

### EXPERIMENT NO. 3

#### OBJECTIVE

To Formulate  $Y_{BUS}$  Matrix By Singular Transformation.

#### SOFTWARE USED

MATLAB

#### THEORY

Here a Network model of power system is shown in figure 1 . The Lumped shunt Admittances at the bus is taken as consideration. Besides the ground nodes it has four nodes (buses) at which the current from the source is injected into the Network . The line admittance between nodes  $i$  and  $k$  is depicted by  $y_{ik}=y_{ki}$  . The Mutual admittances between lines is assumed to be zero. The

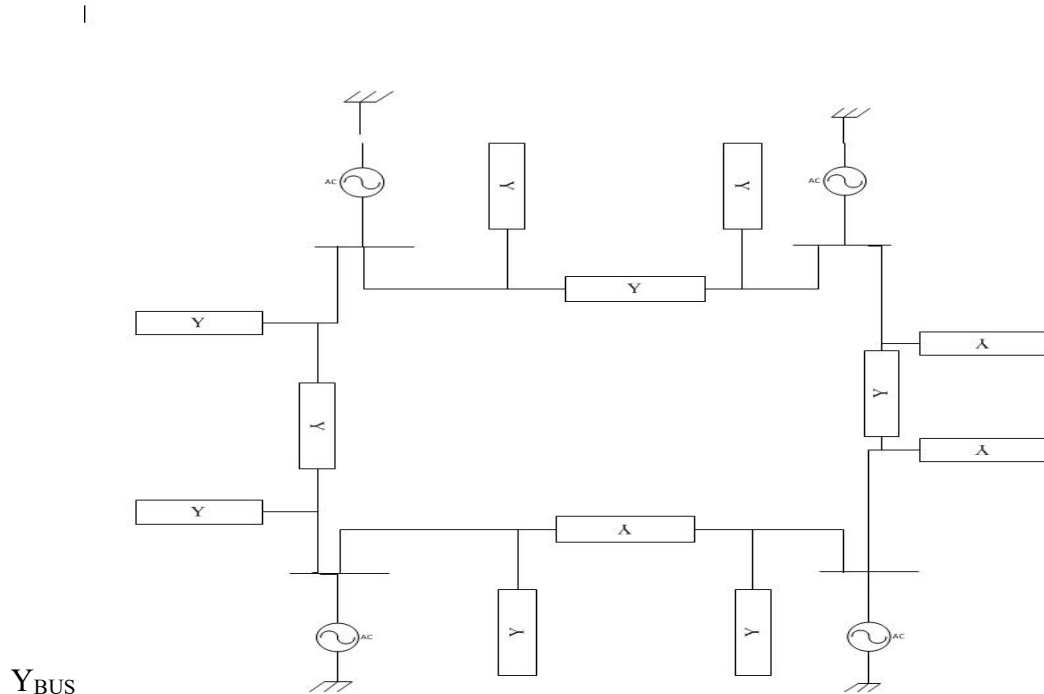


Fig: 1

By applying Kirchoff's current law at node 1, 2, 3, and 4,

$$I_1 = V_1 y_{10} + (V_1 - V_2) y_{12} + (V_1 - V_3) y_{13}$$

$$I_2 = V_2 y_{20} + (V_2 - V_1) y_{21} + (V_2 - V_3) y_{23} + (V_2 - V_4) y_{24}$$

$$I_3 = V_3 y_{30} + (V_3 - V_1) y_{31} + (V_3 - V_2) y_{32} + (V_3 - V_4) y_{34}$$

$$I_4 = V_4 y_{40} + (V_4 - V_2) y_{42} + (V_4 - V_3) y_{43}$$

By rearranging and writing in matrix form , we get

$$\begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} (y_{10} + y_{12} + y_{13}) & -y_{12} & -y_{13} & 0 \\ -y_{12} & (y_{20} + y_{21} + y_{23} + y_{24}) & -y_{23} & -y_{24} \\ -y_{13} & -y_{23} & (y_{30} + y_{31} + y_{32} + y_{34}) & -y_{34} \\ 0 & -y_{24} & -y_{34} & (y_{40} + y_{41} + y_{43} + y_{34}) \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix}$$

This can be rewritten as

$$\begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix}$$

Where

$$Y_{11} = (y_{10} + y_{12} + y_{13})$$

$$Y_{22} = (y_{20} + y_{12} + y_{23} + y_{24})$$

$$Y_{33} = (y_{31} + y_{32} + y_{33} + y_{34})$$

$$Y_{44} = (y_{41} + y_{42} + y_{43} + y_{44})$$

The  $Y_{BUS}$  matrix is exist in pair of  $Z_{BUS}$  matrix network for load flow studies .The  $Y_{BUS}$  is assembled by use of singular transformations .

$$Y_{bus} = A^T Y A; A = \text{Bus incidence matrix}$$

### **PROBLEM STATEMENT**

Figure below shows the one-line diagram of a simple four bus system. Table 1 gives the line impedances identified by the buses on which these terminate. The shunt admittance at all the buses is assumed negligible.

- Find  $Y_{bus}$  assuming that the line shown dotted is not connected.
- What modifications need to be carried out in  $Y_{bus}$  if the line shown dotted is connected.

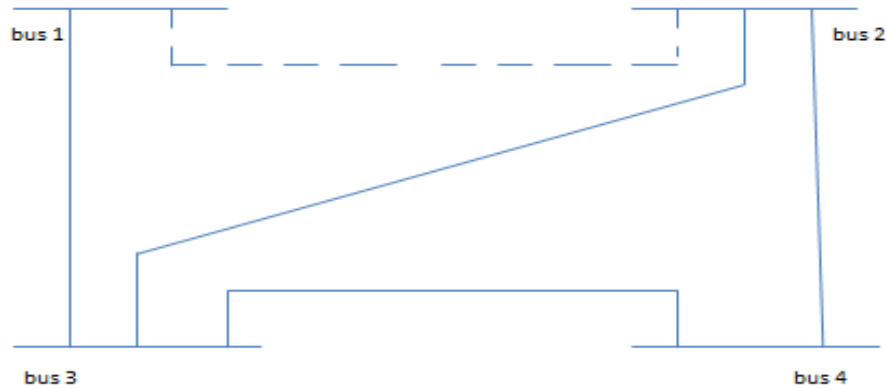


Fig: 2-Sample system

**Table 1**

Line Bus to bus	R pu	X pu
1-2	0.05	0.15
1-3	0.10	0.30
2-3	0.15	0.45
2-4	0.10	0.30
3-4	0.05	0.15

## **CONCLUSION**

Linear network graph helps in systematic assembly of a network model. Singular transformation is an easier method to solve for Y bus matrix. It is helpful when system is large and MATLAB programming is easier.

## **REFERENCES**

- [1]. Stevenson Jr, W. D. (1982). *Elements of Power System Analysis*, (4th), Mc-Graw Hill Higher Education.
- [2]. Hadi Saadat, “*Power System Analysis*”, Milwaukee School of Engineering, McGraw Hill, 1999.
- [3]. Kothari D. P., Nagrath I. J., “*Modern Power System Analysis*”, Mc-Graw Hill Higher Education.

## APPENDIX

### MATLAB CODE

```
ydata=[1 1 2 1/(0.05+j*0.15) 0 0
        2 1 3 1/(90.1+j*0.30) 0 0
        3 2 3 1/(0.15+j*0.45) 0 0
        4 2 4 1/(0.10+j*0.30) 0 0
        5 3 4 1/(0.05+j*0.15) 0 0];
elements=max(ydata(:,1))
yprimitive=zeros(elements,elements)
for i=1:elements,
    yprimitive(i,i)=yadata(i,4)
    if(ydata(i,5)~=0)
        j=ydata(i,5)
        ymutual=ydata(i,6)
        yprimitive(i,j)=ymutual
    end
end
buses =max(max(ydata(2:)),max(ydata(3,:)))
A=zeros(elements,buses)
for i=1:elements
    if ydata(i,2)~=0
        A(i,ydata(i,2))=1;
    end
    if ydata(i,3)~=0
        A(i,ydata(i,3))=-1
    end
end
YBUS=A'*yprimitive*A
```