10'

11.31 Find the rms value of the signal shown in Fig. 11.62.

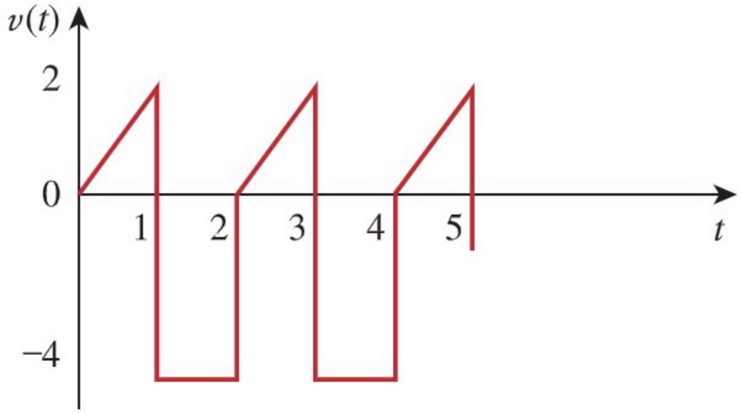


Figure 11.62
For Prob. 11.31.

Exercise 6.1 (10%)

4' 4' 2'

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T [v(t)]^2 dt} = \sqrt{\frac{1}{2}\left[\int_0^1 4t^2 dt + \int_1^2 16 dt\right]}$$

$$= \sqrt{\frac{1}{2}\left(\left[\frac{4}{3}t^3\right]_0^1 + [16t]_1^2\right)} = \sqrt{\frac{1}{2}\left(\frac{4}{3}+16\right)} = \boxed{\frac{\sqrt{78}}{3} \doteq 2.944 \text{ (V)}}$$

20'

11.21 Assuming that the load impedance is to be purely resistive, what load should be connected to terminals *a-b* of the circuits in Fig. 11.52 so that the maximum power is transferred to the load?

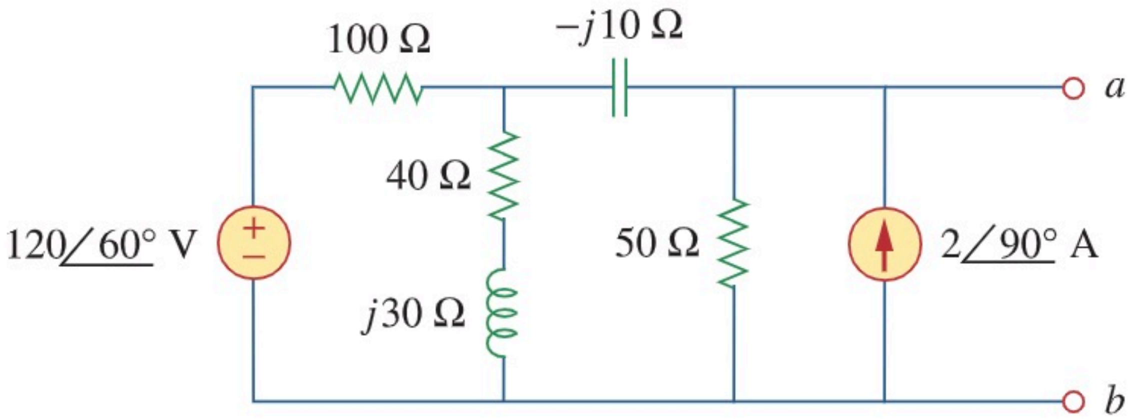
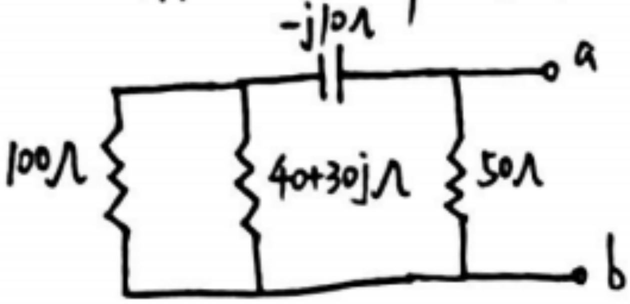


Figure 11.52
For Prob. 11.21.

⇒ turn off all independent sources



3'

$$Z_{ab} = Z_{th} = ((100 \,||\, 40+30j) + (-j10)) \,||\, 50$$ 5'

$$= \left(\frac{4000+3000j}{140+30j} - j10\right) \,||\, 50$$

$$= 19.5 + 1.73j$$ 2'

Z_L purely resistive

$$zL = R_L = \sqrt{19.5^2 + 1.73^2} = 19.58\,\Omega$$

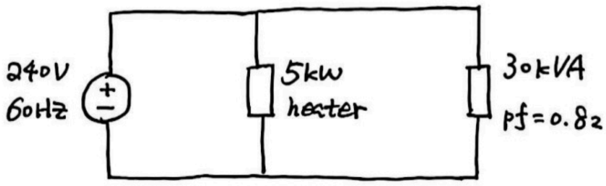
5' 5'

Exercise 6.3 (30%)

A 240-V rms 60-Hz source supplies a parallel combination of a 5-kW heater and a 30-kVA induction motor whose power factor is 0.82. Determine:

1. the system apparent power
2. the system reactive power
3. Sketch the power triangle for the current system and label $|S|$, P, and Q
4. the power factor of the current system
5. the kVA rating of a capacitor required to adjust the system power factor to 0.9 lagging
6. the value of the capacitor required

Exercise 6.3 (30%).



(1). $S_{total} = S_{heater} + S_{motor}$ 3'

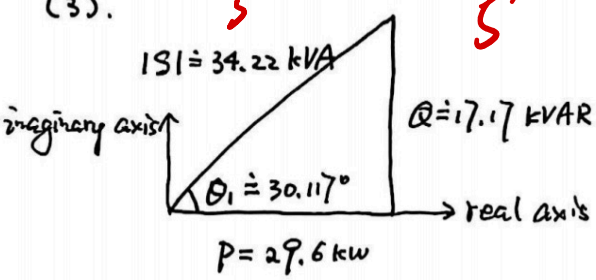
$= 5\times10^3 + 30\times10^3 \times 0.82 + 30\times10^3 \times \sqrt{1-0.82^2}$ 3'

$\doteq 29.6 + 17.17j$ (kVA), lagging, inductive

So, the system apparent power is $|S| = \sqrt{29.6^2 + 17.17^2} \doteq \boxed{34.22 \text{ (kVA)}}$ 2'

(2). the system's reactorive power is $Q \doteq \boxed{17.17 \text{ (kVAR)}}$. 2'

(3). 3' 5'



(4). $pf = \cos\theta_1 = \frac{29.6}{34.22} \doteq \boxed{0.865}$ the system is lagging and inductive. 2'

(5). $P = 29.6\times10^3$ w, $\tan\theta_1 = \frac{\sin\theta_1}{\cos\theta_1} \doteq 0.58$, $\tan\theta_2 = \frac{\sqrt{1-\cos^2\theta_2}}{\cos\theta_2} = \frac{\sqrt{1-0.9^2}}{0.9} \doteq 0.484$ 2'

$\omega = 2\pi f = 120\pi$, $V = 240$, $Q_c = Q_2 - Q_1 = P(\tan\theta_2 - \tan\theta_1) \doteq \boxed{-2832.7 \text{(VAR)}}$ 2' 1'

(6) So, $C = \frac{P(\tan\theta_1 - \tan\theta_2)}{\omega V^2} = \frac{29.6\times10^3 (0.58 - 0.4843)}{120\pi \times 240^2} \doteq \boxed{1.305\times10^{-4} \text{ F}}$ 2' 3'

2

12.71 In Fig. 12.73, two wattmeters are properly connected to the unbalanced load supplied by a balanced source such that $\mathbf{V}_{ab} = 208\underline{/0^\circ}$ V with positive phase sequence.

(a) Determine the reading of each wattmeter.

(b) Calculate the total apparent power absorbed by the load.

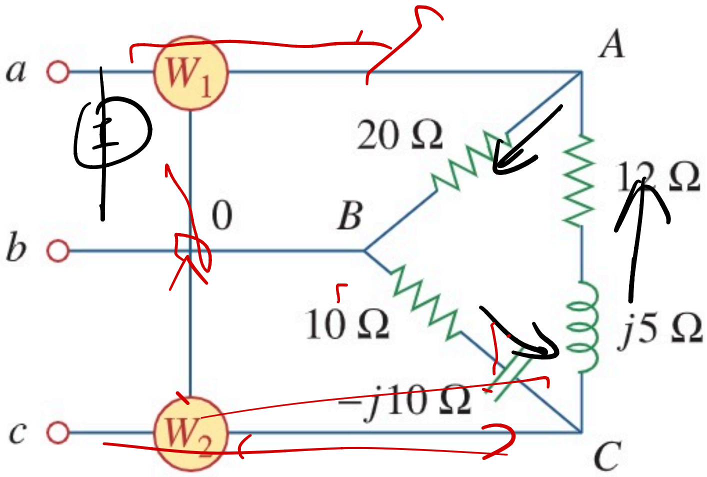


Figure 12.73
For Prob. 12.71.

$V_{ab} = 208$

$V_{bc} = 208 \angle -120^\circ$

$V_{ca} = 208 \angle 120^\circ$

$I_{AB} = \frac{52}{5}$ A $\quad S_{AB} = I^2 R = \frac{10816}{5}$ W $\quad$ 2'

$I_{BC} = 3.806 - 14.206j$ A $\quad S_{BC} = (\frac{10816}{5}$ W $- \frac{10816}{5}$ j VAR$)$

$I_{CA} = -2.053 + 15.867j$ A $\quad S_{CA} = 3072$ W $+ 1280$ j VAR $\quad$ 2'

$$P_I = \mathrm{Re}(V_{AB}\, I_a^{*}) = \mathrm{Re}\big[(\underbrace{I_{AB} - I_{CA}}_{12.45-13.86j})^{*}\, V_{AB}\big]$$

$$\approx 2590\ \mathrm{W}$$

2'

$$I_C = (I_{CA} - I_{BC})$$

$$\approx -5.86 + 30.07j\ \mathrm{A}$$

2'

$$P_{II} = \mathrm{Re}(V_{CB}\, I_C^{*}) \approx 4808\ \mathrm{W}$$

$$S_{AB} = 2163.2\ \mathrm{W}$$

$$S_{BC} = \frac{10816}{5}\mathrm{W} - \frac{10816}{5} i\ \mathrm{VAR}$$

$$S_{AC} = 3072 + 1280 i$$

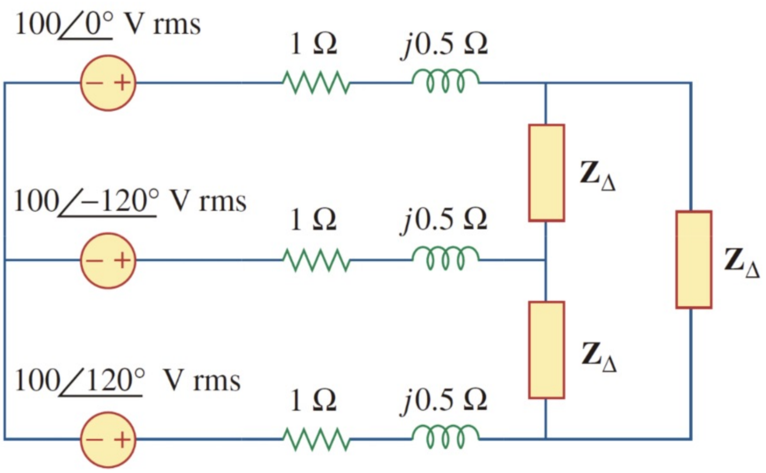
$$|S|_{total} \approx 7430.9\ \mathrm{VA}$$

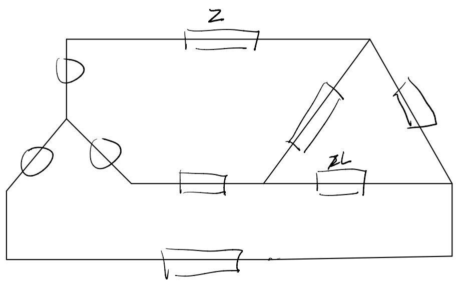
20

Exercise 5.2 (20%)

For the three-phase circuit below, find the average power absorbed by the delta-connected load with

$$Z_\Delta = 21 + j24\,\Omega.$$





Firstly transform $Z_D \to Z_Y$

Then $Z_Y = 7 + 8j$ 4'

$Z_{Ytotal} = 8 + 8.5j$ 2'

Then $I_a = 8.567 \angle 46.73$

$I_b = 8.567 \angle -166.73$ 6'

$I_c = 8.567 \angle 73.264$.

$P_b = P_c = P_a = I^2 R_Y$ 4'

$= 513.76\,W$

The $P_{total} = 3P_a = 1541.28\,W$ 4'