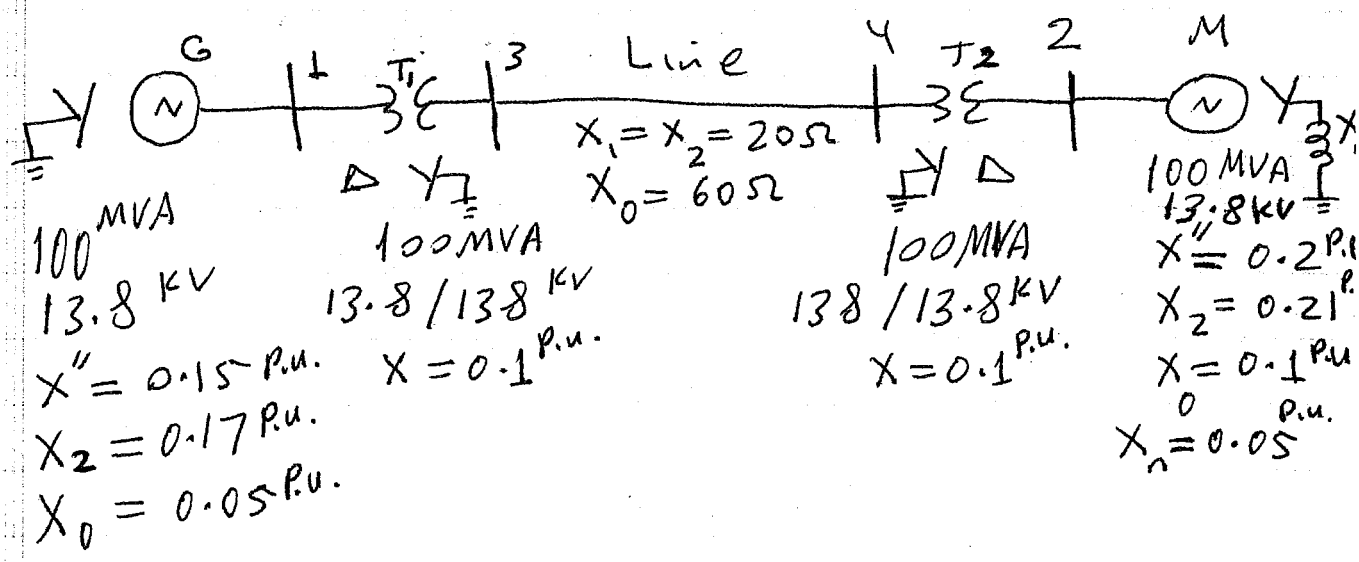
← email to the class

Example 7 [Power sys seq. Networks and their Thevinin eq.]

• Consider the system: with a fault point in the middle of the line.

(1)



Assume $S_B = 100$ MVA, $V_B = 13.8$ KV in generator side. The reactances of the generator, the motor, and the transformer are in p.u. assuming their ratings as bases.

a) Draw the P.U. zero-, pos-, and neg-seq. networks.

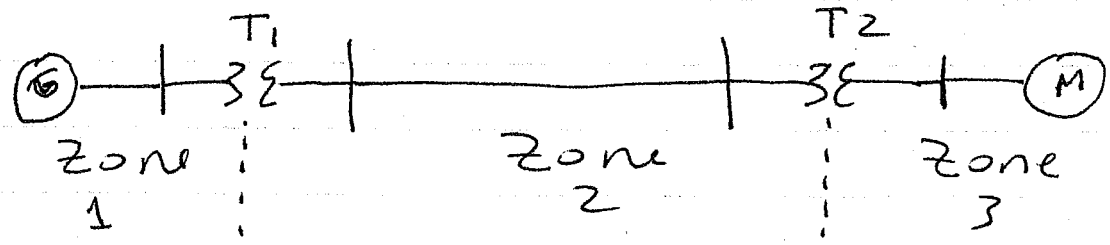
b) Assuming a prefault voltage of $V = 1.05\angle 0^\circ$ for all points of the system, and a fault point at the middle of the transmission line, find the Thevinin eq. ckt's for seq networks as viewed from the fault point.

Note: The book solves this problem assuming Bus 2 is a fault

Solution / example 7

- First we need to find all values in p.u. with bases chosen for the overall system:

(2)



$S_B = 100\ MVA$; given for the whole system

$V_{B1} = 13.8^{KV}$; given

$V_{B2} = V_{B1}\left(\frac{138}{13.8}\right) = 138^{KV}$ ← Voltage-ratio of T_1

$V_{B3} = V_{B2}\left(\frac{13.8}{138}\right) = 13.8^{KV}$ ← Voltage-ratio of T_2

Since the base voltages and base powers of G, T_1, T_2, and M are the same as their ratings, their P.U.-reactances remain the same.

- For the line we have:

$$Z_{B2} = \frac{V_{B2}^2}{S_B} = \frac{(138)^2}{100} = 190.44\ \Omega$$

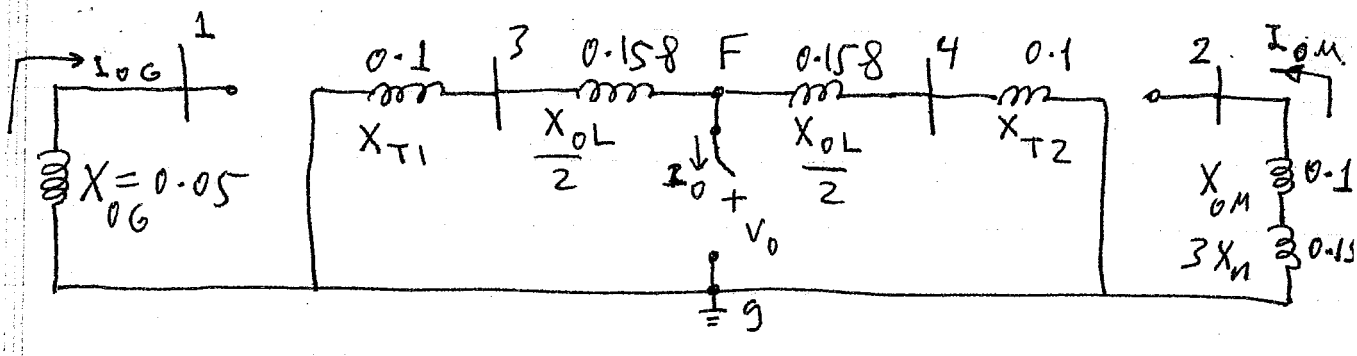
$$X_1^{P.U.} = \frac{X_1^{\Omega}}{Z_B} = 0.105 \ ; \ X_2^{P.U.} = \frac{X_2^{\Omega}}{Z_B} = \cdots = 0.105$$

$$X_0^{P.U.} = \frac{X_0^{\Omega}}{Z_B} = \cdots = 0.315$$

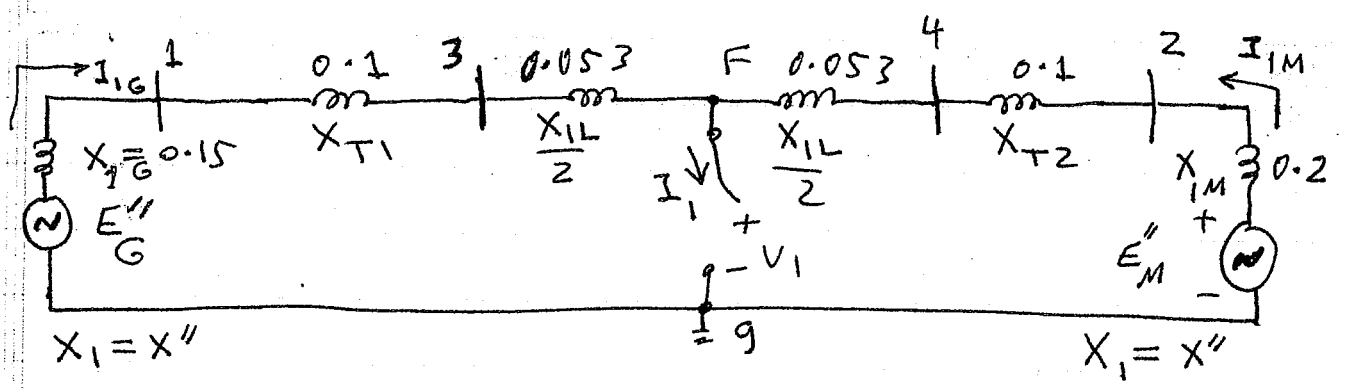
→ See your H/O:

a) Draw the sequence networks as:

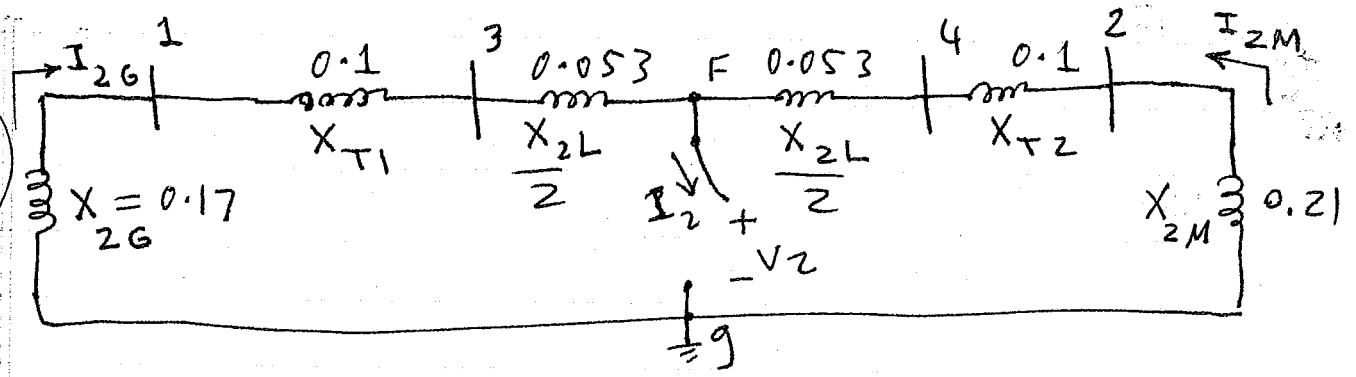
(3)



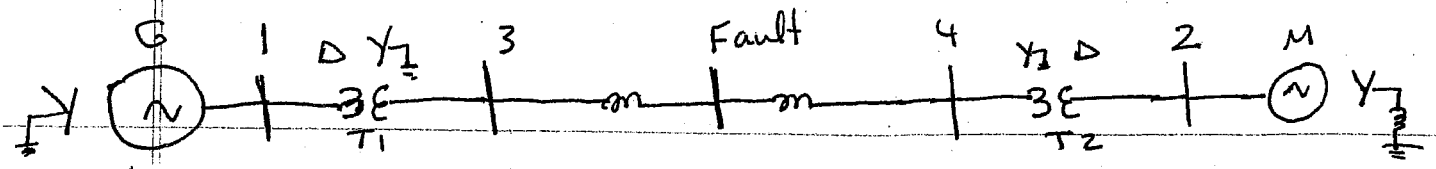
(4)

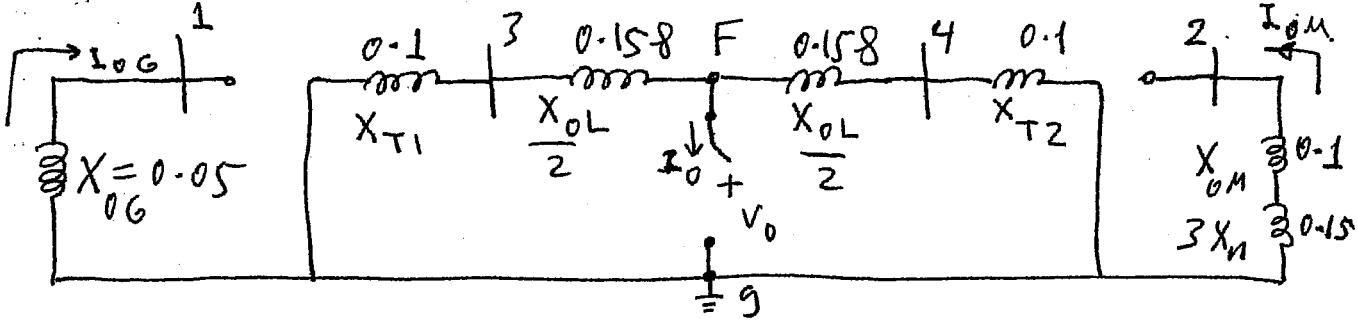


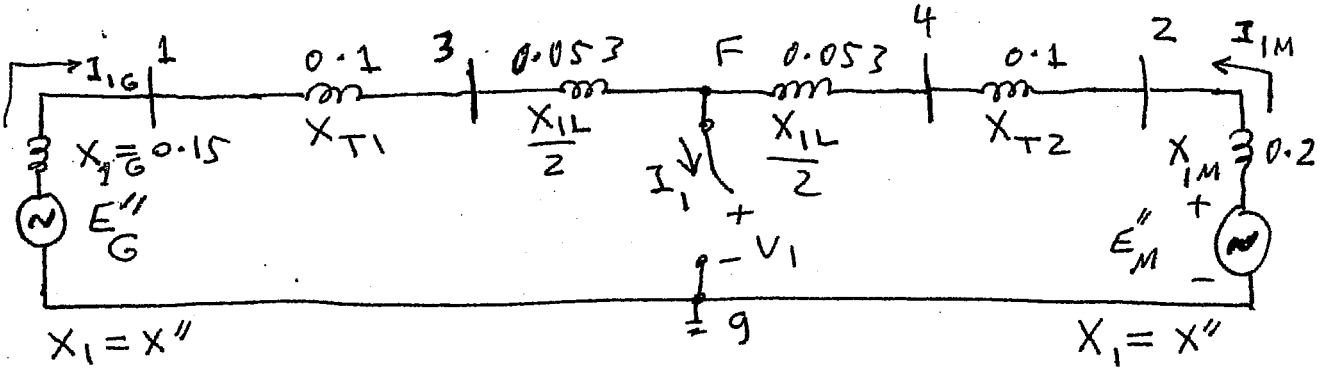
(5)

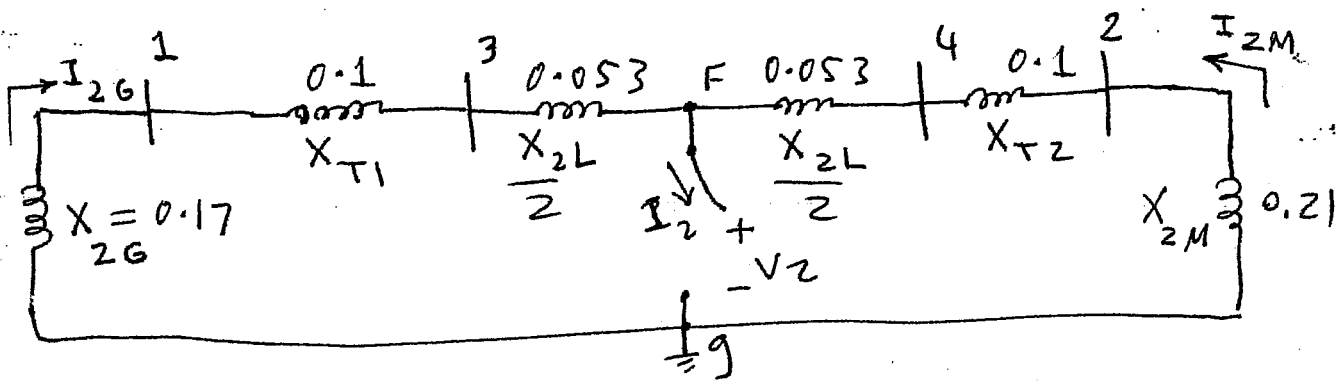


The above show the seq. networks for the system. The pos-seq is similar to the 1φ-eq of 3φ-balance system. The neg. seq network is similar to the pos. seq network without sources. Special attention is required for zero-seq network as it varies from cases to cases.





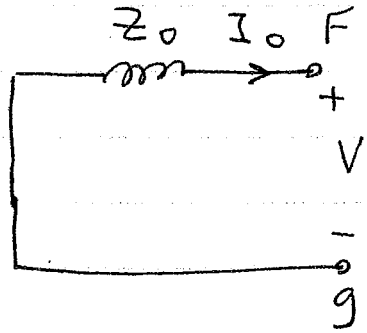




The above shows the seq. networks for the system. The pos-seq is similar to the 1ϕ-eq of 3ϕ-balance system. The neg. seq network is similar to the pos. seq network without sources. Special attention is required for zero-seq network as it varies from cases to cases.

b) Looking from the fault point (from points F and g) for each seq. network, we can find the Thevinin eq. ckt for each as follows:

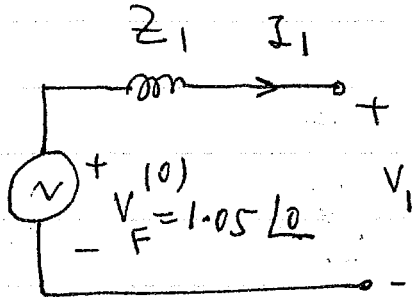
(6)



; $Z_0 = (j0.1 + j0.158) \| (j0.1 + j0.158)$

$= \cdots = j0.129$

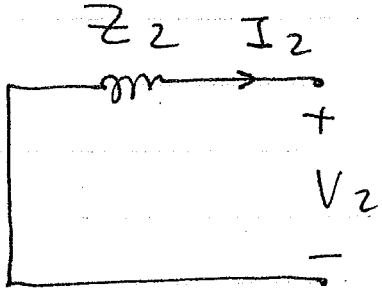
(7)



; $Z_1 = j(0.053 + 0.1 + 0.15) \| j(0.053 + 0.1 + 0.2)$

$= \cdots = j0.163$

(8)



; $Z_2 = j(0.053 + 0.1 + 0.17) \| j(0.053 + 0.1 + 0.21)$

$= \cdots = j0.171$