EEE201
Circuit Analysis II

Ankara University

Faculty of Engineering

Electrical and Electronics Engineering Department

Balanced Three-Phase Circuits

EEE201 Circuit Analysis II

Lecture 7

Agenda

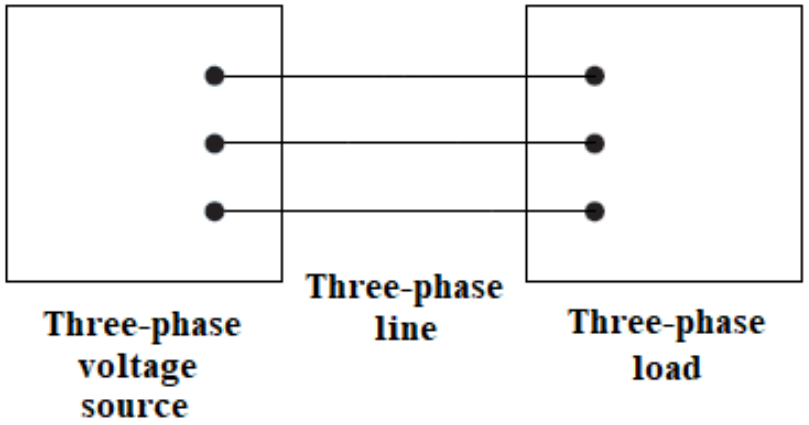
- Balanced Three-Phase Voltages
- Three-Phase Voltage Sources
- Y-Y Circuit

Balanced Three-Phase Voltages

a-phase voltage

b-phase voltage

c-phase voltage

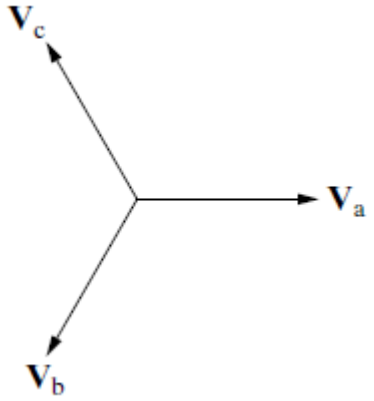


Three-phase sources and loads can be either Y-connected or Δ-connected.

Balanced Three-Phase Voltages

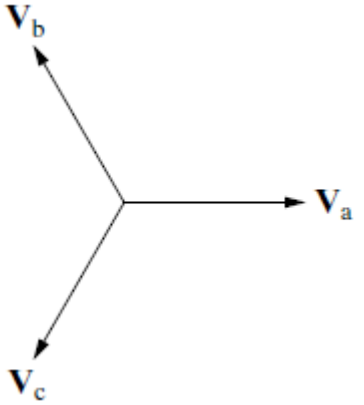
abc (or positive) phase sequence:

$$\boldsymbol{V}_a = V_m\angle 0°$$
$$\boldsymbol{V}_b = V_m\angle -120°$$
$$\boldsymbol{V}_c = V_m\angle +120°$$



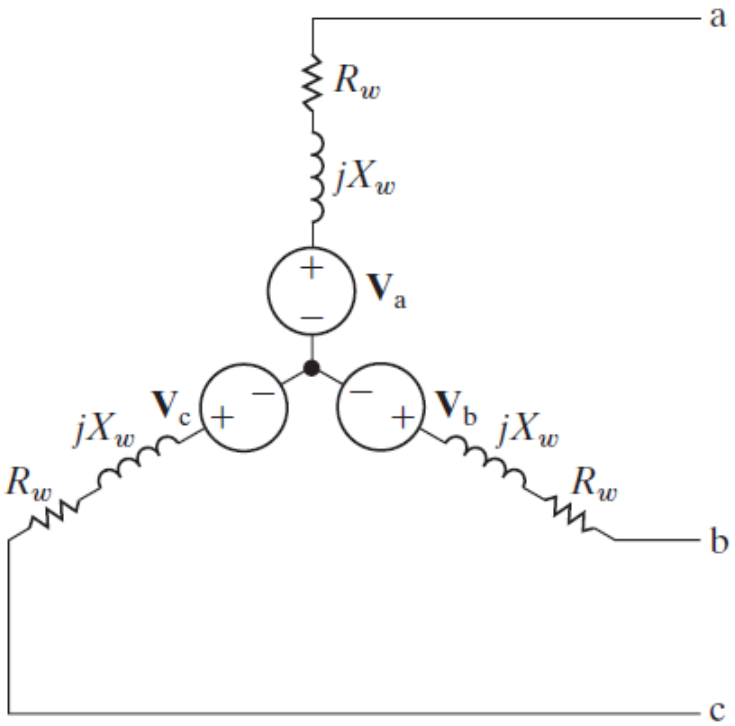
acb (or negative) phase sequence:

$$\boldsymbol{V}_a = V_m\angle 0°$$
$$\boldsymbol{V}_b = V_m\angle +120°$$
$$\boldsymbol{V}_c = V_m\angle -120°$$

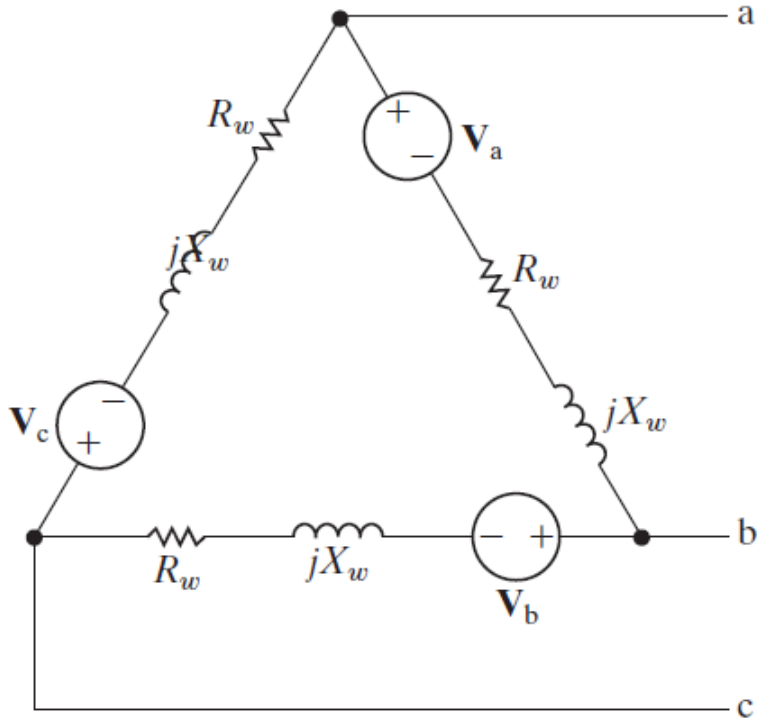


$$\boldsymbol{V}_a + \boldsymbol{V}_b + \boldsymbol{V}_c = 0$$

Three-Phase Voltage Sources



Y-connected source



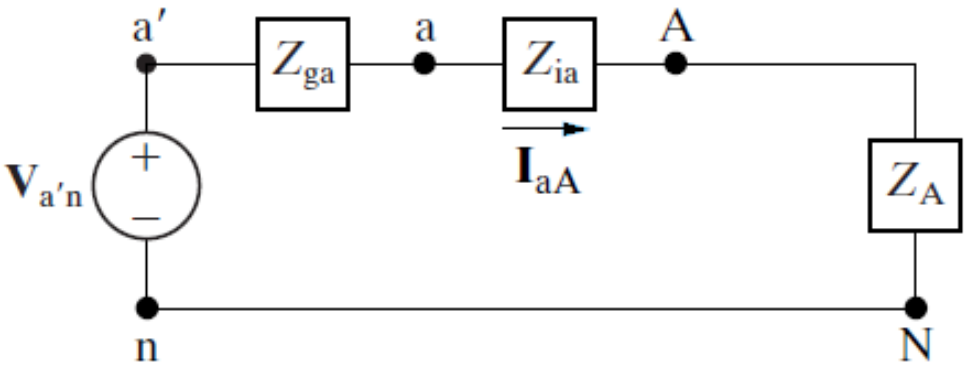
Δ-connected source

Y-Y Circuit

$$\boldsymbol{I}_{aA} = \frac{\boldsymbol{V}_{a'n} - \boldsymbol{V}_N}{Z_A + Z_{1a} + Z_{ga}} = \frac{\boldsymbol{V}_{a'n}}{Z_\emptyset}$$

$$\boldsymbol{I}_{bB} = \frac{\boldsymbol{V}_{b'n} - \boldsymbol{V}_N}{Z_B + Z_{1b} + Z_{gb}} = \frac{\boldsymbol{V}_{b'n}}{Z_\emptyset}$$

$$\boldsymbol{I}_{cC} = \frac{\boldsymbol{V}_{c'n} - \boldsymbol{V}_N}{Z_C + Z_{1c} + Z_{gc}} = \frac{\boldsymbol{V}_{c'n}}{Z_\emptyset}$$



Single-phase equivalent circuit

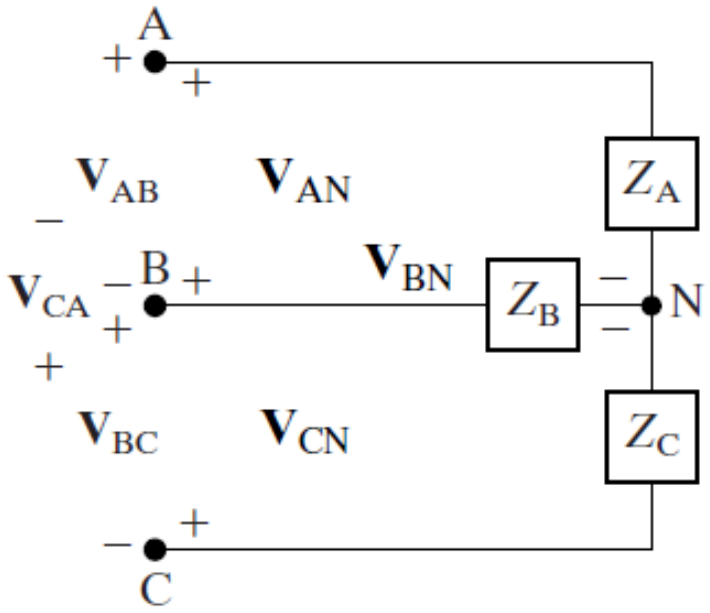
Y-Y Circuit

Line-to-neutral voltages:

$$\boldsymbol{V}_{AN} = V_{\emptyset}\angle 0°$$

$$\boldsymbol{V}_{BN} = V_{\emptyset}\angle -120°$$

$$\boldsymbol{V}_{CN} = V_{\emptyset}\angle +120°$$



Line-to-line voltages:

$$\boldsymbol{V}_{AB} = \sqrt{3}V_{\emptyset}\angle 30°$$

$$\boldsymbol{V}_{BC} = \sqrt{3}V_{\emptyset}\angle -90°$$

$$\boldsymbol{V}_{CA} = \sqrt{3}V_{\emptyset}\angle +150°$$

Reference

- Electric Circuits, Tenth Edition, James W. Nilsson, Susan A. Riedel Pearson, 2015