EEE- 601
POWER SYSTEM ANALYSIS
Unit-2

ALGORITHM FOR FORMATION OF THE BUS IMPEDANCE MATRIX

- Modification of Zbus matrix involves any one of the following 4 cases

Case 1:adding a branch impedance z_b from a new bus p to the reference bus

Addition of new bus will increase the order the Z_{bus} matrix by 1

$$Z_{bus,new} = \begin{pmatrix} z_{original} & 0 \\ 0 & z_b \end{pmatrix}$$

(n+1)th column and row elements are zero except the diagonal diagonal element is z_b

Case 2: adding a branch impedance z_b from a new bus p to the existing bus q

Addition of new bus will increase the order the Z_{bus} matrix by 1

The elements of (n+1)th column and row are the elements of qth column and row and the diagonal element is $Z_{qq}+Z_b$

Case 3:adding a branch impedance z_b from an existing bus p to the reference bus

The elements of (n+1)th column and row are the elements of qth column and row and the diagonal element is $Z_{qq}+Z_b$ and (n+1)th row and column should be eliminated using the following formula

$$Z_{jk,act} = Z_{jk} - \frac{Z_{j(n+1)}Z_{(n+1)k}}{Z_{(n+1)(n+1)}} \; j = 1,2...n; k = 1,2..n$$

Case 4:adding a branch impedance z_b between existing buses h and q elements of (n+1)th column are elements of bus h column –

bus q column and elements of (n+1)th row are elements of

bus h row – bus q row the diagonal element=

$$Z_b + Z_{hh} + Z_{qq} - 2Z_{hq}$$

and (n+1)th row and column should be eliminated using the following formula

$$Z_{jk,act} = Z_{jk} - \frac{Z_{j(n+1)} Z_{(n+1)k}}{Z_{(n+1)(n+1)}} \quad j = 1, 2...n; k = 1, 2..n$$

ALGORITHM FOR SHORT CIRCUIT ANALYSIS USING BUS IMPEDANCE MATRIX

- Consider a n bus network. Assume that three phase fault is applied at bus k through a fault impedance z_f
- Prefault voltages at all the buses are

$$V_{bus}(0) = \begin{bmatrix} V_1(0) \\ V_2(0) \\ . \\ V_k(0) \\ . \\ V_n(0) \end{bmatrix}$$

Draw the Thevenin equivalent circuit i.e Zeroing all voltage sources and add voltage source $V_k(0)$ at faulted bus k and draw the reactance diagram

- The change in bus voltage due to fault is

$$\Delta V_{bus} = \begin{bmatrix} \Delta V_1 \\ . \\ . \\ \Delta V_k \\ . \\ \Delta V_n \end{bmatrix}$$

- The bus voltages during the fault is

$$V_{bus}(F) = V_{bus}(0) + \Delta V_{bus}$$

- The current entering into all the buses is zero.the current entering into faulted bus k is –ve of the current leaving the bus k

$$\Delta V_{bus} = Z_{bus} I_{bus}$$

$$\Delta V_{bus} = \begin{pmatrix} Z_{11} & . & Z_{1k} & . & Z_{1n} \\ . & . & . & . & . \\ Z_{k1} & . & Z_{kk} & . & Z_{kn} \\ . & . & . & . & . \\ Z_{n1} & . & Z_{nk} & . & Z_{nn} \end{pmatrix} \begin{bmatrix} 0 \\ . \\ -I_k(F) \\ . \\ 0 \end{bmatrix}$$

$$V_k(F) = V_k(0) - Z_{kk} I_k(F)$$

$$V_k(F) = Z_f I_k(F)$$

$$I_k(F) = \frac{V_k(0)}{Z_{kk} + Z_f}$$

$$V_i(F) = V_i(0) - Z_{ik} I_k(F)$$

Thank you