

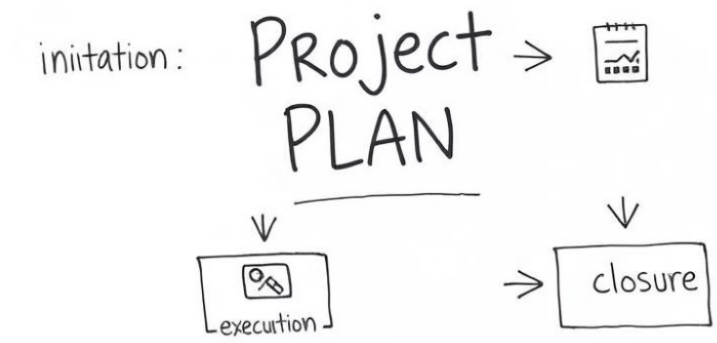
## Lecture 11

Generation of a three phase EMf system. Basic concepts  
and definitions of three phase circuits

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# Plan:

1. Introduction to Three-Phase Systems
2. Basic Concepts of Electromotive Force (EMF) Generation
3. Structure and Components of a Three-Phase Circuit
4. Types of Three-Phase Connections
5. Voltage and Current Relationships in Three-Phase Systems
6. Advantages of Three-Phase Systems
7. Applications of Three-Phase Circuits





# Three-Phase Systems: Powering Our World

Three-phase systems are the backbone of modern electrical power. They generate three alternating currents with equal frequency and amplitude, but  $120^\circ$  apart in phase. This system delivers power more efficiently than single-phase, making it crucial for industry and infrastructure.

# Basic Concepts of EMF Generation

1

## Faraday's Law

A changing magnetic field in a coil induces electric current. This phenomenon is described by Faraday's Law of electromagnetic induction. According to this law, the magnitude of the induced electromotive force (EMF) is proportional to the rate of change of the magnetic field with respect to time. Faraday's Law is fundamental in understanding how three-phase EMF systems are generated.

2

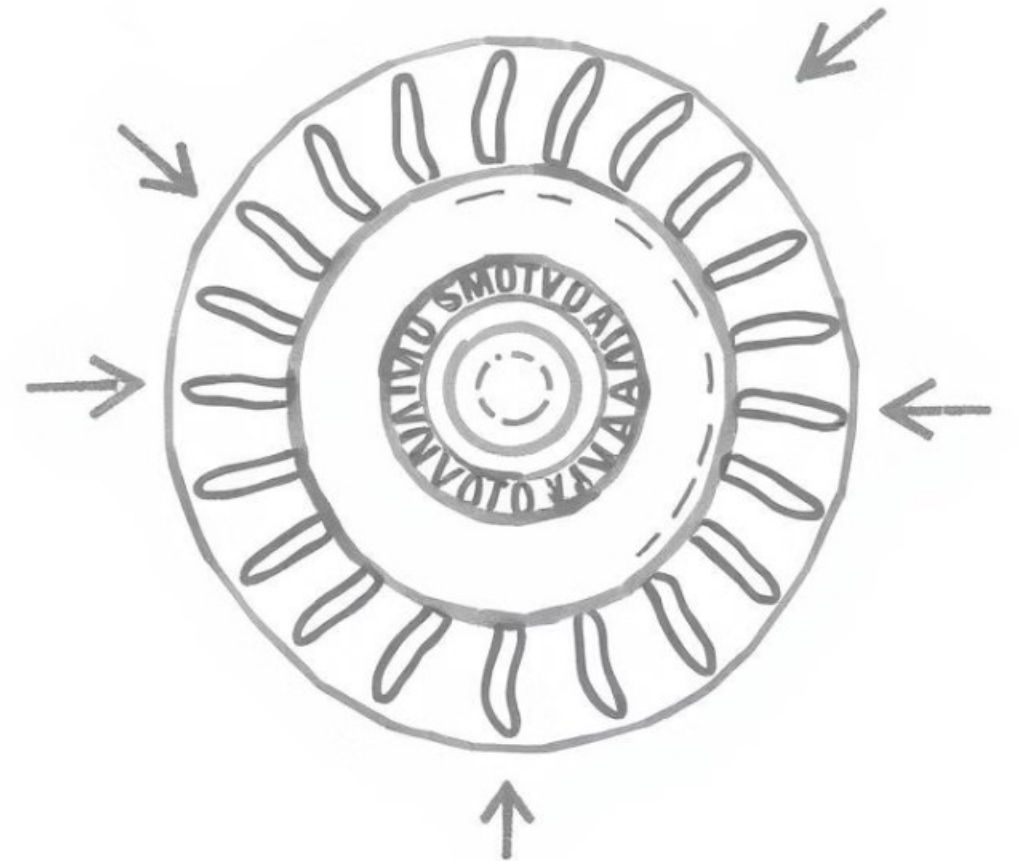
## Alternator Mechanism

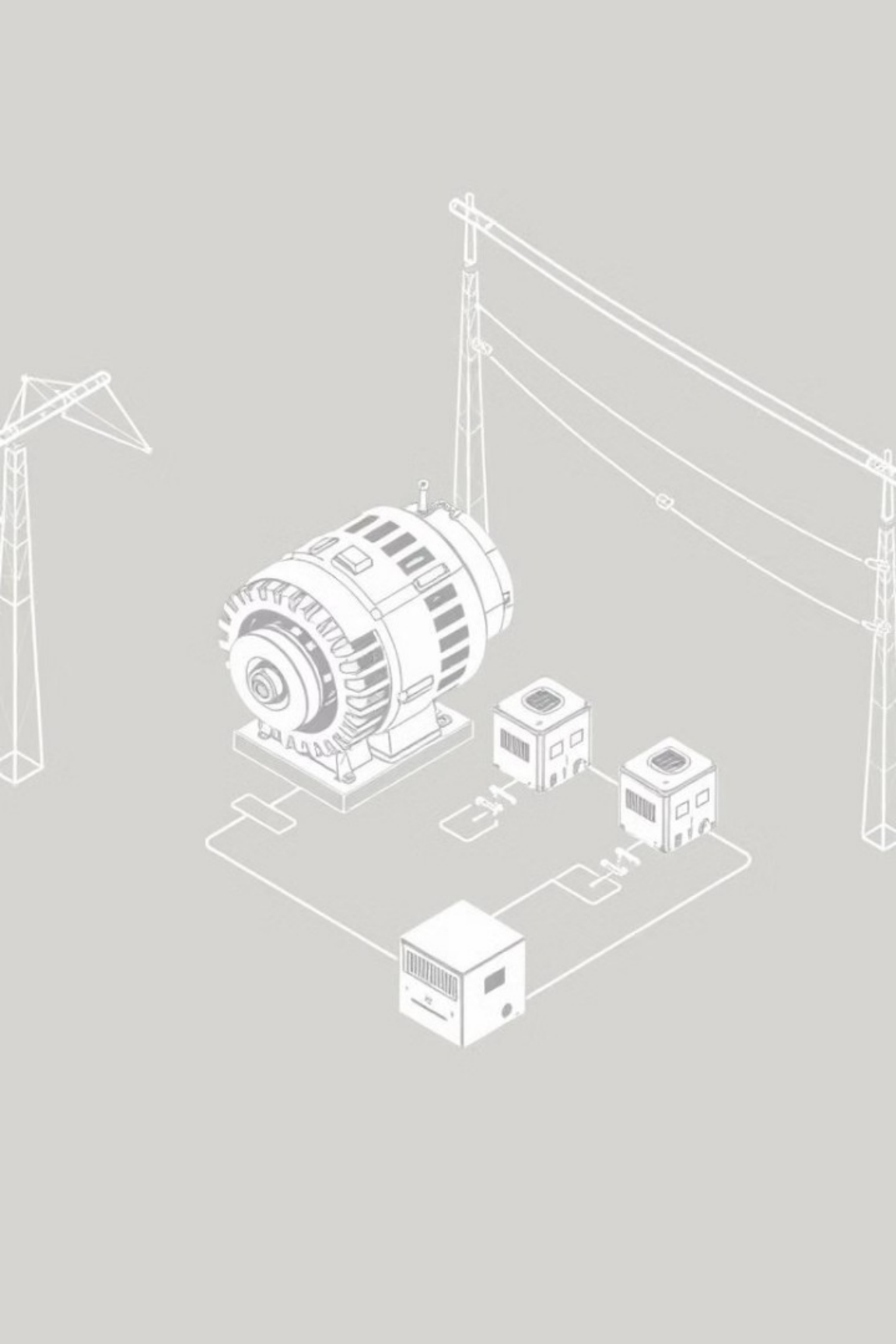
Rotating magnetic field in stator induces EMF in coils. This rotating magnetic field is created by passing three-phase AC current through the stator windings. As the magnetic field rotates, it induces an electromotive force (EMF) in the coils of the alternator. This EMF is then converted to electrical power that can be used to power various devices and systems.

3

## Three Separate Phases

Three coils at  $120^\circ$  intervals produce synchronized AC outputs. These three separate phases in a three-phase EMF system produce synchronized AC outputs. Each phase is offset by  $120^\circ$  from the other two, creating a balanced and efficient distribution of power. This arrangement allows for greater stability and load sharing, making it suitable for large-scale applications in industry and infrastructure.





# Three-Phase Circuit Components



## Alternator

Converts mechanical energy to electrical energy, creating three-phase EMF.



## Transmission Lines

Transport power from source to consumers, using three or four wires.



## Three-Phase Loads

Can be balanced (equal currents) or unbalanced (unequal currents).



# Star (Wye) Connection

## Configuration

Each phase coil connects to a common neutral point, forming a Y shape. This type of connection is called a star or wye connection, and it allows for easier distribution of power to multiple loads. In a star connection, one end of each coil is connected to a common neutral point, while the other ends are connected to the three-phase source. This configuration provides a reliable and efficient method of distributing power in a three-phase system.

## Voltage Relation

Line voltage is  $\sqrt{3}$  times the phase voltage. This relationship holds true in a star connection. It means that the line voltage between any two line conductors is equal to the phase voltage multiplied by the square root of three ( $\sqrt{3}$ ). This voltage relation is important to consider when designing and operating three-phase systems using a star connection.

## Applications

Used for long-distance transmission due to lower line-to-line voltage. The star connection is also commonly used in electrical power systems with a neutral conductor, as it allows for the connection of single-phase loads between each phase and neutral. Additionally, the star connection offers greater flexibility in terms of voltage and power balancing. Another benefit is that if one of the coils fails, the system can still continue to operate using the remaining two coils.

# Delta Connection

## Configuration

Phases are connected in a closed loop, forming a triangle shape.

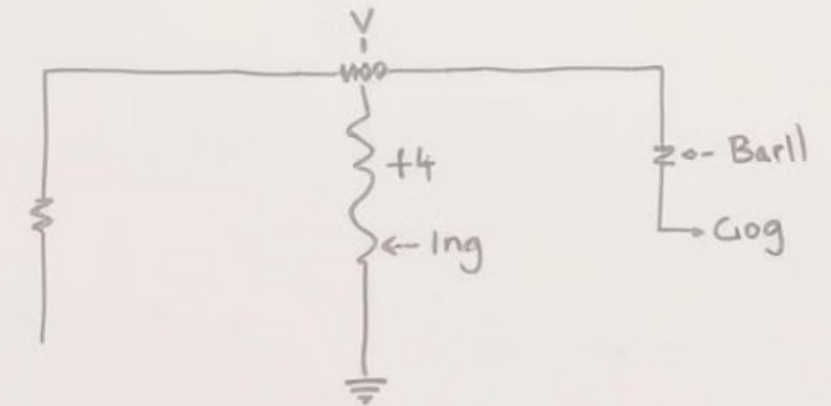
## Current Relation

Line current is  $\sqrt{3}$  times the phase current.

## Applications

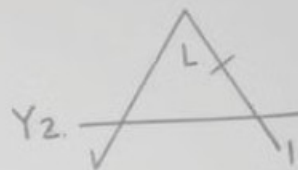
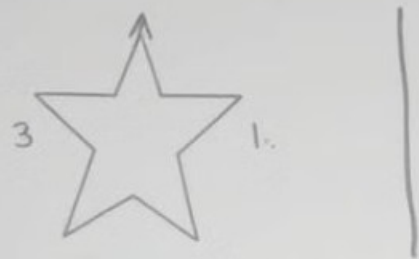
Common in heavy machinery and short-distance transmission due to high power density.

## Delta connection



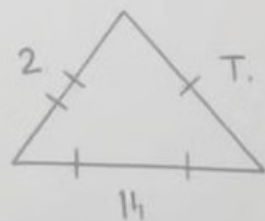
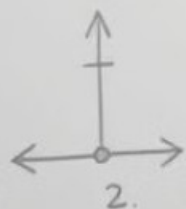
Voltage and delta connections

Star wire and our test three voltage



Seltar connection coltte:

Delta



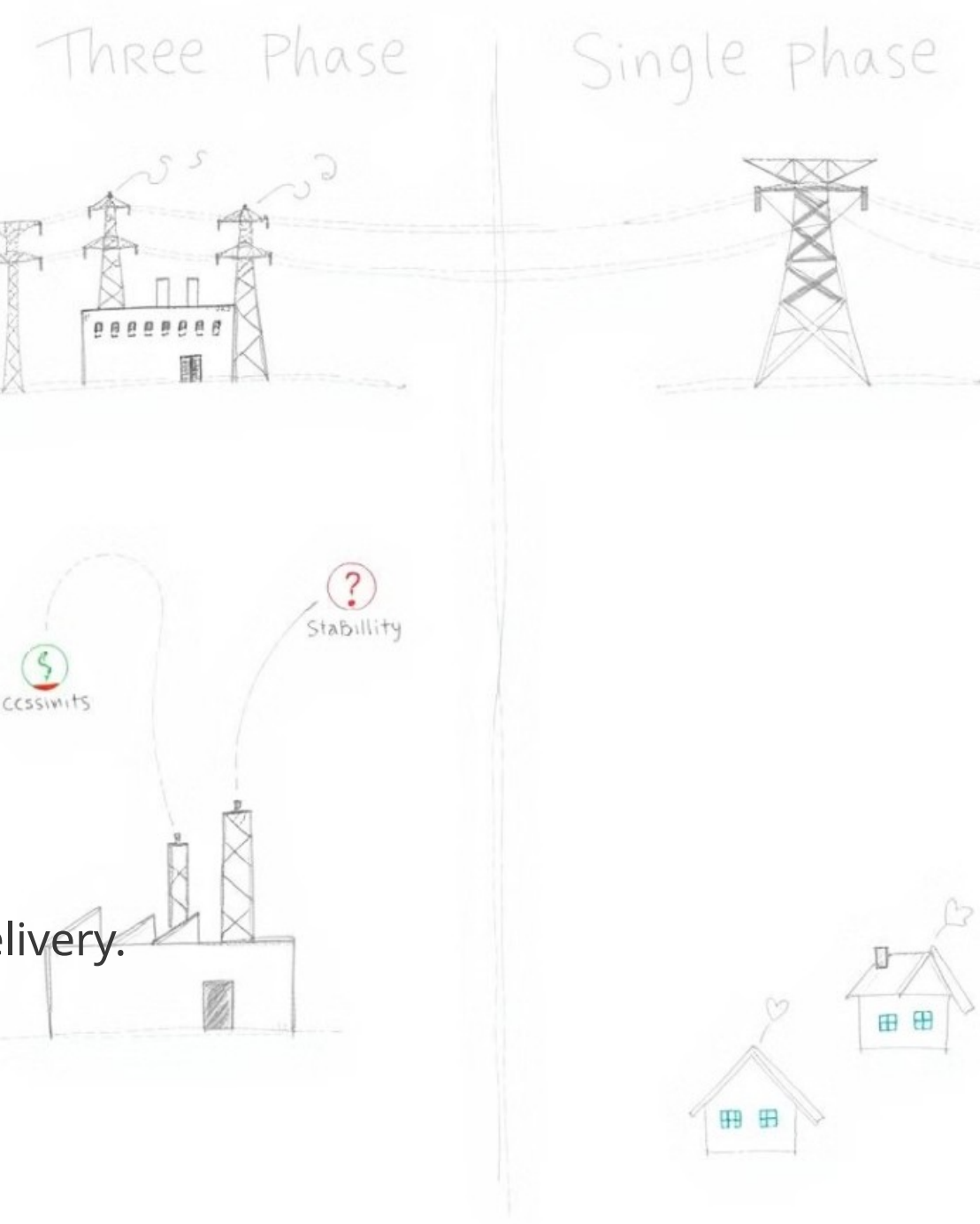
# Voltage and Current Relationships

Connection	Voltage Relation	Current Relation
Star (Wye)	$V_{line} = \sqrt{3} \times V_{phase}$	$I_{line} = I_{phase}$
Delta	$V_{line} = V_{phase}$	$I_{line} = \sqrt{3} \times I_{phase}$



For = phase

# Advantages of Three-Phase Systems



1 Efficiency  
Delivers continuous and balanced power flow, reducing energy losses.

2 Power Stability  
Reduces voltage dips and provides more uniform power delivery.

3 Cost Savings  
Requires less conductor material for the same amount of power delivery.

# Industrial Applications

## Factories

Powers machinery like conveyors, pumps, and fans. Motors

Three-phase systems are commonly used to power electric motors due to their efficiency and power stability.

## Power Plants

Many power plants use three-phase systems to generate and distribute electricity to industrial, commercial, and residential areas.

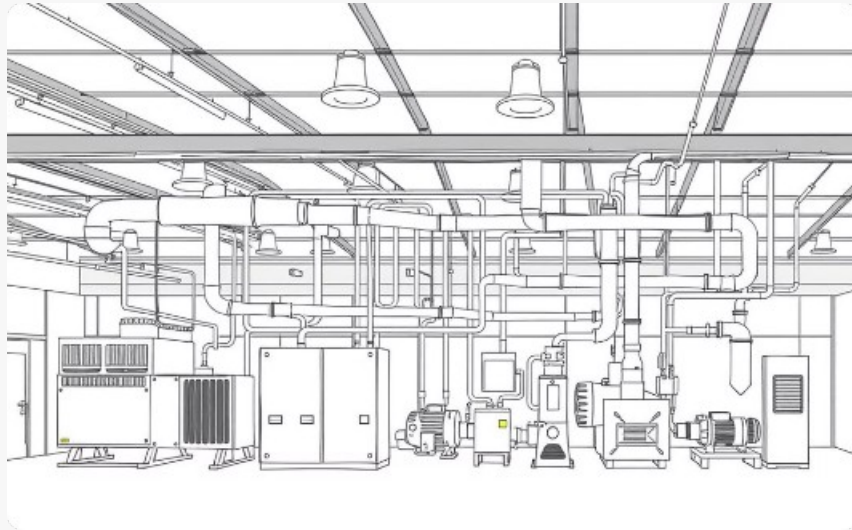
## Motors

Three-phase motors are efficient and provide steady torque output. They are commonly used in various industrial applications such as manufacturing processes, pumps, and fans. Additionally, three-phase motors are often employed in transportation systems like escalators and elevators due to their reliability and ability to handle heavy loads.

## Power Grids

Used for generation, transmission, and distribution of electricity. Three-phase systems play a vital role in power grids by enabling the generation, transmission, and distribution of electricity. The use of three-phase systems in power grids allows for efficient and reliable delivery of electricity to homes, businesses, and other infrastructure. This ensures a stable and consistent power supply across large areas, making three-phase systems

# Infrastructure Applications



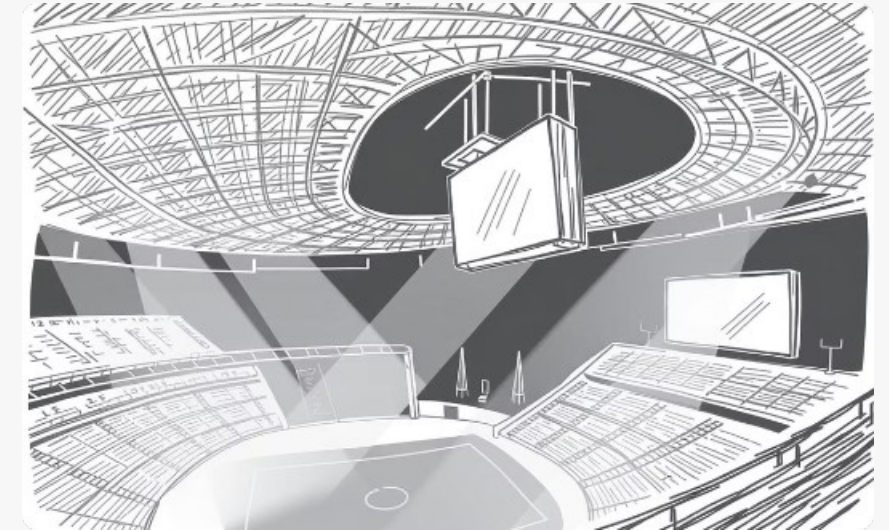
## HVAC Systems

Three-phase power efficiently runs heating, ventilation, and air conditioning in large buildings.



## Elevators

Three-phase motors provide smooth and powerful operation for elevators in tall structures.



## Lighting

Commercial properties use three-phase power for efficient, large-scale lighting systems.

# Future of Three-Phase Systems



1

## Smart Grids

Integration with renewable energy sources and advanced monitoring systems.

2

## Electric Vehicles

Three-phase charging stations for faster and more efficient charging.

3

## Energy Storage

Advanced three-phase inverters for large-scale battery storage sys

# Used Literatures:

1. **Wildi, T.** (2006). *Electrical Machines, Drives, and Power Systems*. Prentice Hall.
2. **Chapman, S. J.** (2011). *Electric Machinery Fundamentals*. McGraw-Hill Education.
3. **Grainger, J. J., & Stevenson, W. D.** (1994). *Power System Analysis*. McGraw-Hill Education.
4. **Fitzgerald, A. E., Kingsley, C., & Umans, S. D.** (2013). *Electric Machinery*. McGraw-Hill Education.
5. **Kerchner, R. M., & Corcoran, G. F.** (1990). *Alternating Current Circuits*. Wiley.