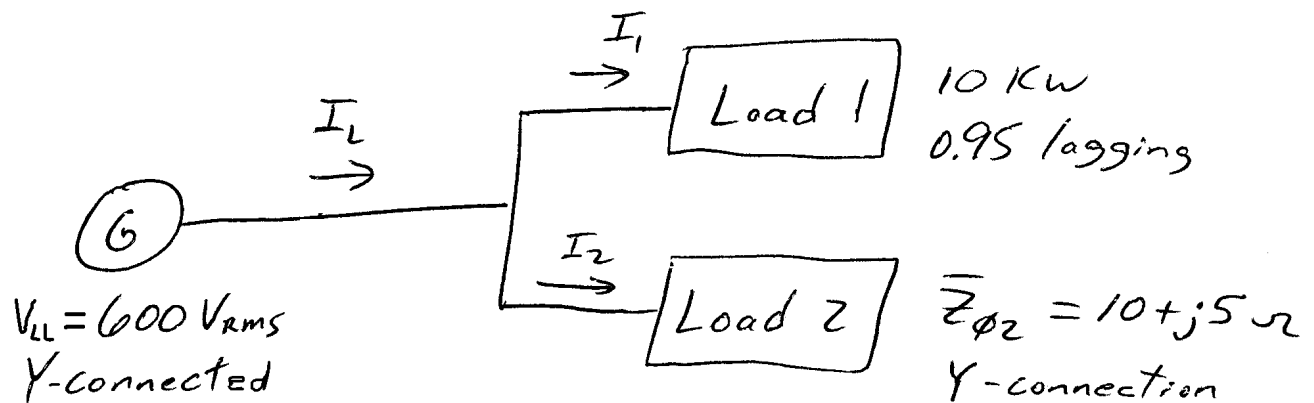
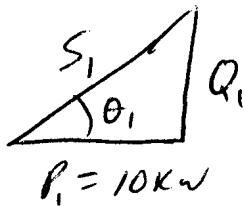


One-line, Three-Phase Power Example

Find currents, voltages, powers, and power factors for the loads and system shown in the one-line diagram.



Load 1



$$PF_1 = \cos \theta_1 = 0.95 \text{ lagging} \Rightarrow \theta_1 = \cos^{-1} 0.95$$

$$\theta_1 = +18.195^\circ$$

$$S_1 = \frac{P_1}{\cos \theta_1} = \frac{10 \text{ kW}}{0.95} = \underline{10.526 \text{ KVA}}$$

$$Q_1 = S_1 \sin \theta_1 = (10.526 \text{ KVA})(\sin 18.195^\circ)$$

$$\underline{Q_1 = 3.2868 \text{ KVAR}}$$

Knowing $V_{LL} = 600 V_{rms}$, the line current I_L is found using (2-29) $P = \sqrt{3} V_{LL} I_L \cos \theta$

$$\hookrightarrow I_L = \frac{P_1}{\sqrt{3} V_{LL} \cos \theta_1} = \frac{10 \times 10^3}{\sqrt{3} (600) 0.95}$$

$$\underline{\underline{I_L = 10.692 \text{ A}_{rms}}}$$

Load 2 (Y-config)

$$\bar{Z}_{\phi_2} = 10 + j5 \Omega = 11.18 \angle 26.565^\circ \Omega$$

$$\Rightarrow \bar{Z}_{\Delta_2} = 3 \bar{Z}_{\phi_2} = 30 + j15 \Omega = 33.54 \angle 26.565^\circ \Omega$$

$$PF_2 = \cos \theta_2 = \cos 26.565^\circ$$

$$\underline{PF_2 = 0.89443 \text{ lagging (inductive reactance)}}$$

$$\text{Using } V_{LL} \text{ \& } \bar{Z}_{\Delta_2}, I_{\phi_2} = \frac{600 V_{rms}}{33.541} = 17.888554 A_{rms} \text{ (For } \Delta\text{-conf.)}$$

$$P_2 = 3 V_{\phi_2} I_{\phi_2} \cos \theta_2 = 3(600)(17.88855) \cos 26.565^\circ$$

$$\underline{P_2 = 28,800 W = 28.8 KW}$$

$$\underline{Q_2 = 3 V_{\phi_2} I_{\phi_2} \sin \theta_2 = 14,400 VAR = 14.4 KVAR}$$

$$\underline{S_2 = \sqrt{P_2^2 + Q_2^2} = 32,200 VA = 32.2 KVA}$$

$$I_2 = \frac{P_2}{\sqrt{3} V_{LL} \cos \theta_2} = \frac{28,800}{\sqrt{3} (600) \cos 26.565^\circ}$$

$$\underline{I_2 = 30.984 A_{rms} = \sqrt{3} (17.888554)}$$

← double-check

Total Powers & line current

$$P = P_1 + P_2 = 10 \text{ kW} + 28.8 \text{ kW} = \underline{\underline{38.8 \text{ kW}}}$$

$$Q = Q_1 + Q_2 = 3.2868 \text{ kVAR} + 14.4 \text{ kVAR} = \underline{\underline{17.6868 \text{ kVAR}}}$$

$$S = \sqrt{P^2 + Q^2} = \underline{\underline{42.6411 \text{ kVA}}}$$

$$\text{PF} = \frac{P}{S} = \frac{38.8}{42.6411} = \underline{\underline{0.9099 \text{ lagging (} Q > 0 \text{)}}}$$

$$\text{Also, } \theta = \theta_v - \theta_i = \cos^{-1} 0.9099 = \underline{\underline{24.5^\circ}}$$

$$P = \sqrt{3} V_{LL} I_L \cos \theta = \sqrt{3} V_{LL} I_L \text{ PF}$$

$$\hookrightarrow I_L = \frac{38,800}{\sqrt{3} (600) 0.9099} = \underline{\underline{41.0314 \text{ Arms}}}$$