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NPTEL ONLINE CERTIFICATION COURSE

Computer aided power system analysis

Fault Analysis (Contd.)

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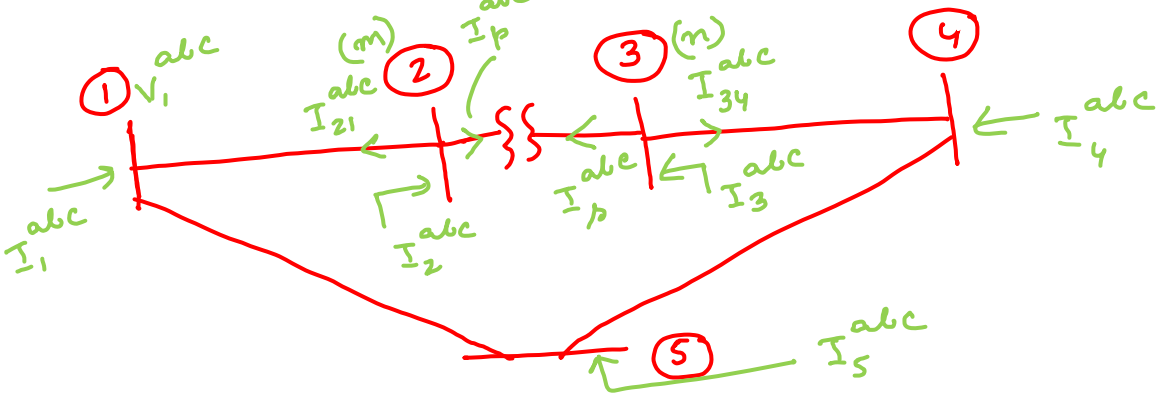
$$\begin{bmatrix} I_1^{abc} \\ I_2^{abc} \end{bmatrix} = \begin{bmatrix} Y_I & Y_{II} \\ Y_{III} & Y_{IV} \end{bmatrix} \begin{bmatrix} V_m^{abc} \\ V_n^{abc} \end{bmatrix}$$

$$\Rightarrow I_1^{abc} = Y_I V_m^{abc} + Y_{II} V_n^{abc}$$

$$I_2^{abc} = Y_{III} V_m^{abc} + Y_{IV} V_n^{abc}$$



Line - models

Y_{mn}^{abc}

$Y_{mn,sh}^{abc}$

m	n
1	2
3	4
1	5
4	5

Bus-1

$$I_1^{abc} = y_{11}^{abc} V_1^{abc} - y_{12}^{abc} V_2^{abc} - y_{15}^{abc} V_5^{abc} \quad \text{--- (1)}$$

$$y_{11}^{abc} = y_{12}^{abc} + y_{12,sh}^{abc} + y_{15}^{abc} + y_{15,sh}^{abc}$$

Transformer model

$$\begin{bmatrix} I_p^{abc} \\ I_s^{abc} \end{bmatrix} = \begin{bmatrix} Y_I & Y_{II} \\ Y_{III} & Y_{IV} \end{bmatrix} \begin{bmatrix} V_2^{abc} \\ V_3^{abc} \end{bmatrix} \Rightarrow$$

$$I_p^{abc} = Y_I V_2^{abc} + Y_{II} V_3^{abc}$$

$$I_s^{abc} = Y_{III} V_2^{abc} + Y_{IV} V_3^{abc}$$

Bus-2

$$I_2^{abc} = I_p^{abc} + I_{21}$$

$$= Y_I V_2^{abc} + Y_{II} V_3^{abc} + y_{12}^{abc} \left(V_2^{abc} - V_1^{abc} \right) + y_{12,sh}^{abc} V_2^{abc}$$

$$\Rightarrow I_2^{abc} = -y_{12}^{abc} V_1^{abc} + \left(Y_I + y_{12}^{abc} + y_{12,sh}^{abc} \right) V_2^{abc} + Y_{II} V_3^{abc} \quad \text{--- (2)}$$

Bus-3

$$I_3^{abc} = I_3^{abc} + I_{34}^{abc}$$

$$= Y_{III} V_2^{abc} + Y_{IV} V_3^{abc} + y_{34}^{abc} \left(V_3^{abc} - V_4^{abc} \right) + y_{34,sh}^{abc} V_3^{abc}$$

$$= Y_{III} V_2^{abc} + \left(Y_{IV} + y_{34}^{abc} + y_{34,sh}^{abc} \right) V_3^{abc} - y_{34}^{abc} V_4^{abc} \quad \text{---- (3)}$$

Bus-4

$$I_4^{abc} = -y_{34}^{abc} V_3^{abc} + y_{44}^{abc} V_4^{abc} - y_{45}^{abc} V_5^{abc} \quad \text{---- (4)}$$

$$y_{44}^{abc} = y_{34}^{abc} + y_{34,sh}^{abc} + y_{45,sh}^{abc} + y_{45}^{abc}$$

Bus-5

$$I_5^{abc} = -y_{15}^{abc} V_1^{abc} - y_{45}^{abc} V_4^{abc} + y_{55}^{abc} V_5^{abc} \quad \text{-- (5)}$$

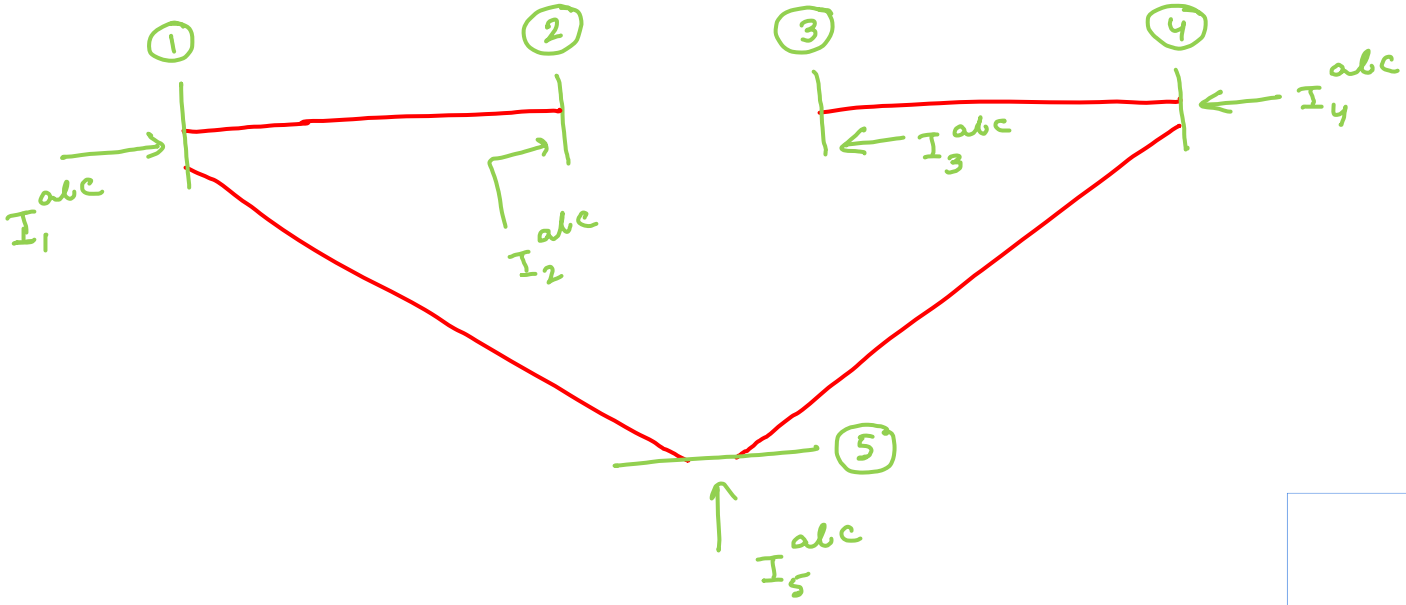
$$Y_{55}^{abc} = y_{15}^{abc} + y_{15,sh}^{abc} + y_{45}^{abc} + y_{45,sh}^{abc}$$

In matrix form

$$\begin{bmatrix} I_1^{abc} \\ I_2^{abc} \\ I_3^{abc} \\ I_4^{abc} \\ I_5^{abc} \end{bmatrix} = \begin{bmatrix} y_{11}^{abc} & -y_{12}^{abc} & 0 & 0 & -y_{15}^{abc} \\ -y_{12}^{abc} & Y_I + y_{12}^{abc} + y_{12,sh}^{abc} & Y_{II} & 0 & 0 \\ 0 & Y_{III} & Y_{IV} + y_{34}^{abc} + y_{34,sh}^{abc} & -y_{34}^{abc} & 0 \\ 0 & 0 & -y_{34}^{abc} & y_{44}^{abc} & -y_{45}^{abc} \\ -y_{15}^{abc} & 0 & 0 & -y_{45}^{abc} & y_{55}^{abc} \end{bmatrix} \begin{bmatrix} V_1^{abc} \\ V_2^{abc} \\ V_3^{abc} \\ V_4^{abc} \\ V_5^{abc} \end{bmatrix}$$

(15×1) (15×15) (15×1)

Reconsider the system by removing the transformer



Write down the Y_{BUS} matrix of this reduced system.