Power Systems Laboratory (EE3P006)

EXPERIMENT-2

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FORMATION OF BUS ADMITTANCE AND IMPEDANCE MATRICES AND SOLUTION OF NETWORKS

AIM:

To develop a program to obtain Ybus matrix for the given networks by the method of inspection.

FORMATION OF Y-BUS MATRIX

Each admittance Yii (i =1,2,……n) is called the self admittance or driving point admittance of bus I and equals the sum of all admittances terminating on the particular bus. Each off-diagonal term Yij (i,j = 1,2…n; j$\neq$i) is the transfer admittance between buses I and j, n=total number of buses. Further, Yij = Yji

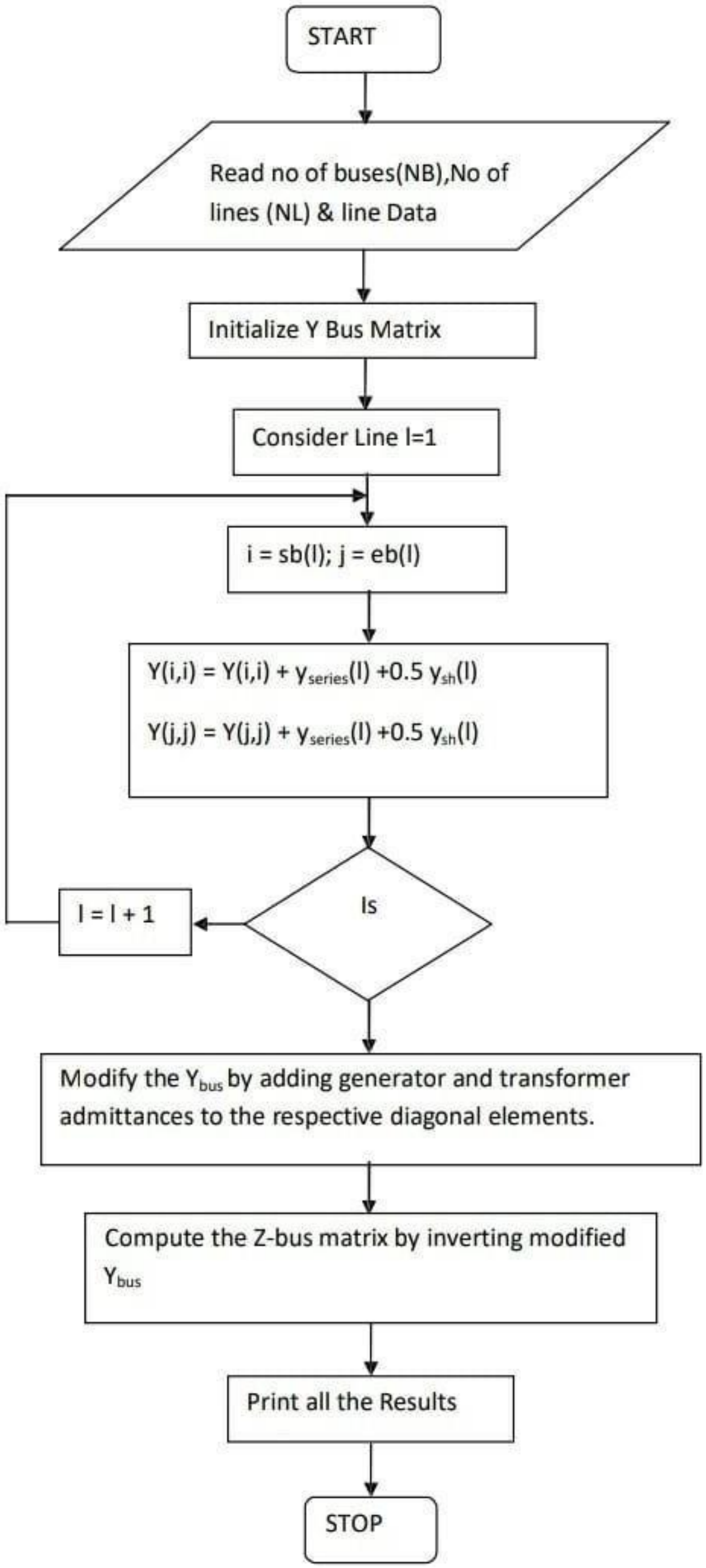
ALGORITHM

Step (1): Initialize [Y-Bus] matrix that is replace all entries by zero. Yij = Yij-yij = Yji = off diagonal element n

Step (2): Compute Yii $=\sum$yij = diagonal element. j $=$1

Step (3) : Modify the Ybus matrix by adding the transformer and the generator admittances to the respective diagonal elements of Y- bus matrix.

Step (4) : Compute the Z-Bus matrix by inverting the modified Ybus matrix.


START
Read no of buses(NB),No of lines (NL) & line Data
Initialize Y Bus Matrix
Consider Line l=1
i = sb(l); j = eb(l)
Y(i,i) = Y(i,i) + y_series(l) +0.5 y_sh(l)
Y(j,j) = Y(j,j) + y_series(l) +0.5 y_sh(l)
Is
l = l + 1
Modify the Y_bus by adding generator and transformer admittances to the respective diagonal elements.
Compute the Z-bus matrix by inverting modified Y_bus
Print all the Results
STOP

1. The [Y-Bus] matrix is formed by inspection method for a four bus system. The line data and is given below.

LINE DATA

Line Number	SB	EB	Series Impedance (p.u)	Line charging Admittance (p.u)
1	1	2	0.10 + j0.40	j0.015
2	2	3	0.15 + j0.60	j0.020
3	3	4	0.18 + j0.55	j0.018
4	4	1	0.10 + j0.35	j0.012
5	4	2	0.25 + j0.20	j0.030

FORMATION OF Y-BUS BY THE METHOD OF INSPECTION

PROGRAM:

```
clc; clear all;
%   lineno. Frombus Tobus series Impeadence Admittance
linedata = [ 1  1   2   0.1+1i*0.4  1i*0.015;
2   2   3   0.15+1i*0.6 1i*0.2;
3   3   4   0.18+1i*0.55    1i*0.018;
4   4   1   0.1+1i*0.35 1i*0.012;
5   4   2   0.25+1i*0.2 1i*0.3];

gfb = linedata(:,2); %going from bus ctb = linedata(:,3); %coming to bus

y= 1./linedata(:,4);
a = linedata(:,5);

nbus = max(max(gfb),max(ctb)); %no of buses in the system nbranch =
length(gfb); %no of branches in the system

Y = zeros(nbus,nbus);

% non diagonal elements for i=1:nbranch
Y(gfb(i),ctb(i)) = -y(i);
Y(ctb(i),gfb(i)) = -y(i);
end
```

```
% diagonal elemnets for i=1:nbus
for j= 1:nbranch
if(gfb(i)==j || ctb(j) == i) Y(i,i) = Y(i,i)+y(j)+a(j)./2;


end

end

end

disp("Admittance bus matrix: "); disp(Y);
Z = Y';
disp("Impeadence bus from inverse of admittance bus:") disp(Z);
```

OUTPUT:

```
Admittance bus matrix:
   1.3430 - 4.9810i  -0.5882 + 2.3529i   0.0000 + 0.0000i  -0.7547 + 2.6415i
  -0.5882 + 2.3529i   3.4194 - 5.6153i  -0.3922 + 1.5686i  -2.4390 + 1.9512i
   0.0000 + 0.0000i  -0.3922 + 1.5686i   0.9296 - 3.1019i  -0.5375 + 1.6423i
  -0.7547 + 2.6415i  -2.4390 + 1.9512i  -0.5375 + 1.6423i   1.2922 - 4.2688i

Impedance bus from inverse of admittance bus:
   1.3430 + 4.9810i  -0.5882 - 2.3529i   0.0000 + 0.0000i  -0.7547 - 2.6415i
  -0.5882 - 2.3529i   3.4194 + 5.6153i  -0.3922 - 1.5686i  -2.4390 - 1.9512i
   0.0000 + 0.0000i  -0.3922 - 1.5686i   0.9296 + 3.1019i  -0.5375 - 1.6423i
  -0.7547 - 2.6415i  -2.4390 - 1.9512i  -0.5375 - 1.6423i   1.2922 + 4.2688i
```

FORMATION OF Z-BUS MATRIX

Z-Bus matrix is an important matrix used in different kinds of power system studies such as short circuit study, load flow study, etc.

- In short circuit analysis, the generator and transformer impedancesmust be taken into account. In contingency analysis, the shunt elements are neglected while forming the Z-Bus matrix, which is used to compute the outage distribution factors.
- This can be easily obtained by inverting the Ybus formed by inspection method or by analytical method. Taking inverse of the Ybus for large systems is time consuming; moreover, modification in the system requires the whole process to be repeated to reflect the changes inthe system. In such cases, the Z-Bus is computed by Z-Bus building algorithm

ALGORITHM:

Step1: Start the program.

Step2: Read the number of buses, starting bus and ending bus.

Step3: Initialize the ZBus matrix.

Step4: Form the Z–Bus matrix as follows:

Case1: When a new bus of impedance Zb is connected to reference bus Zbus, new = [Zb]

Case2: Adding new bus p to existing bus q

$$Z_{bus,new} = \begin{bmatrix} Z_{orig} & & & Z_{1q} \\ & & & Z_{2q} \\ & & & .. \\ Z_{q1} & Z_{q2} & \ldots\ldots & Z_{qq} + Z_b \end{bmatrix}$$

Case3: Adding impedance from an existing bus to reference bus.

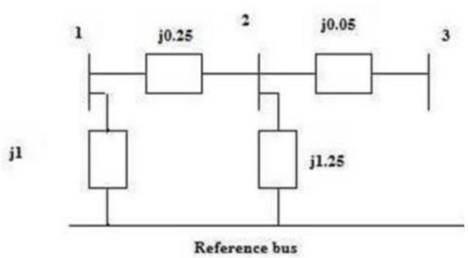
$$Z_{jk,act} = Z_{jk} - \frac{Z_{j(n+1)} * Z_{(n+1)k}}{Z_{(n+1)(n+1)}}$$

Case4: Adding Zb between two existing buses h and q

$$Z_{bus\,new} = \begin{bmatrix} Z_{orig} & & Z_{1h} - Z_{1q} \\ & & Z_{2h} - Z_{2q} \\ Z_{h1} - Z_{q1} & Z_{h2} - Z_{q2} \ldots\ldots & Z_{(n+1)(n+1)} \end{bmatrix}$$

Case5: Print the Z–bus matrix.

2. Z bus




```
%            from  to  Z     type
linedata1= [2     1   1       1;
             3     1   1.25    1;
             4     3   0.05    2;
             3     2   0.25    4];
```

PROGRAM:

```
%   from    to  Z   type
linedata1=  [2  1   1   1;
    3   1   1.25    1;
    4   3   0.05    2;
    3   2   0.25    4];

zbus = (0);zline = linedata1(:,3); type = linedata1(:,4); n =
length(zline);

for i = 1:n
[r,c]=size(zbus);
frbus = linedata1(i,1); tobus = linedata1(i,2);

if (type(i)==1 || type(i)==2) w= min(frbus,tobus);
zbus = [[zbus zbus(:,w)]; [zbus(w,:) zline(i)+zbus(w,w)]];
end

if (type(i)==3 || type(i)==4)
s = zbus(:,frbus)-zbus(:,tobus); s1 = s';
zbus = zbus-(s*s1)/(zline(i)+zbus(frbus,frbus)+zbus(tobus,tobus)-
2*zbus(frbus,tobus));

end
end
n1 = size(zbus);
zbus = zbus(2:n1,2:n1); disp("Impeadence matrix bus: ") disp(zbus);
```

OUTPUT:

```
Impendence matrix bus:
    0.6000    0.5000    0.5000
    0.5000    0.6250    0.6250
    0.5000    0.6250    0.6750
```