ELECTRICAL MACHINE-II LAB

LABORATORY MANUAL

B.Tech. (Semester-Vth)

Subject Code:BEE-553

Session: 2024-25, ODD Semester

Name:	
Roll. No.:	
Group/Branch:	

DRONACHARYA GROUP OF INSTITUTIONS
DEPARTMENT OF EEE
#27 KNOWLEDGE PARK 3

GREATER NOIDA

AFFILATED TO Dr. ABDUL KALAM TECHNICAL UNIVERSITY,LUCKNOW

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Vision and Mission of the Institute

Vision:

"Dronacharya Group of Institutions, Greater Noida aims to instill core human values and facilitating competence to address global challenges by providing Quality Technical Education."

Mission:

M1: Enhancing technical expertise through innovative research and education, fostering creativity and excellence in problem-solving.

M2: Cultivating a culture of ethical innovation and user-focused design, ensuring technological progress enhances the well-being of society.

M3: Equipping individuals with the technical skills and ethical values to lead and innovate responsibly in an ever-evolving digital landscape.

Vision and Mission of the Department

Vision

To be a Centre of Excellence in Globalizing Education and Research in the field of Electrical and Electronics Engineering.

Mission

M1: To empower technocrats with state-of-art knowledge to excel as eminent electrical engineers with multi-disciplinary skills.

M2: To emphasize social values and leadership qualities to meet the industrial needs, societal problems and global challenges.

M3: To enable the technocrats to accomplish impactful research and innovations.

Program Educational Objectives (PEOs)

PEO 1. To foster strong knowledge in basic sciences and electrical engineering that enable technocrats to have successful careers.

PEO 2. Imbibed with the state of art knowledge to adapt ever transforming technical scenario.

PEO 3. Inspire engineers to provide innovative solutions to real-world challenging problems by applying electrical and electronics engineering principles.

Program Outcomes (POs)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6:The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Graduates will be capable to gain knowledge in diverse areas of electrical and electronics engineering and apply that to a successful career, entrepreneurship and higher education.

PSO2: Enhance the competence of graduates to design and analyze systems used in advanced power applications, renewable energy, electrical drives in allied technical fields.

PSO3: Graduate will use advance tools to analyze, design and develop electrical and electronic systems for feasible operation and meet the industry requirements.

University Syllabus

1) To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.
2) To perform load test on a three phase induction motor and draw Torque -speed characteristics
3) To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.
4) To study speed control of three phase induction motor by varying supply voltage and by keeping V/f ratio constant.
5) To perform open circuit and short circuit tests on a three phase alternator.
6) To determine V-curves and inverted V-curves of a three phase synchronous motor.
7) . To determine the direct axis reactance (Xd) and quadrature axis reactance (Xq) of synchronous machine.
8) To study synchronization of an alternator with the infinite bus by using: (i) dark lamp method (ii) two bright and one dark lamp method.
9) To determine speed-torque characteristics of three phase slip ring induction motor and study the effect of including resistance, or capacitance in the rotor circuit.
10) To determine speed-torque characteristics of single phase induction motor and study the effect of voltage variation.
11) To determine speed-torque characteristics of a three phase induction motor by (i) keeping v/f ratio constant (ii) increasing frequency at the rated voltage.
12) To draw O.C. and S.C. characteristics of a three phase alternator from the experimental data and determine voltage regulation at full load, and unity, 0.8 lagging and leading power factors.
13) To determine steady state performance of a three phase induction motor using equivalent circuit.
14) Load Test on Three Phase Alternator.

*The available Experiments from above list may be performed on virtual lab on following virtual lab link: http://vlab.co.in/

Course Outcomes(COs)

Upon successful completion of the course, the students will be able to:

CO 1	Perform various tests and demonstrate the various characteristics of three phase induction motor.
CO 2	Demonstrate the working of three phase synchronous machine under different operating conditions.
CO 3	Evaluate the performance of single-phase induction motor under different operating conditions.
CO 4	Develop simulation models for Electrical Machines

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	1	-	-	-	1	2	-	2
CO 2	3	2	-	-	2	-	-	-	1	2	-	2
CO 3	2	2	2	2	-	-	-	-	1	1	-	1
CO 4	2	-	2	2	2	-	-	-	1	1	-	1
CO 5	1	2	3	2	2	-	-	-	1	1	-	2
Course Correlation mapping	**2.2**	1.2	**1.4**	1.2	**1.4**	-	-	**-**	**1**	**1.4**	**-**	**1.6**

Correlation Levels: High-3, Medium-2, Low-1

CO-PSO Mapping

	PSO1	PSO2	PSO3
CO 1	2	3	1
CO 2	2	3	1
CO 3	2	3	1
CO 4	2	3	1
CO 5	2	3	1

Course Overview

The main objective of this laboratory course on Electrical machines-II is to provide the practical exposure to the student regarding construction and operation of various electrical machines like D Alternators, Synchronous motors, Induction Motors and Special Motors. Students are allowed to conduct various experiments on all the machines for the validation of performance characteristics of all the machines. From these lab courses student will gain the skill to select correct machine for a specific application. By this perspective we have introduced a Laboratory manual cum Observation for Electrical Machine-II lab. The manual uses the plan, cogent and simple language to explain the fundamental aspects of Electrical Machine-II in practical. The manual prepared very carefully with our level best. It gives all the steps in executing an experiment.

List of Experiments mapped with COs

S.No.	Name of the Experiment	Course Outcome
1	To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.	CO 1
2	To perform load test on a three phase induction motor and draw Torque -speed characteristics	CO 1
3	To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.	CO 3
4	To study speed control of three phase induction motor by varying supply voltage and by keeping V/f ratio constant	CO 1
5	To perform open circuit and short circuit tests on a three phase alternator.	CO 2
6	To determine V-curves and inverted V-curves of a three phase synchronous motor.	CO 2
7	To determine the direct axis reactance (Xd) and quadrature axis reactance (Xq) of synchronous machine.	CO 2
8	To study synchronization of an alternator with the infinite bus by using: (i) dark lamp method (ii) two bright and one dark lamp method.	CO 2
9	To determine speed-torque characteristics of three phase slip ring induction motor and study the effect of including resistance, or capacitance in the rotor circuit.	CO 1

Dos and DON'Ts

Dos

1. Without Prior permission do not enter into the Laboratory.
2. While entering into the LAB students should wear their ID cards.
3. The Students should come with proper uniform.
4. Students should sign in the LOGIN REGISTER before entering into the laboratory.
5. Students should come with observation and record note book to the laboratory.
6. Students should maintain silence inside the laboratory.
7. Circuit connections must be checked by the lab-in charge before switching the supply

DON'Ts

1. Students bringing the bags inside the laboratory.
2. Students wearing slippers/shoes insides the laboratory.
3. Students scribbling on the desk and mishandling the chairs.
4. Students using mobile phones inside the laboratory.
5. Students making noise inside the laboratory.
6. Students mishandle the devices.
7. Students write anything on the device.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hand stop rest her chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth if possible isolate the burning equipment from the other surrounding equipment.
3. Sound the fire alarm by activating the nearest alarms which is located in the hall way.
4. Call security and emergency department immediately:

Emergency :201

(Reception)Security :231(GateNo.1)

Guidelines to students for report preparation

All students are required to maintain a record of the experiments conducted by them. Guidelines for its preparation are as follows: -

1) All files must contain a title page followed by an index page. ***The files will not be signed by the faculty without an entry in the index page.***

2) Student's Name, Roll number and date of conduction of experiment must be written on all pages.

3) For each experiment, the record must contain the following

(i) Aim/Objective of the experiment
(ii) Pre-experiment work (as given by the faculty)
(iii) Lab assignment questions and their solutions
(iv) Test Cases(if applicable to the course)
(v) Results/output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.

2. Students must ensure that their lab record is regularly evaluated.

Lab Assessment Criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes are assessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment as well as internal marks in the lab course.

Grading Criteria	Exemplary (4)	Competent (3)	Needs Improvement (2)	Poor (1)
AC1: Designing experiments	The student chooses the problems to explore.	The student chooses the problems but does not set an appropriate goal for how to explore them.	The student fails to define the problem adequately.	The student does not identify the problem.
AC2: Collecting data through observation and/or experimentation	Develops a clear procedure for investigating the problem	Observations are completed with necessary theoretical calculations and proper identification of required components.	Observations are completed with necessary theoretical calculations but without proper understanding. Obtain the correct values for only a few components after calculations. Followed the given experimental procedures but obtained results with some errors.	Observations are incomplete. Lacks the appropriate knowledge of the lab procedures.
AC3: Interpreting data	Decides what data and observations are to be collected and verified	Can decide what data and observations are to be collected but lacks the knowledge to verify	Student decides what data to gather but not sufficient	Student has no knowledge of what data and observations are to be collected
AC4: Drawing conclusions	Interprets and analyses the data in order to propose viable conclusions and solutions	Incomplete analysis of data hence the quality of conclusions drawn is not up to the mark	Cannot analysethe data or observations for any kind of conclusions.	Lacks the required knowledge to propose viable conclusions and solutions
AC5: Lab record assessment	Well-organized and confident presentation of record &ability to correlate the theoretical concepts with the concerned lab results with appropriate reasons.	Presentation of record is acceptable	Presentation of record lacks clarity and organization	No efforts were exhibited

LAB EXPERIMENTS

LAB EXPERIMENT 1

No load and blocked rotor test on a 3- phase induction motor

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

Apparatus required: -

S. No.	Apparatus	Specifications	Types	Qty
1	Auto-transformer	(3-Phase,415V, 10A)	Closed	1
2	Voltmeter	(0-500V)	MI	1
3	Ammeter	(0-10A)	MI	1
4	Wattmeter	(5/10A,300/600V)	Dynamo	1
5	Connecting wire		Stranded	L.S.

Equipment required:-

Induction Motor- (5HP, 415V, 8A, 1410 r.p.m., 50Hz, 3-Phase, Star connected.)

Theory: -

No-load test- this test is similar to the open circuit test on a transformer. The motor is uncoupled from its load and rated voltage at the rated frequency is applied to the stator to run the motor without load. The input power is measured by the two wattmeter method. An ammeter and a voltmeter are connected as shown in figure. The ammeter is measure the no-load current and voltmeter is gives the normal rated supply voltage. Since the no-load current is 20-30% of the full load current, the I^2R losses in the primary may be neglected as they vary with square of the current. Since the motor is running at no-load, total input power equal to constant iron loss, friction and windage losses of the motor.

P_i = P1- P_2 (P_1 and P_2 reading of the two wattmeter)

One wattmeter will show negative reading. It is therefore, necessary to reverse the direction of the current coil or pressure coil terminal of the wattmeter.

If, V_L = Input line voltage.

P_i = Total input power at no-load.

I_0 = Input line current at no-load.

V_P = Input per phase voltage.

R_0 = Per phase resistance.

X_0 = per phase leakage reactance.

Z_0= Per phase impedance.

$$P_i = \sqrt{3V_L} I_0 Cos\phi \therefore Cos\phi = \frac{P_I}{\sqrt{3V_L I_0}}$$

$$I_w = I_0 Cos\phi \ R_0 = \frac{V_P}{I_W}$$

$$I_\mu = I_0 \sin\phi \ X_0 = \frac{V_P}{I_\mu} \ Z_0 = \sqrt{(R^2{}_0 + X^2{}_0)}$$

***Blocked rotor test:* -** This test is analogs to the short circuit test of a transformer. In this test, the shaft of the motor is blocked so that it cannot move and rotor winding is short-circuited. In a slip rings and in cage motor, the rotor bars is permanently short-circuited. This test is also called the blocked rotor test. The circuit diagram for blocked rotor test is shown in figure.

A reduced voltage is supplied to the stator through a 3- phase autotransformer so that full load rated current flows in the stator winding and notes the readings of all connected meters.

If, P_{SC} = Total input power on short circuited or blocked rotor test.

I_{SC} = Line current.

V_{SC} = Line voltage.

P_{SCP} = Per phase power on blocked rotor test.

V_{SCP} = Per phase voltage on blocked rotor test.

I_{SCP} = Per phase current on blocked rotor test.

$$P_{SC} = \sqrt{3} V_{SC} I_{SC} Cos\phi$$

Equivalent resistance of the motor per phase referred to stator,

$$P_{SCP} = 3I^2{}_{SCP} \times R_{e1}$$

$$R_{e1} = \frac{P_{SCP}}{3I^2_{SCP}}$$

Equivalent impedance of the motor per phase referred to stator,

$$Z_{e1} = \frac{V_{SCP}}{I_{SCP}}$$

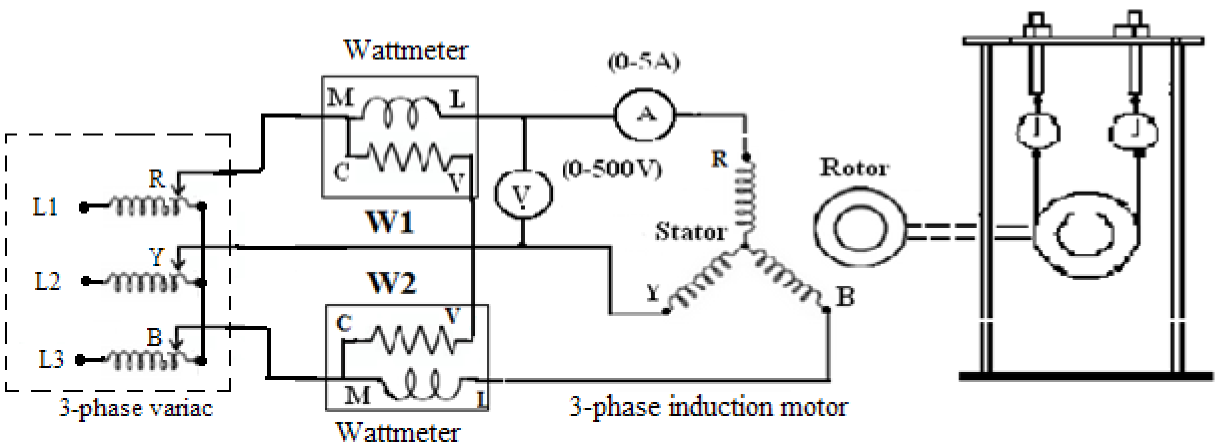
Equivalent leakage reactance of the motor per phase referred to stator,

$$X_{e1} = \sqrt{(Z^2_{e1} - R^2_{e1})}$$

$$\% \, Efficiency = \frac{Motor\ output\ power\ (p)}{Motor\ output\ power\ (p) + Losses} * 100$$

Multiplying factor of wattmeter = (V.I.cos ϕ) / Full scale deflections of wattmeter

Circuit diagram: -



Procedure: -

No-load test-

1. Make the connection as per circuit diagram shown.
2. Motor should be free from the mechanical load.
3. Applied rated voltage through 3- phase auto transformer to the motor.
4. Record all the readings of connected meters.

Blocked rotor test-

1. Make the connection as per circuit diagram shown.
2. Blocked the rotor mechanically.

3. Applied the supply voltage through 3-phase autotransformer of which full load current flows in the motor.
4. Record all the readings of connected meters.

Observation table: -Motor output= - - - - - - .

Full load current= - - - - - .

S.No.	No-load test			Blocked rotor test			Efficiency (%)
	V_L	**I_0**	**$P_i=W_1-W_2$**	**I_{SC}**	**V_{Sc}**	**$P_C=W_1+W_2$**	
1.	415V	3.6A	240W	8A	120V	800W	

Result: -R_0= - - - - Ω. R_{e1}= - - - - - Ω.

X_0= - - - - - Ω. X_{e1} = - - - - Ω.

Z_0 = - - - - Ω. Z_{e1} = - - - - - Ω.

% Efficiency = - - - - - .

Precautions: -

1) All connection should be perfectly tight and no-loose wire should lie on the work table.
2) Do not switch on the supply until and unless the connection is checked by the teacher.
3) Avoid error due to parallax while reading the meters.
4) Ensure that the winding currents do not exceed their rated values.

Viva Questions:

1. Explain why the locus of the induction motor current is a circle.
2. What is the difference between the transformer equivalent circuit and induction motor equivalent circuit?
3. What are the reasons in conducting no-load test with rated voltage and blocked rotor test with rated current?
4. Why do you choose LPF wattmeter in load test and hpf wattmeter in blocked rotor test?
5. How do you reverse the direction of rotation of induction motor?
6. What are the various applications of this motor?

LAB EXPERIMENT 2

Load test on a 3-phase induction motor

Object: -To performed load test on a 3-phase induction motor and draw speed-torque characteristics.

Apparatus required: -

S.No.	Apparatus	Specifications	Types	Quantity
1.	Ammeter	(0-10A)	MI	1
2.	Voltmeter	(0-500V)	MI	1
3.	Tachometer		Digital	1
4.	Connecting wire			L.S

Equipment required:-

3Φ-Induction Motor - **(**2KW/3Hp, 4.5A, 415V, 50Hz, 1410 r.p.m)

Theory: -First of all start the motor with the help of direct on line starter at full speed. The torque developed by motor at no load is-

$$T = \frac{KR_2 / SE^2{}_2}{(R_2/S)^2 + (X_2)^2} = \frac{KSR_2E^2{}_2}{(R^2{}_2 + S^2X^2{}_2)}$$

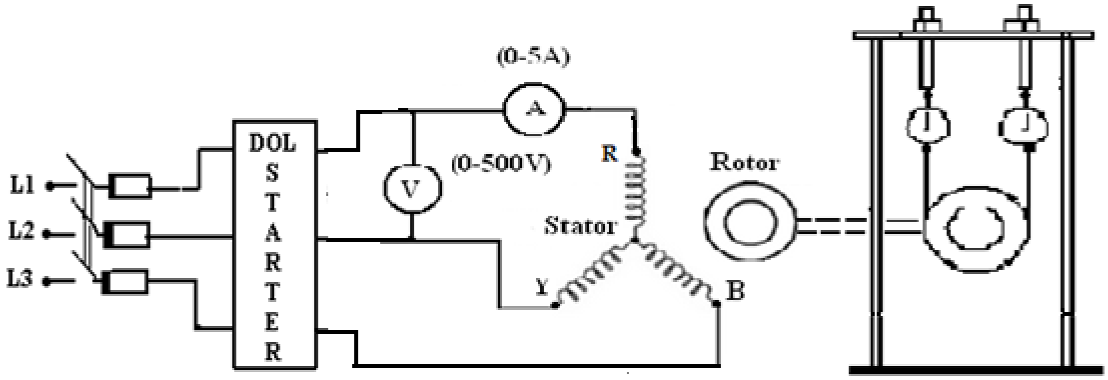
When the slip is zero i.e. s=0, the speed is synchronous speed, torque T is zero. When the slip is very low i.e. the speed is very near to synchronous speed, the torque is very small. Hence for low values of slip, the torque-speed curve is approximately straight line. When the slip increase, i.e. the speed decreases with increase in load, the torque increase and becomes maximum when $s=R_2/X_2$.

This maximum torque is called pull out or breakdown-torque. When slip is further increased i.e. the motor speed is further decreased with increases in motor load, the torque decreases. It gives the torque-speed characteristics as rectangular hyperbola. It will be seen that beyond the point of maximum torque, any further increases in motor load result in decrease of torque developed by the motor, resulting is slowing down and eventually stopping down the motor. The torque-speed curve show as under-but from circuit diagram we can measure the torque as-

$$T = (W_1 - W_2) \times r \times 9.81 N.meter$$

Where, W_1, W_2 are the reading of spring balance in Kg and r is the radius of the pulley in meter.

Circuit diagram: -



3-phase induction motor

Procedure:-

1. Connect circuit as shown in the figure.
2. Now switch on 3-phase supply and start the motor with D.O.L starter at full speed when load is not applied on motor.
3. Now apply the load gradually on motor and note down the speed and weight of the spring balance correspondingly.
4. Then remove the load on motor and switch off the supply.
5. Draw the torque-speed curve.

Observation table: - Radius off pulley(r) = - -0.08 meter - - - - - - (In meter)

S.No.	Volt (V)	Amp (A)	W_1 (Kg)	W_2 (Kg)	Speed (N)	Torque (T) Meter
1.	415V	3.8A	0.0kg	0.0kg	1446 rpm	0
2.	415V	4.0A	9.0kg	3.2kg	1440 rpm	4.55 N.meter

Result: -

Precautions: -

1) All connection should be perfectly tight and no-loose wire should lie on the work table.
2) Do not switch on the supply until and unless the connection is checked by the teacher.
3) Avoid error due to parallax while reading the meters.
4) Ensure that the winding currents do not exceed their rated values.

Viva Questions:

1. Why load test on induction motor is done?
2. What happens to the value of slip when the load is increased?
3. What are the applications of induction motor?
4. Comment on the Speed – Torque characteristics of a induction motor.
5. How does the torque vary with the armature current in a induction motor?

LAB EXPERIMENT 3

No-Load and blocked rotor test on a 1-phase induction motor

Object: -To performed No-Load and blocked rotor test on a 1-phase induction motor and determine equivalent circuit.

***Apparatus required*: -**

S.No.	Apparatus	Specifications	Types	Quantity
1	1- Phase variac	(10Amp, 0-270Volts)	Closed	1
2	Volt meter	(0 -300V)	MI	1
3	Wattmeter dynemtype	(5/10A, 75/150/300V)	Dynamo	1
4	Ammeter	(0 – 5A)	MI	1
5	Flexible wire		Stranded	L.S

Equipment required:-

Capacitor start1-phase induction motor-(1-HP, 230V, 4.5A, 1410 rpm, 50Hz)

Theory: -

1. Blocked rotor test: -This test is analogous to the short circuit test of a 1-phase transformer. In this test the rotor of the motor is blocked. So that it can not move and rotor winding is short circuited. A low voltage is supply to the stator through 1- phase variac so that rated current flow in the stator winding. The input voltage, current, powers are measured by all the connected meters.

R_{1m} = Resistance of the main stator winding.

X_{1m} = Leakage reactance of the main stator winding.

X_m = Magnetizing reactance.

R_2' = Standstill rotor resistance referred to the main stator winding.

X_2' = Standstill rotor leakage reactance referred to the main stator winding.

V_m = Applied voltage.

I_m = Main winding current.

Equivalent impedance (Ze) = $\frac{V_{sc}}{I_{sc}}$

Equivalent resistance (Re) = $\frac{P_{sc}}{I^2_{sc}}$

Equivalent reactance (Xe) = $\sqrt{Z_e^2 - R_e^2}$

$X_{1m} = X_2' = \frac{X_e}{2}$ $R_2' = Re - R_{1m}$

NO-LOAD TEST: - This test similar to the open circuit test on a transformer. The motor is uncoupled from its load and rated voltage and the rated frequency is applied to the stator to run the motor without load. The voltage, current and power measured by the wattmeter, voltmeter and ammeter are connected as shown in fig. Since the no load current is 20 % to 30 % of the full load current, the I^2R losses in the primary may be neglected as they vary with the square of the current. Since the motor is running at no-load, total input power is equal to constant iron and friction losses of the motor. During No-load winding losses are negligible.

P_0 = Input power.

V_0 = Applied power.

I_0 = Input current or stator winding current.

No-load power factor: -

So $\cos\phi_0 = \frac{P_o}{V_o I_o}$ $(\because P_0 = V_0 I_0 \cos\phi)$

$\therefore$ $\sin\phi_0$ = - - - ?

No-load equivalent impedance (Zo) = $\frac{V_0}{I_0}$

No-load equivalent reactance (Xo) = Zo $\sin\phi_0$

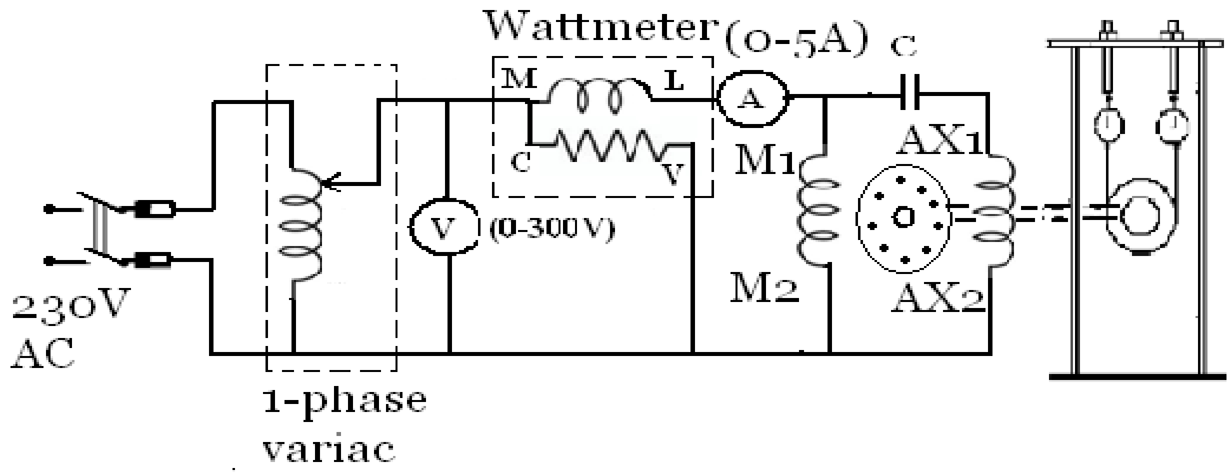
Or $= Zo\sqrt{1 - Cos^2\phi_0}$

Core, friction and windage losses: -

= Power input to motor at No-load – No-load copper loss.

$= Po - I^2o\left(R_{1m} + \frac{R_2'}{4}\right)$

<u>Circuit diagram: -</u>



Procedure: -

Blocked rotor test:

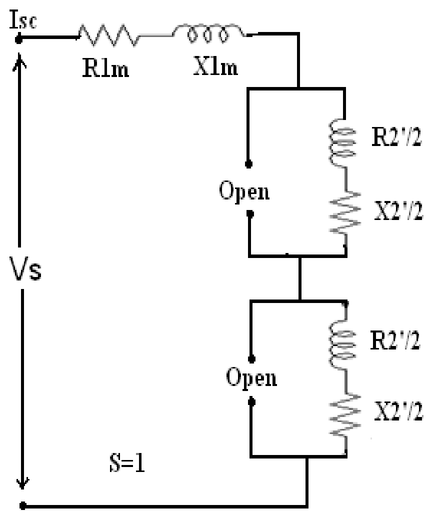
1. Make the connection as per circuit diagram.
2. Blocked the rotor mechanically.
3. Set the variac at zero conditions and start the motor, then gradually increase the Voltage from variac which full load current flow in the motor.
4. Record the reading of all the meters.

No-load test:

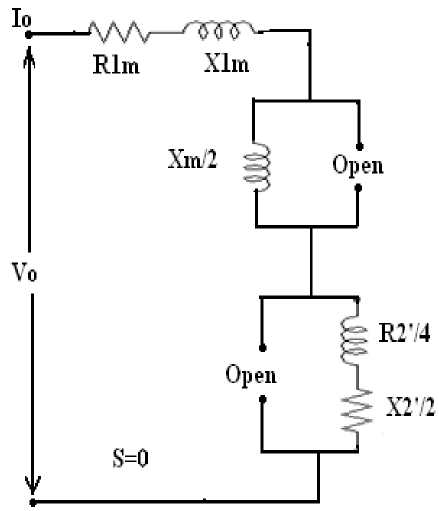
1. Make the connection as per circuit diagram.
2. Motor should be free from the mechanical load.
3. Applied the rated voltage by 1-phase variac.
4. Record the all readings of connected meters.
5. Switch of the motor supply.

Observation table: -

S.No.	No-load test			Blocked rotor test		
	Vo(Volt)	Io(Current)	Po(Watt)	Isc(Current)	Vsc(Volt)	Psc(Watt)
1.	210V	3.75A	188W	4.0A	58V	184W



Equivalent circuit at blocked rotor



Equivalent circuit at no load

Result: -Thus the No-load and blocked rotor test on the 1-phase induction motor has been conducted and the equivalent circuit has been drawn.

Precautions: -

1) All connection should be perfectly tight and no-loose wire should lie on the work table.
2) Do not switch on the supply until and unless the connection is checked by the teacher.
3) Avoid error due to parallax while reading the meters.
4) Ensure that the winding currents do not exceed their rated values.

Viva Questions:

1. What is the difference between the transformer equivalent circuit and induction motor equivalent circuit?
2. What are the reasons in conducting no-load test with rated voltage and blocked rotor test with rated current?
3. Why do you choose LPF wattmeter in load test and hpf wattmeter in blocked rotor test?
4. How do you reverse the direction of rotation of induction motor?
5. What are the various applications of this motor?

LAB EXPERIMENT4

Speed control of 3- phase induction motor

Object: -To study speed control of 3- phase induction motor by keeping **V/F** ratio constant.

Apparatus required**: -**

S.No.	Apparatus	Specifications	Types	Quantity
1.	Voltmeter	(0-500V)	MI	1
2.	Ammeter	(0-5A)	MI	1
3.	Voltmeter	(0-300V)	MC	2
4.	Ammeter	(0-1/2A)	MC	1
5.	Tachometer		Digital	1

Equipment required: -

(1.) M.G. Set: -

1.Motor – DC motor (3 KW, 230V, 10 Amp, 1500 RPM, Shunt wound).

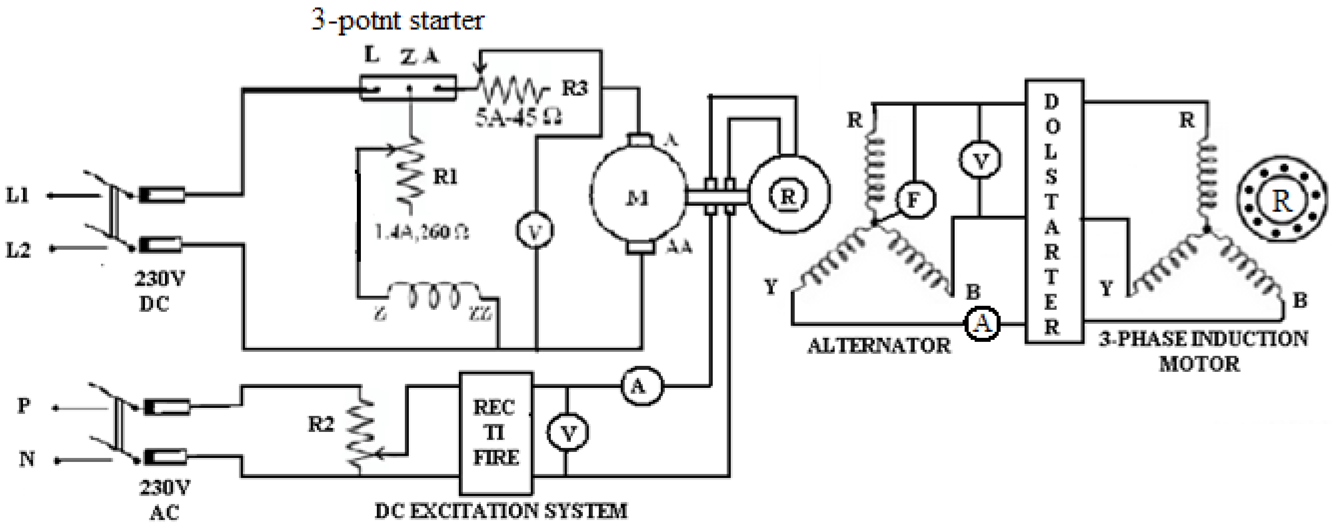
2. AC generator – (2 KVA, 3-phase, 415V, 50Hz, 1500RPM, 2.8Amp, 0.8PF, DC Volt-140, DC current 0.85Amp).

(2.) Induction motor: - (3-Phase, 415V, 50Hz, 1500RPM, 3.6Amp)

Theory: -

Synchronous speed of an induction motor is Ns = 120f / P the speed of the motor can be controlled by varying the supply frequency. The e.m.f. induced in the stator of the induction motor, $E_1 = 4.44kw_1f\phi T_1$. Therefore, if the supply frequency is changed E_1 will be also change to maintain the same air gap flux. If the stator voltage is neglected the terminal voltage equal to E_1. In order to avoid saturation and to minimize losses, motor is operated at rated air gape flux by varying terminal voltage with frequency so as to maintain (V /F) ratio constantans the rated value. This type of control is known as constant volts per hertz. In this method the variable frequencysupply is obtained by M-G Set prime mover.

Circuit diagram: -



Procedure: -

1. Make circuit as per circuit diagram.
2. Connect 1- phase AC power supply for gating variable DC output for excitation.
3. Adjust the position of rheostat R_1 for maximum. Possible current in the field circuit of DC motor to insure low starting speed.
4. Set the position of variac R_3 at zero position.
5. Start the DC motor using starter and set the speed of motor approximately at 1500 rpm (For 4-pole synchronous gen.) by rheostat R_1.
6. Now switch on the field current of alternator and gradually increase the variac to obtain rated voltage.
7. Switch on the D.O.L. starter of induction motor.
8. Then gradually increase the rheostat R_3 and note down the speed of induction motor and all connected meters.
9. Switch OFF the field excitation, thenOFF the DC motor DPIC switch.

Observation table: -

S.No.	Voltage (V)	Frequency(F)	Speed (N)	V/F (Constant ratio)
1.	400V	50Hz	1496 rpm	

Result: -

Precautions: -

1) All connection should be perfectly tight and no-loose wire should lie on the work table.
2) Do not switch on the supply until and unless the connection is checked by the teacher.
3) Avoid error due to parallax while reading the meters.

Viva Questions:

1. What are the various methods of speed control of 3-phase induction motor?
2. What is the purpose of speed control of 3-phase induction motor?
3. In which method of speed control above the base speed can be achieved, why?
4. Why speed control is required in 3-phase induction motor?

LAB EXPERIMENT 5

Open circuit and short circuit test on a 3- phase alternator.

Object: - To perform open circuit and short circuit test on a 3-phase synchronous machine and Determine voltage regulation at full load and unity, 0.8 lagging and 0.8 leading power factor using synchronous impedance method.

Apparatus required: -

S. No.	Apparatus	Specifications	Types	Qty.
1	Ammeter	(0-5A)	MI	1
2	Ammeter	(0-1/2A)	MC	1
3	Voltmeter	(0-300/600V)	MI	1
4	Voltmeter	(0-300V)	MC	1
5	Rheostat	1.4A, 260Ω	Wire wound(Tublar)	1
6	Tachometer		Digital	1

Equipment required: -

Alternator- (2 KVA, 3-Φ, 415V, 2.8A, 50Hz, 1500 RPM)

DC shunt motor- (3HP, 230V, 10A, 1500 RPM)

Theory: -To find out the regulation of alternator by synchronous impedance method, following characteristics and data has to be obtained experimentally.

1. Open - circuit test characteristics at synchronous speed.
2. Short – circuit test characteristics at synchronous speed.
3. AC resistance of the stator winding per phase i.e.R_a.

To find out the synchronous impedance from these characteristics open-circuit voltage E_a and short-circuit current I_a (Full load current) corresponding to a particular value of field current obtained.

Then synchronous impedance per-phase is given by -

Synchronous impedance $(Z_S) = \frac{E_a}{I_a}$

Then synchronous reactance $(X_S) = \sqrt{(Z^2 - R^2)}$

Phasor diagram of the alternator supplying the full load current of I_a lagging the terminal voltage by the angle Φ.

The open circuit voltage E_g of the alternator is given by, $E_g = V + I_a R_a = I_a X_s$

The diagram has been draw with the current as the reference phasor and is self explanatory. The open circuit voltage as finally obtained from the phasor diagram, corresponding to this loading condition is e_g volt. Then the regulation of the alternator under the above loading condition is given by-

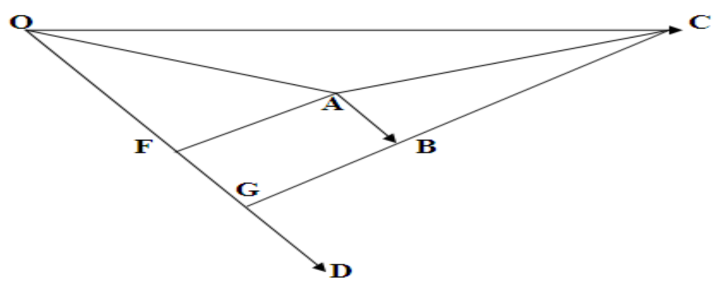
$$\text{Re}\,gulation(R) = \frac{E_g - V}{V} \times 100\,\%$$

An approximate for the open circuit voltage can be established referring to the phasor diagram.

Open-circuit voltage, $E = \sqrt{(OG)^2 + (GC)^2}$

$$= \sqrt{[(OF + FG)^2 + (GB + BC)^2]}$$

$= \sqrt{[(VCos\phi + I_a R_a)^2 + (VSin\phi + I_a X_s)^2]}$ (For lagging power factor load)

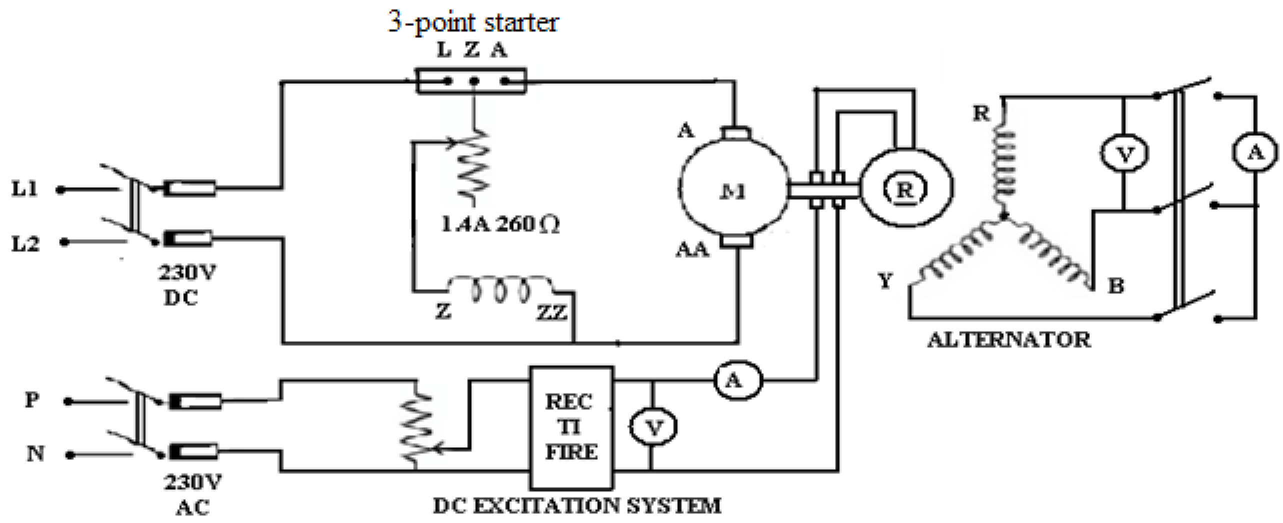


The above expression is for lagging power load. In case alternator is operating at leading power factor open circuit voltage E can be sine out in a singularly given by,

$E = \sqrt{[(VCos\phi + I_a R_a)^2 + (VSin\phi - I_a X_S)^2]}$ (For leading power factor load)

The values of the regulation obtained by this method are higher then obtain from as actual load test as such is called the pessimistic method.

Circuit diagram: -



<u>Procedure:-</u>

Open circuit test-

1. Connect the circuit as per circuit diagram of O.C. test.
2. Set the position of rheostat for minimum current and in the field current of alternator.
3. Switch on the supply and start the DC motor with help of starter and set the speed 1500 rpm by rheostat.
4. Switch on the field current and gradually increase current.
5. Note down the open-circuit voltage and field current.

Short-circuit test –

1. Connect the circuit as per circuit diagram of S.C. test.
2. Set the position of rheostat for minimum current and in the field current of alternator.
3. Switch on the supply and start the DC motor with help of starter and set the speed 1500 rpm by rheostat.
4. Switch on the field current and gradually increase field current to the full load current.
5. Note down the short-circuit voltage and field current.
6. Measure the DC resistance of stator winding.

Observation table: -

S.No.	Open-circuit test		Short-circuit test	
	Terminal voltage Per phase (Vo)	Field current I_f (Amp)	Short circuit current (Isc)	Field current I_f (Amp)
1.	160V	0.1A	0.5A	0.04A
2.	254V	0.2A	1.75A	0.16A

Graph: - Plot the readings to draw following graphs. Use same graph paper for both curves. 1. I_f versus Vo (from OC test) 2. I_f versus Isc (from SC test)

Result: -Regulation of alternator at full load is found to be,

At unity PF = --------------

At 0.8 lagging = ---------------

At 0.8 leading = --------------

Synchronous Impedance varies for different values of excitation

Precautions: -

1) All connection should be perfectly tight and no-loose wire should lie on the work table.
2) Do not switch on the supply until and unless the connection is checked by the teacher.
3) Avoid error due to parallax while reading the meters.
4) Ensure that the winding currents do not exceed their rated values.

Viva Questions:

1. What losses do we get from OC & SC Test?
2. How the losses are measured?
3. How voltage regulations can be obtained from these test?

LAB EXPERIMENT 6

V-curve and inverted V-curve

***Object:* -** To obtain the V-curve and inverted V-curve of a 3-phase synchronous motor.

***Apparatus required:* -**

S. No.	Apparatus	Specifications	Types	Qty.
1.	Voltmeter	(0-500v)	MI	1
2.	Ammeter	(0-5A)	MI	1
3.	Voltmeter	(0-300V)	MC	2
4.	Ammeter	(0-5A)	MC	1
5.	Ammeter	(0-1A)	MC	1

***Equipment required:* -**

(1)D.C.shunt generator (for loading) 1.5KW/2HP 230V, 1500rpm.

(2)Synchronous motor (3H.P, Salient pole, 1500 r.p.m. 50 Hz, 415V, star connected, class-B insulation)

(3)D.C. shunt generator (for excitation) separately, Type- static type through rectifier with controlling arrangement.

***Theory:* -**

With constant mechanical load on the synchronous motor the variation of field current change the armature current drawn by the motor and also its operating power factor. As such the behavior of the synchronous motor is described bellow under three different modes at field current.

(1) Normal excitation: -

The armature current is minimum at a particular value of field current (If) which is called the normal field excitation. The operation power factor is unity at this excitation and thus motor is equivalent to a resistive load.

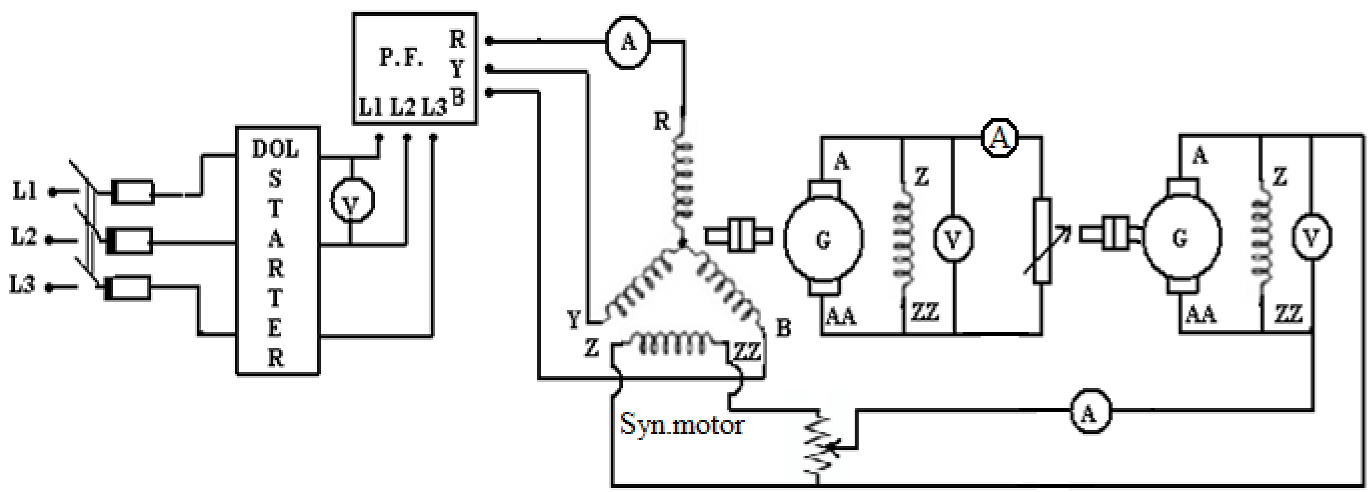
(2) Under excitation: -

When the field current is decreased gradually bellow the normal excitation. The armature current increase and the operating power factor of the motor decreases. The power factor under this condition is lagging. Thus the synchronous motor draws a lagging current, when it is under excited and equivalent to an inductive load.

(3) Over excitation: - When the field current is increased gradually beyond the normal excitation, the armature current again increase the operating power factor increases. How ever the power factor is leading under this condition. Hence, the synchronous motor draws a leading current, when it is over excited and is equivalent to a capacitive load.

It the above variation of field current and the corresponding armature current are plotted for a constant mechanical load, a curve of the shape of V- is obtained and the characteristic curve plotted between input power factor and the field current for a constant mechanical load on the motor are of the shape of inverted V- curves.

Circuit diagram: -



Procedure: -

1. Make the connection a per circuit diagram.

2. Before starting the synchronous motor makes sure that the D.C. excitation switch is in off position.

3. Switch on the A.C. supply and start 3- phase synchronous motor with the help of D.O.L. starter.

4. Observe direction of rotation, in case it is rotating in opposite direction, stop the motor and reverse the sequence. Start the motor again using starter and insure motor is running at no load.

5. Switch on the D.C. excitation switch.

6. Now gradually increase the excitation by the rheostat a few step and note the corresponding decrease in armature current (Ia) and field excitation current (If) Vary excitation till the armature current is minimum. After the point increase excitation, the armature current will increases and note corresponding armature current and field current values. Vary the excitation up till the rated value of synchronous motor. This value with correspond to synchronous motor at no load.

7. Now switch on the load on D.C. generator and various loads setting ½ loads, full load on D.C. generator repeat step no 2 to 5.

8. Plot the graph between field current and armature current for V-curve and inverted curve between power factor and field current.

9. Switch off the D.C. excitation switch, and then stop the motor, by press the red button of D.O.L. starter.

Observation table**: -**

S.No.	Field-current (I_f)	Armature current (I_a)	Power factor (cosΦ)
1.	0.0A	0.75A	
2.	0.1A	0.50A	
3.	0.2A	0.40A	

Graph: - Plot the graph between armature current (I_a) Vs field-current (I_f) andpower factor (cosΦ) Vs field-current (I_f).

Result**: -**

Precautions**: -**

1) All connection should be perfectly tight and no-loose wire should lie on the work table.
2) Do not switch on the supply until and unless the connection is checked by the teacher.
3) Avoid error due to parallax while reading the meters.
4) Ensure that the winding currents do not exceed their rated values.

Viva Questions:

1. What are the difficulties in starting a synchronous motor?

2. What are the commonly employed methods of starting a synchronous motor?
3. What are the applications of synchronous motor?
4. What is synchronous condenser?
5. What do you understand by hunting?

LAB EXPERIMENT 7

X_d and X_q of a three phase salient pole synchronous machine

Object: -To determine X_d and X_q of a three phase salient pole synchronous machine using the slip-test and draw the power angle curve.

Apparatus required: -

S.No.	Name of apparatus	Type	Range	Quantity
1.	Voltmeter	M.I.	(0 – 75/150/300V)	1 No.
2.	Ammeter	M.I.	(0 – 5A)	1 No.
3	Rheostat	Tubular	(1.4A- 260 Ω)	1. No.
4.	3 - Phase variac	-	(8A – 415V)	1 No.
5.	Connecting wire	Stranded	--------	L.S.

***Equipment required*: - MG Set (DC motor + AC generator)**

DC motor: - 3HP, 230V, 10Amp, 1500rpm.

AC generator: - 2 KVA, 3-phase, 415V, 50Hz, 2.8Amp, 1500rpm.

Theory: -The direct axis (X_d) and quardature axis (X_q) synchronous reactance of a salient pole synchronous machine can be determined from simple no load test known as the slip test.

In this test the alternator should be driven at a speed, slightly less then the synchronous speed with field circuit open, 3-phase small voltage at same frequency is applied to the armature (or stator) terminal of the synchronous machine, applied voltage to be adjust from 3-phase variac. So that current drawn by the stator winding is full load rated current. Under this condition of operation, variation of the current and voltage across the stator winding is maximum and minimum. Voltage will be maximum when the crest of the stator m.m.f wave consideds with the direct axis of the rotating field the induced e.m.f. in the open field is zero, the voltage across the stator terminals will be

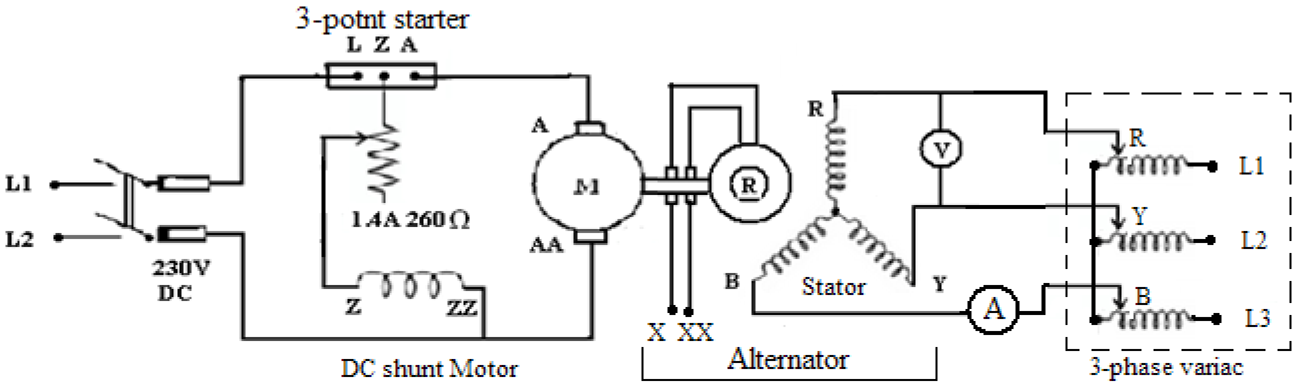
maximum and the current drawn by the stator winding is minimum. Thus the approximate value values of direct axis synchronous reactance –

$$X_d = \frac{E_{max}}{I_{min}}$$

When the crest of stator m.m.f. wave consided with the quardature axis of the rotating field induced e.m.f. in the open circuit field is maximum, the voltage across the stator terminals will be minimum and current drawn by the stator winding is maximum. Hence approximate values of quardature axis synchronous reactance –

$X_q = \frac{E_{min}}{I_{max}}$.

Circuit diagram: -



Procedure: -

1. Connect the circuit as per circuit diagram.

2. Insure that the resistance in the field circuit of DC motor is maximum.

3. Switch ON the DC supply to the motor and start the DC motor with the help of 3-point starter.

4. Adjust the speed of the DC motor slightly less than the synchronous speed of the alternator by varying the resistance in the field circuit of the motor, slip should be extremely low, preferably less than 4%.

5. Insure that the setting of 3-phase variac it's at zero position.

6. Switch on 3- phase AC supply to the stator winding of alternator.

7. Adjust the voltage applied to the stator winding till the current in the stator winding approximately full load rated current.

8. Under this conditions current in the stator winding, the applied voltage to the stator winding and the induced voltage in the open field circuit will fluctuate from minimum to maximum values which may be recorded by the connected meters.

9. Reduced the applied voltage to the stator winding of alternator and switch OFF the 3-phase AC supply.

10. Decrease the speed of DC motor and switch OFF the DC supply

Observation table: -

S.No.	Armature voltage		Armature current	
	V_{min}(Volts)	V_{max} (Volts)	I_{min} (Amps)	I_{max}(Amps)
1.	160V	162V	0.6A	3.0A
2.	149V	150V	0.5A	2.8A

Calculation: -

Direct axis synchronous reactance (X_d) = $\frac{V_{max}}{I_{min}}$ = - - - - Ω

Direct axis synchronous reactance per phase = $\frac{X_d}{\sqrt{3}}$ = - - - - - - Ω

Quardature axis synchronous reactance (X_q) = $\frac{V_{min}}{I_{max}}$ = - - - - - Ω

Quardature axis synchronous reactance per phase = $\frac{X_q}{\sqrt{3}}$ = - - - - - Ω

Result: -The ratio of X_q / X_d determined for a salient pole rotor type synchronous machine by slip test which is found to be- - - -.

Precautions: -

1) All connection should be perfectly tight and no-loose wire should lie on the work table.
2) Do not switch on the supply until and unless the connection is checked by the teacher.
3) Avoid error due to parallax while reading the meters.
4) Ensure that the winding currents do not exceed their rated values.

LAB EXPERIMENT 8

Synchronization of a 3-phase alternator

Object:To study synchronization of a 3-phase alternator.

Apparatus required: -

S.No.	Apparatus	Specifications	Types	Quantity
1	Ammeter	(0-5A)	MC	1
2	Volt meter	(0 -300V)	MC	1
3	Rheostat	(1.4A, 260Ω)	Wire wound	1
4	Ammeter	(0 – 2A)	MC	1
5	Volt meter	(0-500V)	MI	2
6	Flexible wire		Stranded	L.S

Equipment required:-

1. Synchronizing panel for parallel operation, with all accessories.
2. **M-G** set with specification - -- - - 2No.

A.C. generator- (2K.V.A, 3-phase, 50 Hz, 415V, 1500R.P.M, 2.8Amp, D.C.140V, D.C.Amp- 0.85A, P.F-0. 8)

D.C. motor- 230V, 1500R.P.M, 11Amp, shunt wound.

Theory: -

Synchronizing of generator: -Synchronous generator can be put the share the load it should be properly connected in parallel with the common bus-bar. Internal connection of the terminals of a generator with the terminals of another or a bus-bar, to which large number of synchronous generator are already connected is called synchronizing.

Conditions for parallel operation: Following three conditions must be fulfilled.

(1) The generated voltage of the incoming alternator to be connected in parallel with a bus-bar should be equal to the bus-bar voltage.

(2) Frequency of the generated voltage of the incoming alternator should be equal to the bus-bar frequency.

(3) Phase sequence of the voltage of the incoming alternator should be same as that of the bus-bar.

Generated voltage of the incoming alternator can be adjusted by adjusting the field excitation. Frequency of the incoming alternator can be controlled and made equal to bus-bar frequency by controlling the speed of the prime mover driving the alternator.

Phase sequence of the alternator and the bus-bar can be checked by a phase sequence indicator. Alternatively, three lamps can be used for checking of phase

Sequence - Synchronous generator driven at rated speed if all the lamps glow together and dark together then the phase sequence of the incoming alternator in the same as that of the bus-bar.

Method of synchronization: -

1. Synchronizing lamps method – (a) Three bright lamps method
   (b) Two bright and one dark amps method.
2. Synchroscope method.

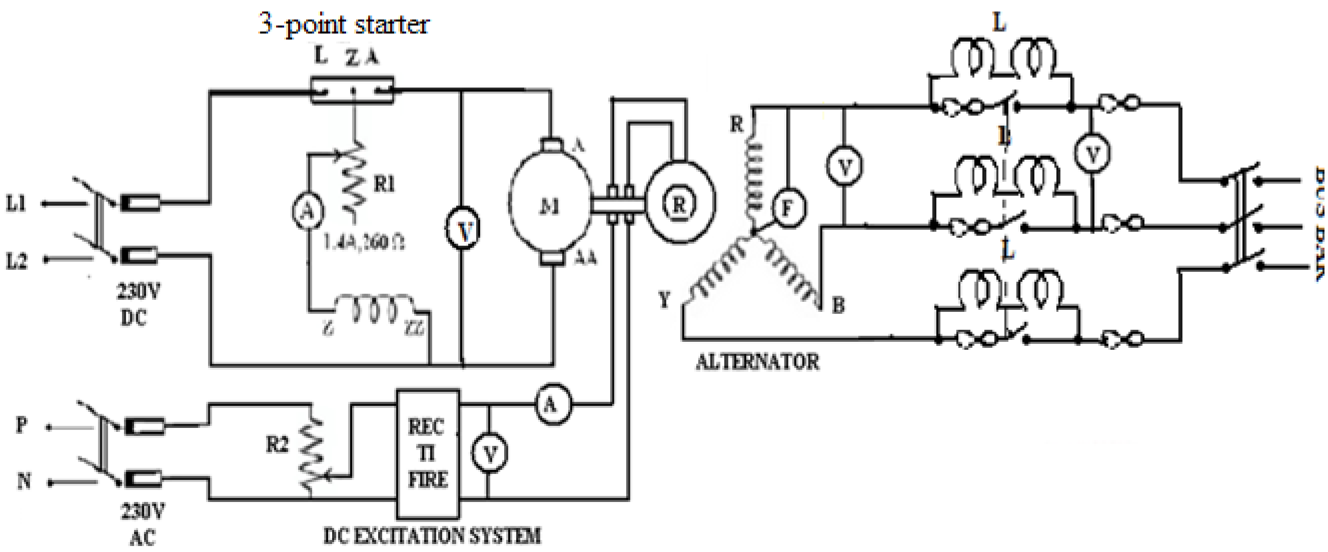
Two bright one dark lamp method:

In the method of synchronizing an alternator three lamps or connected, two lamps are connected with the bus-bar. In this method the brightness of the lamps will vary in sequence. A particular in sequence will indicate if the incoming alternator is running too fast or too slow. Perfect synchronizing will occur when lamp one is dark while two lamps are equally bright.

Synchroscope method:

A synchroscope determine s the instant of synchronism more accurately than the three lamps method. A synchroscope consists of a rotor (moving coil) and stator (fixed coil). One of which is connected the incoming alternator and the other to the bus-bar. A pointer connected to the rotor will rotate, if there is difference in frequencies of the incoming alternator and bus-bar. Anticlockwise rotation of the rotor pointer indicates that the frequency of the incoming alternator is slower, whereas clockwise rotation of the pointer indicates that the frequency is higher than the bus-bar frequency. The speeds of the prime mover driving of the alternator will therefore have to be adjusted such that, when the frequencies are equal to the pointer is stationary. The alternator can be switched on the bus-bar by closing the switch.

Circuit diagram: -



***Procedure*: -**

1. Connections are made as per circuit diagram.

2. Insure that the synchronizing switch is open external resistance in the field circuit of the motor is zero and external resistance in the field circuit of alternator is maximum.

3. Switch on the D.C. supply to the D.C. motor-1 & D.C. motor -2 and start by the starter.

4. Adjust the speed of both the D.C. motor to rated speed of alternators, by varying the rheostat in its field circuit of respective motors.

5. Switch on the D.C. supply to the field of alternator by switching on the M.C.B. and moving the variac knob in clockwise position, so that the generated voltages of both the alternators are equal. Check the the phase sequence of both alternators by using phase sequence indicator. The phase sequence of both alternators should be same. As per the connection of the set of lamps, one set which is directly connected between the same phases should dark and the same instant, the order two set of the lamps, which are cross connected should be bright.

6. Switch on the T.P.S.T.knife switch in upward direction. Now three set of lamps will flicker, in case flickering is fast adjust slowly the speed of both the D.C. motors, so that frequency becomes equal. Check the quantity of two voltages of alternators. Under such a condition, the set of lamps will go IN and OUT very slowly. At this point switch on the M.C.B.for synchroscope and when its pointer is in the middle the two alternators are synchronized and the T.P.I.S.T. switch must be brought in down ward direction. Thus both the alternators are now supplying common voltage to the bus-bar.

7. Watch for the correct instant of synchronization which is denoted by synchroscope pointer in middle with the synchronizing switch in hand and close this switch in downward direction, when the directly connected set of lamps is dark and the other two set of lamps are equal bright, thus synchronizing the incoming alternator with the bus-bar.

8. Switch OFF the synchronizing switch, bus-bar switch and then the D.C. mains to stop the D.C. motor and the other motor.

Result: **-** Synchronous generator can be synchronized with the bus. At the time of synchronization voltage, frequency and phase sequence of incoming alternator should be equal to the bus voltage, frequency and phase sequence.

***Precautions*: -**

1. Always switch on the M.C.B. for D.C. motor keeping in view that A.C. generator is not loaded.
2. Insure that the M.C.B. for D.C. exciter as should be in OFF position.
3. Insure that the T.P.D.T. switch is in middle position.
4. Insure that the M.C.B. for synchroscope should be in OFF position.
5. Insure that field rheostat is connected across F.R. terminals.
6. Never leaves synchroscope and phase sequence indicator permanently connected in the circuit i.e. M.C.B. meant for, Synchroscope should be turned OFF immediately once the synchronizing procedure is over.

LAB EXPERIMENT 9

Object: To obtain performance characteristics of 3 phase slip ring induction motor by varying rotor resistance at no load, half load and full load.

Apparatus required: -

S.No.	Apparatus	Specifications	Types	Quantity
1	Volt meter	(0 -500V)	MI	1
2	Volt meter	(0 -300V)	MC	1
3	Wattmeter 3 Phase	(5/10A, 300/600V)	Dynamo	1
4	Ammeter	(5-10A)	MI	1
5	Ammeter	(5-10A)	MC	1
6	Flexible wire		Stranded	L.S
7	Resistive load	(2kW, 10A)		1

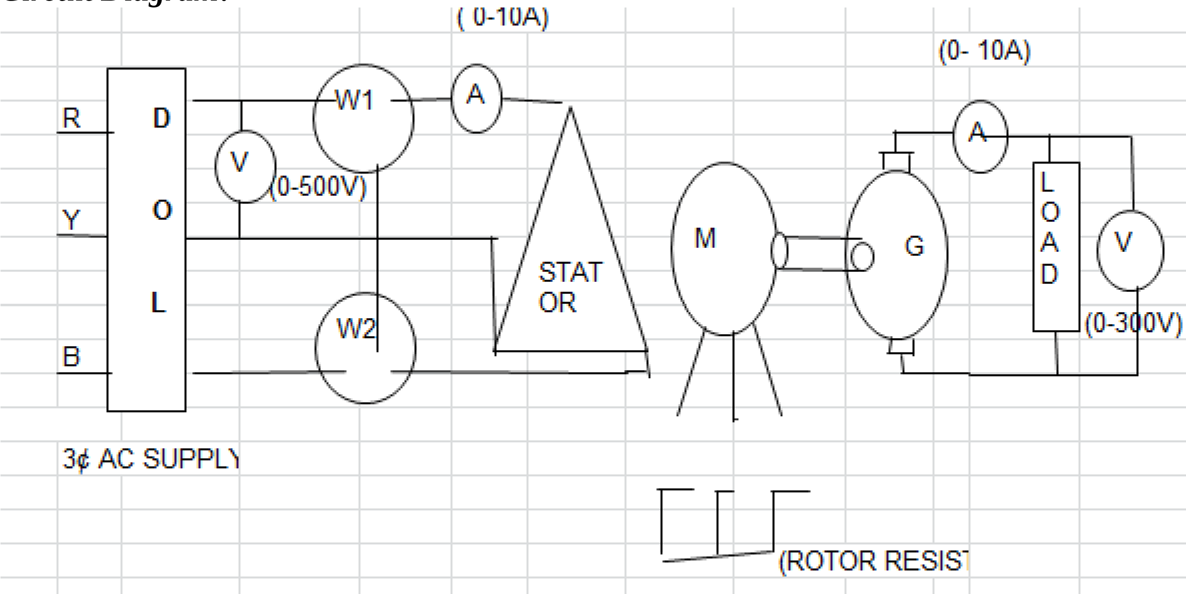
Equipment required:-

(A) 3phase slip ring induction motor 3 hp, 3.6 A, 415 V, 1440 RPM, 50 Hz, squirrel cage/ phase wound type and class B insulation.
(B) DC shunt generator 1.5 kW / HP, 6A, 230V, 1500RPM, shunt wound type.
(C) Panel for slip ring induction motor having DOL starter, 3 Phase MCB, knife switch and rotor resistance starter.

***Theory*:-** It is evident from the equation of the electromagnetic torque for a 3 ¢ induction motor the speed of an induction motor can be controlled by varying its rotor resistance or rotor reactance or both stator and rotor reactance. The variation of stator reactance is possible for squirrel cage type and slip ring motor, but variation of rotor reactance is possible only in case of slip ring type induction by inserting external resistance in the rotor circuit through slip rings.

***Rotor Resistance Control*: -** The internal developed torque is function of rotor speed and rotor resistance from the electromagnetic torque equation. It indicates that the value of torque can be varied for particular speed of the rotor by varing the external resistance connected to the rotor even through the value of the maximum torque is free from that of the rotor resistance however the speed at which the maximum torque occurs can be adjusted by using the rotor resistance, the stable region of operation extends to lower speeds with increases in the rotor resistance there for the starting also increases.

Circuit Diagram:-



Procedure:-

(i)Make the connection as per circuit diagram.
(ii)Switch on 3 ¢ supply and start the motor with the help of DOL starter at no load.
(iii) Reduce the rotor resistance from step 6 to step 1, correspondingly note down the readings per step of connected meters and speed.
(iv) Now apply the half of the full load on the motor through generator and follow the step (iii).
(v) Finally apply the full load on the motor through generator and follow step (iii).
(vi)Draw the graph between speed (N) V/S load current (I_L) and speed (N) V/S power (P).
(vii)Open the switch of 3¢ supply and stop the slip ring induction motor.

Observation Table:-

	NO LOAD TEST			HALF LOAD TEST			FULL LOAD TEST		
STEP	P (in watt)	I (in Amp)	N (in rpm)	P (in watt)	I (in Amp)	N (in rpm)	P (in watt)	I (in Amp)	N (in rpm)
6	120W	2.3A	880rpm	160W	2.35A	700rpm	200W	2.4A	555rpm
5	160W	2.4A	1140rpm	220W	2.50A	1010rpm	280W	2.7A	860rpm
4	170W	2.45A	1254rpm	260W	2.60A	1296rpm	320W	3.0A	1030rpm
3									
2									
1									

Result:-

Precautions:-

1) All connection should be perfectly tight and no-loose wire should lie on the work table.
2) Do not switch on the supply until and unless the connection is checked by the teacher.
3) Avoid error due to parallax while reading the meters.

4) Ensure that the winding currents do not exceed their rated values.

This lab manual has been updated by

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Crosschecked By
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Please spare sometime to provide your valuable feedback.