E_E 491
Review Session #8

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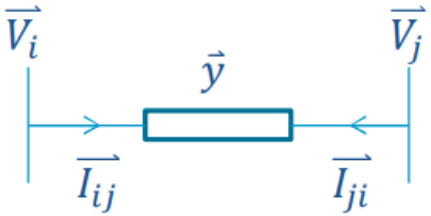
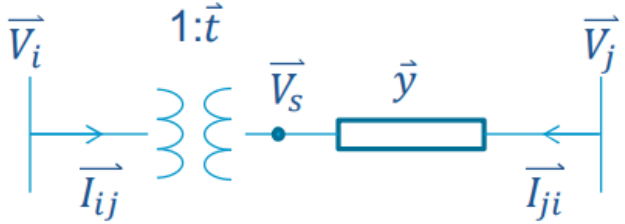
Fall 2020

Ybus Matrix with Tap Changers and Phase Shifters



$$\begin{bmatrix} \vec{I}_{ij} \\ \vec{I}_{ji} \end{bmatrix} = \begin{bmatrix} \vec{y} & -\vec{y} \\ -\vec{y} & \vec{y} \end{bmatrix} \begin{bmatrix} \vec{V}_i \\ \vec{V}_j \end{bmatrix}$$

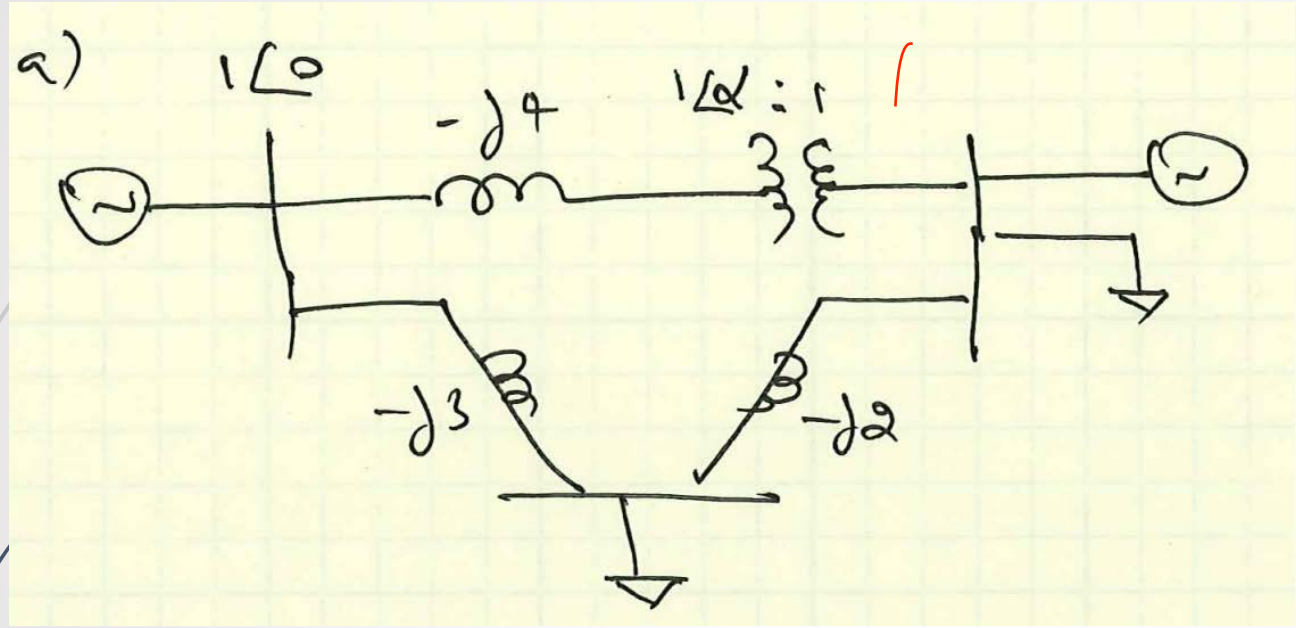


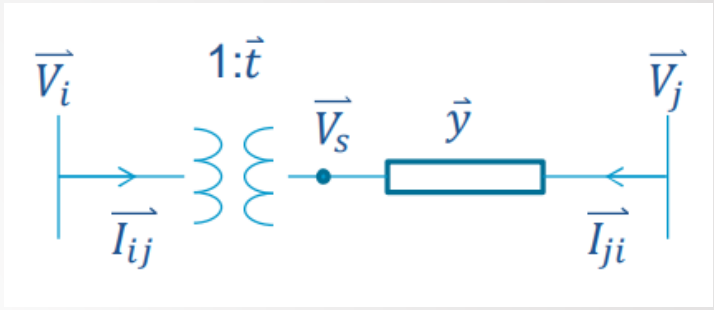
$$\vec{V}_s = \vec{t}\vec{V}_i$$

$$\vec{I}_{ji} = (\vec{V}_j - \vec{t}\vec{V}_i)\vec{y} = -\vec{t}\vec{y}\vec{V}_i + \vec{y}\vec{V}_j$$

$$\begin{bmatrix} \vec{I}_{ij} \\ \vec{I}_{ji} \end{bmatrix} = \begin{bmatrix} |t|^2\vec{y} & -\vec{t}^*\vec{y} \\ -\vec{t}\vec{y} & \vec{y} \end{bmatrix} \begin{bmatrix} \vec{V}_i \\ \vec{V}_j \end{bmatrix}$$

Ybus Matrix (Ex. 1)

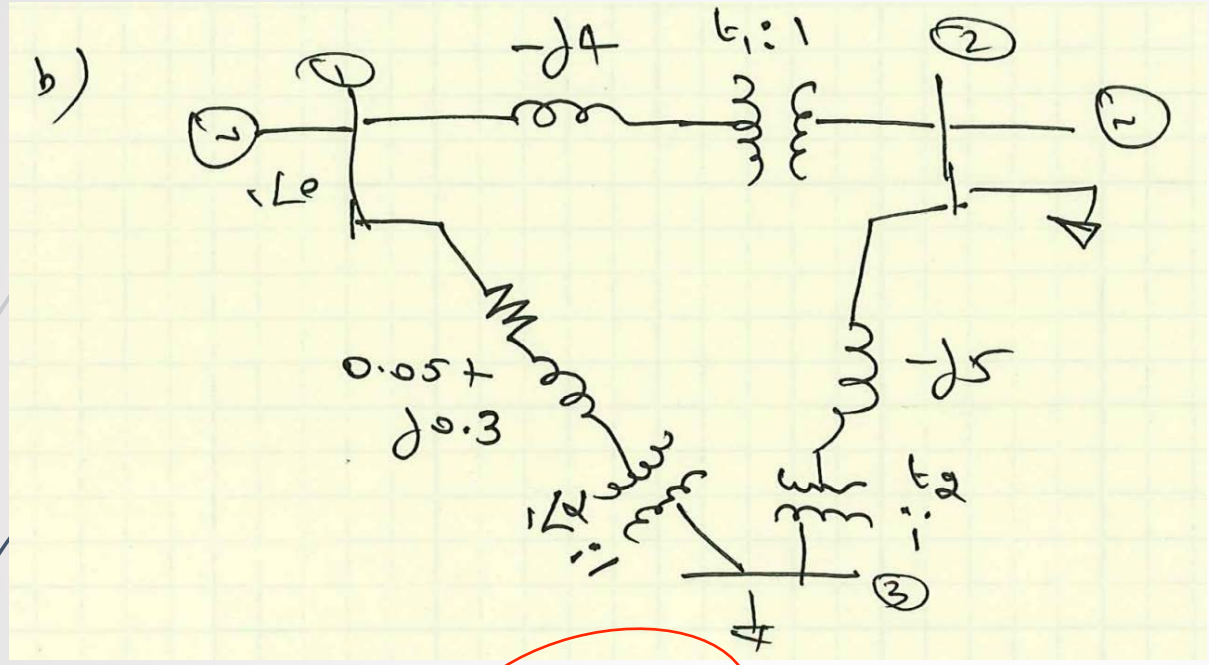


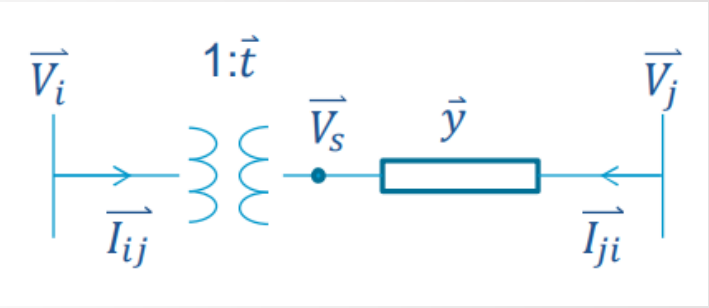


$$\begin{bmatrix} \vec{I}_{ij} \\ \vec{I}_{ji} \end{bmatrix} = \begin{bmatrix} |t|^2\vec{y} & -\vec{t}^*\vec{y} \\ -\vec{t}\vec{y} & \vec{y} \end{bmatrix} \begin{bmatrix} \vec{V}_i \\ \vec{V}_j \end{bmatrix}$$

$$Y_{bus} = \begin{bmatrix} -j4 - j3 & -(1\angle\alpha)(-j4) & j3 \\ -(1\angle -\alpha)(-j4) & -j4 - j2 & j2 \\ j3 & j2 & -j3 - j2 \end{bmatrix} = \begin{bmatrix} -j7 & j4\angle\alpha & j3 \\ j4\angle -\alpha & -j6 & j2 \\ j3 & j2 & -j5 \end{bmatrix}$$

Ybus Matrix (Ex. 2)





$$\begin{bmatrix} \vec{I}_{ij} \\ \vec{I}_{ji} \end{bmatrix} = \begin{bmatrix} |t|^2\vec{y} & -\vec{t}^*\vec{y} \\ -\vec{t}\vec{y} & \vec{y} \end{bmatrix} \begin{bmatrix} \vec{V}_i \\ \vec{V}_j \end{bmatrix}$$

$$Y_{bus} = \begin{bmatrix} -j4 + \frac{1}{0.05+j0.3} & -t_1(-j4) & -(1\angle\alpha)\left(\frac{1}{0.05+j0.3}\right) \\ -t_1^*(-j4) & -j4|t_1|^2 - j5 & -t_2(-j5) \\ -(1\angle -\alpha)\left(\frac{1}{0.05+j0.3}\right) & -t_2^*(-j5) & \frac{1}{0.05+j0.3} - j5|t_2|^2 \end{bmatrix} = \begin{bmatrix} 0.54 - j7.24 & j4t_1 & (-0.54+j3.24)\angle\alpha \\ j4t_1^* & -j4|t_1|^2 - j5 & j5t_2 \\ (-0.54+j3.24)\angle -\alpha & j5t_2^* & 0.54 - j3.24 - j5 \end{bmatrix}$$

Questions?