KINGS COLLEGE OF ENGINEERING
Recognised under 2(f) & 12(B) of UGC
Approved by AICTE, New Delhi.
Affiliated to Anna University, Chennai.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ACADEMIC YEAR: 2023 – 2024 (EVEN SEMESTER)

COURSE FILE - CONTENT PAGE

YEAR & SEM	**: II & IV**	**BATCH**	**: 2022-2026**
SUBJECT CODE	**: EE3411**	**SUBJECT NAME**	**: Electrical Machines II Lab**
REGULATION	**: R2021**	**STAFF IN-CHARGE**	**: Dr. S. Naveen Prakash**

- Syllabus
- Course plan
- Student name list
- Individual time table
- Lab Manual
- Sample Observation notebook & Record
- Model Lab
  - Question paper
  - Sample answer sheet
  - Mark statement
- Content Beyond Syllabus
- Record of Internal Mark

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SUBJECT: ELECTRICAL MACHINES LABORATORY - II

SEMESTER: IV

LAB MANUAL (EE3411)

(Version: 2)

PREPARED BY

Dr. S. NAVEEN PRAKASH, AP/ EEE

EE3411 ELECTRICAL MACHINES LABORATORY – II

L	T	P	C
0	0	3	1.5

SYLLABUS

1. Regulation of three phase alternator by EMF and MMF methods.
2. Regulation of three phase alternator by ZPF and ASA methods.
3. Regulation of three phase salient pole alternator by slip test.
4. Measurements of negative sequence and zero sequence impedance of alternators.
5. V and Inverted V curves of Three Phase Synchronous Motor.
6. Load test on three-phase induction motor.
7. No load and blocked rotor test on three-phase induction motor (Determination of equivalent circuit parameters).
8. Separation of No-load losses of three-phase induction motor.
9. Load test on single-phase induction motor.
10. No load and blocked rotor test on single-phase induction motor.
11. Study of Induction motor Starters.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should have the:

CO1: Ability to understand and analyze EMF and MMF methods.

CO2: Ability to analyze the characteristics of V and Inverted V curves.

CO3: Acquire hands on experience of conducting various tests on alternators and obtaining their performance indices using standard analytical as well as graphical methods. To understand the importance of Synchronous machines.

CO4: Acquire hands on experience of conducting various tests on alternators and obtaining their performance indices using standard analytical as well as graphical methods. To understand the importance of single and three phase Induction motors.

CO5: Ability to acquire knowledge on separation of losses.

SIGNATURE OF STAFF INCHARGE **HOD/EEE**

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ACCREDITED WITH GRADE B++ NAAC

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE PLAN

Sub. Code	: EE3411	**Branch/Year/Sem**	: B.E EEE / II / IV
Sub. Name	: Electrical Machines Laboratory-II	**Batch**	: 2022-2026
Staff Name	: Dr. S. Naveen Prakash	**Academic Year**	: 2023-24 (Even)

COURSE OBJECTIVE

To expose the students to the operation of synchronous machines and induction motors and give them experimental skill.

LEARNING OUTCOMES

Upon the completion of this lab, students should be able to

1. Test single phase and three phase induction motors by direct loading and obtain their performance characteristics.
2. Predetermine the performance of squirrel cage induction motor by means of equivalent circuit and circle diagrams.
3. Predetermine the regulation of cylindrical rotor alternator by EMF, MMF, Potier and ASA methods.
4. Perform slip test on salient pole alternator to find the direct axis and quadrature axis impedances.
5. Measure the negative sequence and zero sequence impedances of an alternator.
6. Obtain V and inverted V curves of Synchronous motor.

PRE-REQUISITIE

1. Knowledge about the Electrical Machines Laboratory – II
2. Knowledge on the classification and working principles of induction motor and alternators.

EQUIPMENTS / COMPONENTS REQUIREMENTS

1. Three Phase Synchronous motor.
2. DC Shunt Motor Coupled With Three phase Alternator.
3. Three Phase Slip ring Induction motor with loading arrangement.
4. Three Phase Induction Motor with loading arrangement.
5. Single Phase Induction Motor with loading arrangement.
6. Tachometer -Digital/Analog.
7. Single Phase Auto Transformer.
8. Three Phase Auto Transformer.
9. Single Phase Resistive Loading Bank.
10. Three Phase Resistive Loading Bank.
11. Three Phase Inductive Loading Bank.

Ex. No.	Date	Title of the Experiment	No. of Hrs. required	Cumulative No. of periods
CYCLE : I				
1		Study of Induction motor Starters	3	3
2		Load test on single-phase induction motor.	3	6
3		No load and blocked rotor test on single-phase induction motor.	3	9
4		Load test on three-phase induction motor.	3	12
5		No load and blocked rotor test on three-phase induction motor (Determination of equivalent circuit parameters).	6	18
6		Separation of No-load losses of three-phase induction motor.	3	21
CYCLE : II				
7		Regulation of three phase alternator by EMF and MMF methods	6	27
8		Regulation of three phase alternator by ZPF and ASA methods	6	33
9		Regulation of three phase salient pole alternator by slip test.	3	36
10		V and Inverted V curves of Three Phase Synchronous Motor.	3	39
11		Measurements of negative sequence and zero sequence impedance of alternators.	6	45

CONTENT BEYOND THE SYLLABUS

1. Draw the Circle diagram of three phase squirrel cage induction motor by conducting no load and blocked rotor test.

MINI PROJECT

1. Wind Power Generation by DC generator.

INTERNAL ASSESSMENT DETAILS

MODEL	I
PORTIONS	CYCLE 1&2 EXPERIMENTS
Date	

Prepared by

Dr. S. NAVEEN PRAKASH, AP/EEE

Verified By

HOD/EEE

Approved by

PRINCIPAL

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EE3411 - Electrical Machines Laboratory-II

Ex.No	Date	Title of the Experiment	Page No.	Mark	Signature
1.					
2.					
3.					
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6.					
7.					
8.					
9.					
10.					
11.					
12.					

Signature of Staff Incharge

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B++ NAAC

Department of Electrical and Electronics Engineering
Academic Year 2023-2024 Even Semester
Name List with Register Number

Class: II / EEE

Class Strength: 60

S. No.	Roll No.	Reg. No	Name of the Student	S. No.	Roll No.	Reg. No	Name of the Student
1	22EE01	821122105001	ABINAYA M	31	22EE31	821122105034	NEELAVATHI G
2	22EE02	821122105002	ABINAYA S	32	22EE32	821122105036	NITHYA SRI R
3	22EE03	821122105003	ABIRAMI M	33	22EE33	821122105037	PONNAGARASAN M G
4	22EE04	821122105005	ARCHANA S	34	22EE34	821122105039	PRAGADESHWARAN R
5	22EE05	821122105006	BABY N	35	22EE35	821122105040	PRIYADHARSHINI L
6	22EE06	821122105007	BALAJI J	36	22EE36	821122105041	PRIYANIRANJANI P
7	22EE07	821122105008	CHARUMATHI M	37	22EE37	821122105042	RAGAVAN M
8	22EE08	821122105009	DEEPIKA R	38	22EE38	821122105043	RAJAGOWRI S
9	22EE09	821122105010	DEVATHARSHAN T	39	22EE39	821122105044	RUBASRI R
10	22EE10	821122105012	DHANALAKSHMI P	40	22EE40	821122105045	SAMUEL G
11	22EE11	821122105013	DHARSHINI G	41	22EE41	821122105046	SATHIYA S
12	22EE12	821122105014	DHIVAKAR S	42	22EE42	821122105047	SHAHATHIYA R
13	22EE13	821122105015	DURGA R	43	22EE43	821122105048	SHANMUGAPRIYA L
14	22EE14	821122105016	DURGA DEVI T	44	22EE44	821122105049	SHANMUGAPRIYA S
15	22EE15	821122105017	GURU PRASATH N	45	22EE45	821122105050	SIVASANGARI G
16	22EE16	821122105018	HARIHARAN V	46	22EE46	821122105051	SRI HARI SRIDHAR L
17	22EE17	821122105019	HARINI U	47	22EE47	821122105052	SUBHASHINI M
18	22EE18	821122105020	HARISH D	48	22EE48	821122105053	SURIYA N
19	22EE19	821122105021	JESTINA SHINY V	49	22EE49	821122105054	THARSHA A.S
20	22EE20	821122105022	KAILASH A	50	22EE50	821122105055	THENMOZHI T
21	22EE21	821122105023	KALAIYARASAN P	51	22EE51	821122105056	UMA S
22	22EE22	821122105024	KATHIRAVAN M	52	22EE52	821122105057	VAISHNAVI C
23	22EE23	821122105025	KEERTHIKA G	53	22EE53	821122105058	VASANTHAKUMAR R
24	22EE24	821122105027	MANISHKUMAR S	54	22EE54	821122105059	VENKADESHWARAN G
25	22EE25	821122105028	MANO B	55	22EE55	821122105060	VETRI D
26	22EE26	821122105029	MELVIN EALIJAH S	56	22EE56	821122105301	ABINESH S
27	22EE27	821122105030	MUTHU MURUGESAN S	57	22EE57	821122105302	HARIHARAN B
28	22EE28	821122105031	NACHIYAMMAL C	58	22EE58	821122105303	KARTHI P
29	22EE29	821122105032	NANDHAKUMAR D	59	22EE59	821122105304	KISHORE KUMAR S
30	22EE30	821122105033	NANDHINI S	60	22EE60	821122105305	RITHISH M

Class Coordinator HOD

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KINGS COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

TIME TABLE (February 2024 -MAY 2024, EVEN SEM)

B.E – EEE (Reg. 2021) - With Effect from 13.03.2024 - Tentative Last working Day 13.06.2024

Batch:2022 - 2026 | **Strength:60**

Year: II | **Semester: IV** | **Class Room: 132** | **Block: I**

Session / Day	1 09.15am - 10.00am	2 10.00am - 10.45am	10.45 am - 11.00 am	3 11.00am - 11.45am	4 11.45am - 12.30pm	12.30 pm - 01.10 pm	5 01.10pm - 01.55pm	6 01.55pm - 02.40pm	02.40 pm - 02.50 pm	7 02.50pm - 03.35pm	8 03.35pm - 04.20pm
MON	EE3402	EE3403	BREAK	EE3404	T&P(SS)	LUNCH BREAK	EE3402	EE3401	BREAK	EE3404	EE3405
TUE	EE3405	EE3404		T&P (A)	EE3401		GE3451	EE3412 (B1) /		EE3411 (B2)	
WED	EE3403	EE3413 (B1) /		EE3412 (B2)			EE3403	GE3451		EE3404	EE3402
THU	EE3402	EE3401		GE3451	EE3404		EE3401	CC		NPTEL	LIB/NET
FRI	EE3405	EE3411 (B1) /		EE3413 (B2)			EE3405	EE3403		EE3402	EE3401
SAT	EE3401	GE3451		EE3403	EE3405		EE3404	EE3402		EE3405	NPTEL

SUB CODE	NAME OF THE SUBJECT	CATEGORY	CREDITS	NAME OF THE STAFF	DEPT	PERIODS/WEEK
TUTORIAL (T), PROFESSIONAL ELECTIVE (E)						
GE3451	Environmental Sciences and Sustainability	BSC	2	Dr. S. Udhayakumar	CHE	4
EE3401	Transmission and Distribution	PCC	3	Dr. S. Naveen Prakash	EEE	6
EE3402	Linear Integrated Circuits	PCC	3	Mr. R. Sathyaraj	ECE	6
EE3403	Measurements and Instrumentation	PCC	3	Mrs. P. Thirumagal	EEE	5
EE3404	Microprocessor and Microcontroller	PCC	3	Dr. P. Narasimman	EEE	6
EE3405	Electrical Machines- II	PCC	3	Dr. S. Vasantharaj	EEE	6
PRACTICAL (P)						
EE3411	Electrical Machines Laboratory - II	PCC	1.5	Dr. S. Naveen Prakash	EEE	3
EE3412	Linear and Digital Circuits Laboratory	PCC	1.5	Mr. R. Sathyaraj	ECE	3
EE3413	Microprocessor and Microcontroller Laboratory	PCC	1.5	Dr. P. Narasimman	EEE	3

VALUE ADDITION INTIATIVES (VAI)

LIB/NET	Library / Internet	VAI	Dr. S. Vasantharaj	EEE	1
NPTEL	NPTEL Swayam Courses	VAI	Dr. S. Vasantharaj	EEE	2
T&P (A)	Training & Placement - Aptitude	VAI	Ms. P. Suganya	T&P	1
T&P(SS)	Training & Placement - Soft skill	VAI	Dr. K. Sudhakar	T&P	1
CC	Certificate Course	VAI	Dr. S. Vasantharaj	EEE	1

CLASS CO-ORDINATOR	NAME OF THE REPRESENTATIVES	ROLL NO
Dr. S. Vasantharaj	1. Venkadeshwaran. G 2. Sivasangari. G	54 45
CLASS COMMITTEE CHAIR PERSON	Mr. R. Sundaramoorthi	

15/02 DEPT. TTC | 15/2/24 HOD | 15/2/2024 PRINCIPAL

8211221050 41

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PRIYADHARSHANI. P
II - EEE

EE3411 - Electrical Machines Laboratory-II

Completed [signature]

[signature]

Signature of Staff Incharge
[Dr. S. Naveen Prakash]
AP/EEE.

Ex. No. : 1	STUDY OF INDUCTION MOTOR STARTERS
Date :	

AIM:

To study the construction and working principles of various types of three phase induction motor starters.

NECESSITY OF STARTER IN INDUCTION MOTOR:

In a three phase induction motor, the magnitude of an induced e.m.f. in the rotor circuit depends on the slip of the induction motor. This induced e.m.f. effectively decides the magnitude of the rotor current. The rotor current in the running condition is given by, But at start, the speed of the motor is zero and slip is at its maximum i.e. unity. So magnitude of rotor induced e.m.f. is very large at start. As rotor conductors are short circuited, the large induced e.m.f. circulates very high current through rotor at start. The condition is exactly similar to a transformer with short circuited secondary. Such a transformer when excited by a rated voltage circulates very high current through short circuited secondary. As secondary current is large, the primary also draws very high current from the supply. Similarly in a three phase induction motor, when rotor current is high, consequently the stator draws a very high current from the supply. This current can be of the order of 5 to 8 times the full load current, at start. Due to such heavy inrush of current at start there is possibility if damage of the motor winding. Similarly such sudden inrush of current causes large line voltage drop. Thus other appliances connected to the same line may be subjected to voltage spikes which may affect their working. To avoid such effects, it is necessary to limit the current drawn by the motor at start. The starter is a device which is basically used to limit high starting current by supplying reduced voltage to the motor at the time of starting. Such a reduced voltage is applied only for short period and once rotor gets accelerated, full normal rated Not only the starter limits the starting current but also provides the protection to the induction motor against overt loading and low voltage situations. The protection against single phasing is also provided by the starter. But such motors also need overload, single phasing and low voltage protection which is provided by a starter.

AUTO TRANSFORMER STARTER:

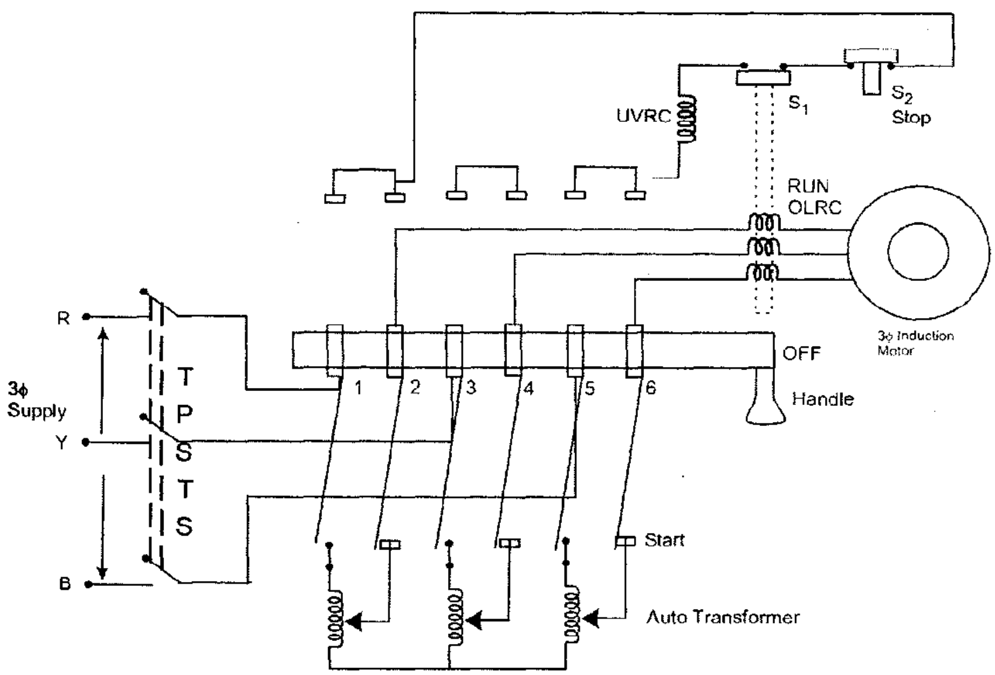


Fig 1.1

A three phase star connected autotransformer can be used to reduce the voltage applied to the stator. Such a starter is called an autotransformer starter. It consists of a suitable change over switch. When the switch is in the start position, the stator winding is supplied with reduced voltage. This can be controlled by tapping provide with autotransformer. When motor gathers 80% of the normal speed, the change over switch is thrown into run position. Due to this, rated voltage gets applied to stator winding. The motor starts rotating with normal speed. Changing of switch is done automatically by using relays. The power loss is much less in this type of starting. It can be used for both star and delta connected motors. But it is expensive than stator resistance starter.

STAR – DELTA STARTER:

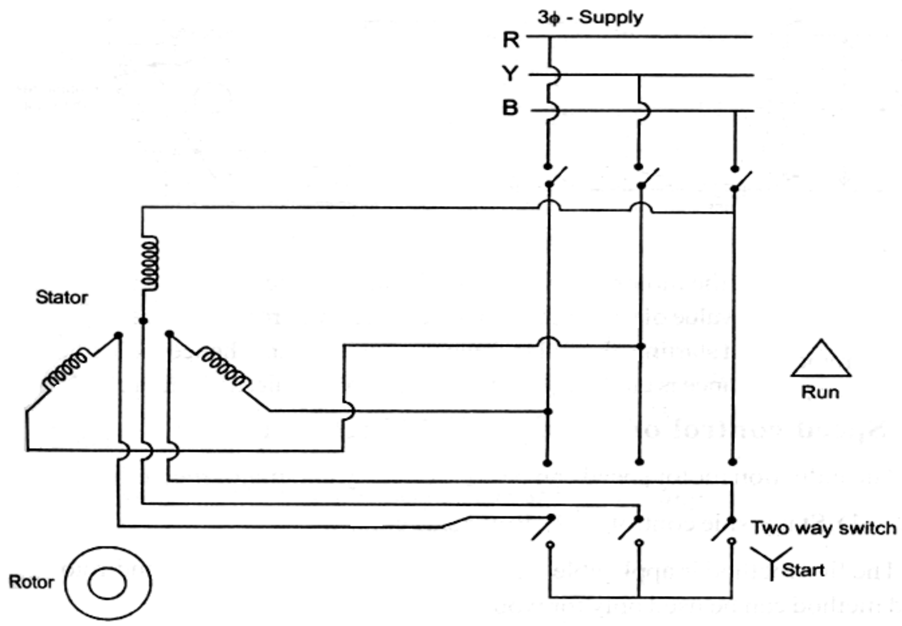


Fig 1.2

This is the cheapest starter of all and hence used very commonly for the induction motors. It uses triple pole double throw (TPDT) switch. The switch connects the stator winding in star at start. Hence per phase voltage gets reduced by the factor $^1/_{\sqrt{3}}$. Due to this reduced voltage, the starting current is limited. When the switch is thrown on other side, the winding gets connected in delta, across the supply. So it gets normal rated voltage. The windings are connected in delta when motor gathers sufficient speed. The operation of the switch can be automatic by using relays which ensures that motor will not start with the switch in Run position. The cheapest of all and maintenance free operation are the two important advantages of this starter. While is limitations are, it is suitable for normal delta connected motors and the factor by while voltage change is $^1/_{\sqrt{3}}$ which cannot be changed.

This method is used in the case of the motor which one built t run normally with a delta connected starter winding. It consists of two ways switch connect the motor in star for starting and then delta for normal running. The star connected applied voltage by a factor of $\frac{1}{\sqrt{3}}$ and hence the torque developed because $\frac{1}{\sqrt{3}}$ of that of which would have been developed if the motor war directly connected in the delta.

The Three types of star delta starters are,

1. Hand Operated
2. Semi Automatic
3. Fully Automatic

DIRECT ON LINE STARTER (or) D.O.L. STARTER:

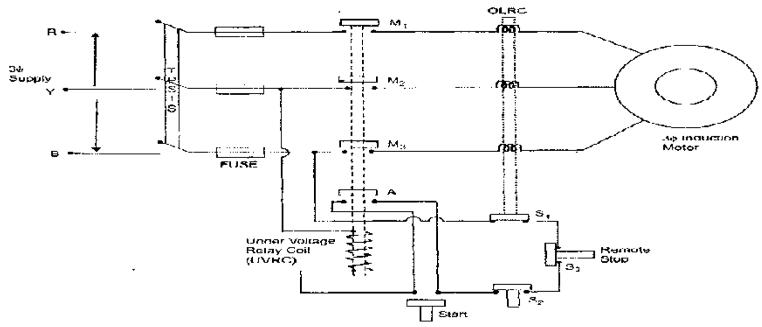


Fig 1.3

In case of small capacity motors having rating less than 5HP, the starting current is not very high and such motors can withstand such starting current without any starter. Thus there is no need to reduce applied voltage, to control the starting current. Such motors use a type of starter which is used to connect stator directly lines without any reduction in voltage. Hence the starter is known as direct on line starter. Through this starter does not reduce the applied voltage, it is used because it protects the motor from various severe abnormal conditions like over voltage, single phasing etc. The NO contact is normally open and NC is normally closed. At start, NO is pushed for fraction of second due to which coil gets energized and attracts the contactor. So stator directly gets supply. The additional contact provided that as long as supply in ON, the coil gets supply and keeps contactor in ON position. When NC is pressed, the coil circuit gets opened due to which coil gets de-energized and motor gets switched OFF from the supply. Under over load condition, current drawn by the motor increase due to which there is an excessive heat produced, which increase temperature beyond limit Thermal relays gets opened due to high temperature, protecting the motor from overload conditions.

ROTOR RESISTANCE STARTER:

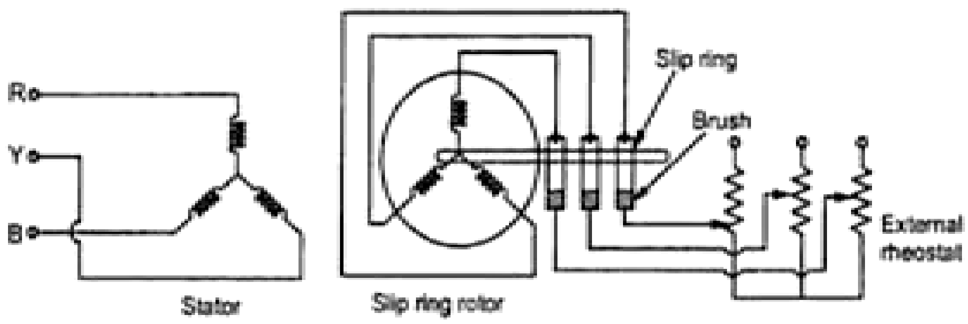


Fig 1.4

This is a starter which is used to start the three phase slip ring induction motor. It has a switch that connects several resistances, one at a time, to a motor to allow the motor to start slowly. The resistances are switched as individual resistances from the highest to the lowest. As each resistance is switched in, the motor receives a certain amount of current, as the motor reaches the speed that switch setting would allow, the next resistance is switched in, replacing the first resistance, and the motor speeds up a little more, until zero resistance is reached and the motor is running at full speed. Best advantage, it is inexpensive, and is good for relatively small motors.

RESULT:

Thus the construction and working principle of three phase induction motor starters were studied.

Ex. No. : 2	LOAD TEST ON SINGLE PHASE SQUIRREL CAGE INDUCTION MOTOR
Date :	

AIM:

To conduct the load test on single-phase squirrel cage induction motor and draw the performance characteristics curves.

NAME PLATE DETAILS:

1ϕ Induction Motor

FUSE RATING:

125% of rated current (Full load current) = Amps

APPARATUS REQUIRED:

S.No.	Name of the apparatus	Type	Range	Qty
1	Ammeter	MI	(0-10) A	1
2	Voltmeter	MI	(0-300) V	1
3	Wattmeter	UPF	(300V,10A)	1
4	Tachometer	-	-	1
5	Connecting wires	-	-	Required

FORMULAE USED:

1.Torque $T = (S_1 \sim S_2) \times \left(R + \frac{t}{2}\right) \times 9.81\ N - m$

Where S_1, S_2 - spring balance in kg
R - Radius of the brake drum in m.
t - Thickness of the belt in m.

2. Output power $(P_{out}) = \frac{2\pi NT}{60}\ Watts$

Where N-rotor speed in rpm
T-Torque in N-m

3. Input power $(P_{in}) = W$ in Watts

W -wattmeter reading in W

4. Percentage of efficiency, $\eta = \frac{Output\ \ Power}{Input\ \ Power}$ X 100

5. Percentage of slip, $S = \frac{N_s - N_r}{N_s}$

Where, N_s- Synchronous speed in rpm
N_r - Speed of the motor in rpm

6. Power factor, $Cos\Phi = \frac{P_{in}}{VI}$

CIRCUIT DIAGRAM:

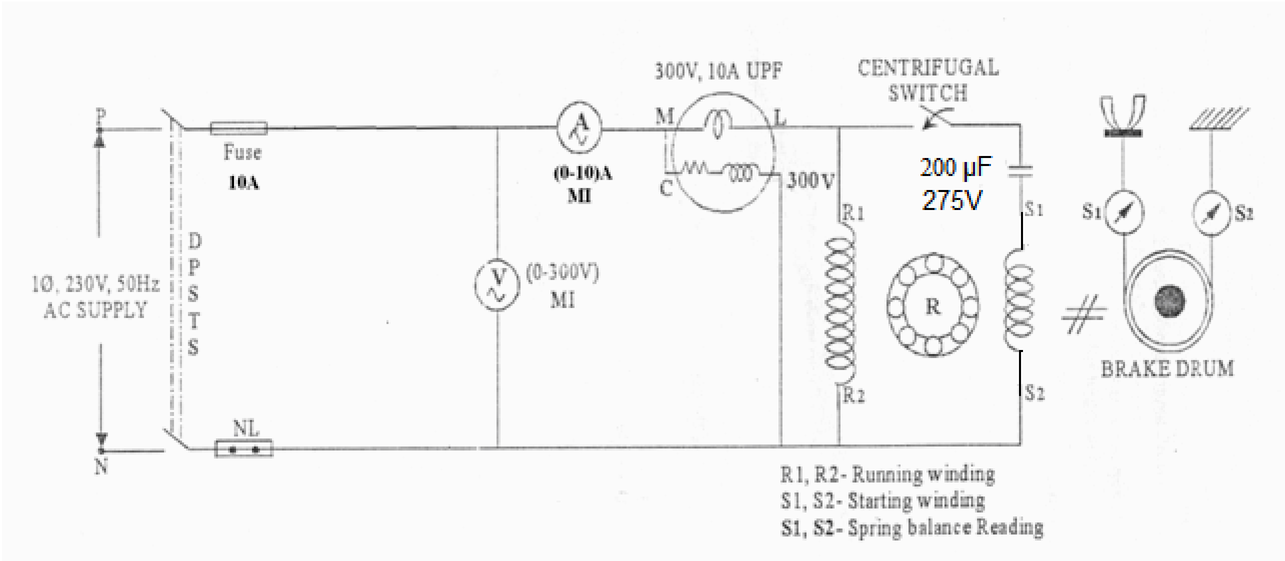


Fig 2.1

TABULATION:

Multiplication Factor:

S. No	Load Current (I_L)	Load Voltage (V_L)	Input Power (W)		Speed of the motor (N)	Spring Balance Reading			Torque	Output Power	η	Slip (S)	P.F
			Observed	Actual		S_1	S_2	$S_1 - S_2$					
	A	V	W	W	RPM	Kg	Kg	Kg	N-m	W	%	%	

DESCRIPTION:

- It is a direct load test
- A stand-in break load arrangement may be used.
- The output equation given by P=2ΠNT/60 W.
- The purpose of the load test maybe either to study the behavior of the induction motor or to perform the heat run test to conform its rating… etc., the input power can be measure by using wattmeter.

PRECAUTION:

1. The motor is started without any load.

PROCEDURE:

Step 1: Note down the nameplate details of motor.

Step 2: Connections are made as per the circuit diagram.

Step 3: Supply is switched on by closing the DPST switch.

Step 4: At no load speed, current, voltage and power are noted.

Step 5: By applying the load, for various values of current the above-mentioned readings are noted.

Step 6: Tabulate the readings using the table given.

Step 7: The load is later released and the motor is switched off and the graph is drawn.

Step 8: The characteristic curves are shown in model graph.

MODEL GRAPH:

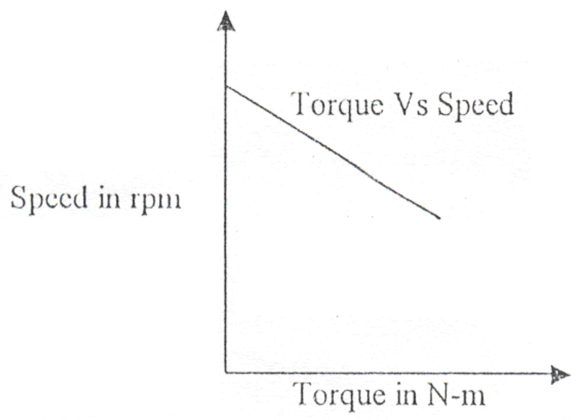


Fig 2.2 Mechanical Characteristics

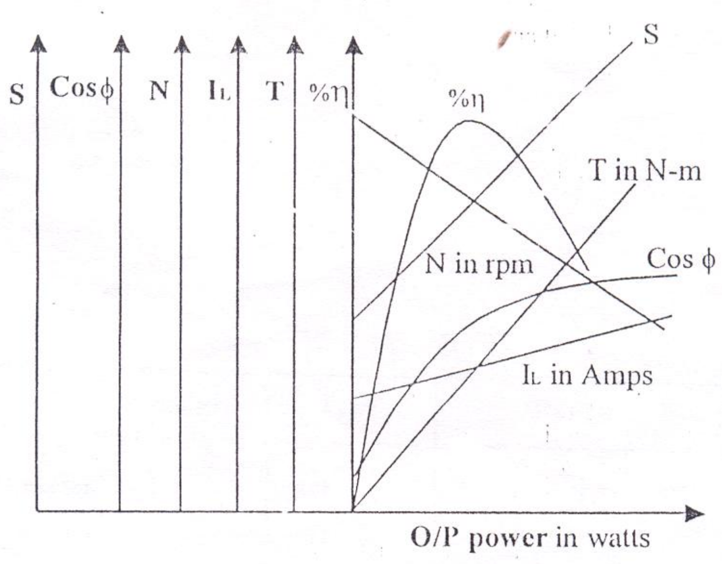


Fig 2.3 Electrical Characteristics

MODEL CALCULATION:

RESULT:

Thus the load test was conducted on single-phase squirrel cage induction motor and the performance curves were drawn.

VIVA QUESTIONS:

1. Why a single phase induction motor is not self-starting?
2. Name any four types of 1-phase induction motors.
3. How the direction of a capacitor start Induction motor is be reversed?
4. What are the inherent characteristics of plain 1-phase Induction motor?
5. An induction motor is generally analogous to?

Ex. No. : 3	NO LOAD AND BLOCKED ROTOR TEST ON SINGLE PHASE SQUIRREL CAGE INDUCTION MOTOR
Date :	

AIM:

To conduct the no load test and blocked rotor test on single-phase squirrel cage induction motor and to draw the equivalent circuit.

NAME PLATE DETAILS:

1ϕ Induction Motor

1ϕ Auto Transformer

FUSE RATING:

No load : 10% of rated current (Full load current) = A
Load : 125% of rated current (Full load current) = A

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	1Φ Auto Transformer	-	230V/(0-270)V	1
2	Voltmeter	MI	(0-300)V	1
3	Voltmeter	MI	(0-150)V	1
4	Voltmeter	MC	(0-30)V	1
5	Ammeter	MC	(0-10)A	1
6	Wattmeter	UPF	(150v,10A)	1
7	Wattmeter	LPF	(300v,10A)	1
8	Rheostat	Wire wound	(20Ω,10A)	1
9	Tachometer	-	-	1
10	Connecting wires	-	-	As Required

FORMULAE USED:
NO LOAD TEST:

No load power, $P_0 = V_0 I_0 cos\Phi_0$ Watts.

∴ No load power factor, $cos\Phi_0 = \frac{P_0}{V_0 I_0}$

$$Z_0 = \frac{V_0}{I_0}\ \Omega$$

$$R_0 = Z_0 cos\Phi_0\ \Omega$$

$$X_0 = Z_0 sin\Phi_0\ \Omega$$

X_0 can be written as,

$$X_0 = X_1 + \frac{X_m}{2} + \frac{X_2}{2} \quad (Note: X_1 = X_2)$$

$$\therefore X_m = 2X_0 - 3X_1$$

BLOCKED ROTOR TEST:

Blocked rotor power $P_{SC} = V_{SC}I_{SC}cos\Phi_{SC}$ Watts.

∴ Power factor, $cos\Phi_{SC} = \frac{P_{SC}}{V_{SC}I_{SC}}$

$$Z_{SC} = \frac{V_{SC}}{I_{SC}}\ \Omega$$

$$R_{SC} = Z_{SC}cos\Phi_{SC}\ \Omega$$

$$X_{SC} = Z_{SC}sin\Phi_{SC}\ \Omega$$

R_{SC} And X_{SC} can be written as,

$$R_{SC} = R_1 + \left[2\frac{R_2}{2}\right] = R_1 + R_2$$

$$R_2 = R_{SC} - R_1$$

Where, $R_1 = 1.2R_m$

$$X_{SC} = X_1 + X_2$$

Assuming, $X_1 = X_2$, we get, $X_1 = X_2 = \frac{X_{SC}}{2}$

CIRCUIT DIAGRAM:

NO LOAD TEST:

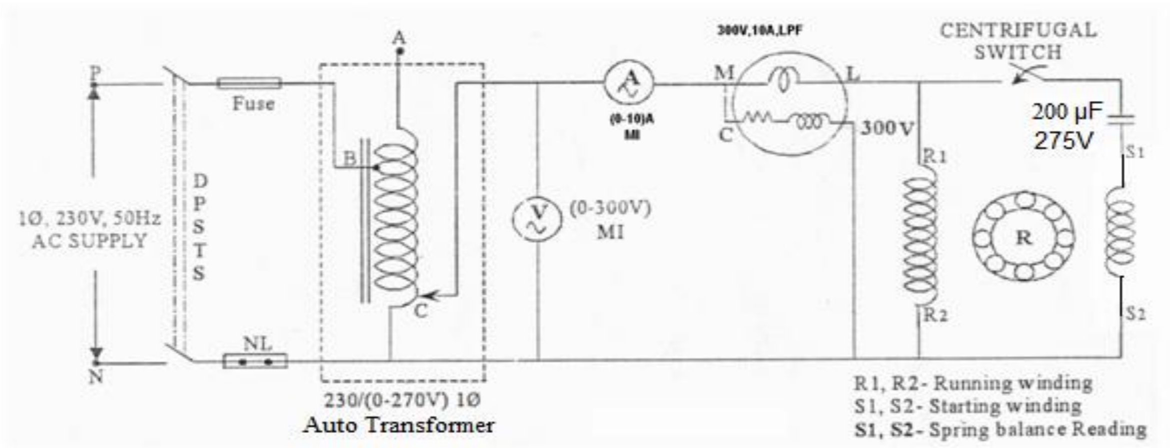


Fig 3.1

BLOCKED ROTOR TEST :

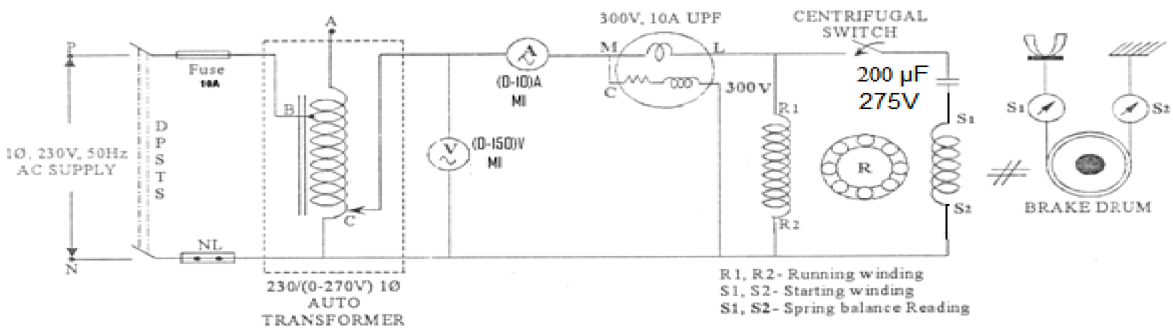


Fig 3.2

TO FIND STATOR RESISTANCE:

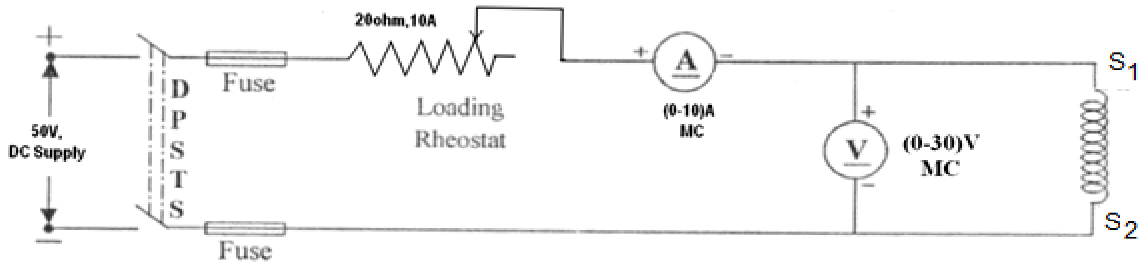


Fig 3.3

PRECAUTIONS:

1. The auto-transformer should be kept in minimum voltage position.
2. The motor is started without any load for no-load test.

PROCEDURE:

Step 1: Make the Connection as per the circuit diagram
Step 2: For no load test or open circuit test by adjusting the autotransformer, apply the rated voltage and note down the ammeter and wattmeter readings. In this test rotor is free to rotate.
Step 3: For short circuit test or blocked rotor test, by adjusting autotransformer, apply rated current and note down the ammeter and wattmeter readings. In this test the rotor is blocked.
Step 4: After that make the connection to measure the stator resistance as per the circuit diagram.
Step 5: By adding the load through the loading rheostat, note down the ammeter, voltmeter reading for various values of load.

TABULATION:
NO LOAD TEST:

Multiplication Factor :

S.No	Open Circuit Voltage (V_o) (Volts)	Open Circuit Current (I_o) (Amps)	Open Circuit Power (P_o) (Watts)	
			Observed	Actual

BLOCKED ROTOR TEST:

Multiplication Factor :

S.No	Blocked Rotor Voltage (V_{sc}) (Volts)	Blocked Rotor Current (I_{sc}) (Amps)	Blocked Rotor Power (P_{sc}) (Watts)	
			Observed	Actual

TO FIND STATOR RESISTANCE :

S.No	Stator current (A)	Stator voltage (V)	Stator resistance R=V/I Ω
		Mean Resistance, R_m	

EQUIVALENT CIRCUIT:

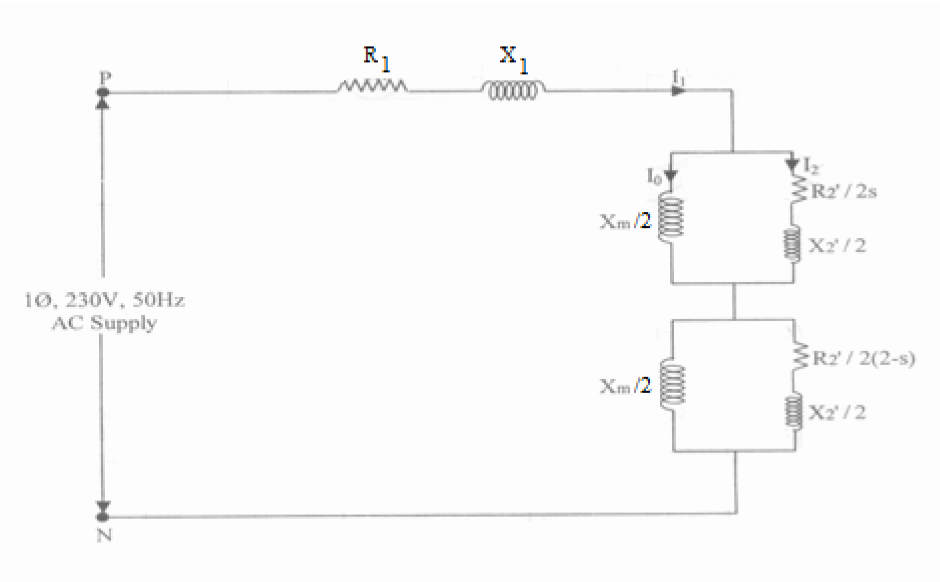


Fig 3.4

MODEL CALCULATION:

RESULT:

Thus the no load test and blocked rotor test on single phase squirrel cage induction motor were conducted and the corresponding equivalent circuit was drawn.

VIVA QUESTIONS:

1. What is equivalent circuit?
2. What is the purpose of no-load and blocked rotor test instead of load test?
3. Name the two different theories with which principle of 1-phase induction motors are explained.
4. What is the normal value of slip of an induction motor operating at full load?
5. List the applications of single phase induction motor.

Ex. No. : 4	LOAD TEST ON THREE PHASE SQUIRREL CAGE INDUCTION MOTOR
Date :	

AIM:

To conduct the load test on three phase squirrel cage induction motor and draw the performance characteristic curves.

NAME PLATE DETAILS:

3ϕ Induction Motor

FUSE RATING:

125% of rated current (full load current) = Amps

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	Ammeter	MI	(0-10) A	1
2	Voltmeter	MI	(0 – 600) V	1
3	Wattmeter	UPF	(600 V,10 A)	2
4	Tachometer	-	-	1
5	Connecting wires	-	-	Required

FORMULAE USED:

1. Torque $T = (S_1 \sim S_2) \times \left(R + \frac{t}{2}\right) \times 9.81\ N-m$

   Where S_1, S_2 - spring balance in kg
   R - Radius of the brake drum in m.
   t - Thickness of the belt in m.

2. Output power (P_{out}) $= \frac{2\pi NT}{60}\ Watts$

   Where N-rotor speed in rpm
   T-Torque in N-m

3. Input power (P_{in}) $= W_1 + W_2$ in Watts

   W_1, W_2-wattmeter readings in W

4. Percentage of efficiency, $\eta = \frac{Output\ Power}{Input\ Power}$ X 100

5. Percentage of slip, $S = \frac{N_s - N_r}{N_s}$

   Where, N_s- Synchronous speed in rpm
   N_r - Speed of the motor in rpm

6. Power factor, $Cos\Phi = \frac{P_{in}}{\sqrt{3} V_L I_L}$

   Where V_L – Line voltage

   I_L – Line current

CIRCUIT DIAGRAM:

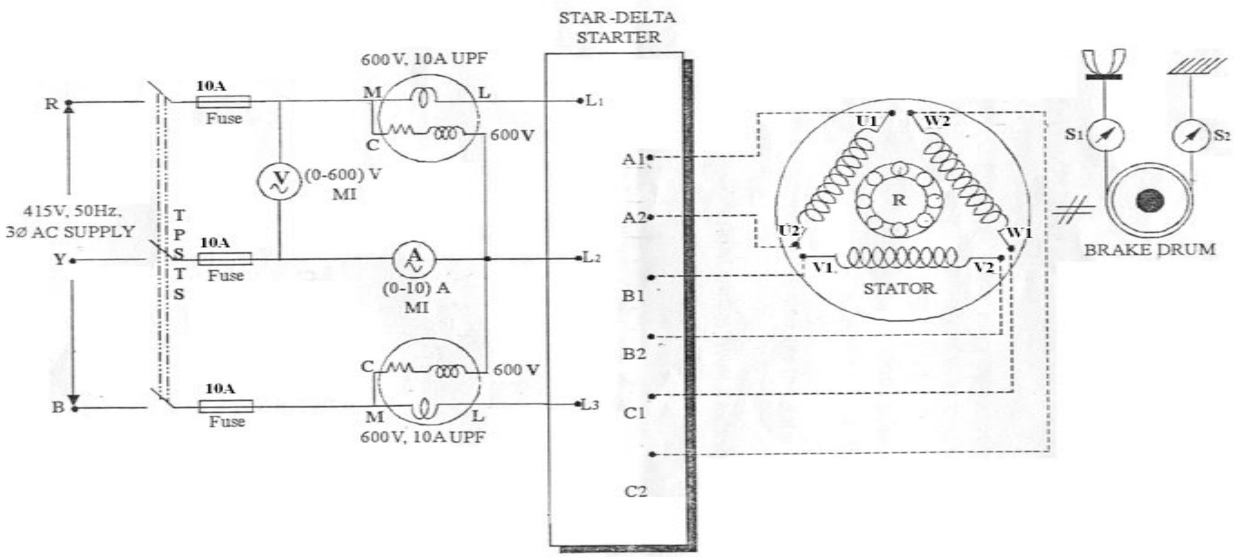


Fig4.1

TABULATION:

Circumference of brake drum =   in m
Thickness of the belt   =   in m

Multiplication Factor for W_1 =   Multiplication Factor for W_2 =

S.No	Load Current (I_L)	Load Voltage (V_L)	Wattmeter Readings				Input Power	Speed of the motor (N)	Spring Balance Reading			Torque	Output Power	η	Slip(S)	PF Cos Φ
			W_1		W_2											
			Obs	Actual	Obs	Actual			S_1	S_2	$S_1 \sim S_2$					
	A	V	W	W	W	W	W	RPM	Kg	Kg	Kg	N-m	W	%	%	

PRECAUTIONS:

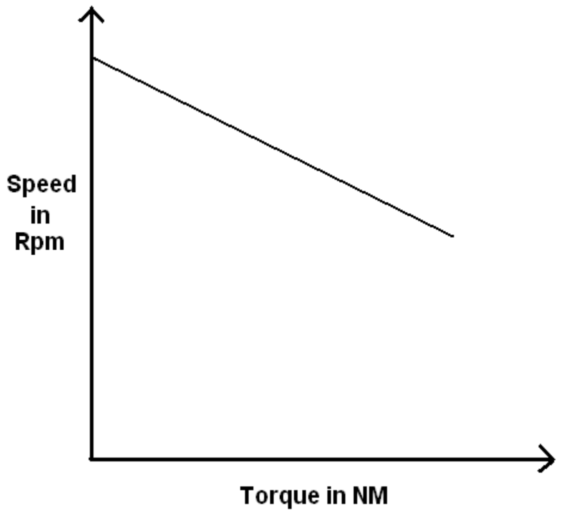
The motor should be started without load

PROCEDURE:

Step 1: Note down the name plate details of the motor.
Step 2: Make the Connections as per the circuit diagram.
Step 3: The TPST switch is closed and the motor is started using star delta starter to run at rated speed.
Step 4: At no load the speed, current, voltage and power are noted.
Step 5: By applying the load for various values of current and the above mentioned readings are noted in tabular column

Step 6: The load is later released and the motor is switched off and the graph is drawn.

MODEL GRAPH:



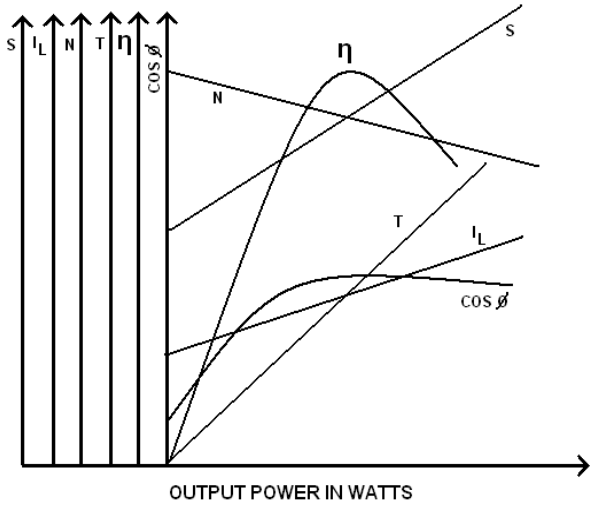


Fig 4.2 Mechanical Characteristics **Fig 4.3 Electrical Characteristics**

CALCULATIONS:

RESULT:

Thus the load test on three phase squirrel cage induction motor was conducted and the performance characteristic curves were drawn.

VIVA QUESTIONS:

1. What are the advantages and disadvantages of direct load test for 3 –phase Induction Motor?
2. What would happen if a 3 phase induction motor is switched on with one phase disconnected?
3. How will you reverse the direction of rotation of three phase induction motor?
4. When the induction motor operate as a generator?
5. Why is starter necessary to start a 3-phase induction motor?

Ex. No. : 5	NO LOAD AND BLOCKED ROTOR TEST ON THREE PHASE SQUIRREL CAGE INDUCTION MOTOR (DETERMINATION OF EQUIVALENT CIRCUIT PARAMETERS)
Date :	

AIM:

To conduct the no load test and blocked rotor test on three phase squirrel cage induction motor and draw the equivalent circuit.

NAME PLATE DETAILS:

3ϕ Induction Motor 3ϕ Auto Transformer

FUSE RATING:

No load: 10% of rated current (full load current) = Amps

Full load: 125% of rated current (full load current) = Amps

APPARATUS / INSTRUMENTS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	Ammeter	MC	(0-10)A	1
2	Ammeter	MI	(0-5)A	1
3	Ammeter	MI	(0-10)A	1
4	Voltmeter	MI	(0-150)V	1
5	Voltmeter	MI	(0-600)V	1
6	Voltmeter	MC	(0-30)V	1
7	Wattmeter	LPF	(600 V, 5A)	2
8	Wattmeter	UPF	(150 V,10A)	2
9	Tachometer	DIGITAL	-	1
10	Connecting wires	-	-	required

FORMULAE USED:
NO LOAD TEST:

No load power, $P_{OC} = \sqrt{3}V_0 I_0 cos\Phi_0$

No load power factor, $cos\Phi_0 = \frac{P_{OC}}{\sqrt{3}V_0 I_0}$

Iron loss component of no load current, $I_W = I_0 cos\Phi_0 \; Amps$

Magnetizing component of no load current, $I_\mu = I_0 sin\Phi_0$

Resistance to account for the iron loss, R_0 per phase = $\frac{\left(\frac{V_0}{\sqrt{3}}\right)}{I_W}$ Ω

Reactance to account for magnetization, X_0 per phase = $\frac{\left(\frac{V_0}{\sqrt{3}}\right)}{I_\mu}$ Ω

BLOCKED ROTOR TEST:

Blocked rotor power, $P_{SC} = \sqrt{3}V_{SC}I_{SC}cos\Phi_{SC}$

Blocked rotor power factor, $cos\Phi_{SC} = \frac{P_{SC}}{\sqrt{3}V_{SC}I_{sc}}$

Mean stator resistance, $R_{S\,mean}$ = Obtained from the tabulation → To find stator resistance.

Total winding resistance as referred to stator side, $R_{01}\ per\ phase = \frac{W_{SC}}{3I_{SC}^2}\ \Omega$

Impedance $Z_{01}\ per\ phase = \frac{\left(\frac{V_{SC}}{\sqrt{3}}\right)}{I_{SC}}\ \Omega$

Total leakage reactance as referred to stator side, $X_{01}\ per\ phase = \sqrt{Z_{01}^2 + R_{01}^2}\ \Omega$

Effective stator resistance, $R_{s(eff)} = \frac{(1.2\times R_m)}{2}\ \Omega$

As, it is difficult to isolate the leakage reactance's $X_1\ and\ X_2'$ they are assumed to be equal and given by, $X_1 = X_2' = \frac{X_{01}}{2}\ \Omega$

Rotor resistance as referred to the stator side, $R_2' = R_{01} - R_{s(eff)}\ \Omega$

Electrical equivalent of the mechanical load, $R_L = R_2'\left(\frac{1-S}{S}\right) = R_2'\left(\frac{1}{S} - 1\right)\ \Omega$

Where, Slip, $S = \frac{N_S - N}{N_s}$

CIRCUIT DIAGRAM:

NO LOAD TEST:

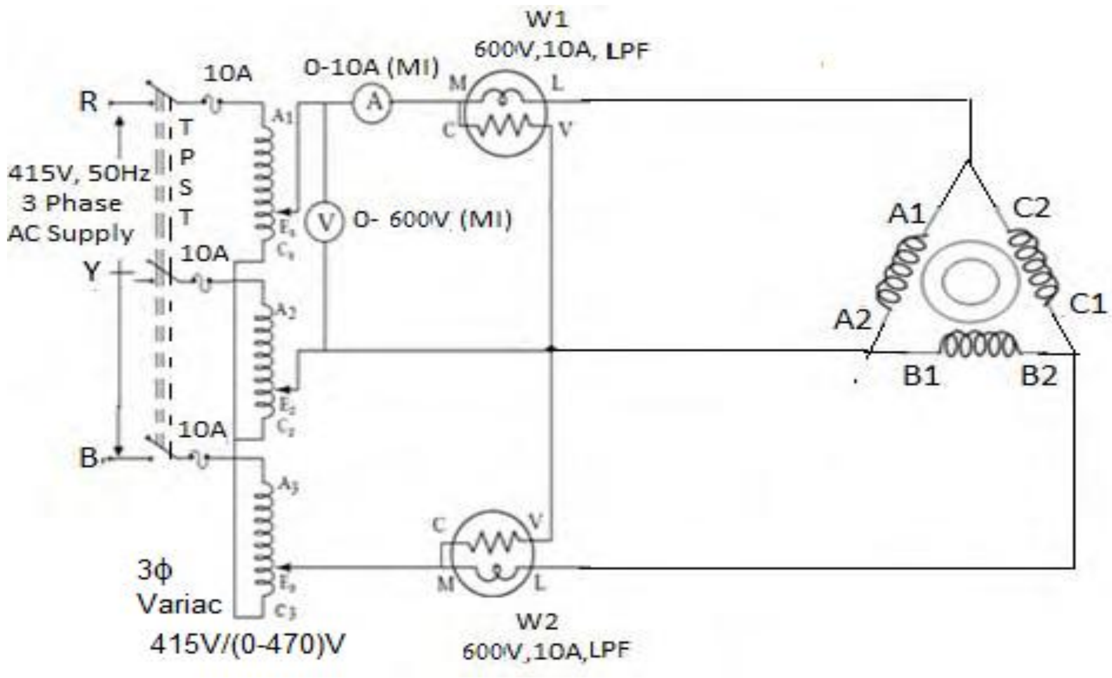


Fig 5.1

BLOCKED ROTOR TEST:

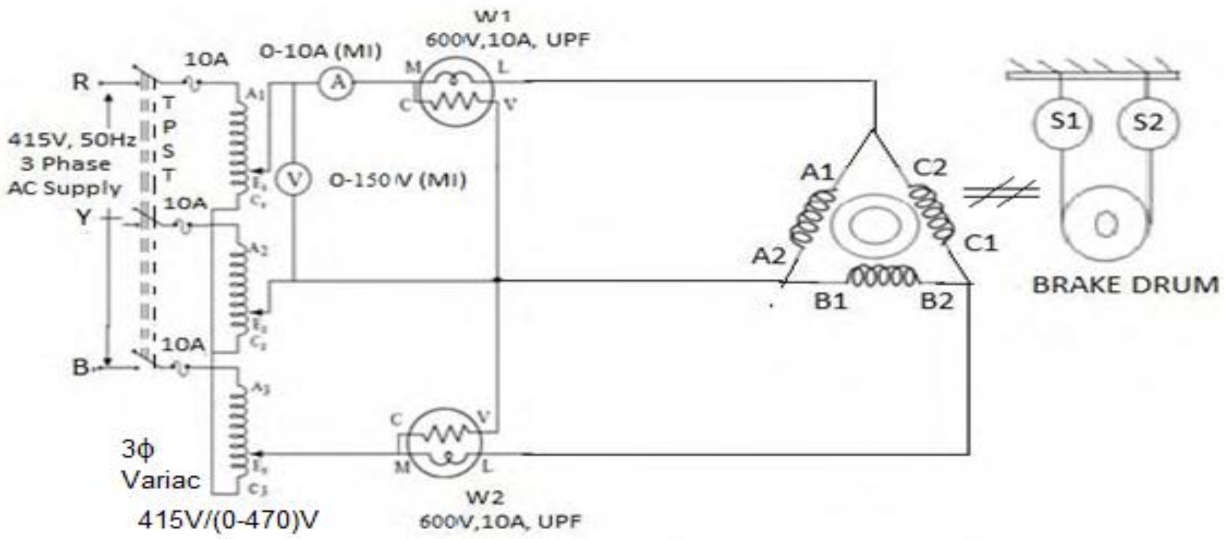


Fig 5.2

TO FIND STATOR RESISTANCE (R_S):

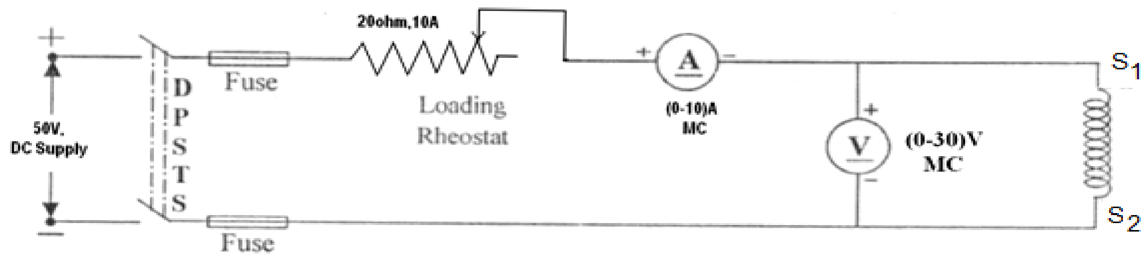


Fig 5.3

TABULATION:

No Load Test: Multiplying Factor: W_1 = W_2 =

S.No	Open Circuit Voltage (V_o) (Volts)	Open Circuit Current (I_o) (Amps)	Open Circuit Power (P_{OC}) (Watts)				
			W_1		W_2		Total (W_1+W_2)
			Observed	Actual	Observed	Actual	

BLOCKED ROTOR TEST: Multiplying Factor : W_1 = W_2 =

S.No	Blocked Rotor Voltage (V_{SC}) (Volts)	Blocked Rotor Current (I_{SC}) (Amps)	Blocked Rotor Power (P_{SC}) (Watts)				
			W_1		W_2		Total (W_1+W_2)
			Observed	Actual	Observed	Actual	

TO FIND STATOR RESISTANCE

S.No	Stator current (I)(Amps)	Stator voltage (V) (Volts)	Stator Resistance R=V/I Ω
Mean Resistance, R_m			

PRECAUTIONS:

The autotransformer should be kept in minimum voltage position**.**

PROCEDURE:

Step 1: Note down the name plate details of motor

Step 2: Connections are made as per the circuit diagram as shown in the figure for open circuit and blocked rotor test

Step 3: For no load test or open circuit test by adjusting the autotransformer, apply the rated voltage and note down the ammeter and wattmeter readings. In this test rotor is free to rotate.

Step 4: For short circuit test or blocked rotor test, by adjusting autotransformer, apply rated voltage and note down the ammeter and wattmeter readings. In this test the rotor is blocked.

Step 5: After that make the connection to measure the stator resistance as per the circuit diagram.

EQUIVALENT CIRCUIT/PHASE:

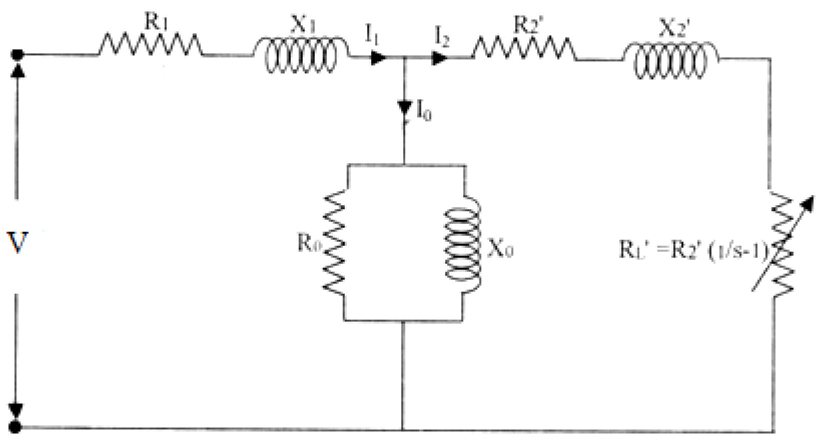


Fig 5.4

CALCULATION:

RESULT:

Thus the no load test and blocked rotor test on three phase squirrel cage induction motor were conducted and the equivalent circuit parameters were calculated.

VIVA QUESTIONS:

1. What are the informations obtained from no-load test in a 3-phase IM?
2. What are the informations obtained from blocked rotor test in a 3-phase IM?
3. What happens if the air gap flux density in an induction motor increases?
4. Can a three phase motor be run on a single phase line?
5. What is the standard direction of rotation of an induction motor?

Ex. No. : 6	SEPARATION OF NO LOAD LOSSES OF THREE PHASE INDUCTION MOTOR
Date :	

AIM:

To separate the no load losses in three phase squirrel cage induction motor.

NAME PLATE DETAILS:

3ϕ Induction Motor 3ϕ Auto Transformer

FUSE RATING:

10% of rated current (Full load current) = Amps

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	3Φ Auto transformer	-	415V/(0-470)V	1
2	Ammeter	MI	(0-10A)	1
3	Ammeter	MC	(0-10A)	1
4	Voltmeter	MC	(0-30V)	1
5	Voltmeter	MI	(0-600V)	1
6	Wattmeter	LPF	(600V,10A)	2
7	Rheostat	Wire wound	20Ω/10A	1
8	Tachometer	-	-	1
9	Connecting Wires	-	-	As required

FORMULAE USED:

1. Input power, $P_{in} = (W_1 + W_2)$ Watts

2. Stator copper loss = $3I_0^2 R_s$ Watts

3. Constant loss /phase$(W_C) = \frac{(P_{in} - 3I_0^2 R_s)}{3}$ Watts

4. Core loss/phase $(W_i) = Constant$ loss/phase$-Mechanical\ loss$

5. Effective stator resistance, $R_{s(eff)} = \frac{(1.2 \times R_m)}{2}$ Ω

PRECAUTION:

1. The autotransformer should be kept at minimum voltage position.

2. The motor should not be loaded throughout the experiment

CIRCUIT DIAGRAM:

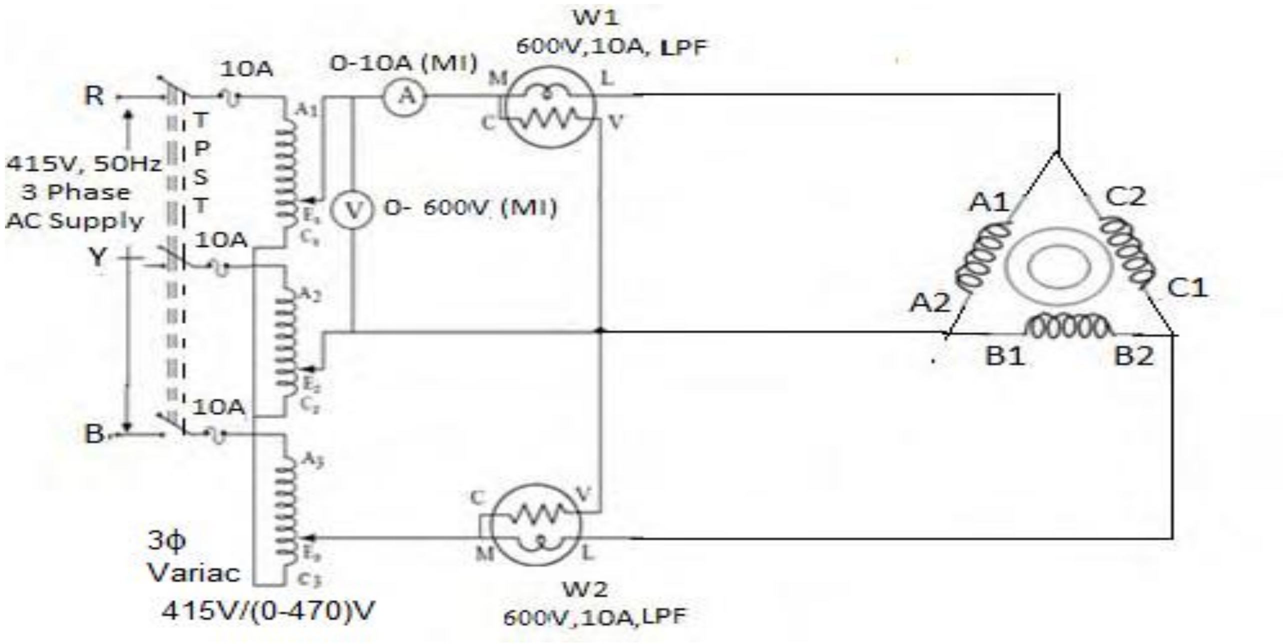


Fig 6.1

TO FIND STATOR RESISTANCE (R_S):

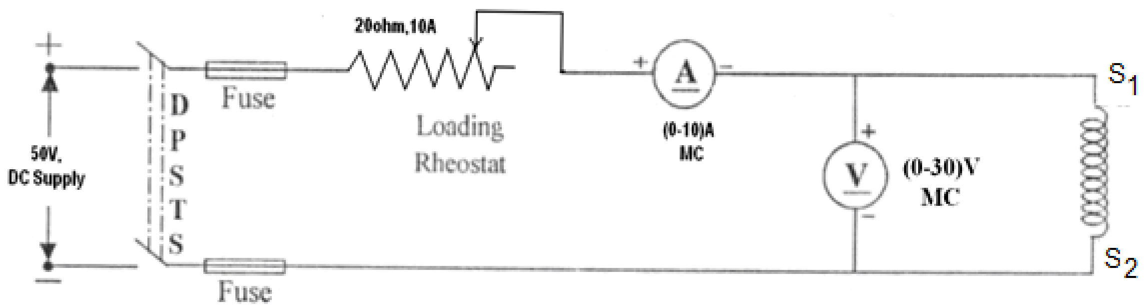


Fig 6.2

TABULATION :

Multiplication Factor: W_1= W_2=

S. No	No load Voltage	No load current	No load input power				Total input power $P_{in}=W_1+W_2$	Stator cu loss	Constant loss/ phase	Core loss/ phase
			W_1		W_2					
			Obs	Act	Obs	Act				

TO FIND STATOR RESISTANCE:

S.No	Stator current (I)(Amps)	Stator voltage (V) (Volts)	Stator Resistance R=V/I Ω
		Mean Resistance,R_m	

PROCEDURE:

Step 1: Note down the nameplate details of motor.
Step 2: The connections should be made as per the circuit diagram shown in figure.
Step 3: By giving 3 phase supply through the autotransformer, start the motor.
Step 4: The autotransformer should be varied till the motor attains its rated speed and tabulate the input power, voltage and current.
Step 4: Repeat the same procedure for some more low values of the voltage and tabulate the readings.
Step 5: Find the stator copper loss and constant loss by respective formula.
Step 6: Draw the graph Constant loss vs No load voltage to find the mechanical loss.
Step 7: Obtain the core loss by separating the mechanical loss from the constant loss

MODEL GRAPH:

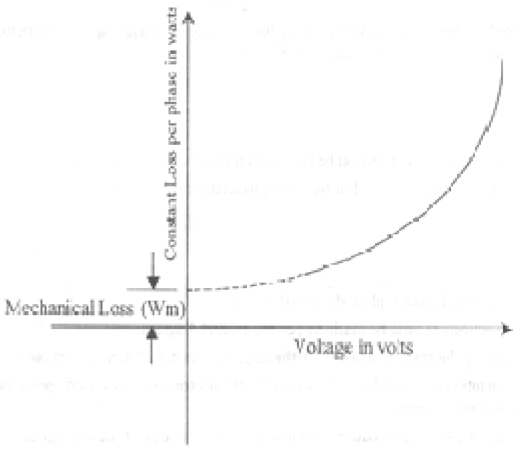


Fig 6.3

CALCULATIONS:

RESULT:

Thus the no load losses in three phase squirrel cage induction motor were separated.

VIVA QUESTIONS:

1. State the principle of 3 phase IM?
2. What is the purpose of using auto transformer?
3. What are the losses occurring in an IM and on what factors do they depend?
4. Why is there no appreciable magnetic losses in the rotor core of Induction Motors?
5. What are all the possible reasons if a 3-phase motor fails to start?

Ex. No. : 7	REGULATION OF THREE PHASE ALTERNATOR BY EMF AND MMF METHODS
Date :	

AIM:

To predetermine the regulation of three phase alternator by EMF and MMF methods.

NAME PLATE DETAILS:

3ϕ Alternator

DC Shunt Motor

FUSE RATING:

125% of Rated Current (Full Load Current)

For DC Shunt Motor: Amps

For Alternator: Amps

APPARATUS REQUIRED:

S.No.	Name of the apparatus	Type	Range	Quantity
1	Ammeter	MC	(0-2)A	1
2	Ammeter	MC	(0-10)A	1
3	Ammeter	MI	(0-10)A	1
4	Voltmeter	MI	(0-600)V	1
5	Voltmeter	MC	(0-30)V	1
6	Rheostat	Wire Wound	(230Ω,1.7A)	1
7	Rheostat	Wire Wound	(300Ω,2A)	1
8	Rheostat	Wire Wound	(20Ω,10A)	1
9	TPST Switch	-	-	1
10	Tachometer	-	-	1
11	Connecting wires	-	-	Required

FORMULA USED:

1. Armature resistance, $R_a = 1.2R_m\ \Omega$
2. Synchronous impedance, $Z_s = \frac{Open\ \ circuit\ \ voltage\ \ (E_{ph})}{Short\ circuit\ \ current\ \ (I_{sc})}$ Ω (from graph)
3. Synchronous reactance, $X_s = \sqrt{Z_s^2 - R_a^2}\ \ \Omega$
4. Open circuit voltage, $E_0 = \sqrt{(V_{rated}\, cos\Phi + I_a R_a)^2 + (V_{rated}\, sin\Phi + I_a X_s)^2}\ Volts.$
   (For lagging power factor)
5. Open circuit voltage, $E_0 = \sqrt{(V_{rated}\, cos\Phi + I_a R_a)^2 - (V_{rated}\, sin\Phi + I_a X_s)^2}\ Volts.$
   (For leading power factor)

6. Open circuit voltage, $E_0 = \sqrt{(V_{rated} + I_a R_a)^2 + (I_a X_s)^2}\ Volts.$
   (For unity power factor)

7. Percentage regulation $= \frac{E_0 - V_{rated}}{V_{rated}} \times 100$ (for both EMF and MMF methods)

MMF METHOD:

1. From the O.C.C. graph, find
   (a) I_{F1} - Field current required to produce rated voltage per phase.
   (b) I_{F2} - Field current required to produce rated current per phase during S.C. test.
2. Calculate, $I_f = \sqrt{I_{F1}^2 + I_{F2}^2 + 2I_{F1}I_{F2}COS(90 + \Phi)}$ - For lagging Power factor
3. Calculate, $I_f = \sqrt{I_{F1}^2 + I_{F2}^2 + 2I_{F1}I_{F2}COS(90 - \Phi)}$ - For leading Power factor
4. Calculate, $I_f = \sqrt{I_{F1}^2 + I_{F2}^2}$ - For unity Power factor
5. Calculate E_0 corresponding to I_f from and O.C.C and S.C.C graphs.
6. Percentage regulation $= \frac{E_0 - V_{rated}}{V_{rated}} \times 100$

CIRCUIT DIAGRAM:

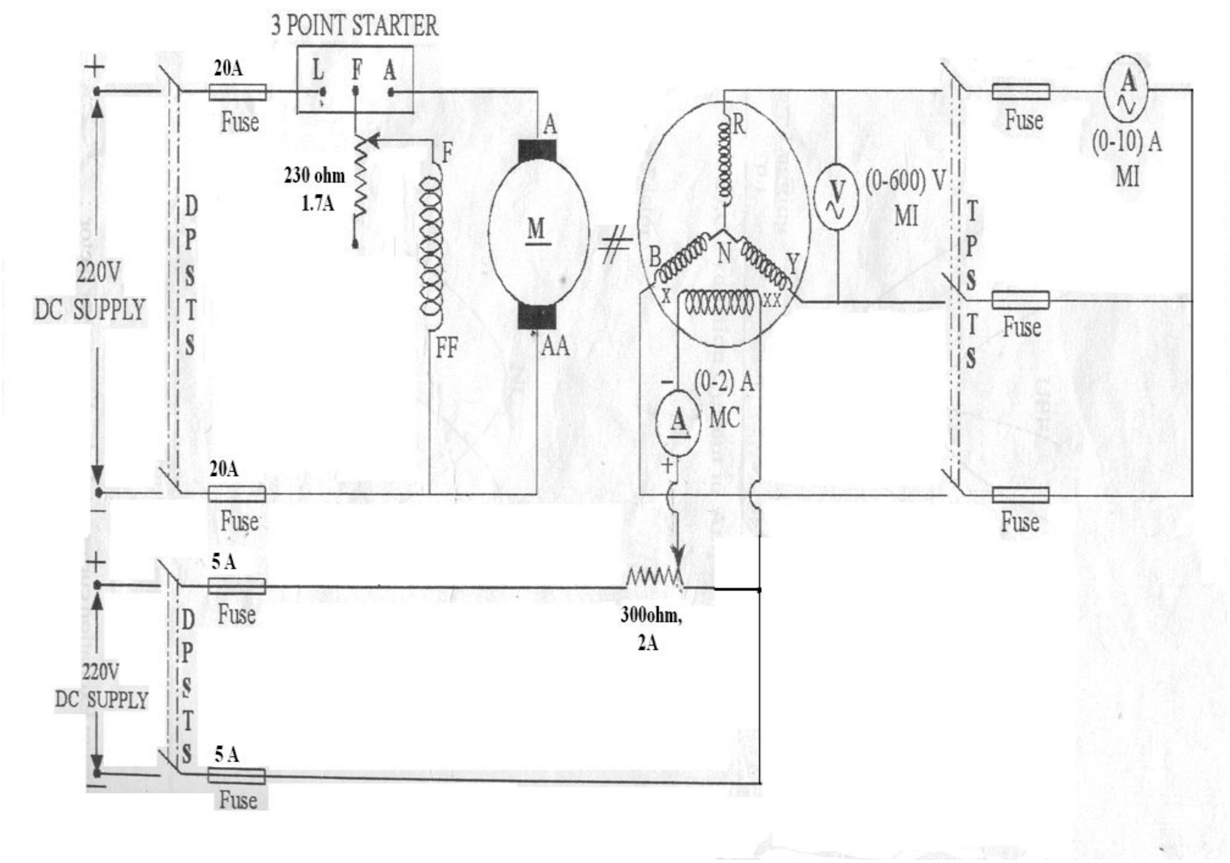


Fig 7.1

TO FIND ARMATURE RESISTANCE (R_a):

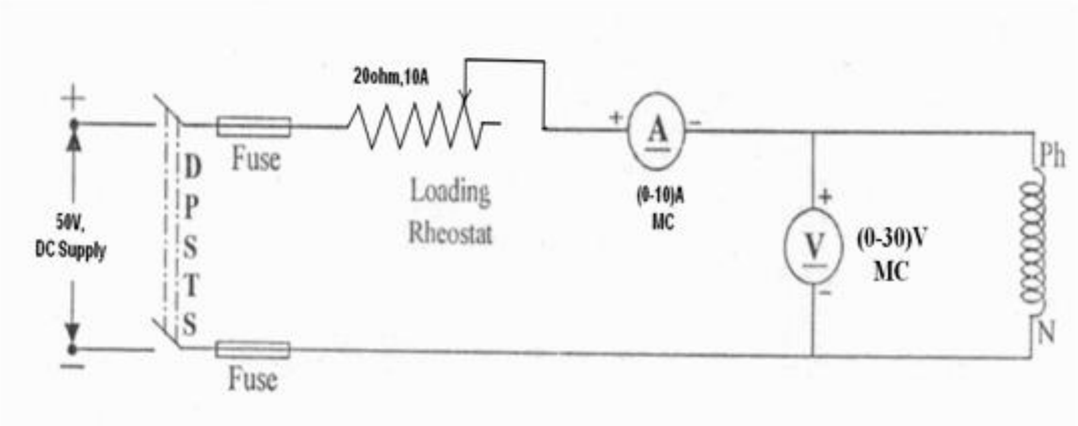


Fig 7.2

TABULATION:

O.C TEST:

S.No	Field current(I_f) (Amps)	Open circuit line voltage(V_{OL}) (Volts)	Open circuit phase voltage($V_{o(ph)}$) (Volts)

S.C TEST:

S.No	Field current(I_f) Amps	Short circuit current (120 to 150% of rated current (I_{SC})) Amps

TO FIND OUT THE ARMATURE RESISTANCE:

S.No	Armature current (I) Amps	Armature voltage (V) Volts	Armature resistance R=V/I Ω
		Mean Resistance, R_m	

S.NO	PERCENTAGE OF REGULATION						
	Power factor	EMF METHOD			MMF METHOD		
		Lagging	Leading	Unity	Lagging	Leading	Unity
1.	0.2			-			-
2.	0.4			-			-
3.	0.6			-			-
4.	0.8			-			-
5.	1.0	-	-		-	-	

PRECAUTIONS:

1. The motor field rheostat should be kept in the minimum resistance position.
2. The alternator field potential divider should be in minimum voltage position
3. Initially all switches are in open position.

PROCEDURE FOR BOTH EMF AND MMF METHODS:

Step 1: The circuit diagram is shown in figure. Note down the name plate details of motor and alternator.
Step 2: Connections are made as per the circuit diagram.
Step 3: Give the supply by closing the DPST switch.
Step 4: Using the three point starter, start the motor to run at the synchronous speed by varying the motor field rheostat.
Step 5: Conduct an open circuit test by varying the potential divider for various values of field current and tabulate the corresponding open circuit readings. The tabulation for regulation of three phase alternator by EMF and MMF methods are shown in table.
Step 6: Conduct a short circuit test by closing the TPST switch and adjust the potential divider to set the rated armature current, tabulate the corresponding field current.
Step 7: Conduct a stator resistance test by giving connection as per the circuit diagram and tabulate the voltage and current readings for various resistive loads.

PROCEDURE TO DRAW THE GRAPH FOR EMF METHOD:

Step 1: Draw the open circuit characteristics curve (generated voltage per phase vs field current)
Step 2: Draw the short circuit characteristics curve(short circuit current vs field current)
Step 3: From the graph find the open circuit voltage per phase ($E_{1(PH)}$) for rated short circuit current(I_{SC}).
Step 4: By using respective formulae find the Z_s, X_s, E_o and percentage regulation.
Step 5: Draw the graph as shown in model graph.

PROCEDURE TO DRAW THE GRAPH FOR MMF METHOD:

Step 1: Draw the open circuit characteristics curve (generated voltage per phase vs field current)
Step 2: Draw the short circuit characteristics curve (short circuit current vs field current)
Step 3: Draw the line OL to represent I_F' which gives the rated generated voltage (V)
Step 4: Draw the line LA at an angle ($90\pm\phi$) to represent I_F" which gives the rated full load current (I_{SC}) on short circuit ($90+\phi$) for lagging power factor and ($90-\phi$) for leading power factor)
Step 5: Join the points O and A and find the field current (I_F) by measuring the distance OA that gives the open circuit voltage (E_0) from the open circuit characteristics.
Step 6: Find the percentage regulation by using suitable formulae.

MODEL GRAPH:

EMF METHOD

REGULATION CURVE:

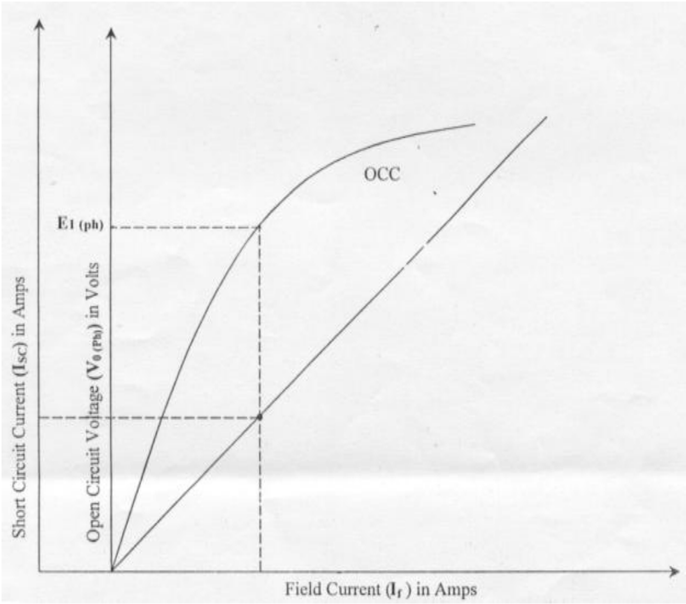


Fig 7.2

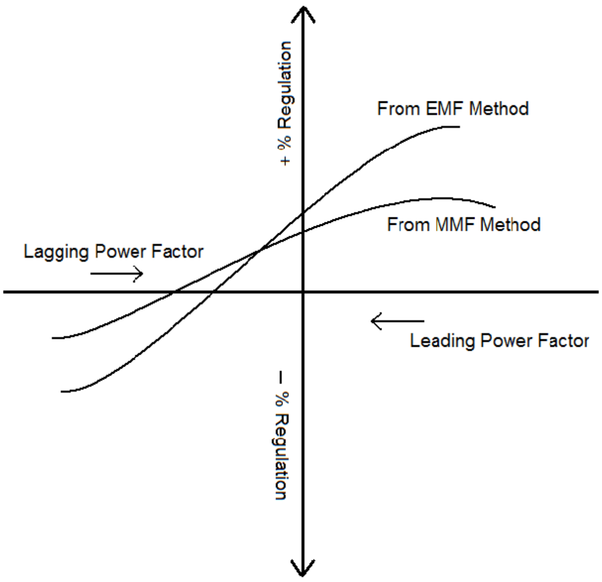


Fig 7.3

MMF METHOD:

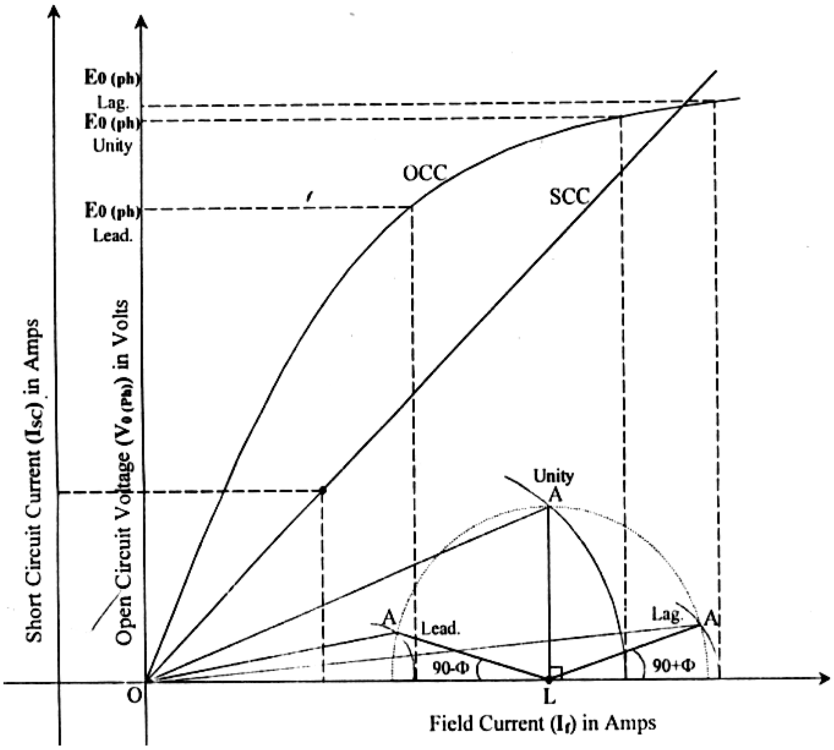


Fig 7.4

CALCULATIONS:

RESULT:

Thus the regulation of three phase alternator was predetermined by EMF and MMF methods.

VIVA QUESTIONS:

1. What is an alternator? How it is classified?
2. Why are alternators rated in KVA?
3. What is the necessity for predetermination of Voltage regulation?
4. Why is the synchronous impedance method of estimating voltage regulation considered as pessimistic method?
5. Why is the MMF method of estimating the voltage regulation considered as the optimistic method?

Exp. No. : 8	REGULATION OF THREE PHASE ALTERNATOR BY ZPF AND ASA METHODS
Date :	

AIM:

To predetermine the regulation of three phase alternator by ZPF and ASA methods.

NAME PLATE DETAILS:

3ϕ Alternator

DC Shunt Motor

FUSE RATING:

125% of Rated Current (Full Load Current)

For DC Shunt Motor: Amps

For Alternator: Amps

APPARATUS REQUIRED:

S.No.	Name of the apparatus	Type	Range	Quantity
1	Ammeter	MC	(0-2)A	1
2	Ammeter	MC	(0-10)A	1
3	Ammeter	MI	(0-10)A	1
4	Voltmeter	MI	(0-600)V	1
5	Voltmeter	MC	(0-30)V	1
6	Rheostat	Wire Wound	(230Ω,1.7A)	1
7	Rheostat	Wire Wound	(300Ω,2A)	1
8	Rheostat	Wire Wound	(20Ω,10A)	1
9	Wattmeter	LPF	600V,10A	2
10	Inductive Load	-	415V,10A	1
11	TPST Switch	-	-	1
12	Tachometer	-	-	1
13	Connecting wires	-	-	Required

FORMULA USED:

$$\text{Percentage regulation} = \frac{V\text{no load} - \text{V load}}{\text{Vno load}} \text{ X100}$$

Armature Resistance, $R_a = 1.2Rf$

PRECAUTIONS:

1. The motor field rheostat should be kept in minimum position.
2. The Alternator field potential divider should be in the maximum voltage position.
3. Initially all switches are in open position.

CIRCUIT DIAGRAM:

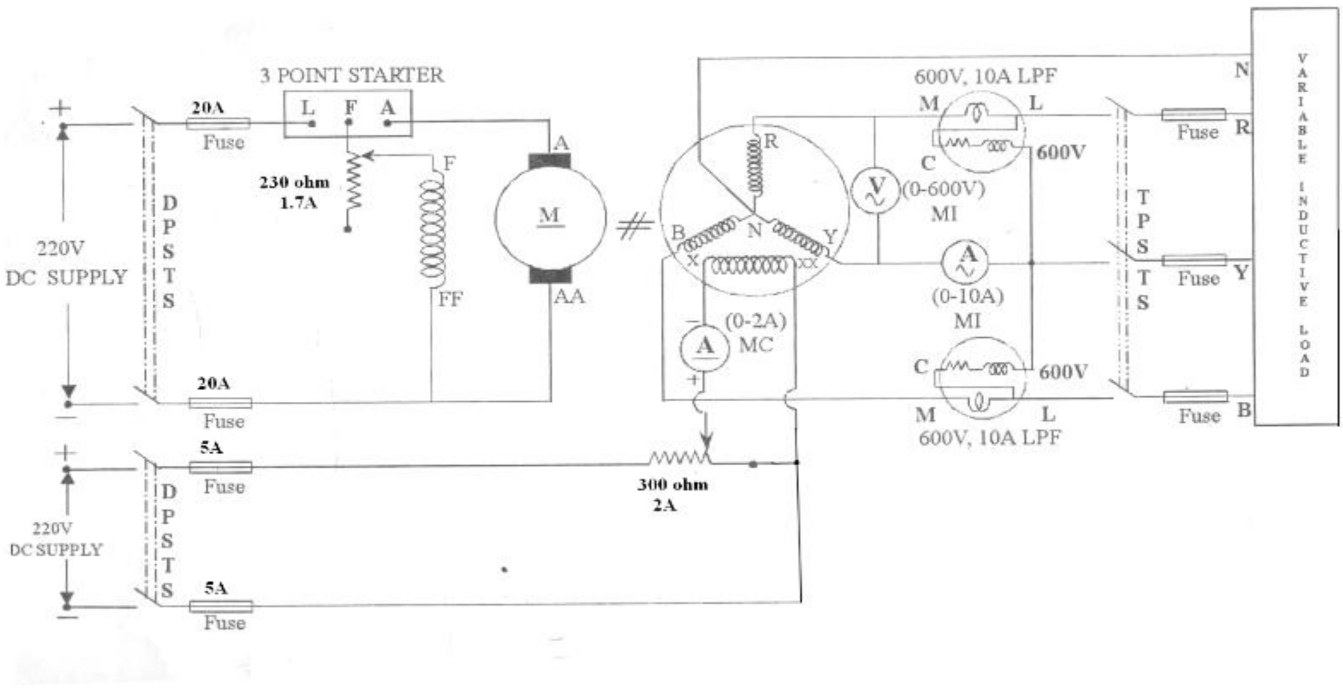


Fig 8.1

TO FIND ARMATURE RESISTANCE:

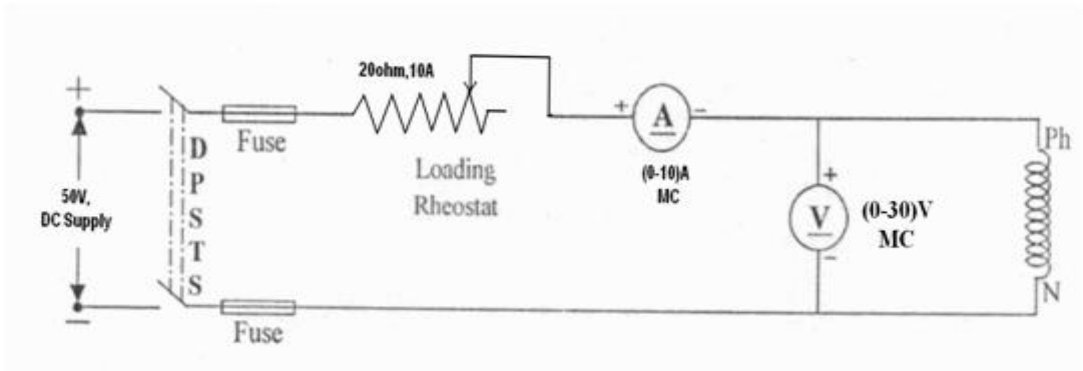


Fig 8.2

TABULATION:
O.C TEST:

S.No	Field current(I_f) (Amps)	Open circuit line voltage(V_{OL}) (Volts)	Open circuit phase voltage($V_{o(ph)}$) (Volts)

S.C TEST:

S.No	Field current(I_f) Amps	Short circuit current (120 to 150% of rated current (I_{SC})) Amps

TO FIND OUT THE ARMATURE RESISTANCE:

S.No	Armature current (I) Amps	Armature voltage (V) Volts	Armature resistance R=V/I Ω
		Mean Resistance, R_m	

ZERO POWER FACTOR TEST:

S.No	Field current (A)	Rated armature Current (A)	Rated armature Voltage (V)	W_1 (Watts)		W_2 (Watts)		Total Watts (W_1+W_2)
				OBS	ACT	OBS	ACT	

PROCEDURE FOR BOTH POTIER AND ASA METHODS:

Step 1: Note down the complete nameplate details of motor and alternator.

Step 2: Connections are made as per the circuit diagram.

Step 3: Switch on the supply by closing the DPST main switch.

Step 4: Using the Three point starter, start the motor to run at the synchronous speed by varying the motor field rheostat.

Step 5: Conduct an Open Circuit Test by varying the Potential Divider for various values of Field current and tabulate the corresponding Open circuit voltage readings.

Step 6: Conduct a Short Circuit Test by closing the TPST knife switch and adjust the potential divider the set the rated Armature current, tabulate the corresponding Field current.

Step 7: To conduct zero power factor test, the switch TPST is kept closed. Due to this, an inductive load gets connected to an alternator through an ammeter. A purely inductive load has power factor of cos i.e. zero lagging hence the test is called zero power factor test. The machine speed is maintained constant at its synchronous value. The load current delivered by an alternator to purely inductive load is maintained constant at its rated full load value by varying excitation and by adjusting variable inductance of the inductive load. Note that, due to purely inductive load, an alternator will always operate at zero p.f. lagging. This is the graph of terminal voltage against excitation when delivering full load zero power factor current

Step 8: Conduct a armature resistance test by giving connection as per the circuit diagram and tabulate the voltage and Current readings by changing the value of rheostat.

PROCEDURE TO DRAW POTIER TRIANGLE [ZPF METHOD]:

Step 1: Plot OCC and SCC.
Step 2: Draw tangent to OCC (air gap line).
Step 3: Conduct ZPF test at full load for rated voltage and fix the point B.
Step 4: Draw the line BH with length equal to field current required to produce full load current at short circuit.
Step 5: Draw HD parallel to the air gap line so as to touch the OCC.
Step 6: Draw DE parallel to voltage axis. Now, DE represents voltage drop IX_L and BE represents the field current required to overcome the effect of armature reaction.
Step 7: Triangle BDE is called Potier triangle and X_L is the Potier reactance
Step 8: Find E from V, IX_L and Φ. Consider R_a also if required. The expression to use is

$$E = \sqrt{(V\cos\Phi + IR_a)^2 + (V\sin\Phi + IX_L)^2}$$

Step 9: Find field current corresponding to *E.*
Step 10: Draw FG with magnitude equal to BE at angle (90+Ψ) from field current axis, where Ψ is the phase angle of current from voltage vector *E* (internal phase angle).
Step 11: The resultant field current is given by OG. Mark this length on field current axis.
Step 12: From OCC find the corresponding E_0. Then regulation is calculated.

PROCEDURE TO DRAW ASA DIAGRAM:

Step 1: Follow steps 1 to 7 as in ZPF method.
Step 2: Find I_{f1} corresponding to terminal voltage *V* using air gap line (OF_1 in figure).
Step 3: Draw I_{f2} with length equal to field current required to circulate rated current during short circuit condition at an angle (90+Φ) from I_{f1}. The resultant of I_{f1} and I_{f2} gives *If* (OF_2 in figure).
Step 4: Extend OF_2 up to F so that F_2F accounts for the additional field current accounting for the effect of saturation. F_2F is found for voltage E as shown.
Step 5: Project total field current OF to the field current axis and find corresponding voltage E_0 using OCC. Then regulation is calculated.

MODEL GRAPH:
ZPF METHOD:

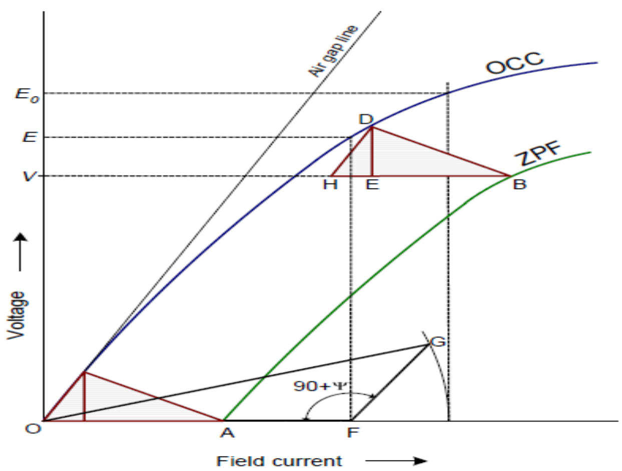


Fig 8.3

ASA METHOD:

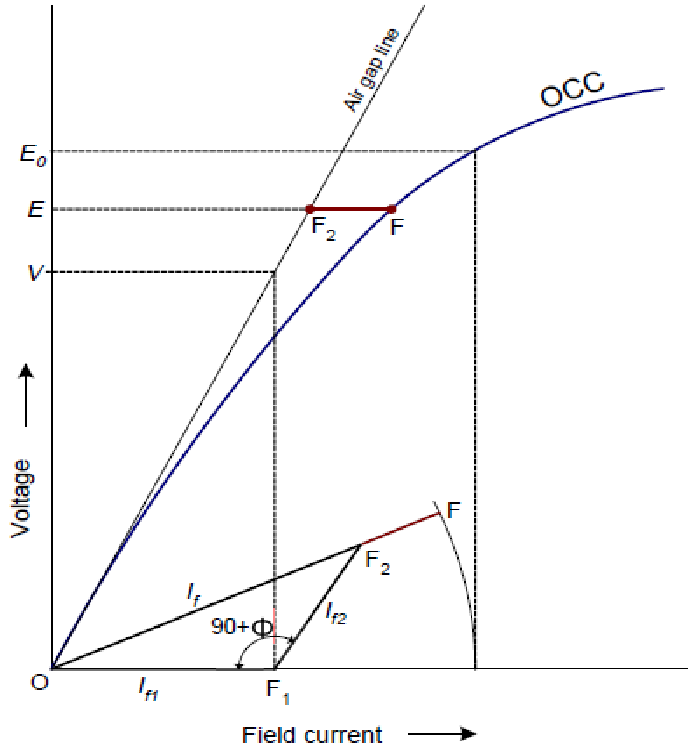


Fig 8.4

CALCULATIONS:

RESULT:

Thus the regulation of three phase alternator was predetermined by ZPF and ASA methods.

VIVA QUESTIONS:

1. Can a D.C. generator be converted into an alternator? If yes, how it is achieved?
2. What are the characteristics required for potier method of computing voltage regulation?
3. Why is the short circuit characteristic of an alternator linear?
4. How will you obtain zero power factor lagging curve?
5. What is meant by ASA?

Exp. No. : 9	REGULATION OF THREE PHASE SALIENT POLE ALTERNATOR BY SLIP TEST
Date :	

AIM:

To predetermine the regulation of three phase salient pole alternator by performing slip test.

NAME PLATE DETAILS:

3ϕ Alternator

DC Shunt Motor

FUSE RATING:

125% of rated full load current.

For DC Shunt Motor: Amps

For Alternator: Amps

APPARATUS REQUIRED:

S.No.	Name of the apparatus	Type	Range	Quantity
1	3Φ Auto transformer	-	415V/(0-470)V	1
2	Ammeter	MC	(0-10)A	1
3	Ammeter	MI	(0-10)A	1
4	Voltmeter	MI	(0-150)V	1
5	Voltmeter	MC	(0-30)V	1
6	Rheostat	Wire Wound	(230Ω,1.7A)	1
7	Rheostat	Wire Wound	(20Ω,10A)	1
8	TPST Switch	-	-	1
9	Tachometer	-	-	1
10	Connecting wires	-	-	As Required

FORMULA USED:

1. Effective Armature Resistance, $R_a = 1.2 R_m \Omega$
2. Direct axis impedance, $Z_d = \frac{Maximum\ \ Voltage}{Minimum\ \ Current}\ \Omega$
3. Quadrature axis impedance, $Z_q = \frac{Minimum\ \ Voltage}{Maximum\ \ Current}\ \Omega$
4. Direct axis reactance, $X_d = \sqrt{(Z_d^2 - R_a^2)}\ \Omega$
5. Quadrature axis reactance, $X_q = \sqrt{(Z_q^2 - R_a^2)}\ \Omega$
6. $\Psi = tan^{-1}\left(\frac{V\ sin\Phi + I_a X_q}{V\ cos\Phi + I_a R_a}\right)$ $where, I_a = Rated\ armature\ current$
7. $\delta = \Psi - \Phi$ (Angle Φ is taken positive for lagging P.F and negative for leading P.F)

8. Direct axis current, $I_d = I_a sin\Psi$ Amps

9. Quadrature axis current, $I_q = I_a cos\Psi$ Amps

10. $E_0 = V\ cos\delta + I_q R_a + I_d X_d$ Volts

11. Percentage voltage regulation $= \frac{E_0 - V_{rated}}{V_{rated}} \times 100$

CIRCUIT DIAGRAM:

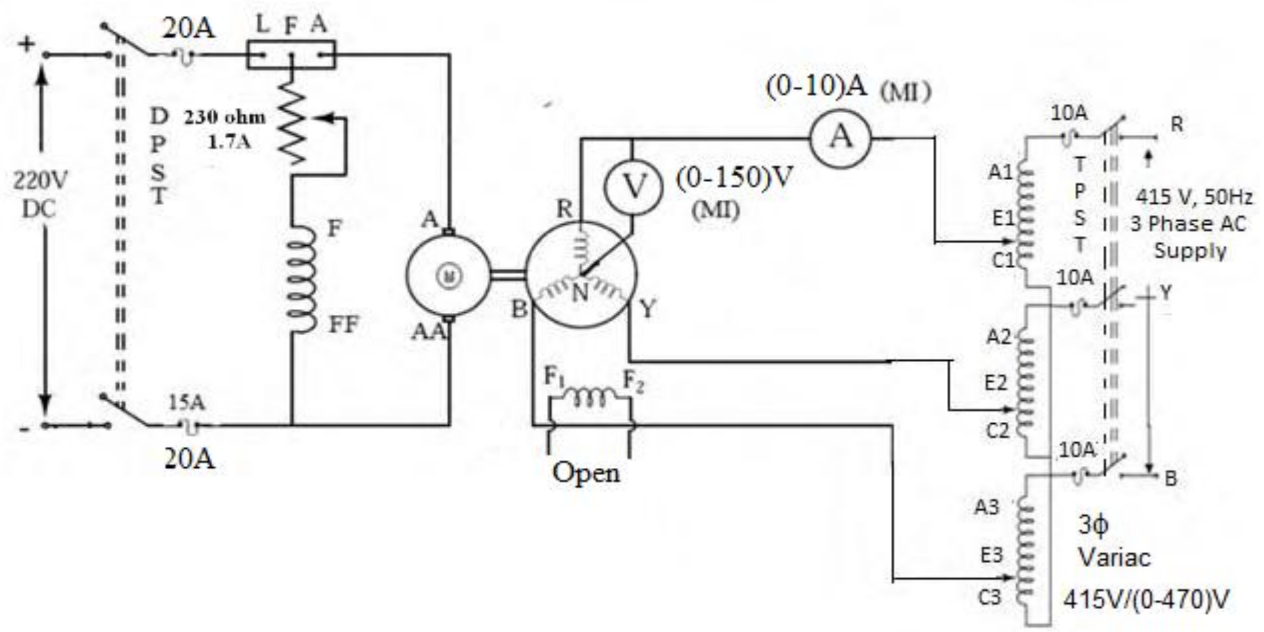


Fig 9.1

TO FIND ARMATURE RESISTANCE (R_a):

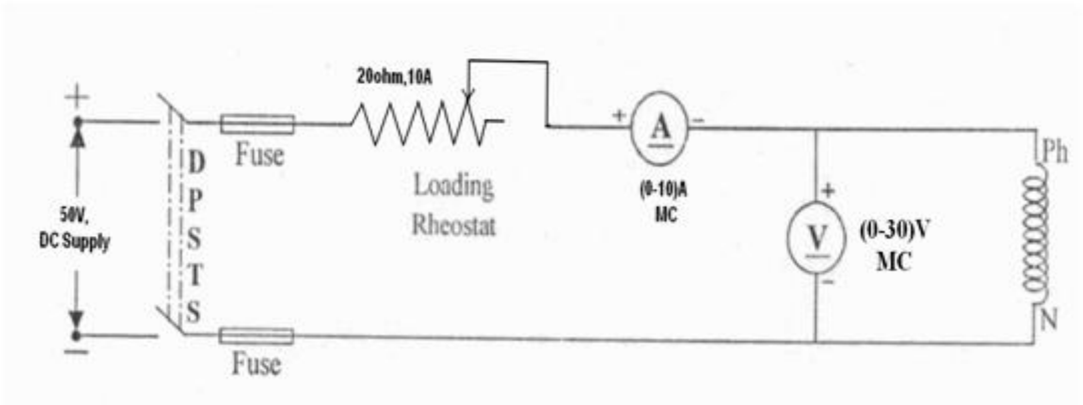


Fig 9.2

PRECAUTIONS:

1. The motor field rheostat and three phase VARIAC should be kept in minimum position.
2. The Alternator field should be kept open.
3. Initially all switches are in open position.

TABULATION:

TO FIND Z_d and Z_q:

S. No	Maximum Voltage (Volts)	Minimum Voltage (Volts)	Maximum Current (Amps)	Minimum Current (Amps)	Direct axis impedance (Z_d)Ω	Quadrature axis impedance (Z_q)Ω
				Average		

TO FIND OUT THE ARMATURE RESISTANCE:

S.No	Armature current (I) Amps	Armature voltage (V) Volts	Armature resistance R=V/I Ω
		Mean Resistance,R_m	

PERCENTAGE REGULATION:

S.No	Power factor (Cosϕ)	No load Voltage (E_o) Volts	% Regulation
1	0.6 lead		
2	0.8 lead		
3	Unity		
4	0.6 lag		
5	0.8 lag		

PROCEDURE:

Step 1: Make connections as shown in circuit diagram.

Step 2: Start the set and bring it to near synchronous speed keeping the field of the alternator open.

Step 3: Apply an AC voltage of reduced magnitude (about 25% of the rated value). The field poles and armature mmf should rotate in same direction this can be verified by measuring the voltage across the field winding (It should be nearly equal to zero) Otherwise interchange the stator terminals.

Step 4: Adjust the speed of the alternator to get sufficient oscillations (Maximum deflection) in the meter.

Step 5: Note down the maximum and minimum value of ammeter and voltmeter.

MODEL GRAPH:

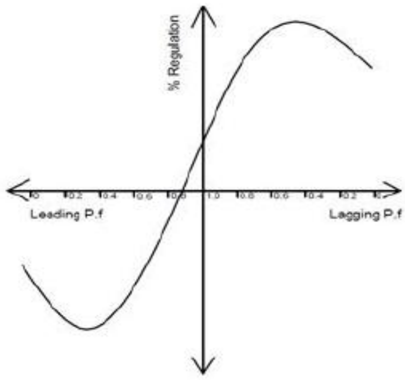


Fig 9.3

CALCULATIONS:

RESULT:

Thus the regulation of three phase salient pole alternator was predetermined by slip test.

VIVA QUESTIONS:

1. Compare salient pole rotor with cylindrical rotor.
2. What is the purpose of conducting slip test in an alternator?
3. Why voltage regulation of an alternator is negative for leading P.F?
4. Specify the condition beyond which the synchronous machine is said to be out-of-step?
5. In an alternator, smooth rotor is used for high speeds and salient pole rotor for low speeds. Why?

Exp. No. : 10	V AND INVERTED V CURVES OF THREE PHASE SYNCHRONOUS MOTOR
Date :	

AIM:

To draw the V and inverted V curves of three phase synchronous motor.

NAME PLATE DETAILS:

3ϕ Synchronous Motor

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	3Φ Auto transformer	-	415V/(0-470)V	1
2	Ammeter	MC	(0-2)A	1
3	Ammeter	MI	(0-10)A	1
4	Voltmeter	MI	(0-600)V	1
5	Power factor meter	Double element	(500V,10A)	1
6	Rheostat	Wire wound	500Ω,10A	1
7	Tachometer	Digital	-	1
8	Connecting Wires	-	-	As required

FUSE RATING:

125% of rated current (Full load current)

For DC excitation = Amps
For synchronous motor = Amps

PRECAUTION:-

1. The potential divider should be in the maximum position.
2. The motor should be started without any load.
3. Initially all switches are in open position.

PROCEDURE:

Step 1: Connections are made as per the circuit diagram.
Step 2: Close the T. P. S. T. switch.
Step 3: The auto transformer is varied gradually to start the motor.
Step 4: The auto transformer is adjusted till the voltmeter reads the rated voltage of the synchronous motor.
Step 5: Close the D. P. S. T. switch and increase the field current.
Step 6: At no load condition, increase the field current in steps and note down the corresponding armature current and power factor.
Step 7: Repeat the same procedure for different load conditions.
Step 8: Reduce the load on the motor.
Step 9: Reduce the field current to zero value.
Step 10: Reduce voltage by varying auto transformer.
Step 11: Open all the switches.

CIRCUIT DIAGRAM:

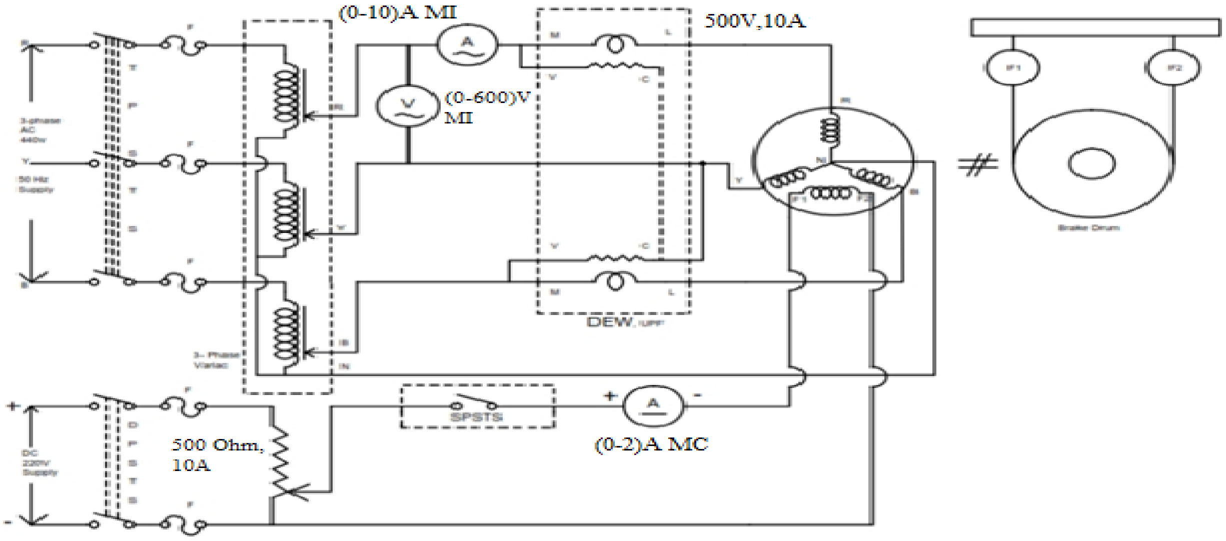


Fig 10.1

TABULATION:

WITHOUT LOAD

S.No	Stator Voltage	Stator Current	Field Current	Power Factor

WITH LOAD

S.No	Stator Voltage	Stator Current	Field Current	Power Factor	Spring Balance	
					S1	S2

MODEL GRAPH :

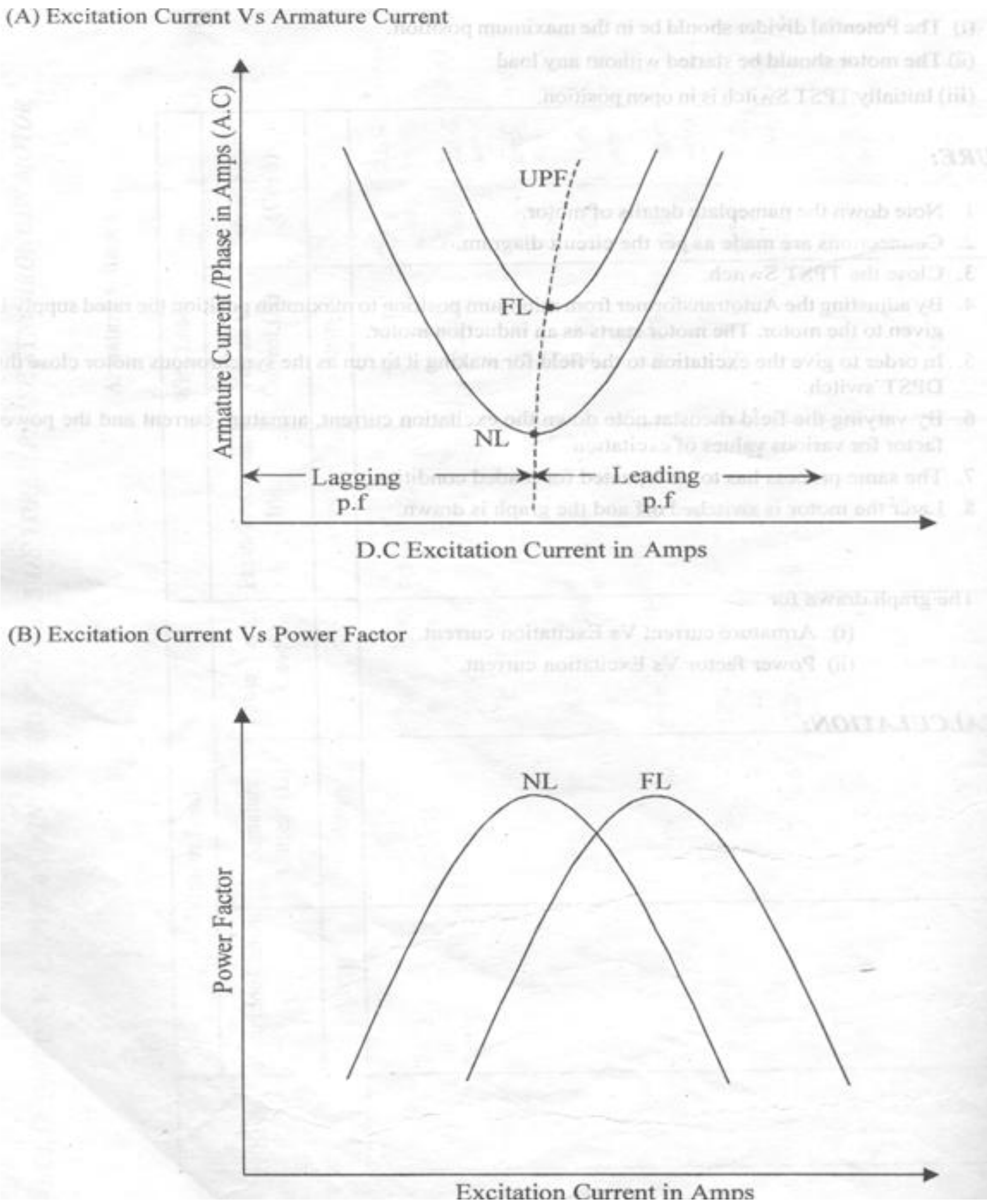


Fig 10.2

RESULT:

Thus the V and inverted V curves of three phase synchronous motor were drawn.

VIVA QUESTIONS:

1. What are the characteristic features of synchronous motor?
2. In what way synchronous motor is different from other motors?
3. What is the effect on speed if the load is increased on a 3 phase synchronous motor?
4. Why a synchronous motor is a constant speed motor?
5. How the synchronous motor can be used as s synchronous condenser?

Exp. No. : 11	MEASUREMENTS OF NEGATIVE SEQUENCE AND ZERO SEQUENCE IMPEDANCES OF AN ALTERNATOR
Date :	

AIM:

To determine negative sequence and zero sequence impedances of an alternator.

NAME PLATE DETAILS:

3Φ Alternator   DC Shunt Motor

FUSE RATING:

125% of rated current

DC Shunt Motor = Amps
3Φ Alternator = Amps

APPARATUS REQUIRED:

S.No.	Name of the apparatus	Type	Range	Quantity
1	1Φ Auto transformer	-	230V/(0-270)V	1
2	Ammeter	MC	(0-2)A	1
3	Ammeter	MI	(0-10)A	1
4	Voltmeter	MI	(0-150)V	1
5	Voltmeter	MI	(0-300)V	1
6	Rheostat	Wire Wound	(230Ω,1.7A)	1
7	Rheostat	Wire Wound	(300Ω,2A)	1
8	Wattmeter	LPF	300V,10A	1
9	Connecting wires	-	-	As Required

FORMULA USED:

$$\text{Negative Sequence Impedance, } Z_2 = \left(\frac{\left(\frac{V_{RY}}{\sqrt{3}}\right)}{I_{sc}}\right) \Omega$$

$$\text{Zero Sequence Impedance, } Z_0 = \frac{V_0}{\left(\frac{I_0}{3}\right)} = \frac{3V_0}{I_0}\ \Omega$$

PRECAUTIONS:

1. Initially all switches should be in kept open.
2. At start, VARIAC should be kept in minimum position.

CIRCUIT DIAGRAM:

TO DETERMINE NEGATIVE SEQUENCE IMPEDANCE Z_2:

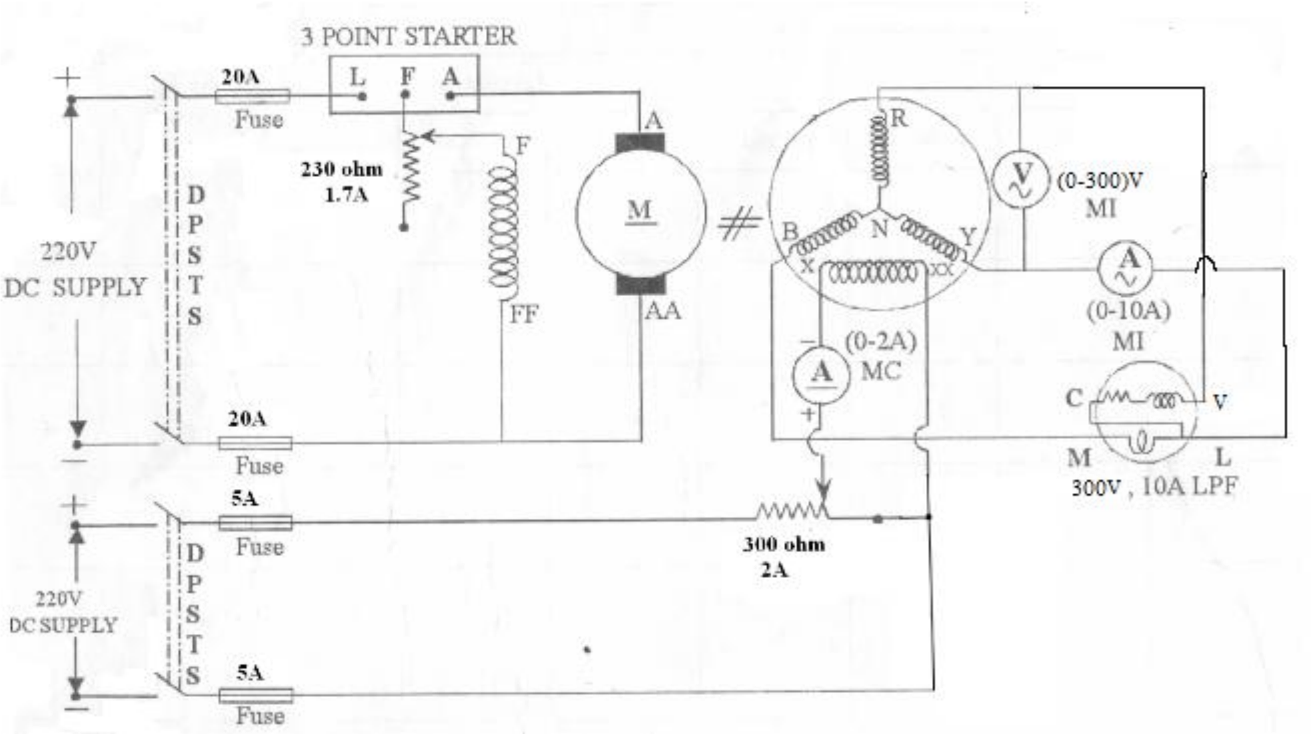


Fig 11.1

TO DETERMINE ZERO SEQUENCE IMPEDANCE Z_0:

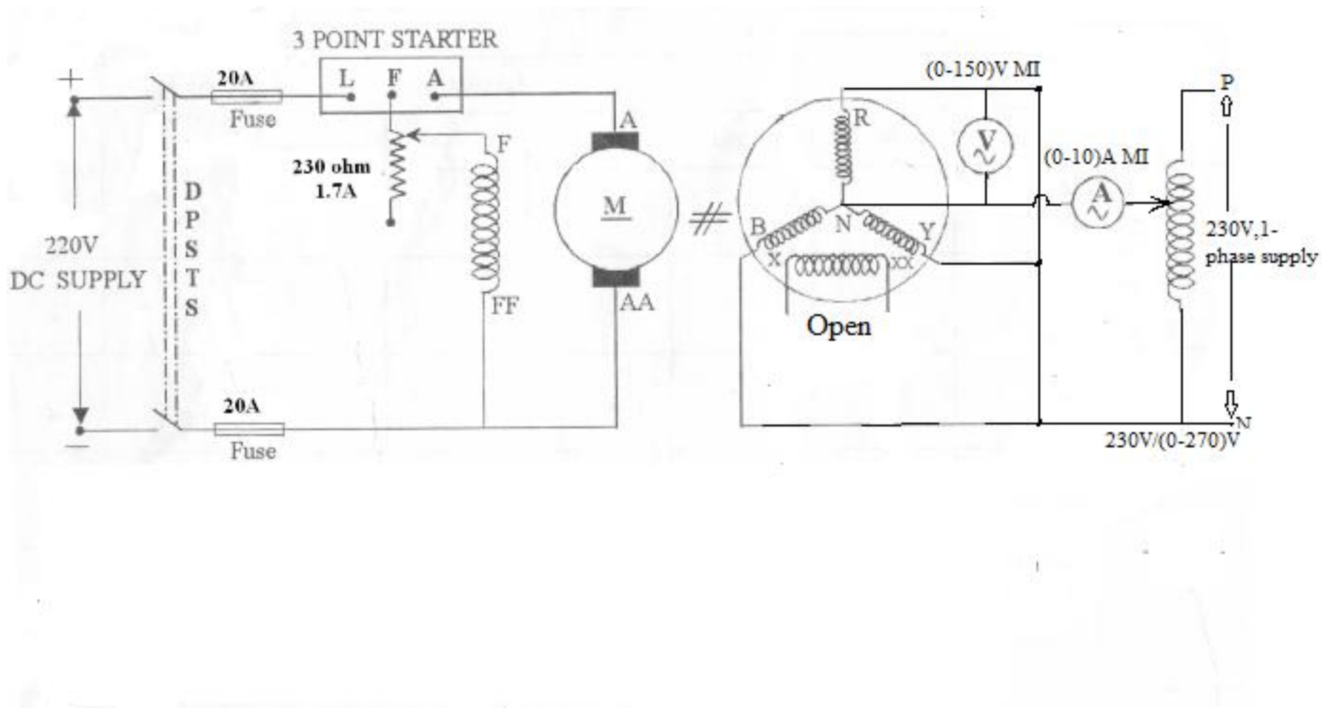


Fig 11.2

PROCEDURE:

TO DETERMINE NEGATIVE SEQUENCE IMPEDANCE Z_2:

Step 1: Make the connections as shown in figure for determining Z_2.
Step 2: Run the machine at rated speed.
Step 3: Short circuit two phases of the alternator through an ammeter and the current coil of the wattmeter.
Step 4: Connect the voltage coil of the wattmeter and the voltmeter between the open phase and any short circuited phase.
Step 5: Gradually increase the excitation such that the short circuit current does not exceed its rated value.
Step 6: Note the reading of voltage, current and power.

TO DETERMINE ZERO SEQUENCE IMPEDANCE Z_0:

Step 1: Connect the armature winding in parallel according to the circuit diagram.
Step 2: Connect the single phase variac to the parallel common point of an alternator armature winding as shown in the circuit diagram.
Step 3: Run the machine at rated speed.
Step 4: Apply low voltage from a variac and measure both voltage V_0 and current I_0 taken by the armature windings and zero sequence impedance can be calculated.

TABULATION:

TO DETERMINE NEGATIVE SEQUENCE IMPEDANCE (Z_2):

S.No	Voltage(V_{RY}) (Volts)	Current(I_{SC}) (Amps)	Power (Watts)	Negative Sequence Impedance (Z_2)Ω
			Average (Z_2)Ω	

TO DETERMINE ZERO SEQUENCE IMPEDANCE(Z_0):

S.No	Voltage(V_0) (Volts)	Current(I_0) (Amps)	Zero Sequence Impedance (Z_0)Ω
		Average (Z_0)Ω	

CALCULATION:

RESULT:

Thus the negative sequence impedance and zero sequence impedance of an alternator were determined.

VIVA QUESTIONS:

1. Mention the fault, in which only positive sequence reactance is present.

2. Which statement is correct for negative and zero sequence impedances?

3. Under what type of winding connections the zero sequence current can flow from transmission line to a transformer?

4. When negative sequence current rotates with respect to field winding?

5. Why synchronous generators are to be constructed with more synchronous reactance and negligible resistance?

Exp. No. : 12	DRAW THE CIRCLE DIAGRAM OF 3-PHASE SQUIRREL CAGE INDUCTION MOTOR BY CONDUCTING NO LOAD AND BLOCKED ROTOR TEST
Date :	

AIM:

To conduct the no load test and blocked rotor test on three phase squirrel cage induction motor and draw the circle diagram.

NAME PLATE DETAILS:

3ϕ Induction Motor   3ϕ Auto Transformer

FUSE RATING:

No load :10% of rated current (full load current) = Amps

Full load:125% of rated current (full load current) = Amps

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	Ammeter	MC	(0-10)A	1
2	Ammeter	MI	(0-5)A	1
3	Ammeter	MI	(0-10)A	1
4	Voltmeter	MI	(0-150)V	1
5	Voltmeter	MI	(0-600)V	1
6	Voltmeter	MC	(0-30)V	1
7	Wattmeter	LPF	(600 V, 5A)	2
8	Wattmeter	UPF	(150 V,10A)	2
9	Tachometer	Digital	-	1
10	Connecting wires	-	-	As required

PRECAUTIONS:

The autotransformer should be kept in minimum voltage position.

PROCEDURE:

1. Note down the name plate details of motor
2. Connections are made as per the circuit diagram as shown in the figure for open circuit and blocked rotor test
3. For no load test or open circuit test by adjusting the autotransformer, apply the rated voltage and note down the ammeter and wattmeter readings. In this test rotor is free to rotate.
4. For short circuit test or blocked rotor test, by adjusting autotransformer, apply rated voltage and note down the ammeter and wattmeter readings. In this test the rotor is blocked.
5. After that make the connection to measure the stator resistance as per the circuit diagram.

CIRCUIT DIAGRAM:

NO LOAD TEST:

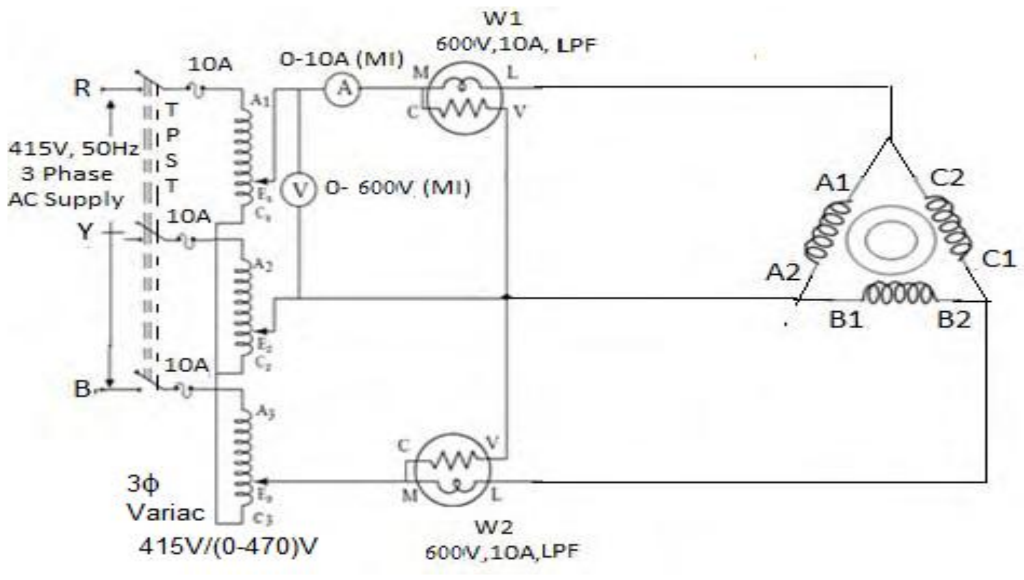


Fig 12.1

BLOCKED ROTOR TEST:

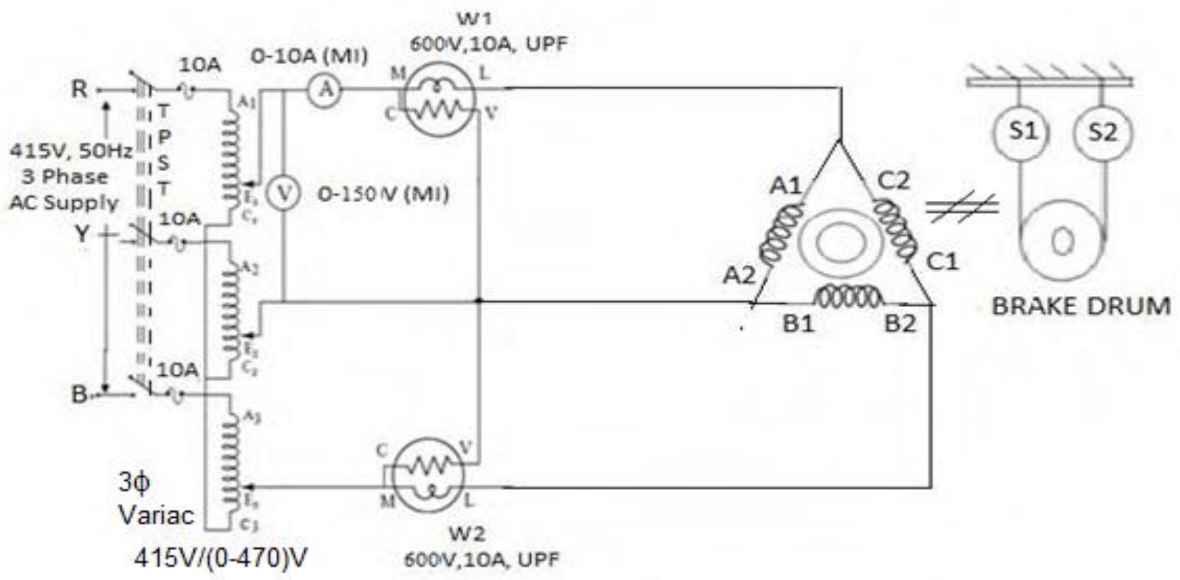


Fig 12.2

TO FIND STATOR RESISTANCE (R_S):

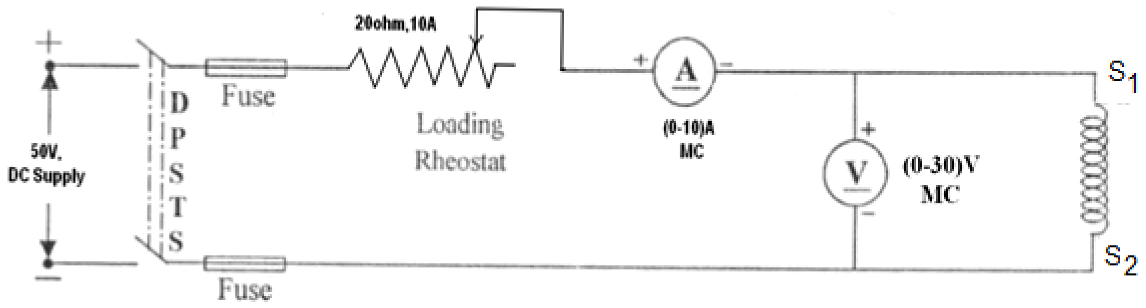


Fig 12.3

TABULATION:

No Load Test : Multiplying Factor : W_1 = W_2 =

S.No	Open Circuit Voltage (V_o) (Volts)	Open Circuit Current (I_o) (Amps)	Open Circuit Power (P_{OC}) (Watts)				
			W_1		W_2		Total (W_1+W_2)
			Observed	Actual	Observed	Actual	

BLOCKED ROTOR TEST : Multiplying Factor : W_1 = W_2 =

S.No	Blocked Rotor Voltage (V_{SC}) (Volts)	Blocked Rotor Current (I_{SC}) (Amps)	Blocked Rotor Power (P_{SC}) (Watts)				
			W_1		W_2		Total (W_1+W_2)
			Observed	Actual	Observed	Actual	

TO FIND STATOR RESISTANCE

S.No	Stator current (I)(Amps)	Stator voltage (V) (Volts)	Stator Resistance R=V/I Ω
		Mean Resistance,R_m	

PROCEDURE TO DRAW CIRCLE DIAGRAM:

Step 1: Draw the lines by taking the current (I) in X-axis, voltage (V) in Y-axis.(V & I are line values)

Step 2: From the No-load test find the current I_0 and draw the vector OA with the magnitude of I_0 from the origin by suitable current scale, which lags the voltage (Y axis) V by angle Φ_0.

$$P_{OC} = \sqrt{3}V_0 I_0 cos\Phi_0$$

$$cos\Phi_0 = \left(\frac{P_{OC}}{\sqrt{3} \times V_0 \times I_0}\right)$$

$$\text{Where, } \Phi_0 = cos^{-1} = \left(\frac{P_{OC}}{\sqrt{3} \times V_0 \times I_0}\right)$$

Step 3: From the blocked rotor or short circuit test, find the I_{SN} (short circuit current corresponding to the normal voltage) and Φ_S.

$$\text{Short Circuit current, } I_{SN} = I_{SC}\left(\frac{V_O}{V_{SC}}\right)$$

$$P_{SC} = \sqrt{3}V_{SC} I_{SC} cos\Phi_S$$

$$cos\Phi_S = \left(\frac{P_{SC}}{\sqrt{3} \times V_{SC} \times I_{SC}}\right)$$

$$\text{Where, } \Phi_S = cos^{-1} = \left(\frac{P_{SC}}{\sqrt{3} \times V_{SC} \times I_{SC}}\right)$$

Step 4: Draw the vector OB line magnitude of I_{SN} from the origin by the same current scale, which lags the voltage (Y-axis) V by angle, Φ_S.

Step 5: Join the points B and A get the output line.

Step 6: Draw the line parallel to X-axis from point A and parallel to the Y-axis from point B towards the X-axis, then locate point E (in X-axis) and point D (intersection point of these two parallel lines). ED represents fixed loss.

Step 7: To find the centre point C of the circle, bisect the output line AB at right angles, then locate point C and draw a semi circle with radius CA.

Step 8: The line EB represents total loss (EB=ED+DB, Where ED = fixed loss and DB = variable loss)

Step 9: Draw the torque line AG. (Line which separates the stator and rotor copper losses).When the rotor is locked, all the power supplied to the motor goes to meet the core losses and copper losses in the stator and rotor windings. The power input is proportional to BE. Out of this, ED represents fixed losses i.e., stator core loss and friction and windage losses. DB is proportional to the sum of the stator and rotor copper losses. The point G is such that,

$$\frac{BG}{GD} = \frac{rotor\ copper\ loss}{stator\ copper\ loss}$$

To locate point G, find the stator resistance per phase i.e., R_1 is found from stator resistance test. ($R_1 = 1.2R_m$). Now the short circuit motor input W_{SC} is approximately equal to motor copper losses (neglecting iron losses). Therefore,

$$Stator\ Copper\ loss = 3I_{SC}^2R_1 \text{ and } Rotor\ copper\ loss = W_{SC} - 3I_{SC}^2R_1 \therefore \frac{BG}{GD} = \frac{W_{SC} - 3I_{SC}^2R_1}{3I_{SC}^2R_1}$$

$$Short\ circuit/Blocked\ rotor\ input\ with\ normal\ Volatge, W_{SC} = P_{SC}\left(\frac{V_0}{V_{SC}}\right)^2$$

This power W_{SC} represents the value EB and measure it by using scale, then $\frac{W_{SC}}{EB\,(cm)}$ gives power scale.(Watts/cm). The line ED represents no load losses i.e, fixed losses and DB represents total copper losses, therefore, $DB = W_{SC} - P_{OC}$. Then DB is bisected at point G to separate stator and rotor copper losses. AG represents torque line.

Step 10: To find the load quantities, draw the line BK $\left(= \frac{full\ load\ output\ power\ (rated\ power).}{Watts\ /cm}\right)$

Step 11: Now draw line PK parallel to output line meeting the circle at point P.

Step 12: Draw line PT parallel to Y-axis meeting output line at Q, torque line at R, constant-loss line at S and X-axis at T.

Step 13: To find the maximum quantities,

a) Maximum Output:

It occurs at point H where the tangent is parallel to output line AB. Point H may be located by drawing a line CH from point C such that it is perpendicular to the output line AB. Then the vertical line HH' represents maximum output.

b) Maximum torque:

It occurs at point I where the tangent is parallel to torque line AG. Point N may be located by drawing a line CI perpendicular to the torque line AG. Then the vertical line II' represents maximum torque.

c) Maximum input power:

It occurs at the highest point of the circle i.e., at point J where the tangent to the circle is horizontal. It is proportional to JJ'. As the point J is beyond the point of maximum torque, the induction motor will be unstable here. However, the maximum input is a measure of the size of the circle and is an indication of the ability of the motor to carry short-time over loads. Generally, JJ' is twice or thrice the motor input at rated load.

CIRCLE DIAGRAM:

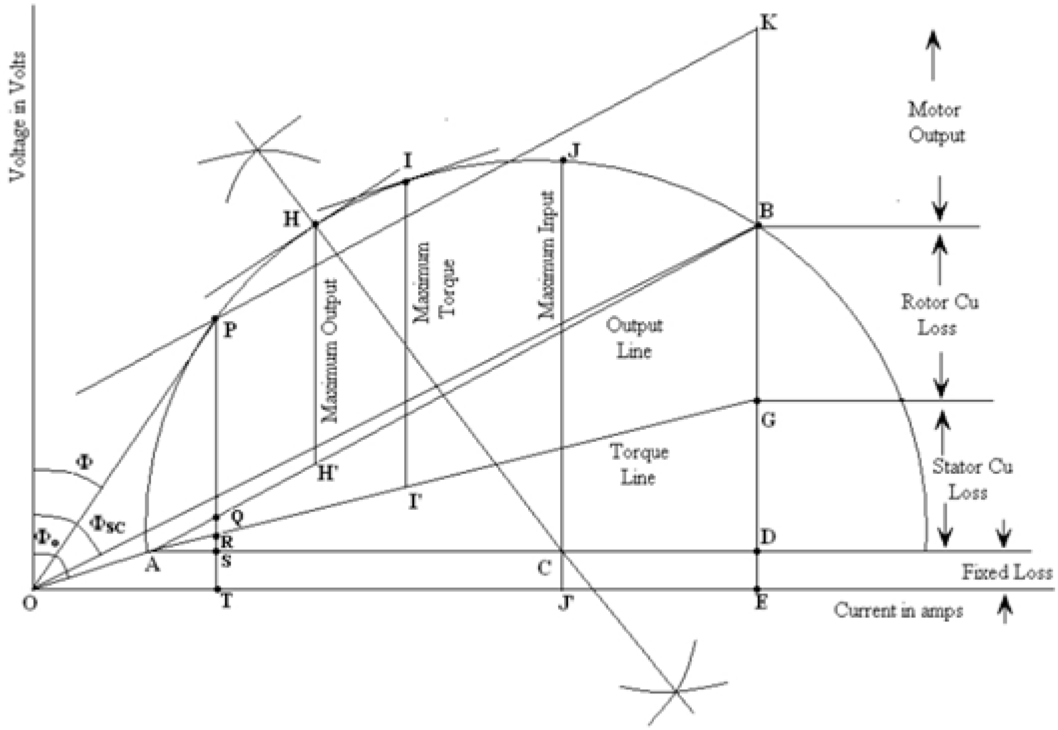


Fig 12.4

CALCULATION:

RESULT:

Thus the no load test and blocked rotor test on three phase squirrel cage induction motor were conducted and the circle diagram was drawn.

VIVA QUESTIONS:

1. What is circle diagram of an IM?
2. What are the advantages and disadvantages of circle diagram method of predetermining the performance of 3 –phase IM?
3. What is slip of an induction motor?
4. Compare squirrel cage with slip ring induction motor.
5. In what respect does a 1-phase Induction motor differ from a 3-phase Induction motor?

8211221050 41

INDEX

PRIYANIKANJANI. P
II - EEE

EE3411 - Electrical Machines Laboratory-II

Completed

Signature of Staff Incharge
[Dr. S. Naveen Prakash]
AP/EEE.

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BONAFIDE CERTIFICATE

Register Number: 821122105043

This is to certify that, the record work was done by the candidate Mr./Ms. S. RAJA GOWRI ***of*** II ***Year,*** IV ***Semester, B.E.*** ELECTRICAL AND ELECTRONICS ENGINEERING ***for*** ELECTRICAL MACHINES LABORATORY - II EE3411 ***during the academic year*** 2023 - 2024.

Staff In-Charge ***Head of the Department***

This record is submitted for Anna University, Chennai, practical examination held on 04.08.2024 ***at Kings College of Engineering, Punalkulam.***

Internal Examiner ***External Examiner***

Index

Expresso

Index

Completed 1/8/24

B.E / B.Tech. PRACTICAL END SEMESTER EXAMINATIONS, APRIL/MAY 2024

Fourth Semester

EE3411 – ELECTRICAL MACHINES LABORATORY- II

(Regulations 2021)

Time : 3 Hours | Answer any one Question | Max. Marks 100

Aim/Principle/Apparatus required/Procedure	Circuit Diagram/Tabulation	Calculation & Results	Viva-Voce	Record	Total
20	30	30	10	10	100

1. Predetermine the voltage regulation of a three phase alternator by conducting suitable experiment which gives higher values of synchronous reactance. (100)

2. Predetermine the voltage regulation of three phase alternator for full load and 0.8 leading, 0.8 lagging power factor by EMF method. (100)

3. Predetermine the voltage regulation of an alternator by a method in which phasor diagram of the alternator is deployed for computation. (100)

4. Predetermine the voltage regulation of three phase alternator for full load and 0.95 leading, 0.95 lagging power factor by MMF method. (100)

5. Conduct an experiment which gives more accurate predetermination of voltage regulation for a three phase alternator. (100)

6. Conduct a experiment to predetermine the regulation of three phase alternator by modified MMF method and plot its regulation curve. (100)

7. Conduct a suitable experiment to predetermine the voltage regulation of three phase salient pole alternator by slip test at full load, unity p.f. (100)

8. Conduct a suitable experiment to compute the negative and zero sequence impedance of synchronous generator. (100)

9. Conduct a suitable experiment on three phase machine which delivers mechanical output and draw the V and inverted V curves. (100)

10. Conduct a suitable experiment to plot V curves and inverted V curves for a three phase machine which delivers mechanical output for the following load condition i) ¼ load ii) full load (100)

11. Conduct load test on a three phase induction motor and obtain its performance characteristics at 50%, 100% and 130% load condition. (100)

12. Conduct load test on a three phase induction motor and draw its torque and efficiency characteristic curves. (100)

13. Conduct No load and blocked rotor test on a three phase motor which is widely used in industrial drive and obtain the equivalent circuit parameters. (100)

14. Draw the equivalent circuit of a three phase induction motor by conducting suitable test. (100)

15. Conduct a suitable experiment to separate no-load losses occurring in a three phase motor which is widely used in industrial drives. (100)

16. Conduct a suitable test to separate the fixed losses in a three phase induction motor. (100)

17. Conduct load test on a single phase induction motor and obtain its performance characteristics at 20%, 40% and 90% load condition. (100)

18. Conduct load test on a single phase induction motor and draw its slip and speed characteristic curves. (100)

19. Conduct No load and blocked rotor test on a single phase motor which is widely lower power applications like pumps and obtain the equivalent circuit parameters. (100)

20. Draw the equivalent circuit of a single phase induction motor by conducting suitable test. (100)

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MODEL PRACTICAL EXAMINATION 2024 (EVEN SEM)

DEPARTMENT : ELECTRICAL AND ELECTRONICS ENGINEERING
SUB. CODE & NAME : EE3411 & ELECTRICAL MACHINES – II LABORATORY
YEAR/SEM : II / IV
DATE : 11.06.24

MARK STATEMENT

S.NO	REGISTER NUMBER	STUDENT NAME	MARK	MARK IN WORDS
1	821122105001	ABINAYA M	89	Eight Nine
2	821122105002	ABINAYA S	90	Nine Zero
3	821122105003	ABIRAMI M	90	Nine Zero
4	821122105005	ARCHANA S	87	Eight Seven
5	821122105006	BABY N	79	Seven Nine
6	821122105007	BALAJI J	75	Seven Five
7	821122105008	CHARUMATHI M	77	Seven Seven
8	821122105009	DEEPIKA R	80	Eight Zero
9	821122105010	DEVATHARSHAN T	77	Seven Seven
10	821122105012	DHANALAKSHMI P	80	Eight Zero
11	821122105013	DHARSHINI G	83	Eight Three
12	821122105014	DHIVAKAR S	77	Seven Seven
13	821122105015	DURGA R	79	Seven Nine
14	821122105016	DURGA DEVI T	80	Eight Zero
15	821122105017	GURU PRASATH N	77	Seven Seven
16	821122105018	HARIHARAN V	70	Seven Zero
17	821122105019	HARINI U	79	Seven Nine
18	821122105020	HARISH D	70	Seven Zero
19	821122105021	JESTINA SHINY V	89	Eight Nine
20	821122105022	KAILASH A	77	Seven Seven
21	821122105023	KALAIYARASAN P	75	Seven Five
22	821122105024	KATHIRAVAN M	79	Seven Nine
23	821122105025	KEERTHIKA G	80	Eight Zero
24	821122105027	MANISHKUMAR S	85	Eight Five
25	821122105028	MANO B	80	Eight Zero
26	821122105029	MELVIN EALIJAH S	85	Eight Five
27	821122105030	MUTHU MURUGESAN S	80	Eight Zero

INTERNAL EXAMINER

HOD/EEE

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MODEL PRACTICAL EXAMINATION 2024 (EVEN SEM)

S.NO	REGISTER NUMBER	STUDENT NAME	MARK	MARK IN WORDS
28	821122105031	NACHIYAMMAL C	90	Nine Zero
29	821122105032	NANDHAKUMAR D	85	Eight Five
30	821122105033	NANDHINI S	80	Eight Zero
31	821122105034	NEELAVATHI G	75	Seven Five
32	821122105036	NITHYA SRI R	83	Eight Three
33	821122105037	PONNAGARASAN M G	85	Eight Five
34	821122105039	PRAGADESHWARAN R	79	Seven Nine
35	821122105040	PRIYADHARSHINI L	83	Eight Three
36	821122105041	PRIYANIRANJANI P	92	Nine Two
37	821122105042	RAGAVAN M	77	Seven Seven
38	821122105043	RAJAGOWRI S	85	Eight Five
39	821122105044	RUBASRI R	80	Eight Zero
40	821122105045	SAMUEL G	75	Seven Five
41	821122105046	SATHIYA S	75	Seven Five
42	821122105047	SHAHATHIYA R	90	Nine Zero
43	821122105048	SHANMUGAPRIYA L	75	Seven Five
44	821122105049	SHANMUGAPRIYA S	80	Eight Zero
45	821122105050	SIVASANGARI G	80	Eight Zero
46	821122105051	SRI HARI SRIDHAR L	85	Eight Five
47	821122105052	SUBHASHINI M	80	Eight Zero
48	821122105053	SURIYA N	79	Seven Nine
49	821122105054	THARSHA A.S	83	Eight Three
50	821122105055	THENMOZHI T	85	Eight Five
51	821122105056	UMA S	90	Nine Zero
52	821122105057	VAISHNAVI C	87	Eight Seven
53	821122105058	VASANTHAKUMAR R	75	Seven Five
54	821122105059	VENKADESHWARAN G	75	Seven Five
55	821122105060	VETRI D	70	Seven Zero
56	821122105301	ABINESH S	77	Seven Seven
57	821122105302	HARIHARAN B	80	Eight Zero
58	821122105303	KARTHI P	85	Eight Five
59	821122105304	KISHORE KUMAR S	79	Seven Nine
60	821122105305	RITHISH M	77	Seven Seven

INTERNAL EXAMINER

HOD/EEE

MODEL LAB EXAM

NAME : PRIYANIRANJANI. P
ROllNO : 22EE36
REG NO : 821122105041

SUB CODE/NAME : EE3411 - ELECTRICAL MACHINES LAB - II

S.No	DESCRIPTION	MARKS	MARKS OPTAINED
1.	AIM / PRICIPLE / APPARATUS REQUIRED / PROCEDURE	20	20
2.	CIRCUIT DIAGRAM / TABULATION	30	27
3.	CALCULATION / RESULTS	30	27
4.	VIVA - VOCE	10	08
5.	RECORD	10	10
	TOTAL	100	92

(Nine Two)

INTERNAL EXAMINER
(Dr. S. Naresh Ramesh, AP/EEE)

AIM:-

To Separate the no load losses in three phase squirrel cage Induction motor:-

NAME PLATE DETAILS:

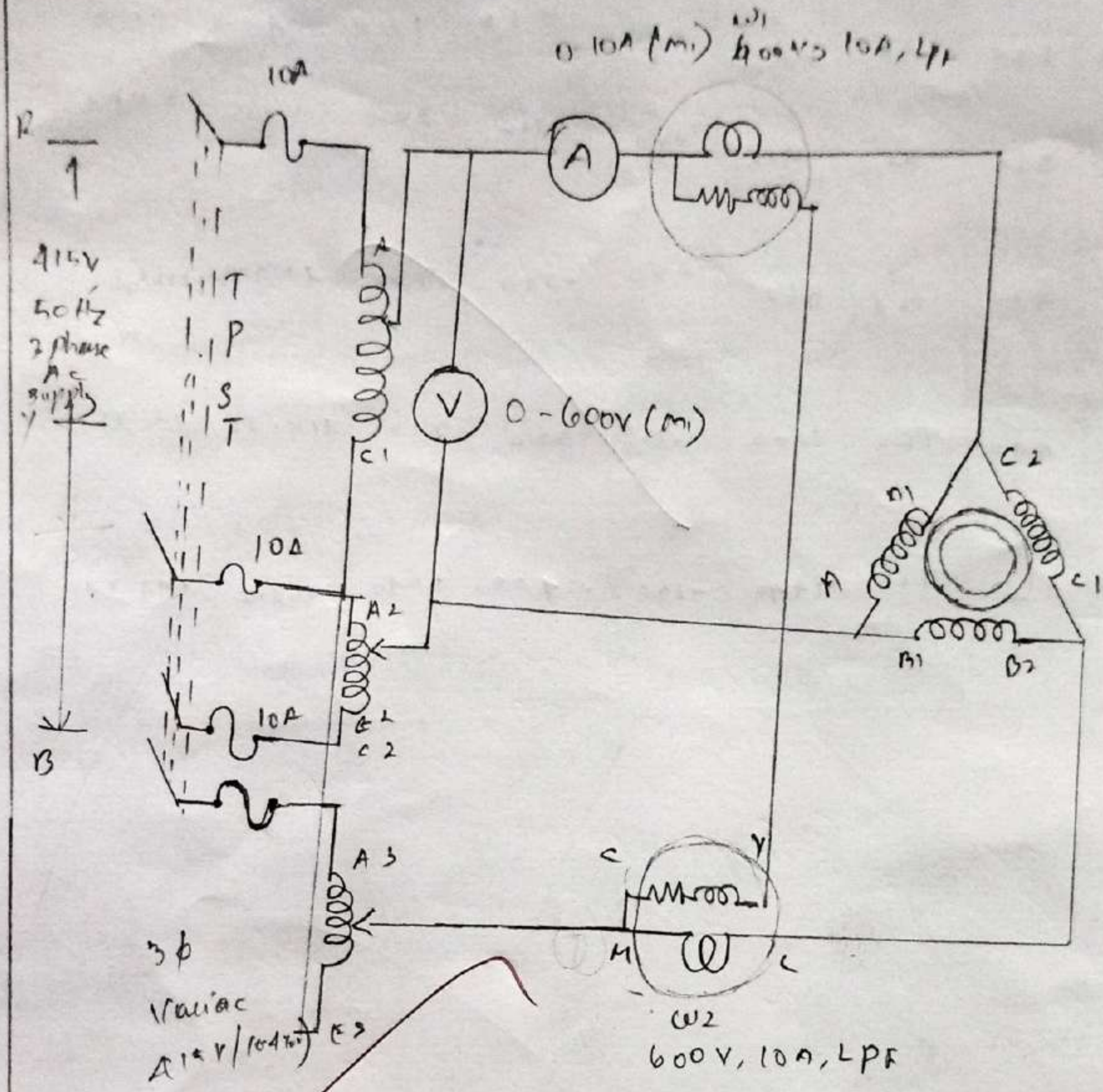
3 ϕ induction — 3 ϕ auto transformer.

FUSE RATING

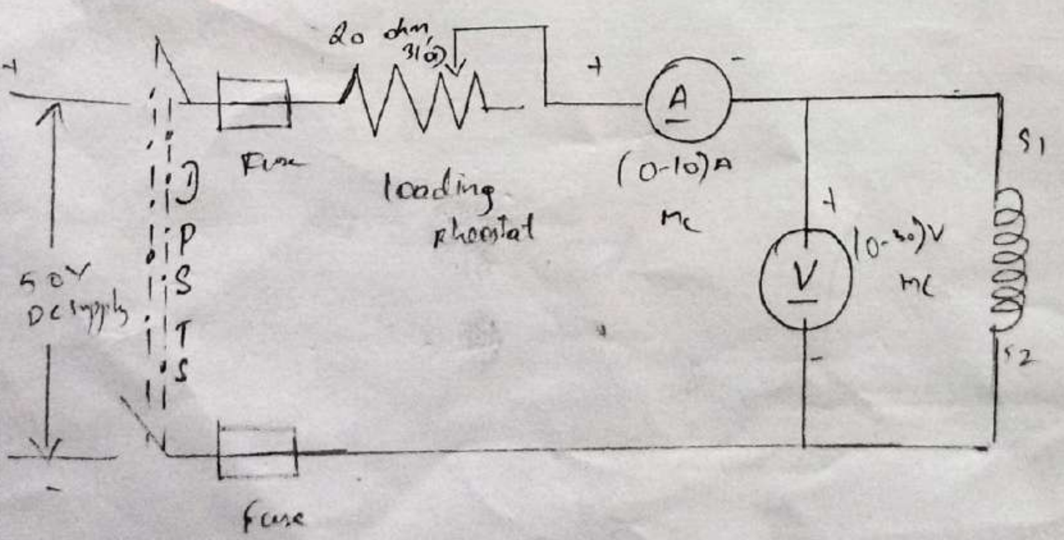
10% of rated current (Full load current) = amps

APPARATUS REQUIRED:-

S.No	Name of the apparatus	Type	Range	Quantity
1.	3 ϕ auto transformer	-	415V/(0-470)	1
2.	Ammeter	MI	(0-10A)	1
3.	Ammeter	MC	(0-10A)	1
4.	Voltmeter	MC	(0-30V)	1
5.	Voltmeter	MI	(0-600V)	1
6.	Wattmeter	LPF	600V, 10A	2
7.	Rheostat.	wire wound	20Ω/10A.	1
8.	Tachometer.	-		1
9.	Connecting wires	-		As required



Stator Resistance (RS:



Formula used:

$$\text{Percentage regulation} = \frac{V_{no.load} - V_{load}}{V_{no\ load}} \times 100.$$

Armature Resistance, $R_a = 1.2 R_f$.

PRECAUTION:-

1) The motor field rheostant should be kept in minimum position

2) The Alternator field potential divider should be in the maximum voltage position.

PROCEDURE FOR BOTH POTIER AND ASA METHOD:-

Step1: Note down the complete nameplate details of motor and alternator

Step2: Connections are made as per the circuit diagram

Step3: Switch on the supply by closing the DPST diagram.

Step4: Using the three point starter, start the motor to run at the synchronous speed by varying the motor field rheostant.

Step 5: Conduct a armature resistance test by giving connection as per the circuit diagram and tabulate the voltage and current reading by changing the value of rheostat.

Formulae used:-

1) Input power, $P_{in} = (\omega_1 + \omega_2)$ watts

2) Stator Copper loss = $3I_0^2 R_s$ Watts

3) constant loss / phase (Wc) = $\frac{(P_{in} - 3I_0^2 R_s)}{3}$ Watts

4) core loss / phase (Wi) = constant loss / phase - Mechanical loss.

5) Effective Stator resistance, $R_s(eff) = \frac{(1.2 \times R_m)}{2} \Omega$

Precaution:-

1) The autotransformer should be kept at minimum Voltage position.

2) The motor should not be loaded through out the experiment.

Procedure:-

Step 1: Note down the nameplate details of motor

Step 2: The Connections should be made as per the circuit diagram.

Step 3: By giving 3 phase supply through the autotransformer, Start the motor

Step 4: The autotransformer should through be varied till the motor attains its rated Speed and tabulate the input power, voltage and current.

Step 5: Obtain the core loss by Separating the mechanical loss from the constant losses.

Formula used:

$$\text{Percentage regulation} = \frac{V_{no.load} - V_{load}}{V_{no\ load}} \times 100.$$

Armature Resistance, $R_a = 1.2 R_f$.

PRECAUTION:-

1) The motor field rheostant should be kept in minimum position

2) The Alternator field potential divider should be in the maximum voltage position.

PROCEDURE FOR BOTH POTIER AND ASA METHOD:-

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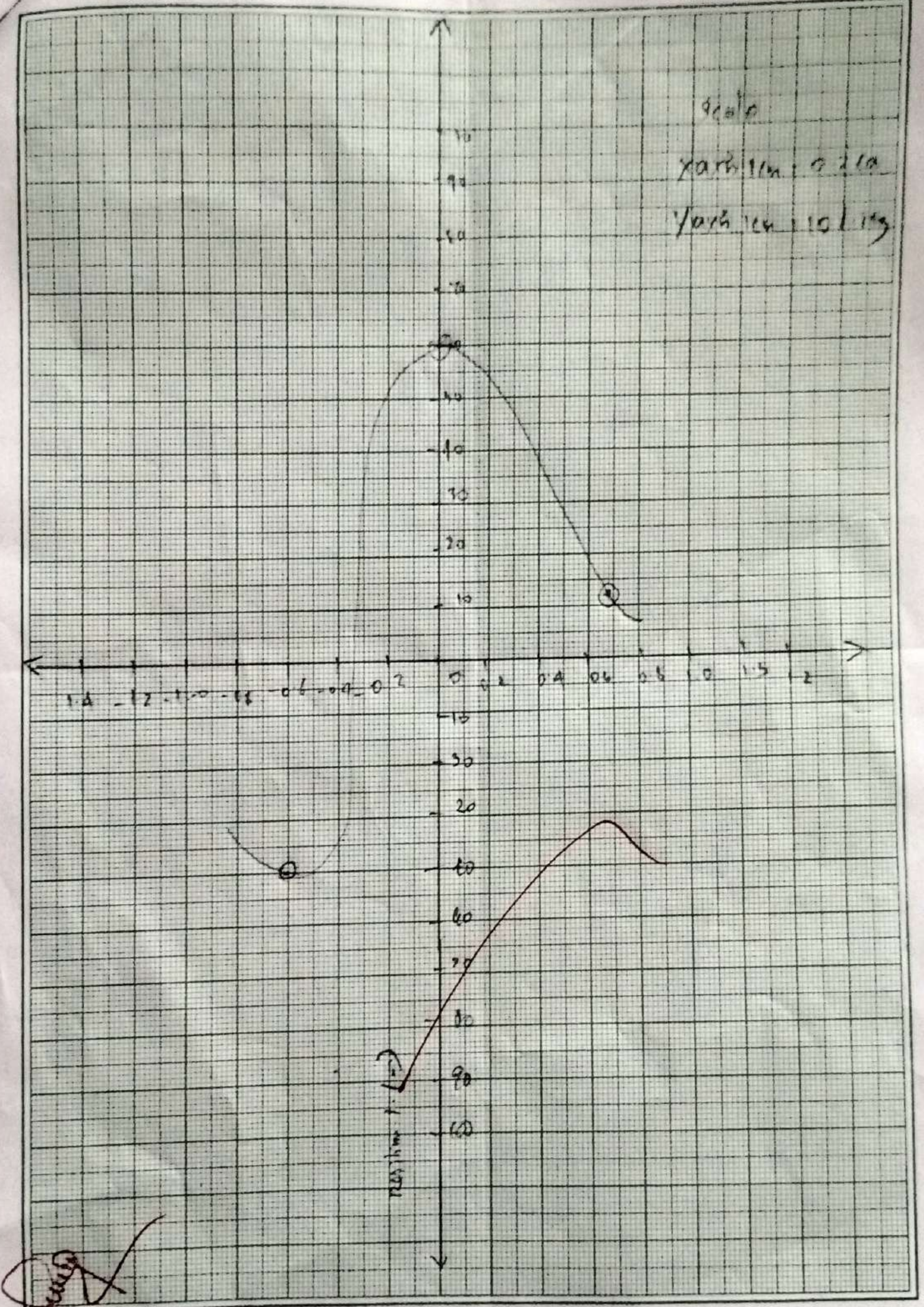
Step 2: Connections are made as per the circuit diagram

Step 3: Switch on the supply by closing the DPST diagram.

Step 4: Using the three point starter, start the motor to run at the synchronous speed by varying the motor field rheostant.

Step 5: Conduct a armature resistance test by giving connection as per the circuit diagram and tabulate the voltage and current reading by changing the value of rheostat.


Scale
X axis 1cm : 0.2 cm
Y axis 1cm : 10 kg

RESULT:-

Thus the regulation of three phase alternator was predetermined by ZPF and ASA methods

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ACADEMIC YEAR: 2023-24 (EVEN SEMESTER)

Format B

CONTENT BEYOND THE SYLLABUS

TITLE : Circle diagram of three phase squirrel cage induction motor by conducting no load and blocked rotor test.

OBJECTIVE : To draw the circle diagram of 3ϕ squirrel cage Ind. motor by conducting suitable tests.

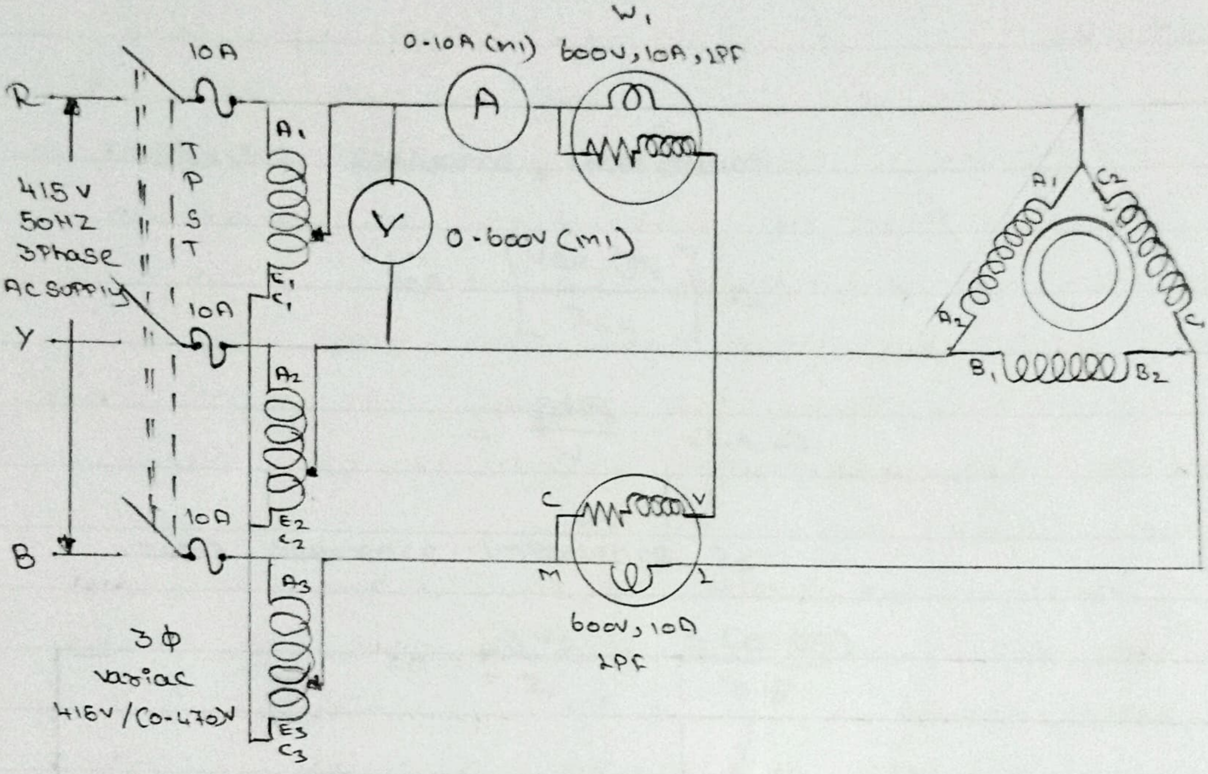
METHODOLOGY : Experiment

DATE OF COMPLETION: 12/06/24

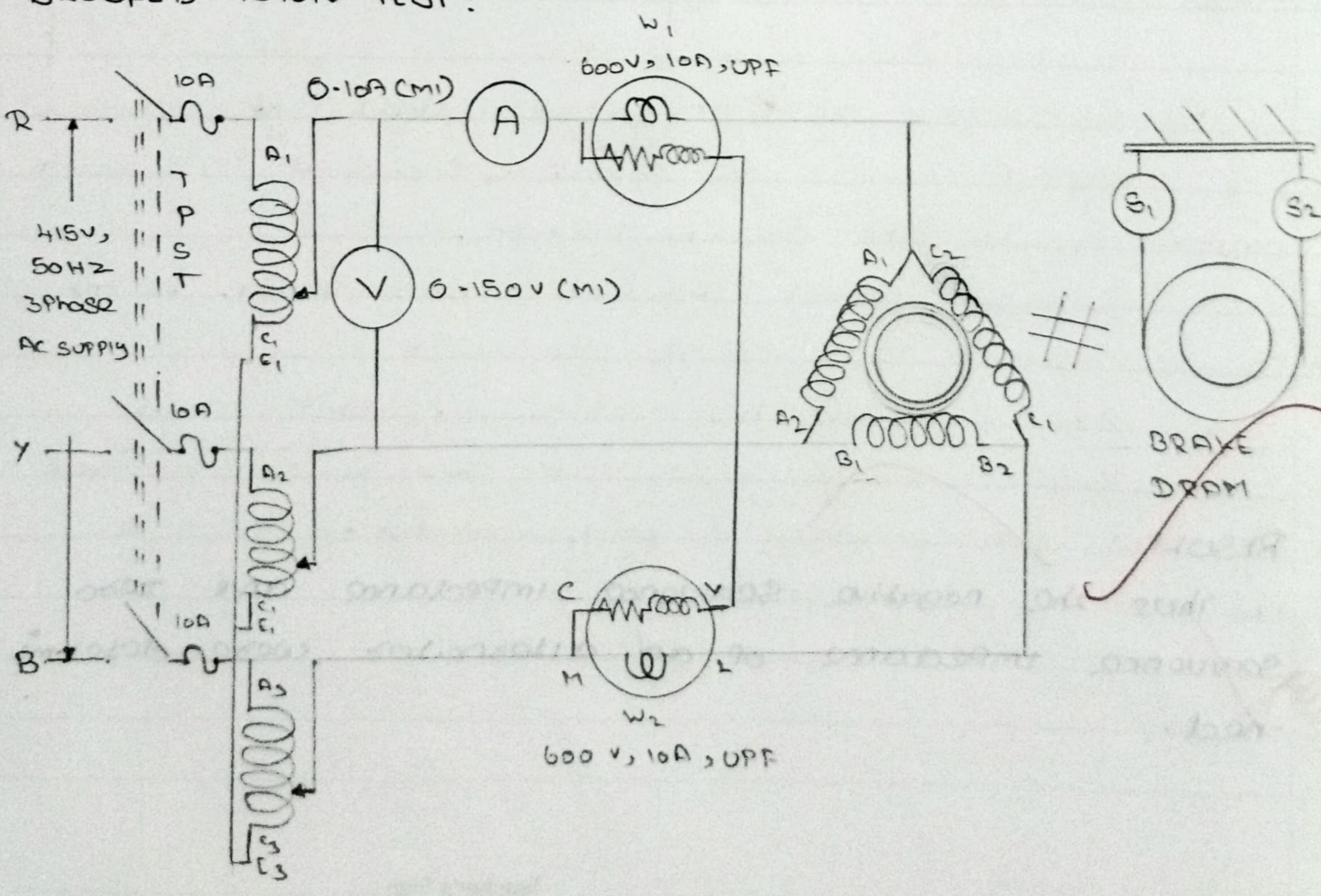
STAFF INCHARGE SIGN

CIRCUIT DIAGRAM

NO LOAD TEST :



BLOCKED ROTOR TEST :



DRAW THE CIRCLE DIAGRAM OF 3. PHASE SQUIRREL CAGE INDUTION MOTOR BY CONDUCTING NO LOAD AND BLOCKD ROTOR TEST

AIM:

To conduct the no load test and blocked rotor test on three phase squirrel cage induction motor and draw the circle diagram.

APPARATUS REQUIRED

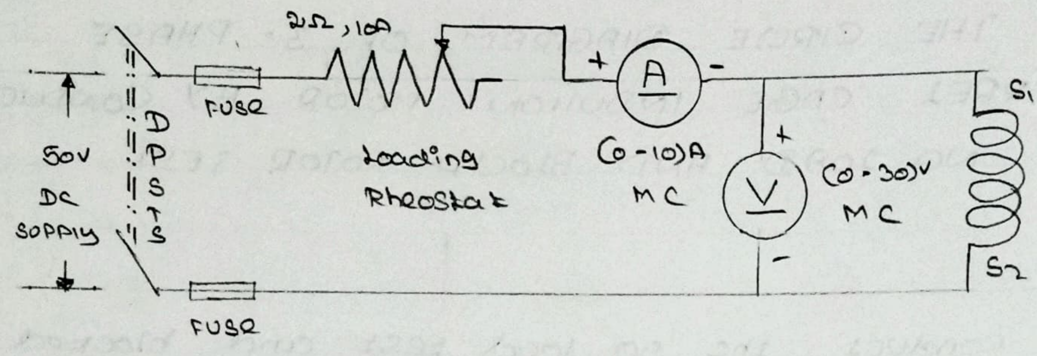
S. No	Name of the Apparatus	Type	Range	Quantity
1.	Ammeter	MC	(0-10)A	1
2.	Ammeter	MI	(0-5)A	1
3.	Ammeter	MI	(0-10)A	1
4.	Voltmeter	MI	(0-150)V	1
5.	Voltmeter	MI	(0-600)V	1
6.	Voltmeter	MC	(0-30)V	1
7.	Wattmeter	UPF	(600V,5A)	2
8.	Wattmeter	UPF	(150 V, 10A)	2
9.	Tachometer	Digital	-	1
10.	Connecting wires	-	-	required

PRECAUTIONS

The autotransformer should be kept in minimum voltage position.

Teacher's Sign :

To find stator resistance (Rs):



TABULATION:

No Load test

S. No	Open circuit voltage (Vo)(Volts)	Open circuit current (Io) (Amps)	Open circuit Power (Poc) Watts				
			W1		W2		total
			observed	Actual	observed	Actual	(W1+W2)
1.	400	3.7	112	896	.74	-592	804

Blocked Rotor test

S. No	Blocked Rotor voltage (Vsc) (Volts)	Blocked Rotor current (Isc) (Amps)	Blocked Rotor Power (Psc) Watts				
			W1		W2		total
			observed	Actual	observed	Actual	(W1+W2)
1.	81	7.5	60	480	0	0	480

PROCEDURE

1. Note down the name plate details of motor.

2. connections are made as per the circuit diagram as shown in the figure for open circuit and blocked rotor test.

3. for no load test or open circuit test by adjusting the autotransformer, apply the rated voltage and note down the ammeter and wattmeter readings.

4. for short circuit test or blocked rotor test, by adjusting autotransformer, apply rated voltage and note down the ammeter and wattmeter readings.

5. After that make the connection to measure the stator resistance as per the circuit diagram

PROCEDURE TO DRAW CIRCLE DIAGRAM:

Step 1: Draw the lines by taking the current (I) in x-axis, voltage (V) in y-axis. (V & I are line values).

Step 2: from the No-load test find the current I_0 and draw the vector OA with the magnitude of I_0 from the origin by suitable current scale, which lags the voltage (y axis) V by angle ϕ_0.

$$P_{oc} = \sqrt{3} V_0 I_0 \cos\phi_0$$

$$\cos\phi_0 = (P_{oc}/\sqrt{3} \times V_0 \times I_0)$$

where, $\phi_0 = \cos^{-1} = (P_{oc}/\sqrt{3} \times V_0 \times I_0)$

TO find Stator Resistance

S. NO	Stator current (I)(Amps)	Stator voltage (V) (Volts)	Stator Resistance $R = V/I\ \Omega$
1.	1.6	7.7	4.023
2.	2.0	9.2	4.6
3.	3.6	6	4.54
4.	5	2.4	4.8
	Mean Resistance, Rm		4.64

Step 3: From the blocked rotor or short circuit test, find the I_{SN} (short circuit current corresponding to the normal voltage) and ϕ_s.

Short circuit current, $I_{SN} = I_{sc} (V_0/V_{sc})$

$P_{sc} = \sqrt{3} V_{sc} I_{sc} \cos\phi_s$

$\cos\phi_s = (P_c / \sqrt{3} \times V_{sc} \times I_{sc})$

where, $\phi_s = \cos^{-1} = (P_{sc} / \sqrt{3} \times V_{sc} \times I_{sc})$

Step 4: Draw the vector OB line magnitude of I_{SN} from the origin by the same current scale.

Step 5: Join the points B and A get the output line.

Step 6: Draw the line parallel to x-axis from point A and parallel to the y-axis from point B towards the x-axis, then locate point E (in x-axis and point D.

Step 7: To find the centre point C of the circle, bisect the output line AB at right angles.

Step 8: The line EB represents total loss (EB = ED+DB, where ED = Fixed loss and DB = variable loss).

Step 9: Draw the torque line AG. (Line which separates the stator and rotor copper losses). When the rotor is blocked, all the power supplied to the motor goes to meet the core losses and copper losses in the stator and rotor windings.

BG/GD = rotor copper loss / stator copper loss

To locate point G, find the stator resistance per phase. R_1 is found from stator resistance test. ($R_1 = 1.2 R_m$). Now the short circuit motor input W_{sc} is approximately equal to motor copper losses.

Stator copper loss = $3I_{sc}^2R_1$ and

Rotor copper loss = $W_{sc} - 3I_{sc}^2R_1$ $\therefore$ $BG/GD = \frac{W_{sc} - 3I_{sc}^2R_1}{3I_{sc}^2R_1}$

Short circuit / Blocked rotor input with normal voltage,

$W_{sc} = P_{sc}(V_0/V_{sc})$

Step 10: To find the load quantities, draw the line BK (= full load output power (rated power). / watts/cm).

Step 11: Now draw line PK parallel to output line meeting the circle at point P.

Step 12: Draw line PT parallel to Y-axis meeting output line at Q, torque line at R, constant-loss line at S and X-axis at T.

Step 13: To find the maximum quantities,

a) Maximum output:

It occurs at point H where the tangent is parallel to output line AB. Point H may be located by drawing a line CH from point C such that it is perpendicular.

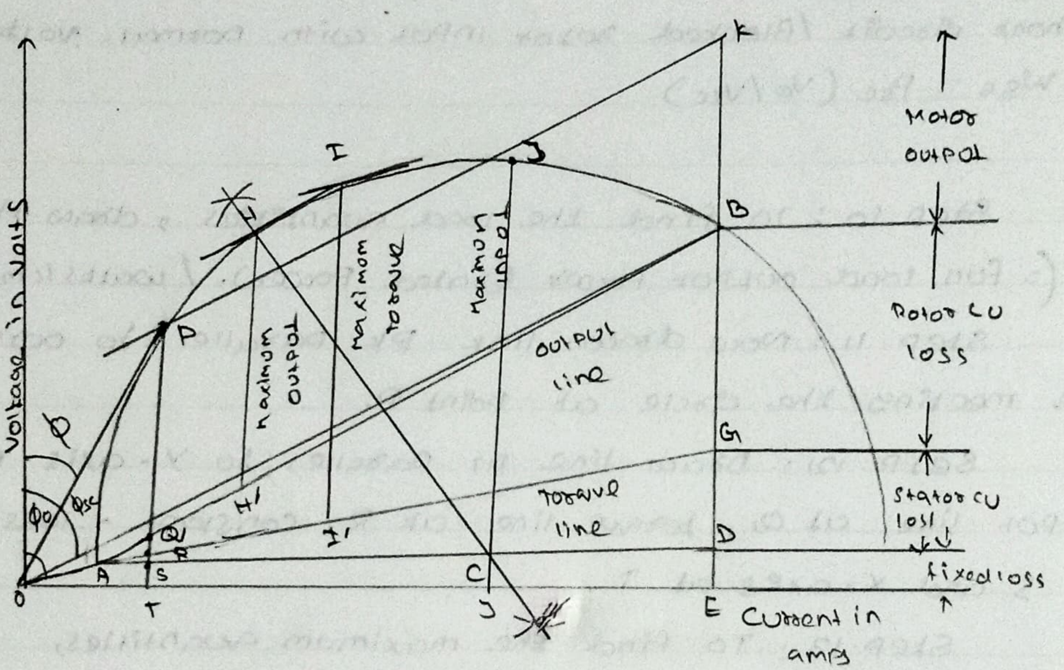
b) Maximum torque:

It occurs at point N where the tangent is parallel to torque line AG. Point N may be located by drawing a line CN perpendicular to the torque line AG.

c) Maximum input power.

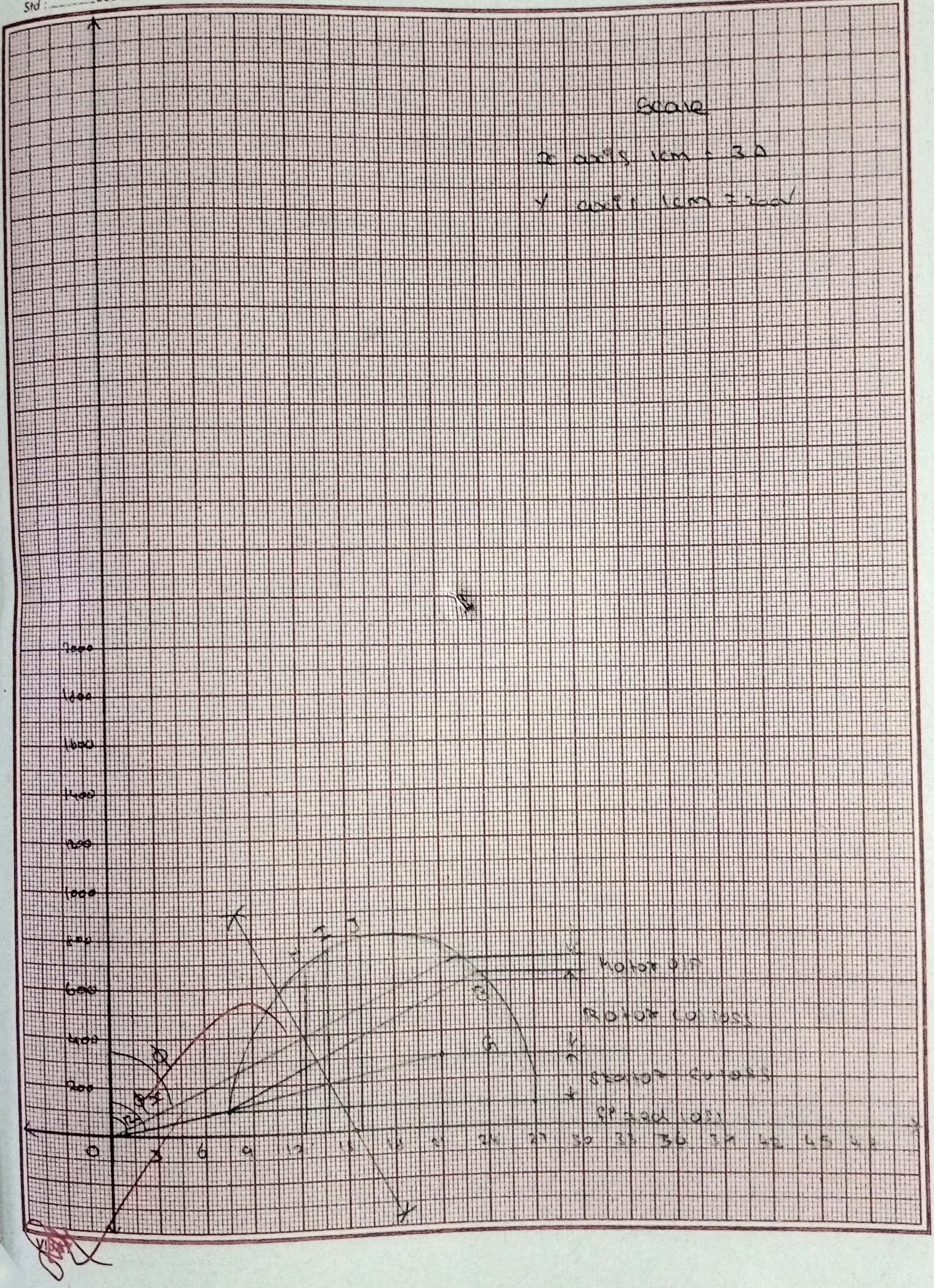
It occurs at the highest point of the circle i.e., at point d where the tangent to the circle

CIRCLE DIAGRAM



Name : .... School : ....

Std : .... Sec : ....



is horizontal. It is proportional to JJ'. As the point J is beyond the point of maximum torque, the induction motor will be unstable here. Generally, JJ' is twice or thrice the motor input at rated load.

RESULT

Thus the no load test and blocked rotor test on three phase squirrel cage induction motor were conducted and the circle diagram was drawn.

Completed

1/8/14