continued from last day,

$$\underline{I}_A = \underline{K} V_A + \underline{L} \underline{V}_x \quad (1)$$

$$\underline{I}_x = \underline{L}^T V_A + \underline{M} \underline{V}_x \quad (2)$$

$$\underline{I}_x = 0$$

$$(2) \Rightarrow \quad \underline{L}^T \underline{V}_A = -\underline{M} \underline{V}_x \quad (3)$$

$$V_x = -\underline{M}^{-1} \underline{L}^T \underline{V}_A \quad (4)$$

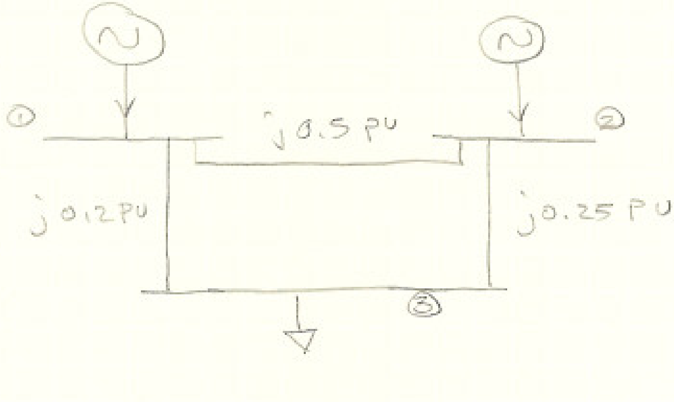
$$(4) \to (1) \quad \underline{I}_A = \underline{K} \underline{V}_A - \underline{L} \underline{M}^{-1} \underline{L}^T \underline{V}_A$$

$$\underline{I}_A = \underbrace{\boxed{\left[\underline{K} - \underline{L} \underline{M}^{-1} \underline{L}^T \right]}}_{\underline{Y}_{new}} \underline{V}_A$$

This ladder equation enables us to construct the network with the unwanted nodes eliminated.

Matrix partitioning is convenient but it requires to invert the submatrix M, which can be a large matrix. To avoid inverting $\underline{M}$, elimination can be carried out by eliminating one node at a time, making the process very simple.

Ex:



form the Ybus, find the new Ybus by eliminating node #3

SOL

$$\underline{Y}_{BUS} = \begin{bmatrix} -j7.0 & j2 & j5 \\ j2 & -j6 & j4 \\ j5 & j4 & -j9 \end{bmatrix}$$

$$\begin{bmatrix} \underline{I}_A \\ \underline{I}_x \end{bmatrix} = \begin{bmatrix} \underline{K} & \underline{L} \\ \underline{L}^T & \underline{M} \end{bmatrix} \begin{bmatrix} V_A \\ V_x \end{bmatrix}$$

in our case we have

$$\begin{bmatrix} \underline{I}_1 \\ \underline{I}_2 \\ 0 \end{bmatrix} = \begin{bmatrix} -j7 & j2 & j5 \\ j2 & -j6 & j4 \\ j5 & j4 & -j9 \end{bmatrix} \begin{bmatrix} \underline{V}_1 \\ \underline{V}_2 \\ \underline{V}_3 \end{bmatrix}$$

I_A I_x K L L^T M V_A V_x

$$\therefore (\underline{Y}_{bus})_{new} = \left[\underline{K} - \underline{L}\,\underline{M}^{-1}\underline{L}^T\right]$$

$$= j\begin{bmatrix} -7 & 2 \\ 2 & -6 \end{bmatrix} - j\begin{bmatrix} 5 \\ 4 \end{bmatrix}\left(\frac{1}{j9}\right) j\begin{bmatrix} 5 & 4 \end{bmatrix}$$

$$= j\left[\begin{bmatrix} -7 & 2 \\ 2 & -6 \end{bmatrix} + \frac{1}{9}\begin{bmatrix} 25 & 20 \\ 20 & 25 \end{bmatrix}\right]$$

$$= j\begin{bmatrix} -4.222 & 4.222 \\ 4.222 & -4.222 \end{bmatrix}$$

note: It will be symetrical, but not nessisarilly the same values

LOAD FLOW PROBLEM

Basically a load flow study is the solution of a system for relavant voltages, phase angles and active/reactive power flows, given specified loads and operating limits on the system.

From this data, satisfactory or unsatisfactory operation with respect to line flows and voltage levels can be found and variations in system operation, addition and deletion of lines can be studied.

A basic load flow may be modified to minimize operating costs and maximise reliability and provide a starting point for

"What happens if..." explorations

SYSTEM EQUATIONS

the basic equations relating voltage and current in a system, may be expressed by loop, node, or mixed equations.

Here in this course, we shall only use the nodal formulation as it has several advantages. These include quick, easy selection of proper equations and sparsity of the resulting admitance matrix.

A sparce matrix is one in which most of the off-diagonal elements are zero. This is an advantage in Programming as is saves time and storage.