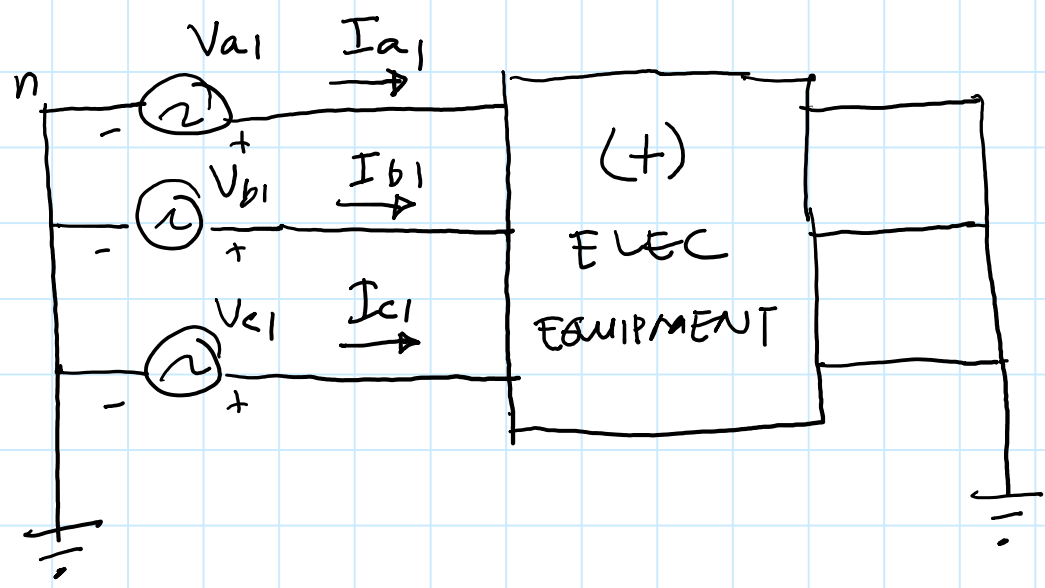
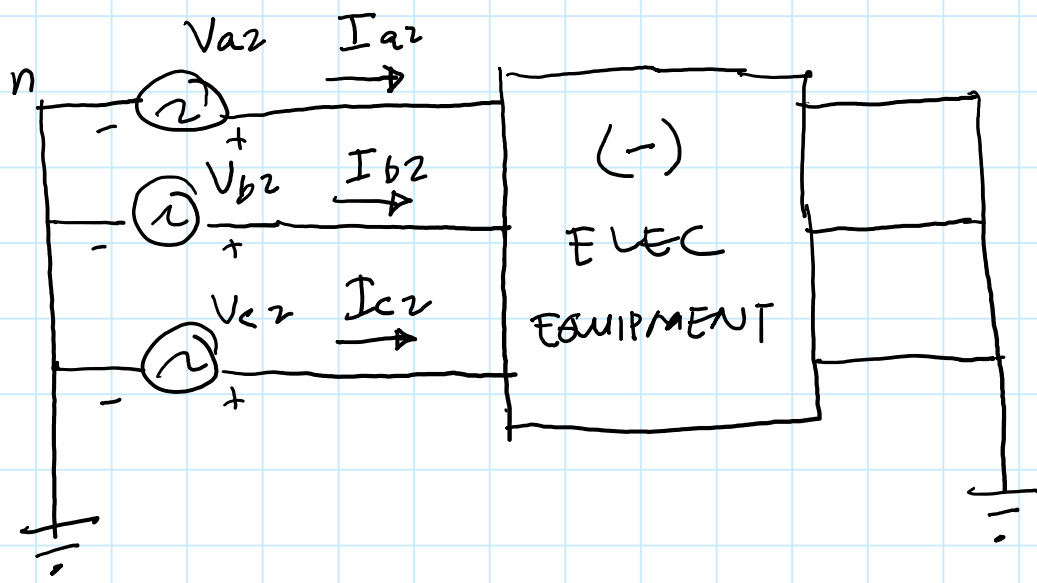


POSITIVE SEQUENCE IMPEDANCE



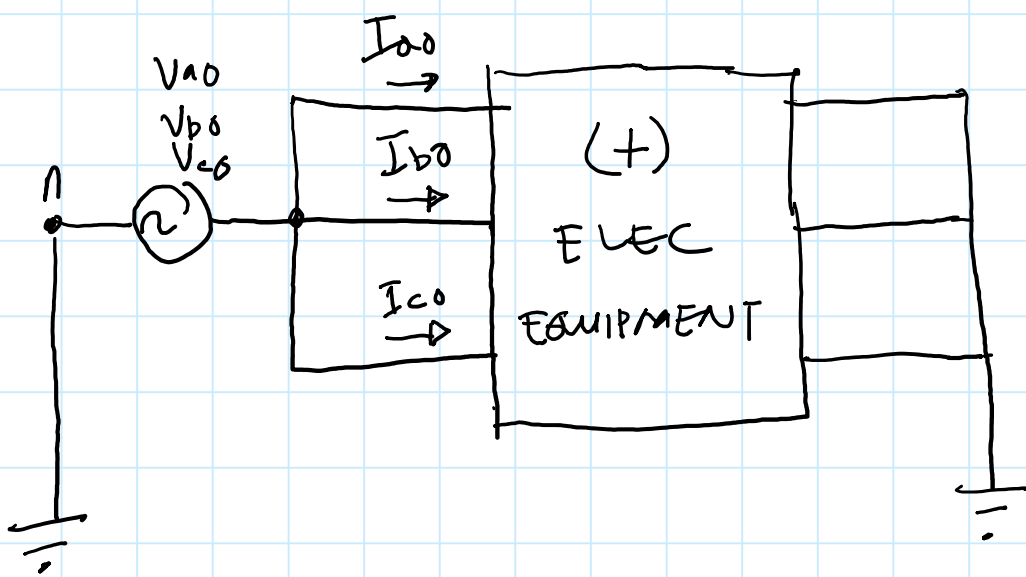
$$Z_1 = R_1 + jX_1 = \frac{V_{a1}}{I_{a1}} = \frac{V_{b1}}{I_{b1}} = \frac{V_{c1}}{I_{c1}}$$

NEGATIVE SEQUENCE IMPEDANCE



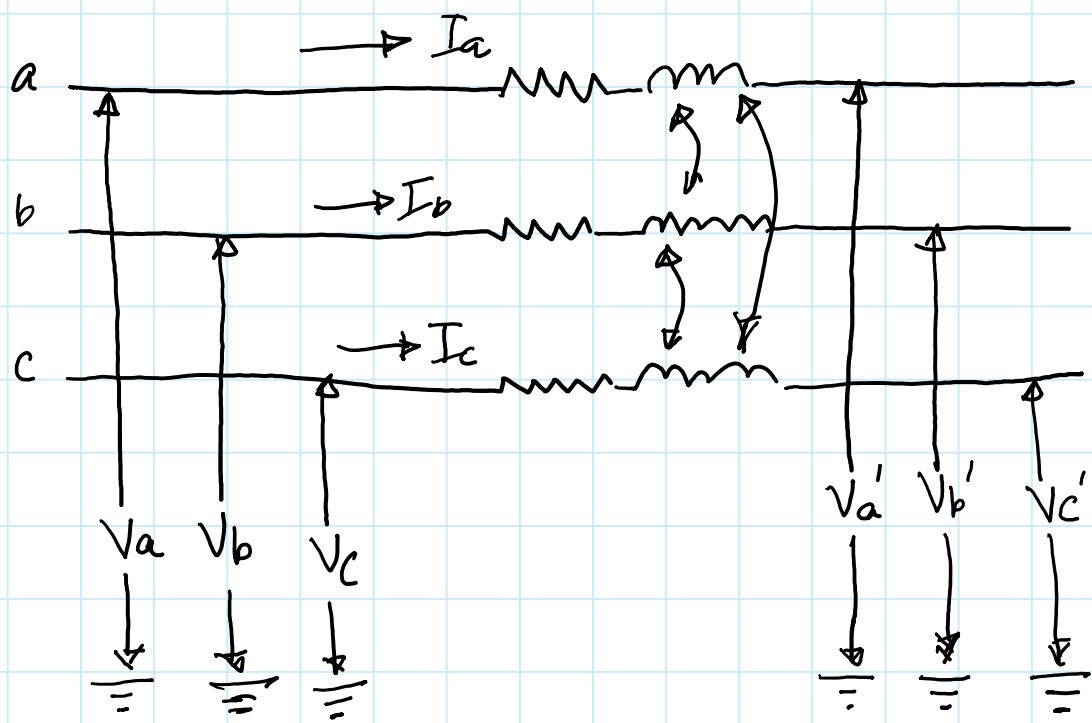
$$Z_2 = R_2 + jX_2 = \frac{V_{a2}}{I_{a2}} = \frac{V_{b2}}{I_{b2}} = \frac{V_{c2}}{I_{c2}}$$

ZERO SEQUENCE IMPEDANCE



$$Z_0 = R_0 + jX_0 = \frac{V_{a0}}{I_{a0}} = \frac{V_{b0}}{I_{b0}} = \frac{V_{c0}}{I_{c0}}$$

TRANSMISSION LINE



$$\begin{aligned} V_a &= Z_s I_a + Z_m I_b + Z_m I_c + V_a' \\ V_b &= Z_m I_a + Z_s I_b + Z_m I_c + V_b' \\ V_c &= Z_m I_a + Z_m I_b + Z_s I_c + V_c' \end{aligned}$$

$$\begin{aligned} V_{a1} &= Z_s I_{a1} + Z_m I_{b1} + Z_m I_{c1} + V_{a1}' \\ V_{a1} &= (Z_s - Z_m) I_{a1} + V_{a1}' \end{aligned}$$

$$\begin{aligned} V_{a1} &= (Z_s - Z_m) I_{a1} \\ V_{b1} &= (Z_s - Z_m) I_{b1} \\ V_{c1} &= (Z_s - Z_m) I_{c1} \end{aligned}$$

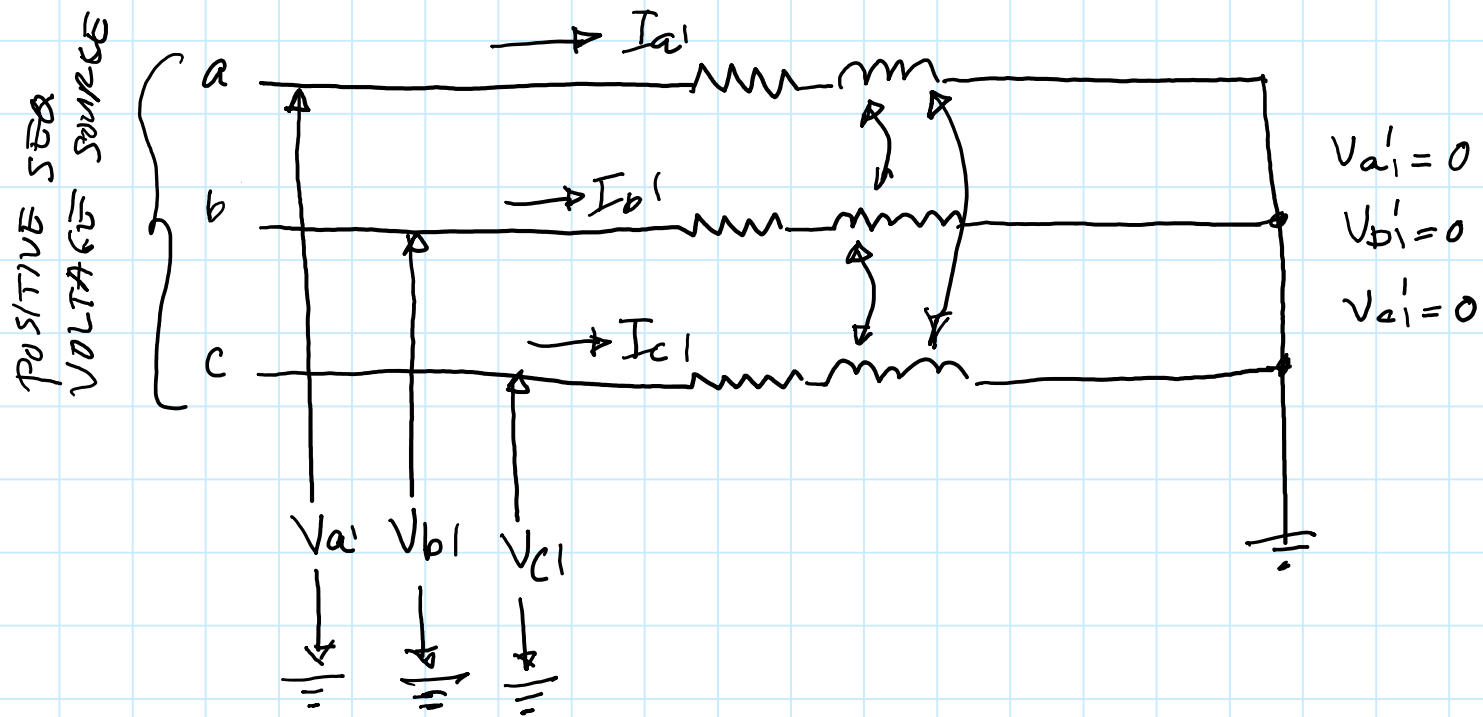
$$Z_s - Z_m = \frac{V_{a1}}{I_{a1}} = \frac{V_{b1}}{I_{b1}} = \frac{V_{c1}}{I_{c1}} = Z_1$$

$$Z_1 = Z_s - Z_m$$

$$Z_2 = Z_s - Z_m$$

$$Z_1 = Z_2$$

TRANSMISSION LINE POSITIVE SEQUENCE IMPEDANCE



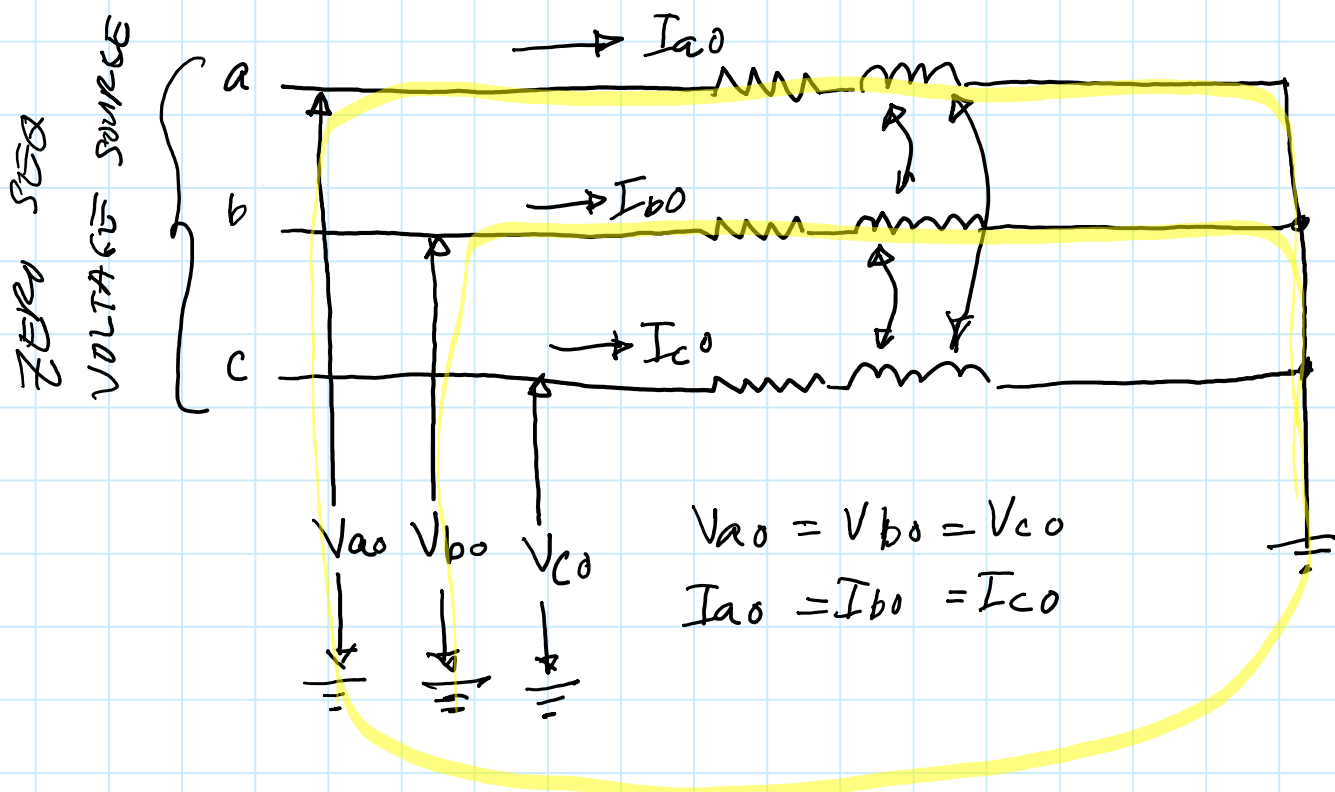
$$\begin{aligned} I_{a1} + I_{b1} + I_{c1} &= 0 \\ Z_m I_{b1} + Z_m I_{c1} &= -Z_m I_{a1} \end{aligned}$$

$$\begin{aligned} V_a &= Z_s I_a + Z_m I_b + Z_m I_c + V_a' \\ V_b &= Z_m I_a + Z_s I_b + Z_m I_c + V_b' \\ V_c &= Z_m I_a + Z_m I_b + Z_s I_c + V_c' \end{aligned}$$

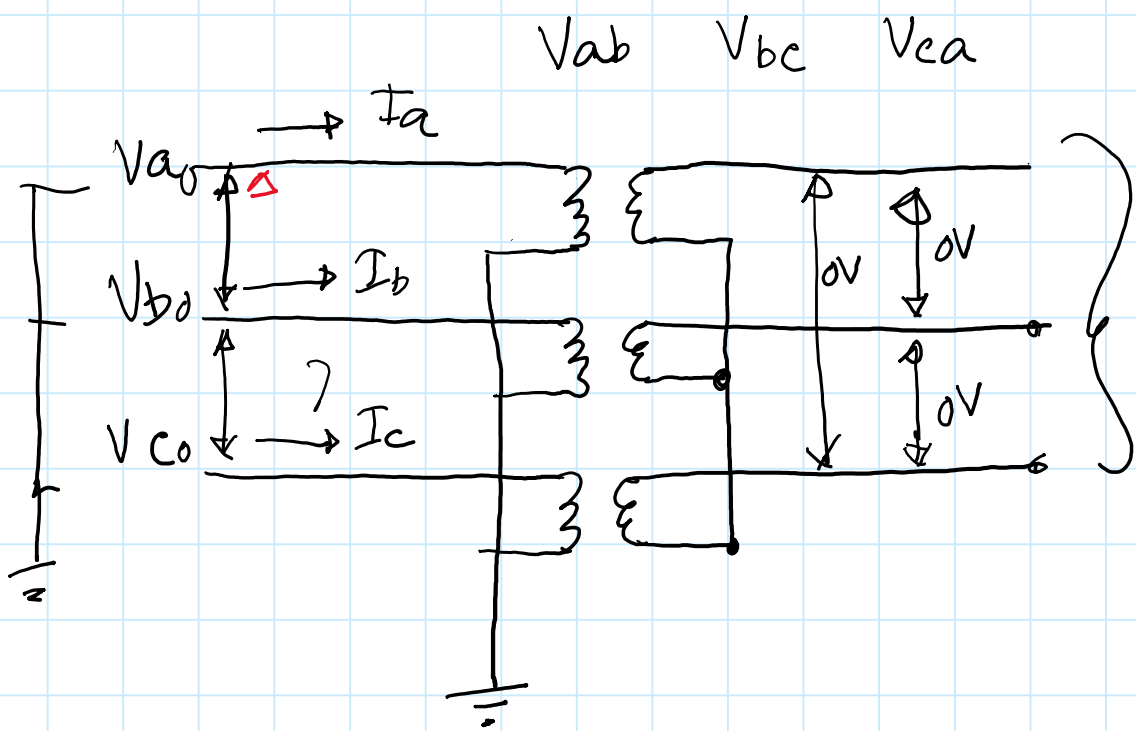
$$\begin{aligned} V_{a0} &= Z_s I_{a0} + Z_m I_{b0} + Z_m I_{c0} + V_{a0}' = (Z_s + 2Z_m) I_{a0} \\ V_{b0} &= Z_m I_{a0} + Z_s I_{b0} + Z_m I_{c0} + V_{b0}' = (Z_s + 2Z_m) I_{b0} \\ V_{c0} &= Z_m I_{a0} + Z_m I_{b0} + Z_s I_{c0} + V_{c0}' = (Z_s + 2Z_m) I_{c0} \end{aligned}$$

$$Z_0 = Z_s + 2Z_m$$

$$Z_0 > Z_1$$



WYE - WYE TRANSFORMER

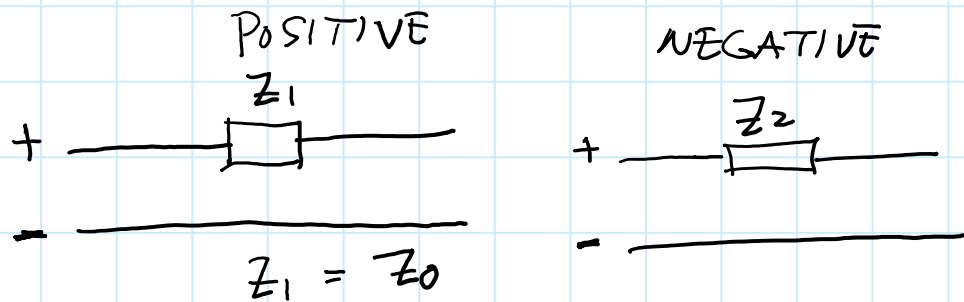


$$V_{Ao} = V_{Bo} = V_{Co}$$

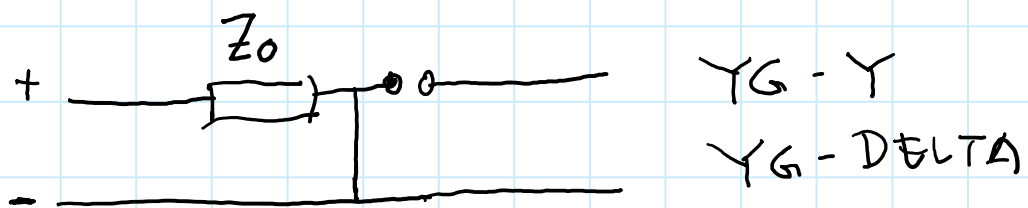
POS/NEG SEQ IMPEDANCE (YG-YG)

$$V_a = 1 \angle 0^\circ \quad V_b = 1 \angle -120^\circ \quad V_c = 1 \angle 120^\circ$$

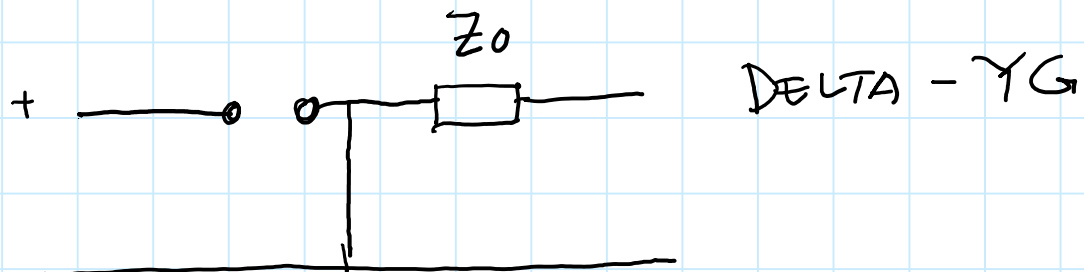
$$V_{ab} = V_a - V_b = 1 \angle 0^\circ - 1 \angle -120^\circ = \sqrt{3} \angle 30^\circ$$



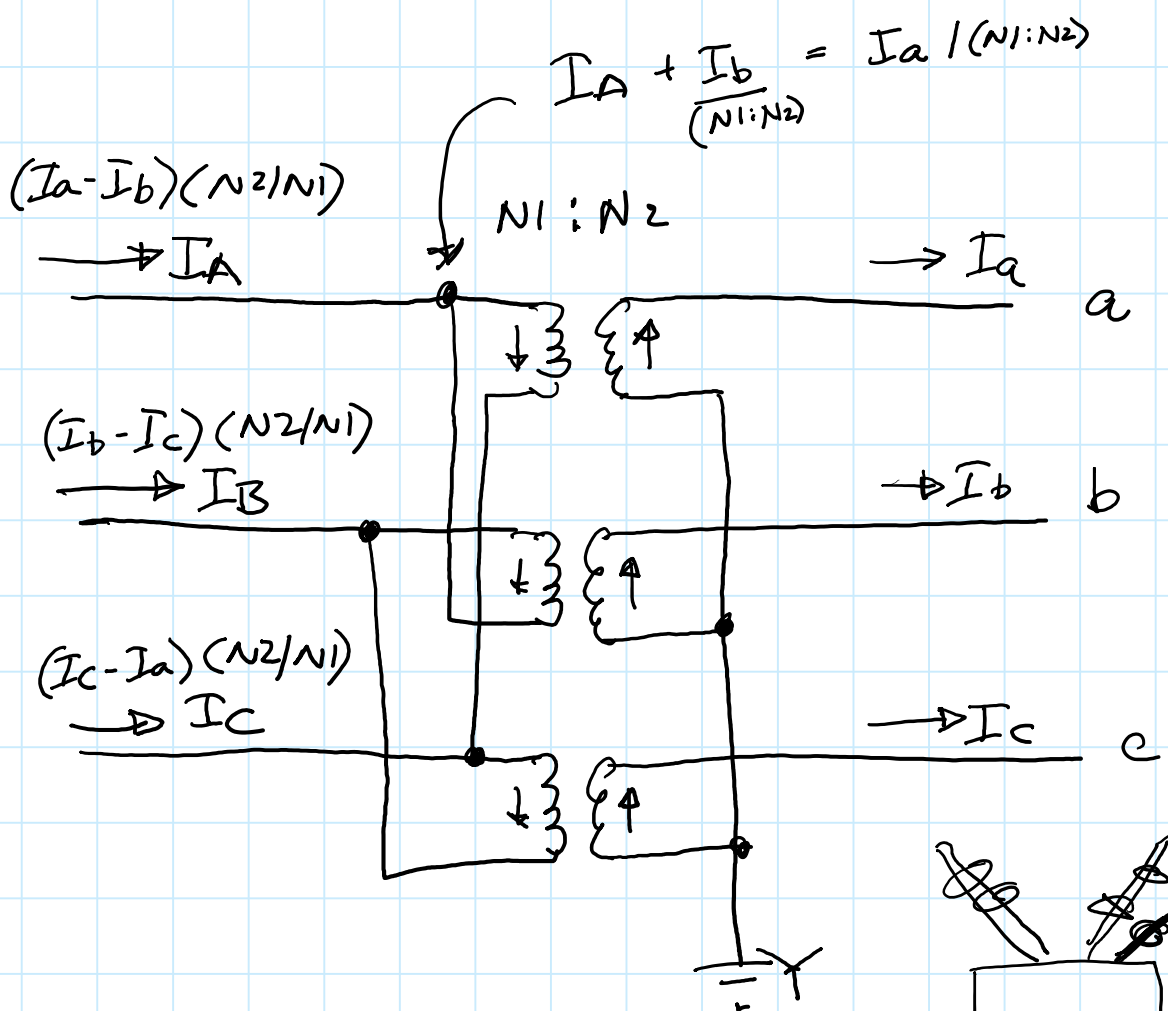
$$Z_1 = Z_0$$



YG - Y
YG - DELTA



DELTA - YG



$$I_A = (I_a - I_b) (N_2 / N_1)$$

$$I_B = (I_b - I_c) (N_2 / N_1)$$

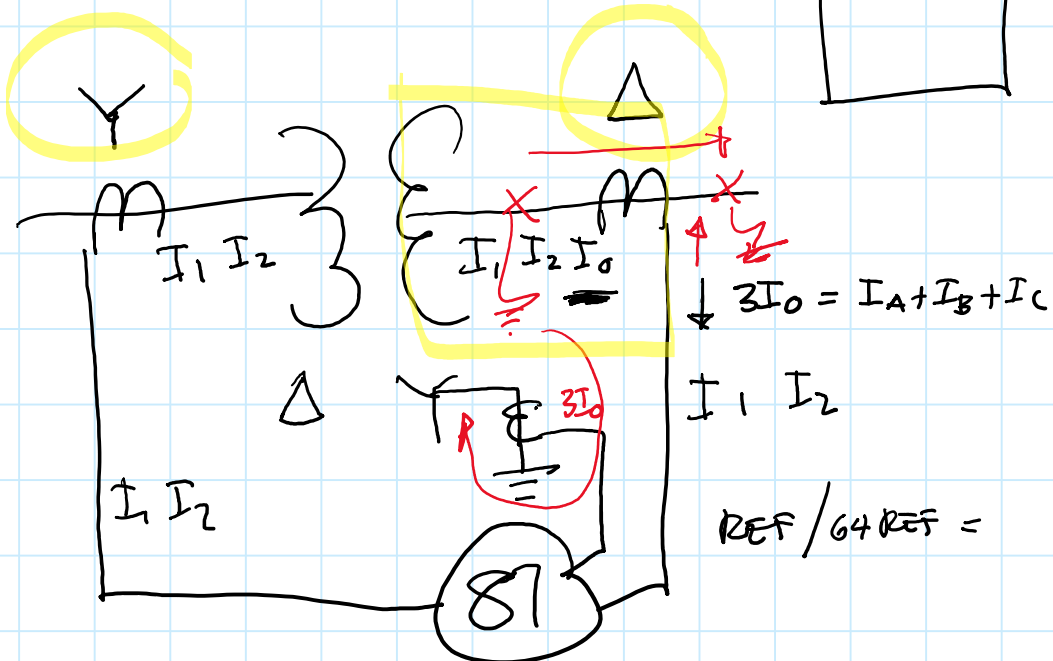
$$I_C = (I_c - I_a) (N_2 / N_1)$$

$$I_A = (I_a - I_b) (N_2 / N_1) = (I_{a0} + I_{a1} + I_{a2}) - (I_{b0} + I_{b1} + I_{b2})$$

But $I_{a0} = I_{b0} = I_{c0}$

$$I_A = I_{a1} + I_{a2} - I_{b1} - I_{b2}$$

There is no zero sequence currents in the line conductors. They are "trapped" in the windings.



$$I_{REF} / G_{REF} =$$





