| Exp - 04 | Formation of Bus Impedance Matrix |
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# Formation of Bus Impedance Matrix

## Aim:

To find the bus impedance Matrix of a given bus structure of power system using bus building algorithm.

## Apparatus Required:

| SI.No | Apparatus | Specification |
|---|---|---|
| 1 | PC | Dual core, RAM 512 MB 1.2 GHz speed, 80 GB |
| 2 | MATLAB | 7.5 |

## Theory:

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

In short circuit analysis the generator uses transformer impedance must be taken into account. In quality analysis the two-short element are neglected by forming the z-bus matrix which is used to compute the voltage distribution factor. This can be largely obtained by reversing the y-bus formed by resection method or by analytical method.

Taking inverse of the y-bus for large system in time conditioning managing modification in the system requires whole process to be repeated to voltage changes in the system. In such cases z-bus computed to z-bus solving algorithm.

## Procedure:

Case 1: Adding a new branch of impedance between Reference bus to new bus

In this case the elements of (n+1)th column and row are all zeros except the diagonal. The diagonal element is the added branch impedance Zb.

$$Z_{Bus,new} = \begin{bmatrix} Z_{Bus\,orig} & 0 \\ 0 & Z_b \end{bmatrix}$$

Case 2: Adding new branch from Existing bus to New Bus

In this elements of (n+1) th row and column are the same value of q th row and column correspondingly. The diagonal element is given by sum of Zqq and Zb.

$$Z_{Bus,new} = \begin{bmatrix} & & & Z_{1q} \\ & Z_{orig} & & \vdots \\ & & & \vdots \\ & & & Z_{nq} \\ Z_{q1} & ..... & Z_{qn} & Z_{qq} + Z_b \end{bmatrix}$$

Case 3: Adding a new branch between existing bus to reference bus

In this case , it will be an addition as that of case -2 and the (n+1)×(n+1) matrix has reduced n×n matrix by the formula

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

Case 4: Adding a new branch between two existing branch.

In this case the elements of (n+1) column is the difference between h-column and q-column and (n+1) row is as same as column.

$$Z_{Bus,new} = \begin{bmatrix} & & & Z_{1h} - Z_{1q} \\ & Z_{orig} & & \vdots \\ & & & \vdots \\ & & & Z_{nh-} Z_{nq} \\ Z_{h1} - Z_{q1} & ..... & Z_{h2} - Z_{qn} & Z_{(n+1)(n+1)} \end{bmatrix}$$

Program:

```
clc
clear all
%// Impedance Matrix - Bus Building Algorithm//
N=input('enter the  No Buses (((includes Ref Bus))) ==');
for i=1:N
    for j=1:N
        fprintf('enter the impedance value b/w %d and %d bus',i,j)
        z(i,j)=input('=');
    end
end
z
disp('')
disp('case 1:Ref bus to New bus')
disp('case 2:Existing bus to New bus')
disp('case 3:Existing bus to Ref bus')
disp('case 4:Existing bus to Existing Bus')
for i=1:N
    for j=1:N
        if z(i,j)~=0
        fprintf('Enter Case of branch Between buses %d and %d',i,j)
        b(i,j)=input('=');
        end
    end
end
b
k=0;
s=1;
for t=1:2
for i=s:N
    for j=1:N
        if z(i,j)~=0
            cond=b(i,j);
switch cond
    case 1
        %Ref bus to New bus
        Z(k+1,k+1)=z(i,j);
        k=k+1;
        fprintf(' Impedance matrix at step%d is=',k)
        Z
    case 2
        %Existing bus to New bus
        Z(k+1,k+1)=Z(k,k)+z(i,j);
        Z(k+1,1:k)=Z(k,1:k);
        Z(1:k,k+1)=Z(1:k,k);
        k=k+1;
        fprintf(' Impedance matrix at step%d is=',k)
        Z
    case 3
        %Existing bus to Ref bus
        Z(k+1,k+1)=Z(k,k)+z(i,j);
        Z(k+1,1:k)=Z(k,1:k);
        Z(1:k,k+1)=Z(1:k,k);
        for p=1:k
```

```
            for q=1:k
                Z1(p,q)=Z(p,q)-(Z(p,k+1)*Z(k+1,q))/Z(k+1,k+1);
            end
        end
        Z=Z1;
        fprintf(' Impedance matrix at step%d after reduce is=',k+1)
        Z
    case 4
         %Existing bus to Existing Bus
         Z(k+1,k+1)=z(i,j)+Z(i-1,i-1)+Z(j-1,j-1)-2*Z(i-1,j-1);
         Z(k+1,1:k)=Z(j-1,1:k)-Z(i-1,1:k);
         Z(1:k,k+1)=Z(1:k,j-1)-Z(1:k,i-1);
         for p=1:k
            for q=1:k
                Z1(p,q)=Z(p,q)-(Z(p,k+1)*Z(k+1,q))/Z(k+1,k+1);
            end
         end
        Z=Z1;
        fprintf(' Impedance matrix at step%d after reduce is=',k+1)
        Z
end
        s=j;
        z(i,j)=0;
        j=N;
        end
    end
end
end
Z
```

Result: