Last time:
\[ S_{ph} = 3V_L I_L \cos(\theta) = \sqrt{3} V_L I_L \cos(\theta) \] for both wye and delta loads

\[ P_{ph} = 3V_L I_L \cos(\theta) = \sqrt{3} V_L I_L \cos(\theta) \]
\[ Q_{ph} = 3V_L I_L \sin(\theta) = \sqrt{3} V_L I_L \sin(\theta) \]

Answers to Questions:
Why Wye or Delta Connection?

**Voltages:**
- Wye gives \( V_p \)
- Delta gives \( V_L \)

* If \( V_p \) needed, use wye connection.

Power Triangle Still Works?

* Yes: just remember \( S_{ph} = 3V_L I_L = \sqrt{3} V_L I_L \)

Today:

1) Per phase equivalents
2) HW set up

Section 2.6 in Textbook

Wye Source to Wye Load

* We want to calculate \( I_a, I_b, I_c \)

* Simplify calculations by first examining only a phase

\[ I_a = \frac{V_{an}}{Z_L + Z_L} \]

* To get \( I_b \) and \( I_c \), just rotate by 120°.
Wye Source to Delta Load

\[ V_{an} = V_{a} \angle 0^\circ \quad \Rightarrow \quad V_{ab} = V_{a} \angle 0^\circ \]
\[ V_{ac} = V_{a} \angle 90^\circ \]
\[ V_{a} = V_{a} \angle 180^\circ \]

Wye Rules

\[ I_{ab} = \frac{V_{ab}}{Z_{a}} = \frac{\sqrt{3} V_{a} \angle 0^\circ}{Z_{a}} \]

\[ I_{a} = (\sqrt{3} \angle 0^\circ) I_{ab} = \frac{3V_{a} \angle 0^\circ}{Z_{a}} \quad \Rightarrow \quad I_{a} = \frac{V_{a} \angle 0^\circ}{Z_{a}/\sqrt{3}} \]

\[ Z_{y} = \frac{Z_{a}}{3} \]

Then rotate by 120° for \( I_{b} \) and \( I_{c} \)
Homework Setup

2.16)

Given: \( V_L = 345 \text{ V} \) \hspace{1cm} S_{–\phi} = 750 \text{ MVA} \hspace{1cm} PF = 0.8 \log

Find: a) \( \overline{Z} \) \hspace{1cm} c) \( P_{\text{hub}} \) and \( Q_{\text{hub}} \)

b) \( I_L \) and \( I_{\phi} \) \hspace{1cm} d) \( S_{\text{hub}} \)

Solution: a) \( S_{\text{hub}} = \sqrt{3} V_L I_L = 3 I_{\phi} \)

\[ S_{\text{hub}} = 3 V_L I_L \]
\[ \overline{I}_{\phi} = I_L \angle \theta = \frac{V_L}{Z} \]

b) \( I_{\phi} \) from (a): \( I_L = 13 I_{\phi} \)

c) \( P_{\text{hub}} = \frac{P_{\text{hub, \theta}}}{3} = \frac{S_{\text{hub, cos \theta}}}{3} \)

\[ Q_{\text{hub}} = \frac{Q_{\text{hub, \theta}}}{3} = \frac{S_{\text{hub, sin \theta}}}{3} \]

2.17)

Given: \( V_L = 2400 \text{ V} \), \( S_1 = 120 \text{ MVA} \) \hspace{1cm} PF = 0.8 lead, \( P_1 = 180 \text{ kW} \) \hspace{1cm} PF = 0.6 lag, \( P_3 = 50 \text{ kW} \) \hspace{1cm} PF = 1

Find: a) \( \overline{S}_{\text{tot}} = \overline{S}_1 + \overline{S}_2 + \overline{S}_3 \)

b) \( PF_{\text{tot}} \) \hspace{1cm} d) QC for \( PF_{\text{tot}} = 1 \), \( I_L = \frac{\overline{S}_{\text{tot, QC}}}{\sqrt{3} V_L} \)
Given: \( V_L = 440 \text{V} \)  
\( P_{34} = 120 \text{kW} \)  
\( \text{PF} = 0.85 \) lag before adding capacitors  
\( Q_{34} = -50 \text{kVAR} \)

Find:  
a) \( I_L \) before and after adding capacitors  
b) \( \text{PF} \) after capacitors added

Solution: 
a) \( P_{34} = \sqrt{3} V_L I_L (\text{PF}) \)  
\[ I_L = \frac{P_{34}}{\sqrt{3} V_L (\text{PF})} \]

\[ Q_{34,0} = \sqrt{3} V_L I_L \sin(\phi) \]  
\[ Q_C = 3 Q_{34,0} \]

\[ Q_{34} = Q_{34,0} + Q_C \]

\[ S_{34} = \sqrt{P_{34}^2 + Q_{34}^2} = \sqrt{3} V_L I_L \]

2.20) See section on per phase equivalents

2.25)

Given: \( P_1 = 500 \text{kW} \)  
\( \text{PF} = 0.96 \) lag

Find: \( Q_C \) for \( \text{PF} = 0.99 \) lag

Solution: Use Power triangle
SP1) \( V_L = 480 \, V \)
\[ I_L = 23 \, A \]

Then, capacitors added
\[ Q_L = -8 \, kVAR \]
\[ I_L = 18 \, A \quad V_L = 480 \, V \]

Find: \( P \) and \( Q \) before capacitors added.

Solution:
\[ S_1 = \sqrt{3} V_L I_L \]
\[ S_2 = \sqrt{3} V_L I_L \]
\[ S_L = P^* + Q^* \]
\[ S_L = P^* - Q^* \]
\[ P^* = S_1 - Q_1 \]
\[ S_2 = P^* (Q_1 + Q^*) \]

* Substitute and solve for \( Q_1 \)
  then get \( P \).

SP2) Similar to other problems.