Desk Copy

ECE 300
Spring Semester, 2007
HW Set #12

Due: April 25, 2007

Name wlg
Print (last, first)

Wlg: Version 2

Use engineering paper. Work only on one side of the paper. Use this sheet as your cover sheet, placed on top of your work and stapled in the top left-hand corner. Number the problems at the top of the page, in the center of the sheet. **Do neat work. Underline your answers. Show how you got your equations.** **Be sure to show how you got your answers.** Each problem counts 10 points.

11.4 $P_5 = 14.86$ W, $P_8 = 5.588$ W, $P_S = 20.43$ W

11.7 160 W

11.28 $V_{RMS} = 2.92$ V, $P = 4.27$ W

11.46 (a) (i) $S = (95.25-j55)$ VA $= 110\angle{-30}$deg VA;
(ii) $|S| = 110$ VA
(iii) $P = 95.26$ W
(iv) $Q = 55$ VARs
(v) Pf = cos(-30) = .866 leading

(b) $S = (1497.2 + j401.2)$ VA $= 1550\angle 15$ deg VA
(i) $S = (1497.2 + j401.2)$ VA
(ii) $|S| = 1550$ VA
(iii) $P = 1497.2$ W
(iv) $Q = 401.2$ VARs
(v) Pf = .9659 lagging
(vi)

11.52 (a) pf = 0.9845 leading; (b) $I_{RMS} = 35.55\angle 55.11°$ A

11.64 $I_S = 39.47\angle{-159.9}$ deg V (previous answer used RMS source which was no indicated in the text)

11.71 (a) $Z = 0.05107\angle 2°\ \Omega$

(b) pf = 0.9994 lagging

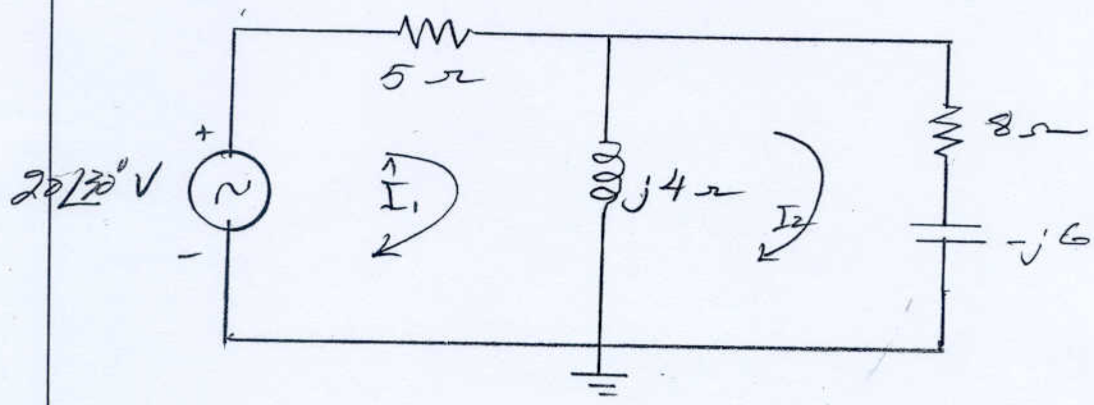
(c) $I_{RMS} = 2.392\angle{-2°}$ KA

11.74 (a) pf = 0.8992 lagging

(b) C = 5.74 mF

ECE 300
H.W. #12
Spring 2007

11.04 For the circuit below, find the power supplied to the 2 resistors. Verify that this power is the same that is supplied by the $20\angle 30$ V source



$$\begin{bmatrix} 5+j4 & -j4 \\ -j4 & 8-j2 \end{bmatrix} \begin{bmatrix} \vec{I}_1 \\ \vec{I}_2 \end{bmatrix} = \begin{bmatrix} 20\angle 30° \\ 0 \end{bmatrix}$$

$\vec{I}_1 = 2.434 - j.128 = 2.44\angle -3° A$ $\vec{I}_2 = 1.18\angle 101°$ A

$P_5 = \frac{1}{2}|\vec{I}_1|^2 5 = 14.88 W$

$P_8 = \frac{1}{2}|\vec{I}_2|^2 8 = 5.57 W$

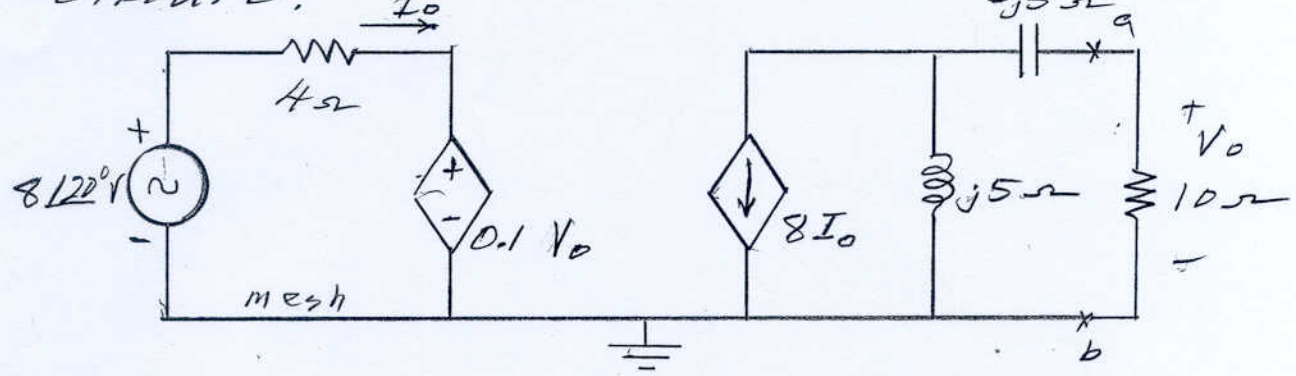
$P_5 + P_8 = 20.45 W$

$P_{20 \, source} = \frac{1}{2}(20) \times (2.44) \cos(30+3)$.

$P_{20} = 20.46 W$ check

11.7

Find the average power absorbed by the 10 Ω resistor in the following circuit.



mesh 1

$$4\hat{I}_o + 0.1\hat{V}_o = 8\angle 20$$

$$\hat{V}_o = \frac{-10 \times [8\hat{I}_o(5\angle 90)]}{[10 + j5 - j5]}$$

$$\hat{V}_o = 40\angle -90\ I_o$$

$$40\angle -90\ \hat{I}_o - \hat{V}_o = 0$$

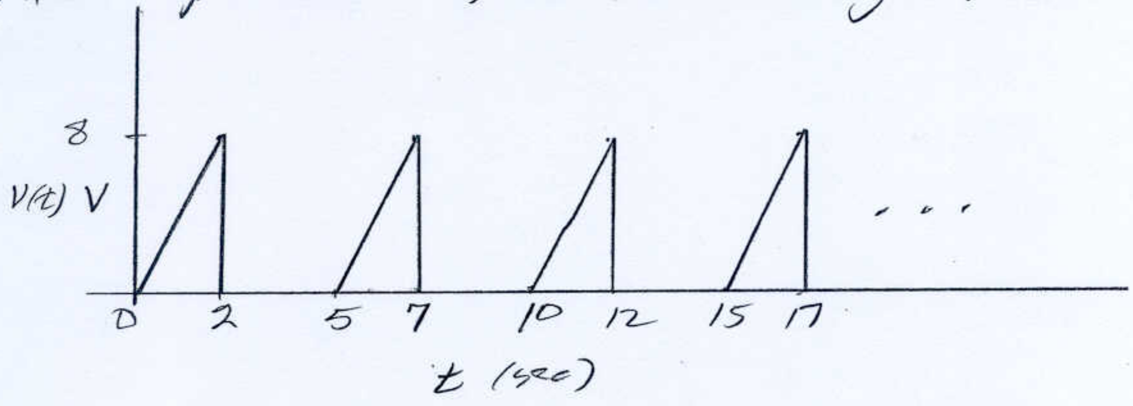
$$\begin{bmatrix} 0.1 & 4 \\ -1 & 40\angle -90 \end{bmatrix} \begin{bmatrix} \hat{V}_o \\ \hat{I}_o \end{bmatrix} = \begin{bmatrix} 8\angle 20^\circ \\ 0 \end{bmatrix}$$

$$\hat{V}_o = 56.57\angle -25^\circ\ V$$

$$P_{10} = \frac{1}{2}\frac{|\vec{V}_o|^2}{10} = \frac{56.57^2}{20} = 160\ W$$

11.28

Find the RMS value of the following periodic voltage waveform. Also find the power absorbed by a 2 Ω resis



$$V_{Rms} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt} = \sqrt{\frac{1}{5}\int_0^2 (4t)^2\,dt}$$

$$V_{Rms} = \sqrt{\frac{1}{5} \times \frac{16t^3}{3}\Big|_0^2} = \sqrt{\frac{1}{5} \times \frac{16 \times 2^3}{3}}$$

(a)

$$\boxed{V_{Rms} \simeq 2.92 \text{ V}}$$

(b)

$$P_2 = \frac{V_{Rms}^2}{2} \simeq \frac{(2.92)^2}{2}$$

$$\boxed{P_2 = 4.26 \text{ W}}$$

11.46

For the following voltage and current phasors, calculate the (i) complex power (ii) apparent power, (iii) real power, (iv) reactive power. Specify whether the pf is leading or lagging.

(a) $\hat{V} = 220\angle 30^\circ$ V rms $\quad I = 0.5\angle 60^\circ$ A rms

$\hat{S} = \hat{V}_{rms}\hat{I}^*_{rms} = (220\angle 30)(0.5\angle -60^\circ)$

$\hat{S} = (95.26 - j55)$ VA $= 110\angle -30$ VA

(i) $\hat{S} = (95.26 - j55)$ VA

(ii) $S = 110$ VA

(iii) $P = 95.26$ W

(iv) $Q = -55$ VARS or

$Q = 55$ VARS capacitive

P.f. = cos(−30) leading

P.f. = 0.866 leading

11.46 (b)

$\vec{V} = 250\angle{-10^\circ}$ V RMS

$\vec{I} = 6.2\angle{-25^\circ}$ A rms

(i)

$\vec{S} = \vec{V}_{rms}\vec{I}^*_{rms} = (250\angle{-10})(6.2\angle{25})$

$\boxed{\vec{S} = (1497.2 + j\,401.2)\ VA}$

(ii) $\boxed{S = |\vec{S}| = 1550\ VA}$

$\vec{S} = 1550\angle{15^\circ}$ VA

(iii) $\boxed{P = 1497.2\ W}$

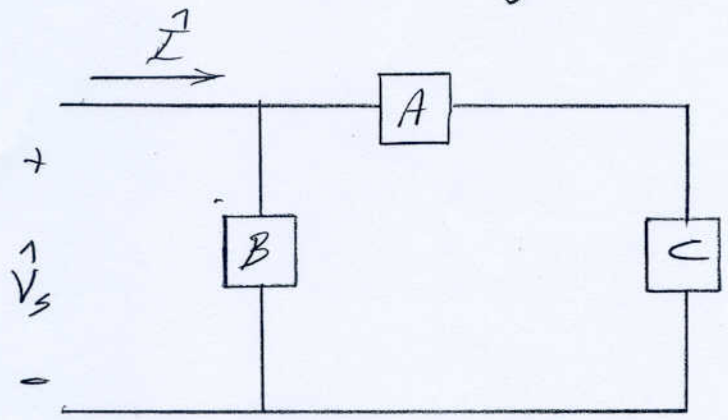
(iv) $\boxed{Q = 401.2\ \text{VARs inductive}}$

$P.f. = \dfrac{P}{S} = \dfrac{1497.2}{1550} = 0.9657$

$\boxed{P.f. = 0.9659\ \text{lagging}}$

11.52

Given the configuration below.



A → 2 kW 0.8 p.f. lagging

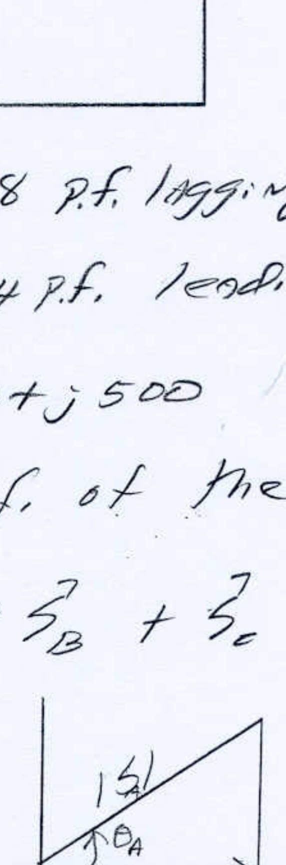
B → 3 kVA 0.4 p.f. leading

C → $\vec{S} = 1000 + j500$

(a) Find the p.f. of the entire system

$$\vec{S}_{TOTAL} = \vec{S}_A + \vec{S}_B + \vec{S}_C$$

For $\vec{S}_A$



$\cos\theta_A = .8$

$$\cos\theta_A = .8 = \frac{2k}{|S_A|}$$

$$|S_A| = \frac{2k}{.8} = 2500 \qquad \boxed{\vec{S}_A = 2500\angle 36.87^\circ \text{ VA}}$$

\#

For S_B

$\theta_B = \cos^{-1}.4 = -66.4^\circ$ (negative because it's leading

$$\therefore \boxed{\vec{S}_B = 3000\angle -66.4^\circ \text{ VA}}$$

11.52

For $\vec{S}_c$

Given directly

$$\vec{S}_c = 1000 + j500 = 1118 \angle 26.57^\circ \text{ VA}$$

Now

$$\vec{S}_{TOTAL} = (2500 \angle 36.87) + (3000 \angle -66.4) + (1118 \angle 26.57)$$

$$\vec{S}_{TOTAL} = (4200.97 - j749) \text{ VA}$$

$$\vec{S}_{TOTAL} = 4267.22 \angle -10.11^\circ \text{ VA}$$

$$\text{P.F.} = \frac{P}{|S|} = \frac{4200.97}{4267.22} = \underline{0.9845 \text{ leading}}$$

leading because $\angle S$ is negative

(b) $\vec{S}_{source} = \vec{V}_{rms} \vec{I}^*_{rms}$

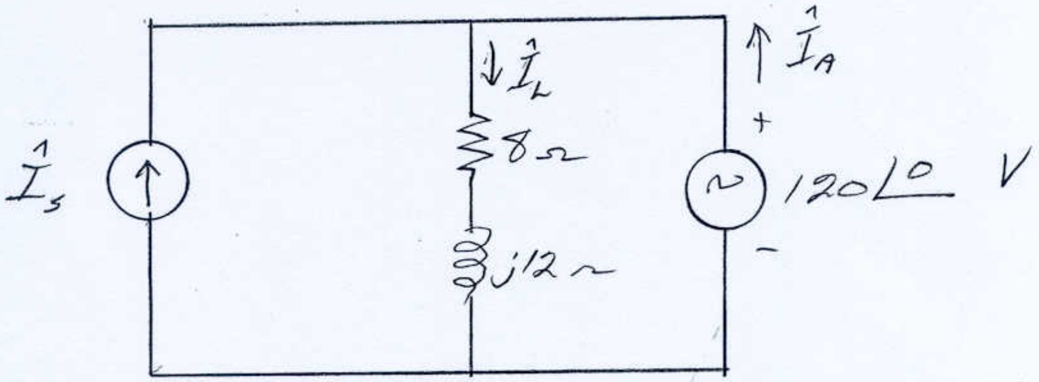
$$\vec{I}^*_{rms} = \frac{4267.22 \angle -10.11}{120 \angle 45}$$

$$\vec{I}^*_{rms} = 35.56 \angle -55.1 \text{ A}$$

$$\boxed{\vec{I}_{rms} = 35.56 \angle 55.1 \text{ A}}$$

11.64

Given the following circuit, Determine $\hat{I}_s$ if the $120\angle 0°$ V source supplies 2.5 kW with 0.4 kVA leading (i.e. $\hat{S} = (2.5 - j0.4)$ kVA $= 2.532\angle -9.1°$ kVA



Now;

$$\hat{I}_L = \frac{(120\angle 0)}{(8+j12)} = 8.32\angle -56.31° \text{ A}$$

At the voltage source

$$\hat{S} = 2532\angle -9.1° = \frac{(120\angle 0)(\hat{I}_A^*)}{2} \text{ kVA}$$

$$\hat{I}_A^* = \frac{2 \times 2.532\angle -9.1° \text{ kVA}}{120} = 42.2\angle -9.1° \text{ A}$$

$$\hat{I}_A = 42.2\angle 9.1° \text{ A}$$

$$\hat{I}_s = -\hat{I}_A + \hat{I}_L = -(42.2\angle 9.1) + (8.32\angle -56.31°)$$

$$\boxed{\hat{I}_s = 39.47\angle -159.9 \text{ A}}$$

using peak values

$\hat{I}$ = 19.19 ∠−147.7° A using

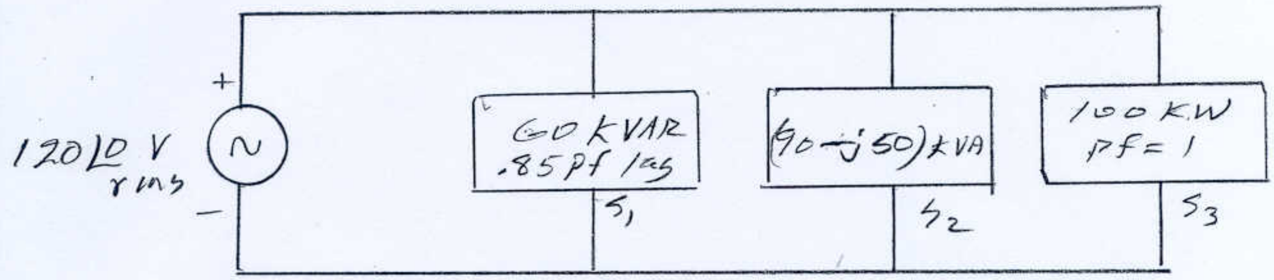
11.71

Given the following power circuit.

(a) Find the equivalent $\vec{Z}$.

(b) Calculate the p.f. for the total circuit

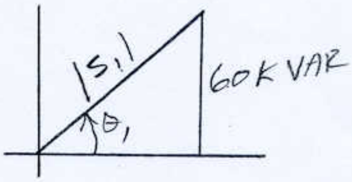
(c) Determine the current supplied by the source.



For $\vec{S}_1$

$\theta_1 = \cos^{-1} .85$

$\theta_1 = 31.79°$



$$|\vec{S}_1| = \frac{60k}{\sin 31.79} = 113.89 \text{ KVA}$$

$$\vec{S}_1 = 113.89 \angle 31.79 \text{ KVA}$$

For $\vec{S}_2$

$$\vec{S}_2 = (90 - j50) \text{ KVA}$$

For $\vec{S}_3$ $\quad \vec{S}_3 = 100 \text{ KVA}$

$$\vec{S}_{TOTAL} = \vec{S}_1 + \vec{S}_2 + \vec{S}_3 = 286.2 \angle 1.91°$$

(2)

11.71 cont.

$$\vec{S} = \frac{V_{rms}^2}{Z^*}$$

$$Z^* = \frac{(120)^2}{286.2 \angle 1.91 \times 10^3} = \frac{50.31 \angle -1.91}{1 \times 10^3}$$

$$\vec{Z} = 50.31 \times 10^{-3} \angle 1.91$$

$$\vec{Z} = .0503 \angle 1.91^\circ \ \Omega$$

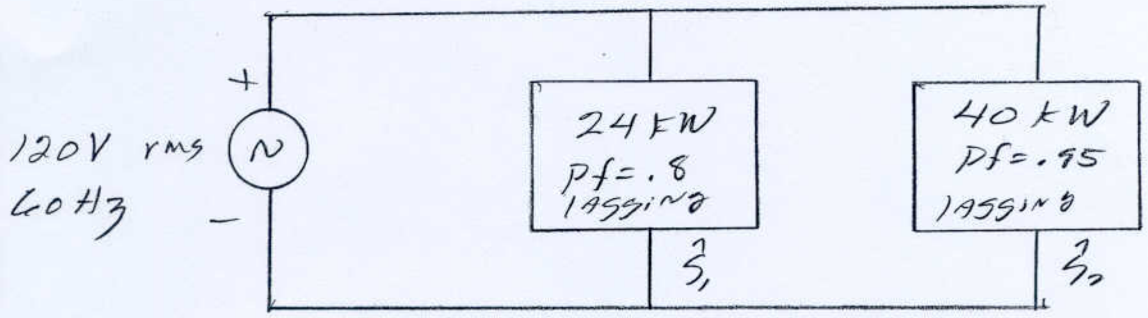
(b)

$$P.f. = \cos 1.91 = 0.9994$$

(c) $$I = \frac{V_{source}}{\vec{Z}} = \frac{120 \angle 0}{.0503 \angle 1.91}$$

$$\vec{I} = 2.386 \angle -1.91 \ kA$$ wow! lot of Amps

11.74 Given the following power system.



(a) Find the p.f. of the combination load.

(b) Determine C, connected in parallel with the loads, that will provide a unity power factor.

For $\vec{S}_1$

$$|S_1| = \frac{24K}{.8} = 30\ KVA \qquad \theta_1 = \cos^{-1} .8 = 36.87^\circ$$

$$\vec{S}_1 = 30\angle 36.87^\circ\ KVA = (24+j18)\ KVA$$

For $\vec{S}_2$

$$|S_2| = \frac{40\ K}{.95} = 42.1 \qquad \theta_2 = \cos^{-1} .95 = 18.19$$

$$\vec{S}_2 = 42.1\angle 18.19^\circ\ KVA = (40+j13.14)\ KVA$$

The reactive part of the load is

$$Q_T = Q_1 + Q_2$$

$$Q_T = (18 + 13.14)\ K\ VAR$$

11.74 cont. (2)

(a) For the combined p.f.

$$\vec{S}_{total} = \left[(24+j18)+(40+j13.14)\right] \text{kVA}$$

$$S_{TOTAL} = (64+j\,31.144)\ \text{kVA}$$

$$\tan\theta_{pf} = \frac{31.144}{64}$$

$$\theta = 25.95^\circ$$

$$\cos\theta = p.f. = \cos 25.95 = 0.8992$$

(b) You want to cancel out

$(18 + 13.14)$ kV = 31.14

Do this with the parallel capacitor.

$$C = \frac{31140}{2\pi \times 60 \times 120^2}$$

$$\boxed{C = 5.74\ mF}$$