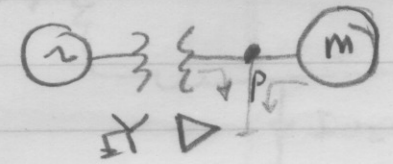
EE 740

12.9 A generator supplies a motor through a Y-Δ transformer. The generator is connected to the Y side of the transformer. A fault occurs between the motor terminals and the transformer. The symmetrical components of the subtransient current in the motor flowing toward the fault are $I_{a1} = -0.8 - j2.6$ per unit, $I_{a2} = -j2.0$ per unit, and $I_{a0} = -j3.0$ per unit. From the transformer toward the fault $I_{a1} = 0.8 - j0.4$ per unit, $I_{a2} = -j1.0$ per unit, and $I_{a0} = 0$. Assume $X_1'' = X_2$ for both the motor and the generator. Describe the type of fault. Find (*a*) the prefault current, if any, in line *a*, (*b*) the subtransient fault current in per unit, and (*c*) the subtransient current in each phase of the generator in per unit.

solution



Fault occurs at P. The sum of I_{a1} from the transformer and the motor gives I_{a1} in the fault

The sum of I_{a1} toward from the motor and from trans. trans. gives I_{a1} in the fault

$$I_{a1_F} = I_{a1,\,motor} + I_{a1\,trans.}$$

$$I_{a1_F} = -.8 - j2.6 + .8 - j.4 = -j3.0$$

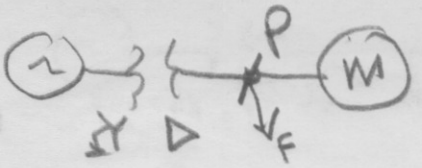
similarly

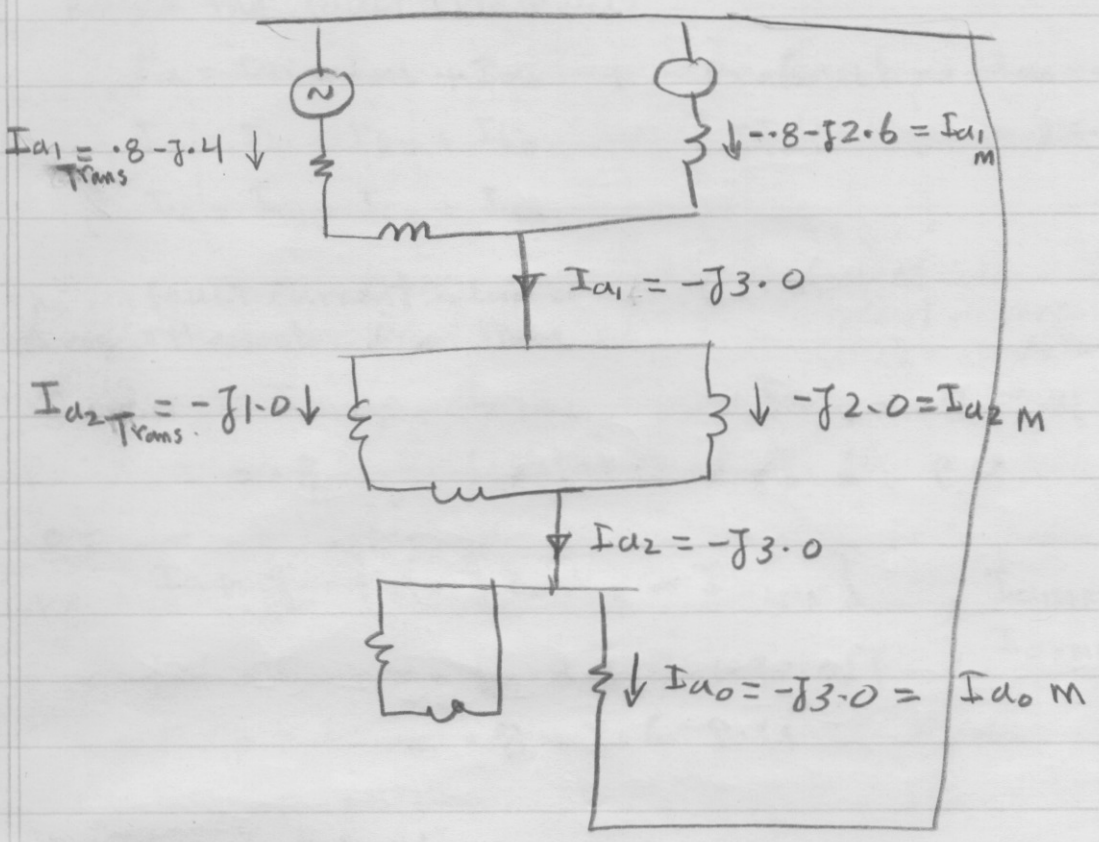
$$I_{a2_F} = -j2.0 - j1.0 = -j3.0$$

$$I_{a0_F} = -j3.0$$

since $I_{a_1} = I_{a_2} = I_{a_0}$, then we have a single-line-to-ground fault.

The connection of the sequence network is:

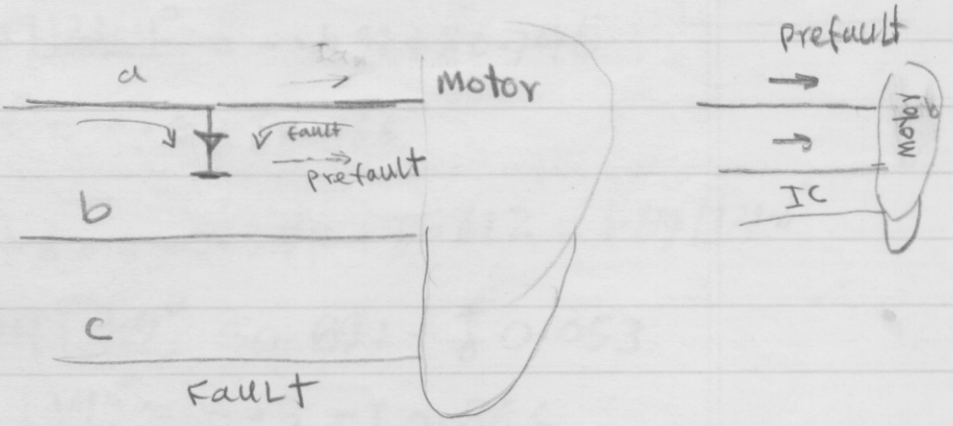


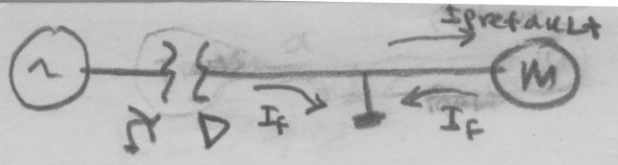


a) currents are marked on the network diag.

The division of the current due to the fault between the branches of the positive-sequence network is the same as between the branches of the negative sequence network since all X_1 values equal to X_2 values in corresponding branches.

The prefault current in the line a toward the motor is





Before the fault (prefault)

$I_a = I_{a1} + I_{a2} + I_{a0}$, Prefault $\Rightarrow I_{a0} = 0$

$I_b = I_{b1} + I_{b2} + I_{b0}$ $I_{prefault\ from\ trans} = I_{prefault\ Toward\ Mobr}$

$I_c = I_{c1} + I_{c2} + I_{c0}$

The prefault current in line a toward the motor from trans

(prefault direction of current is opposite of the fault condition

$I_{a\,prefault} = I_{a1TF} - I_{a2TF}$ $I_{a1TF} = .8 - j.4$, $I_{a2TF} = -j1.0$

$= .8 - j.4 - (-j.10) = 0.8 + j.6$ P.U

or

$I_{a\,prefault} = -\left[I_{a1MF} - I_{a2MF}\right]$, $I_{a1MF} = -.8 - j2.6$

$I_{a2MF} = -j2.0$

$= -\left[-.8 - j2.6 - (-j2.0)\right]$

$= .8 + j.6$ P.U

b) subtransient fault current

$I_{af} = 3\,I_{a1} = 3(-j3.0) = -j9.0$ P.U

c) In the generator

$I_{A1} = -j(0.8 - j.4) = -.4 - j.8 = 0.894 \angle -116.6^\circ$

$I_{A2} = j(-j1.0) = 1.0 \angle 0^\circ$, $I_{A0} = 0$

$I_A = I_{A1} + I_{A2} = .6 - j0.8 = 1.0 \angle -53.1^\circ$

$I_{a1} = +j I_{A1}$

$I_{a2} = -j I_{A2}$

$I_{B1} = 0.894 \angle 123.4^\circ = -.492 + j0.746$

$I_{B2} = 1.0 \angle 120^\circ = -.5 + j0.866$

$I_B = I_{B1} + I_{B2} = -0.992 + j1.612 = 1.89 \angle 121.6^\circ$

$I_{C1} = 0.894 \angle 3.4^\circ = 0.892 + j0.053$

$I_{C2} = 1.0 \angle 240^\circ = -.5 - j0.866$

$I_C = I_{C1} + I_{C2} = .392 - j.813 = 0.903 \angle -64.3^\circ$