Government Polytechnic Vaishali, Bihar

Under Department of Science, Technology and Technical Education, Bihar
Affiliated By State Board of Technical Education

LAB MANUAL

AC MACHINE

SUBJECT CODE – P2420403

Government Polytechnic Vaishali

Department of Electrical Engineering

Vision

To nurture industry-ready and ethically responsible diploma engineers in Electrical Engineering, equipped with modern technical skills, digital competence, and adaptability to support evolving industrial, infrastructural, and societal needs.

Mission

M1: To provide a student-centric and outcome-based learning ecosystem that integrates classroom instruction with modern laboratories, simulation software, digital learning platforms, and hands-on practices for effective knowledge acquisition.

M2: To impart application-oriented technical skills in electrical machines, power distribution systems, industrial wiring, control circuits, basic automation, and testing instruments, emphasizing safety standards, quality practices, and the use of contemporary tools and technologies.

M3: To strengthen industry readiness, employability, entrepreneurship, and preparedness for higher education through industry–institute interaction, internships, field exposure, expert lectures, skill development programs, guidance, innovation support, and awareness of emerging trends such as energy efficiency, renewable integration, and smart electrical systems.

M4: To foster professional ethics, teamwork, communication skills, problem-solving ability, environmental consciousness, and lifelong learning attitude, enabling diploma holders to contribute responsibly to industry, society, and national development.

Practical/Lab Session Outcomes (LSOs)

S.NO	Laboratory Experiment	Lab Session Outcomes
1	Assemble/ Disassemble a cut section model of a given 3 phase Induction motor and identify its parts	Identify different parts of a cut section model of the given three phase Induction motor.
2	Slip measurement of a 3-phase Induction motor by using: (i) Tachometer (ii) Stroboscopic method.	Measure slip of the given Induction motor by using tachometer and stroboscopic method.
3	Direct load test on three phase induction motor and draw performance characteristics.	Test the performance of three phase induction motor.
4	Starting of three phase induction motor using starters.	Start a given three phase induction motor using DOL, star delta and auto transformer starter.
5	Speed control of squirrel cage induction motor.	1. Control the speed of squirrel cage Induction motor by changing supply voltage. 2. Control the speed of squirrel cage Induction motor by changing frequency
6	Speed control of slip-ring induction motor.	Control the speed of slip ring induction motor by using rotor rheostat.
7	No load and blocked rotor test of a 3-phase induction motor.	Analyze the performance of given three phase Induction motor.
8	Testing of ceiling fan motor.	Test the performance of a ceiling fan motor.

9	No load test on a single-phase induction motor to measure rotational losses.	Measure rotational losses of the given single-phase induction motor using no load test method.
10	Load test on single phase capacitor type induction motor.	Test the performance of single-phase capacitor type induction motor.
11	Load test on alternator to determine voltage regulation.	Test the performance of an alternator by direct load test method to determine the voltage regulation.
12	Open circuit and short circuit test on a single-phase alternator	Perform Open Circuit (OC) and Short Circuit (SC) test on a single-phase alternator to determine the voltage regulation at unity, lag and lead pf.
13	Synchronization of alternator with infinite bus bar- [i] By two bright and one dark lamp Method [ii] By Synchroscope	1. Synchronize the given alternator with infinite bus bar by using two bright and one dark lamp method. 2. Synchronize the given alternator with infinite bus bar by using Synchroscope method.
14	Performance of synchronous motor at different load conditions to see the effect of variation ofexcitation and pf (V & inverted V curve).	1. Test the performance of given synchronous motor at different load conditions. 2. Analyze V and Inverted V curve for the given synchronous motor.
15	Testing of AC servo motor.	Test the performance of AC servo motor.
16	Demonstrate the working of a Linear Induction Motor.	Test the performance of Linear Induction motor.
17	Demonstrate the working of a Stepper Motor.	Test the performance of stepper motor.

18	Demonstrate the working of a Hysteresis Motor.	Test the performance of hysteresis motor.
19	Demonstrate the working of a reluctance Motor.	Test the performance of reluctance motor
20	Demonstrate the working of a Universal Motor	Demonstrate the working of a Universal motor

LIST OF EXPERIMENTS

1	Assemble/ Disassemble a cut section model of a given 3 phase Induction motor and identify its parts
2	Slip measurement of a 3- phase Induction motor by using: (i) Tachometer and (ii) Stroboscopic method.
3	Direct load test on three phase induction motor and draw performance characteristics.
4	Starting of three phase induction motor using starters.
5	Speed control of squirrel cage induction motor.
6	Speed control of slip-ring induction motor.
7	No load and blocked rotor test of a 3-phase induction motor
8	Testing of ceiling fan motor.
9	No load test on a single-phase induction motor to measure rotational losses.
10	Load test on single phase capacitor type induction motor
11	Load test on alternator to determine voltage regulation.
12	Open circuit and short circuit test on a single-phase alternator

13	Synchronization of alternator with infinite bus bar- [i] By two bright and one dark lamp Method [ii] By Synchroscope
14	Performance of synchronous motor at different load conditions to see the effect of variation of excitation and pf (V & inverted V curve)
15	Testing of AC servo motor.
16	Demonstrate the working of a Linear Induction Motor.
17	Demonstrate the working of a Stepper Motor.
18	Demonstrate the working of a Hysteresis Motor.
19	Demonstrate the working of a reluctance Motor.
20	Demonstrate the working of a Universal Motor.

PRACTICAL OUTCOMES

CO	Statement
1	Maintain three phase Induction Motor.
2	Use relevant Single-phase Induction Motors for various applications.
3	Synchronize an alternator with bus bar/another alternator
4	Use synchronous motors for industrial applications.
5	Use special electrical machines for different applications

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO No.	Program Educational Objectives Statements
PEO1	To prepare diploma holders with a strong foundation in electrical engineering fundamentals and state-of-the-art technologies, enabling continuous learning, skill upgradation, and adaptability to emerging industrial and technological trends.
PEO2	To develop professionally responsible diploma holders with effective communication skills, leadership qualities, ethical values, and the ability to work efficiently as individuals and as members of multidisciplinary teams.
PEO3	To enhance employability by providing industry-oriented training, hands-on experience, and exposure through industrial visits, internships, seminars, workshops, and interaction with industry professionals and academicians.
PEO4	To enable diploma holders to apply project-based learning, modern tools, and innovative approaches to develop solutions addressing technical, socio-economic, and environmental challenges in a sustainable and socially responsible manner.

PROGRAM SPECIFIC OUTCOMES

PSO1: Design, Install, operate, and troubleshoot electrical systems, machines and power circuits using modern tools while adhering to safety standards and environmental consideration.

PSO2: Work effectively in multidisciplinary teams to solve real-time electrical engineering problems and communicate technical information clearly and professionally.

PROGRAM OUTCOMES (POS)

P01: Basic and Discipline specific knowledge: Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.

PO2: Problem analysis: Identify and analyse well-defined engineering problems using codified standard methods.

PO3: Design/ development of solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

P04: Engineering Tools, Experimentation and Testing: Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

PO5: Engineering practices for society, sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO6: Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

PO7: Life-long learning: Ability to analyze individual needs and engage in updating in the context of technological changes.

MAPPING

Sl. No.	Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	To generate the sine wave using MATLAB	3	2	2	3			1	2	1
CO2	To generate the impulse signal using MATLAB	3	2	2	3			1	2	1
CO3	Perform various arithmetic operations and plot different types of plots using MATLAB	3	2	2	3			1	2	
CO4	Interpret the results of various electric and electronic circuits developed using MATLAB	3	2	3	3			1	2	1
CO5	Simulate model of electrical/electronic circuits using Simulink.	3	2	3	3			1	3	1

EXPERIMENT NO: 01

Aim:-

To assemble and disassemble a cut section model of a 3-phase induction motor and identify its various parts.

Theory:-

A 3-phase induction motor is an electrical machine that converts electrical energy into mechanical energy using electromagnetic induction. It works on the principle that when a 3-phase AC supply is given to the stator windings, a rotating magnetic field (RMF) is produced.

The stator consists of three-phase windings placed 120° apart. When supply is applied, it creates a rotating magnetic field which rotates at synchronous speed. This rotating magnetic field cuts the rotor conductors and induces an electromotive force (EMF) in them due to electromagnetic induction.

As the rotor conductors are short-circuited, current flows in them and produces its own magnetic field. The interaction between stator magnetic field and rotor magnetic field produces torque, causing the rotor to rotate.

Important formula:

Synchronous speed, $N_s = (120 \times f) / P$

Where,

f = supply frequency

P = number of poles

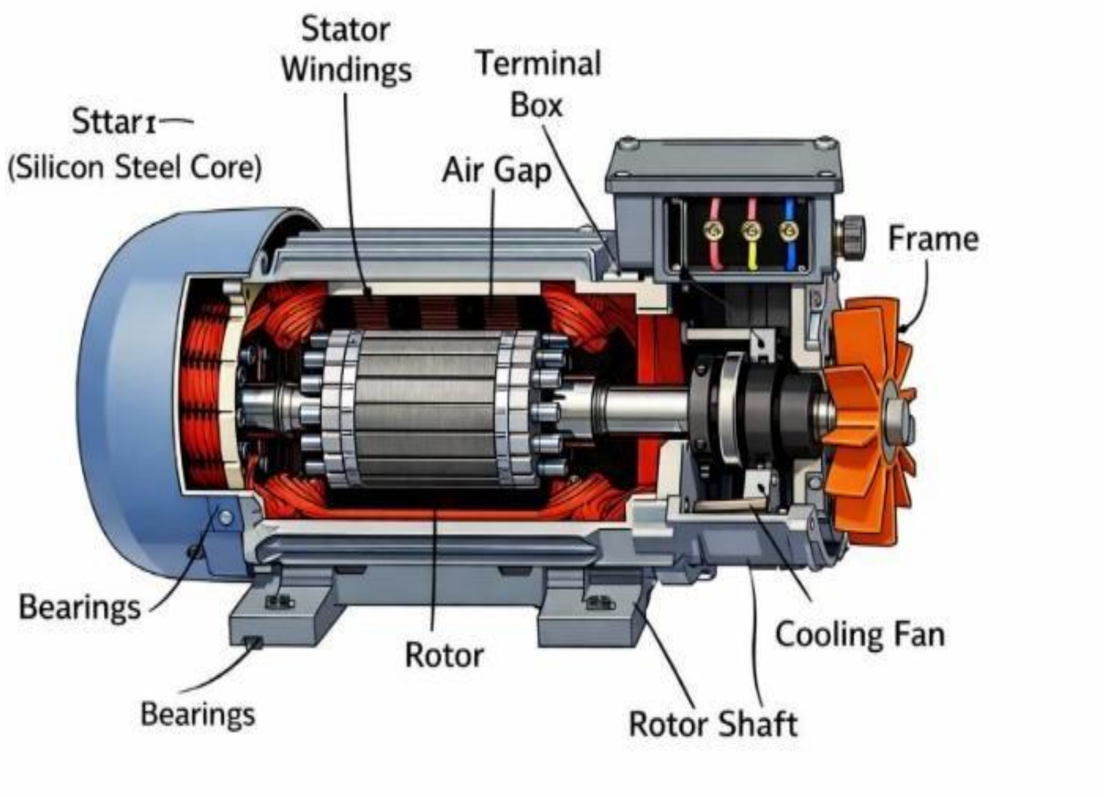
Slip, $S = (N_s - N_r) / N_s$

Main parts of induction motor:

Stator, Rotor (squirrel cage or slip ring), Air gap, Shaft, Bearings, Frame, Cooling fan, Terminal box.

Practical Set-up / Circuit Diagram:-

A cut section model of a 3-phase induction motor is placed on a working table. The model is partially opened so that internal parts like stator windings, rotor, shaft, and bearings are visible. No electrical connections are required as this is a mechanical assembly and identification experiment.



Cut Section Diagram of a 3-Phase Induction Motor

Apparatus Required:-

Cut section model of 3-phase induction motor, screwdrivers, spanner set, cleaning cloth

Precautions to be Followed :-

1. Handle all parts carefully to avoid damage
2. Do not apply excessive force while disassembling

3. Keep all removed parts in proper order
4. Use proper tools for opening and tightening
5. Ensure hands are clean and dry
6. Reassemble parts correctly to avoid misalignment

Procedure:-

1. Place the cut section model on a stable surface
2. Observe the external parts such as frame, terminal box, and shaft
3. Carefully start disassembling the motor using proper tools
4. Remove outer casing and observe internal parts
5. Identify stator, rotor, windings, bearings, and air gap
6. Note the construction and arrangement of each part
7. After observation, start reassembling the motor
8. Fix each part in its original position properly
9. Tighten all screws and ensure proper alignment
10. Verify that all parts are correctly assembled

Observations and Calculations:-

Observation Table

S.No	Part Name	Function	Material Used	Remarks
1	Stator	Produces rotating magnetic field	Silicon steel	Fixed part
2	Rotor	Rotates and produces torque	Aluminium/Copper	Rotating part
3	Shaft	Transfers mechanical output	Steel	Connected to load
4	Bearings	Reduce friction	Steel	Smooth rotation
5	Frame	Protects internal parts	Cast iron	Outer body

6	Cooling Fan	Provides cooling	Plastic/Metal	Mounted on shaft
7	Terminal Box	Electrical connections	Insulated material	External part

Result:-

The cut section model of a 3-phase induction motor was successfully assembled and disassembled. All major parts were identified and their functions were studied clearly.

VIVA BOOK:-

1. Explain 3-phase induction motor?
2. Explain the working principle of an induction motor.
3. What is slip in an induction motor?
4. Differentiate between squirrel cage rotor and slip ring rotor?
5. Explain the function of the stator in an induction motor?

EXPERIMENT NO: 02

Aim:-

To measure the slip of a 3-phase induction motor using a tachometer and a stroboscopic method.

Theory

Slip is the difference between synchronous speed and rotor speed in an induction motor. It is an important parameter that determines motor performance.

When a 3-phase supply is given to the stator, a rotating magnetic field is produced at synchronous speed (Ns). The rotor rotates at a speed (Nr) slightly less than synchronous speed. This difference is necessary for the production of torque.

Slip is given by:

$S = (Ns - Nr) / Ns$

Synchronous speed is given by:

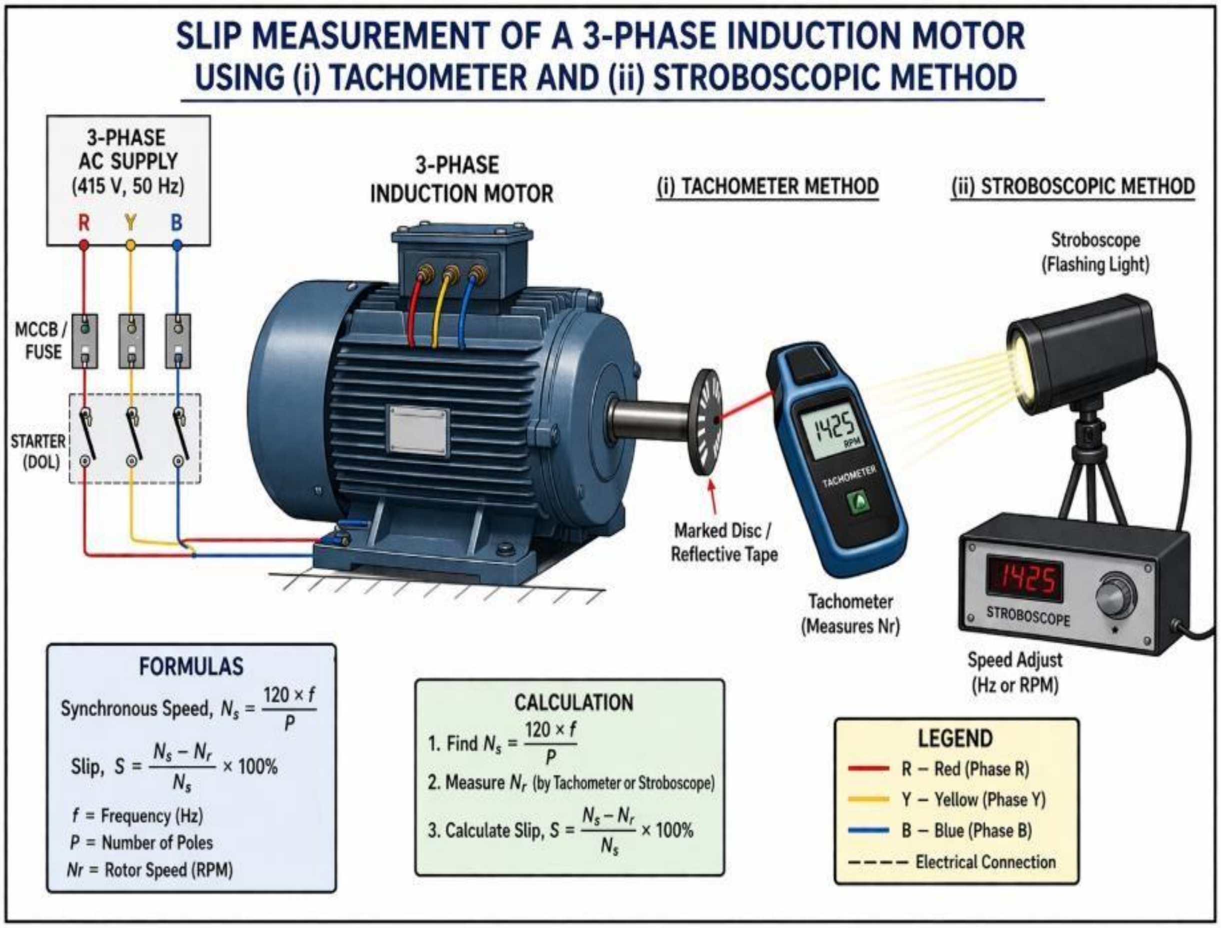
$Ns = (120 \times f) / P$

Where,
f = supply frequency

P = number of poles

In the tachometer method, rotor speed is measured directly using a tachometer. In the stroboscopic method, a flashing light is used to visually match rotor markings to determine speed.

Practical Set-up / Circuit Diagram:-



A 3-phase induction motor is connected to a 3-phase AC supply through a suitable starter. A tachometer is used to measure rotor speed in the first method. For the stroboscopic method, a stroboscope is directed towards a marked rotating disc attached to the motor shaft. The supply frequency and number of poles are known to calculate synchronous speed.

Apparatus Required:-

3-phase induction motor, tachometer, stroboscope, 3-phase AC supply, starter, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON supply
2. Do not touch rotating parts during operation
3. tachometer carefully to avoid damage

4. Use Maintain proper alignment of stroboscope with rotating disc
5. Switch OFF supply before making any changes
6. Wear safety equipment if required

Procedure:-

1. Connect the 3-phase induction motor to the supply through starter
2. Switch ON the supply and allow the motor to reach steady speed
3. Note the supply frequency and number of poles
4. Calculate synchronous speed using formula
5. Measure rotor speed using tachometer
6. Record the readings
7. Calculate slip using formula
8. For stroboscopic method, mark a point on rotor shaft or disc
9. Direct stroboscope light on rotating shaft
10. Adjust flashing frequency until the mark appears stationary
11. Note the speed from stroboscope
12. Calculate slip using observed speed
13. Compare results from both methods

Observations and Calculations:-

Observation Table:-

S.No	Frequency (f)	Poles (P)	Synchronous Speed (Ns)	Rotor Speed (Nr)	Slip (S)
1					
2					

Sample Calculation

Formula Used:

Ns = (120 × f) / P

$S = (Ns - Nr) / Ns$

Result:-

The slip of the 3-phase induction motor was measured using tachometer and stroboscopic methods. The values obtained were close and verified the theoretical concept of slip.

VIVA BOOK:-

1. Explain slip in an induction motor?
2. Differentiate between synchronous speed and rotor speed.
3. Explain how to measure slip using a stroboscopic method.
4. Explain why slip occurs in an induction motor.
5. Explain the difference in readings between tachometer and stroboscopic methods.

EXPERIMENT NO:03

Aim:-

To perform direct load test on a three phase induction motor and draw its performance characteristics.

Theory:-

In a direct load test, a 3-phase induction motor is tested under different load conditions to study its performance. The motor is connected to a load (mechanical or electrical), and readings of voltage, current, power, and speed are taken at various load levels.

The important performance characteristics include efficiency, power factor, torque, and slip. As load increases, current and torque increase, while speed slightly decreases due to increase in slip.

Efficiency is given by:

Efficiency (η) = (Output Power / Input Power) × 100

Input Power (Pin) = $\sqrt{3} \times V \times I \times \cos\varphi$

Slip, S = (Ns − Nr) / Ns

Where,

V = voltage

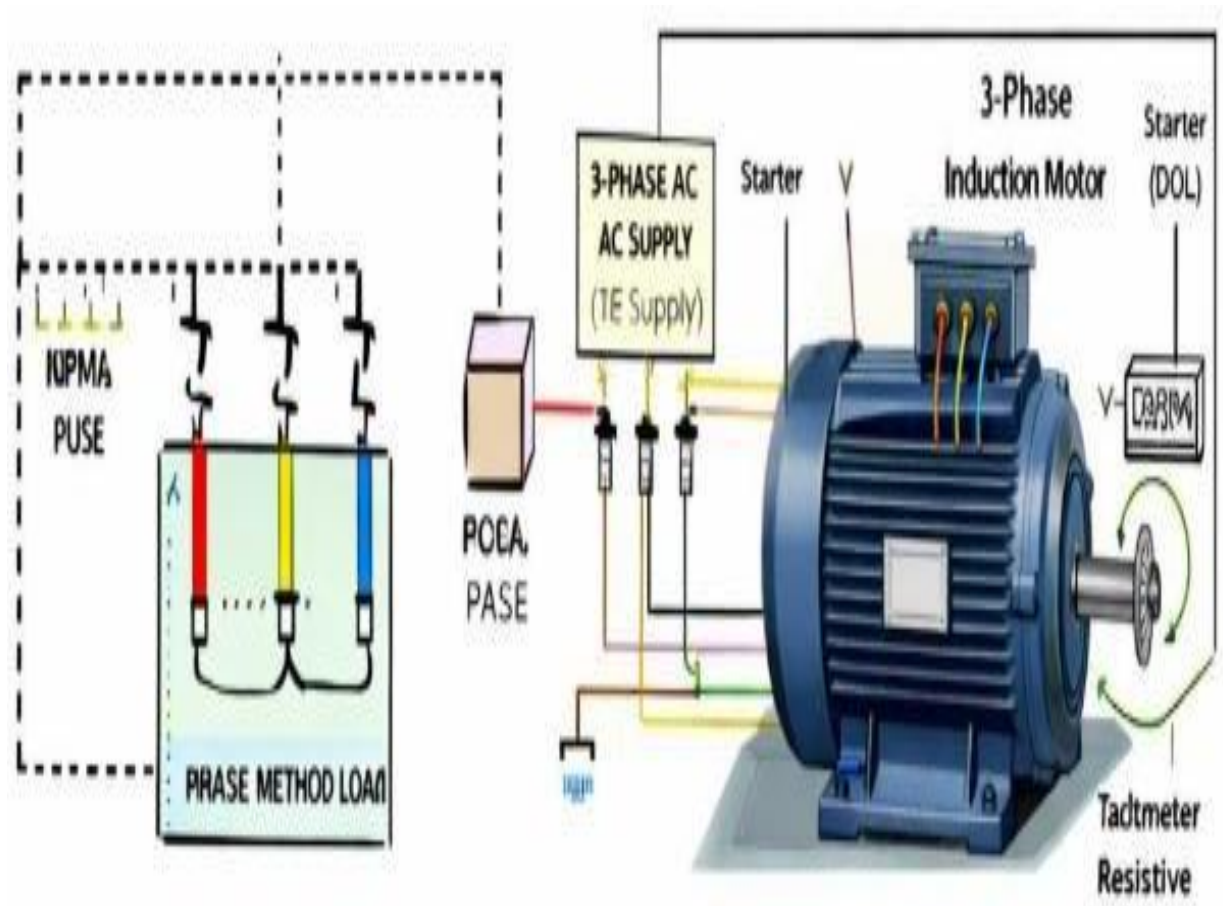
I = current

$\cos\varphi$ = power factor

Ns = synchronous speed

Nr = rotor speed

Practical Set-up / Circuit Diagram:-



A 3-phase induction motor is connected to a 3-phase AC supply through a starter. Measuring instruments like voltmeter, ammeter, and wattmeter are connected to measure voltage, current, and power. A mechanical load (such as brake drum or dynamometer) is coupled to the motor shaft to apply load. Speed is measured using a tachometer.

Apparatus Required:-

3-phase induction motor, 3-phase supply, starter, voltmeter, ammeter, wattmeter, tachometer, mechanical load, connecting wires

Precautions to be Followed:-

1. Ensure all connections are correct before switching ON supply
2. Apply load gradually to avoid sudden shock
3. Do not exceed rated load of motor
4. Note readings carefully and accurately

5. Keep hands away from rotating parts
6. Switch OFF supply before disconnecting

Procedure:-

1. Connect the motor to 3-phase supply through starter
2. Connect voltmeter, ammeter, and wattmeter properly
3. Start the motor and allow it to run at no load
4. Note no-load readings of voltage, current, and power
5. Gradually apply load in steps
6. At each load, record voltage, current, power, and speed
7. Continue till rated load is reached
8. Calculate input power, output power, efficiency, and slip
9. Plot graphs:

(i) Efficiency vs Load

(ii) (ii) Current vs Load

(iii) (iii) Speed vs Load

(iv) (iv) Power factor vs Load

10. Switch OFF supply after completion

Observations and Calculations:-

Observation Table:-

S.No	Voltage (V)	Current (A)	Power (W)	Speed (rpm)	Input Power	Output Power	Efficiency (%)
1							
2							
3							

Sample Calculation

Formula Used:

nput Power = $\sqrt{3} \times V \times I \times \cos\varphi$

Efficiency = (Output Power / Input Power) × 100

Result:-

The direct load test on the three phase induction motor was performed successfully. Performance characteristics such as efficiency, current, and speed variation with load were studied and graphs were drawn.

VIVA BOOK:-

1. What is a direct load test on an induction motor?
2. Explain efficiency of a motor?
3. Why does speed decrease with increase in load?
4. What are performance characteristics of an induction motor?
5. Differentiate between between no-load and full-load condition?

EXPERIMENT NO:04

Aim:-

To study the starting methods of a three phase induction motor using different starters.

Theory:-

A three phase induction motor draws a very high current at the time of starting (about 5 to 7 times the full load current). This high current can damage the motor and cause voltage drop in the supply system. To reduce this starting current, different types of starters are used.

Common starters are:

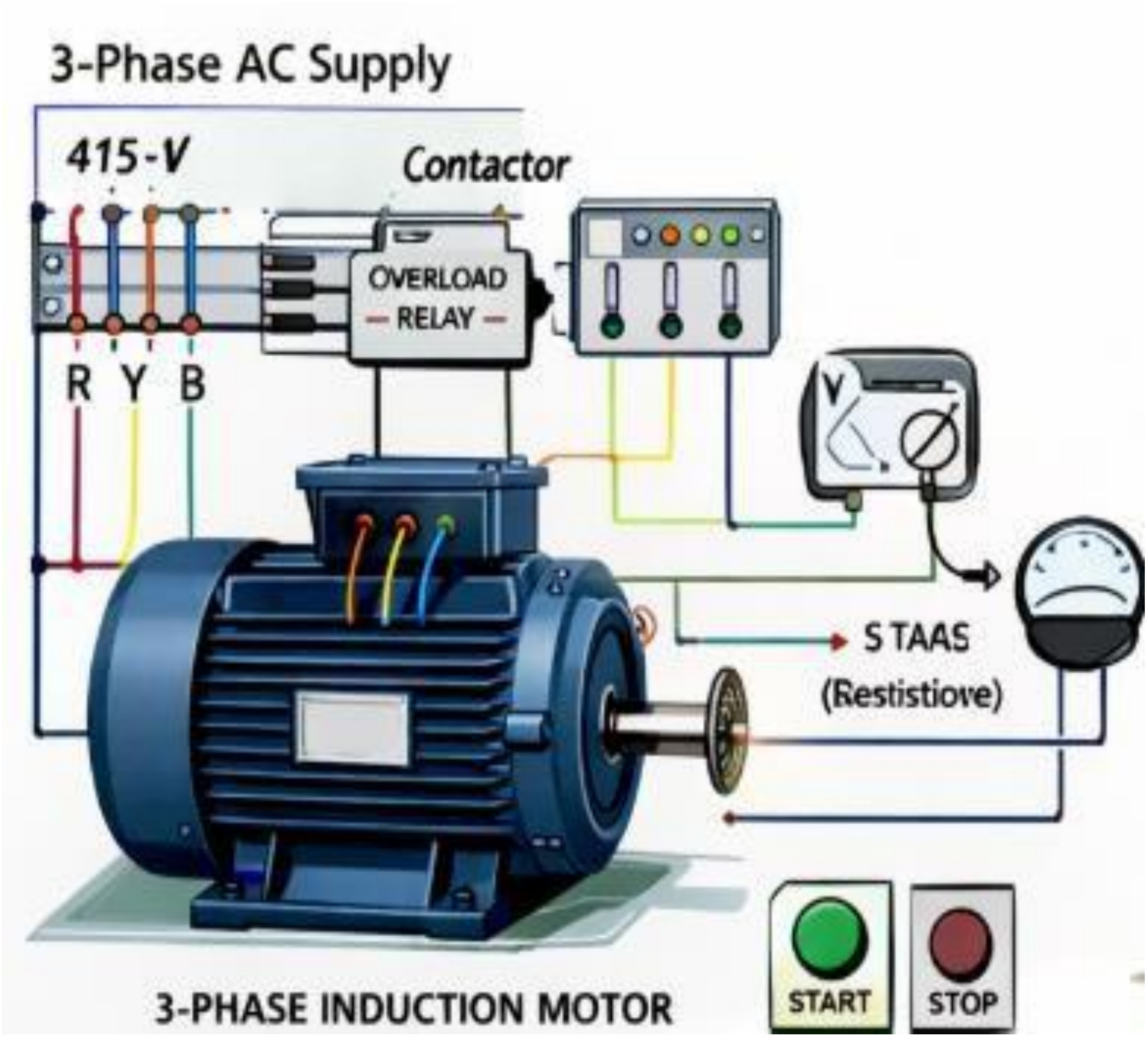
1. Direct On Line (DOL) Starter – Applies full voltage directly to motor
2. Star-Delta Starter – Starts motor in star connection and then changes to delta
3. Auto-transformer Starter – Uses reduced voltage during starting

In DOL starter, full voltage is applied, so starting current is high but torque is also high. In star-delta starter, voltage is reduced to $1/\sqrt{3}$ times, reducing current and torque.

Torque $\propto$ (Voltage)^2

Thus, reducing voltage reduces starting torque and current.

Practical Set-up / Circuit Diagram:-



Description of setup:

A three phase induction motor is connected to a 3-phase AC supply through a starter (DOL or Star-Delta). Control circuit includes push buttons (start/stop), contactor, overload relay, and supply lines. Measuring instruments like ammeter and voltmeter may be connected to observe starting conditions.

Apparatus Required:-

3-phase induction motor, DOL starter, star-delta starter, 3-phase AC supply, ammeter, voltmeter, connecting wires

Precautions to be Followed:-

1. Ensure proper wiring before switching ON
2. Do not touch live terminals
3. Use correct starter for given motor rating
4. Start motor without load initially
5. Observe readings carefully
6. Switch OFF supply before making changes

Procedure:-

1. Connect the 3-phase induction motor through DOL starter
2. Check all connections properly
3. Switch ON the supply
4. Press start button and observe motor starting
5. Note starting current and behavior
6. Stop the motor using stop button
7. Now connect star-delta starter
8. Start the motor and observe change from star to delta
9. Note starting current and smoothness
10. Compare both methods of starting

Observations and Calculations:-

Observation Table

S.No	Starter Type	Voltage (V)	Starting Current (A)	Starting Torque	Remarks
1	DOL			High	
2	Star-Delta			Medium	

Result:-

Result

The starting of a three phase induction motor using different starters was studied successfully. It was observed that starters reduce starting current and provide safe operation of the motor.

VIVA BOOK:-

1. Why is a starter required for an induction motor?
2. What is the working of a DOL starter?
3. What is the difference between DOL and star-delta starter?
4. Why is starting current high in induction motor?
5. What is the function of overload relay?

EXPERIMENT NO:5

Aim:-

To study the methods of speed control of a squirrel cage induction motor.

Theory:-

The speed of a squirrel cage induction motor depends on supply frequency and number of poles. It is given by:

$N_s = (120 \times f) / P$

Where,
f = supply frequency

P = number of poles

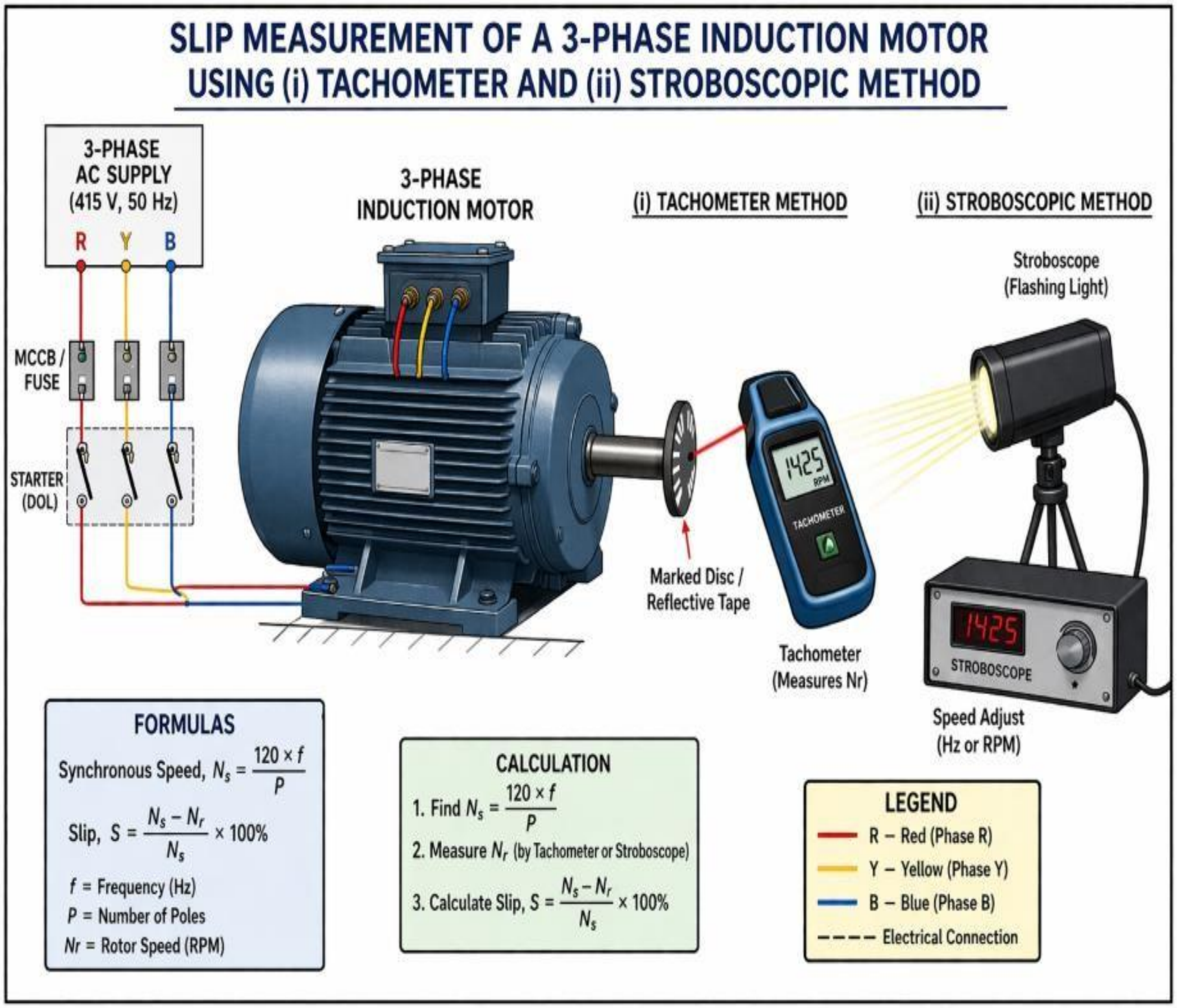
Since rotor speed is slightly less than synchronous speed, controlling these parameters changes motor speed.

Methods of speed control:

1. Frequency Control – By changing supply frequency using a variable frequency drive (VFD)
2. Pole Changing Method – Changing number of stator poles
3. Voltage Control – Changing stator voltage (limited control)

Among these, frequency control is the most efficient and widely used method. As frequency increases, speed increases proportionally.

Practical Set-up / Circuit Diagram:-



A squirrel cage induction motor is connected to a 3-phase AC supply through a Variable Frequency Drive (VFD). The VFD controls the supply frequency and voltage. A tachometer is used to measure motor speed at different frequency settings.

Apparatus Required:-

Squirrel cage induction motor, VFD (variable frequency drive), 3-phase AC supply, tachometer, connecting wires

Precautions to be Followed:-

1. Ensure proper wiring before switching ON
2. Do not change frequency suddenly

3. Avoid overloading the motor
4. Keep hands away from rotating parts
5. Operate VFD carefully
6. Switch OFF supply after experiment

Procedure:-

1. Connect the induction motor to VFD and supply
2. Check all connections properly
3. Switch ON the supply
4. Set initial frequency (low value) on VFD
5. Start the motor and note speed using tachometer
6. Increase frequency gradually in steps
7. Record speed at each frequency
8. Observe variation of speed with frequency
9. Plot graph of Speed vs Frequency
10. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Frequency (Hz)	Voltage (V)	Speed (rpm)
1			
2			
3			

Formula Used:

Ns = (120 × f) / P

Result:-

The speed control of squirrel cage induction motor was studied successfully. It was observed that motor speed increases with increase in supply frequency.

VIVA BOOK:-

1. What is the formula for synchronous speed?
2. Why is frequency control preferred for speed control?
3. What is a squirrel cage induction motor?
4. What is the function of VFD?
5. What is the effect of voltage on speed?

EXPERIMENT NO:6

Aim:-

To study the speed control of a slip-ring induction motor by rotor resistance method.

Theory:-

A slip-ring induction motor allows external resistance to be added in the rotor circuit through slip rings. By adding resistance in the rotor circuit, the rotor current and slip increase, which results in a decrease in speed.

Speed of induction motor is given by:

$N_s = (120 \times f) / P$

Slip is given by:

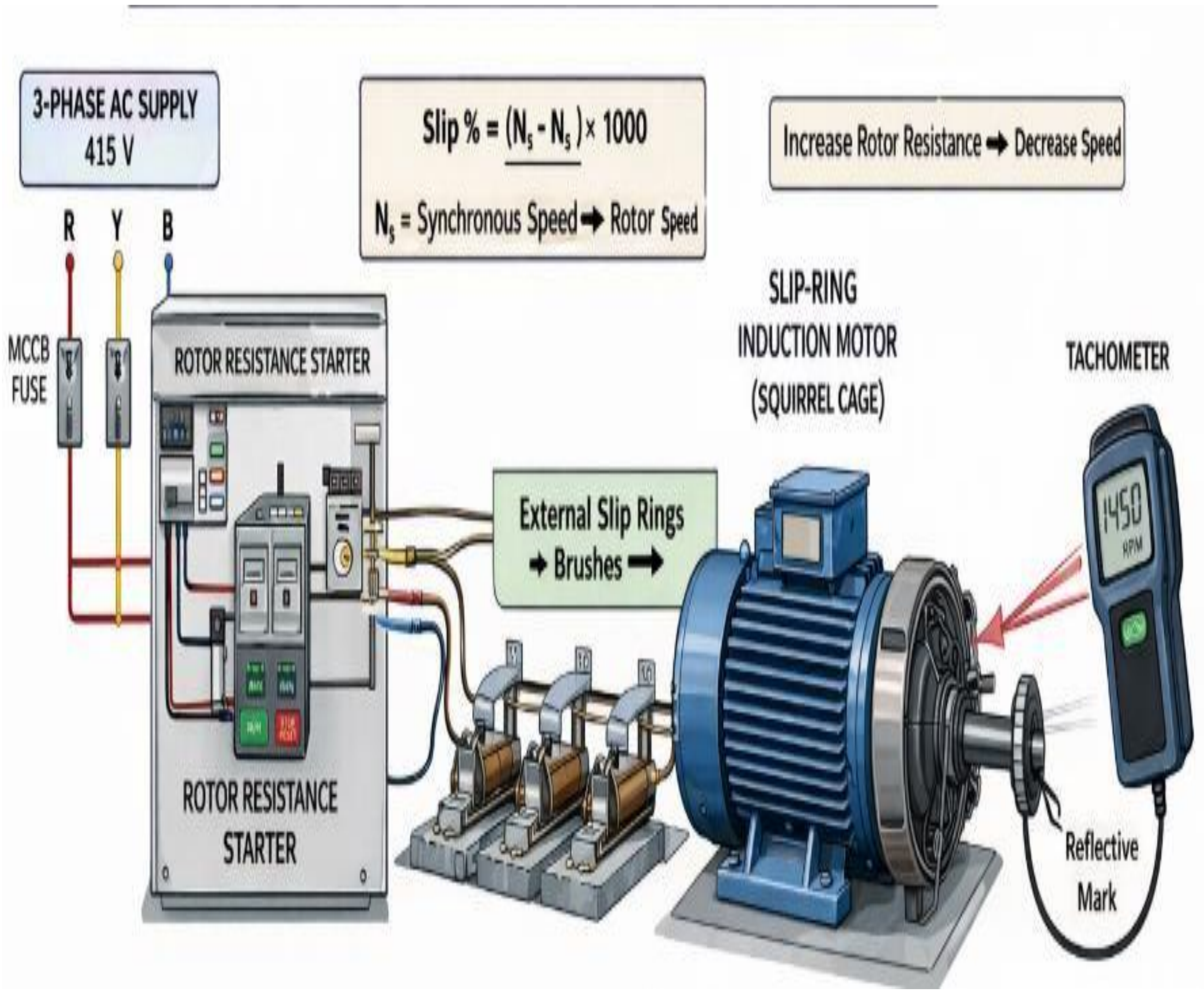
$S = (N_s - N_r) / N_s$

In slip-ring motors, speed can be controlled by:

1. Rotor Resistance Control – External resistance is added in rotor circuit
2. Cascade Control (advanced method)

When rotor resistance increases, slip increases, and speed decreases. This method provides smooth speed control but reduces efficiency due to power loss in resistors.

Practical Set-up / Circuit Diagram:



slip-ring induction motor is connected to a 3-phase AC supply through a starter. The rotor windings are connected to an external variable resistance through slip rings and brushes. A tachometer is used to measure speed at different resistance values.

Apparatus Required;-

1 Slip-ring induction motor, rotor resistance starter, 3-phase AC supply, rheostat (variable resistor), tachometer, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Do not change resistance suddenly
3. Avoid short circuit in rotor circuit

4. Keep hands away from moving parts
5. Do not overload the motor
6. Switch OFF supply after experiment

Procedure:-

1. Connect the slip-ring induction motor to supply through starter
2. Connect external resistance in rotor circuit
3. Check all connections properly
4. Switch ON the supply
5. Start the motor with maximum resistance
6. Measure speed using tachometer
7. Gradually decrease resistance step by step
8. Note speed at each step
9. Observe change in speed with resistance
10. Plot graph of Speed vs Rotor Resistance
11. Switch OFF supply after completion

Observations and Calculations:-
Observation Table

S.No	Rotor Resistance	Voltage (V)	Current (A)	Speed (rpm)
1				
2				
3				

Formula Used:

$N_s = (120 \times f) / P$

Result-

The speed control of slip-ring induction motor was studied successfully. It was observed that speed decreases with increase in rotor resistance.

VIVA BOOK:-

1. What is a slip-ring induction motor?
2. Why is rotor resistance added in slip-ring motor?
3. What is slip in an induction motor?
4. What is the effect of rotor resistance on speed?
5. What is the difference between squirrel cage and slip-ring motor?

EXPERIMENT NO:7

Aim:-

To perform no-load and blocked rotor test on a 3-phase induction motor and determine its parameters.

Theory:-

These tests are used to determine the equivalent circuit parameters of a 3-phase induction motor.

1. No-Load Test:

   In this test, the motor runs without any load. It is used to determine core losses, friction and windage losses. At no-load, current is small and power consumed mainly represents losses.

2. Blocked Rotor Test:

   In this test, the rotor is locked (not allowed to rotate). A reduced voltage is applied to circulate rated current. This test is similar to short circuit test of transformer and is used to determine copper losses and impedance.

Important formulas:

Input Power, $P_{in} = \sqrt{3} \times V \times I \times \cos\varphi$

For No-load:

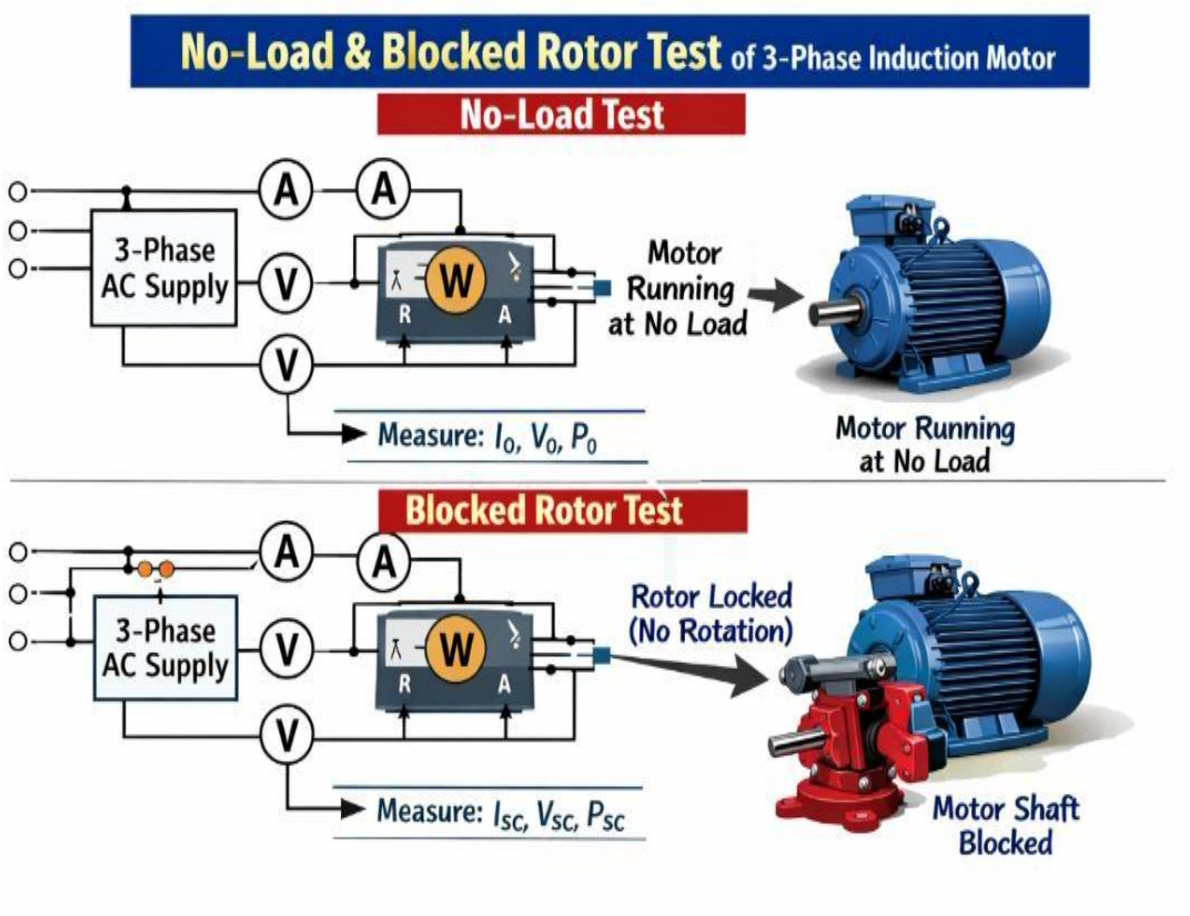
Core Loss ≈ Input Power

For Blocked Rotor:

Impedance, $Z = V / I$

Power Factor, $\cos\varphi = P / (\sqrt{3} \times V \times I)$

Practical Set-up / Circuit Diagram:-



A 3-phase induction motor is connected to AC supply through a starter. Measuring instruments such as voltmeter, ammeter, and wattmeter are connected. For no-load test, motor runs freely without load. For blocked rotor test, rotor is mechanically locked and reduced voltage is applied through autotransformer..

Apparatus Required:-

3-phase induction motor, voltmeter, ammeter, wattmeter, autotransformer, starter, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Apply reduced voltage during blocked rotor test
3. Do not run blocked rotor test for long duration
4. Keep hands away from moving parts

5. Record readings carefully
6. Switch OFF supply after experiment

Procedure:-

No-Load Test:

1. Connect the motor to supply through starter
2. Keep motor without load
3. Switch ON the supply
4. Note voltage, current, and power readings
5. Allow motor to run at rated speed
6. Record readings

Blocked Rotor Test:

7. Switch OFF supply
8. Lock the rotor mechanically
9. Apply reduced voltage using autotransformer
10. Adjust voltage to get rated current
11. Note voltage, current, and power readings
12. Switch OFF supply immediately after readings

Observations and Calculations:-

Observation Table

No-Load Test:

S.No	Voltage (V)	Current (A)	Power (W)
1			

Blocked Rotor Test:

S.No	Voltage (V)	Current (A)	Power (W)
1			

Formula Used:

$Z = V / I$

$\cos\varphi = P / (\sqrt{3} \times V \times I)$

Result:-

The no-load and blocked rotor tests were performed successfully. The parameters of the 3-phase induction motor were determined and analyzed.

VIVA BOOK:-

1. What is the purpose of no-load test?
2. Why is reduced voltage applied in blocked rotor test?
3. What is the difference between no-load and blocked rotor test?
4. What losses are determined in no-load test?
5. What is impedance in blocked rotor test?

EXPERIMENT NO:8

Aim:-

To test the performance of a ceiling fan motor and observe its working characteristics.

Theory:-

A ceiling fan motor is a single-phase induction motor, generally of the capacitor start and run type. It works on the principle of a rotating magnetic field produced by two windings: main winding and auxiliary winding.

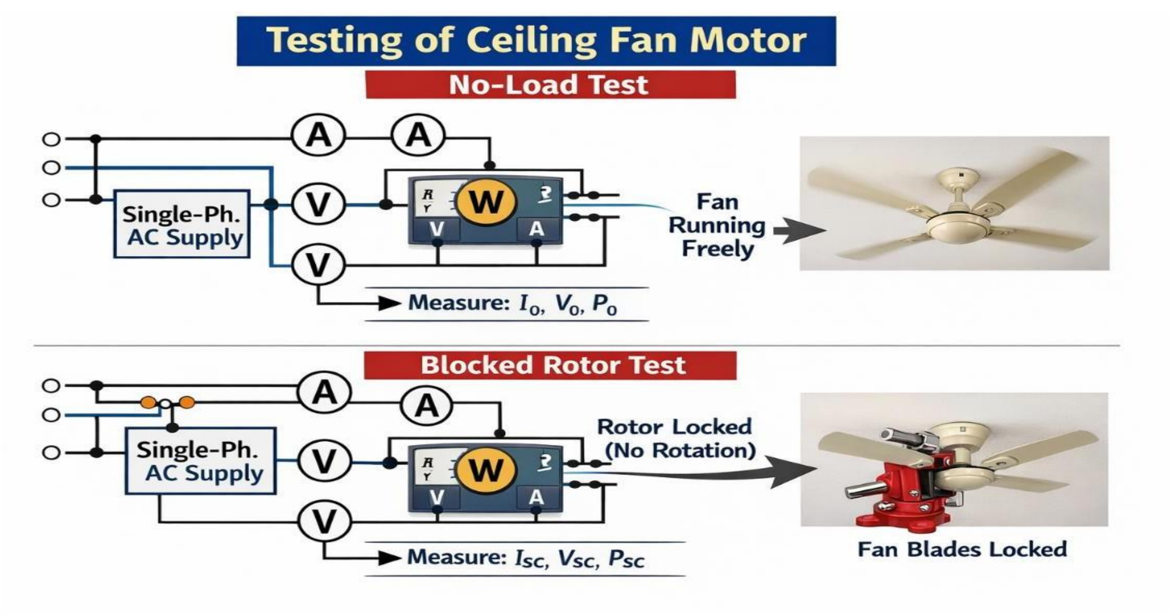
A capacitor is connected in series with the auxiliary winding to create a phase difference between currents, which produces a rotating magnetic field and starts the motor.

During operation, electrical energy is converted into mechanical energy to rotate the fan blades. The performance of the motor is tested by measuring voltage, current, power, and speed.

Input Power, Pin = V × I × cosφ

Efficiency (η) = (Output Power / Input Power) × 100

Practical Set-up / Circuit Diagram:-



A ceiling fan is connected to a single-phase AC supply through a regulator. A voltmeter, ammeter, and wattmeter are connected to measure voltage, current, and power. A tachometer may be used to measure speed. The capacitor is connected internally with the auxiliary winding.

Apparatus Required:-

Ceiling fan motor, single-phase AC supply, regulator, voltmeter, ammeter, wattmeter, tachometer, connecting wires

Precautions to be Followed:-

1. Ensure proper wiring before switching ON
2. Do not touch live terminals
3. Ensure fan is properly mounted
4. Avoid overvoltage supply
5. Record readings carefully
6. Switch OFF supply after experiment

Procedure:-

1. Connect the ceiling fan to single-phase supply through regulator
2. Connect voltmeter, ammeter, and wattmeter
3. Switch ON the supply
4. Start the fan using regulator
5. Vary speed using regulator
6. Note voltage, current, and power at different speeds
7. Measure speed using tachometer (if available)
8. Record all readings
9. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Voltage (V)	Current (A)	Power (W)	Speed (rpm)
1				
2				
3				

Formula Used:

Input Power = $V \times I \times \cos\varphi$

Result:-

The ceiling fan motor was tested successfully. Its performance characteristics at different speeds were observed and analyzed.

VIVA BOOK:-

1. What type of motor is used in a ceiling fan?
2. What is the function of capacitor in a fan motor?
3. How is speed controlled in a ceiling fan?
4. What is the working principle of a single-phase induction motor?
5. Why is auxiliary winding required?

EXPERIMENT NO:9

Aim:-

To perform a no-load test on a single-phase induction motor and determine its rotational losses.

Theory:-

In a no-load test, the motor is run without any mechanical load. The power drawn under this condition mainly represents the rotational losses, which include:

1. Core (iron) losses
2. Friction losses
3. Windage losses

A single-phase induction motor works on the principle of a rotating magnetic field produced by main and auxiliary windings with the help of a capacitor. At no-load, the motor runs close to synchronous speed and draws a small current.

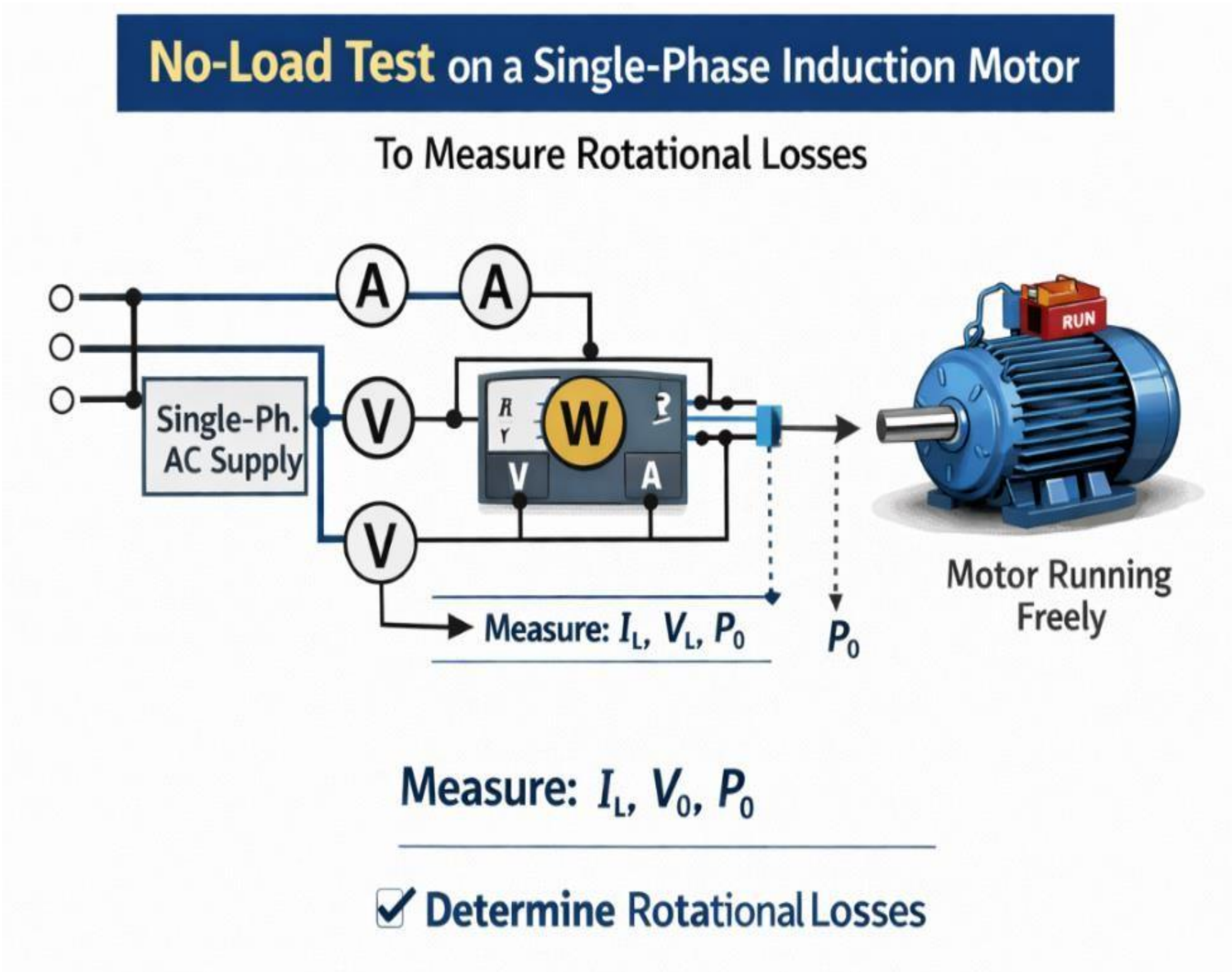
Input power at no-load is given by:

$P_{in} = V \times I \times \cos\varphi$

Since output power is nearly zero at no-load,

Rotational losses ≈ Input power

Practical Set-up / Circuit Diagram:-



A single-phase induction motor is connected to a single-phase AC supply through a switch. Measuring instruments such as voltmeter, ammeter, and wattmeter are connected to measure voltage, current, and power. The motor is allowed to run without any load.

Apparatus Required:-

Single-phase induction motor, voltmeter, ammeter, wattmeter, single-phase AC supply, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Do not touch rotating parts
3. Ensure motor runs without load
4. Record readings accurately

5. Avoid overvoltage
6. Switch OFF supply after experiment

Procedure:-

1. Connect the motor to single-phase supply
2. Connect voltmeter, ammeter, and wattmeter properly
3. Ensure no mechanical load is connected
4. Switch ON the supply
5. Allow motor to reach steady speed
6. Note voltage, current, and power readings
7. Record the observations
8. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Voltage (V)	Current (A)	Power (W)
1			
2			

Formula Used:

Input Power (Pin) = V × I × cosφ

Rotational Losses ≈ Input Power

Result-

The no-load test on the single-phase induction motor was performed successfully. The rotational losses of the motor were determined from the no-load input power.

VIVA BOOK:-

1. What is a no-load test?

2. What are rotational losses in a motor?
3. Why is output power nearly zero at no-load?
4. What type of motor is a single-phase induction motor?
5. What losses are included in rotational losses?

EXPERIMENT NO:10

Aim:-

To perform load test on a single-phase capacitor type induction motor and study its performance characteristics.

Theory:-

A single-phase capacitor type induction motor uses a capacitor in series with the auxiliary winding to create a phase difference, producing a rotating magnetic field for starting and running.

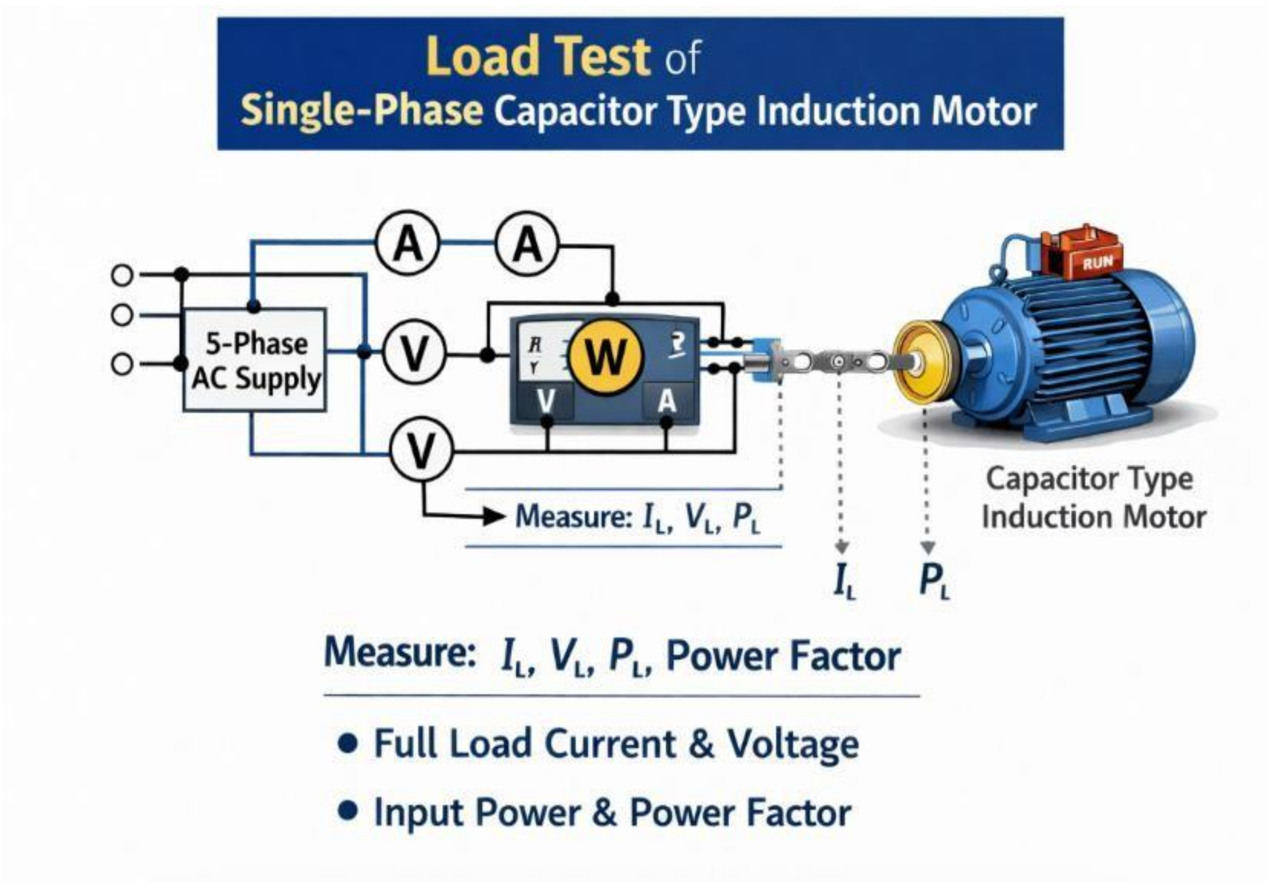
In a load test, the motor is subjected to different load conditions and parameters like voltage, current, power, and speed are measured. From these readings, performance characteristics such as efficiency, power factor, and speed variation are studied.

Input Power, Pin = $V \times I \times \cos\varphi$

Efficiency (η) = (Output Power / Input Power) × 100

As load increases, current increases, speed slightly decreases, and efficiency first increases and then may decrease after full load.

Practical Set-up / Circuit Diagram:-



A single-phase capacitor type induction motor is connected to a single-phase AC supply through a switch. Measuring instruments like voltmeter, ammeter, and wattmeter are connected. A mechanical load (such as brake drum or loading arrangement) is coupled to the motor shaft to apply load. Speed is measured using a tachometer.

Apparatus Required:-

Single-phase capacitor type induction motor, voltmeter, ammeter, wattmeter, tachometer, loading arrangement, single-phase AC supply, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Apply load gradually
3. Do not exceed rated load
4. Keep hands away from moving parts

5. Record readings carefully
6. Switch OFF supply after experiment

Procedure:-

1. Connect the motor to single-phase supply
2. Connect voltmeter, ammeter, and wattmeter properly
3. Start the motor without load
4. Note no-load readings
5. Apply load gradually in steps
6. At each load, record voltage, current, power, and speed
7. Continue up to rated load
8. Calculate input and output power
9. Calculate efficiency
10. Plot graphs:

(i) Efficiency vs Load

(ii) Current vs Load

(iii) Speed vs Load

11. Switch OFF supply after completion.

Observations and Calculations:-

Observation Table

S.No	Voltage (V)	Current (A)	Power (W)	Speed (rpm)	Input Power	Output Power	Efficiency (%)
1							
2							

Formula Used:

Input Power = V × I × cosφ

Efficiency = (Output Power / Input Power) × 100

Result:-

The load test on the single-phase capacitor type induction motor was performed successfully. Performance characteristics such as efficiency, current, and speed variation with load were observed.

VIVA BOOK:-

1. Explain capacitor type induction motor?
2. What is the function of capacitor in the motor?
3. What is efficiency of a motor?
4. Why does speed decrease with increase in load?
5. What are performance characteristics of a motor?

EXPERIMENT NO:11

Aim:-

To perform load test on an alternator and determine its voltage regulation at different load conditions.

Theory:-

An alternator (synchronous generator) converts mechanical energy into electrical energy. When load is applied, the terminal voltage of the alternator changes due to internal impedance and armature reaction.

Voltage regulation is defined as the change in terminal voltage from no-load to full-load, expressed as a percentage of full-load voltage.

Voltage Regulation = $[(E_0 - V) / V] \times 100$

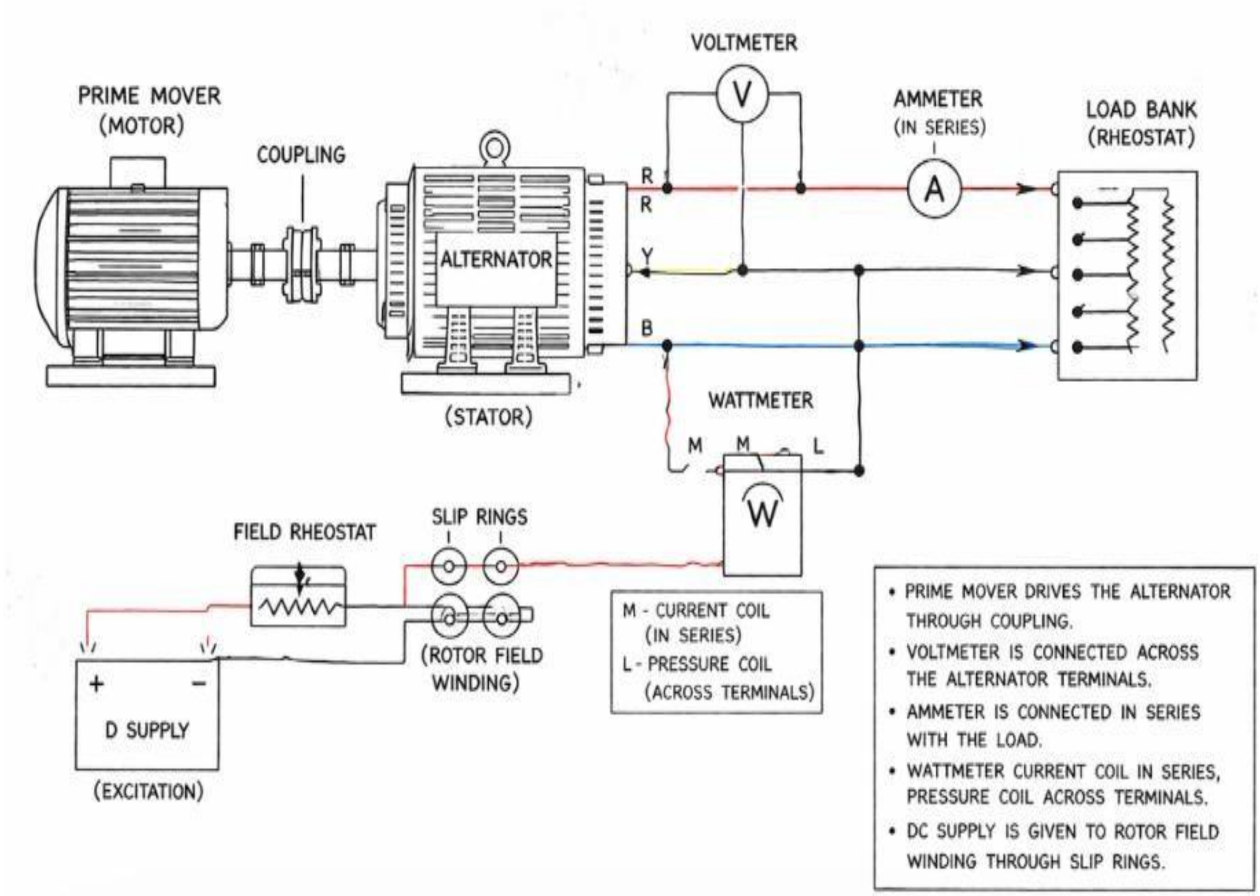
Where,
E_0 = No-load voltage

V = Full-load terminal voltage

During load test, different loads are applied and corresponding voltage, current, and power are measured. Voltage regulation depends on load and power factor.

Practical Set-up / Circuit Diagram:-

DIAGRAM : CONNECTION DIAGRAM OF ALTERNATOR WITH LOAD BANK, METERS AND DC EXCITATION



An alternator is driven by a prime mover (like DC motor). The output is connected to a load bank. Voltmeter, ammeter, and wattmeter are connected to measure electrical parameters. Field excitation is provided through a DC supply to the rotor. Load is varied step by step and readings are taken.

Apparatus Required:-

Alternator, prime mover, DC excitation supply, voltmeter, ammeter, wattmeter, load bank, tachometer, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Maintain constant speed of alternator

3. Apply load gradually
4. Do not exceed rated current
5. Record readings carefully
6. Switch OFF supply after experiment

Procedure:-

1. Connect alternator with prime mover
2. Provide DC excitation to the field winding
3. Start the prime mover and bring alternator to rated speed
4. Measure no-load voltage (E_0)
5. Apply load gradually using load bank
6. At each load, record voltage, current, and power
7. Continue up to full-load condition
8. Calculate voltage regulation using formula
9. Plot graph of Voltage vs Load
10. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Load Current (A)	Terminal Voltage (V)	Power (W)	No-load Voltage (E_0)	Voltage Regulation (%)
1					
2					
3					

Formula Used:

Voltage Regulation = $[(E_0 - V) / V] \times 100$

Result:-

The load test on the alternator was performed successfully. The voltage regulation was calculated and variation of terminal voltage with load was studied.

VIVA BOOK:-

1. What is an alternator?
2. Define voltage regulation of an alternator.
3. Why does terminal voltage change with load?
4. What is the function of field excitation?
5. What is the difference between generator and alternator?

EXPERIMENT NO:12

Aim:-

To perform open circuit and short circuit tests on a single-phase alternator and determine its characteristics.

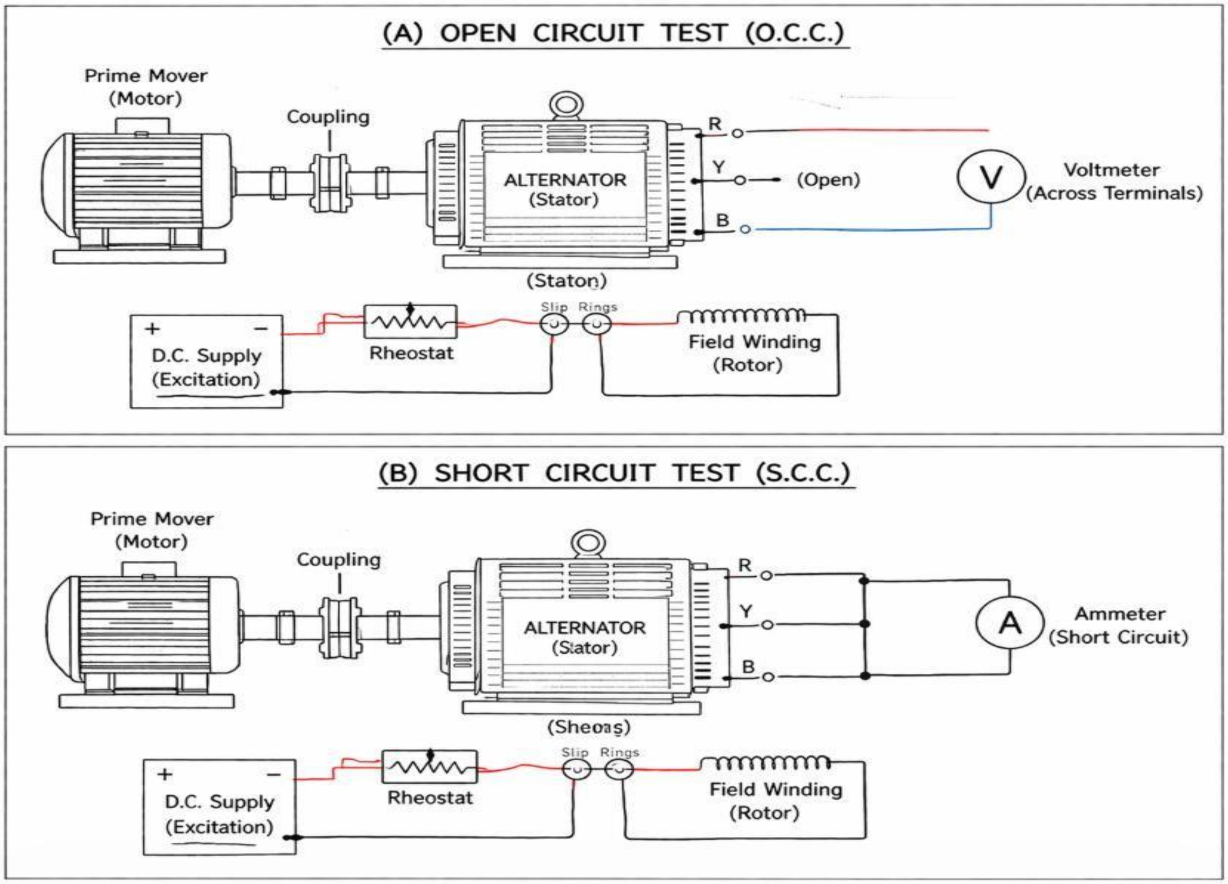
Theory:-

Open circuit and short circuit tests are conducted to determine the performance characteristics of an alternator without loading it fully.

1. Open Circuit Test (OCC):
2. In this test, the alternator is run at rated speed with no load connected. The field current is varied and the corresponding terminal voltage is measured. This gives the Open Circuit Characteristic (OCC), which shows the relationship between field current and generated voltage.
3. Short Circuit Test (SCC):
4. In this test, the alternator terminals are short-circuited through an ammeter. The field current is varied and corresponding armature current is measured. The voltage remains nearly zero due to short circuit. This gives the Short Circuit Characteristic (SCC).

These tests help in determining parameters like synchronous impedance and voltage regulation.

Practical Set-up / Circuit Diagram:-



A single-phase alternator is coupled with a prime mover. For OCC, the alternator terminals are kept open and a voltmeter is connected across terminals. For SCC, the terminals are shorted through an ammeter. A DC supply is provided to the field winding to control field current.

Apparatus Required:-

Single-phase alternator, prime mover, DC excitation supply, voltmeter, ammeter, rheostat, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Maintain constant speed during test
3. Do not exceed rated field current
4. Apply short circuit carefully

5. Record readings accurately
6. Switch OFF supply after experiment

Procedure:-

Open Circuit Test:

1. Connect alternator with prime mover
2. Keep terminals open
3. Connect voltmeter across terminals
4. Start prime mover and run at rated speed
5. Vary field current using rheostat
6. Note corresponding terminal voltage
7. Record readings

Short Circuit Test:

8. Switch OFF supply
9. Short circuit alternator terminals through ammeter
10. Start the machine again at rated speed
11. Increase field current gradually
12. Note armature current readings
13. Record observations and switch OFF supply

Observations and Calculations:-

Observation Table

Open Circuit Test:

S.No	Field Current (A)	Terminal Voltage (V)
1		
2		

Short Circuit Test:

S.No	Field Current (A)	Armature Current (A)
1		
2		

Result:-

The open circuit and short circuit tests on the single-phase alternator were performed successfully. The OCC and SCC characteristics were obtained and analyzed.

VIVA BOOK:-

1. What is an open circuit test?
2. What is a short circuit test?
3. What is OCC of an alternator?
4. What is SCC of an alternator?
5. Why are these tests performed?

EXPERIMENT NO:13

Aim:-

To synchronize an alternator with an infinite bus bar using lamp method and synchroscope method.

Theory:-

Synchronization is the process of connecting an alternator to an infinite bus bar (power system) so that it operates in parallel. For proper synchronization, the following conditions must be satisfied:

1. Equal voltage
2. Same frequency
3. Same phase sequence
4. Zero phase angle difference

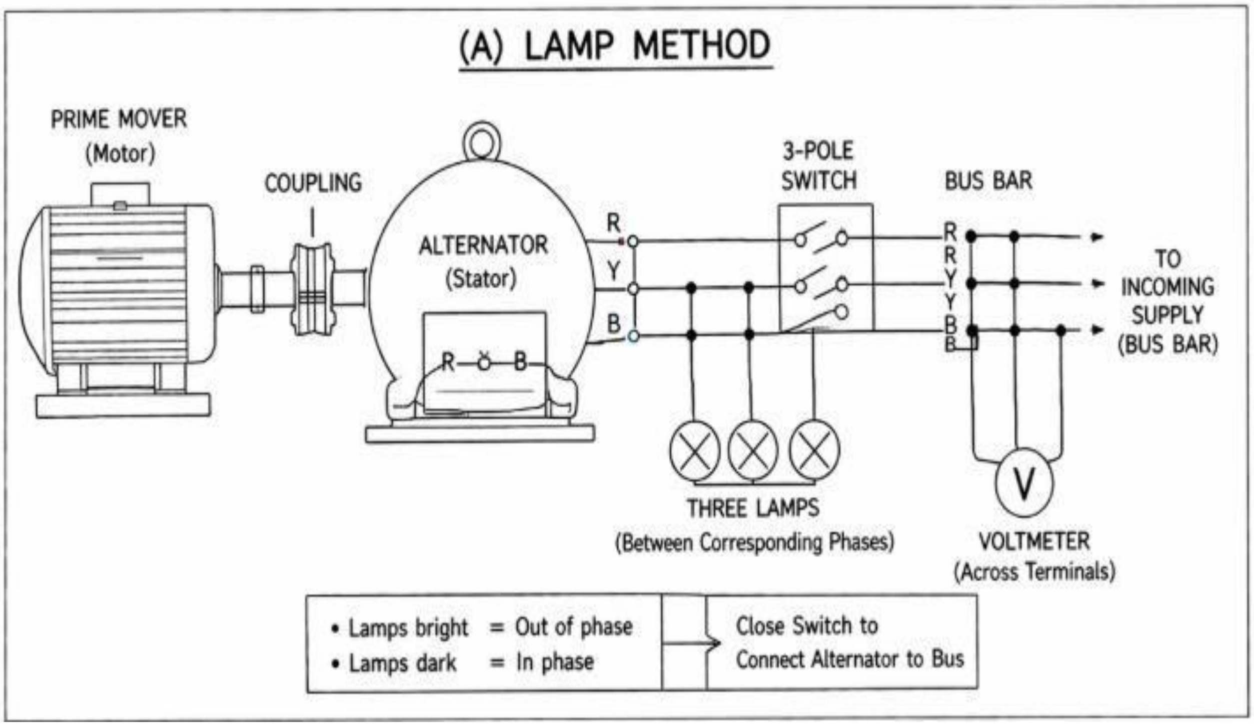
(i) Two Bright and One Dark Lamp Method:

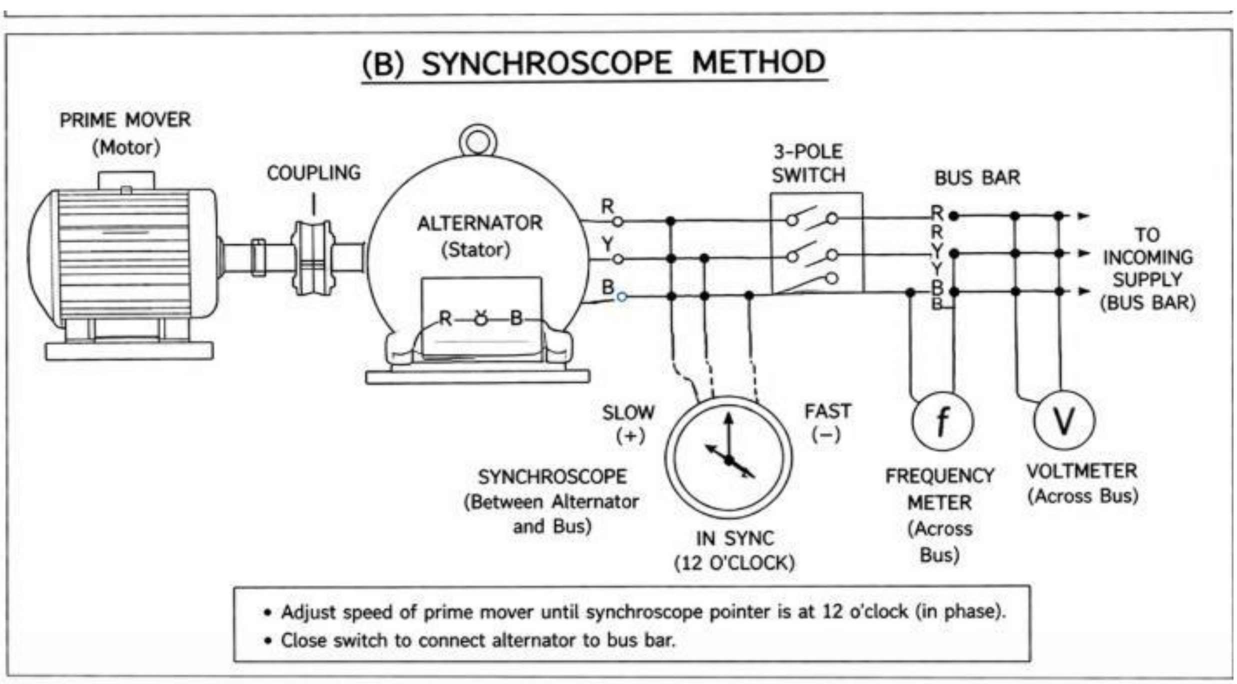
In this method, three lamps are connected between bus bar and alternator terminals. At correct synchronization, two lamps glow bright and one lamp remains dark. This indicates correct phase sequence and phase matching.

(ii) Synchroscope Method:

A synchroscope is used to indicate the phase difference and frequency difference between alternator and bus bar. The pointer rotates when there is a difference in frequency. When the pointer is at 12 o'clock position and stationary, synchronization condition is achieved.

Practical Set-up / Circuit Diagram:-





An alternator is driven by a prime mover and connected to bus bars through a switch. Three lamps are connected for lamp method. A synchroscope is also connected across phases. Measuring instruments are used to match voltage and frequency before closing the switch.

Apparatus Required:-

Alternator, prime mover, synchroscope, lamps, voltmeter, frequency meter, switchgear, connecting wires

Precautions to be Followed:-

1. Ensure correct phase sequence before synchronization
2. Match voltage and frequency properly
3. Close switch only at correct instant
4. Do not allow large phase difference
5. Handle instruments carefully
6. Maintain constant speed of alternator

Procedure:-

1. Connect alternator with bus bar through lamps
2. Start prime mover and bring alternator to rated speed
3. Adjust field current to match voltage
4. Observe lamps glowing pattern
5. When two lamps are bright and one is dark, close switch
6. Note synchronization condition

Synchroscope Method:

7. Connect synchroscope across alternator and bus bar

8. Start alternator and adjust speed

9. Observe pointer rotation

10. Adjust speed until pointer moves slowly

11. When pointer is at 12 o’clock position, close switch

12. Note synchronization condition

Observations and Calculations:-

Observation Table

S.No	Voltage (V)	Frequency (Hz)	Lamp Condition / Synchroscope Reading	Remarks
1				
2				

Result:-

The alternator was successfully synchronized with the infinite bus bar using lamp method and synchroscope method. Proper synchronization conditions were observed.

VIVA BOOK:-

1. What is synchronization of alternator?
2. What are the conditions for synchronization?
3. Explain two bright and one dark lamp method.
4. What is the function of a synchroscope?
5. What happens if synchronization is not done properly?

EXPERIMENT NO:14

Aim:-

To study the performance of a synchronous motor at different load conditions and observe the effect of variation of excitation on power factor by plotting V and inverted V curves.

Theory:-

A synchronous motor runs at constant speed (synchronous speed) regardless of load. The field excitation controls the power factor of the motor.

When field excitation is varied:

- Under excitation → motor operates at lagging power factor
- Normal excitation → unity power factor
- Over excitation → leading power factor

V-Curve:
It is the graph between armature current and field current. It is called V-curve because of its V-shape. At normal excitation, armature current is minimum.

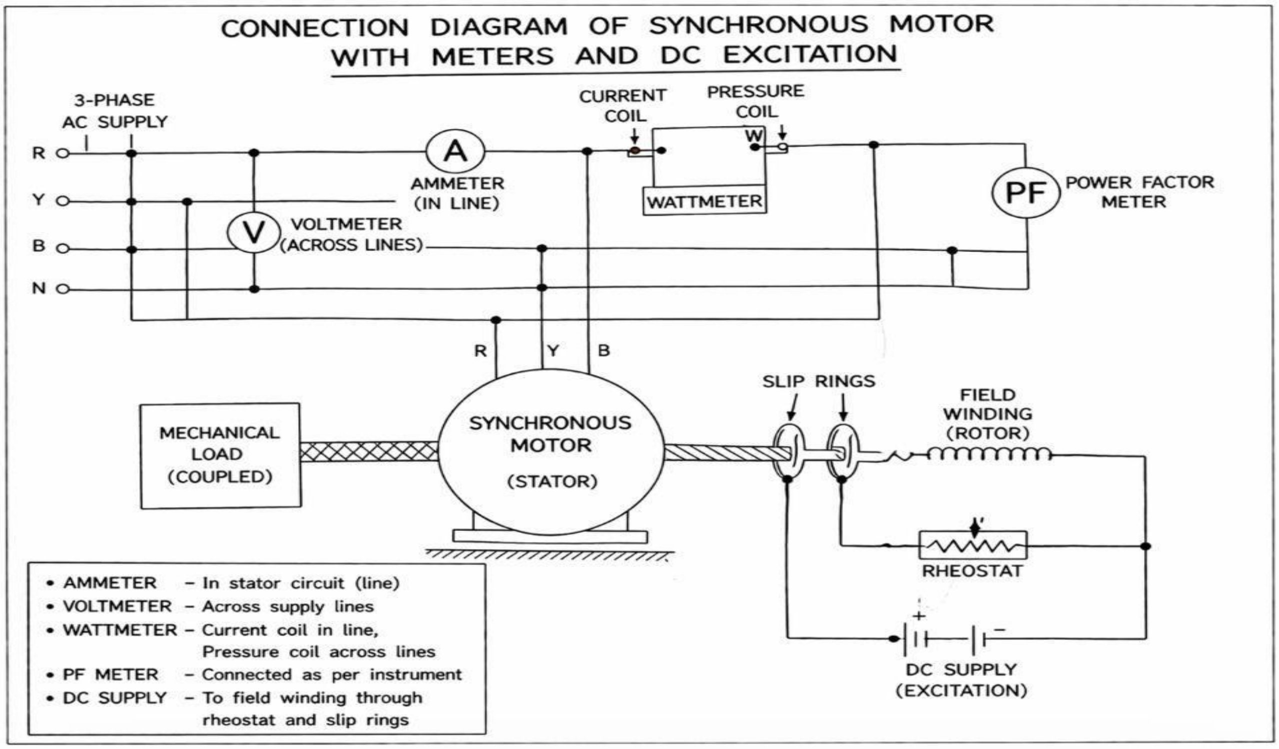
Inverted V-Curve:

It is the graph between power factor and field current. It shows how power factor varies with excitation.

Synchronous speed:

$N_s = (120 \times f) / P$

Practical Set-up / Circuit Diagram:-



A synchronous motor is connected to a 3-phase AC supply through a starter. DC excitation is provided to the rotor using a DC supply. Ammeter, voltmeter, wattmeter, and power factor meter are connected. Load is applied using a mechanical arrangement. Field current is varied using a rheostat.

Apparatus Required:-

Synchronous motor, DC excitation supply, rheostat, 3-phase AC supply, voltmeter, ammeter, wattmeter, power factor meter, load arrangement, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Do not start motor without excitation
3. Vary field current slowly
4. Do not exceed rated current
5. Keep hands away from moving parts
6. Switch OFF supply after experiment

Procedure:-

1. Connect synchronous motor to 3-phase supply
2. Provide DC excitation to rotor
3. Start the motor and bring it to synchronous speed
4. Apply a constant load
5. Vary field current gradually
6. Note armature current and power factor for each value
7. Record readings for different excitation levels
8. Plot V-curve (Armature current vs Field current)
9. Plot inverted V-curve (Power factor vs Field current)
10. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Field Current (A)	Armature Current (A)	Power Factor
1			
2			
3			

Result:-

The performance of the synchronous motor at different excitation levels was studied successfully. V and inverted V curves were plotted showing variation of armature current and power factor with field current.

VIVA BOOK:-

1. What is a synchronous motor?
2. What is V-curve of synchronous motor?

3. What is inverted V-curve?
4. What is the effect of excitation on power factor?
5. Why does synchronous motor run at constant speed?

EXPERIMENT NO:15

Aim:-

To study the working and performance of an AC servo motor under different conditions..

Theory:-

Theory

An AC servo motor is a special type of induction motor used in control systems for precise position and speed control. It generally consists of two windings: reference winding and control winding.

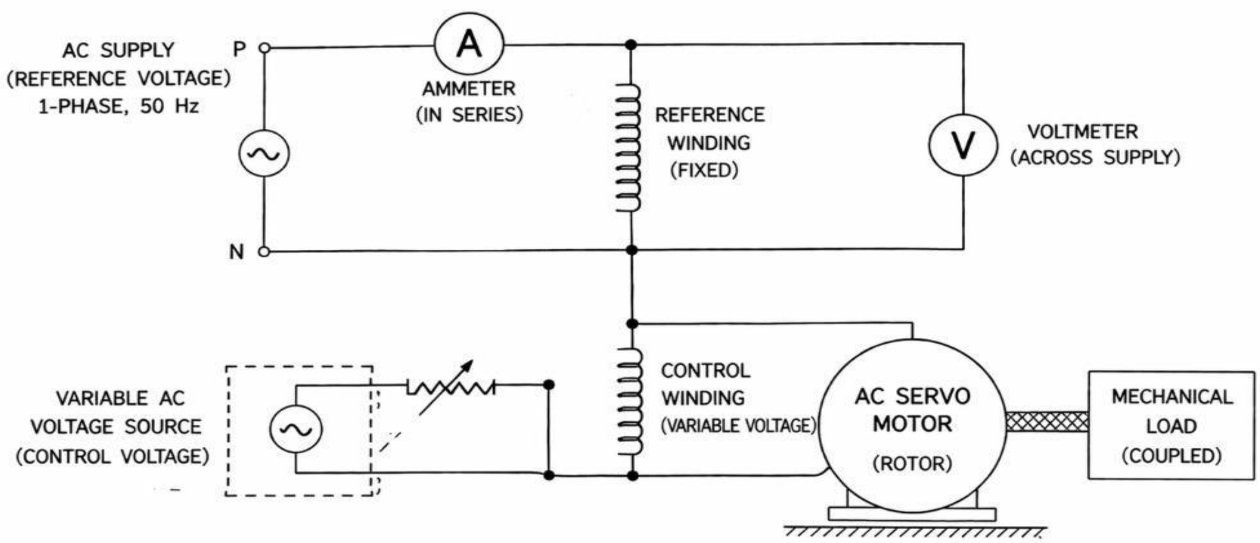
The reference winding is supplied with constant AC voltage, while the control winding is supplied with a variable voltage signal. The phase difference between these two voltages produces a rotating magnetic field, which controls the direction and speed of the motor.

The torque developed in an AC servo motor is proportional to the control voltage.

Torque $\propto$ Control Voltage

AC servo motors are widely used in robotics, automation, and feedback control systems due to their fast response and high accuracy.

Practical Set-up / Circuit Diagram:-



An AC servo motor is connected to an AC supply. The reference winding is given constant supply, and the control winding is connected through a variable control voltage source. Measuring instruments like voltmeter and ammeter are used. A mechanical load may be applied to observe performance.

Apparatus Required:-

AC servo motor, AC supply, control voltage source, voltmeter, ammeter, load arrangement, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Do not apply excessive control voltage
3. Handle motor carefully
4. Keep hands away from rotating parts
5. Record readings accurately
6. Switch OFF supply after experiment

Procedure:-

1. Connect the reference winding to AC supply
2. Connect control winding to variable voltage source
3. Check all connections properly
4. Switch ON the supply
5. Apply small control voltage
6. Observe motor rotation and direction
7. Increase control voltage gradually
8. Note speed and current at different voltages
9. Apply load if required and observe changes
10. Record all readings
11. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Control Voltage (V)	Current (A)	Speed (rpm)	Remarks
1				
2				
3				

Formula Used:

Torque ∝ Control Voltage°.

Result:-

The AC servo motor was tested successfully. It was observed that speed and torque vary with control voltage.

VIVA BOOK:-

1. What is an AC servo motor?
2. What is the function of control winding?
3. How is direction controlled in servo motor?
4. What is the relation between torque and control voltage?
5. Where are AC servo motors used?

EXPERIMENT NO:16

Aim:-

To study and demonstrate the working of a linear induction motor.

Theory:-

A linear induction motor (LIM) is a special type of induction motor that produces linear motion instead of rotational motion. It works on the same principle as a 3-phase induction motor but the stator is cut and laid flat to produce a travelling magnetic field.

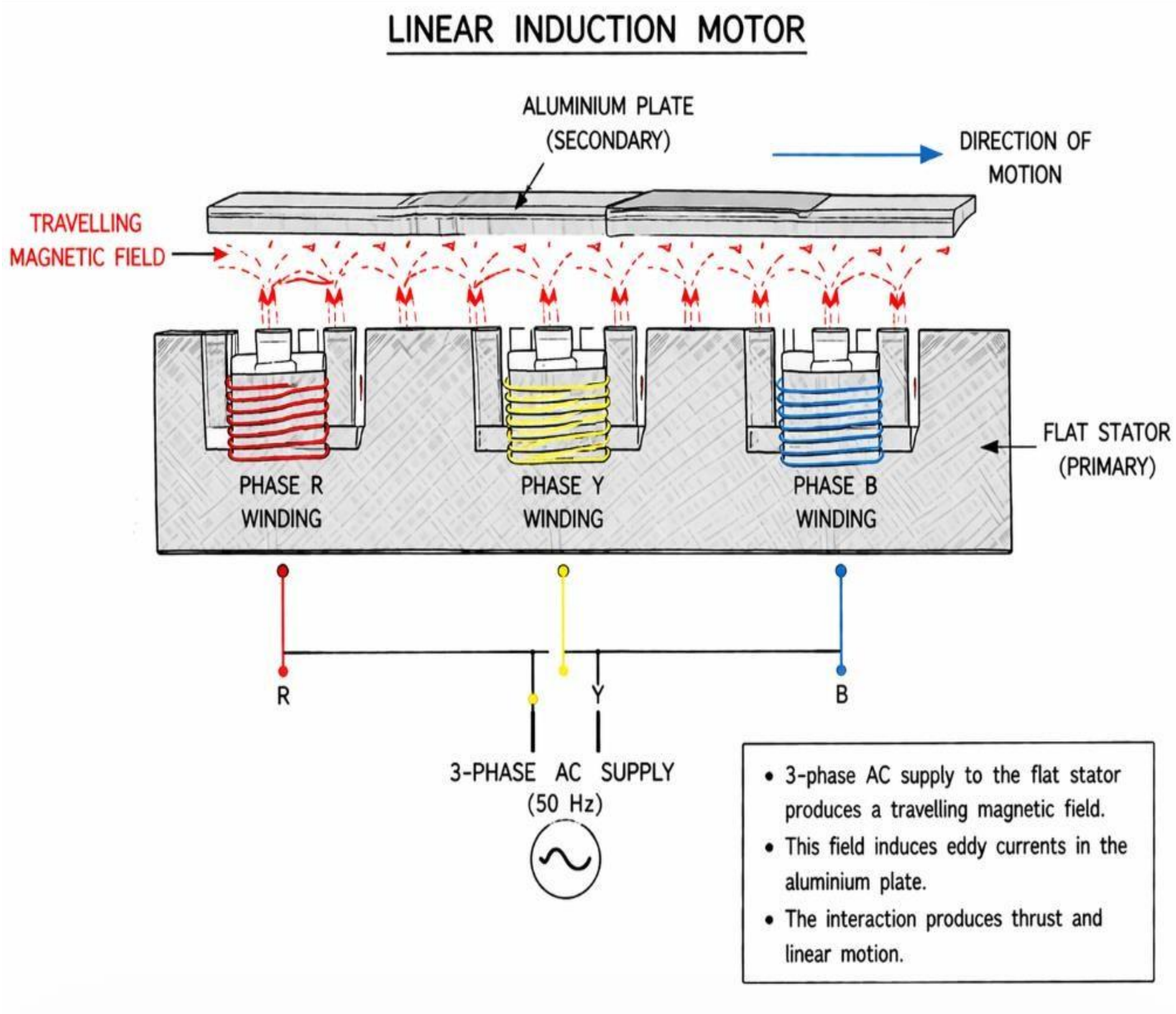
When a 3-phase AC supply is applied to the stator windings, a travelling magnetic field is produced along the length of the stator. This moving magnetic field induces current in the secondary conductor (usually an aluminium plate), which produces a force due to electromagnetic interaction.

This force moves the secondary conductor in a straight line.

Force $\propto$ Magnetic Field $\times$ Induced Current

Linear induction motors are used in applications like electric trains, conveyor systems, and automatic doors.

Practical Set-up / Circuit Diagram:-



A linear induction motor setup consists of a flat stator connected to a 3-phase AC supply. An aluminium sheet or conducting plate is placed above or below the stator. When supply is given, the plate moves linearly due to the travelling magnetic field.

Apparatus Required:-

Linear induction motor setup, aluminium plate, 3-phase AC supply, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Do not touch moving plate during operation
3. Keep the setup clean and aligned

4. Avoid overvoltage supply
5. Observe movement carefully
6. Switch OFF supply after experiment.

Procedure:-

1. Place the aluminium plate properly over the stator
2. Connect the stator to 3-phase AC supply
3. Check all connections
4. Switch ON the supply
5. Observe the movement of the plate
6. Note direction and speed of motion
7. Change supply phase sequence and observe direction change
8. Record observations
9. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Supply Voltage (V)	Observation of Motion	Direction	Remarks
1				
2				

Result:-

The working of the linear induction motor was demonstrated successfully. It was observed that the conductor moves linearly due to the travelling magnetic field.

VIVA BOOK:-

1. What is a linear induction motor?
2. What is the difference between rotary and linear induction motor?

3. What is travelling magnetic field?
4. How is force produced in LIM?
5. Where are linear induction motors used?

.

EXPERIMENT NO:17

Aim:-

To study and demonstrate the working of a stepper motor.

Theory:-

A stepper motor is a special type of motor that moves in discrete steps instead of continuous rotation. It converts electrical pulses into mechanical rotation. Each pulse rotates the motor shaft by a fixed angle called step angle.

Stepper motors work on the principle of electromagnetic attraction. When current is supplied to stator windings in a sequence, a magnetic field is produced which attracts the rotor and causes it to rotate step by step.

Step angle is given by:

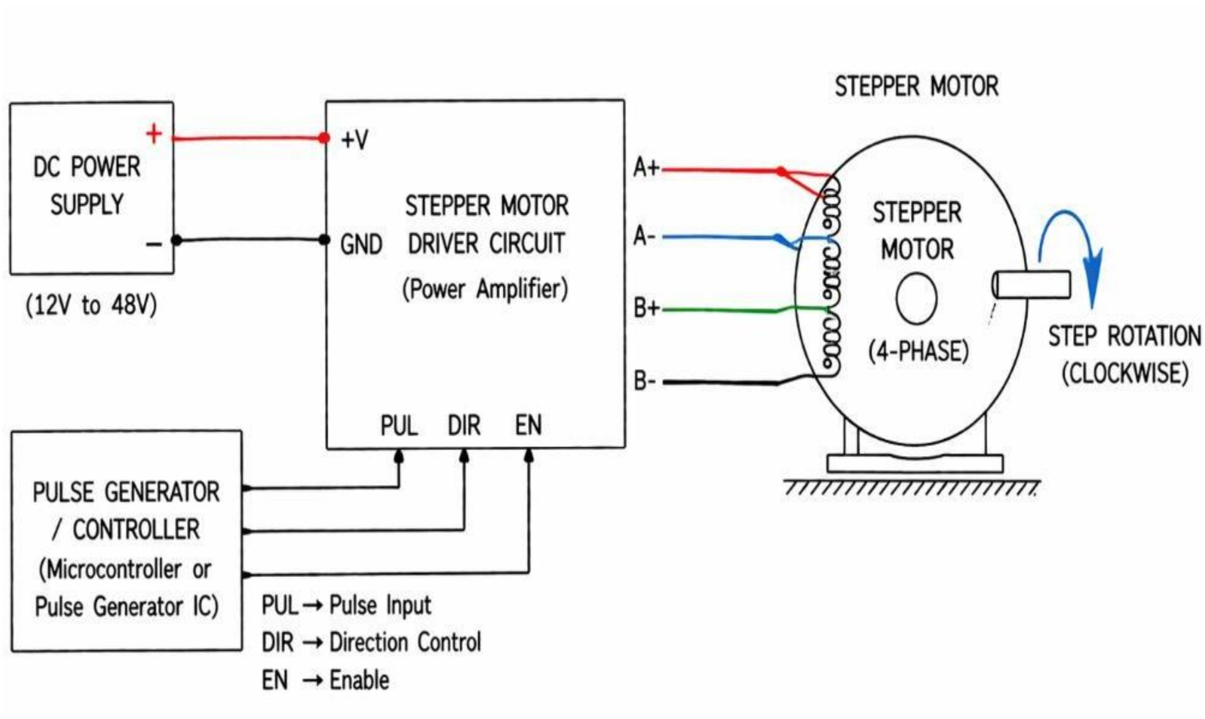
Step Angle = 360° / Number of steps per revolution

The direction of rotation depends on the sequence of excitation of windings. By changing the sequence, direction can be reversed.

Types of stepper motors include:

1. Permanent magnet type
2. Variable reluctance type
3. Hybrid type

Practical Set-up / Circuit Diagram:-



A stepper motor is connected to a driver circuit which provides controlled pulse signals. The driver is connected to a DC power supply. A controller or pulse generator is used to provide input pulses. Each pulse causes the motor to rotate by one step.

Apparatus Required:-

Stepper motor, driver circuit, DC power supply, pulse generator/controller, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Do not apply excessive voltage
3. Follow correct pulse sequence
4. Do not overload the motor
5. Handle components carefully
6. Switch OFF supply after experiment.

Procedure:-

1. Connect stepper motor to driver circuit

2. Connect driver to DC power supply
3. Connect pulse generator to driver input
4. Switch ON the supply
5. Apply pulses to the motor
6. Observe step-by-step rotation
7. Change pulse sequence to reverse direction
8. Vary pulse frequency and observe speed change
9. Record observations
10. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Pulse Input	Direction of Rotation	Step Movement	Remarks
1				
2				

Formula Used:

Step Angle = 360° / Number of steps per revolution

Result:-

The working of the stepper motor was demonstrated successfully. It was observed that the motor rotates in discrete steps according to input pulses.

VIVA BOOK:-

1. What is a stepper motor?
2. What is step angle?
3. How is direction controlled in stepper motor?
4. What is the working principle of stepper motor?
5. What are the applications of stepper motor?

EXPERIMENT NO:18

Aim:-

To study and demonstrate the working of a hysteresis motor.

Theory:-

A hysteresis motor is a type of synchronous motor that works on the principle of magnetic hysteresis. It has a smooth cylindrical rotor made of hard magnetic material with high retentivity and coercivity.

When a single-phase AC supply is given to the stator, a rotating magnetic field is produced. This rotating magnetic field magnetizes the rotor. Due to hysteresis effect, the magnetization of rotor lags behind the stator magnetic field, producing a torque.

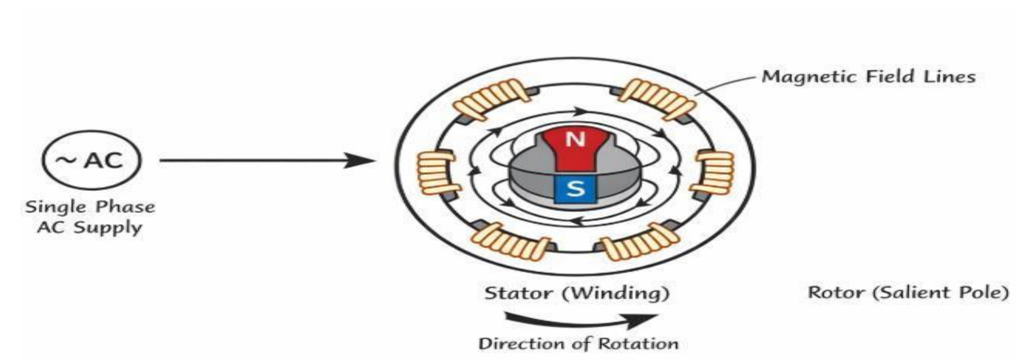
The motor starts as an induction motor and then runs at synchronous speed. Once it reaches synchronous speed, it continues to run without slip.

Hysteresis loss is given by:

Hysteresis Loss $\propto$ Area of hysteresis loop

The motor runs quietly and smoothly and is used in applications requiring constant speed.

Practical Set-up / Circuit Diagram



A hysteresis motor is connected to a single-phase AC supply. Measuring instruments like voltmeter and ammeter are connected. The motor is allowed to run without load or with light load to observe its smooth and constant speed operation.

Apparatus Required:-

Hysteresis motor, single-phase AC supply, voltmeter, ammeter, connecting wires

Precautions to be Followed:- :-

1. Ensure proper connections before switching ON
2. Do not touch moving parts
3. Avoid overvoltage supply
4. Handle motor carefully
5. Record observations properly
6. Switch OFF supply after experiment

Procedure:-

1. Connect the hysteresis motor to AC supply
2. Connect voltmeter and ammeter
3. Check all connections properly
4. Switch ON the supply
5. Observe starting of motor
6. Note that motor runs smoothly
7. Observe constant speed operation
8. Record observations
9. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S. No	Voltage (V)	Current (A)	Speed Observation	Remarks
1				
2				

Result:-

The working of the hysteresis motor was demonstrated successfully. It was observed that the motor runs smoothly at constant synchronous speed.

VIVA BOOK:-

1. What is a hysteresis motor?
2. What is the working principle of hysteresis motor?
3. What is hysteresis loss?
4. Why does hysteresis motor run at constant speed?
5. What are the applications of hysteresis motor?

EXPERIMENT NO:19

Aim:-

To study and demonstrate the working of a reluctance motor..

Theory:-

A reluctance motor is a type of synchronous motor that works on the principle of magnetic reluctance. The rotor is made of ferromagnetic material with salient poles and no windings.

When AC supply is given to the stator, a rotating magnetic field is produced. The rotor tends to align itself with the position of minimum reluctance (maximum magnetic flux path). This tendency produces torque and causes the rotor to rotate.

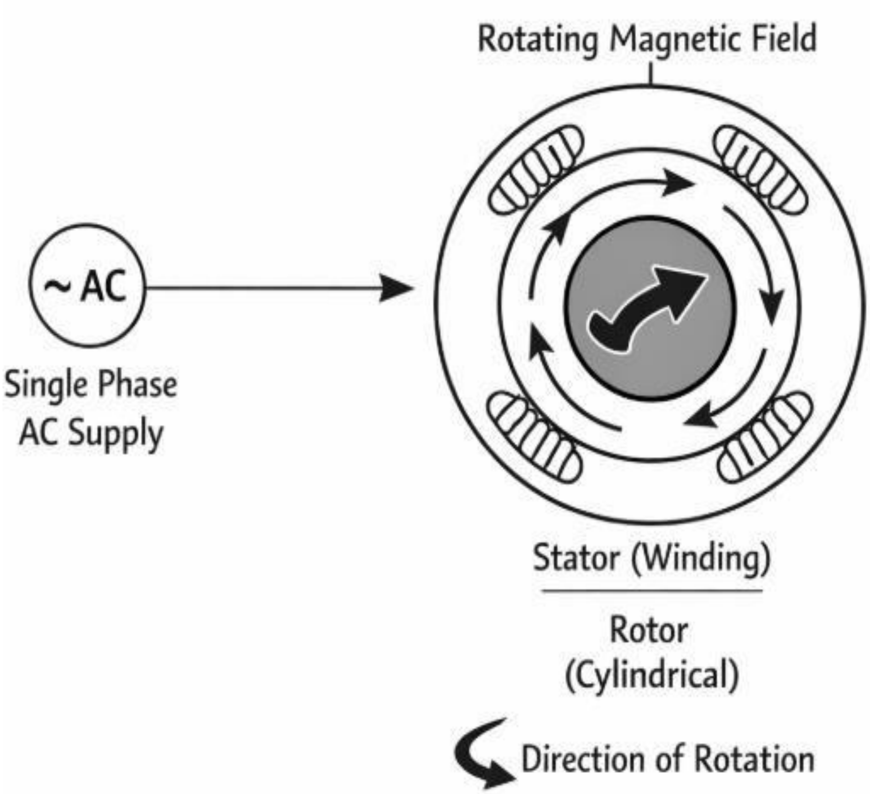
Initially, the motor starts as an induction motor and then locks into synchronous speed. Once synchronized, it runs at constant speed.

Reluctance torque is produced due to:

Torque $\propto$ (Difference in reluctance)

The motor has simple construction and is used where constant speed is required.

Practical Set-up / Circuit Diagram:-



A reluctance motor is connected to a single-phase AC supply. Measuring instruments like voltmeter and ammeter are connected. The motor is allowed to run and its starting and synchronous operation are observed.

Apparatus Required:-

Reluctance motor, single-phase AC supply, voltmeter, ammeter, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Do not touch moving parts
3. Avoid overvoltage supply

4. Handle motor carefully
5. Record observations properly
6. Switch OFF supply after experiment

Procedure:-

1. Connect the reluctance motor to AC supply
2. Connect voltmeter and ammeter
3. Check all connections properly
4. Switch ON the supply
5. Observe starting of motor
6. Note that motor accelerates and reaches synchronous speed
7. Observe steady operation
8. Record observations
9. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Voltage (V)	Current (A)	Speed Observation	Remarks
1				
2				

Result:-

The working of the reluctance motor was demonstrated successfully. It was observed that the motor runs at synchronous speed due to reluctance torque.

VIVA BOOK:-

1. What is a reluctance motor?
2. What is the principle of operation of reluctance motor?
3. What is reluctance torque?
4. Why does the motor run at synchronous speed?
5. What are the applications of reluctance motor?

EXPERIMENT NO:20

Aim:-

To study and demonstrate the working of a universal motor.

Theory:-

A universal motor is a single-phase series motor that can operate on both AC and DC supply. It works on the principle that a current-carrying conductor placed in a magnetic field experiences a force.

In this motor, the field winding and armature winding are connected in series. When current flows through both, a magnetic field is produced and torque is developed.

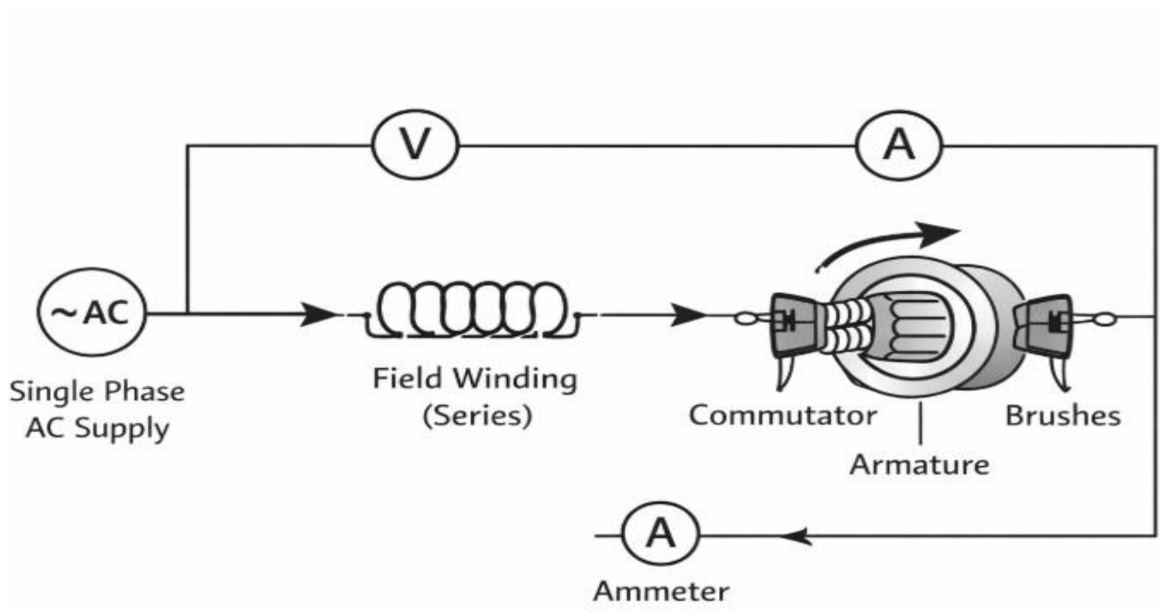
In AC supply, although current direction changes, both field and armature current reverse simultaneously, so the direction of torque remains the same.

Speed of a universal motor is very high and depends on load.

Torque $\propto I^2$

Universal motors are commonly used in appliances like fans, mixers, drills, and vacuum cleaners.

Practical Set-up / Circuit Diagram:-



A universal motor is connected to a single-phase AC supply through a switch. Measuring instruments like voltmeter and ammeter are connected. A load may be applied to observe speed variation.

Apparatus Required:-

Universal motor, single-phase AC/DC supply, voltmeter, ammeter, rheostat, connecting wires

Precautions to be Followed:-

1. Ensure proper connections before switching ON
2. Do not run motor at no-load for long time
3. Avoid overvoltage supply
4. Keep hands away from rotating parts
5. Handle motor carefully
6. Switch OFF supply after experiment

Procedure:-

1. Connect the universal motor to AC supply
2. Connect voltmeter and ammeter
3. Check all connections properly
4. Switch ON the supply
5. Observe starting and rotation
6. Note speed and current
7. Apply load and observe speed change
8. Record observations
9. Switch OFF supply after completion

Observations and Calculations:-

Observation Table

S.No	Voltage (V)	Current (A)	Speed Observation	Remarks
1				
2				

Result:-

The working of the universal motor was demonstrated successfully. It was observed that the motor operates on both AC and DC supply with high speed.

VIVA BOOK:-

1. What is a universal motor?
2. Why is it called universal motor?
3. What is the working principle of universal motor?
4. Why does torque remain unidirectional in AC supply?
5. What are the applications of universal motor?