



# **SNS COLLEGE OF TECHNOLOGY**

## **(AN AUTONOMOUS INSTITUTION)**

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## **Department of Biomedical Engineering**

**Course Name: 23BMT201 & Circuit Analysis**

**II Year : III Semester**

**Unit III -THREE PHASE SYSTEM**

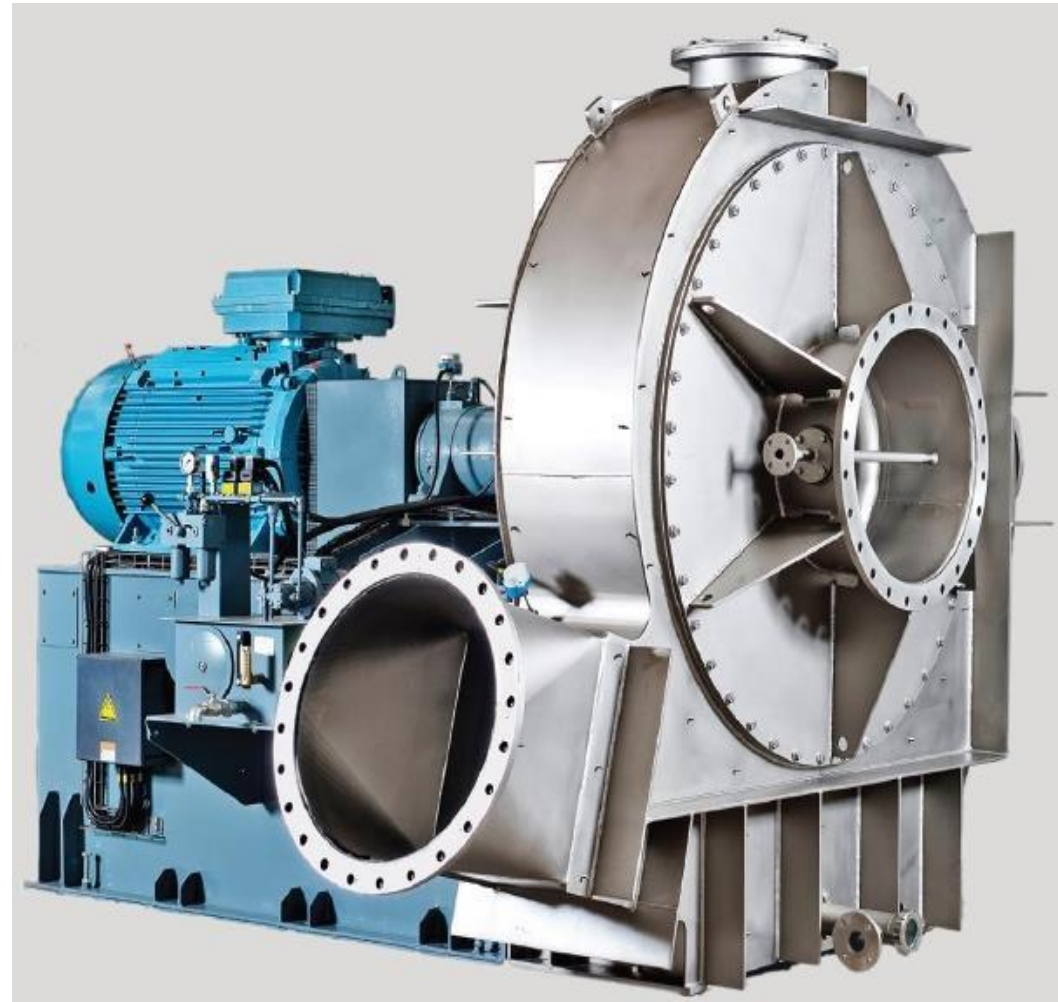
**Topic : Characteristics of Sinusoids**



# Introduction



## Application:



Industrial Fans  
(Vacuum Pumps)

Vision Tit



Tesla Model S Rear Drive Unit: The  
3-phase 4-pole induction motor

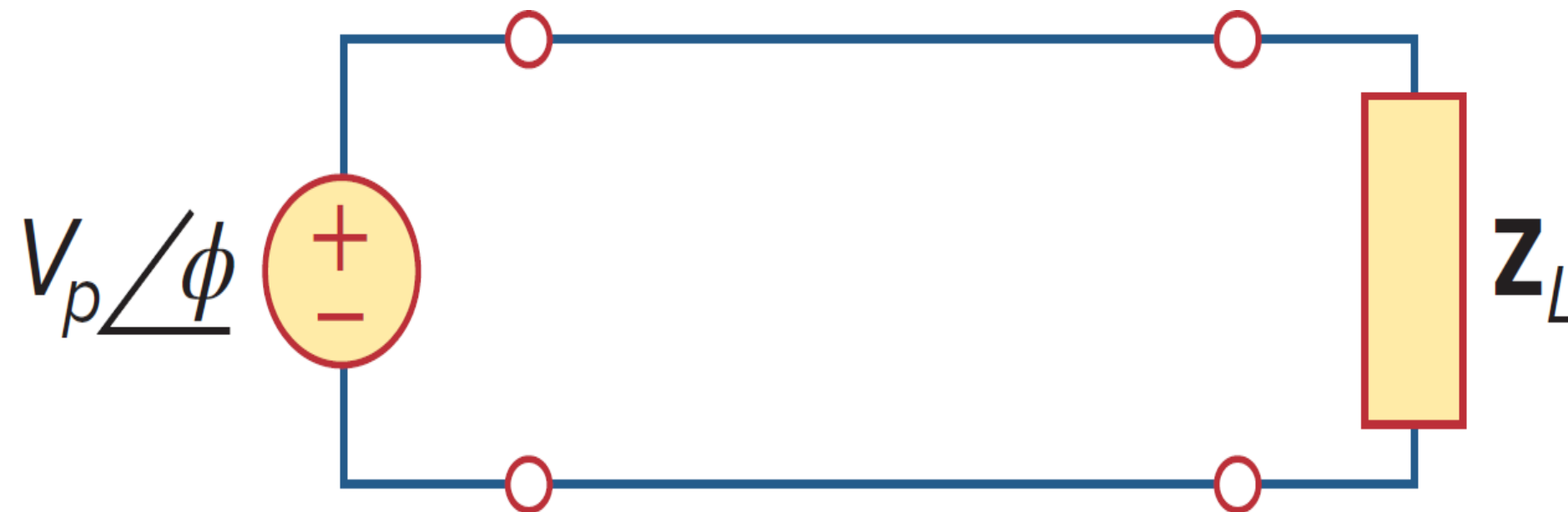


# Introduction

## Single-Phase Systems:

- Single phase system consists of a generator connected through a pair of wires (a transmission line) to a load.
- $V_p$  is the rms magnitude of the source voltage.
- $\phi$  is the phase.

Vision Title 3





# Introduction



## Polyphase Systems:

- Circuits or systems in which the **AC sources operate at the same frequency but different phases are known as Polyphase.**
- Examples:
  - Two-phase systems.
  - Three-phase systems, etc...

Vision Title 3

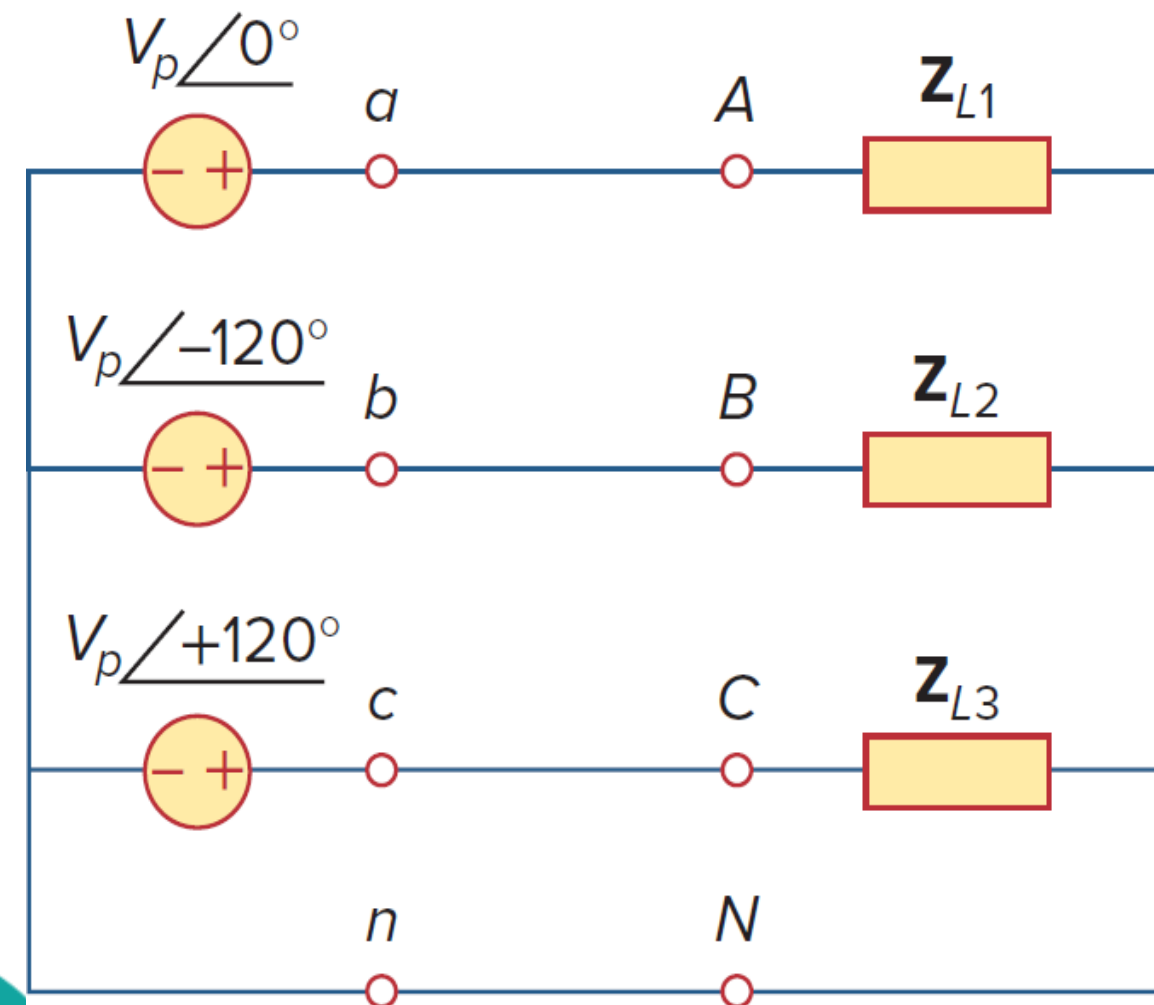


# Introduction

## Three-Phase Systems:

- It is produced by a generator consisting of three sources having the same amplitude and frequency but out of phase with each other by  $120^\circ$ .

Vision Title 3



Three-phase four-wire system



## Disadvantages of the Single-phase System



- Initial application of AC supply was for heating the filaments of electric lamps. For this, single-phase system was perfectly satisfactory.
- Few years later, AC motors were developed, and it was found that for this application the single-phase system was not very satisfactory.
- For example, single-phase induction motor is not self-starting unless it is fitted with an auxiliary winding.
- The single-phase induction motor is not self-starting and has poor efficiency and power factor than the corresponding three-phase machine.



## Advantages of Three-phase System



1. Nearly, all electric power is **generated and distributed in three-phase**.
2. When **one-phase or two-phase** inputs are required, they are taken from the **three-phase system** rather than generated independently.
3. **Even when more than 3 phases are needed**, they can be provided by manipulating the available three phases.
4. The **instantaneous power in a three-phase system can be constant (not pulsating)**. This results in **uniform power transmission and less vibration** of three-phase machines.
5. For the same amount of power, the three-phase system is **more economical than the single-phase**.
6. The **amount of wire required** for a three-phase system is less than that required for an equivalent single-phase system.

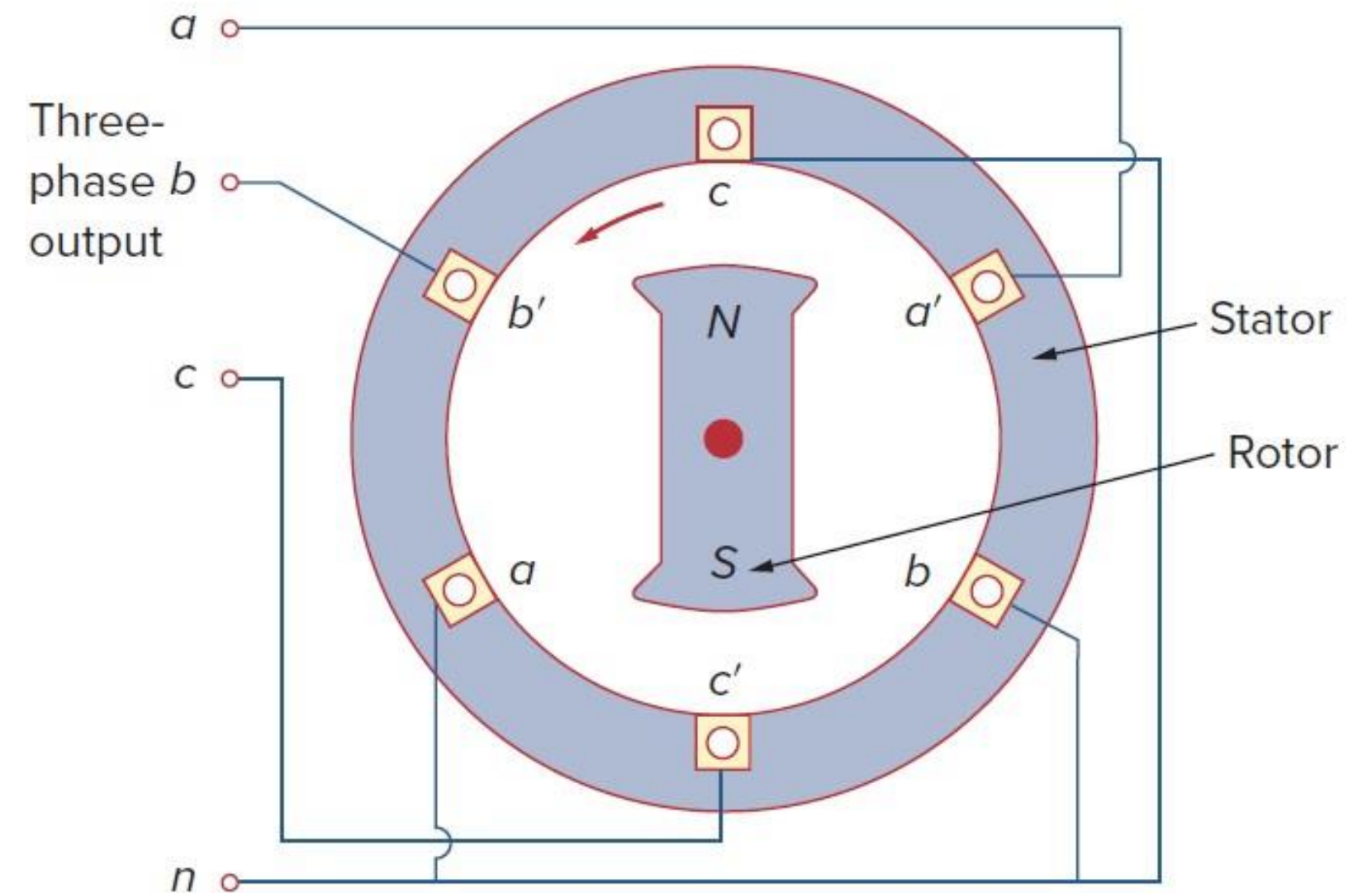


# Generation of Balanced Three-phase Voltages



The generator basically consists of a

- Rotating magnet (called the **rotor**).
- Stationary winding (called the **stator**).
- **Three separate windings** or coils with terminals  $a-a'$ ,  $b-b'$ , and  $c-c'$  are physically placed  **$120^\circ$  apart around the stator**.



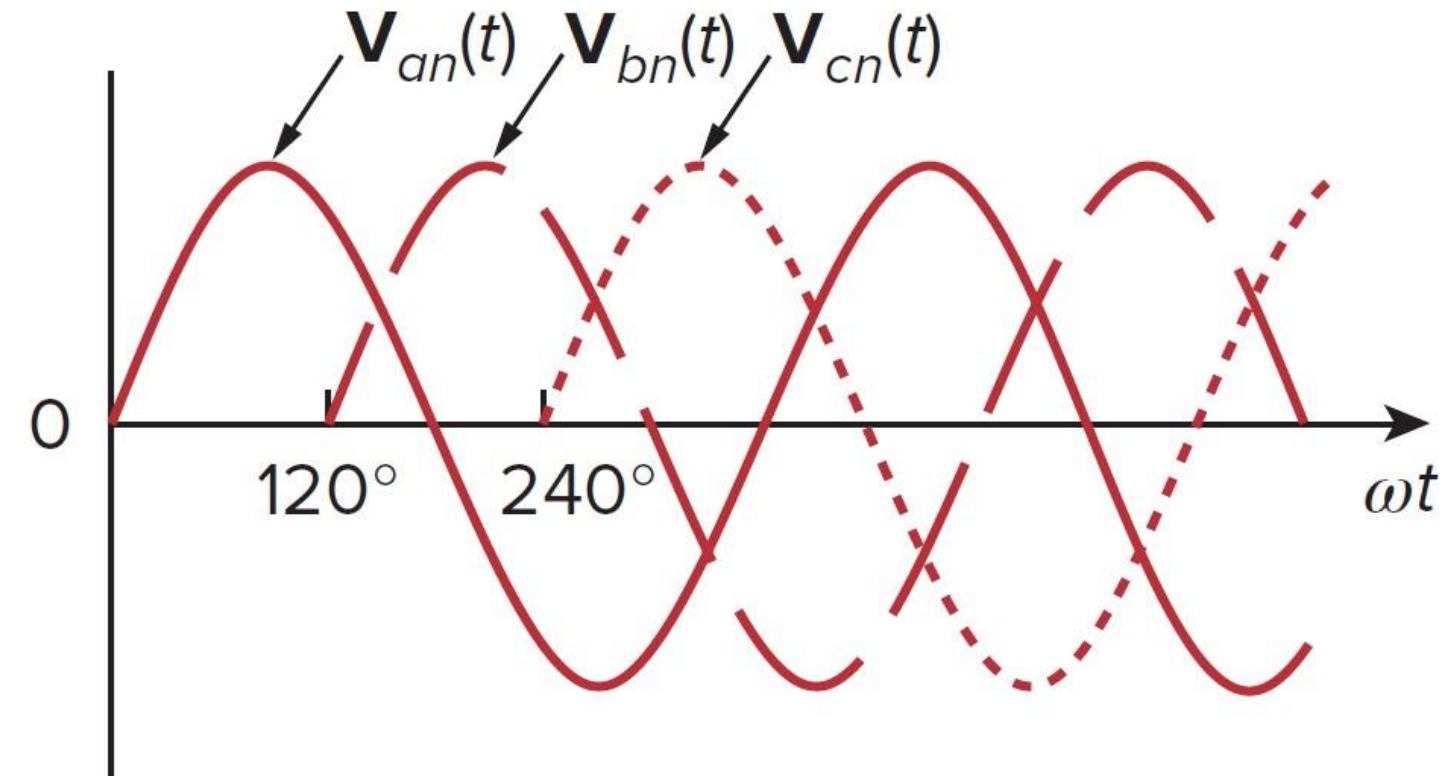
Three Phase Generator





## Generation of Balanced Three-phase Voltages

- As the rotor rotates, its magnetic field creates time-varying flux in the three coils and induces voltages in the coils.
- Because the coils are placed  $120^\circ$  apart, the induced voltages in the coils are equal in magnitude but out of phase by  $120^\circ$ .

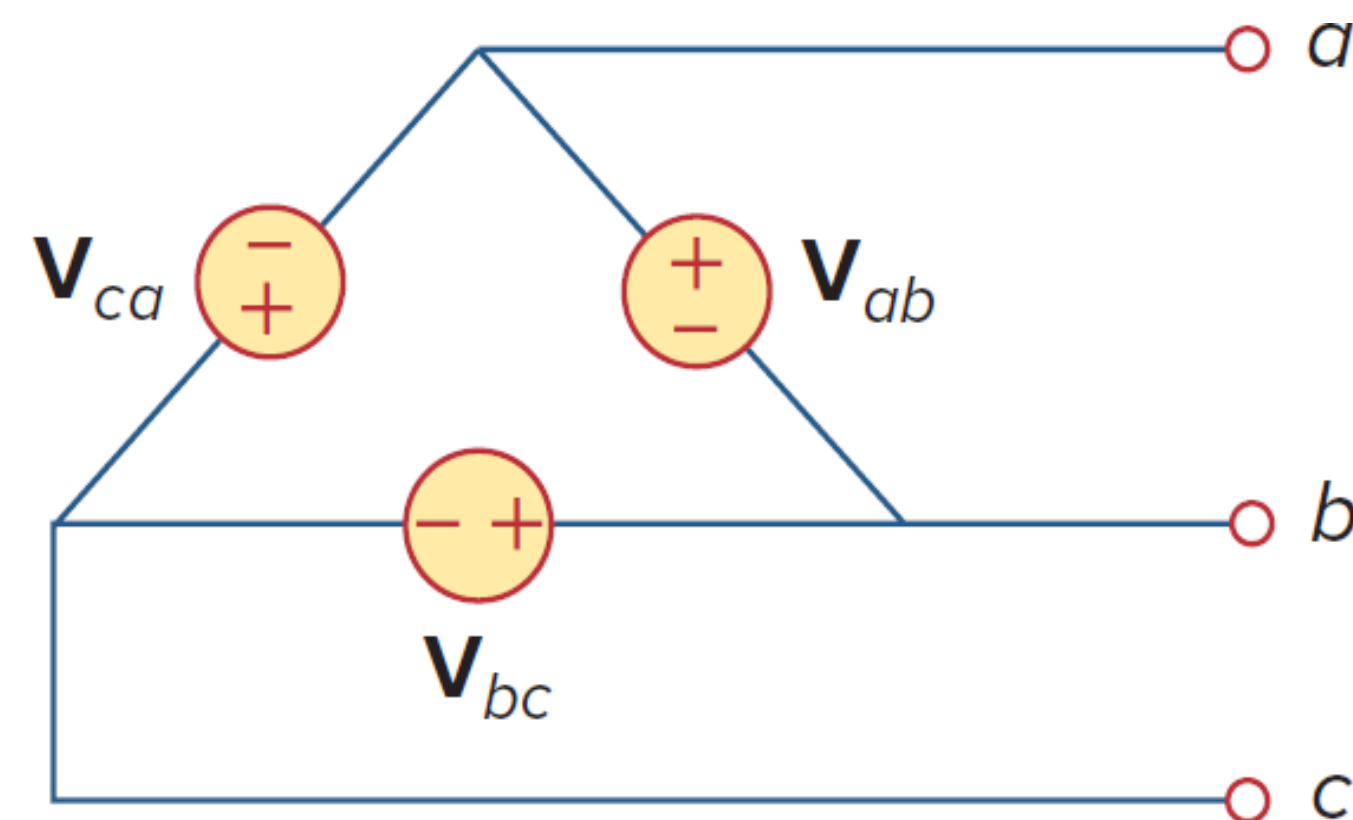
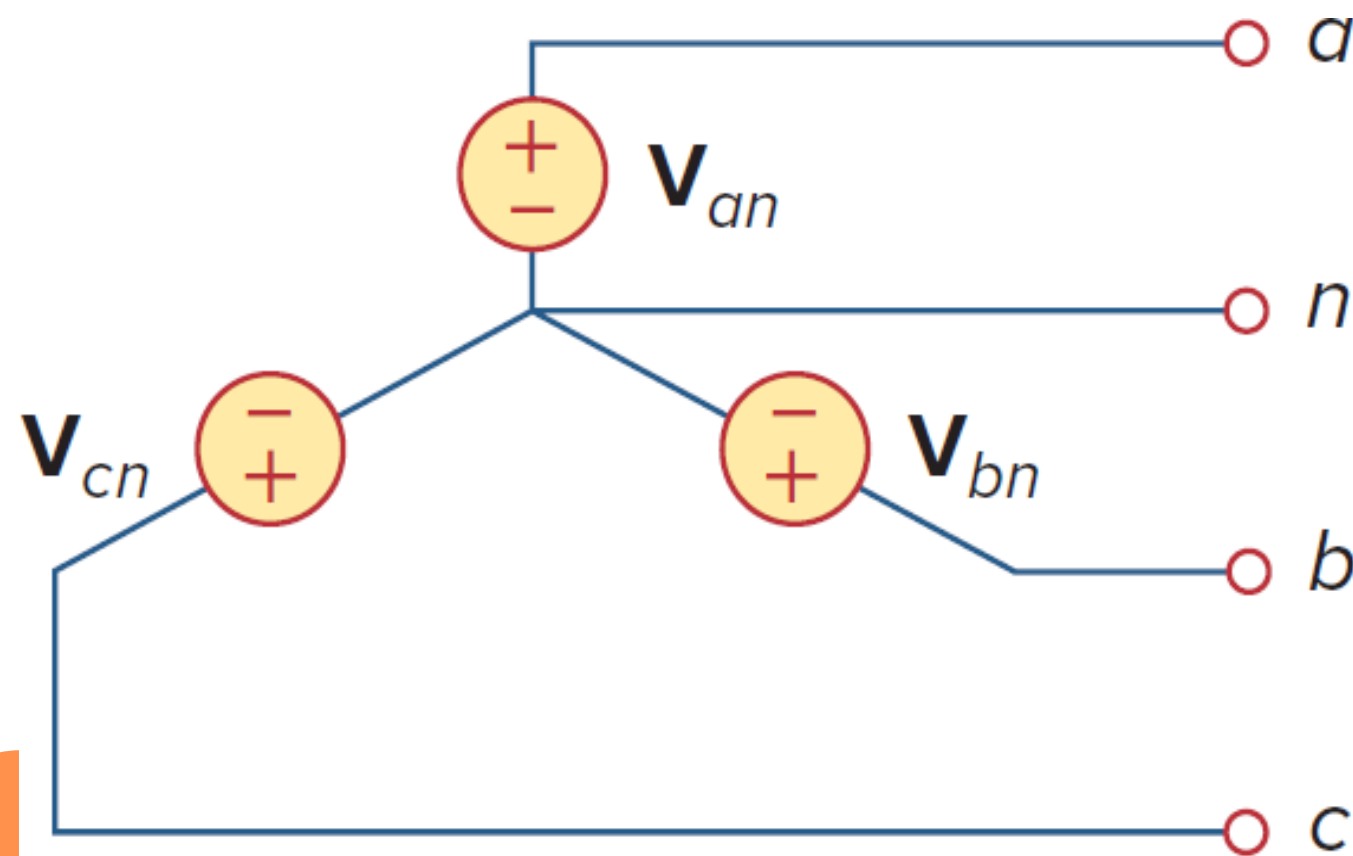


$120^\circ$  apart from each other



# Balanced Three-phase System

- A typical three-phase system consists of three voltage sources connected to loads by three or four wires (or transmission lines).
- The voltage sources can be **either wye connected or delta-connected.**



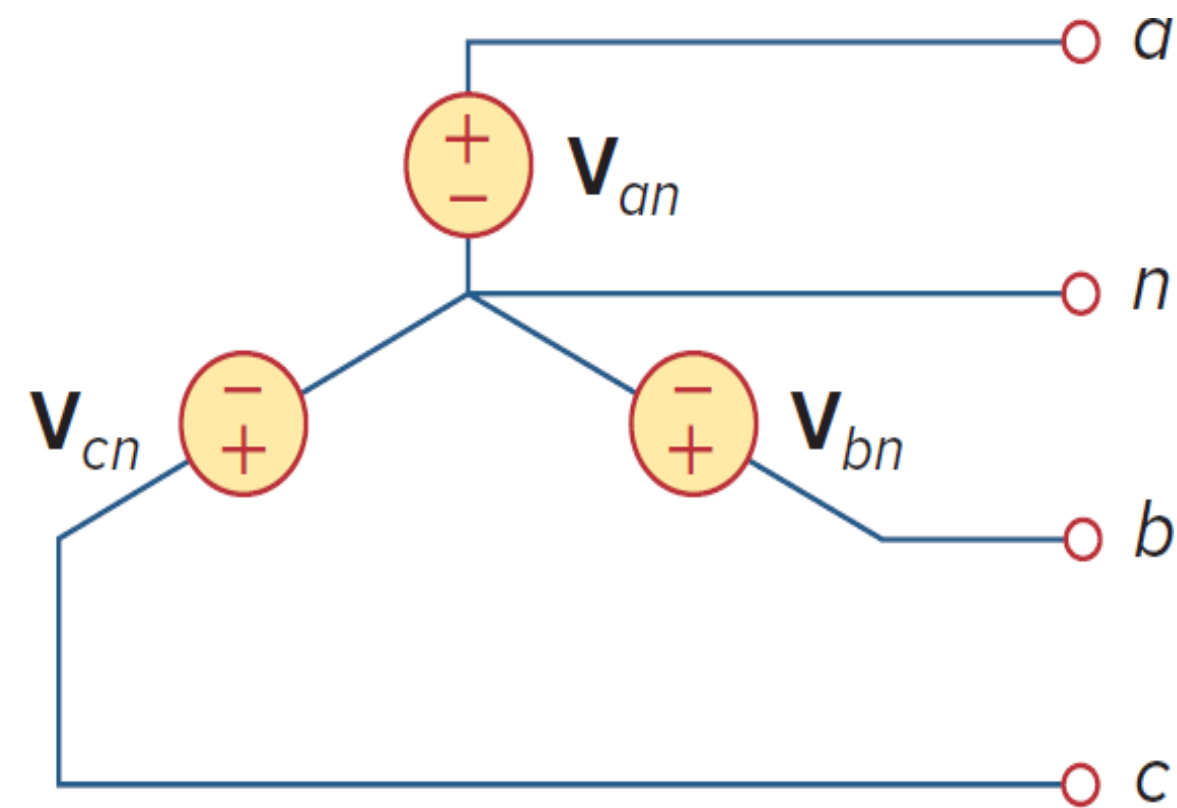


# Balanced Three-phase System

- **Phase voltages:** voltages between lines  $a$ ,  $b$ , and  $c$  and the neutral line  $n$  ( $V_{an}$ ,  $V_{bn}$ , and  $V_{cn}$ ).
- If the **voltage sources have the same amplitude and frequency  $\omega$  and are out of phase with each other by  $120^\circ$** , the voltages are said to be **balanced**

i.e.  $V_{an} + V_{bn} + V_{cn} = 0$

$$|V_{an}| = |V_{bn}| = |V_{cn}|$$





# Balanced Three-phase System



## Phase Sequence:

- The *phase sequence* is the time order in which the voltages pass through their respective maximum values.
  1. *abc* sequence or positive sequence
  2. *acb* sequence or negative sequence

Vision Title 3

## Importance of Phase Sequence:

- It is important in three-phase power distribution because, it determines the direction of the rotation of a motor connected to the power source.



## Balanced Three-phase System



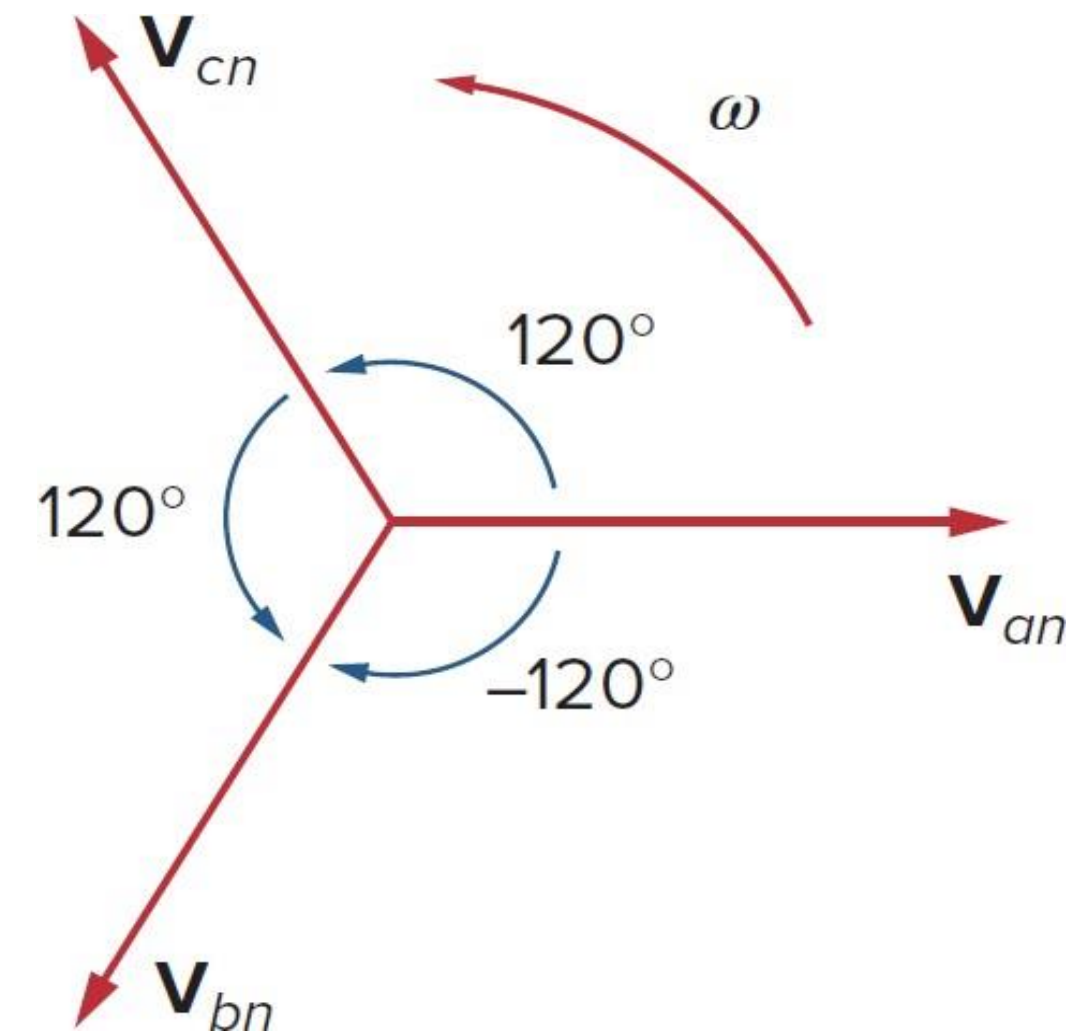
### ***abc* Sequence or Positive Sequence:**

- This sequence is produced when the **rotor rotates counterclockwise**.
- $V_{an}$  leads  $V_{bn}$ , which in turn leads  $V_{cn}$ .

$$V_{an} = V_p \angle 0$$

$$V_{bn} = V_p \angle -120$$

$$V_{cn} = V_p \angle -240 = V_p \angle +120$$



*abc* or positive sequence

where  $V_p$  is the effective or rms value of the phase voltages.



## Balanced Three-phase System



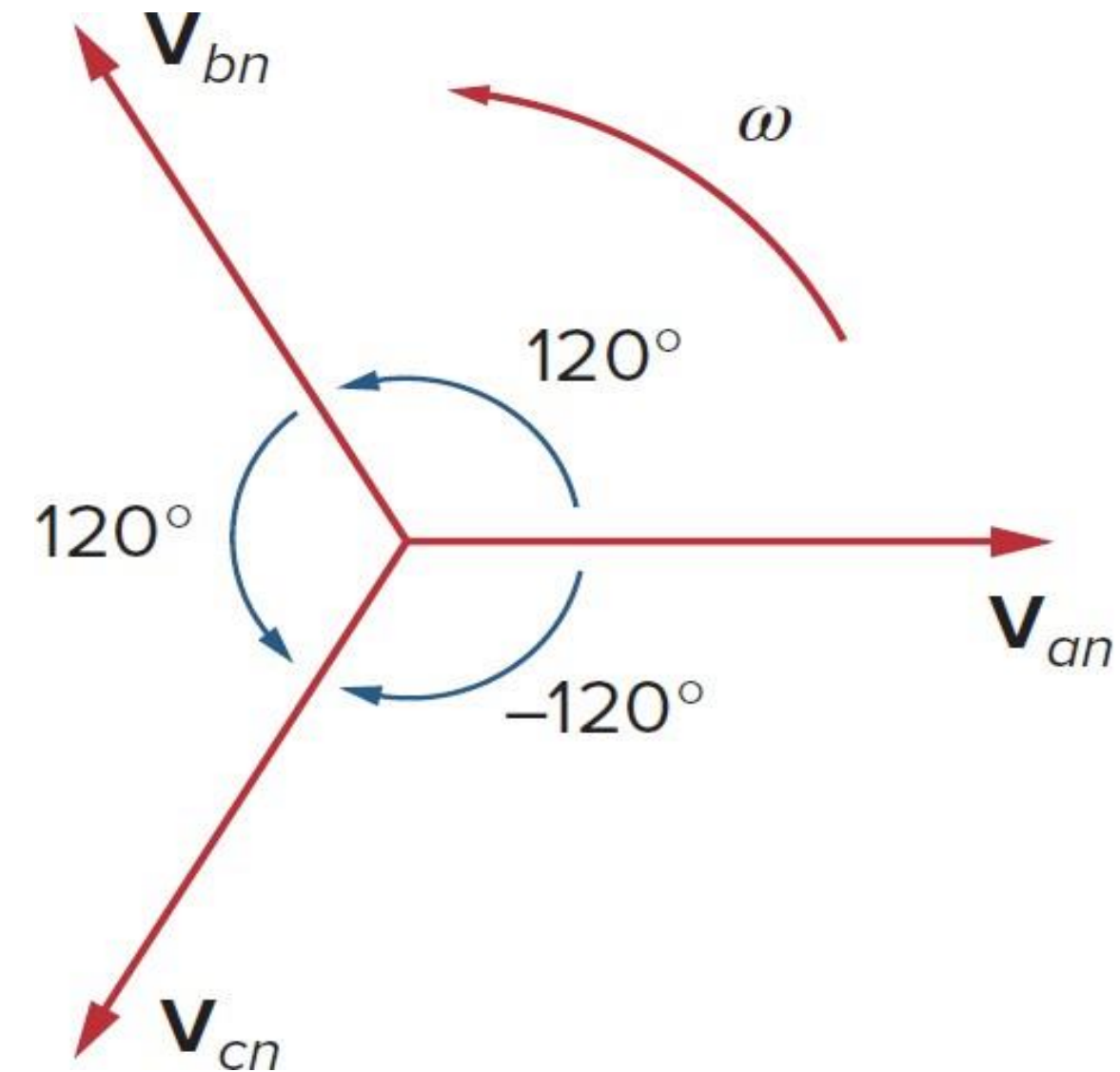
### **acb Sequence or Negative Sequence:**

- It is produced when the rotor rotates in the **clockwise direction**.
- $V_{an}$  leads  $V_{cn}$ , which in turn leads  $V_{bn}$ .

$$V_{an} = V_p \angle 0$$

$$V_{cn} = V_p \angle -120$$

$$V_{bn} = V_p \angle -240 = V_p \angle +120$$



*acb* or negative sequence

where  $V_p$  is the effective or rms value of the phase voltages.