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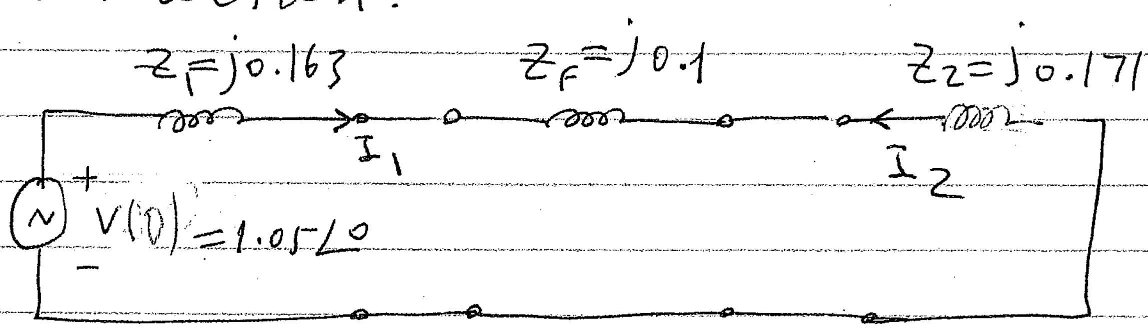
<u>Example 9</u> Consider the system and the fault point as given in Example 7 solved previously, [see Z_0, Z_1, Z_2, and $V(0)$ from Example 7].

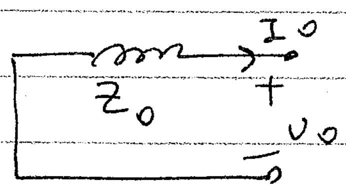
a) Consider a line-to-line fault with $Z_F = j0.1$ at the middle of the line.
Find the phase voltages at the fault point during fault and the phase current through the generator G and the motor M due to the fault

b) The same as part (a) except, assume a line-to-line-to ground fault with $Z_F = j0.1$

Solution / Example 9

a) For Line-to-Line fault, we have the following sequence network connection:





; $I_0 = 0.$

$$I_1 = -I_2 = \frac{V(0)}{Z_1 + Z_F + Z_2} = \cdots = -j2.423$$

$V_2 = -Z_2 I_2 = \cdots = +0.414$

$V_1 = (Z_F + Z_2) I_1 = \cdots = 0.656$

$I_0 = 0$; $V_0 = 0$

Now,

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix} = \cdots$$

• Find $I_{abc,G}$ & $I_{abc,M}$. First we need to find the related ~~seq~~ values.

>> See Fig (3) of the previous example:

$\Delta I_{0G} = 0$
$\Delta I_{0M} = 0$ > as seen from this fig.

>> See Fig (4).

$$\Delta I_{1G} = \frac{\left(\frac{X_{1L}}{2} + X_{T2} + X_{1M}\right) * I_1}{\left(\frac{X_{1L}}{2} + X_{T1} + X_{1G}\right) + \left(\frac{X_{1L}}{2} + X_{T2} + X_{1M}\right)}$$

$\Delta I_{1M} = I_1 - \Delta I_{1G}$; we are using Δ-values, thus sources are ignored.

>> See Fig (5).

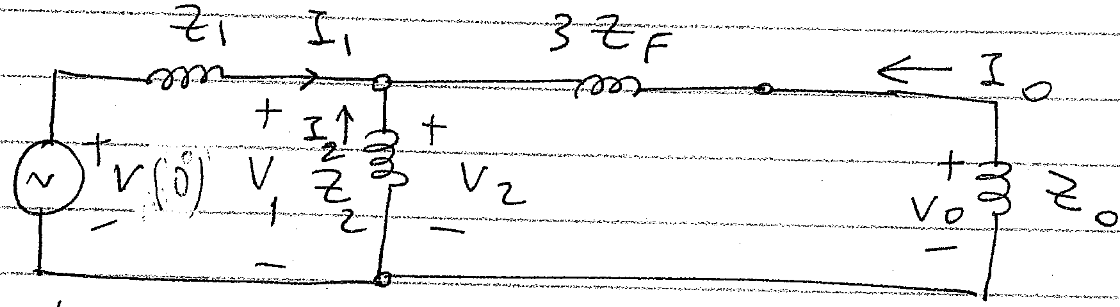
$$\rightarrow \Delta I_{2G} = \frac{\left(\frac{X_{2L}}{2} + X_{T2} + X_{2M}\right) I_2}{\left(\frac{X_{2L}}{2} + X_{T2} + X_{2M}\right) + \left(\frac{X_{2L}}{2} + X_{T1} + X_{2G}\right)}$$

$\rightarrow \Delta I_{2M} = I_2 - \Delta I_{2G}$

Now, use transformation to find to find the phase values of these currents.

<u>note</u>: Since prefault currents are zeros due to flat voltage profile, the Δ-values of the currents are the currents during fault.

b) For double line to ground fault we have:



$V_F^{(0)} = 1.05\angle 0$; $Z_1 = j\,0.163$, $Z_2 = j\,0.171$

$Z_0 = j\,0.129$; $3Z_F = j\,0.3$

now,

$$I_1 = \frac{V(0)}{Z_1 + Z_2 \| (Z_0 + 3Z_F)} = \ldots$$

$$I_2 = \frac{(3Z_F + Z_0)\,(-I_1)}{(3Z_F + Z_0) + Z_2} = \ldots$$

$$I_0 = -I_1 - I_2$$

$$V_0 = -Z_0 I_0$$

$$V_2 = -Z_2 I_2\ ;\ V_1 = V_2$$

now,

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \\ V_2 \end{bmatrix}$$

For the rest of part (b) follow the procedure used in part (a).