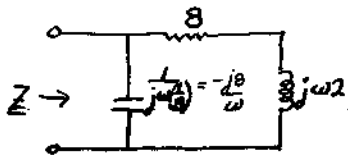


PR 9.22



$$Z = \frac{(8+j\omega 2)(\frac{j8}{\omega})}{8+j\omega 2 - \frac{8}{\omega}}$$

$$\omega = 2 \times 60$$

$$\downarrow -j0.0212 = 0.0212 \angle 90^\circ$$

a) $\theta = -90^\circ$
 $pf = \cos(-90^\circ) = 0$

b) $-90^\circ = \angle V - \angle I \Rightarrow \angle I > \angle V \Rightarrow I \text{ leads } V \Rightarrow \text{leading pf}$

c) $pf = 0.8 \text{ lagging} \Rightarrow \theta = +\cos^{-1}(0.8) = 36.87^\circ$

$$I = \frac{V}{\frac{1}{j\omega C}} + \frac{V}{8+j\omega 2} = V(j\omega C + \frac{8+j\omega 2}{8+j\omega 2})$$

$$\Rightarrow Z = \frac{V}{I} = \frac{1}{j\omega C + \frac{8+j\omega 2}{8+j\omega 2}} = \frac{8+j\omega 2}{j\omega C(8+j\omega 2)+1}$$

$$\Rightarrow \angle Z = \angle 8+j\omega 2 - \angle (1-j\omega^2 2C + j\omega C 8)$$

$$= 89.37^\circ - \tan^{-1}(\frac{\omega 8C}{1-\omega^2 2C}) = 36.87^\circ$$

$$\Rightarrow -\tan^{-1}(\frac{\omega 8C}{1-\omega^2 2C}) = -52.52^\circ$$

$$\Rightarrow \frac{\omega 8C}{1-\omega^2 2C} = \tan 52.52^\circ$$

$$\Rightarrow \omega 8C = \tan 52.52^\circ - \omega^2 2C \tan 52.52^\circ$$

$$\Rightarrow C(8\omega + \omega^2 2 \tan 52.52^\circ) = \tan 52.52^\circ$$

$$\Rightarrow C = \frac{\tan(52.52^\circ)}{8(2 \times 60) + (2 \times 60)^2 \tan 52.52^\circ} \approx 3.5 \times 10^{-6} = 3.5 \mu F$$

$$C \approx 3.5 \mu F$$

PR 9.23

$$P = V_e I_e \cos \theta$$

$$\Rightarrow I_e = \frac{P}{V_e \cos \theta}$$

$$= \frac{500}{(115)(.95)} = 4.6 \text{ Arms}$$

$$I_e = 4.6 \text{ Arms}$$

PR 9.30

$$a) * V_{9A} = I_1 9 = 18\sqrt{2} \angle 105^\circ$$

$$S_{9A} = V_{9A} I_1^* = 18 \angle 105^\circ 2 \angle 105^\circ = 36$$

$$* V_{j6} = I_1 j6 = 2\sqrt{2} \angle 105^\circ 6 \angle 90^\circ = 12\sqrt{2} \angle 15^\circ$$

$$S_{j6} = V_{j6} I_1^* = 12 \angle 15^\circ 2 \angle 105^\circ = 24 \angle 90^\circ = j24$$

$$* V_{j6} = (I_1 - I_2) j6 = (2\sqrt{2} \angle 105^\circ - \sqrt{2} \angle 105^\circ) j6 = \sqrt{2} \angle 105^\circ 6 \angle 90^\circ = 6\sqrt{2} \angle 15^\circ$$

$$S_{j6} = V_{j6} (I_2 - I_1)^* = (6 \angle 15^\circ)(1 \angle 105^\circ) = 6 \angle 90^\circ = j6$$

$$* V_{j12} = I_2 j12 = \sqrt{2} \angle 105^\circ 12 \angle 90^\circ = 12\sqrt{2} \angle 15^\circ$$

$$S_{j12} = V_{j12} I_2^* = 12 \angle 15^\circ (1 \angle 105^\circ) = 12 \angle 90^\circ = j12$$

$$* V_{-j6} = I_2 (-j6) = \sqrt{2} \angle 105^\circ 6 \angle 270^\circ = 6\sqrt{2} \angle 135^\circ$$

$$S_{-j6} = V_{-j6} I_2^* = 6 \angle 135^\circ (1 \angle 105^\circ) = 6 \angle 90^\circ = j6$$

$S_{9A} = 36$	VA
$S_{j6} = j24$	VA
$S_{j6} = j6$	VA
$S_{j12} = j12$	VA
$S_{-j6} = j6$	VA

$$b) S_{source} = -\left(\frac{36}{12} \angle 105^\circ\right) \angle 2 \angle 105^\circ = -36 \angle 145^\circ$$

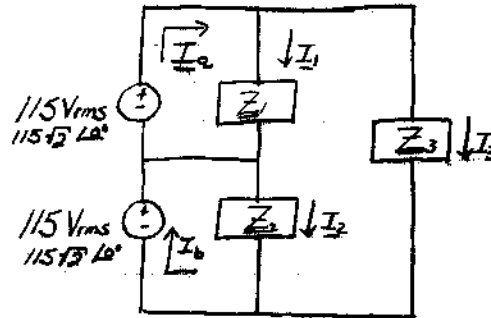
$$= -36 + j36$$

$$= -36 - j36$$

$S_{source} = 36 + j36$	supplied
$S_{load} = -36 - j36$	absorbed

$$c) \Sigma S = 36 + j24 + j6 + j12 - j6 - 36 - j36 = 0 \quad \Sigma S_{supplied} = \Sigma S_{absorbed}$$

PR 9.34



$$Z_1: 500 \text{ W @ } \log \text{ pf} = 0.8$$

$$Z_2: 1000 \text{ W @ } \log \text{ pf} = 0.9$$

$$Z_3: 1500 \text{ W @ leading pf} = 0.95$$

$$Z_1: S_1 = V_e I_{1c}^* = 115 \angle 12^\circ I_c \angle \theta = \underbrace{500}_{P} + j115 I_c \sin(\cos^{-1}(0.8))$$

$$\Rightarrow 115 I_c (0.8) = 500$$

$$\Rightarrow I_c = 500 / (115 \times 0.8) = 5.43 \text{ Arms}$$

$$\theta = \cos^{-1}(0.8) = 0 - \phi_1$$

$$\Rightarrow \phi_2 = -\cos^{-1}(0.8) = -36.9^\circ$$

$$\Rightarrow \underline{I}_1 = 5.43 \sqrt{2} \angle -36.9^\circ = 7.69 \angle -36.9^\circ \text{ A}$$

$$Z_2: V_e I_{2c} \cos \theta = P$$

$$\Rightarrow 115 I_{2c} (0.9) = 1000$$

$$\Rightarrow I_{2c} = 9.66 \text{ Arms}$$

$$\theta = 0 - \phi_2 = \cos^{-1}(0.9)$$

$$\Rightarrow \phi_2 = -25.8^\circ$$

$$\Rightarrow \underline{I}_2 = 9.66 \sqrt{2} \angle -25.8^\circ = 13.66 \angle -25.8^\circ \text{ A}$$

$$Z_3: V_e I_{3c} \cos \theta = P$$

$$\Rightarrow 230 I_{3c} (0.95) = 1500$$

$$\Rightarrow I_{3c} = 6.87 \text{ Arms}$$

$$\theta = 0 - \phi_3 = -\cos^{-1}(0.95)$$

$$\Rightarrow \phi_3 = 18.19^\circ$$

$$\Rightarrow \underline{I}_3 = 6.87 \sqrt{2} \angle 18.19^\circ = 9.71 \angle 18.19^\circ \text{ A}$$

$$\text{KCL at top: } \underline{I}_a = \underline{I}_1 + \underline{I}_3 = 7.69 \angle -36.9^\circ + 9.71 \angle 18.19^\circ = 15.5 \angle -5.89^\circ$$

$$\underline{I}_a = 15.5 \angle -5.89^\circ \text{ A}$$

$$\underline{I}_{ae} = 10.93 \angle -5.89^\circ \text{ Arms}$$

$$\text{KCL at bottom } \underline{I}_b = \underline{I}_2 + \underline{I}_3$$

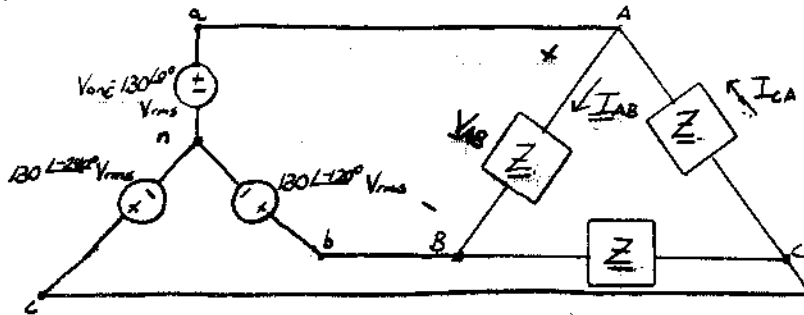
$$= 13.66 \angle -25.8^\circ + 9.71 \angle 18.19^\circ = 21.7 \angle -7.7^\circ$$

$$\underline{I}_b = 21.7 \angle -7.7^\circ \text{ A}$$

$$\underline{I}_{be} = 15.36 \angle -7.7^\circ \text{ Arms}$$



PR 9.40



$$Z = 4\sqrt{2} \angle 45^\circ \Omega$$

$$V_{ABc} = V_{obc} = V_{ane} - V_{enc} = 130 \angle 0^\circ - 130 \angle 120^\circ = 130\sqrt{3} \angle 30^\circ V_{rms}$$

$$I_{ABc} = \frac{V_{ABc}}{Z} = \frac{130\sqrt{3} \angle 30^\circ}{4\sqrt{2} \angle 45^\circ} = \frac{130\sqrt{6}}{8} \angle -15^\circ \text{ Arms}$$

$$V_{bcn} = 130\sqrt{3} \angle -90^\circ, \quad V_{cAn} = 130\sqrt{3} \angle -210^\circ$$

$$I_{CAc} = \frac{V_{CAc}}{Z} = \frac{130\sqrt{3} \angle -210^\circ}{4\sqrt{2} \angle 45^\circ} = \frac{130\sqrt{6}}{8} \angle -255^\circ \text{ Arms}$$

$$\begin{aligned} I_{aAc} &= I_{ABc} - I_{CAc} = \frac{130\sqrt{6}}{8} \angle -15^\circ - \frac{130\sqrt{6}}{8} \angle -255^\circ = \frac{130\sqrt{6}}{8} \sqrt{3} \angle -45^\circ \\ &= \frac{130(3)\sqrt{2}}{8} \angle -45^\circ \\ &= 48.75\sqrt{2} \angle -45^\circ \\ &= 68.9 \angle -45^\circ \text{ Arms} \end{aligned}$$

$$I_{aAc} = 68.9 \angle -45^\circ \text{ Arms or } I_{aA} = 97.5 \angle -45^\circ \text{ A}$$

$$I_{bBc} = 68.9 \angle -165^\circ \text{ Arms or } I_{bB} = 97.5 \angle -165^\circ \text{ A}$$

$$I_{cCc} = 68.9 \angle -75^\circ \text{ Arms or } I_{cC} = 97.5 \angle -75^\circ \text{ A}$$

$$S_{AB} = V_{AB} I_{AB}^* = (130\sqrt{3} \angle 30^\circ) \left(\frac{130\sqrt{6}}{8} \angle 15^\circ \right) = \underbrace{6337.5}_{P_{AB}} + j6337.5$$

$$\rightarrow \text{total power } 3P_{AB} = \boxed{19,013 \text{ W} = P_{TOT}}$$