

Electrical Circuit (2)

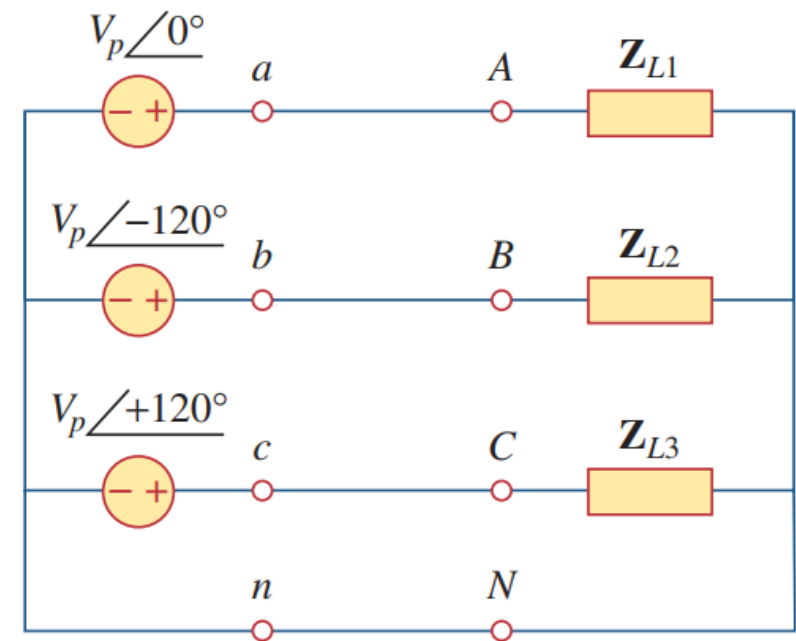
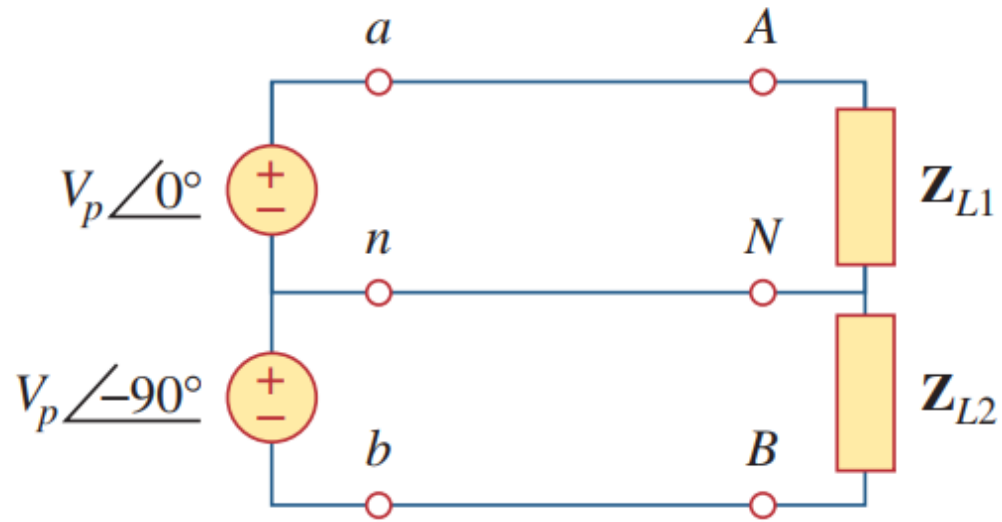
Introduction to Three Phase (week8 class1)

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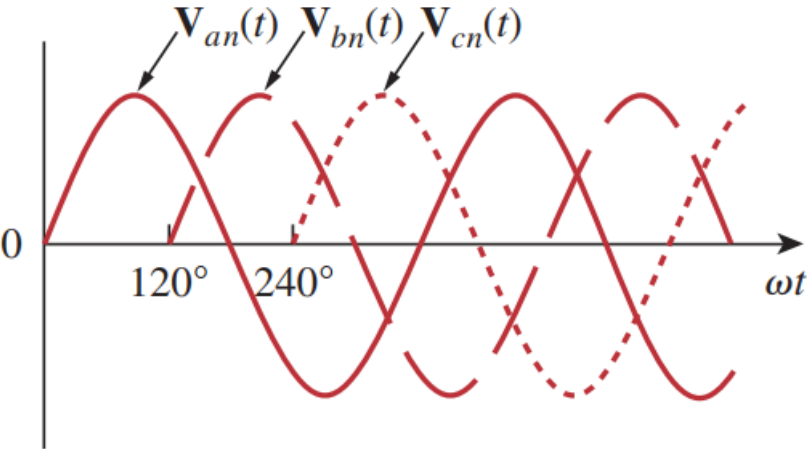
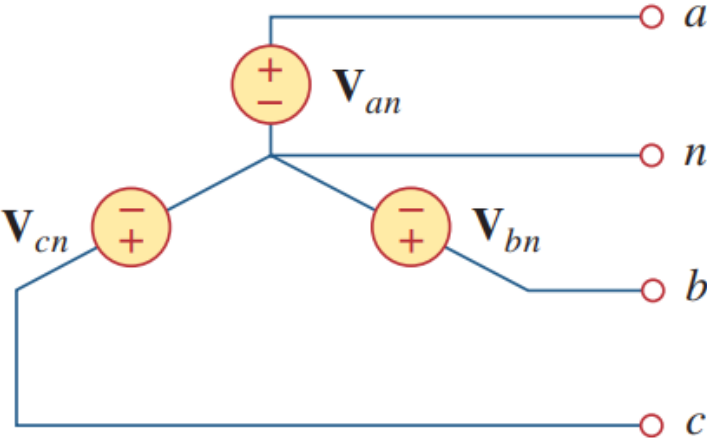
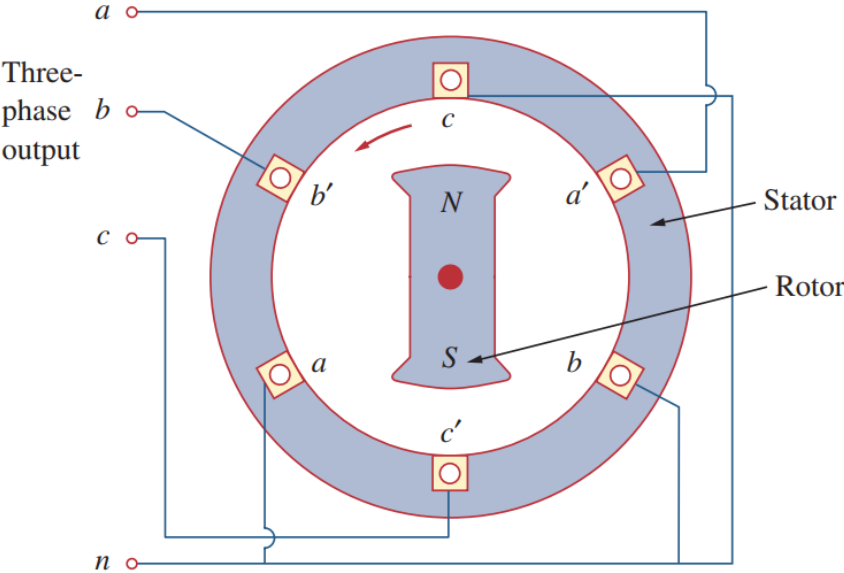
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12.1 Introduction



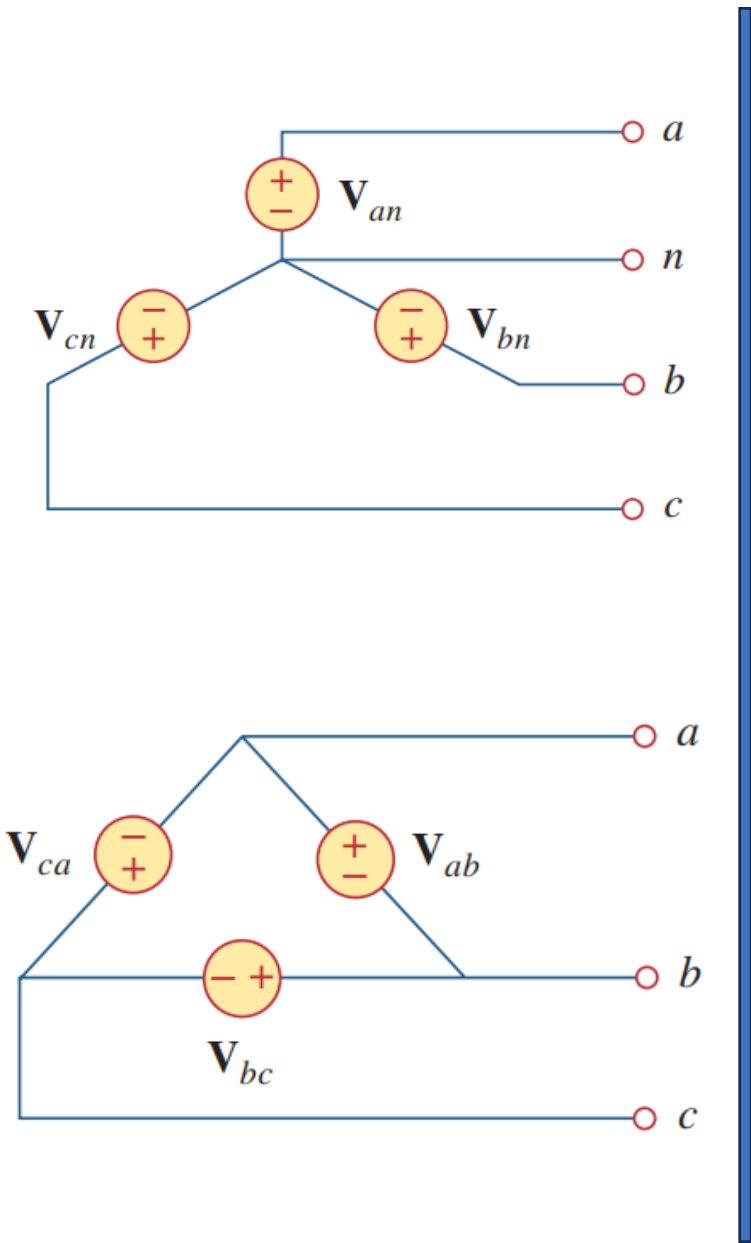
12.2

Balanced Three-Phase Voltages



12.2

Balanced Three-Phase Voltages

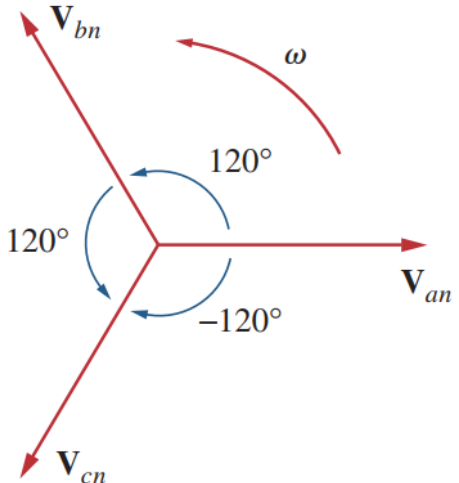
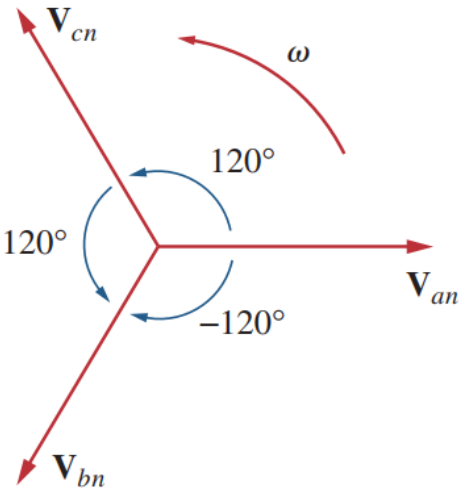


$$\begin{aligned} \mathbf{V}_{an} &= V_p \angle 0^\circ \\ \mathbf{V}_{bn} &= V_p \angle -120^\circ \\ \mathbf{V}_{cn} &= V_p \angle -240^\circ = V_p \angle +120^\circ \end{aligned}$$

Balanced phase voltages are equal in magnitude and are out of phase with each other by 120°.

$$\begin{aligned} \mathbf{V}_{an} &= V_p \angle 0^\circ \\ \mathbf{V}_{cn} &= V_p \angle -120^\circ \\ \mathbf{V}_{bn} &= V_p \angle -240^\circ = V_p \angle +120^\circ \end{aligned}$$

$$\begin{aligned} \mathbf{V}_{an} + \mathbf{V}_{bn} + \mathbf{V}_{cn} &= V_p \angle 0^\circ + V_p \angle -120^\circ + V_p \angle +120^\circ \\ &= V_p (1.0 - 0.5 - j0.866 - 0.5 + j0.866) \\ &= 0 \end{aligned}$$



(b)

Figure 12.7
Phase sequences: (a) *abc* or positive sequence, (b) *acb* or negative sequence.

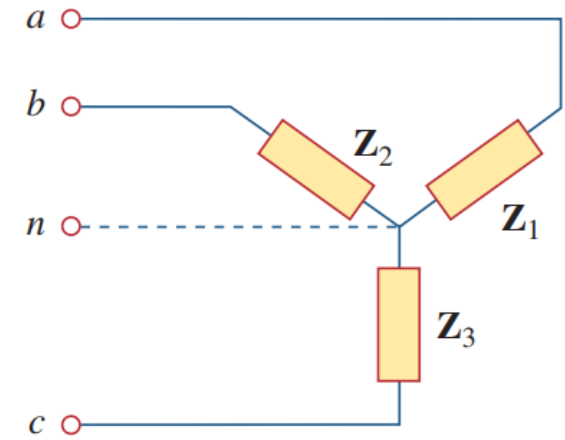
12.2 Balanced Three-Phase Voltages

A **balanced load** is one in which the phase impedances are equal in magnitude and in phase.

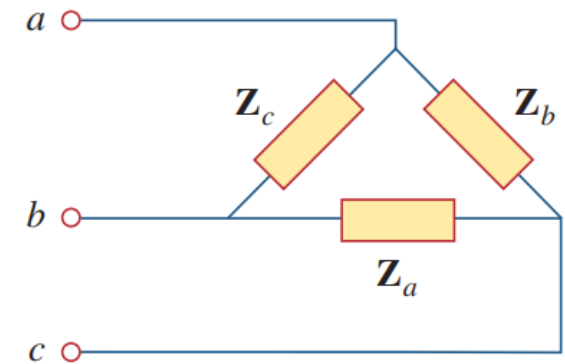
$$\mathbf{Z}_1 = \mathbf{Z}_2 = \mathbf{Z}_3 = \mathbf{Z}_Y$$

$$\mathbf{Z}_a = \mathbf{Z}_b = \mathbf{Z}_c = \mathbf{Z}_\Delta$$

$$\mathbf{Z}_\Delta = 3\mathbf{Z}_Y \quad \text{or} \quad \mathbf{Z}_Y = \frac{1}{3}\mathbf{Z}_\Delta$$



(a)



(b)

Figure 12.8

Two possible three-phase load configurations: (a) a Y-connected load, (b) a Δ-connected load.

12.2 Balanced Three-Phase Voltages

Given that $\mathbf{V}_{bn} = 110\angle 30^\circ \text{ V}$, find $\mathbf{V}_{an}$ and $\mathbf{V}_{cn}$, assuming a positive (abc) sequence.

Answer: $110\angle 150^\circ \text{ V}$, $110\angle -90^\circ \text{ V}$.

12.2 Balanced Three-Phase Voltages

Given that $\mathbf{V}_{bn} = 110\angle 30^\circ \text{ V}$, find $\mathbf{V}_{an}$ and $\mathbf{V}_{cn}$, assuming a positive (abc) sequence.

Answer: $110\angle 150^\circ \text{ V}$, $110\angle -90^\circ \text{ V}$.

$$\mathbf{V}_{an} = \mathbf{V}_{bn} \angle \theta_{bn} + 120 = 110 \angle 150$$

$$\mathbf{V}_{cn} = \mathbf{V}_{bn} \angle \theta_{bn} - 120 = 110 \angle -90$$

12.2 Balanced Three-Phase Voltages

- 12.3 Determine the phase sequence of a balanced three-phase circuit in which $\mathbf{V}_{bn} = 440 \angle 130^\circ \text{ V}$ and $\mathbf{V}_{cn} = 440 \angle 10^\circ \text{ V}$. Obtain $\mathbf{V}_{an}$.

12.2 Balanced Three-Phase Voltages

- 12.3 Determine the phase sequence of a balanced three-phase circuit in which $\mathbf{V}_{bn} = 440 \angle 130^\circ \text{ V}$ and $\mathbf{V}_{cn} = 440 \angle 10^\circ \text{ V}$. Obtain $\mathbf{V}_{an}$.

$$\mathbf{V}_{an} = 440 \angle (130 + 120) = 440 \angle 250$$

$$\mathbf{V}_{an} = 440 \angle (10 - 120) = 440 \angle -110$$

12.2**Balanced Three-Phase Voltages**

If $V_{ab} = 400$ V in a balanced Y-connected three-phase generator, find the phase voltages, assuming the phase sequence is:

(a) abc

(b) acb

12.2 Balanced Three-Phase Voltages

If $V_{ab} = 400$ V in a balanced Y-connected three-phase generator, find the phase voltages, assuming the phase sequence is:

- (a) abc (b) acb

(a) If $V_{ab} = 400$, then

$$V_{an} = \frac{400}{\sqrt{3}} \angle -30^\circ = \underline{\underline{231 \angle -30^\circ \text{ V}}}$$

$$V_{bn} = \underline{\underline{231 \angle -150^\circ \text{ V}}}$$

$$V_{cn} = \underline{\underline{231 \angle -270^\circ \text{ V}}}$$

(b) For the acb sequence,

$$V_{ab} = V_{an} - V_{bn} = V_p \angle 0^\circ - V_p \angle 120^\circ$$

$$V_{ab} = V_p \left(1 + \frac{1}{2} - j \frac{\sqrt{3}}{2} \right) = V_p \sqrt{3} \angle -30^\circ$$

i.e. in the acb sequence, V_{ab} lags V_{an} by 30° .

Hence, if $V_{ab} = 400$, then

$$V_{an} = \frac{400}{\sqrt{3}} \angle 30^\circ = \underline{\underline{231 \angle 30^\circ \text{ V}}}$$

$$V_{bn} = \underline{\underline{231 \angle 150^\circ \text{ V}}}$$

$$V_{cn} = \underline{\underline{231 \angle -90^\circ \text{ V}}}$$

