American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-6, Issue-12, pp-272-277
www.ajer.org
Research Paper Open Access

Formation of Zbus Martix By Using Step By Step Method For 8 Bus Power System.

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ABSTRACT: *Power flow analysis is the backbone of power system analysis and design. They are necessary for planning, operation, economic scheduling and exchange of power between utilities. The principal information of power flow analysis is to find the magnitude and phase angle of voltage at each bus and the real and reactive power flowing in each transmission lines. Power flow analysis is an importance tool involving numerical analysis applied to a power system. In this analysis a general and procedural algorithm for- Y matrix building is proposed in this paper. We know that the procedure for obtaining 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 largesystemsthat 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 and analysis of large no of bus system can be done easily.Zbus by taking a casestudy of 110/33 KVVishrambag substation of 8bus by using tool MATLAB R2014a, version 8.3.0.532.by this method calculation is easy and required less time as compared to hand calculation.Hand calculation's time consuming as the no buses increases.*

Keywords: *Load flow, step by stepmethod, formulation of Zbus*

Date of Submission: 05-12-2017 Date of acceptance: 22-12-2017

I. INTRODUCTION

Load flow studies are used to ensure that electrical power transfer from generators to consumers through the grid system is stable, reliable and economic. Conventional techniques for solving the load flow problem, using the direct inspection method or the step by step methods. Load flow analysis forms an essential prerequisite for power system studies[7]. Considerable research has already been carried out in the development of computer programs for load flow analysis of large power systems[18,6]. However, these general purpose programs may encounter convergence difficulties when a radial distribution system with a large number of buses is to be solved and, hence, development of a special program for radial distribution studies becomes necessary[14,15]. There are many solution techniques for load flow analysis. The solution procedures and formulations can be precise or approximate, with values adjusted or unadjusted, intended for either on-line or offline application, and designed for either single-case or multiplecase applications. Since an engineer is always concerned with the cost of products and services, the efficient optimum economic starting, transformer energizing, earth faults and short circuit faults will cause short duration increase operation and planning of electric power generation system have always occupied an important position in the electric power industry[1,2]. With large interconnection of the electric networks, the energy crisis in the world and continuous rise in prices, it is very essential to reduce the running charges of the electric energy[12,13]. A saving in the operation of the system of a small percent represents a significant reduction in operating cost as well as in the quantities of fuel consumed[8]. The classic problem is the economic load dispatch of generating systems to achieve minimum operating cost.

1.1 Step By Step Algorithm

He Ybus /Zbus Matrix Constitutes The Models Of the passive portions of the power network. The impedance matrix is a full matrix and is most useful for short circuit studies[11,17]. An algorithm for formulating [Zbus] is described in terms of modifying an existing bus impedance matrix designated as [Zbus] old. The modified matrix is designated as [Zbus] new[20,21]. The network consists of a reference bus and a number of other buses. When a new element having self-impedanceZb is added, a new bus may be created (if the new element is a tree branch) or a new bus may not be created (if the new element is a link)[16,22]. Each of these two cases can be subdivided into two cases so that Zb may be added in the following ways:

1. Adding Zb from a new bus to reference bus.
2. Adding Zb from a new bus to an existing bus.
3. Adding Zb from an existing bus to reference bus.
4. Adding Zb between two existing buses.

1.3 Type 1 modification:

In type 1 modification, an impedance Zb is added between a new bus p and the reference bus as shown in Figure 1.

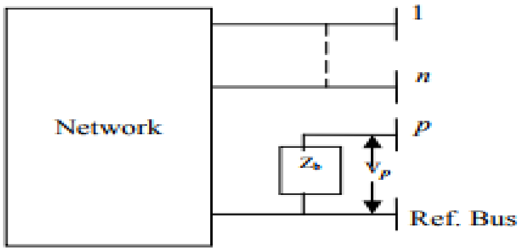

Figure 1. Type 1 modification of Z_{bus}

Let the current through bus p be Ip, and then the voltage across the bus p is given by,

$$V_p = I_p Z_b$$

The potential at other buses remains unaltered and the system equations can be written as,

$$\begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ \vdots \\ V_n \\ \cdots \\ V_p \end{bmatrix} = \begin{bmatrix} & & & & & \vdots & 0 \\ & & & & & \vdots & 0 \\ & & [Z_{bus}]_{old} & & & \vdots & 0 \\ & & & & & \vdots & 0 \\ & & & & & \vdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \vdots & \cdots \\ 0 & 0 & 0 & 0 & 0 & \vdots & Z_b \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ \vdots \\ \vdots \\ I_n \\ \cdots \\ I_p \end{bmatrix}$$

1.4 Type 2 modification:

In type 2 modification, an impedance Zb is added between a new bus p and an existing bus k as shown in Figure 2. The voltages across the bus k and p can be expressed as,

Vk (new) = Vk + IpZkk

Vp = Vk (new) + IpZp = Vk + Ip (Zb + Zkk)

Where, Vk is the voltage across bus k before the addition of impedance Zb,

Zkk is the sum of all impedance connected to bus k.

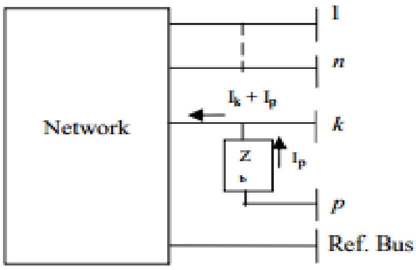

Figure 2.Type 2 Modification of Z_{bus}

The system of equations can be expressed as,

$$\begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ \vdots \\ V_n \\ \cdots \\ V_p \end{bmatrix} = \begin{bmatrix} & & & & & \vdots & Z_{1k} \\ & & & & & \vdots & Z_{2k} \\ & & \left[Z_{bus}\right]_{old} & & & \vdots & \vdots \\ & & & & & \vdots & \vdots \\ & & & & & \vdots & \vdots \\ \cdots & \cdots & \cdots & \cdots & \cdots & \vdots & \cdots \cdots\cdots \\ Z_{k1} & Z_{k2} & \cdots & \cdots & \cdots & \vdots & Z_{kk}+Z_b \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ \vdots \\ \vdots \\ I_n \\ \cdots \\ I_p \end{bmatrix}$$

1.4 Type 3 Modification:

In this modification, an impedance Zb is added between a existing bus *k* and a reference bus.

Then the following steps are to be followed:
1. Add Zb between a new bus *p* and the existing bus *k* and the modifications are done as in type 2.
2. Connect bus *p* to the reference bus by letting Vp = 0.
To retain the symmetry of the Bus Impedance Matrix, network reduction technique can be used to remove the excess row or column.

1.5 Type 4 Modification:

In this type of modification, an impedance Zb is added between two existing buses j and k as shown in Figure 3. From Figure 3, the relation between the voltages of bus *k* and *j* can be written as, Vk – Vj = IbZb .... (1)

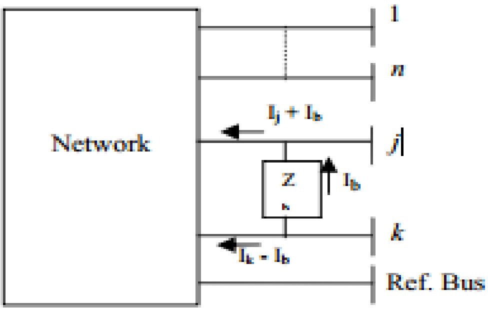

Figure 3.Type 4 Modification of Z_{bus}

The voltages across all the buses connected to the network changes due to the addition of impedance Zb and they can be expressed as,

V1 = Z11I1 + Z12I2 + - - - - - - - - + Z1j(Ij + Ib) + Z1k(Ik – Ib)+- - -
V2 = Z21I1 + Z22I2 + - - - - - - - - + Z2j(Ij + Ib) + Z2k(Ik – Ib)+ - - -
: : :

: : :
Vj = Zj1I1 + Zj2I2 + - - - - - - - - + Zjj(Ij + Ib) + Zjk(Ik – Ib) + - - - ....(2)
Vk = Zk1I1 + Zk2I2 + - - - - - - - - + Zkj(Ij + Ib) + Zkk(Ik – Ib) + - - -
: : :
Vn = Zn1I1 + Zn2I2 + - - - - - - - - + Znj(Ij + Ib) + Znk(Ik – Ib) + - - -

On solving the Equations (1) and (2), the system of equations can be rewritten as,

$$\begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ \vdots \\ V_n \\ \cdots \\ V_p \end{bmatrix} = \left[\begin{array}{c|c} & (Z_{1j}-Z_{1k}) \\ & \vdots \\ [Z_{bus}]_{old} & \vdots \\ & \vdots \\ & (Z_{kj}-Z_{kk}) \\ \hline \cdots\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots\ \cdots & \cdots\ \cdots\ \cdots \\ (Z_{j1}-Z_{k1})\ \cdots\ \cdots\ \cdots (Z_{jk}-Z_{kk}) & Z_{bb} \end{array}\right] \begin{bmatrix} I_1 \\ I_2 \\ \vdots \\ \vdots \\ I_n \\ \cdots \\ I_p \end{bmatrix}$$

Where,

$$Z_{bb} = Z_{jj} + Z_{kk} - 2Z_{jk} + Z_b$$

III. PROCEDURE FOR FORMATION OF ZBUS MATRIX

Step1: Number the nodes of the given network, starting with those nodes at the ends of branches connected to the reference node.
Step2: Start with a network composed of all those branches connected to the reference node.
Step3: Add a new node to the *i*thnode of the existing network.
Step4: Add a branch between *i*thandjthnodes. Continue until all the remaining branches are connected.

IV. LOAD FLOW SOLUTION

A bus is a node at which one or many lines, one or many loads and generators are connected. In a power system each node or bus is associated with 4 quantities, such as magnitude of voltage, phage angle of voltage, active or true power and reactive power in load flow problem two out of these 4 quantities are specified and remaining 2 are required to be determined through the solution of equation. Depending on the quantities that have been specified, the buses are classified into 3 categories[3,19]. Slack bus or reference bus in this bus active and reactive power is unknown .Generator Bus and Load bus .For load flow studies it is assumed that the loads are constant and they are defined by their real and reactive power consumption. The main objective of the load flow is to find the voltage magnitude of each bus and its angle when the powers generated and loads are pre-specified[4,5].There is a shown the single line diagram of bus system in this 2are incoming buses and 5 are outgoing buses. For Zbus formation the bus impedance are required so the different lines are different impedance. For calculation we use the step by step method.In single Line diagram Transformer is connected to bus no 2 & 3.The off Nominal Ratio Of transformer is given its 0.976[9,10]. The Turns Ratio is equal to Rated Voltage Ratio then it is called NOMINAL RATIO if the ratio is not equal it is called OFFNMINAL RATIO of Transformer.

Vishrambag Substation Data

Line No.	SB	EB	Name of the Line	Impedance Positive Sequence	Off Nominal Ratio
1	1	2	110KV Miraj-I	1.04+j2.625	-
2	2	3	Transformer	j0.1045	0.976
3	3	4	33KV Digraj	1.395+j1.989	-
4	3	5	33KV Old Sangli City	0.62+j0.884	-
5	3	6	33KV Mhaishal	3.1+j0.442	-
6	3	7	33KV Madhavnagar	2.015+j2.873	-
7	3	8	33KV New Sangli city	0.62+j0.844	-

Table No 1: Line Data

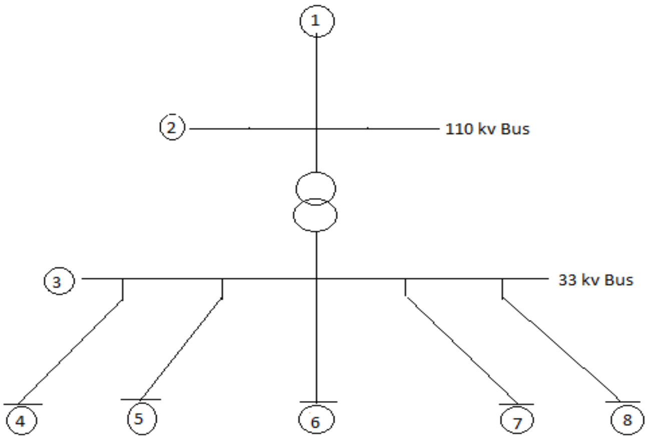

Figure 4. One Line Diagram of 8 Buses System

V. RESULT

Zbus=

[ ]

$$\begin{bmatrix} 0.1305-j0.5692 & 0 & -0.1305+j0.3293 & 0 & 0 & 0 & 0 & 0 \\ 0 & -j9.3778 & j9.5694 & 0 & 0 & 0 & 0 & 0 \\ -0.1305+j0.3293 & j9.5694 & 1.9102-j12.0305 & -0.2364+j0.3370 & -0.5318+j0.7582 & -0.3162+j0.0451 & -0.1636+j0.233 & -0.5318+j0.7582 \\ 0 & 0 & -0.2364+j0.3370 & 0.2364-j0.3370 & 0 & 0 & 0 & 0 \\ 0 & 0 & -0.5318+j0.7582 & 0 & 0.5318-j0.7582 & 0 & 0 & 0 \\ 0 & 0 & -0.3162+j0.0451 & 0 & 0 & 0.3162-j0.0451 & 0 & 0 \\ 0 & 0 & -0.1636+j0.233 & 0 & 0 & 0 & 0.1636-j0.2333 & 0 \\ 0 & 0 & -0.5318+j0.7582 & 0 & 0 & 0 & 0 & 0.5318-j0.7582a \end{bmatrix}$$

VI. CONCLUSION

Power flow or load-flow studies are important for planning future expansion of power systems as well as in determining the best operation of existing systems. The principal information obtained from the power flow study is the magnitude and phase angle of the voltage at each bus, and the real and reactive power flowing in each line.Before calculation of voltage we have to form bus Zbusmatrix. The Zbus matrix can be computed by matrix inversion of the Ybus matrix.We have formulated the algorithm and designed the MATLAB programs for bus Impedance matrix, converting polar form to rectangular form by using Step By Step method.for analyzing the Zbus matrix of the 8 bus systems. The Zbus matrix formation for 8 bus system were observed for different number of buses or 8 buses step by step methodby using MATLAB programing tools .

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*PriyankaGajanan Mane,"Formation of Zbus Martix By Using Step By Step Method For 8 Bus Power System" American Journal of Engineering Research (AJER), vol. 6, no. 12, 2017, pp. 272-277.