VINNITSA NATIONAL AGRARIAN UNIVERSITY

Department of Electric Power Engineering, Electrical Engineering and Electromechanics

THREE-PHASE ELECTRIC CIRCUITS Δ CONNECTIONS

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THREE PHASE CONNECTION

SOURCE-LOAD CONNECTION

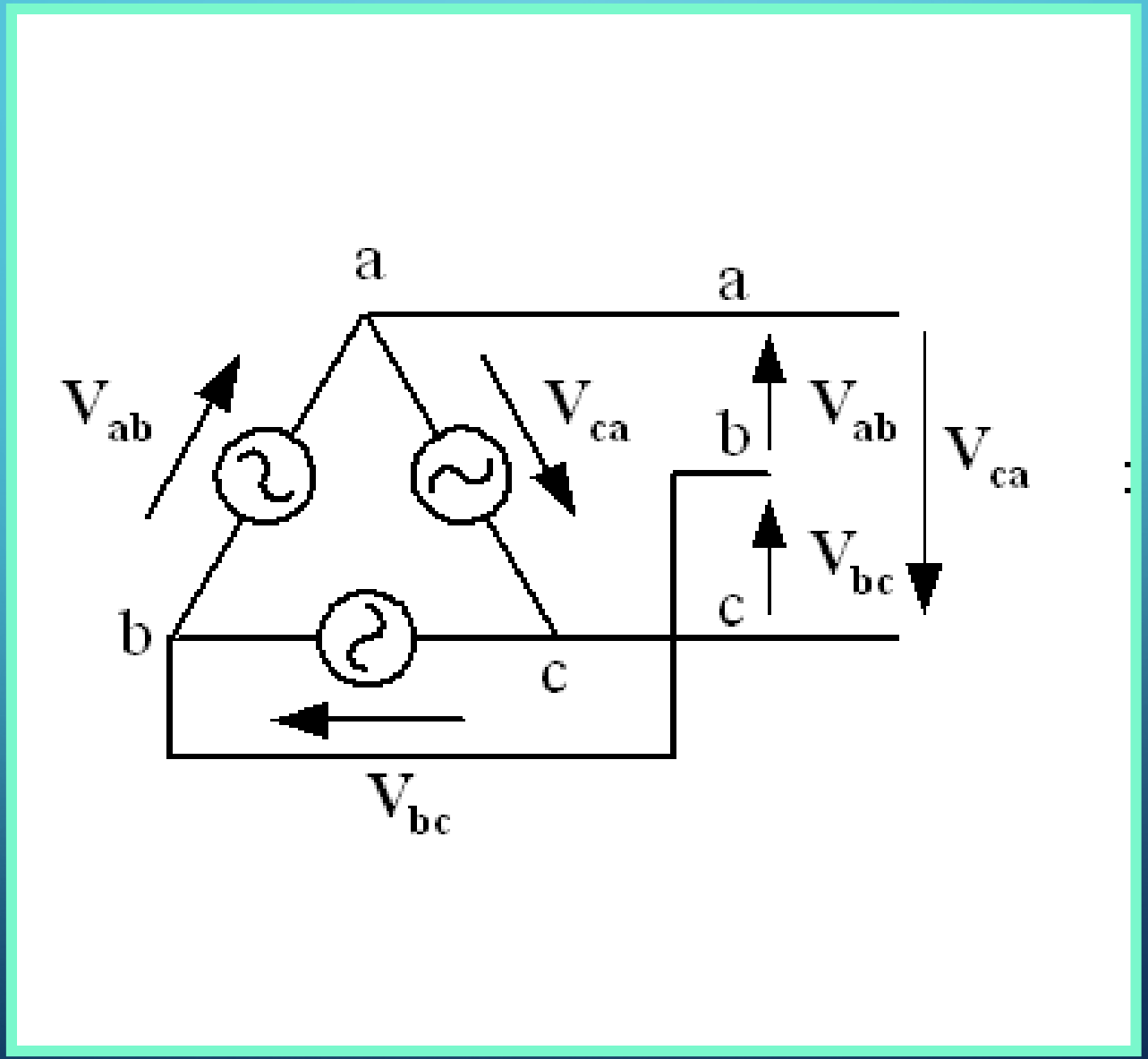
SOURCE	LOAD	CONNECTION
Wye	Wye	Y-Y
Wye	Delta	Y-Δ
Delta	Delta	Δ- Δ
Delta	Wye	Δ-Y

SOURCE-LOAD CONNECTION

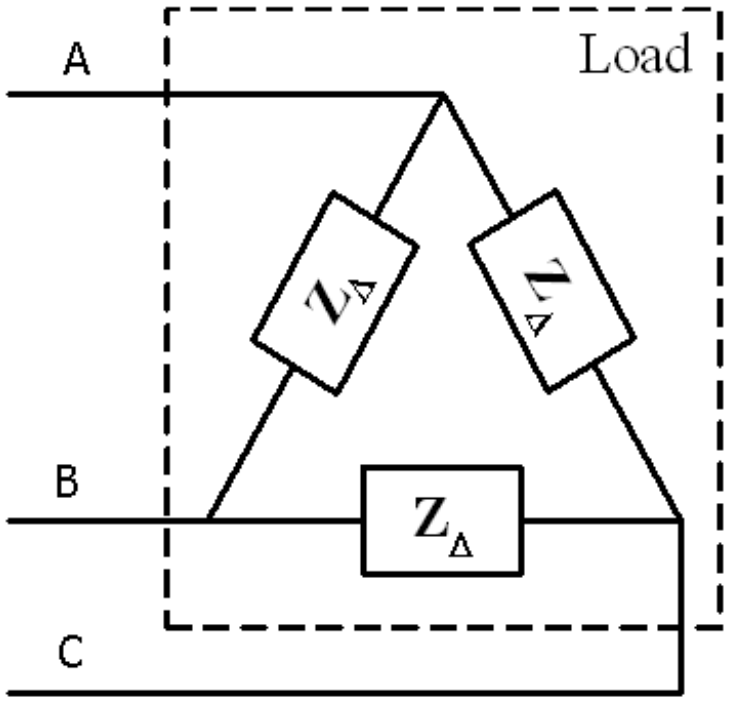
- Common connection of source: WYE
  - Delta connected sources: the circulating current may result in the delta mesh if the three phase voltages are slightly unbalanced.
- Common connection of load: DELTA
  - Wye connected load: neutral line may not be accessible, load can not be added or removed easily.

DELTA CONNECTION

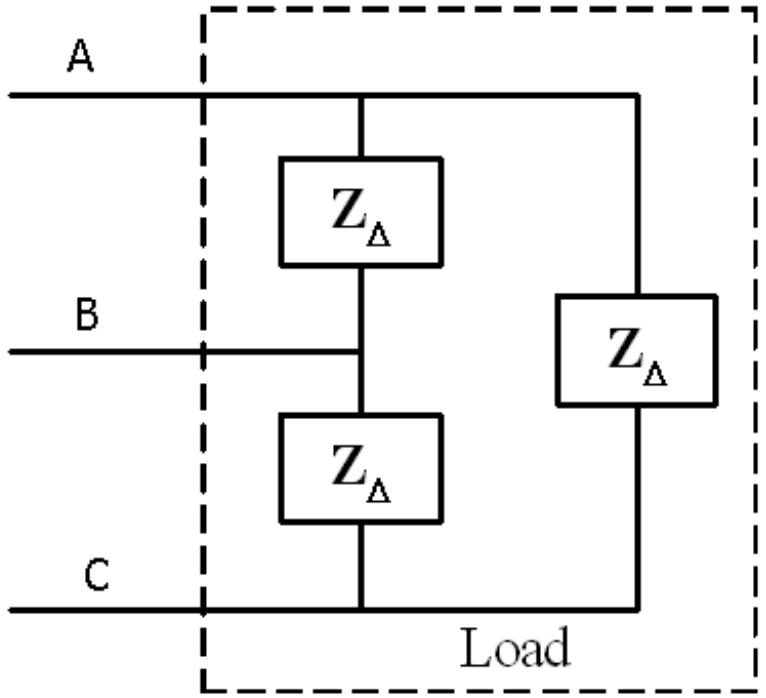
DELTA CONNECTED SOURCES



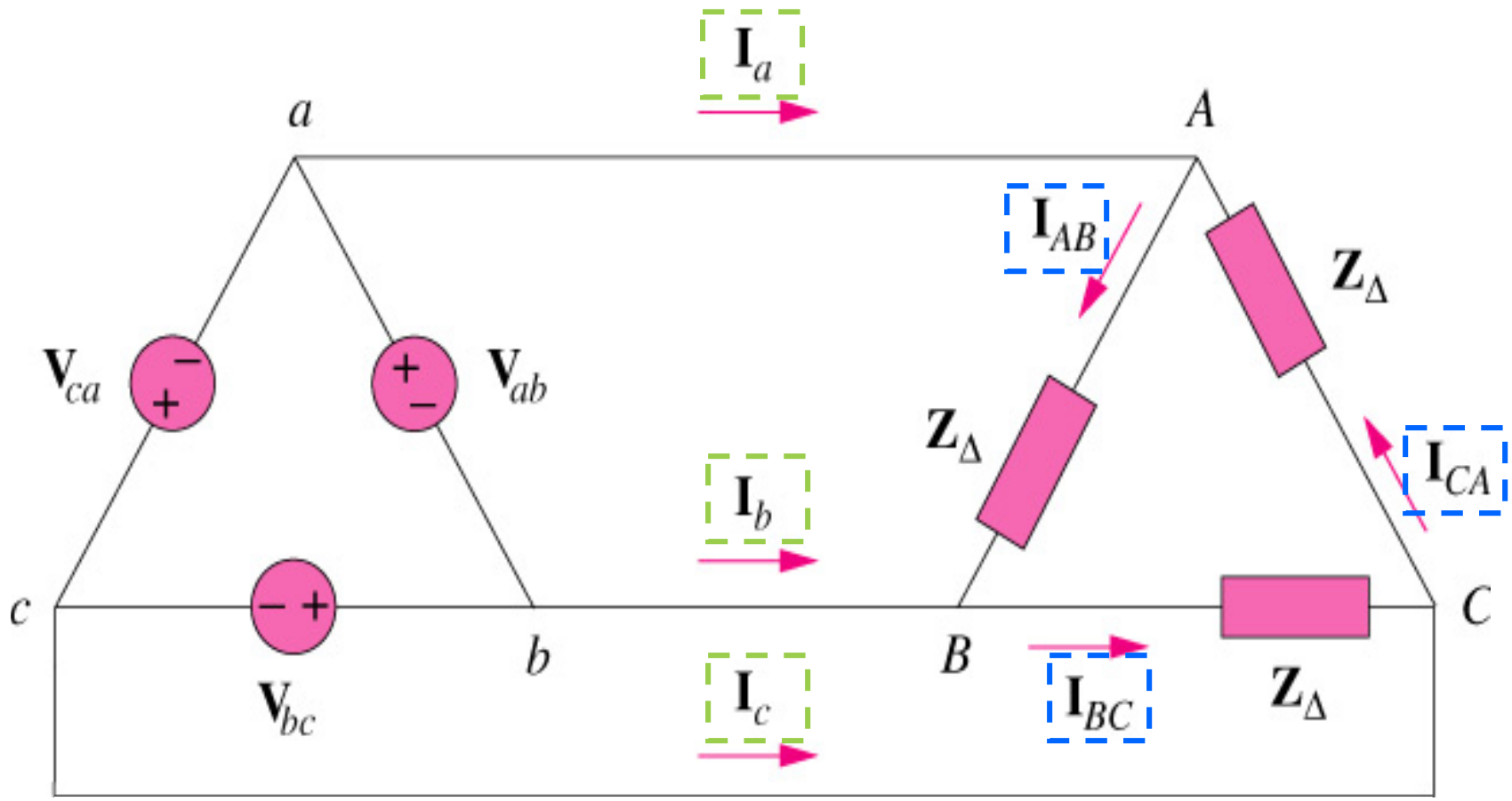
DELTA CONNECTED LOAD



OR



BALANCED Δ- Δ CONNECTION



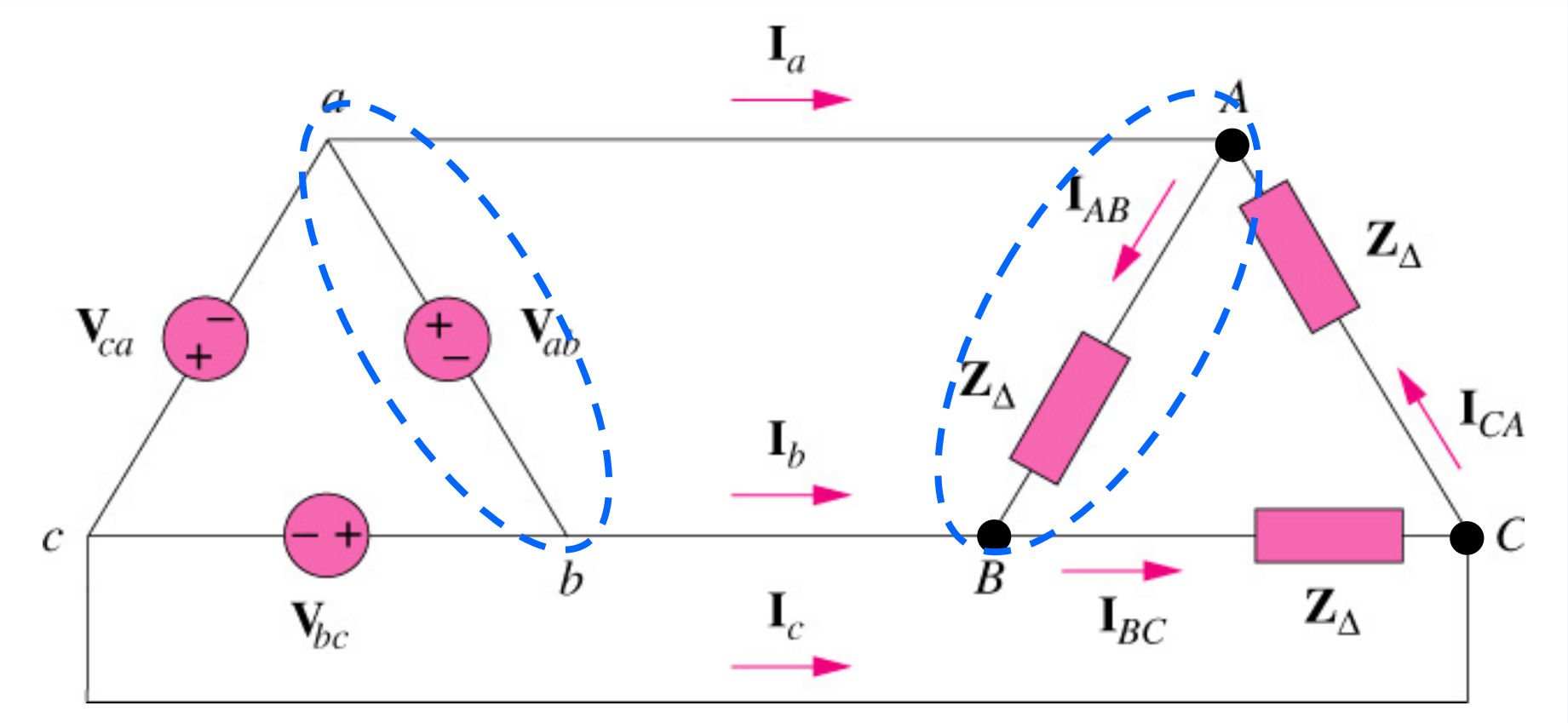
PHASE VOLTAGE AND LINE VOLTAGE

- In Δ-Δ system, line voltages equal to phase voltages:

$$V_L = V_\varphi$$

PHASE VOLTAGE, V_ϕ

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



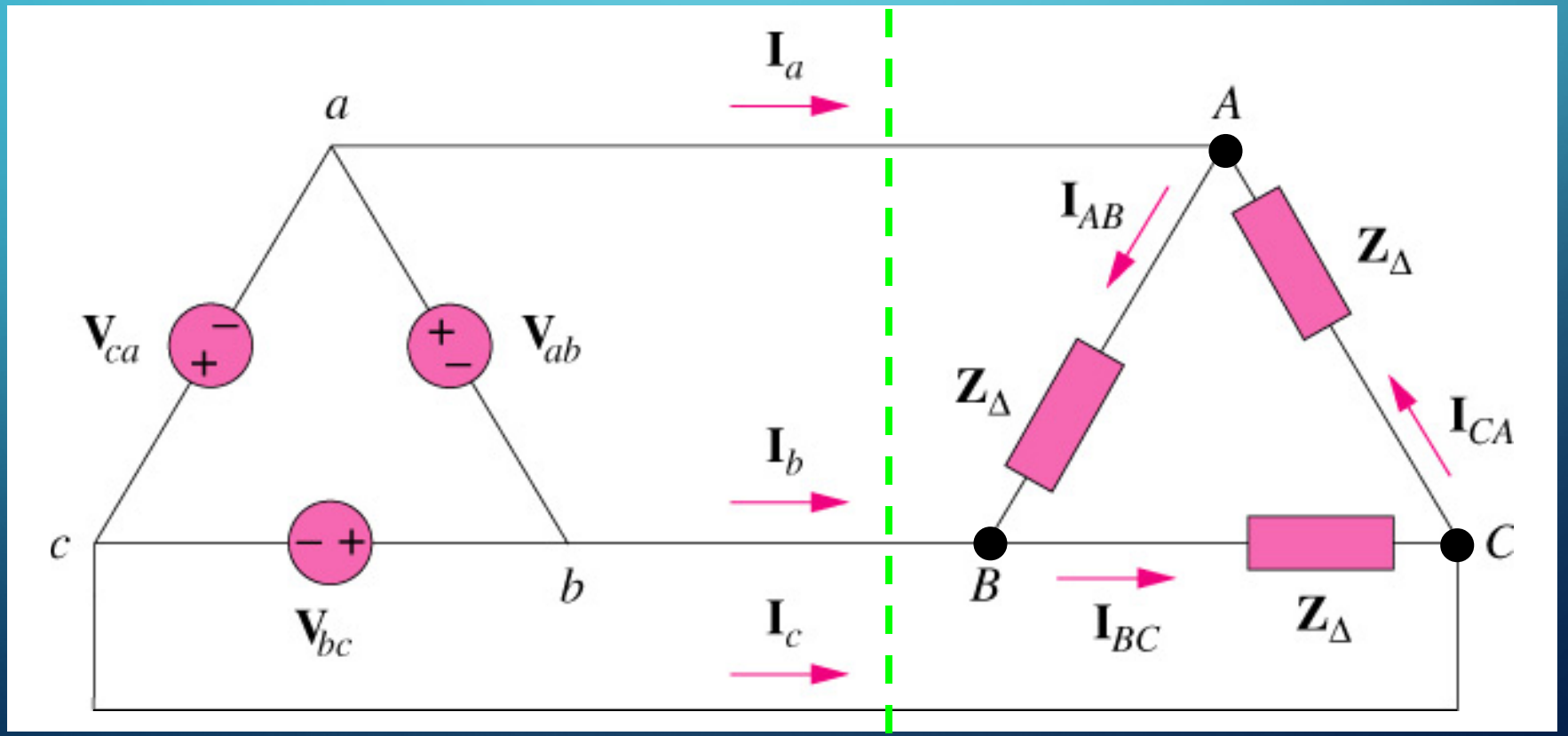
PHASE CURRENTS, I_ϕ

- 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

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

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

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

$$I_a = \sqrt{3}\, I_{AB} \angle -30°$$

$$I_b = I_a \angle -120°$$

$$I_c = I_a \angle +120°$$

PHASE CURRENTS (I_ϕ)

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

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

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

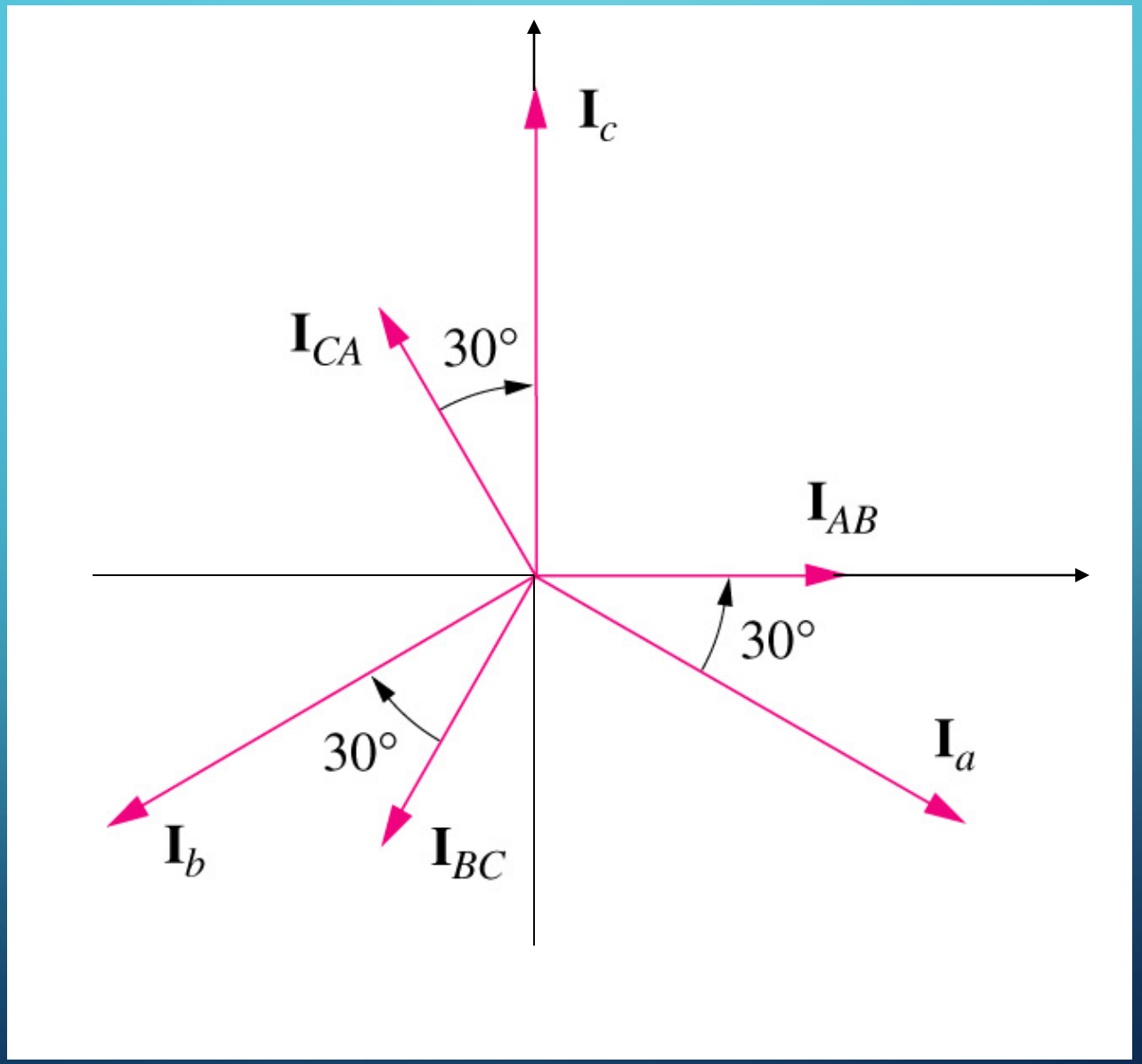
LINE CURRENTS (I_L)

$$I_a = \sqrt{3}\, I_{AB} \angle -30°$$

$$I_b = I_a \angle -120°$$

$$I_c = I_a \angle +120°$$

PHASE DIAGRAM OF I_L AND I_ϕ



PROPERTIES OF PHASE CURRENT

- All phase currents have the same magnitude,

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

- Out

PROPERTIES OF LINE CURRENT

- All line currents have the same magnitude,

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

- Out of pha

RELATIONSHIP BETWEEN I_ϕ AND I_L

1. Magnitude

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

2. Phase

- I_L LAG their corresponding I_ϕ by 30°

$$\angle I_L = \angle I_\phi - 30°$$

EXAMPLE

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

GIVEN QUANTITIES

$$\Rightarrow Z_{\Delta} = 20 - j15\,\Omega = 25\angle -36.87^{\circ}$$

$$\Rightarrow V_{ab} = 330\angle 0^{\circ}$$

PHASE CURRENTS

$$I_{AB} = \frac{V_{AB}}{Z_{\Delta}} = \frac{330\angle 0°}{25\angle -36.87°} = 13.2\angle 36.87°\,A$$

$$I_{BC} = I_{AB}\angle -120° = 13.2\angle -83.13°\,A$$

$$I_{CA} = I_{AB}\angle +120° = 13.2\angle 156.87°\,A$$

LINE CURRENTS

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

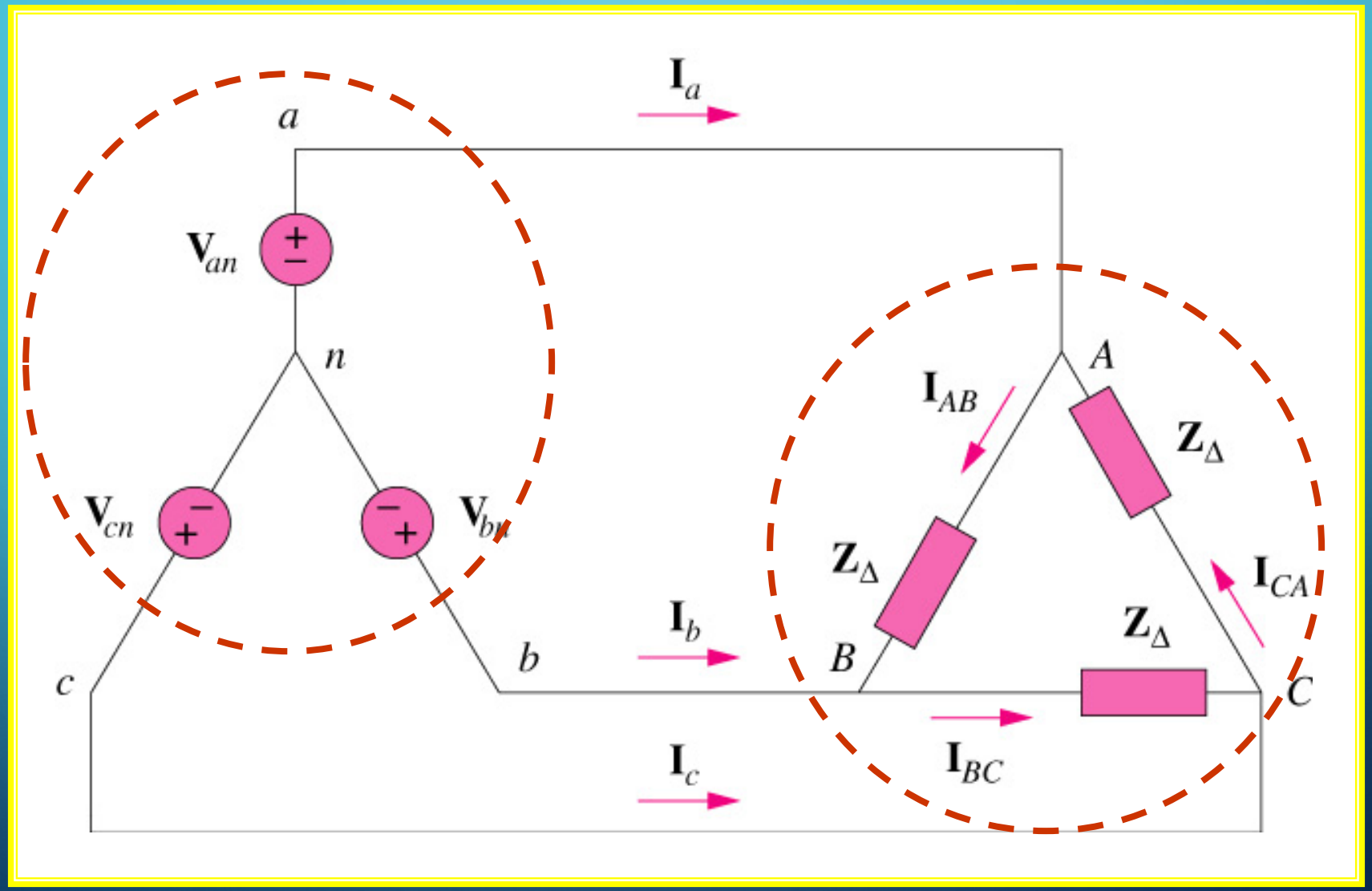
$$= (13.2\angle 36.87^\circ)(\sqrt{3}\angle -30^\circ)\text{A}$$

$$= 22.86\angle 6.87^\circ$$

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

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

BALANCED WYE-DELTASYSTEM



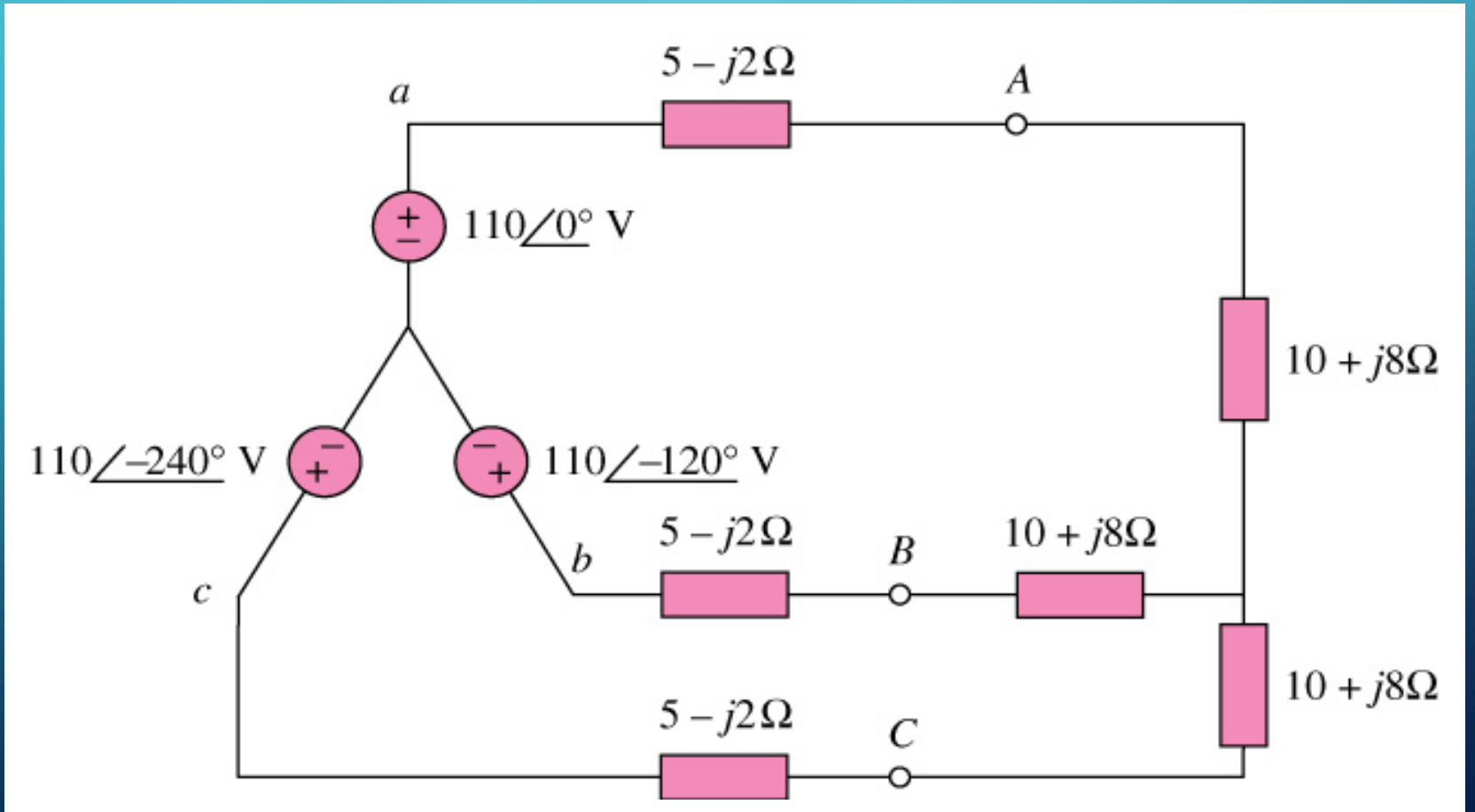
EXAMPLE 2

A balanced positive sequence Y-connected source with $V_{an}=100\angle 10^{\circ}$ V is connected to a Δ-connected balanced load $(8+j4)\Omega$ per phase. Calculate the phase and line currents.

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



EXAMPLE 4

A three phase motor can be regarded as a balanced Y-load.

A three phase motor draws 5.6 kW when the line voltage is 220 V and the line current is 18.2 A. Determine the power factor of the motor

THANK FOR YOUR ATTENTION!