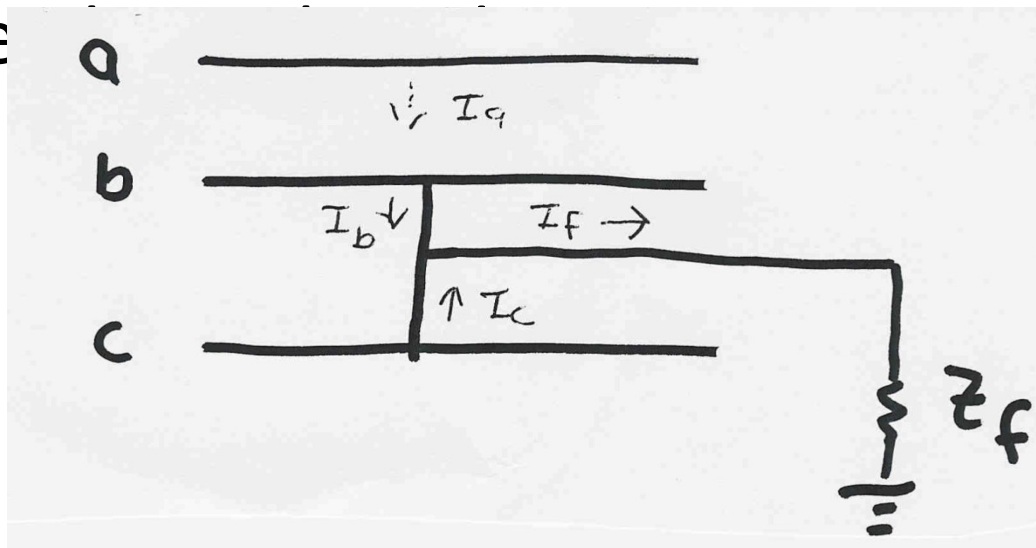
EEE- 601
POWER SYSTEM ANALYSIS
Unit-2

Double Line-to-Ground Faults

- With a double line-to-ground (DLG) fault two line conductors come in contact both with each other and ground. We'll assume these are



$$I_a^f = 0 \qquad V_{bg}^f = V_{cg}^f = Z_f(I_b^f + I_c^f)$$

DLG Faults, cont'd

From the current relationships we get

$$\begin{bmatrix} I_a^f \\ I_b^f \\ I_c^f \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha^2 & \alpha \\ 1 & \alpha & \alpha^2 \end{bmatrix} \begin{bmatrix} I_f^0 \\ I_f^+ \\ I_f^- \end{bmatrix}$$

Since $I_a^f = 0 \quad \rightarrow \quad I_f^0 + I_f^+ + I_f^- = 0$

Note, because of the path to ground the zero sequence current is no longer zero.

DLG Faults, cont'd

From the voltage relationships we get

$$\begin{bmatrix} V_f^0 \\ V_f^+ \\ V_f^- \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \end{bmatrix}\begin{bmatrix} V_{ag}^f \\ V_{bg}^f \\ V_{bg}^f \end{bmatrix} \rightarrow$$

Since $V_{bg}^f = V_{cg}^f \rightarrow \quad V_f^+ = V_f^-$

Then $V_{bg}^f = V_f^0 + (\alpha^2 + \alpha)V_f^+$

But since $1 + \alpha + \alpha^2 = 0 \rightarrow \quad \alpha^2 + \alpha = -1$

$$V_{bg}^f = V_f^0 - V_f^+$$

DLG Faults, cont'd

$$V_{bg}^{f} = V_f^0 - V_f^+$$
$$= Z_f(I_b^f + I_c^f)$$

Also, since

$$I_b^f = I_f^0 + \alpha^2 I_f^+ + \alpha I_f^+$$
$$I_c^f = I_f^0 + \alpha I_f^+ + \alpha^2 I_f^+$$

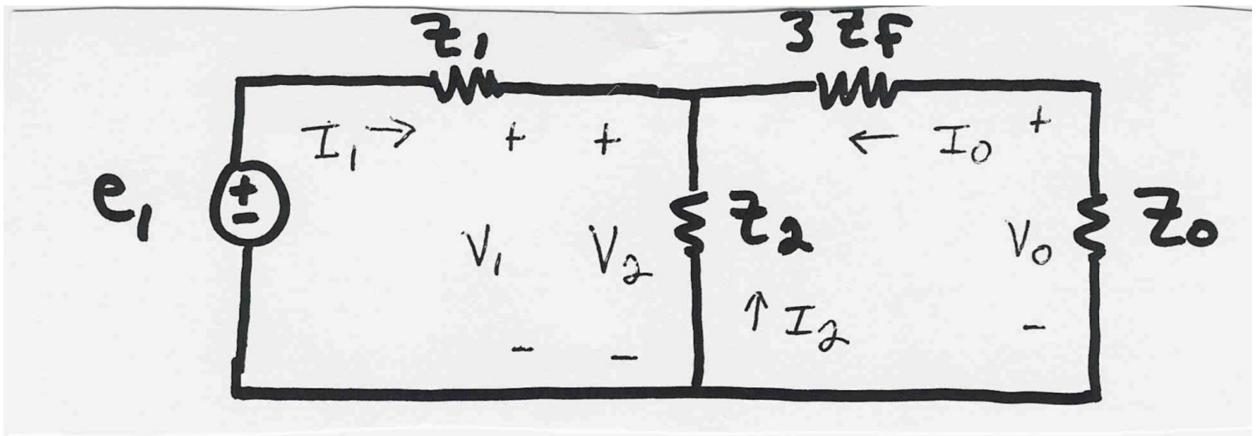
Adding these together (with $\alpha + \alpha^2 = -1$)

$$V_{bg}^{f} = Z_f(2I_f^0 - I_f^+ - I_f^-) \quad \text{with } I_f^0 = -I_f^+ - I_f^-$$

$$V_f^0 - V_f^+ = 3Z_f I_f^0$$

DLG Faults, cont'd

- The three sequence networks are joined as follows

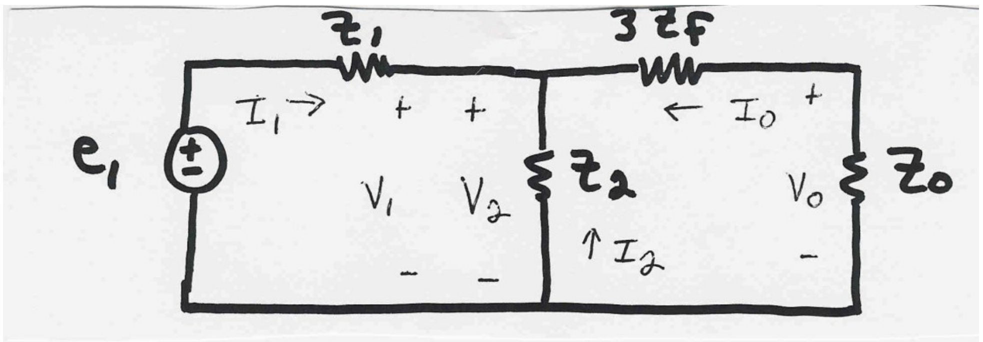


Assuming Z_f=0, then

$$I_f^+ = \frac{V^+}{Z^+ + Z^- \square \quad \cdots \quad {}_f)} = \frac{1.05\angle 0^\circ}{j0.1389 + j0.092}$$

$$= \ 4.547\angle -90^\circ$$

DLG Faults, cont'd



$$V_f^+ = 1.05 - 4.547\angle -90° \times j0.1389 = 0.4184$$

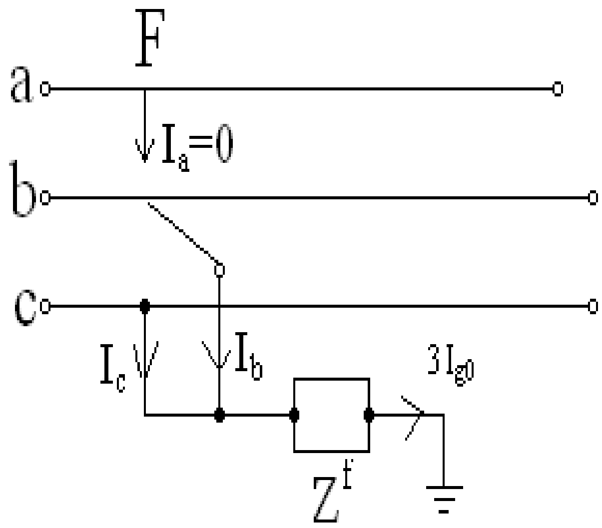
$$I_f^- = -0.4184 / j0.1456 = j2.874$$

$$I_f^0 = -I_f^+ - I_f^- = j4.547 - j2.874 = j1.673$$

Converting to phase: $I_b^f = -1.04 + j6.82$

$$I_c^f = 1.04 + j6.82$$

DOUBLE LINE TO GROUND (LLG) FAULT



$$I_{a0} = 0$$

$$I_{a1} + I_{a2} + I_{a0} = 0$$

$$V_b = V_c = Z^f (I_b + I_c) = 3Z^f I_{a0}$$

$$V_{a0} - V_{a1} = V_b = 3Z^f I_{a0}$$

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

Consider a fault between phase b and c through an impedance z_f to ground

Thank you