A function called **Y = ybus(zdata)** is written for the formation of the bus admittance matrix. **zdata** is the line data input and contains four columns. The first two columns are the line bus numbers and the remaining columns contain the line resistance and reactance in per unit. The function returns the bus admittance matrix. The algorithm for the bus admittance program is very simple and basic to power system programming. Therefore, it is presented here for the reader to study and understand the method of solution. In the program, the line impedances are first converted to admittances. Y is then initialized to zero. In the first loop, the line data is searched, and the off-diagonal elements are entered. Finally, in a nested loop, line data is searched to find the elements connected to a bus, and the diagonal elements are thus formed.

The solution of equation $\mathbf{I}_{bus} = \mathbf{Y}_{bus}\mathbf{V}_{bus}$ by inversion is very inefficient. It is not necessary to obtain the inverse of $\mathbf{Y}_{bus}$. Instead, direct solution is obtained by optimally ordered triangular factorization. In *MATLAB*, the solution of linear simultaneous equations $AX = B$ is obtained by using the matrix division operator \ (i.e., $X = A \backslash B$), which is based on the triangular factorization and Gaussian elimination. This technique is superior in both execution time and numerical accuracy. It is two to three times as fast and produces residuals on the order of machine accuracy.

There are two choices. The current flow through a network component can be related to the voltage drop across it by either an admittance or an impedance parameter. This chapter treats the admittance representation in the form of a *primitive model* which describes the electrical characteristics of the network components. The primitive model neither requires nor provides any information about how the components are interconnected to form the network. The steady-state behavior of all the components acting together as a system is given by the *nodal admittance matrix* based on nodal analysis of the network equations.

The nodal admittance matrix of the typical power system is large and sparse, and can be constructed in a systematic building-block manner. The building-block approach provides insight for developing algorithms to account for network changes. Because the network matrices are very large, *sparsity techniques* are needed to enhance the computational efficiency of computer programs employed in solving many of the power system problems described in later chapters.

In a power system, **Bus Admittance Matrix** represents the nodal admittances of the various buses. With the help of the transmission line, each bus is connected to the various other buses. Admittance matrix is used to analyse the data that is needed in the load or a power flow study of the buses. It explains the admittance and the topology of the network. The following are the advantages of the bus admittance matrix.

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

The amount of current present in the bus can be calculated with the help of formation of the Admittance matrix. It is expressed as shown above.

In the simplest form, the above matrix can be written as shown below.

$$I = [Y]\,V$$

Where,

- I is the current of the bus in the vector form.
- Y is the admittance matrix
- V is the vector of the bus voltage.

Ybus by the Building Block Matrix Approach

For a network branch defined by voltage nodes ***m*** and ***n*** with branch admittance, $\mathbf{Y_b}$

1. If neither node **m** and **n** is connected to the reference (or ground) then Nodal admittance equation w.r.t. ***m*** and ***n***:

$$\begin{matrix} & m & n \\ m & \left[\begin{matrix} 1 \\ -1 \end{matrix}\right. & \left.\begin{matrix} -1 \\ 1 \end{matrix}\right] Y_b \\ n & & \end{matrix}$$

2. If one of the nodes (m or n) is connected to the reference, for instance, node m then

$$\begin{matrix} & n \\ n & [1]\ Y_b \end{matrix}$$

- The Building Block Matrix approach has advantages when extended to networks with mutually coupled branches

- In this case neither of the nodes **m** nor **n** is connected to the reference, this $\mathbf{Y_{bus}}$ matrix is singular. (inverse does not exist or **det** [.]=0)
- If one of **m** or **n** is connected to the reference, then Ybus is 1 x 1

$$\begin{matrix} & m \\ m & [\mathrm{Y_b}] \end{matrix} V_m = I_m$$