EEE- 601
POWER SYSTEM ANALYSIS
Unit-1

Symmetrical Component Example 1

$$\text{Let } \mathbf{I} = \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \begin{bmatrix} 10\angle 0° \\ 10\angle -120° \\ 10\angle 120° \end{bmatrix} \qquad \text{Then}$$

$$\mathbf{I}_\mathrm{s} = \mathbf{A}^{-1}\mathbf{I} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \end{bmatrix}\begin{bmatrix} 10\angle 0° \\ 10\angle -120° \\ 10\angle 120° \end{bmatrix} = \begin{bmatrix} 0 \\ 10\angle 0° \\ 0 \end{bmatrix}$$

$$\text{If } \mathbf{I} = \begin{bmatrix} 10\angle 0° \\ 10\angle +120° \\ 10\angle -120° \end{bmatrix} \rightarrow \quad \mathbf{I}_\mathrm{s} = \begin{bmatrix} 0 \\ 0 \\ 10\angle 0° \end{bmatrix}$$

Symmetrical Component Example 2

$$\text{Let } \mathbf{V} = \begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 5\angle 90° \\ 8\angle 150° \\ 8\angle -30° \end{bmatrix}$$

Then

$$\mathbf{V}_s = \mathbf{A}^{-1}\mathbf{V} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \end{bmatrix}\begin{bmatrix} 5\angle 90° \\ 8\angle 150° \\ 8\angle -30° \end{bmatrix} = \begin{bmatrix} 1.67\angle 90° \\ 3.29\angle -135° \\ 6.12\angle 68° \end{bmatrix}$$

Symmetrical Component Example 3

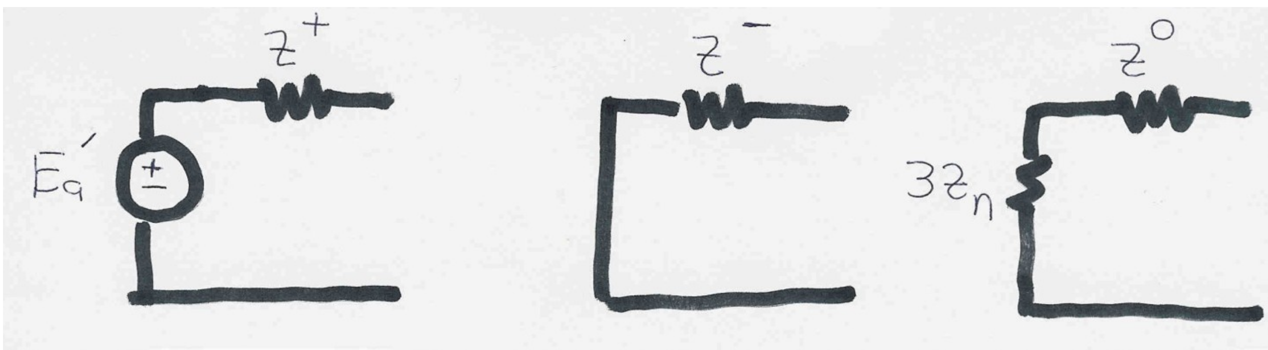
$$\text{Let } \mathbf{I}_s = \begin{bmatrix} I^0 \\ I^+ \\ I^- \end{bmatrix} = \begin{bmatrix} 10\angle 0^\circ \\ -10\angle 0^\circ \\ 5\angle 0^\circ \end{bmatrix}$$

Then

$$\mathbf{I} = \mathbf{A}\mathbf{I}_s = \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha^2 & \alpha \\ 1 & \alpha & \alpha^2 \end{bmatrix} \begin{bmatrix} 10\angle 0^\circ \\ -10\angle 0^\circ \\ 5\angle 0^\circ \end{bmatrix} = \begin{bmatrix} 5.0\angle 0^\circ \\ 18.0\angle 46.1^\circ \\ 18.0\angle -46.1^\circ \end{bmatrix}$$

Sequence diagrams for generators

- Key point: generators only produce positive sequence voltages; therefore only the positive sequence has a voltage source



During a fault $Z^+ \approx Z^- \approx X_d''$. The zero sequence impedance is usually substantially smaller. The value of Z_n depends on whether the generator is grounded

SEQUENCE IMPEDANCE

- Impedances offered by power system components to positive, negative and zero sequence currents.
- **Positive sequence impedance**

The impedance of a component when positive sequence currents alone are flowing.

- **Negative sequence impedance**

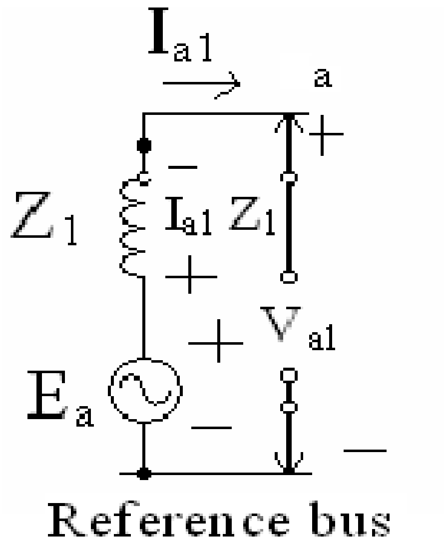
The impedance of a component when negative sequence currents alone are flowing.

- **Zero sequence impedance**

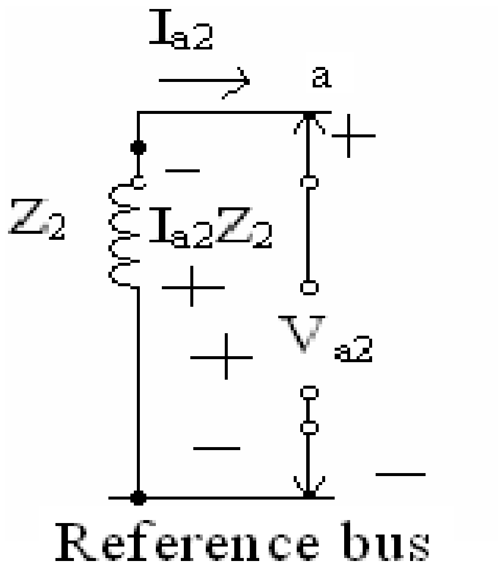
The impedance of a component when zero sequence currents alone are flowing.

SEQUENCE NETWORK

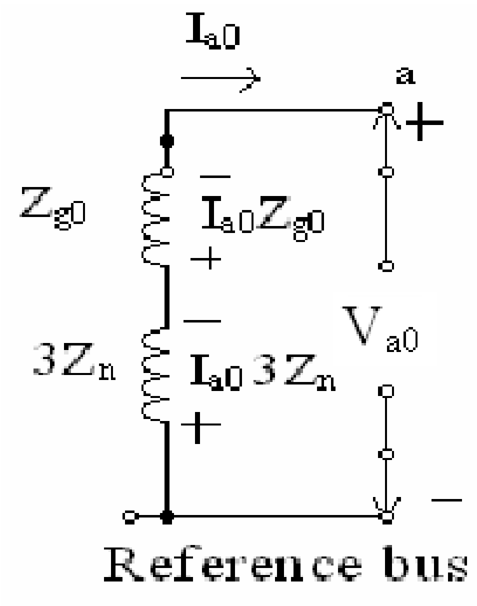
SEQUENCE NETWORK FOR GENERATOR



positive sequence network



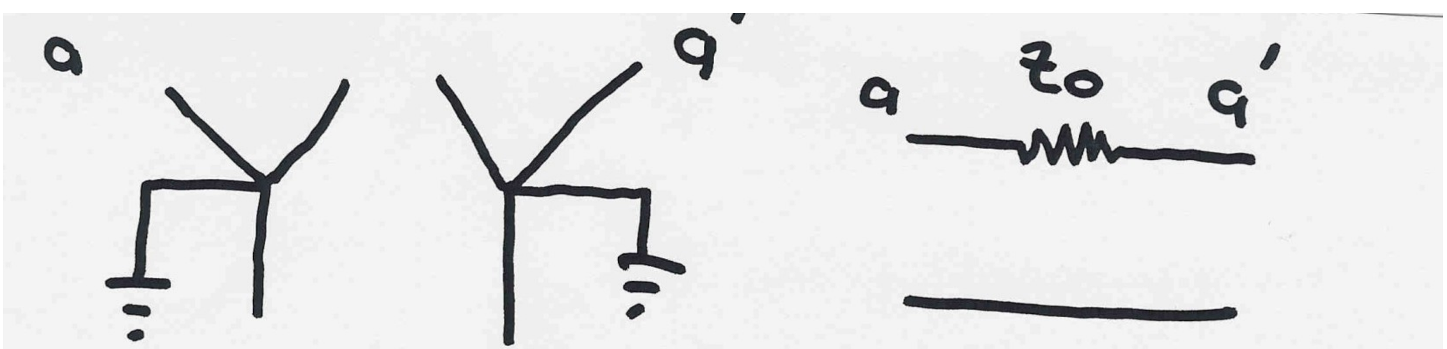
negative sequence network



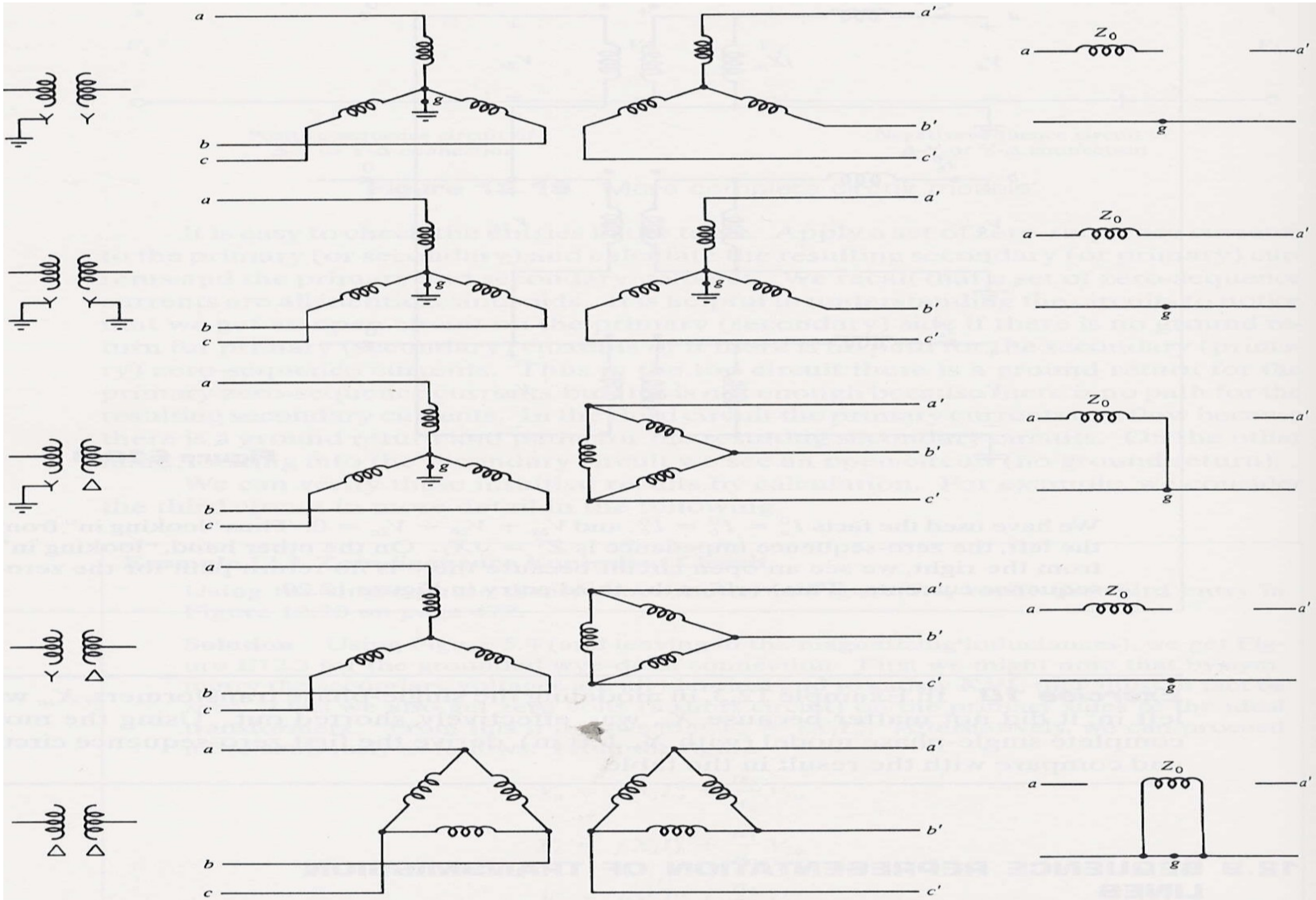
Zero sequence network

Sequence diagrams for Transformers

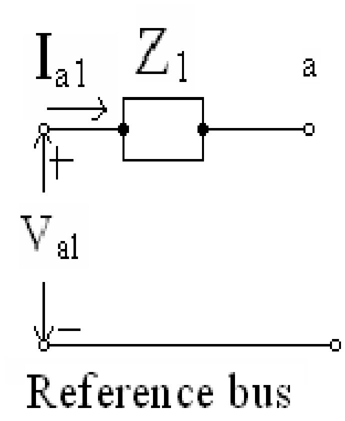
- The positive and negative sequence diagrams for transformers are similar to those for transmission lines.
- The zero sequence network depends upon both how the transformer is grounded and its type of connection. The easiest to understand is a double grounded wye-wye



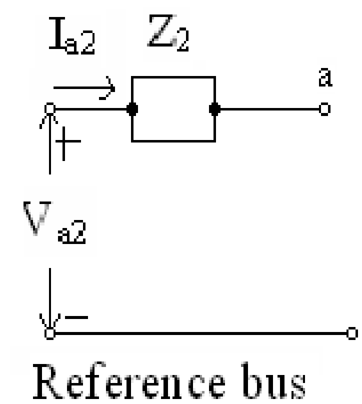
Transformer Sequence Diagrams



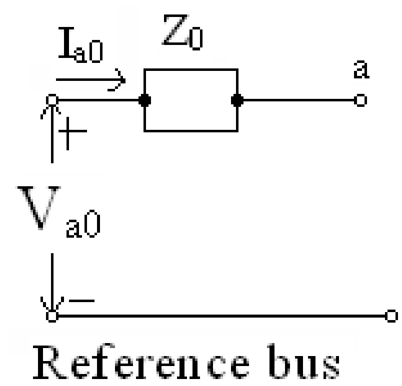
SEQUENCE NETWORK FOR TRANSMISSION LINE



positive sequence network

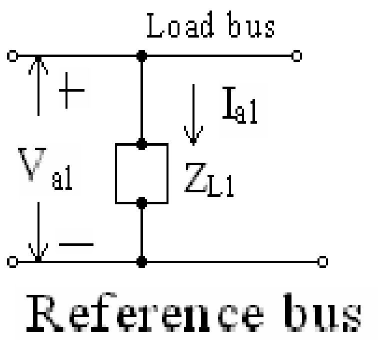


negative sequence network

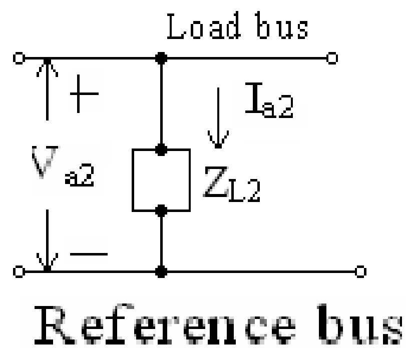


Zero sequence network

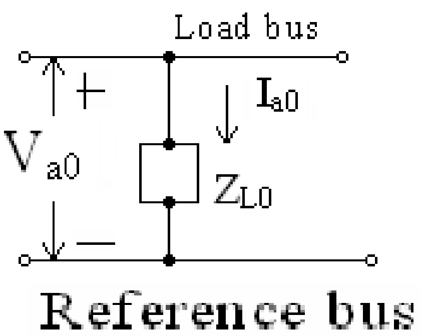
SEQUENCE NETWORK FOR LOAD



positive sequence network



negative sequence network



Zero sequence network

Thank you