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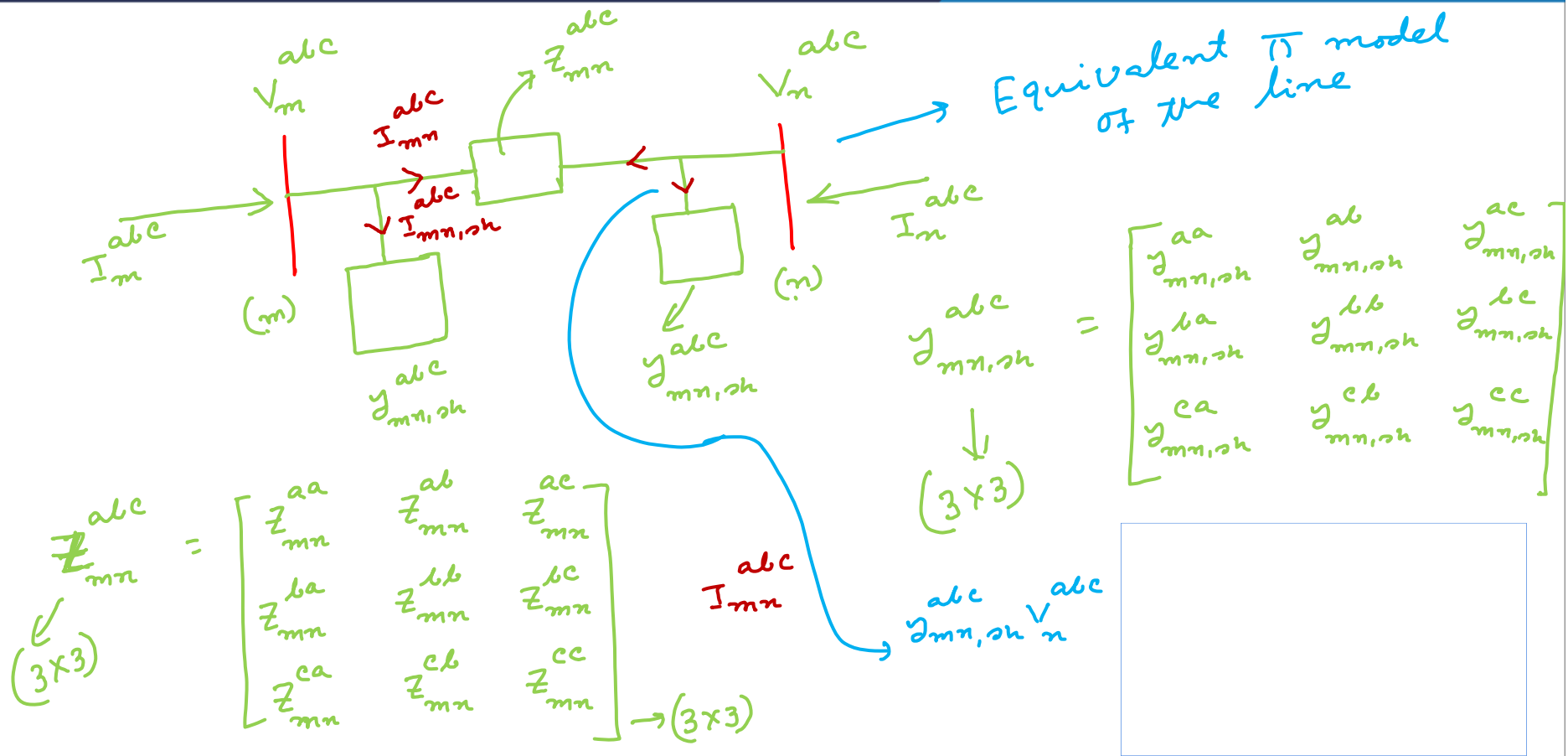
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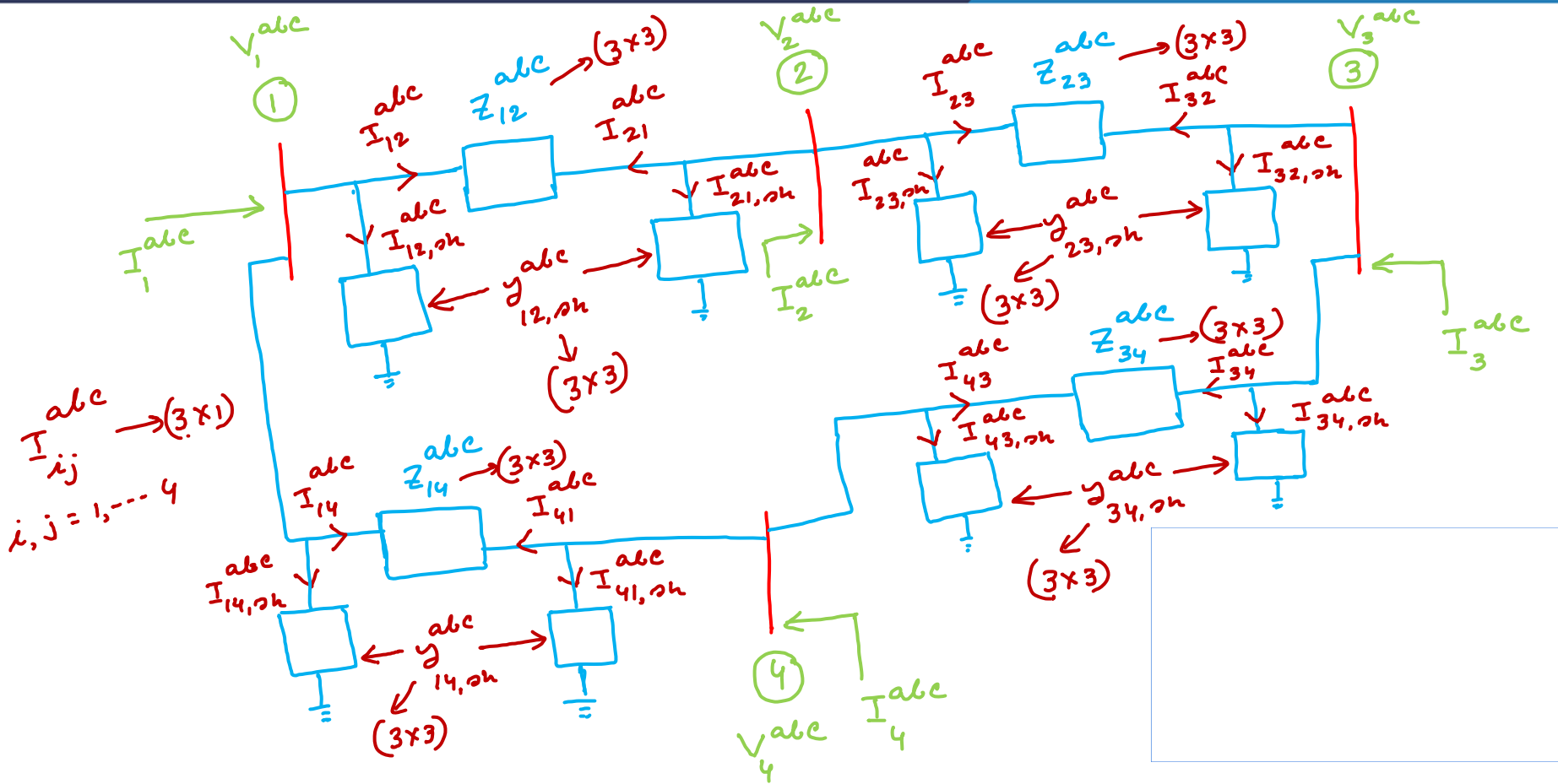
Computer aided power system analysis

Fault Analysis (Contd.)

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$$\begin{bmatrix} V_m^a \\ V_m^b \\ V_m^c \end{bmatrix} = \begin{bmatrix} V_n^a \\ V_n^b \\ V_n^c \end{bmatrix} + \begin{bmatrix} Z_{mn}^{aa} & Z_{mn}^{ab} & Z_{mn}^{ac} \\ Z_{mn}^{ba} & Z_{mn}^{bb} & Z_{mn}^{bc} \\ Z_{mn}^{ca} & Z_{mn}^{cb} & Z_{mn}^{cc} \end{bmatrix} \begin{bmatrix} I_{mn}^a \\ I_{mn}^b \\ I_{mn}^c \end{bmatrix}$$

I_{mn}^p → complex current flowing in phase 'p' of the series branch of the line between the buses 'm' and 'n'. $p = a, b, c$

$$I_{mn}^{abc} = \begin{bmatrix} I_{mn}^a & I_{mn}^b & I_{mn}^c \end{bmatrix}^T \rightarrow (3 \times 1)$$

$$Y_{mn}^{abc} = [Z_{mn}^{abc}]^{-1}$$

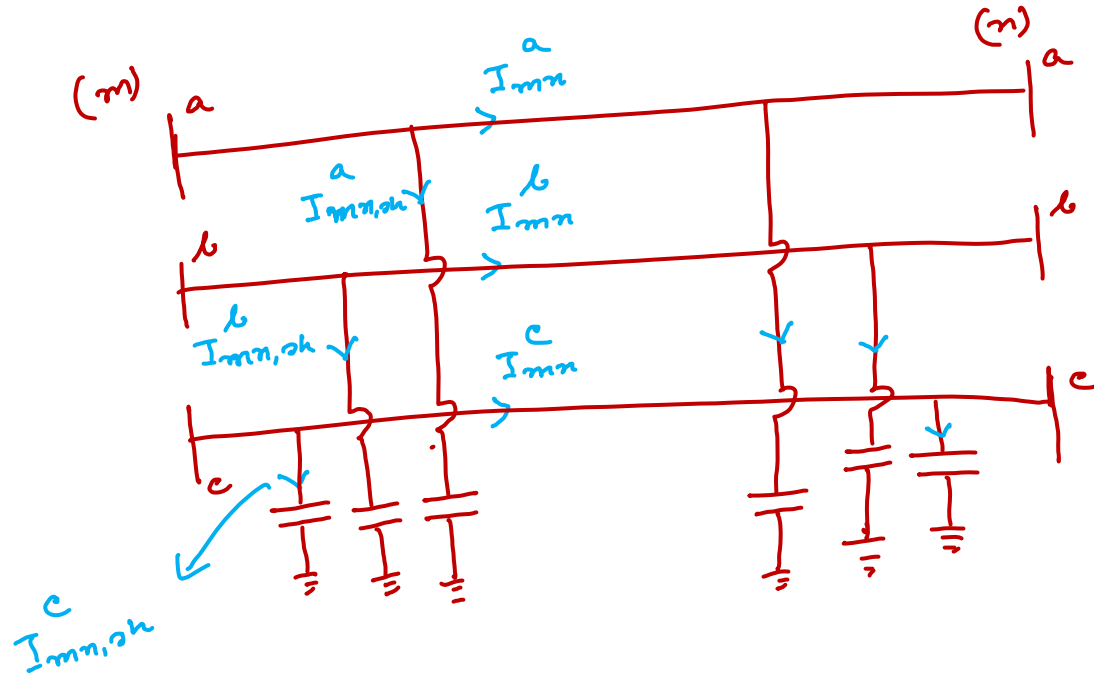
$\downarrow (3 \times 3)$

$$\begin{aligned} V_m^{abc} - V_n^{abc} &= Z_{mn}^{abc} I_{mn}^{abc} \\ \Rightarrow I_{mn}^{abc} &= [Z_{mn}^{abc}]^{-1} (V_m^{abc} - V_n^{abc}) \\ &= Y_{mn}^{abc} (V_m^{abc} - V_n^{abc}) \end{aligned}$$



Again we note that

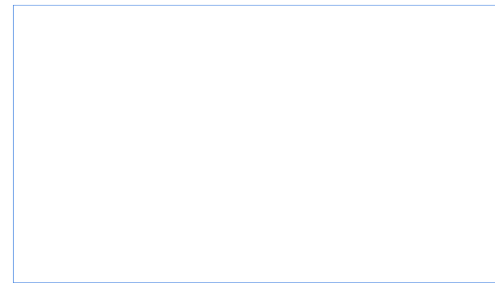
$$I_{mn,sh}^{abc} = \begin{bmatrix} I_{mn,sh}^a & I_{mn,sh}^b & I_{mn,sh}^c \end{bmatrix}^T \rightarrow (3 \times 1)$$



$$\begin{bmatrix} I_{mn,sh}^a \\ I_{mn,sh}^b \\ I_{mn,sh}^c \end{bmatrix} = \begin{bmatrix} y_{mn,sh}^{aa} & y_{mn,sh}^{ab} & y_{mn,sh}^{ac} \\ y_{mn,sh}^{ba} & y_{mn,sh}^{bb} & y_{mn,sh}^{bc} \\ y_{mn,sh}^{ca} & y_{mn,sh}^{cb} & y_{mn,sh}^{cc} \end{bmatrix} \begin{bmatrix} V_m^a \\ V_m^b \\ V_m^c \end{bmatrix}$$

$\swarrow (3 \times 1)$
 $\searrow (3 \times 3)$
 $\rightarrow (3 \times 1)$

$$I_{mn,sh}^{abc} = y_{mn,sh}^{abc} V_m^{abc}$$



Equations for the complete system

Bus 1

$$\begin{aligned}
 I_1^{abc} &= I_{12,sh}^{abc} + I_{12}^{abc} + I_{14,sh}^{abc} + I_{14}^{abc} \\
 &= y_{12,sh}^{abc} V_1^{abc} + y_{12}^{abc} (V_1^{abc} - V_2^{abc}) + y_{14,sh}^{abc} V_1^{abc} + y_{14}^{abc} (V_1^{abc} - V_4^{abc}) \\
 &= \left(y_{12,sh}^{abc} + y_{12}^{abc} + y_{14,sh}^{abc} + y_{14}^{abc} \right) V_1^{abc} - y_{12}^{abc} V_2^{abc} - y_{14}^{abc} V_4^{abc} \quad \dots (1) \\
 y_{12}^{abc} &= (Z_{12}^{abc})^{-1}; \quad y_{14}^{abc} = (Z_{14}^{abc})^{-1}; \quad y_{23}^{abc} = (Z_{23}^{abc})^{-1}
 \end{aligned}$$

Bus 2

$$\begin{aligned}
 I_2^{abc} &= I_{21,sh}^{abc} + I_{21}^{abc} + I_{23,sh}^{abc} + I_{23}^{abc} \\
 &= y_{12,sh}^{abc} V_2^{abc} + y_{12}^{abc} (V_2^{abc} - V_1^{abc}) \\
 &\quad + y_{23,sh}^{abc} V_2^{abc} + y_{23}^{abc} (V_2^{abc} - V_3^{abc})
 \end{aligned}$$



$$\Rightarrow I_2^{abc} = -y_{12}^{abc} V_1^{abc} + (y_{12,2h}^{abc} + y_{12}^{abc} + y_{23,2h}^{abc} + y_{23}^{abc}) V_2^{abc} - y_{23}^{abc} V_3^{abc} \quad \dots (2)$$

Ans 3

$$I_3^{abc} = I_{32,2h}^{abc} + I_{32}^{abc} + I_{34,2h}^{abc} + I_{34}^{abc}$$

$$= y_{23,2h}^{abc} V_3^{abc} + y_{23}^{abc} (V_3^{abc} - V_2^{abc}) + y_{34,2h}^{abc} V_3^{abc} + y_{34}^{abc} (V_3^{abc} - V_4^{abc})$$

$$\Rightarrow I_3^{abc} = -y_{23}^{abc} V_2^{abc} + (y_{23,2h}^{abc} + y_{23}^{abc} + y_{34,2h}^{abc} + y_{34}^{abc}) V_3^{abc} - y_{34}^{abc} V_4^{abc} \quad \dots (3)$$

$$y_{34}^{abc} = (Z_{34}^{abc})^{-1}$$

Ans-4

$$I_4^{abc} = I_{41,2h}^{abc} + I_{41}^{abc} + I_{43,2h}^{abc} + I_{43}^{abc}$$



$$\begin{aligned}
 I_4^{abc} &= y_{14,2n}^{abc} V_4^{abc} + y_{14}^{abc} (V_4^{abc} - V_1^{abc}) + y_{34,2n}^{abc} V_4^{abc} + y_{34}^{abc} (V_4^{abc} - V_3^{abc}) \\
 &= -y_{14}^{abc} V_1^{abc} - y_{34}^{abc} V_3^{abc} + \left(y_{14,2n}^{abc} + y_{14}^{abc} + y_{34,2n}^{abc} + y_{34}^{abc} \right) V_4^{abc} \\
 &\quad \dots \textcircled{4}
 \end{aligned}$$

