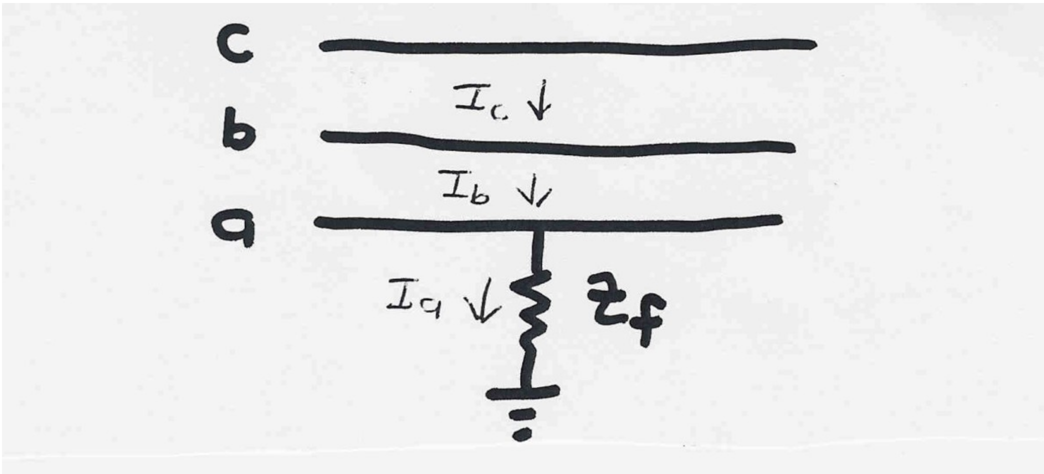
EEE- 601
POWER SYSTEM ANALYSIS
Unit-2

Single Line-to-Ground (SLG) Faults

- Unbalanced faults unbalance the network, but only at the fault location. This causes a coupling of the sequence networks. How the sequence networks are coupled depends upon the fault type. We'll derive these relationships for several common faults.
- With a SLG fault only one phase has non-zero fault current -- we'll assume it is phase A.

SLG Faults, cont'd



$$\begin{bmatrix} I_a^f \\ I_b^f \\ I_c^f \end{bmatrix} = \begin{bmatrix} ? \\ 0 \\ 0 \end{bmatrix}$$

Then since

$$\begin{bmatrix} I_f^0 \\ I_f^+ \\ I_f^- \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \end{bmatrix}\begin{bmatrix} ? \\ 0 \\ 0 \end{bmatrix} \rightarrow I_f^0 = I_f^+ = I_f^- = \frac{1}{3} I_a^f$$

SLG Faults, cont'd

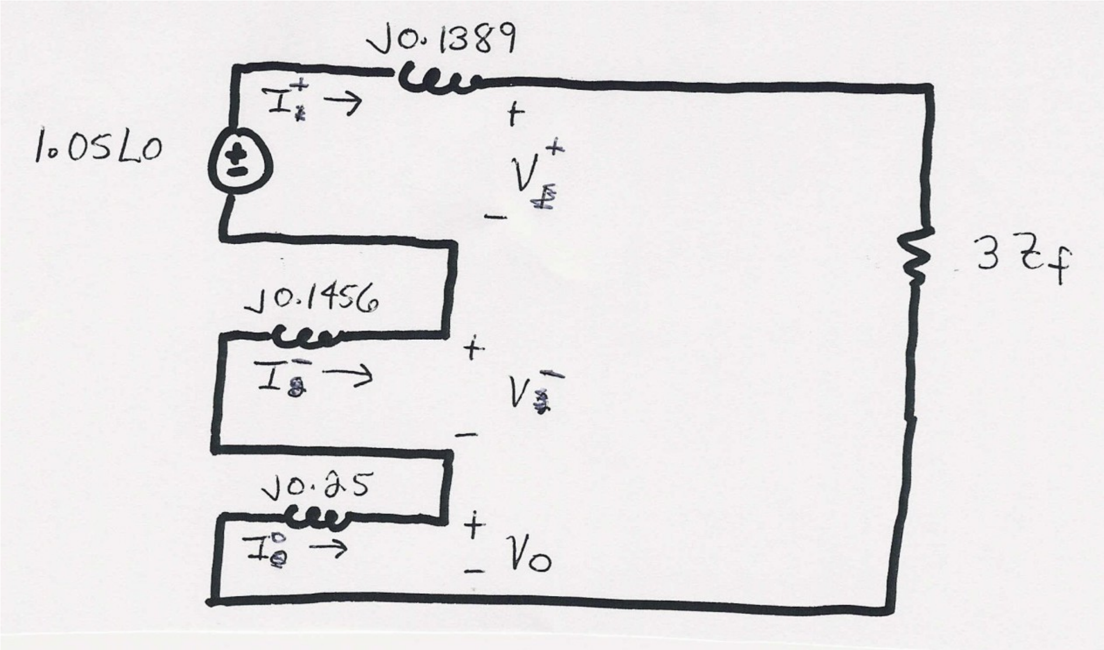
$$V_a^f = Z_f I_a^f$$

$$\begin{bmatrix} V_a^f \\ V_b^f \\ V_c^f \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha^2 & \alpha \\ 1 & \alpha & \alpha^2 \end{bmatrix} \begin{bmatrix} V_f^0 \\ V_f^+ \\ V_f^- \end{bmatrix}$$

This means $V_a^f = V_f^0 + V_f^+ + V_f^-$

The only way these two constraints can be satisified is by coupling the sequence networks in series

SLG Faults, cont'd

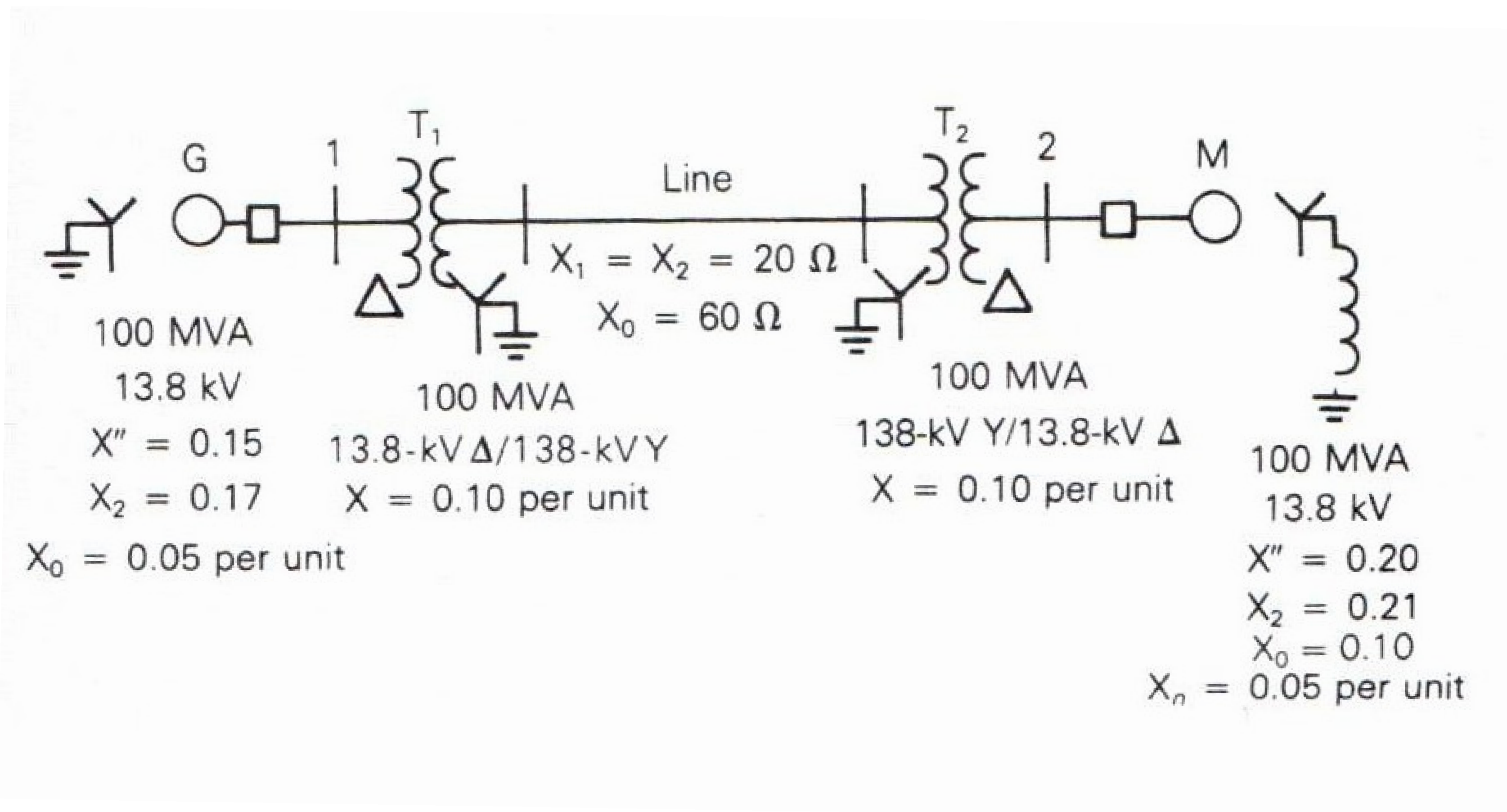


With the sequence networks in series we can solve for the fault currents (assume Z_f=0)

$$I_f^+ = \frac{1.05\angle 0^\circ}{j(0.1389+0.1456+0.25+3Z_f)} = -j1.964 = I_f^- = I_f^0$$

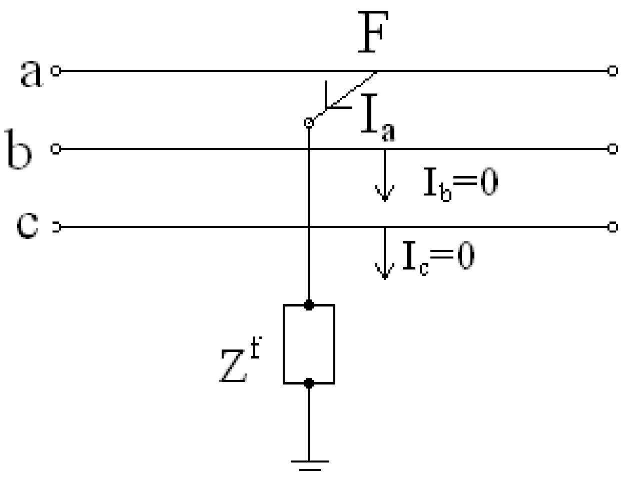
$$\mathbf{I} = \mathbf{A}\,\mathbf{I}_s \rightarrow I_a^f = -j5.8 \ \ (\text{of course, } I_b^f = I_c^f = 0)$$

Example 9.3



G
1
T1
Line
T2
2
M
X1 = X2 = 20 Ω
X0 = 60 Ω
100 MVA
13.8 kV
X″ = 0.15
X2 = 0.17
X0 = 0.05 per unit
100 MVA
13.8-kV Δ/138-kV Y
X = 0.10 per unit
100 MVA
138-kV Y/13.8-kV Δ
X = 0.10 per unit
100 MVA
13.8 kV
X″ = 0.20
X2 = 0.21
X0 = 0.10
Xn = 0.05 per unit

SINGLE LINE TO GROUND FAULT



$$I_b = 0$$

$$I_c = 0$$

$$V_a = Z^f I_a$$

$$I_{a1} = I_{a2} = I_{a0} = I_a / 3$$

$$I_{a1} = \frac{E_a}{Z_1 + Z_2 + Z_0 + 3Z^f}$$

Consider a fault between phase a and ground through an impedance z_f

Thank you