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Section : A-2

Course No : EEE-4402

Exp No : 03

Exp Name : Formation of Bus admittance Matrix Using MATLAB

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Theory:

In power system analysis, buses (or nodes) are interconnected through transmission lines, transformers, and other components. The electrical relationship between bus voltages are injected currents is represented by the bus admittance matrix (YBUS). For an n-bus system, this relationship can be expressed as:

$$I = Y_{bus} \cdot V$$

$$\Rightarrow \begin{bmatrix} I_1 \\ I_2 \\ \vdots \\ I_n \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} & \cdots & Y_{1n} \\ Y_{21} & Y_{22} & \cdots & Y_{2n} \\ \vdots & & \cdots & \vdots \\ Y_{n1} & Y_{n2} & \cdots & Y_{nn} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ V_n \end{bmatrix}$$

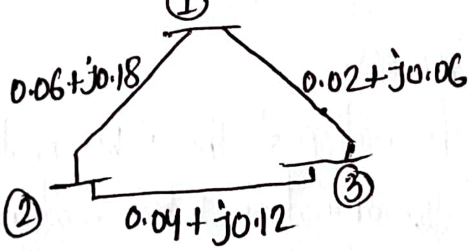
- Diagonal element (Y_{ij}): These represent the sum of all admittances connected to bus i and are referred to as self-admittance.

- Off-diagonal elements (Y_{ij}): These represent the negative of the admittance of the line directly connecting buses i and j. They are also called mutual admittance. If no lines exists between two buses, this element is zero.

The inverse of the Y-bus matrix gives the bus impedance matrix (ZBUS), which is particularly important in short-circuit studies. While the Y-Bus is typically sparse in structure, the Z-BUS is generally a full matrix.

Overall, the Y-bus matrix forms the foundation for a wide range of power system studies, including load flow analysis, fault analysis, and stability investigations.

Sample problem: Theoretical



Formation of YBUS:

$$Y_{bus} = \begin{bmatrix} \left(\frac{1}{0.06+j0.18} + \frac{1}{0.04+j0.12}\right) & \frac{-1}{0.06+j0.18} & \frac{-1}{0.02+j0.06} \\ \frac{-1}{0.06+j0.18} & \left(\frac{1}{0.06+j0.18} + \frac{1}{0.04+j0.12}\right) & \frac{-1}{0.04+j0.12} \\ \frac{-1}{0.02+j0.06} & \frac{-1}{0.04+j0.12} & \left(\frac{1}{0.04+j0.12} + \frac{1}{0.02+j0.06}\right) \end{bmatrix}$$

$$
= \begin{bmatrix} 6.66-j19.9 & -1.66+j5 & -5+j15 \\ -1.66+j5 & 4.16-j12.38 & -2.5+j7.5 \\ -5+j15 & -2.5+j7.5 & 7.5-j22.39 \end{bmatrix}
$$

Problem 2

$$
Y_{bus} = \begin{bmatrix} \left(\frac{1}{j0.25}+\frac{1}{j0.125}+\frac{1}{j0.4}\right) & \frac{-1}{j0.125} & \frac{-1}{j0.25} & \frac{-1}{j0.4} \\ -\frac{1}{j0.125} & \left(-\frac{1}{j0.25}+\frac{1}{j0.125}+\frac{1}{j0.2}\right) & \frac{-1}{j0.25} & \frac{-1}{j0.2} \\ -\frac{1}{j0.4} & -\frac{1}{j0.2} & 0 & \frac{1}{j0.2}+\frac{1}{j0.4}+\frac{1}{j1.25} \end{bmatrix}
$$

$$
= \begin{bmatrix} -14.5j & 8j & 4j & 2.5j \\ 8j & -17j & 4j & 5j \\ 4j & 4j & -8.8j & 0 \\ 2.5j & 5j & 0 & -8.3j \end{bmatrix}
$$

Matlab codes are written in the next page.

So, here we can see that the theoretical calculations obtained and the result from the MATLAB coding are exactly the same.

Discussion:

In this experiment we learned how to construct a Y-BUS matrix for a given power system network. To acheive this, we first required the Z-BUS dataset, which is essential for forming the Y-bus matrix. We also practiced generating the Z-bus dataset from a specified network, a step that plays a critical role in the process.

Additionally, we implemented the formation of the Y-bus matrix using MATLAB. By doing so, we compared the theoretically calculated Y-bus matrix with the results obtained from our user-defined MATLAB function. The outcomes showed a perfect match, confirming the accuracy of both our theoretical approach and the MATLAB implementation.