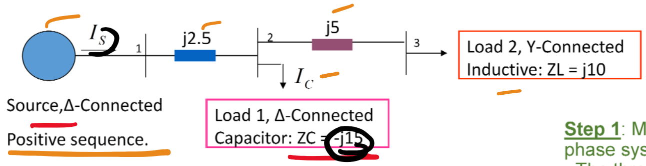
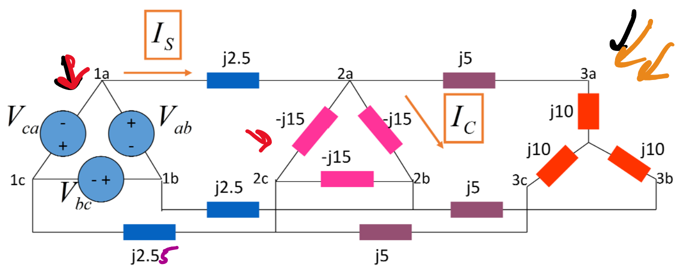
4.1 3- Phase Power : In-Class Zoom Notes

Tuesday, 2 February 2021 11:58 am

Example: Given a one-line diagram, If the voltage source is $|V_{line}| = \sqrt{3}$ V. Find, the current magnitude supplied by source, $|I_S|$, and, the current magnitude through a capacitor, $|I_C|$.





Step 1: Make sure that the three-phase system is balanced.
- The three-phase sources need to have the same magnitude with 120 degree phase difference.
- The three-phase impedances must be of the same value (both phase and magnitude).

18

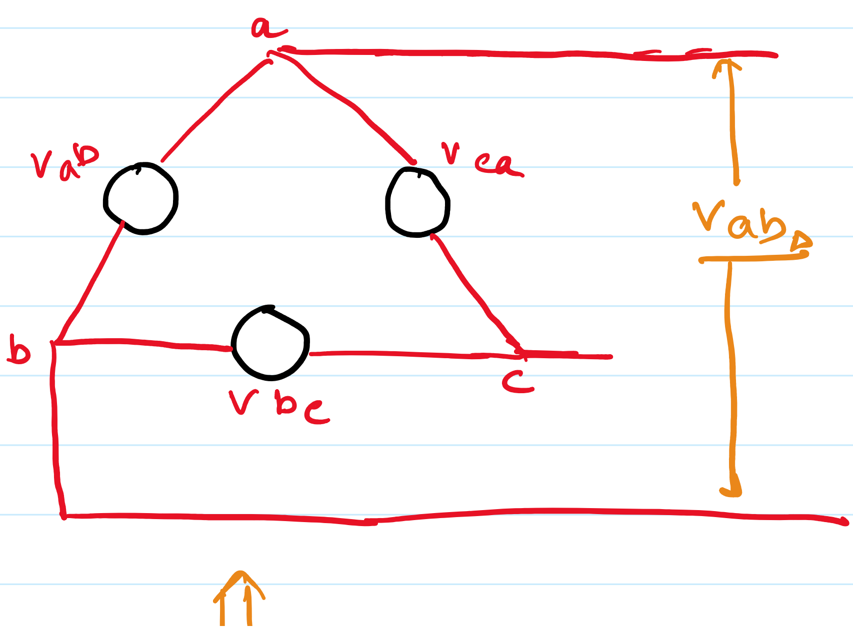
2)a) Convert from Δ → Y

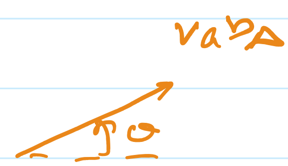
$Z_{c\Delta} \to Z_{cY}$

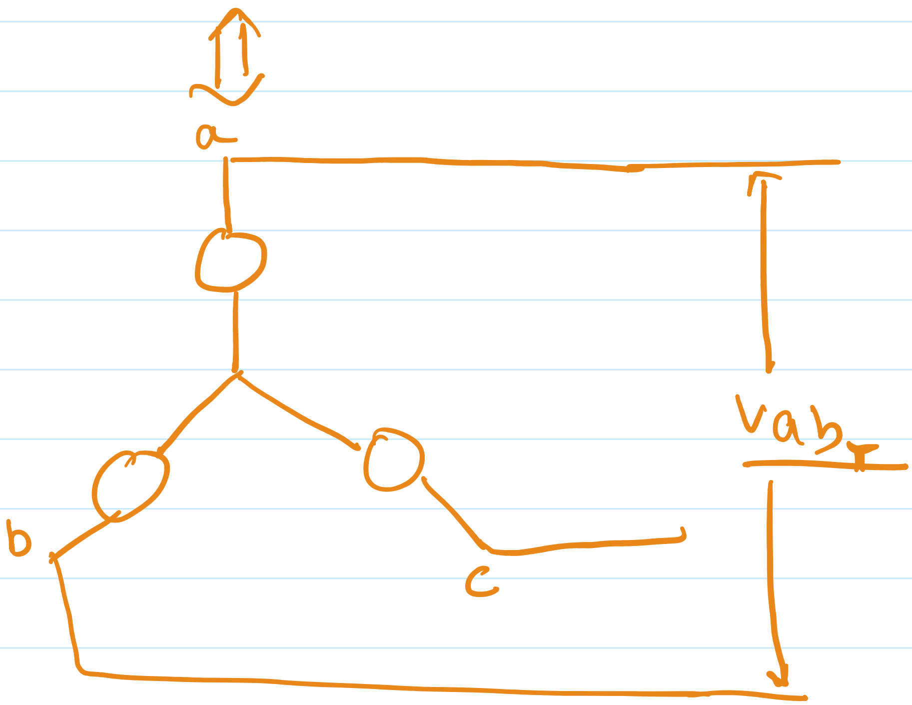
Load1 → Δ conneted load $Z_{c\Delta} = -j15$

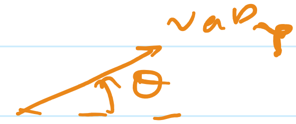
Δ → Y load, $Z_{cY} = \frac{Z_{c\Delta}}{3} = -j5\,\Omega$

b) Convert Voltage from Δ to Y line voltage = $|\sqrt{3}|$ V

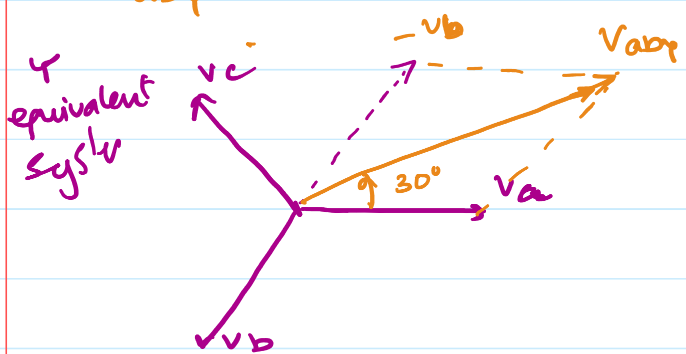








$$V_{abY} = V_a - V_b = V_a + (-V_b)$$



$$V_{abY} = V_a + (-V_b)$$

$$= V_a + V_a \angle 60^\circ$$

$$V_{abY} = \sqrt{3}\, V_a \angle 30^\circ \quad \text{— A}$$

$$V_{ab\Delta} = |\sqrt{3}| \angle \theta^\circ$$

$$V_{abY} = V_{ab\Delta} \quad \text{— B}$$

$$\sqrt{3}\, V_a \angle 30^\circ = V_{ab\Delta}$$

$$V_a = \frac{V_{ab\Delta}}{\sqrt{3} \angle 30^\circ}$$

$$= \sqrt{3} \angle \theta^\circ$$

$\sqrt{3}\angle 30^\circ$

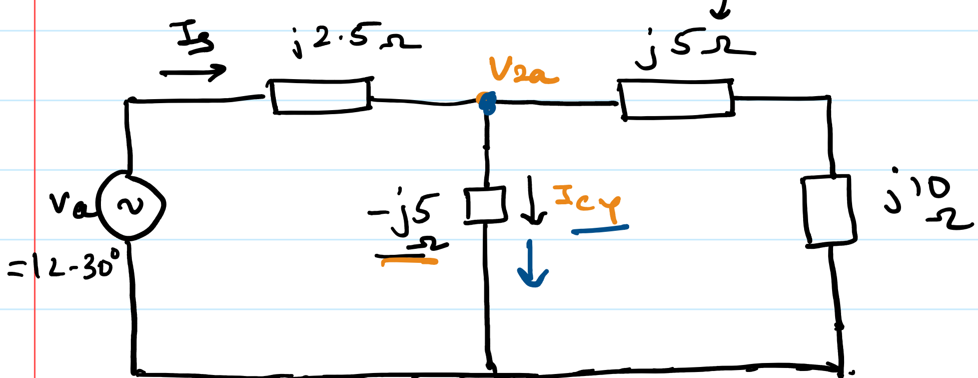
$$= \frac{\sqrt{3}\angle 0^\circ}{\sqrt{3}\angle 30^\circ}$$

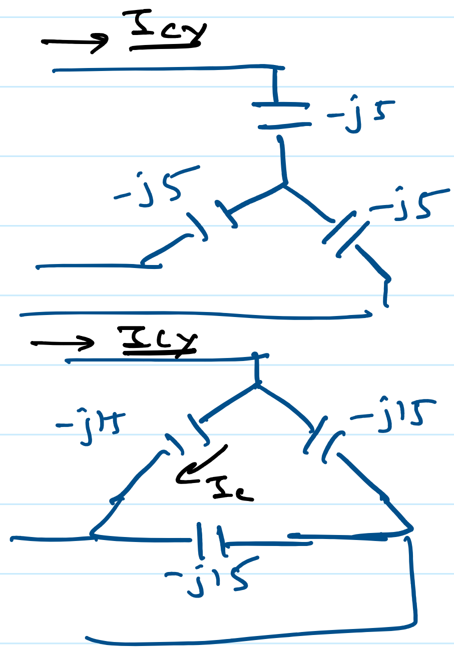
$$V_a = 1\angle(\theta - 30^\circ)$$

Assuming $V_{ab\Delta}$ angle $(\theta = 0^\circ)$

$$V_a = 1\angle -30^\circ$$

Drawing the 1-phase diagram

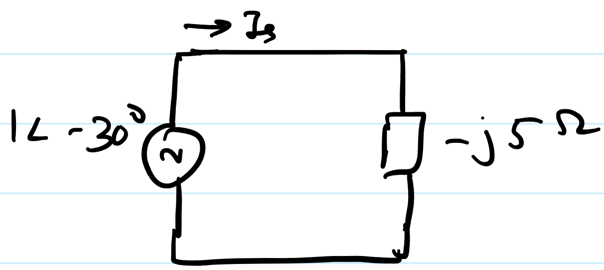




$$Z_{eq} = \left((j5 + j10) \parallel -j5\right) + j2.5$$

$$= (j15 \parallel -j5) + j2.5$$

$$= -j5\ \Omega.$$



$$I_s = \frac{1\angle -30}{-j5} = \frac{1\angle-30}{5\angle-90}$$

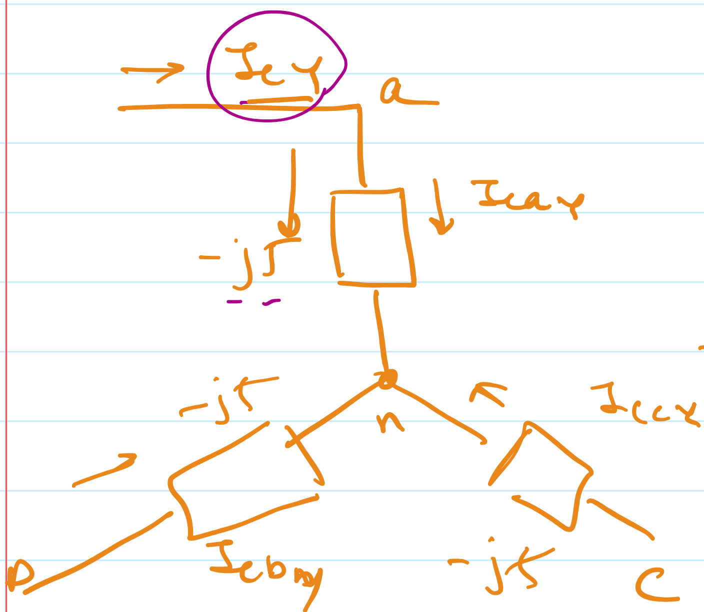
$$= 0.2\angle 60^\circ A$$

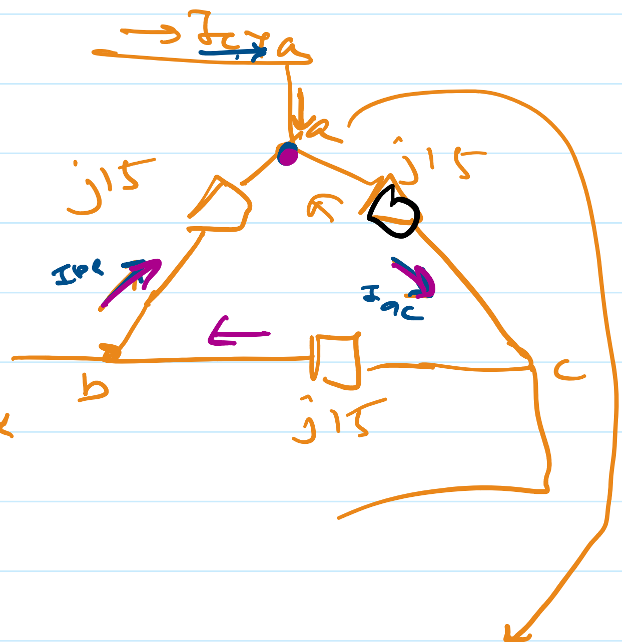
$$|I_s| = \underline{\underline{0.2\,A}}$$

$$I_{cY} = \frac{V_{Za}}{-j5} = \frac{V_a - I_s(j2.5)}{-j5}$$

$$= \frac{1\angle -30 - 0.2\angle 60^\circ (2.5\angle 90^\circ)}{5\angle -90^\circ}$$

$$= \frac{1.5\angle -30^\circ}{5\angle -90^\circ} = 0.3\angle 60^\circ \text{ A}$$





$I_{cY} + I_{ba} = I_{ac}$ (Apply KCL@ a)

$I_{cY} = I_{ac} - I_{ba}$

$= \sqrt{3}\, I_{ac} \angle -30^\circ \Rightarrow \boxed{I_{ac} = \frac{I_{cY}}{\sqrt{3}\angle -30^\circ}}$

$$I_{ac} = I_e = \frac{0.3\angle 60^\circ}{\sqrt{3}\angle -30^\circ}$$

$$I_c = \left|\frac{\sqrt{3}}{10}\right| \angle 90^\circ \text{ A.}$$

$3(V_e \cdot I_e^*)$

$= \quad -j5$

$$|I_e| = \frac{\sqrt{3}}{10} \text{ A}$$

$I_{ab} - I_{ca} = \sqrt{3}\, I_{ab} \angle -30^\circ$

$I_{ac} - I_{ba} = \sqrt{3}\, I_{ac} \angle -30^\circ$