

# VINNITSA NATIONAL AGRARIAN UNIVERSITY

Department of Electric Power Engineering, Electrical Engineering and Electromechanics



## THREE-PHASE ELECTRIC CIRCUITS $\Delta$ CONNECTIONS

by Associate Professor V. Hraniak





# THREE PHASE CONNECTION

# SOURCE-LOAD CONNECTION

SOURCE	LOAD	CONNECTION
Wye	Wye	Y-Y
Wye	Delta	Y- $\Delta$
Delta	Delta	$\Delta$ - $\Delta$
Delta	Wye	$\Delta$ -Y

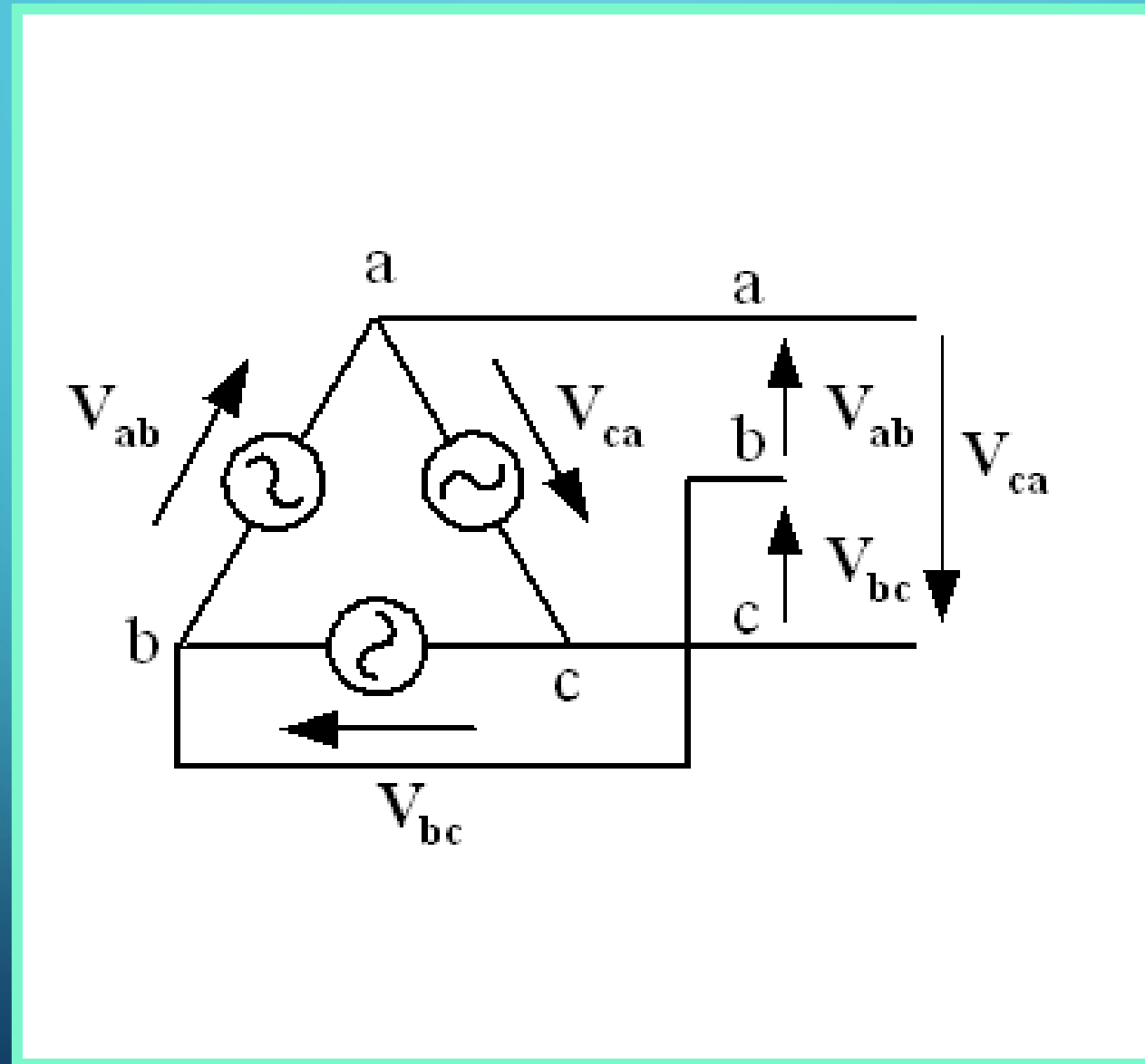
# SOURCE-LOAD CONNECTION

- **Common connection of source: WYE**
  - Delta connected sources: the circulating current may result in the delta mesh if the three phase voltages are slightly unbalanced.
- **Common connection of load: DELTA**
  - Wye connected load: neutral line may not be accessible, load can not be added or removed easily.

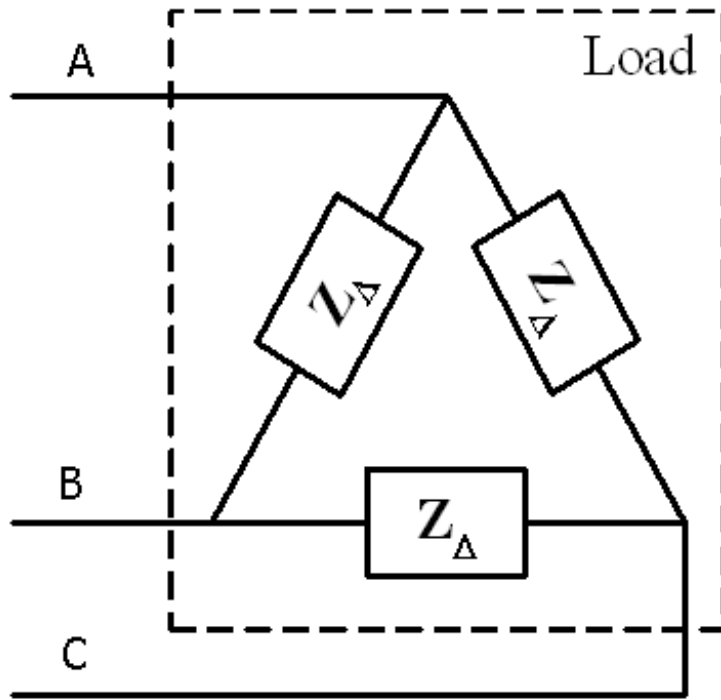


# DELTA CONNECTION

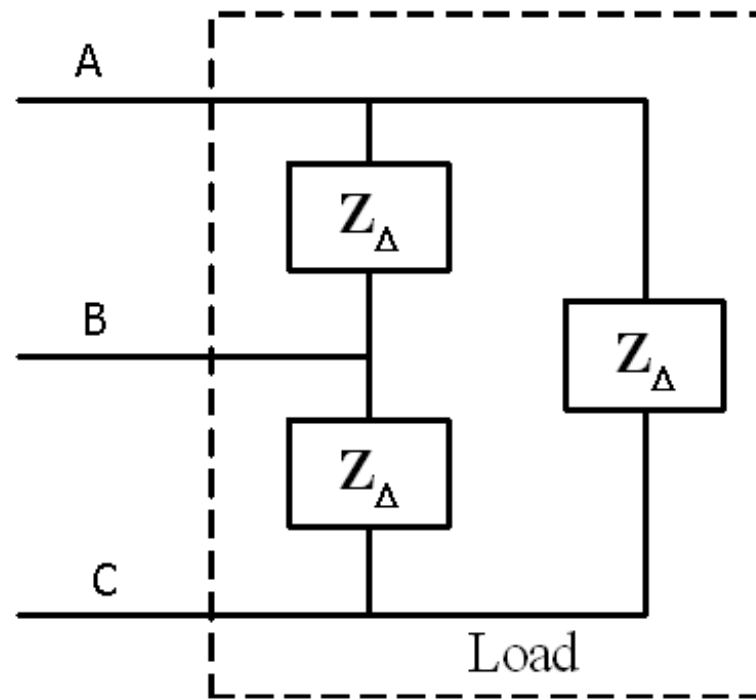
# DELTA CONNECTED SOURCES



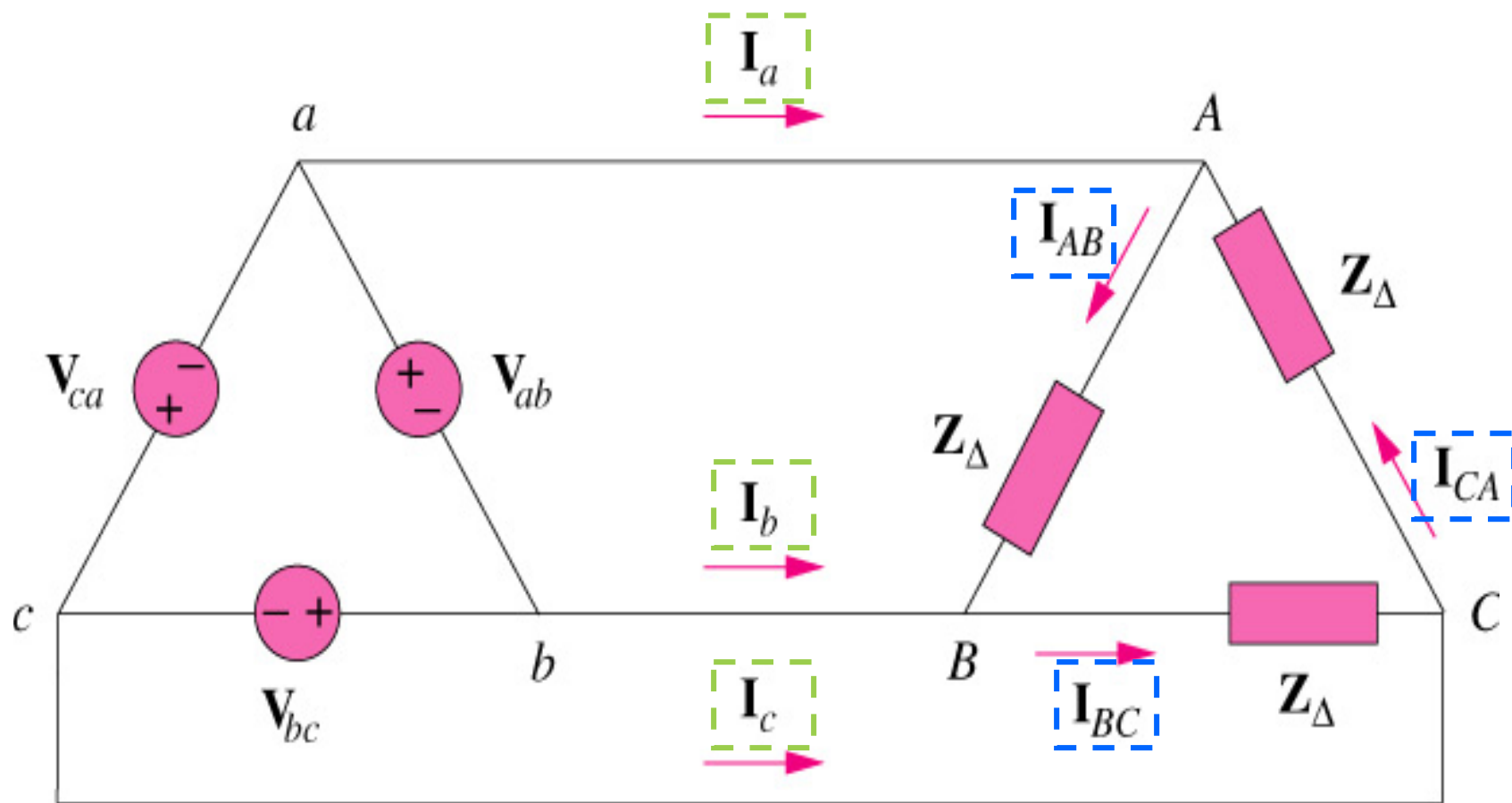
# DELTA CONNECTED LOAD



OR



# BALANCED $\Delta$ - $\Delta$ CONNECTION





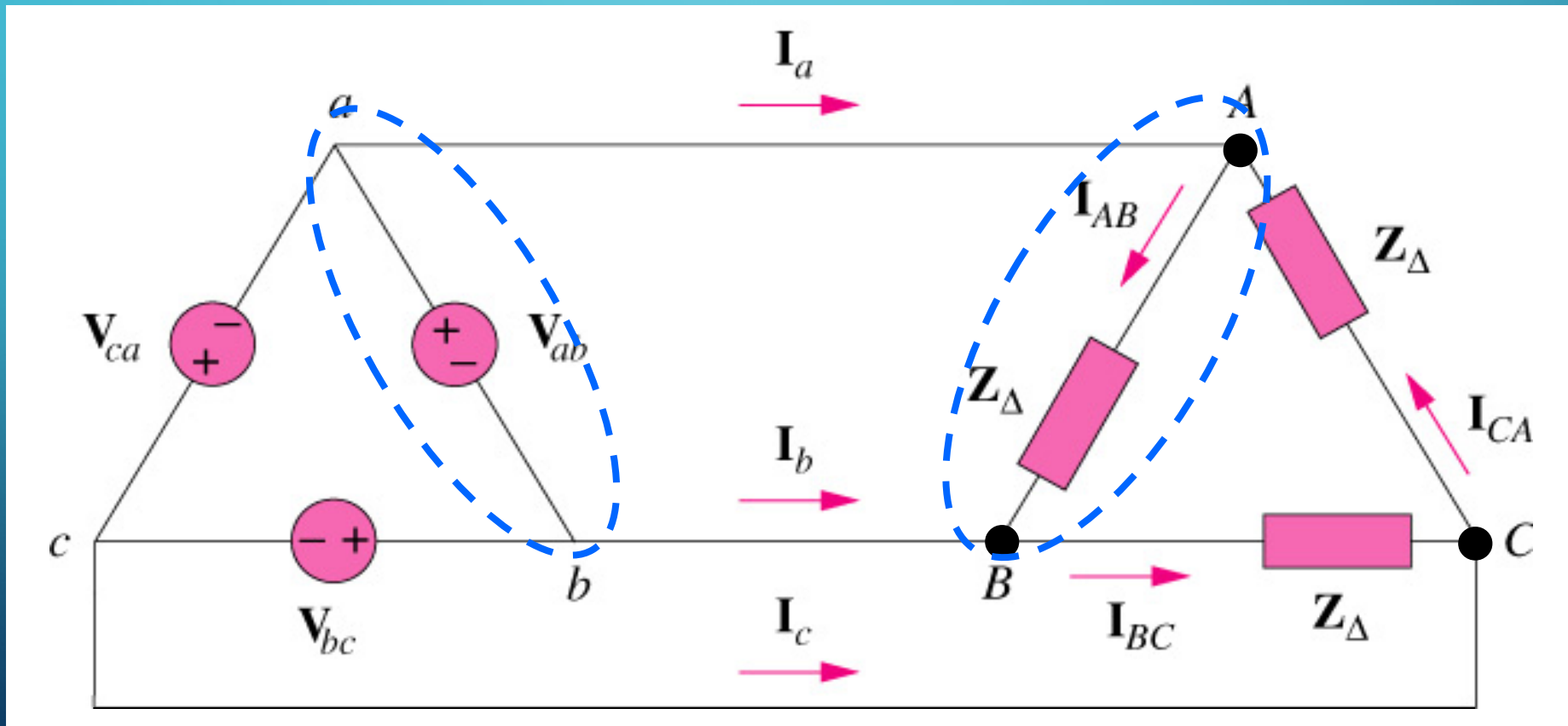
# PHASE VOLTAGE AND LINE VOLTAGE

- In  $\Delta$ - $\Delta$  system, line voltages equal to phase voltages:

$$V_L = V_\phi$$

# PHASE VOLTAGE, $V_\phi$

- Phase voltages are equal to the voltages across the load impedances.



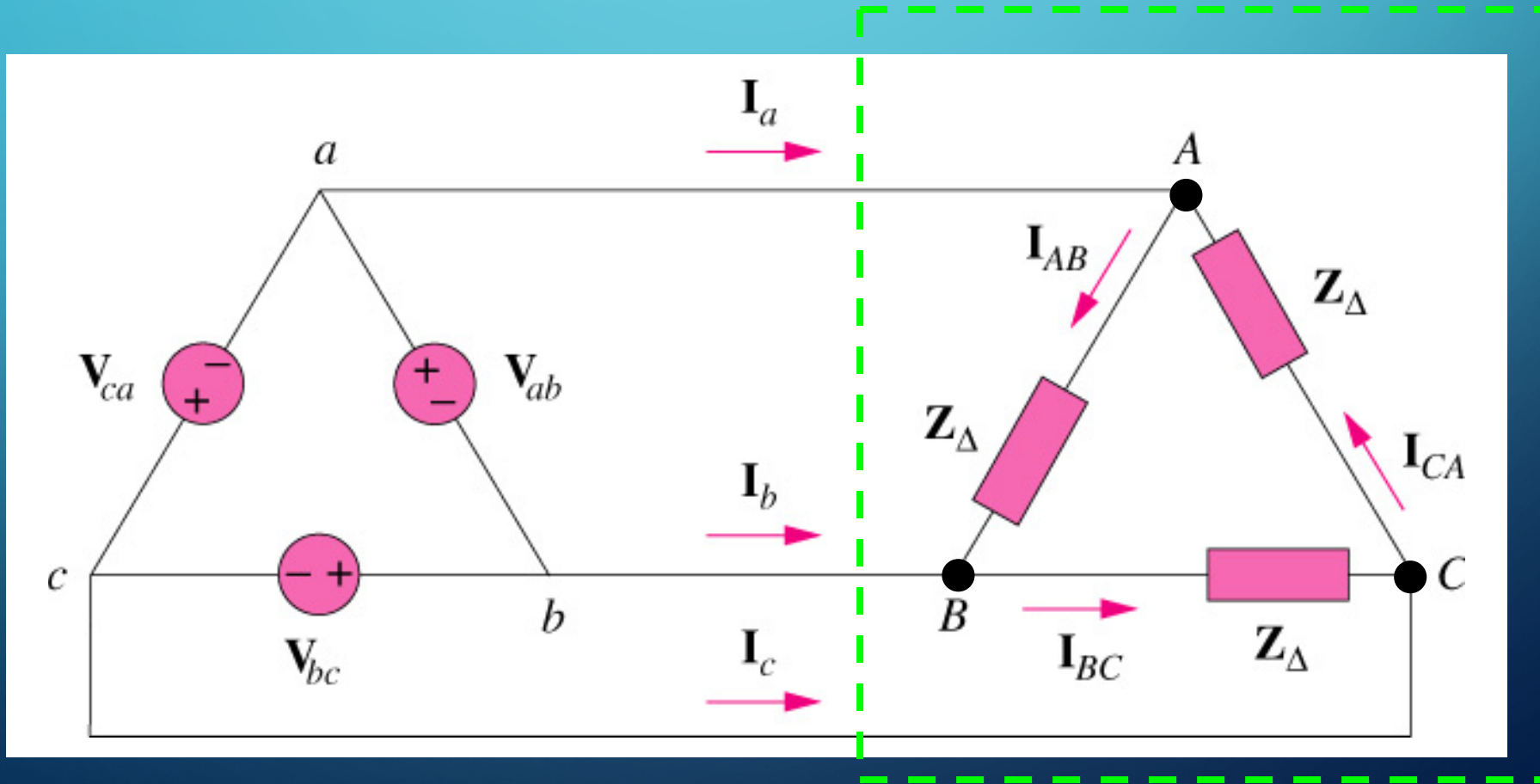
# PHASE CURRENTS, $I_{\phi}$

- The

$$I_{AB} = \frac{V_{AB}}{Z_{\Delta}}, \quad I_{BC} = \frac{V_{BC}}{Z_{\Delta}}, \quad I_{CA} = \frac{V_{CA}}{Z_{\Delta}}$$

# LINE CURRENTS, $I_L$

- The line currents are obtained from the phase currents by applying KCL at nodes A, B, and C.



# LINE CURRENTS, $I_L$

$$I_a = I_{AB} - I_{CA}$$

$$I_b = I_{BC} - I_{AB}$$

$$I_c = I_{CA} - I_{BC}$$



$$I_a = \sqrt{3} I_{AB} \angle -30^\circ$$

$$I_b = I_a \angle -120^\circ$$

$$I_c = I_a \angle +120^\circ$$

## PHASE CURRENTS ( $I_\phi$ )

$$I_{AB} = \frac{V_{AB}}{Z_\Delta}$$

$$I_{BC} = \frac{V_{BC}}{Z_\Delta}$$

$$I_{CA} = \frac{V_{CA}}{Z_\Delta}$$

## LINE CURRENTS ( $I_L$ )

$$I_a = \sqrt{3} I_{AB} \angle -30^\circ$$

$$I_b = I_a \angle -120^\circ$$

$$I_c = I_a \angle +120^\circ$$



# PROPERTIES OF PHASE CURRENT

- All phase currents have the same magnitude,

$$I_{\phi} = |I_{AB}| = |I_{BC}| = |I_{CA}| = \left| \frac{V_{\phi}}{Z_{\Delta}} \right|$$

- Out



# PROPERTIES OF LINE CURRENT

- All line currents have the same magnitude,

$$I_L = |I_a| = |I_b| = |I_c|$$

- Out of phase

# RELATIONSHIP BETWEEN $I_\phi$ AND $I_L$

## 1. Magnitude

$$|I_L| = \sqrt{3}|I_\phi|$$

## 2. Phase

-  $I_L$  **LAG** their corresponding  $I_\phi$  by  **$30^\circ$**

$$\angle I_L = \angle I_\phi - 30^\circ$$

# EXAMPLE

A balanced delta connected load having an impedance  $20-j15 \Omega$  is connected to a delta connected, positive sequence generator having  $V_{ab} = 330 \angle 0^\circ \text{ V}$ . Calculate the phase currents of the load and the line currents.

# GIVEN QUANTITIES

$$\Rightarrow \mathbf{Z}_{\Delta} = 20 - j15 \Omega = 25 \angle -36.87^{\circ}$$

$$\Rightarrow \mathbf{V}_{ab} = 330 \angle 0^{\circ}$$

## PHASE CURRENTS

$$I_{AB} = \frac{V_{AB}}{Z_{\Delta}} = \frac{330 \angle 0^{\circ}}{25 \angle -36.87^{\circ}} = 13.2 \angle 36.87^{\circ} \text{ A}$$

$$I_{BC} = I_{AB} \angle -120^{\circ} = 13.2 \angle -83.13^{\circ} \text{ A}$$

$$I_{CA} = I_{AB} \angle +120^{\circ} = 13.2 \angle 156.87^{\circ} \text{ A}$$

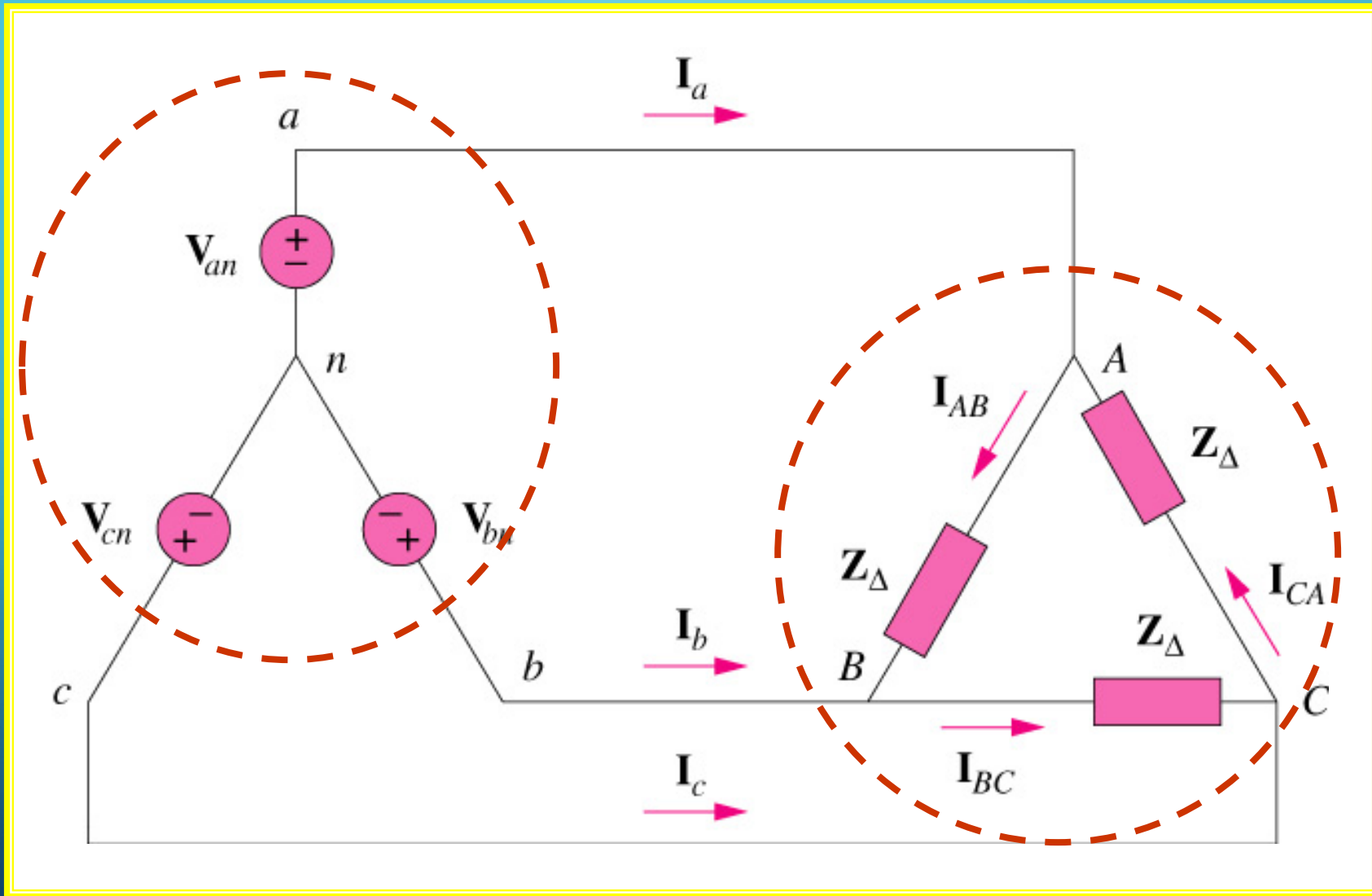
## LINE CURRENTS

$$\begin{aligned} I_a &= I_{AB} \sqrt{3} \angle -30^\circ \\ &= (13.2 \angle 36.87^\circ) (\sqrt{3} \angle -30^\circ) \text{ A} \\ &= 22.86 \angle 6.87^\circ \end{aligned}$$

$$I_b = I_a \angle -120^\circ = 22.86 \angle -113.13^\circ \text{ A}$$


$$I_c = I_a \angle +120^\circ = 22.86 \angle 126.87^\circ \text{ A}$$

# BALANCED WYE-DELTA SYSTEM





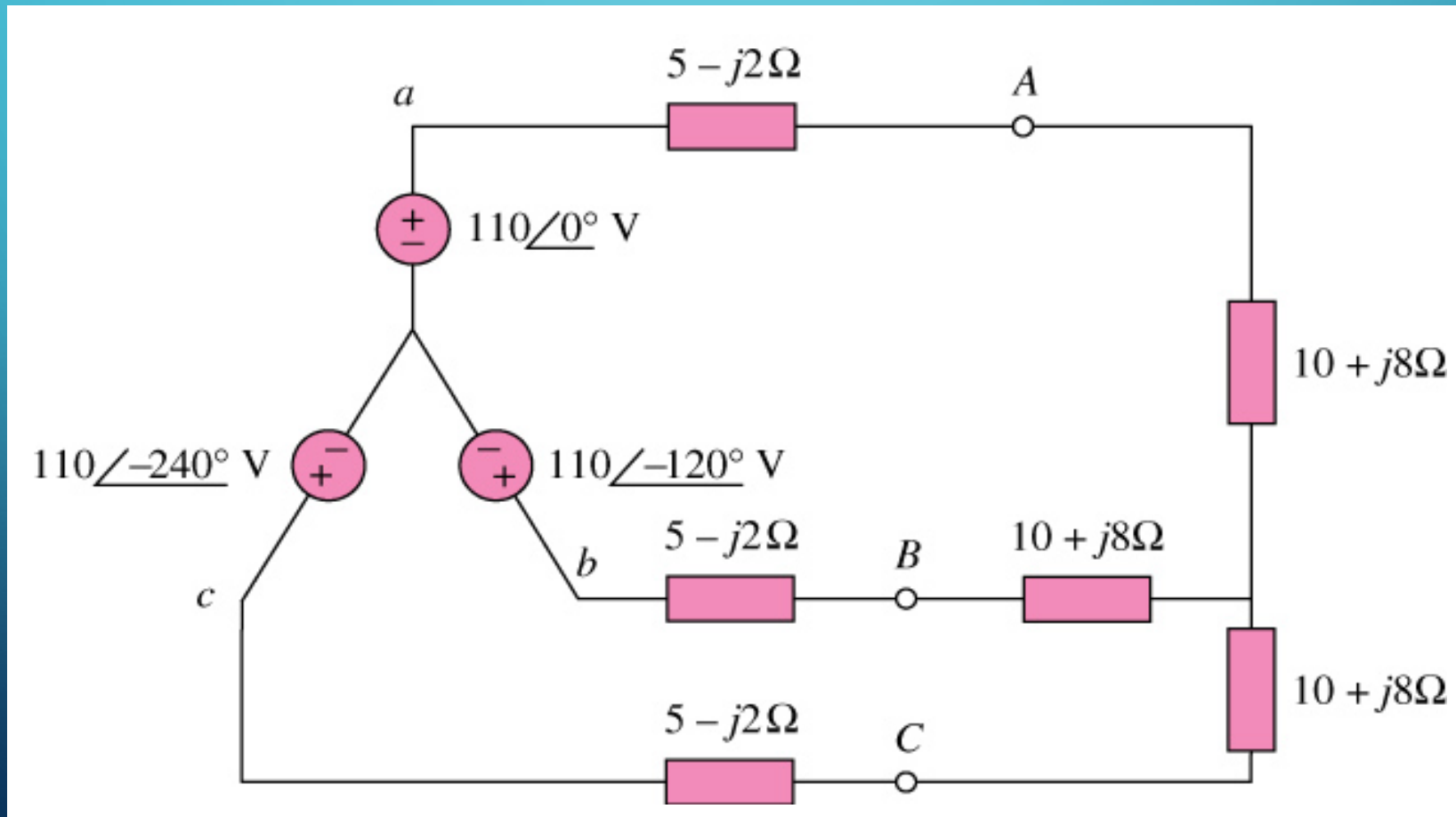




# THREE PHASE POWER MEASUREMENT

## EXAMPLE 3

Determine the total power ( $P$ ), reactive power ( $Q$ ), and complex power ( $S$ ) at the source and at the load





The image features a blue gradient background with white circuit-like lines in the corners. The lines consist of straight segments connected by small circles, resembling a network or data flow diagram. The lines are positioned in the top-left, top-right, bottom-left, and bottom-right corners, framing the central text.

**THANK FOR YOUR ATTENTION!**