Various Building Algorithm For The Y Bus & Z Bus

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Abstract— A general and procedural algorithm for- Y matrix building is proposed in this paper. We know that the procedure for obtaining Y bus or Z bus matrices in any frame of reference Requires Matrix Transformation Involving Inversion And Multiplications. It Could Be Very Laborious And Time Consuming Process For Large System Involving Hundreds Of Nodes Or Buses. Such an algorithm would be very convenient for various manipulations that may needed while the system is in operation such as addition of line, removal of lines and change in parameters. The bus impendence matrix can be directly found by using building algorithm.

Key words: Rule of Inspection, Point by point method, Y bus or Z bus

I. Introduction

The solution of a given linear network problem requires the formation of a set of equations describing the response of the network. The mathematical model so derived, must describe the characteristics of the individual network components, as weel as the relationship which governs the interconnection of the individual components. In the bus frame of reference the variables are the node voltages and node currents.

The independent variables in any reference frame can be either currents or voltages. Corespondingly, the coefficient matrix relating the dependent variables and the independent variables will be either an impedance or admitance matrix. The formulation of the apropriate relationships between the independent and dependent variables is an integral part of a digital computer program for the solution of power system problems. The formulation of the network equations in different frames of reference requires the knowledge of graph theory. Elementary graph theory concepts are presented here, followed by development of network equations in the bus frame of reference.

II. General Algorithm Structure

The Z-matrix describes the relationship between the bus voltages and bus current injections by

$V_b = Z_{matriax}\, I$ (1)

Where V_b and $J_{matriax}$ are the vectors of bus voltages and bus current injections, respectively; Z matrix is the bus impedance matrix.

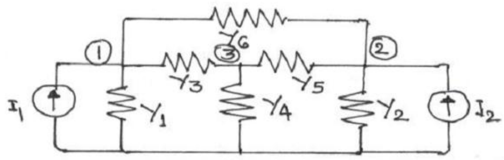
III. Formation of Y Bus and Z Bus

The bus admittance matrix, YBUS plays a very important role in computer aided power system analysis. It can be formed in practice by either of the methods as under:

(1) Rule of Inspection
(2) Singular Transformation
(3) Point by point method.

A. *Rule Of Inspection:*

Consider the 3-node admitance network as shown in figure5. Using the basic branch relation: I = (YV), for al the elemental curents and aplying Kirchof’s Curent Law principle at he nodal points, we get he relations as under:



Example System for finding YBUS

At node 1: $I_1 = Y_1V_1 + Y_3(V_1-V_3) + Y_6(V_1-V_2)$...2
At node 2: $I_2 = Y_2V_2 + Y_5(V_2-V_3) + Y_6(V_2-V_1)$...3
At node 3: $0 = Y_3(V_3-V_1) + Y_4V_3 + Y_5(V_3-V_2)$...4

These are the performance equations of the given network in admittance form and they can be represented in matrix form as:

$$\begin{bmatrix} I_1 \\ I_2 \\ 0 \end{bmatrix} = \begin{bmatrix} Y_1+Y_3+Y_6 & -Y_6 & Y_3 \\ -Y_6 & Y_2+Y_5+Y_6 & -Y_5 \\ Y_3 & -Y_5 & Y_3+Y_4+Y_5 \end{bmatrix}$$

In other words, the relation of equation (9) can be represented in the form

$I_{bus} = Y_{bus}\, E_{bu}$ 5

Where, Y_{BUS} is the bus admittance matrix, I_{BUS} & E_{BUS} are the bus current and bus voltage vectors respectively. By observing the elements of the bus admittance matrix, Y_{BUS} of equation (), it is observed that the matrix elements can as well be obtained by a simple inspection of the given system diagram:

Diagonal elements: A diagonal element (Yii) of the bus admittance matrix, Y_{BUS}, is equal to the sum total of the admittance values of all the elements incident at the bus/node i ,

Off Diagonal elements: An off-diagonal element (Y_{ij}) of the bus admittance matrix, Y_{BUS}, is equal to the negative of the admittance value of the connecting element present between the buses I and j, if any.

This is the principle of the rule of inspection. Thus the algorithmic equations for the rule of inspection are obtained as:

$Y_{ii} = \sum y_{ij} (j = 1,2,\ldots\ldots.n)$ 6
$Y_{ij} = -\, y_{ij} (j = 1,2,\ldots\ldots.n)$ 7

For i = 1,2,….n, n = no. of buses of the given system, Y_{ij} the admittance of element connected between buses i and j and Y_{ii} is the admittance of element connected between bus i and ground (reference bus).

B. *Singular Transformations:*

The primitive network matrices are the most basic matrices and depend purely on the impedance or admittance of the individual elements. However, they do not contain any information about the behaviour of the interconnected network variables. Hence, it is necessary to transform the primitive matrices into more meaningful matrices which can relate variables of the interconnected network.

Bus admittance matrix, Y_{bus} and Bus impedance matrix, Z_{bus}

In the bus $_{frame}$ of reference, the performance of the interconnected network is described by n independent nodal equations, where n is the total number of buses (n+1 nodes are present, out of which one of them is designated as the reference node). For example a 5-bus system will have 5 external buses and 1 ground/ ref. bus). The performance equation relating the bus voltages to bus current injections in bus frame of reference in admittance form is given by

$I_{BUS} = Y_{BUS} E_{BUS}$ 8

Where, E_{BUS}= vector of bus voltages measured with respect to reference bus

I_{BUS}= Vector of currents injected into the bus

Y_{BUS}= bus admittance matrix

The performance equation of the primitive network in admittance form is given by

$i + j = [y] v$ 9

Pre-multiplying by At (transpose of A), we obtain

$A^t i + A^t j = A^t[y] v$ 10

For, Short circuit condition

$A^t i = 0$ 11

Since it indicates a vector whose elements are the algebraic sum of element currents incident at a bus, which by Kirchhoff's law is zero. Similarly, At j gives the algebraic sum of all source currents incident at each bus and this is nothing but the total current injected at the bus. Hence,

$A^t j = I_{BUS}$ 12

Thus from (10) we have,

$I_{BUS} = A^t [y] v$ 13

However, we have

$V = A E_{BUS.}$ 14

And hence substituting in (13) we get,

$I_{BUS} = A^t[y] A E_{BUS}$ 15

We obtain..comparing (14) and(5)

$Y_{BUS} = A^t[y] A$ 16

The bus incidence matrix is rectangular and hence singular. Hence, () gives a singular transformation of the primitive admittance matrix [y]. The bus impedance matrix is given by,

$Z_{BUS} = Y_{BUS}\text{-}1$ 17

Note: This transformation can be derived using the concept of power invariance, however, since the transformations are based purely on KCL and KVL, the transformation will obviously be power invariant.

C. Point By Point Method:

Consider A Bus Admittance Matrix Y Bus Of N×n Dimensions

Where N= Number Of Buses

X=n+1=number Of Node{including Reference Node}

The Matrix Can Be Described As

$$[Y_{bus}]n \times n = \begin{bmatrix} Ymm & Ymp \\ Ypm & Ypp \end{bmatrix}$$

Where,

Y_{mm} , Y_{pp}=Diagonal Element Which Are Driving Point Admittance Of M And P Node

Ymp ,Ypn=Off Diagonal Elements Which Are Transfer Admittance Between P And M Node

If Some Element Is Add In This Network Then The Existing Bus Admittance Matrix Will Also Be Affected Modification in two case

case 1: Element Having Admittance Y_{mp} Connected Between Buses M And P Due This The Y_{bus} Matrix Get Affected

$Y_{mm}[new]=Y_{mm}[old]+Y_m$ 18

$Y_{mp}[new]=Y_{mp}[old]–Y_{mp}$ 19

Ypm[new]=Ypm[old] – Ymp 20

$Y_{pp}[new]=Y_{pp}$ [Old] – Y_{mp} 21

This Elements One By One Add And Modify The Y_{bus}

case 2: When The New Element Is Connected From M^{th} Bus To Reference On Ground

For This Case Only Entry Y_{mm} Will Be Affected

$Y_{mm}[new]=Y_{mm}[old]+Y_{mm}$ 22

IV. CONCLUSIONS

Numerical example demonstrates the performance of the proposed method; shows its effectiveness and good characteristic of being programmable for the network with the controlled sources.

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