A three-phase fault occurs at bus ② of the network of Fig. 10.5
Determine the initial symmetrical rms current (that is, the subtransient current) i
the fault; the voltages at buses ①, ③, and ④ during the fault; the current flow
in the line from bus ③ to bus ①; and the current contributions to the fault from
lines ③ - ②, ① - ②, and ④ - ②. Take the prefault voltage V_f at bus ②
equal to $1.0\angle 0°$ per unit and neglect all prefault currents.

$$
Z_{bus} = \begin{array}{c|cccc}
 & ① & ② & ③ & ④ \\
\hline
① & j0.2436 & j0.1938 & j0.1544 & j0.1456 \\
② & j0.1938 & j0.2295 & j0.1494 & j0.1506 \\
③ & j0.1544 & j0.1494 & j0.1954 & j0.1046 \\
④ & j0.1456 & j0.1506 & j0.1046 & j0.1954
\end{array}
$$

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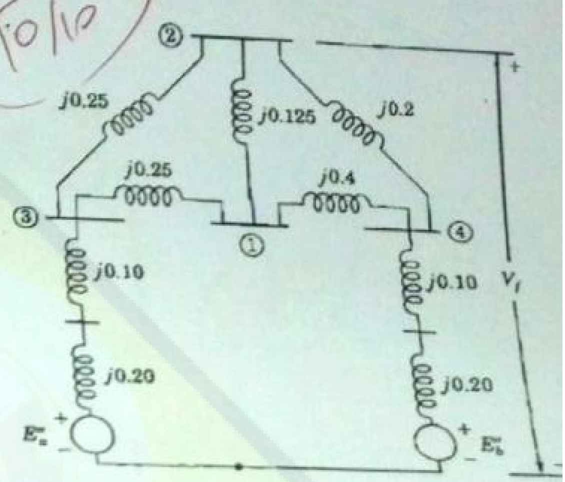
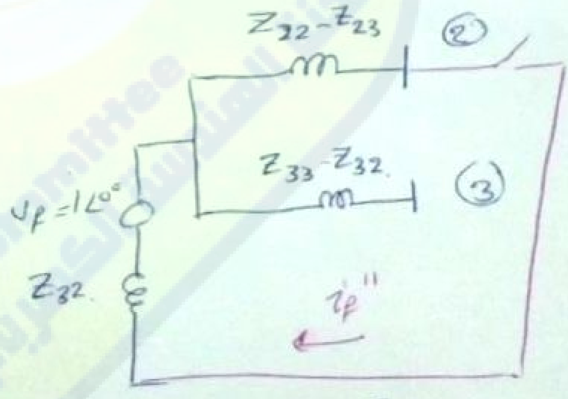


$i_f Z_{22} - 1 = 0$.

Fault @ bus $\boxed{2}$.

$$i_f'' = \frac{V_f}{Z_{22}} = \boxed{-j4.35729 \text{ pu}}$$

$-V_3 + -Z_{32} i_f'' + V_f = 0$.



~~$V_3 = \ldots i_f''$~~

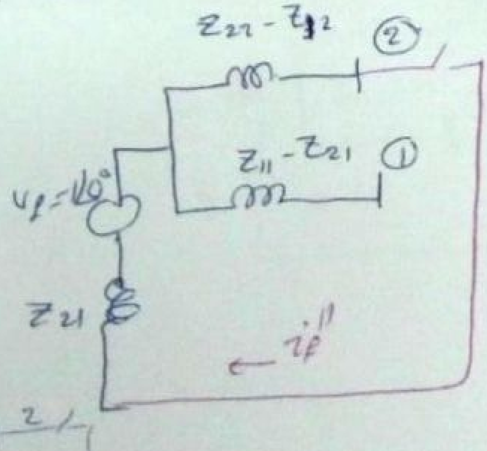
$V_3 = V_f - Z_{32} i_f''$

$\boxed{V_3 = 0.3490 \text{ pu}}$

$-V_1 + 0 + 1 - i_f'' Z_{12} = 0$.

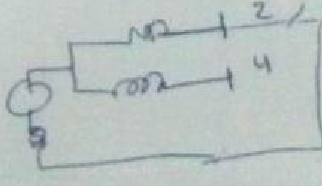
$V_1 = 1 - i_f''(Z_{12})$

$\boxed{V_1 = 0.1556 \text{ pu}}$



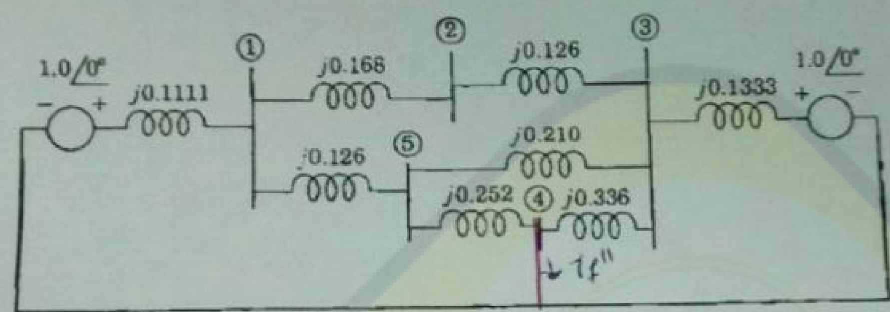
$-V_4 + 0 + 1 - i_f'' Z_{42} = 0$.

$\boxed{V_4 = 0.34379 \text{ pu.}}$



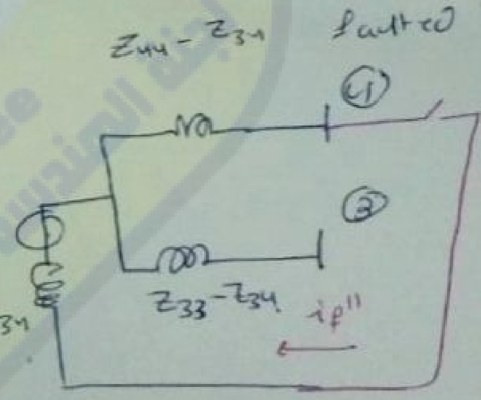
تكملة ⇐

A five-bus network has generators at buses ① and ③ rated 270 and 225 MVA, respectively. The generator subtransient reactances plus the reactances of the transformers connecting them to the buses are each 0.30 per unit on the generator rating as base. The turns ratios of the transformers are such that the voltage base in each generator circuit is equal to the voltage rating of the generator. Line impedances in per unit on a 100-MVA system base are shown in Fig. 10.8. All resistances are neglected. Using the bus impedance matrix for the network which includes the generator and transformer reactances, find the



10/10

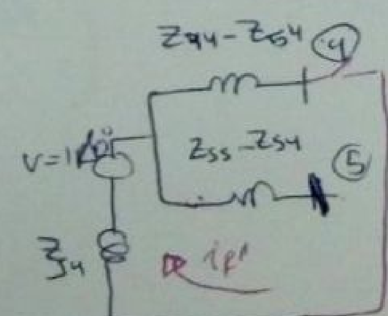
$$
\begin{array}{cc}
 & \begin{array}{ccccc} ① & ② & ③ & ④ & ⑤ \end{array} \\
\mathbf{Z}_{bus} = \begin{array}{c} ① \\ ② \\ ③ \\ ④ \\ ⑤ \end{array} &
\begin{bmatrix}
j0.0793 & j0.0558 & j0.0382 & j0.0511 & j0.0608 \\
j0.0558 & j0.1338 & j0.0664 & j0.0630 & j0.0605 \\
j0.0382 & j0.0664 & j0.0875 & j0.0720 & j0.0603 \\
j0.0511 & j0.0630 & j0.0720 & j0.2321 & j0.1002 \\
j0.0608 & j0.0605 & j0.0603 & j0.1002 & j0.1301
\end{bmatrix}
\end{array}
$$



$$i_f'' = \frac{V_f}{Z_{44}} = -j4.308 \text{ pu.}$$

$$V_3 = 1 - i_f'' Z_{34}$$

$$V_3 = 0.6897 \text{pu}$$



$$V_5 = 1 - i_f'' Z_{45}$$

$$= 0.56828 \text{ pu.}$$

$$i_{54} = \frac{V5 - 0}{j0.252} = -j2.2551 \text{pu.}$$

$$i_{34} = \frac{0.689 - 0}{j0.336} = -j2.052 \text{pu.}$$

$$i_{54} + i_{34} = -j4.308 \text{ pu}$$

a) Derive the sequence components and draw the sequence circuits of a Y grounded synchronous machine

b) Derive the sequence components and draw the sequence circuits of a Δ-Y grounded Transformer.

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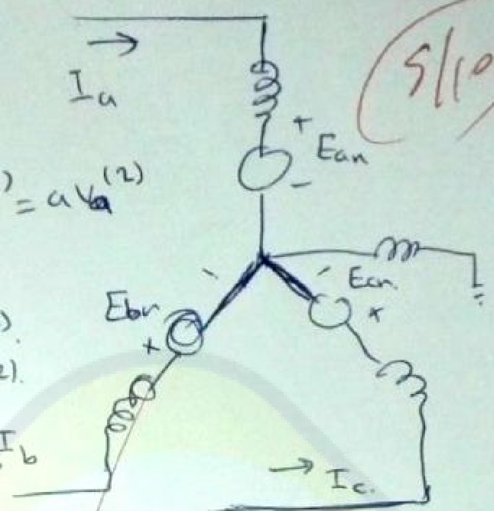


$V_a^{(0)} = V_b^{(0)} = V_c^{(0)}$.

$V_b^{(1)} = a^2 V_a^{(1)}$, $V_b^{(2)} = a V_a^{(2)}$

$V_a = V_a^{(0)} + V_a^{(1)} + V_a^{(2)}$

$V_b = V_a^{(0)} + a^2 V_a^{(1)} + a V_a^{(2)}$.

$V_c = V_a^{(0)} + a V_a^{(1)} + a^2 V_a^{(2)}$.

$V_{abc} = A V_{012}$.

$$\begin{bmatrix} V_{ab} \\ V_{bc} \\ V_{ca} \end{bmatrix} = A \begin{bmatrix} V_{ab}^{(0)} \\ V_{ab}^{(1)} \\ V_{ab}^{(2)} \end{bmatrix}.$$

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix}$$

$$A^{-1} = \frac{1}{3} \begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix}$$

$V_{ab} = V_a - V_b = \left[V_a^{(0)} + V_a^{(1)} + V_a^{(2)}\right] - \left[V_b^{(0)} + V_b^{(1)} + V_b^{(2)}\right]$.

$V_{bc} = V_b - V_c =$ like pervious $= \left[V_b^{(0)} + V_b^{(1)} + V_b^{(2)}\right] - \left[V_c^{(0)} + V_c^{(1)} + V_c^{(2)}\right]$

$V_{ca} = V_c - V_a = \left[V_c^{(0)} + V_c^{(1)} + V_c^{(2)}\right] - \left[V_a^{(0)} + V_a^{(1)} + V_a^{(2)}\right]$.

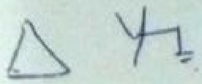
$V_a^{(1)} = V_{an}^{(1)} \angle 30^\circ$, $V_a^{(2)} = V_{an} \angle -30$.

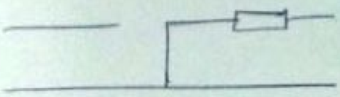
$V_b^{(1)} = a^2 V_{an}^{(1)} \angle 30^\circ$

~~In Delta.~~

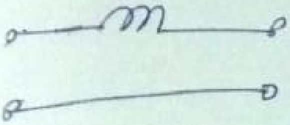
$\cancel{i_a = -(i_b + i_c)}$

Q_3 [2]

 transformer.

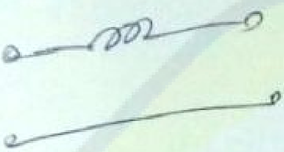


Zero seq.



+ve seq.

~~if there is any E_{an} (source) we put it.~~



−ve seq.

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = -[R + j\omega(L_s + M_s)] \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} + j\omega M_s \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} + \begin{bmatrix} E_{an} \\ E_{bn} \\ E_{cn} \end{bmatrix}$$

نضرب ب A^{-1}

$$\begin{bmatrix} V_{ab}^{(0)} \\ V_{ab}^{(1)} \\ V_{ab}^{(2)} \end{bmatrix} = -[R + j\omega(L_s + M_s)] \begin{bmatrix} I_a^{(0)} \\ I_a^{(1)} \\ I_a^{(2)} \end{bmatrix} + j\omega M_s \begin{bmatrix} 3 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} I_a^{(0)} \\ I_a^{(1)} \\ I_a^{(2)} \end{bmatrix} + \begin{bmatrix} 0 \\ E_{bn} \\ 0 \end{bmatrix}$$

$$V_{ab}^{(0)} = -[R + j\omega[L_s + M_s]]\, I_a^{(0)} + 3j\omega M_s I_a^{(0)} + 0.$$

$$V_{ab}^{(0)} = -R_a I_a^{(0)} + 2j\omega M_s I_a^{(0)} + j\omega L_s I_a^{(0)}$$

$$V_{ab}^{(1)} = -R_a I_a^{(1)} + j\omega(L_s + M_s)\, I_a^{(1)} + E_{bn}.$$

$$V_{ab}^{(2)} = -R_a I_a^{(2)} + j\omega(L_s + M_s)\, I_a^{(2)}.$$