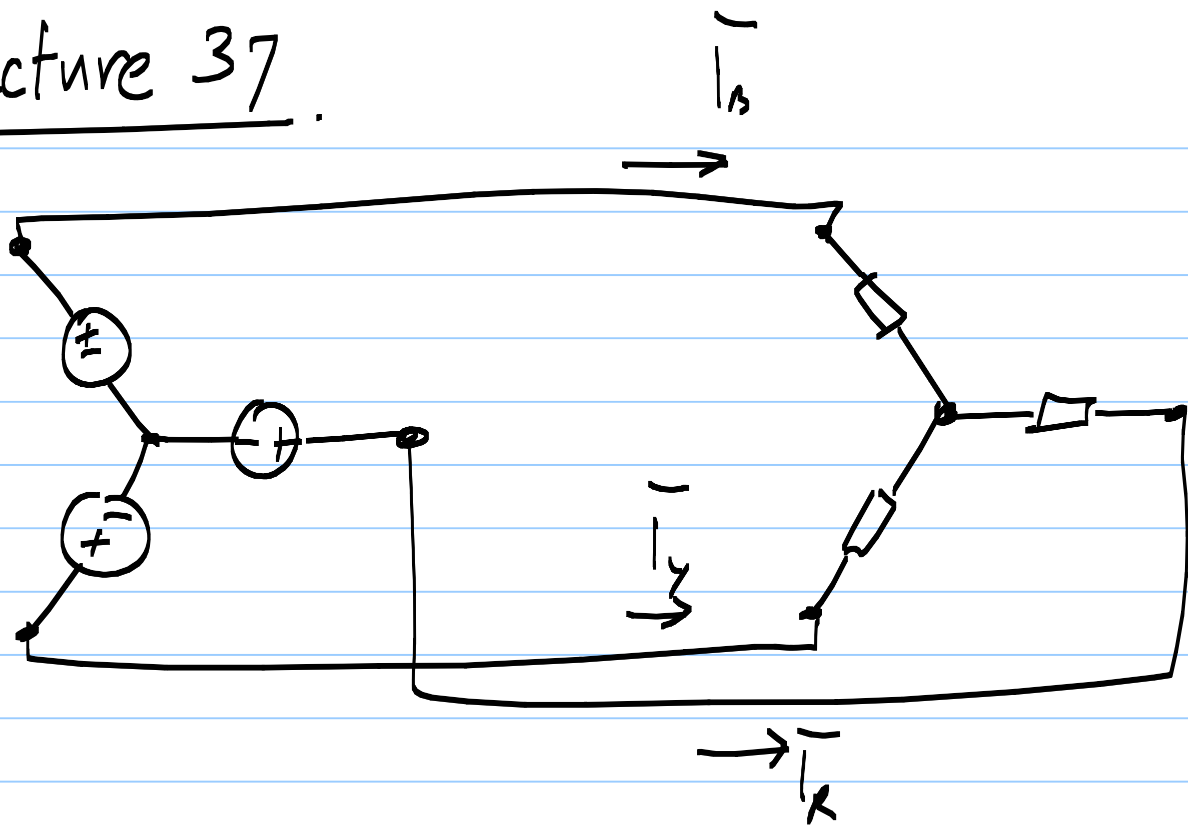
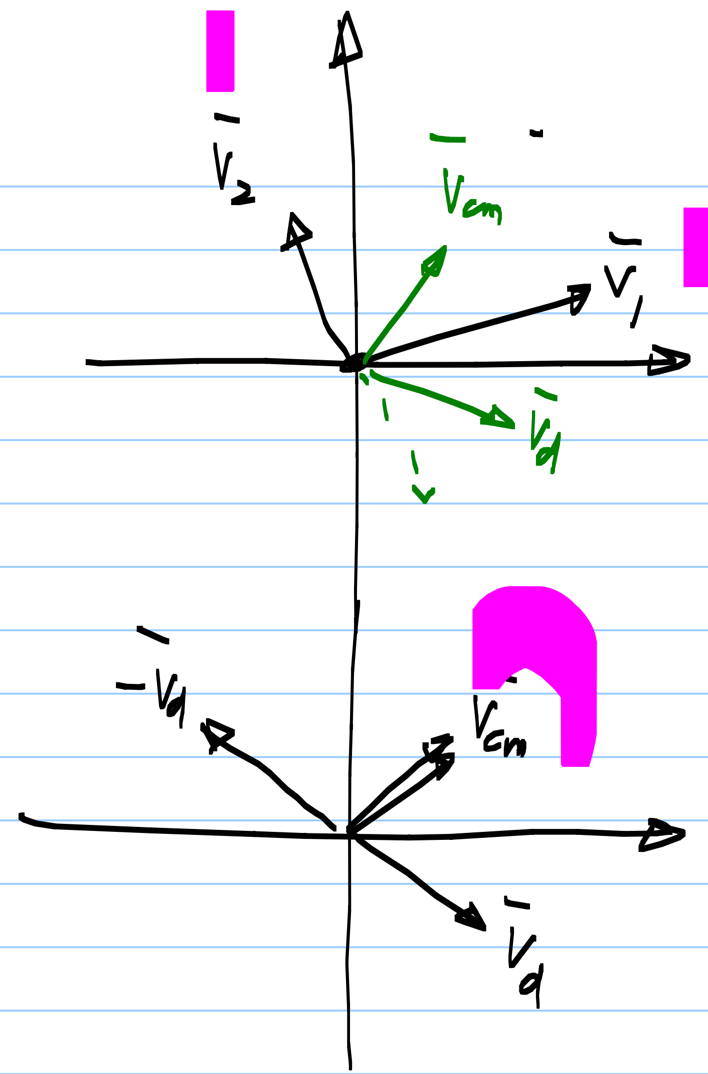
Lecture 37



$$\begin{bmatrix} \bar{I}_R \\ \bar{I}_Y \\ \bar{I}_B \end{bmatrix} =$$

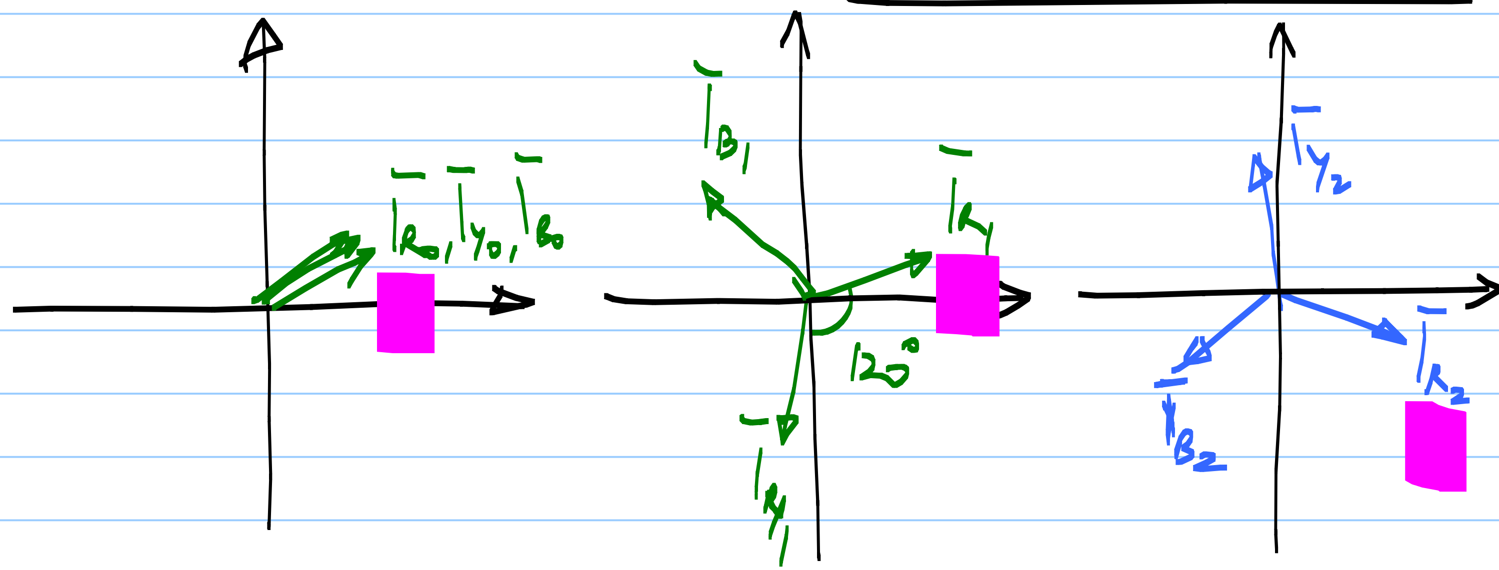
$$\bar{V}_1 = \underbrace{\frac{\bar{V}_1 + \bar{V}_2}{2}}_{\bar{V}_{cm}} + \underbrace{\frac{\bar{V}_1 - \bar{V}_2}{2}}_{\bar{V}_d}$$

$$\bar{V}_2 = \frac{\bar{V}_1 + \bar{V}_2}{2} - \frac{\bar{V}_1 - \bar{V}_2}{2}$$



Symmetrical component representation of 3 phase unbalanced signal

$$\begin{bmatrix} \bar{I}_R \\ \bar{I}_Y \\ \bar{I}_B \end{bmatrix} =$$



Zero sequence

positive sequence

negative sequence

$$\bar{I}_R = \bar{I}_{R_0} + \bar{I}_{R_1} + \bar{I}_{R_2}$$

$$\bar{I}_Y = \bar{I}_{R_0} + \alpha^2 \bar{I}_{R_1} + \alpha \cdot \bar{I}_{R_2}$$

$$\bar{I}_B = \bar{I}_{R_0} + \alpha \bar{I}_{R_1} + \alpha^2 \bar{I}_{R_2}$$

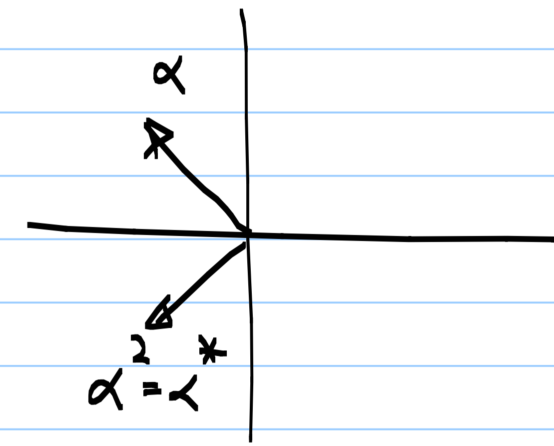
$$\begin{bmatrix} \bar{I}_R \\ \bar{I}_Y \\ \bar{I}_B \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha^2 & \alpha \\ 1 & \alpha & \alpha^2 \end{bmatrix} \begin{bmatrix} \bar{I}_{R_0} \\ \bar{I}_{R_1} \\ \bar{I}_{R_2} \end{bmatrix}$$

$$\alpha = \exp(j2\pi/3)$$

$$\alpha^2 = \exp(j4\pi/3) = \alpha^*$$

$$\alpha + \alpha^2 = -1$$

$$1 + \alpha + \alpha^2 = 0$$



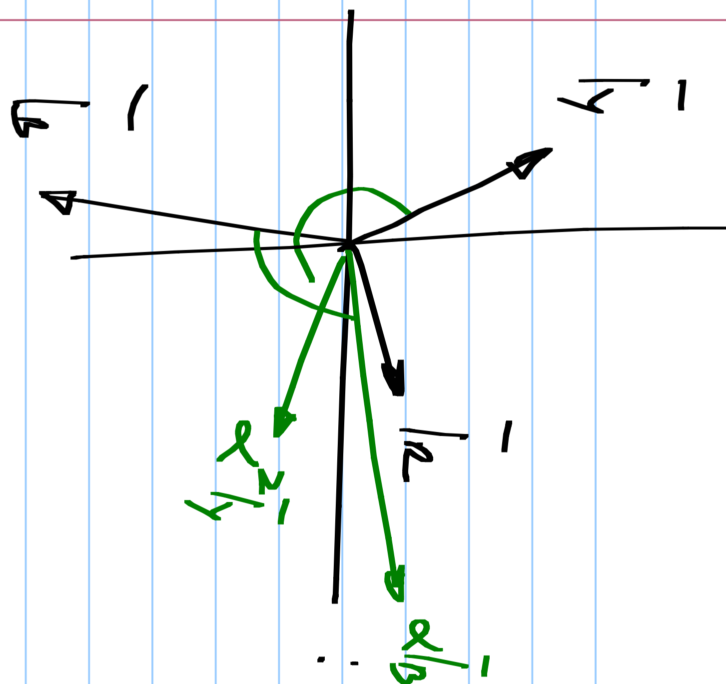
$$\begin{bmatrix} \bar{I}_R \\ \bar{I}_Y \\ \bar{I}_B \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha^2 & \alpha \\ 1 & \alpha & \alpha^2 \end{bmatrix} \begin{bmatrix} \bar{I}_{R0} \\ \bar{I}_{R1} \\ \bar{I}_{R2} \end{bmatrix}$$

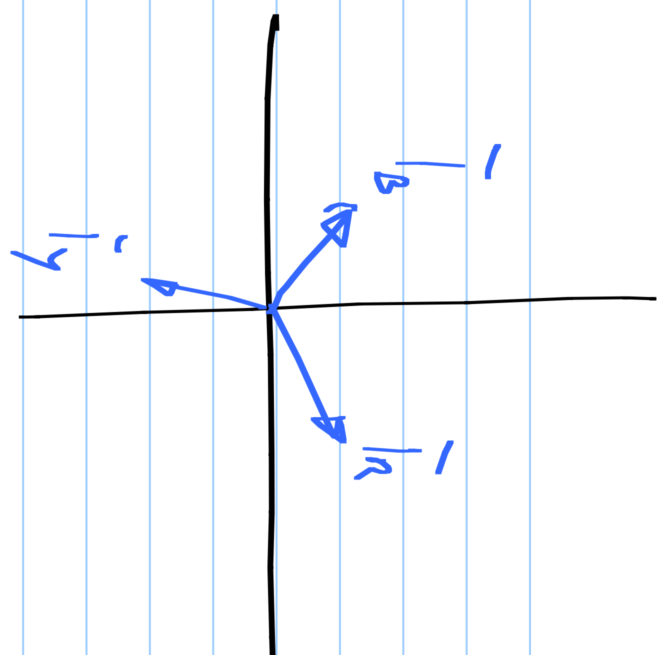
$$[\Lambda]$$

$$[\Lambda]^T = [\Lambda]^*$$

$$[\Lambda]^{-1} = \frac{1}{3} \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \end{bmatrix}$$

$$\begin{bmatrix} \bar{I}_{R0} \\ \bar{I}_{R1} \\ \bar{I}_{R2} \end{bmatrix} = [\Lambda]^{-1} \begin{bmatrix} \bar{I}_R \\ \bar{I}_Y \\ \bar{I}_B \end{bmatrix} = \frac{1}{3} \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \end{bmatrix} \begin{bmatrix} \bar{I}_R \\ \bar{I}_Y \\ \bar{I}_B \end{bmatrix}$$





3 phase unbalanced load: (star connected)

phase voltages: $\bar{V}_R, \bar{V}_y, \bar{V}_B$ } $[\bar{V}_{R_0}, \bar{V}_{R_1}, \bar{V}_{R_2}]^T$

currents: $\bar{I}_R, \bar{I}_y, \bar{I}_B$ } $\bar{I}_{R_0}, \bar{I}_{R_1}, \bar{I}_{R_2}$

$$P = \frac{1}{2} Re \left[\bar{V}_R \bar{I}_R^* + \bar{V}_y \bar{I}_y^* + \bar{V}_B \cdot \bar{I}_B^* \right]$$

$$\begin{bmatrix} \bar{V}_R \\ \bar{V}_y \\ \bar{V}_B \end{bmatrix} = \underline{\bar{V}} \qquad \begin{bmatrix} \bar{I}_R \\ \bar{I}_y \\ \bar{I}_B \end{bmatrix} = \underline{\bar{I}}$$

$$= \frac{1}{2} Re \ \underline{\bar{V}}^T \cdot \underline{\bar{I}}^*$$

$$\underline{\bar{V}} = [\Lambda] \underline{\bar{V}_s}$$

$$\underline{\bar{I}} = [\Lambda] \cdot \underline{\bar{I}_s}$$

$$= \frac{1}{2} Re \ \underline{\bar{V}_s}^T \cdot \underbrace{[\Lambda]^T [\Lambda]^*}_{3 \cdot [I]} \cdot \underline{\bar{I}_s}^*$$

$$= \frac{3}{2} \operatorname{Re}\left[\underline{\bar{V}}_s^{T} \cdot \underline{\bar{I}}_s^{*} \right]$$

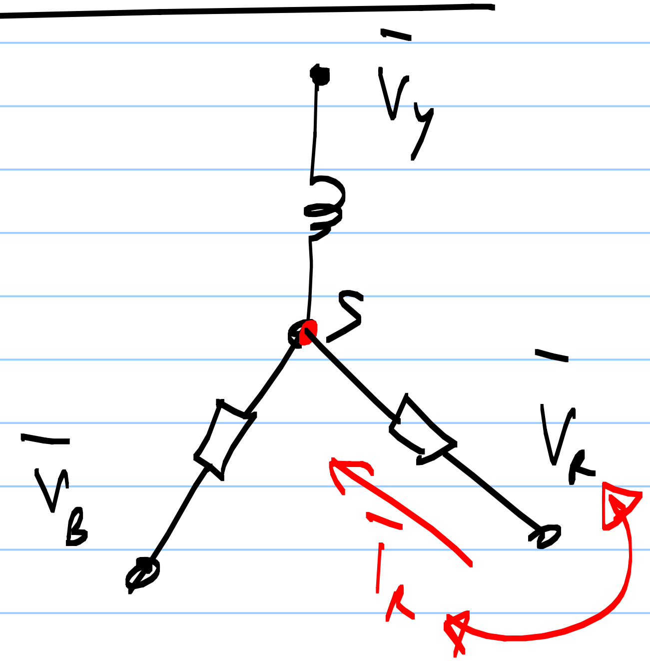
$$= \frac{3}{2} \operatorname{Re}\left[\bar{V}_{s_0} \bar{I}_{s_0}^{*} + \bar{V}_{s_1} \bar{I}_{s_1}^{*} + \bar{V}_{s_2} \bar{I}_{s_2}^{*} \right]$$

$$\underline{\bar{V}} = [Z] \cdot \underline{\bar{I}}$$

$$[\Lambda] \underline{\bar{V}_s} = [Z] [\Lambda] \cdot \underline{\bar{I}_s}$$

$$\underbrace{\underline{\bar{V}_s}} = \underbrace{[\Lambda]^{-1} [Z] [\Lambda]}_{[Z_s]} \cdot \underbrace{\underline{\bar{I}_s}}$$

Source: balanced:



3 wire: