ECE 300
Spring Semester, 2006
HW Set #15

Due: April 18, 2006 **Name** Desk Copy
wlg Print (last, first)

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.

11.49 (a) $\hat{S}=(4+j2.373)\,kVA$;

(b) $\hat{S}=(1.6-j1.2)\,kVA$;

(c) $\hat{S}=(0.4624+j1.271)\,kVA$

(d) $\hat{S}=(110.77+j166.16)\,kVA$

11.51 (a) pf = 0.9956 lagging;

(b) P = 15.56 W;

(c) Q = 1.466 VAR;

(d) S = 15.63 VA

(e) $\hat{S}=15.56+j1.466)\,VA$

11.56 $\hat{S}=(4.543+j1.396)\,VA$

11.58 $\hat{S}$ = 51.2 mVA

11.60 $V_O = 7.098\angle 32.29°$ kV; pf = 0.8454 lagging

11.69 (a) pf = 0.6402 lagging

(b) P = 590.16 W

(c) C = 130.4 μF

11.71 (a) $Z = 0.0502\angle 2°\ \Omega$ (This is the answer for 11.71, not assigned)

(b) pf = 0.9994 lagging

11.70 Ans: 69.45 μF

(c) $I_{rms} = 2.392\angle -2°$ kA

ECE 300
HW #15

11.49 Find the complex power for the following cases:

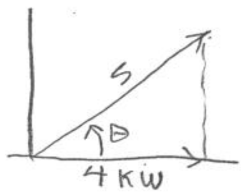
(a) $P = 4$ kW, pf $= 0.86$ (lagging)

(b) $S = 2$ kVA, $P = 1.6$ kW (capacitive)

(c) $\mathbf{V}_{rms} = 208\angle 20°$ V, $\mathbf{I}_{rms} = 6.5\angle -50°$ A

(d) $\mathbf{V}_{rms} = 120\angle 30°$ V, $\mathbf{Z} = 40 + j60\ \Omega$

(a)



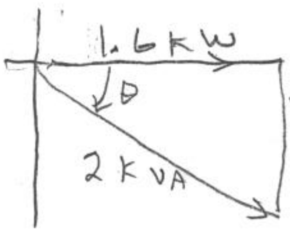
$\cos\theta = 0.86$

$\theta = 30.68°$

$$|S| = \frac{4\text{ KW}}{\cos\theta} = \frac{4\text{KW}}{.86} = 4.65$$

$$\hat{S} = 4.65\angle 30.68°\ \text{VA} = (4 + j2.37)\ \text{VA}$$

(b)



$\cos\theta = \frac{1.6}{2}$; $\theta = -36.87°$

$$\hat{S} = 2\angle -36.87°\ \text{KVA} = (1.6 - j1.2)\ \text{KVA}$$

(c)

$$\hat{S} = \hat{V}_{rms}\hat{I}^{*}_{rms} = (208\angle 20)(6.5\angle 50)\ \text{VA}$$

$$\hat{S} = (462.4 + j1270)\ \text{VA}$$

(d)

$$\hat{S} = \frac{|V_{rms}|^2}{Z^*} = \frac{(120)^2}{(40 - j60)}$$

$$\hat{S} = (110.8 + j166.2)\ \text{VA}$$

11.51 For the entire circuit in Fig. 11.70, calculate:

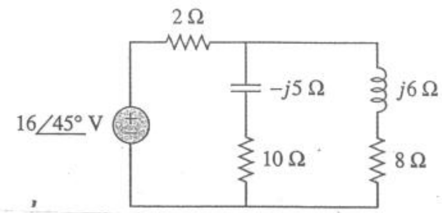
(a) the power factor

(b) the average power delivered by the source

(c) the reactive power

(d) the apparent power

(e) the complex power



$$Z_{in} = 2 + \frac{(10-j5)(8+j6)}{18+j} = 8.19\angle 5.39\ \Omega$$

(a) $p.f. = \cos\angle Z = \cos 5.39 = 0.9956$ lagging

(b)

$$\hat{I} = \frac{16\angle 45}{8.19\angle 5.39} = 1.954\angle 39.61^\circ\ A$$

$$\hat{S} = \frac{\hat{V}\hat{I}^*}{2} = \frac{|V_m|^2}{2Z^*} = (15.56 + j1.468)\ VA$$

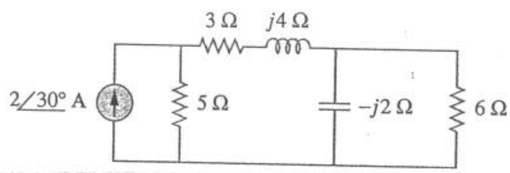
$P = Re[\hat{S}] = 15.56\ W$

(c) $Q = j$ part $\hat{S} = 1.468\ VAR$

(d) $|S| = 15.63\ VA$

(e) $\hat{S} = (15.56 + j1.468)\ VA$

11.56 Obtain the complex power delivered by the source in the circuit of Fig. 11.75.



First find the impedance seen by the source.

$$\hat{Z}_1 = (3+j4) + \frac{(12\angle -90)}{6-j2}$$

$$\hat{Z}_1 = 4.219\angle 31.43^\circ\ \Omega$$

$$\hat{Z}_{IN} = 5 \parallel \hat{Z}_1$$

$$\hat{Z}_{IN} = \frac{(5)(4.219\angle 31.43)}{((5\angle 0) + (4.219\angle 31.43))}$$

$$\hat{Z}_{IN} = 2.376\angle 17.08$$

$$\vec{S} = \frac{|\vec{I}|^2}{2} \times \vec{Z}_{IN} = \frac{(2)^2}{2} \times Z_{IN}$$

$$\vec{S} = (4.542 + j1.396)\ VA$$

11.58 Obtain the complex power delivered to the 10-kΩ resistor in Fig. 11.77 below.

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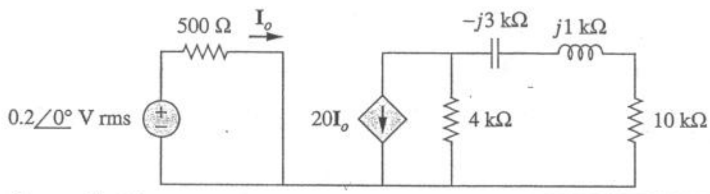


$$I_o = \frac{0.2}{500} = .4 \times 10^{-3} A$$

$$I_{10} = \frac{20 I_o \times 4 k}{(14 - j2) k} = \frac{20 \times 4 \times .4^{-3}}{(14 - j2)}$$

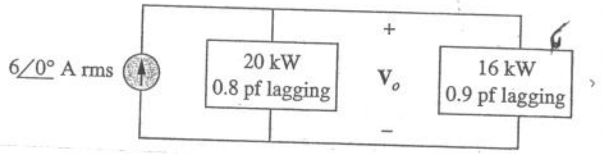
vp

$$I_{10} = 2.263 \angle 8.13^\circ \text{ A}$$

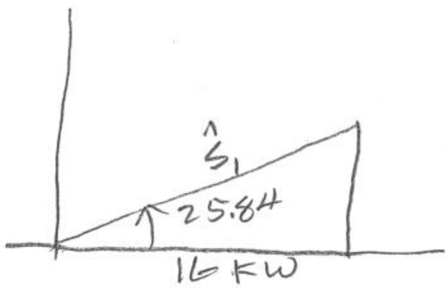
$$\hat{S} = |I_{10}|^2 \times 10 \times 10^3 = 5.121 \times 10^{-6} \times 10 \times 10^3$$

$$\hat{S} = 51.2 \text{ mVA}$$

11.60 For the circuit in Fig. 11.79, find $\mathbf{V}_o$ and the input power factor.



$\underline{S_1}$



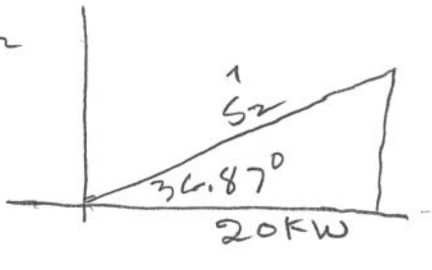
$\cos\theta_1 = .9$

$\theta_1 = 25.84^\circ$

$$|S_1| = \frac{16K}{\cos\theta_1} = \frac{16K}{.9} = 17.78\ KVA$$

$$\hat{S}_1 = 17.78 \angle 25.84^\circ\ KVA$$

S_2



$\cos\theta_2 = .8$

$\theta_2 = 36.87^\circ$

$$|\hat{S}_2| = \frac{20K}{.8} = 25\ KVA$$

$$\hat{S}_2 = 25 \angle 36.87^\circ\ KVA$$

$$\hat{S}_L = \hat{S}_1 + \hat{S}_2 = \left[(17.78 \angle 25.84) + (25 \angle 36.87)\right] KVA$$

$$\hat{S}_L = 42.59 \angle 32.29\ KVA$$

11.60 cont.

$$\vec{S} = \vec{V}_{rms} \vec{I}^{*}_{rms}$$

$$\vec{V}_{rms} = \frac{42.59 \angle 32.29}{6} K$$

$$\vec{V}_{rms} = 7.1 \angle 32.29 \text{ kV}$$

11.69 Refer to the circuit shown in Fig. 11.88.

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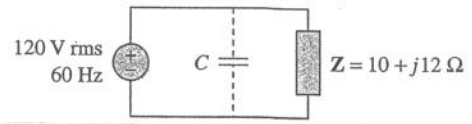
(a) What is the power factor?

(b) What is the average power dissipated?

(c) What is the value of the capacitance that will give a unity power factor when connected to the load?



(a) Since $Z = 10 + j12 = 15.62 \angle 50.19$

so $p.f. = \cos 50.19 = .6402$ lagging

(b)

$$\vec{I}_{rms} = \frac{V_{rms}}{\vec{Z}} = \frac{120 \angle 0}{15.62 \angle 50.19}$$

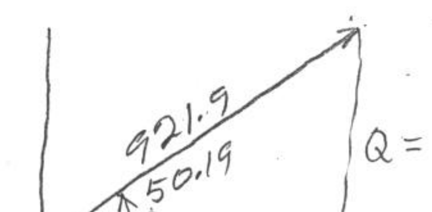
$$\vec{I}_{rms} = 7.68 \angle -50.19$$

$$\vec{S} = \frac{|V_{rms}|^2}{Z^*} = 921.87 \angle 50.19$$

$$\vec{S} = (590.16 + j708.2)\ VA$$

$$P = 590.16\ W$$

(c)



$$\frac{Q}{|S|} = \sin 50.19$$

11.69 cont'd.

$Q = 921.9 \times \sin 50.19 = 708.18$

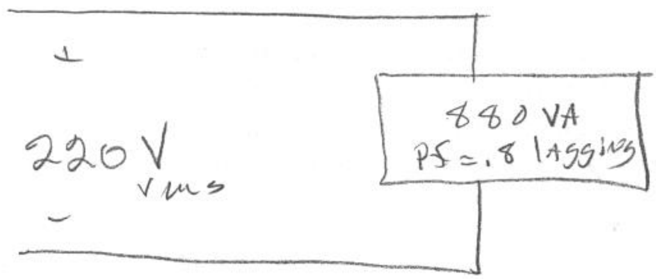
$\therefore$

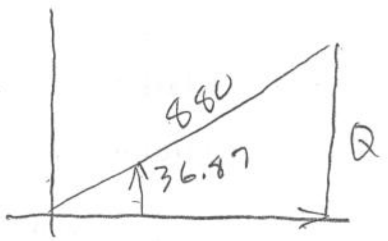
$\omega C V_{rms}^2 = 708.18$

$C = \dfrac{708.18}{2\pi \times 60 \times 120^2}$

$C = 130.45 \mu F$

11.70 An 880-VA, 220-V, 50-Hz load has a power factor of 0.8 lagging. What value of parallel capacitance will correct the load power factor to unity?





$\cos\theta = .8$

$\theta = 36.87^\circ$

$Q = 880 \times \sin 36.87 = 528$ VAR

$\omega C V_{rms}^2 = Q = \omega C \dfrac{V_m^2}{2}$

$$C = \frac{528 \times 2}{2\pi \times 50 \times (220)^2}$$

$C = 69.45\ \mu F$