* Quiz Friday September 14

2018-09-12-1

Last time:

$\overline{S}_{3\phi} = 3V_\phi I_\phi \angle\theta = \sqrt{3}V_L I_L \angle\theta$ for both wye and delta loads

$P_{3\phi} = 3V_\phi I_\phi \cos(\theta) = \sqrt{3}V_L I_L \cos(\theta)$

$Q_{3\phi} = 3V_\phi I_\phi \sin(\theta) = \sqrt{3}V_L I_L \sin(\theta)$

Answers to Questions:

Why Wye or Delta Connection?

Voltges: Wye gives V_ϕ

Delta gives V_L

* If V_ϕ needed, use wye connection.

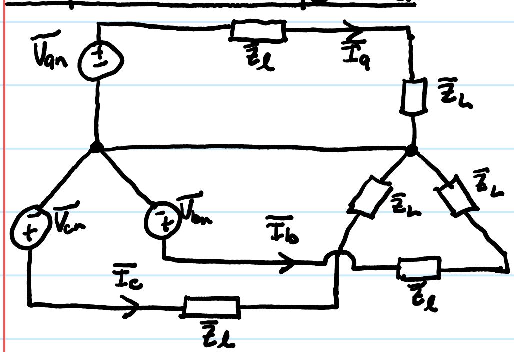
Power triangle still works?

* Yes: just rember $S_{3\phi} = 3V_\phi I_\phi = \sqrt{3}V_L I_L$

Today: 1) Per phase equivalents — Section 2.6 in Textbook

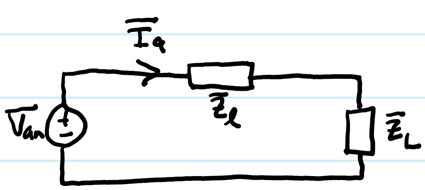
2) HW set up

Wye Source to Wye load



* We want to calculate $\overline{I}_a$, $\overline{I}_b$, $\overline{I}_c$

* Simplify calculations by first examing only a phase

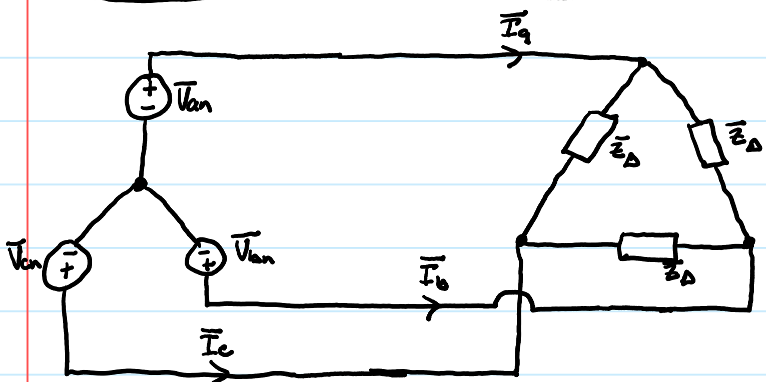


$$\overline{I}_a = \frac{\overline{V}_{an}}{\overline{Z}_\ell + \overline{Z}_L}$$

* To get $\overline{I}_b$ and $\overline{I}_c$, just rotate by 120°

2018-09-12-2

Wye Source to Delta Load

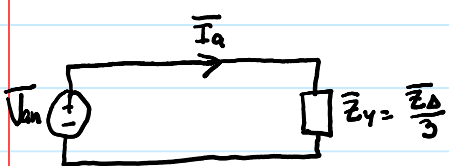


$\bar{V}_{an} = V_\phi \angle 0 \quad \Rightarrow \quad$ $\left.\begin{aligned} \bar{V}_{ab} &= V_\phi \sqrt{3} \angle 30^\circ \\ \bar{V}_{bc} &= V_\phi \sqrt{3} \angle -90^\circ \\ \bar{V}_{ca} &= V_\phi \sqrt{3} \angle 150^\circ \end{aligned}\right\}$ Wye Rules

$$\bar{I}_{ab} = \frac{\bar{V}_{ab}}{\bar{Z}_\Delta} = \frac{\sqrt{3} V_\phi \angle 30^\circ}{\bar{Z}_\Delta}$$

$$\bar{I}_a = \underbrace{\left(\sqrt{3} \angle -30^\circ\right)}_{\Delta \text{ rules}} \bar{I}_{ab} = \frac{3 V_\phi \angle 0}{\bar{Z}_\Delta} \Rightarrow \bar{I}_a = \frac{V_\phi \angle 0}{\bar{Z}_\Delta / 3}$$

$$\bar{Z}_Y = \frac{\bar{Z}_\Delta}{3}$$

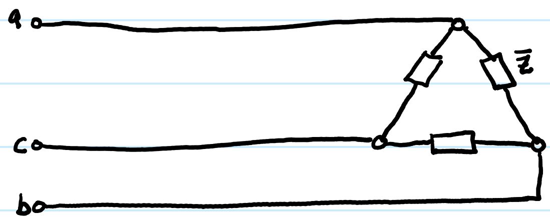


* Then rotate by 120° for $\bar{I}_b$ and $\bar{I}_c$

2018-09-12-3

Homework Setup

2.16)



Given: $V_L = 345$ V $\quad S_{3\phi} = 750$ MVA $\quad PF = 0.8$ lag

Find: a) $\bar{Z}$ $\quad$ c) $P_{1\phi}$ and $Q_{1\phi}$

b) I_L and I_ϕ $\quad$ d) $\bar{S}_{3\phi}$

Solution: a) $S_{3\phi} = \sqrt{3} V_L I_L = 3 V_L I_\phi$

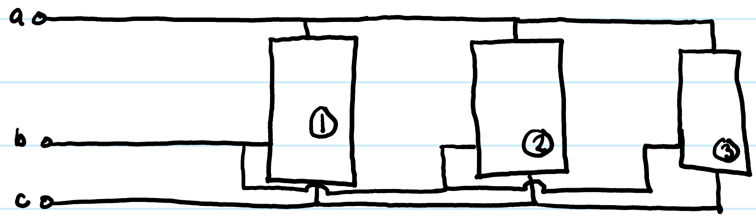
$S_{3\phi} = 3 V_L I_\phi$ $\qquad \bar{I}_\phi = I_\phi \angle -\theta = \frac{\bar{V}_L}{\bar{Z}}$

b) I_ϕ from (a). $\qquad I_L = \sqrt{3} I_\phi$

c) $P_{1\phi} = \frac{P_{3\phi}}{3} = \frac{S_{3\phi}\cos(\theta)}{3}$

$Q_{1\phi} = \frac{Q_{3\phi}}{3} = \frac{S_{3\phi}\sin(\theta)}{3}$

2.17)



Given: $V_L = 2400$ V, $S_1 = 120$ kVA $PF_1 = 0.8$ lead, $P_2 = 180$ kW $PF_2 = 0.6$ lag, $P_3 = 30$ kW $PF_3 = 1$

Find: a) $\bar{S}_{TOT} = \bar{S}_1 + \bar{S}_2 + \bar{S}_3$ $\quad$ c) $I_L = \frac{S_{TOT}}{\sqrt{3} V_L}$

b) PF_{TOT} $\quad$ d) QC for $PF_{TOT} = 1$, $I_L = \frac{S_{TOT,new}}{\sqrt{3} V_L}$

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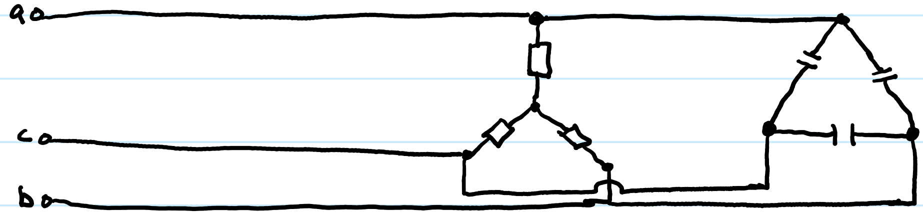
2.19)



Given: $V_L = 440\,V$ $P_{3\phi} = 120\ kW$ $PF = 0.85$ lag before adding capacitors

$Q_{1\phi} = -50/3\ kVAR$

Find: a) I_L before and after adding capacitors

b) PF after capacitors added

Solution: a) $P_{3\phi} = \sqrt{3}\, V_L I_L (PF)$

$I_L = \dfrac{P_{3\phi}}{\sqrt{3}\, V_L (PF)}$

b) $\theta_N = \tan^{-1}\left(\frac{Q_N}{P}\right)$

$PF_N = \cos(\theta_N)$

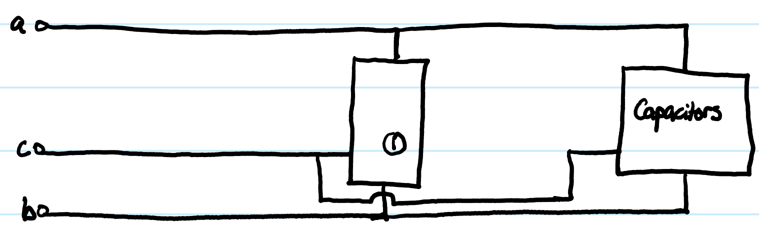
$Q_{3\phi,0} = \sqrt{3}\, V_L I_L \sin(\theta_0)$ $Q_c = 3 Q_{c1\phi}$

$Q_N = Q_{3\phi,0} + Q_c$

$S_N = \sqrt{P^2 + Q^2} = \sqrt{3}\, V_L I_L$

2.20) See section on per phase equivalents

2.25)



Given: $P_1 = 300\ kW$ $PF_1 = 0.6$ lag

Find: Q_c for $PF = 0.9$ lag

Solution: Use Power triangle

2018-09-12-5

SP1) $V_L = 480\ V$

$I_L = 23A$

Then, capacitors added

$Q_c = -8\ kVAR$

$I_L = 18A \quad V_L = 480V$

<u>Find</u>: P and Q before capacitors added

<u>Solution:</u>

$S_1 = \sqrt{3}\, V_L I_{L_1}$ | $S_2 = \sqrt{3}\, V_L I_{L_2}$

$S_1^2 = P^2 + Q_1^2$ | $S_2^2 = P^2 + Q_2^2$

$P^2 = S_1^2 - Q_1^2$ | $S_2^2 = P^2 + (Q_1 + Q_c)^2$

* Substitute and solve for Q_1

then get P.

SP2) Similar to other problems