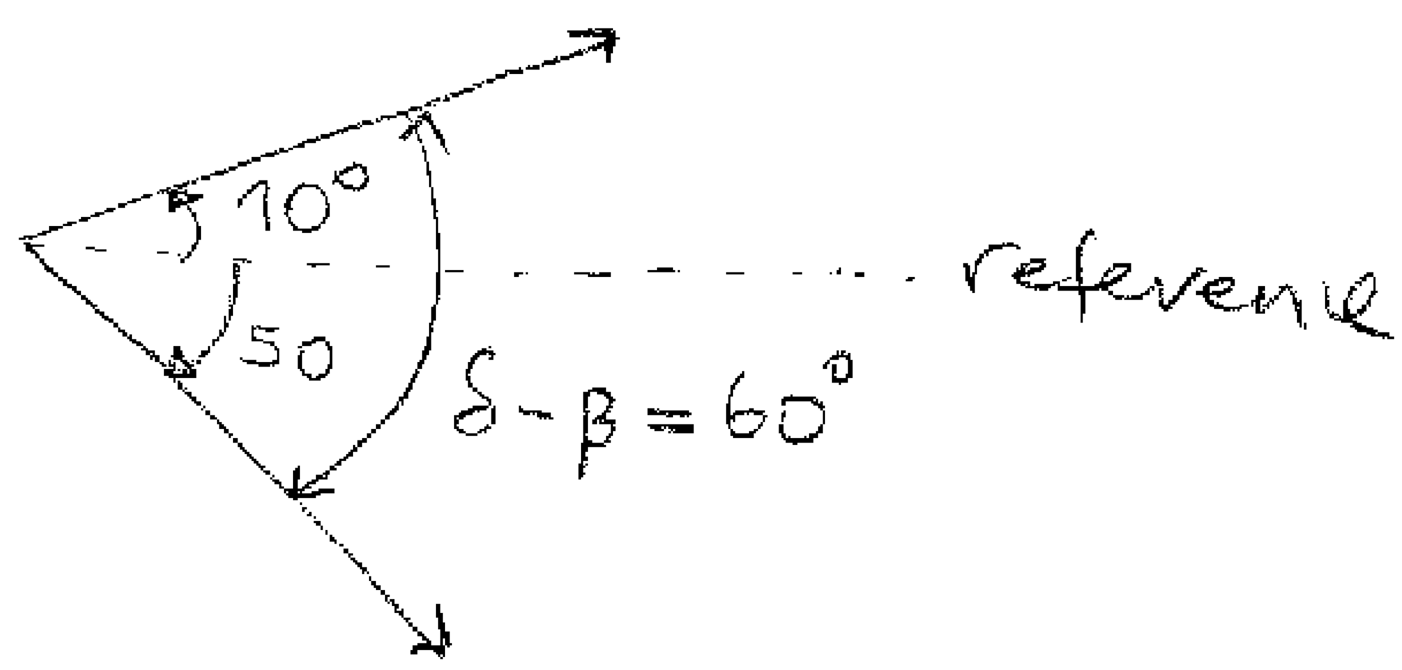
Dr. Salih FADIL

July 13, 2011

#1) $v(t) = 150 \cos(\omega t + 10^\circ)$ V.

$i(t) = 5 \cos(\omega t - 50^\circ)$ A

a)

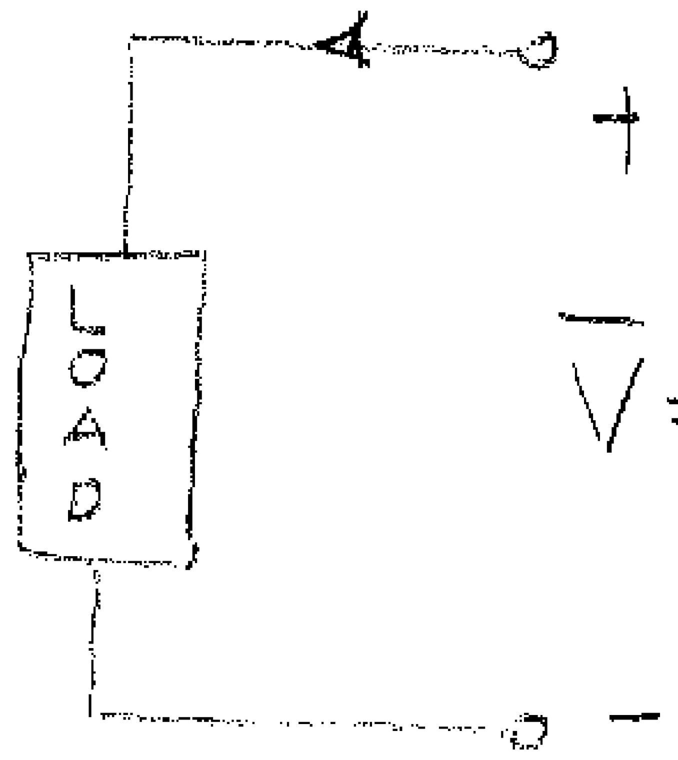



$\varphi = \delta - \beta = 10 - (-50) = 60^\circ$

power factor $= \cos(60^\circ) = 0{,}5$ lagging

b)

$\bar{I} = \frac{5}{\sqrt{2}} \angle -50^\circ$ A




$\bar{V} = \frac{150}{\sqrt{2}} \angle 10^\circ$ volt

Load representation

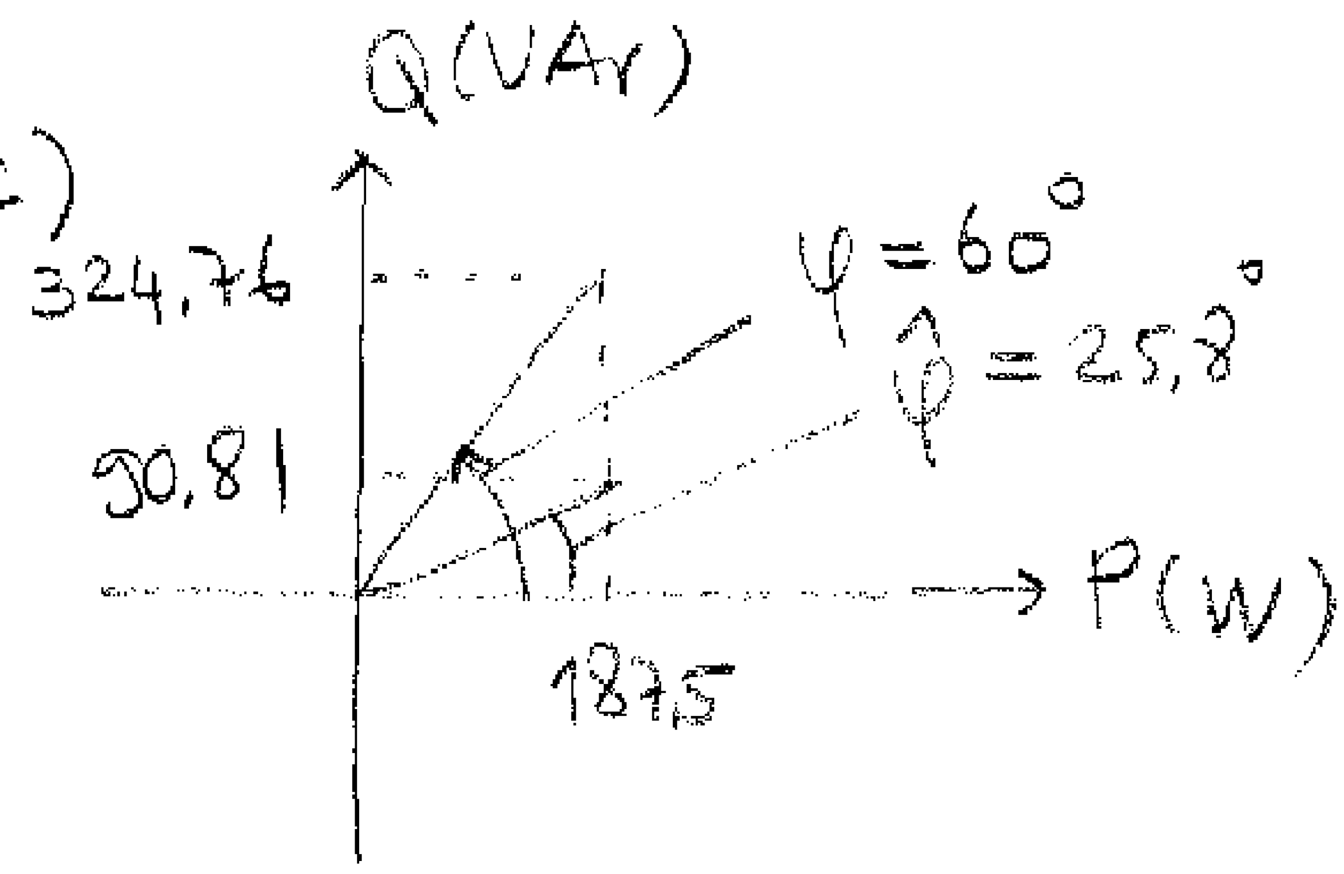
$P = \frac{150}{\sqrt{2}} \frac{5}{\sqrt{2}} \cos(60^\circ)$ W

$P = 187{,}5$ W absorbs.

$Q = \frac{750}{2} \sin(60^\circ)$ VAr

$Q = 324.76$ VAr absorbs

c)




$\cos\hat{\varphi} = 0{,}9 \rightarrow \hat{\varphi} = \cos^{-1}(0{,}9) = 25.8^\circ$

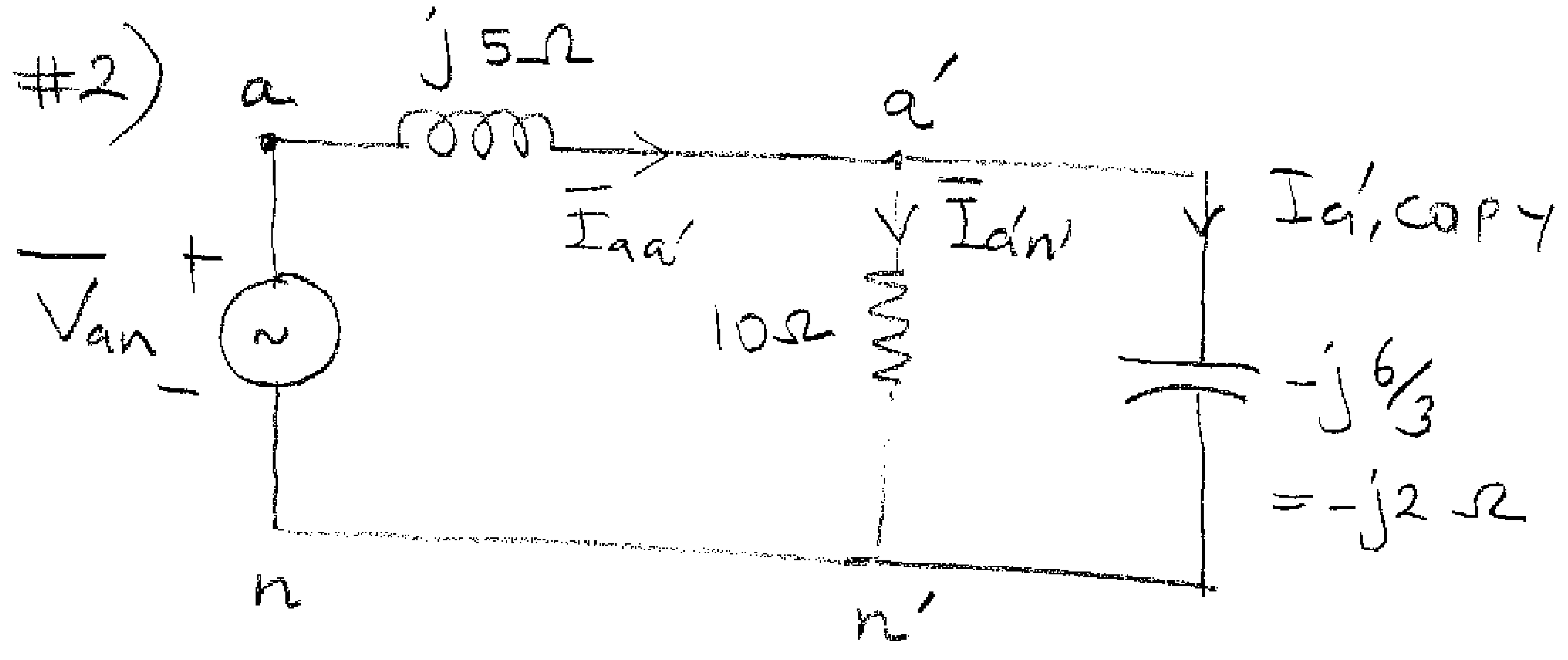
$\hat{Q} = 187{,}5 \tan(25{,}8^\circ) = 90{,}8$ VAr.

$Q_c = 324{,}76 - 90{,}81 = \underline{\underline{234}}$ VAr

d) $324 = 2\pi\, 50\, C \left(\frac{150}{\sqrt{2}}\right)^2$

$$C = \frac{234}{100\pi \left(\frac{150}{\sqrt{2}}\right)^2} = 66{,}2\ \mu F$$

#2)




$\bar{V}_{bc} = 380\angle 90^\circ$

$\bar{V}_{bn} = \frac{380}{\sqrt{3}}\angle 90-30^\circ = 220\angle 60^\circ$ volt

$\bar{V}_{an} = \bar{V}_{bn}\angle 60-240^\circ = 220\angle -180^\circ$

$\bar{V}_{an} = -220$ volt

$\bar{Z}_{eq} = \frac{2\angle -90^\circ \times 10}{10-2j} = \frac{20\angle -90^\circ}{10.198\angle -11.3^\circ} = 1.961\angle -78.7^\circ = 0,384 - j\,1,923\ \Omega$

$\bar{I}_{aa'} = \frac{220\angle 180^\circ}{0,384 + j(5-1,923)} = \frac{220\angle 180^\circ}{3.1\angle 82,8^\circ} = 70,96\angle 97,2^\circ$ A

$\bar{I}_{a'n'} = 70,96\angle 97,2^\circ \ \frac{2\angle -90^\circ}{10.198\angle -11.3^\circ} = 13,908\angle 18,5^\circ$ A.

$\bar{I}_{a',capy} = 70,96\angle 97,2^\circ \ \frac{10}{10,198\angle -11,3^\circ} = 69,582\angle 108,5^\circ$ A

$\bar{I} = \bar{I}_{c'n'} = \bar{I}_{a'n'}\angle +120^\circ = 13,908\angle 138,5^\circ$ A

$\bar{I}'_{b',capy} = 69.582\angle 108,5^\circ + 240^\circ = 69.582\angle 348.5^\circ$ A.

$\bar{I}_{b'c'_\Delta} = \frac{69.582}{\sqrt{3}}\angle 348,5^\circ + 30^\circ = 40,173\angle 18,5^\circ$ A

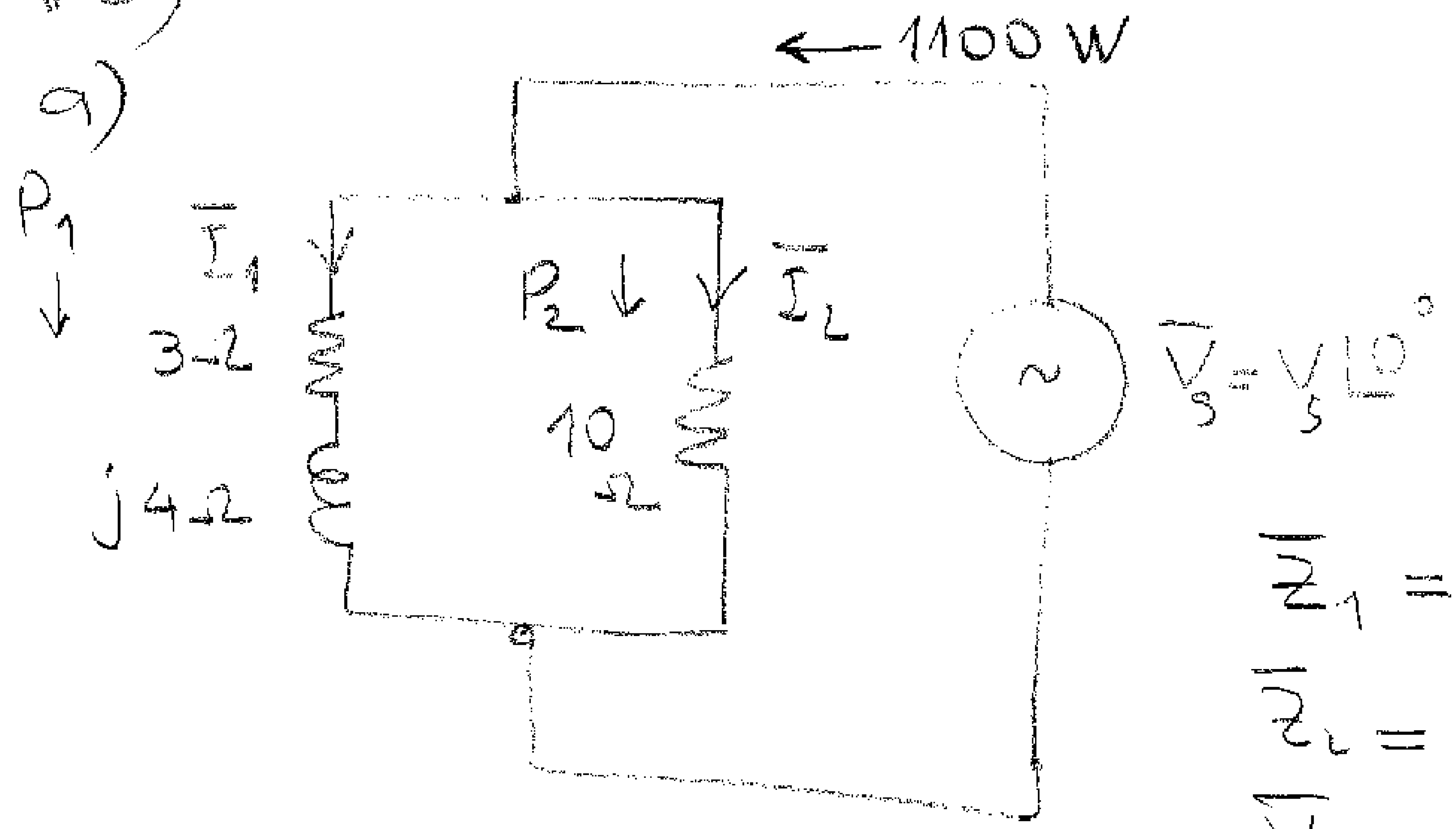
$\bar{V}_{b'c'} = 40,173 \times 6\ \angle 18.5^\circ - 90^\circ = 241\ \angle -71,5^\circ$ Volt

b) $\bar{S}_s = 3\ 220\angle 180\ \ 70.96\angle -97,2 = 46883.6\angle 82 = 6525 + j\,46427$ VA

$P_s = 6525$ W del. $Q_s = 46427$ VAr del.

#3)

a)




$\bar{Z}_1 = 3 + j4\,\Omega = 5\angle 53.13°\ \Omega$

$\bar{Z}_2 = 10\angle 0°\ \Omega$

$\bar{V}_s = V_s \angle 0°$ Volt

$\bar{I}_1 = \frac{V_s}{5}\angle -53.13°\ ,\quad \bar{I}_2 = \frac{V_s}{10}\angle 0°$

$3\left(\frac{V_s}{5}\right)^2 + 10\left(\frac{V_s}{10}\right)^2 = 1100 \qquad \left(\frac{3}{25} + \frac{10}{100}\right)V_s^2 = 1100$ (4)

$\frac{22}{100}V_s^2 = 1100 \qquad V_s^2 = \frac{1100\times 100}{22} \Rightarrow V_s = \pm\left(\frac{110000}{22}\right)^{1/2}$

$= \pm\, 70.7106$ volt

select $V_s = 70.7106$

$P_1 = \left(\frac{70.7106}{5}\right)^2 \times 3 = 600\,W$

$P_2 = \left(\frac{70.7106}{10}\right)^2 \times 10 = 500\,W$

1100 W

(17)

b) $\bar{I}_s = \frac{70.7106}{5}\angle -53.13° + \frac{70.7106}{10}\angle 0°$

$= (8.4850 + 7.071) - j\,11.313$

$= 15.5562 - j\,11.313$

$= 19.234 \angle -36.02°$ A

(16)