KINGS
COLLEGE OF ENGINEERING
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Approved by AICTE, New Delhi.
Affiliated to Anna University, Chennai.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ACADEMIC YEAR :2022-2023 (ODD SEMESTER)

COURSE FILE - CONTENT PAGE

YEAR & SEM	**: II & III**	**BATCH**	**: 2021 -2025**
SUBJECT CODE	**: EE3311**	**SUBJECT NAME**	**: ELECTRICAL MACHINES LABORATORY-I**
REGULATION	**: 2021**	**STAFF IN-CHARGE**	**:Dr.P.Narasimman**

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

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SUBJECT: ELECTRICAL MACHINES LABORATORY- I

SEMESTER: III

LAB MANUAL (EE3311)
(Version:1)

PREPARED BY

Dr.P. NARASIMMAN,
AP / EEE

EE3311 ELECTRICAL MACHINES LABORATORY – I

L	T	P	C
0	0	3	1.5

SYLLABUS

1. Open circuit and load characteristics of DC shunt generator- calculation of critical resistance and critical speed.
2. Load characteristics of DC compound generator with differential and cumulative
 connections.
3. Load test on DC shunt motor.
4. Load test on DC compound motor.
5. Load test on DC series motor.
6. Swinburne's test and speed control of DC shunt motor.
7. Hopkinson's test on DC motor – generator set.
8. Load test on single-phase transformer and three phase transformers.
9. Open circuit and short circuit tests on single phase transformer.
10. Sumpner's test on single phase transformers.
11. Separation of no-load losses in single phase transformer.
12. Study of starters and 3-phase transformers connections.

TOTAL:45 PERIODS

P. Narayany 13/9/22

SIGNATURE OF STAFF INCHARGE

13/9/22

HOD/EEE

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE PLAN

Sub. Code: EE3311	**Branch/Year/Sem:** B.E EEE / II / III
Sub. Name: Electrical Machines Laboratory-I	**Batch** : 2021-2025
Staff Name: Dr.P.Narasimman	**Academic Year** : 2022-23 (Odd)

COURSE OBJECTIVE

- To expose the students to determine the characteristics of DC machines and transformers by performing experiments on these machines.
- To provide hands on experience to evaluate the performance parameters of DC machines and transformer by conducting suitable tests.

LEARNING OUTCOMES

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

1. Construct the circuit with appropriate connections for the given DC machine/transformer.
2. Experimentally determine the characteristics of different types of DC machines.
3. Demonstrate the speed control techniques for a DC motor for industrial applications.
4. Identify suitable methods for testing of transformer and DC machines.
5. Predetermine the performance parameters of transformers and DC motor.
6. Understand DC motor starters and 3-phase transformer connections.

PRE-REQUISITIE

1. Knowledge about the working principles of DC Machines and Transformers.
2. Knowledge on identification of power supply source (AC or DC), ammeters voltmeters, wattmeters and their connections.

EQUIPMENTS / COMPONENTS REQUIREMENTS

1. DC Shunt Motor with Loading Arrangement
2. DC Series Motor with Loading Arrangement
3. DC compound Motor with Loading Arrangement
4. DC Shunt Motor Coupled with DC Compound Generator
5. DC Shunt Motor Coupled with DC Shunt Generator
6. DC Shunt Motor Coupled with Three phase Alternator
7. Single Phase Transformer
8. Three Phase Transformer
9. Tachometer -Digital/Analog
10. Single Phase Auto Transformer
11. Three Phase Auto Transformer
12. Single Phase Resistive Loading Bank
13. Three Phase Resistive Loading Bank

Ex. No.	Date	Title of the Experiment	No. of Hrs. required	Cumulative No. of periods
		CYCLE : I		
1		Study of starters and 3-phase transformers connections.	3	3
2		Speed control of DC shunt motor	3	6
3		Load test on DC shunt motor	3	9
4		Load test on DC series motor.	3	12
5		Load test on single-phase transformer	3	15
6		Load test on three phase transformer	3	18
7		Swinburne's test of DC shunt motor	3	21

CYCLE : II				
8		Open circuit and load characteristics of DC shunt generator- calculation of critical resistance and critical speed.	6	27
9		Load characteristics of DC compound generator with differential and cumulative connections.	3	30
10		Load test on DC compound motor.	3	33
11		Hopkinson's test on DC motor – generator set.	3	36
12		Open circuit and short circuit tests on single phase transformer.	3	39
13		Sumpner's test on single phase transformers.	3	42
14		Separation of no-load losses in single phase transformer	3	45

CONTENT BEYOND THE SYLLABUS

1. Load Characteristics of DC Series Generator.

Virtual Lab

http://em-iitr.vlabs.ac.in/

INTERNAL ASSESSMENT DETAILS

Model	
Portions	Cycle I & II Experiments
Date	

Prepared by

P. Narasimman 13/9/22

Dr.P.Narasimman

Verified By

HOD/ EEE 13/9/22

Approved by

13/9/2022

PRINCIPAL

Verified 13/9/22

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
Academic Year 2022-23 (ODD SEM)
Year/Sem : II/III

STUDENTS NAME LIST

S. No.	Roll No.	Register Number	Student Name
1	21EE01	821121105001	ABIBHARATHI A
2	21EE02	821121105002	AKASH P
3	21EE03	821121105003	ARAVINDHAN R
4	21EE04	821121105004	DHESINGH J
5	21EE05	821121105005	GAYATHRI K C
6	21EE06	821121105006	GOKUL M
7	21EE07	821121105007	GOPINATH S
8	21EE08	821121105008	HARISHMA R
9	21EE09	821121105009	JEGADEESAN R
10	21EE10	821121105010	KARTHIKEYAN S
11	21EE11	821121105011	MEENA P
12	21EE12	821121105012	MILTON INFANT RAI P
13	21EE13	821121105013	PRAVEEN V C
14	21EE14	821121105014	RUTHRAN K
15	21EE15	821121105015	SARAVANAKUMAR M
16	21EE16	821121105016	SHANMUGAESWARAN S
17	21EE17	821121105017	SIVANANTHAM S
18	21EE18	821121105018	SIVANESAN C
19	21EE19	821121105019	SUJITHA S
20	21EE20	821121105020	SURIYA G
21	21EE21	821121105021	THAVATHEESH S
22	21EE22	821121105022	THUSARI S
23	21EE23	821121105023	VAISHNAVI V
24	21EE24	821121105024	VIDHYA M
25	21EE25	821121105025	VIJAY V
26	21EE27	821121105027	YOGESH C
27	21EE28	821121105028	YUVARAJ A
28	KL22EE01		MONISHAN A
29	KL22EE02	821121105303	PARTHASARATHY B
30	KL22EE03	821121105302	PANDIYARAJAN R
31	KL22EE04	821121105304	PRAGADEESHWARAN S
32	KL22EE05	821121105306	VEERASELVAN.V
33	KL22EE06	821121105305	UDHAYAM.S

STAFF INCHARGE

27/01/23
HOD/EEE

Format-QP06

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.E - EEE (Reg. 2021) - With Effect from 22.8.2022 - Tentative Last working Day 08.12.22

Batch:2021 - 2025 **Strength:30**

Year: II **Semester: III** **Class Room : 132** **Block: I**

Session	1	2	10.45 am - 11.00 am	3	4	12.30 pm - 01.10 pm	5	6	02.40 pm - 02.50 pm	7	8
Day	09.15am - 10.00am	10.00am - 10.45am		11.00am - 11.45am	11.45am - 12.30pm		01.10pm - 01.55pm	01.55pm - 02.40pm		02.50pm - 03.35pm	03.35pm - 04.20pm
MON	CS3354	EE3303		MA3303	EE3301	LUNCH BREAK	EE3302	CS3363	BREAK	CS3363	
TUE	EE3301	MA3303		EC3301	CS3354		EE3303	MA3303		EE3302	T & P (SS)
WED	EE3302	EE3301		EC3301	LIB/ NET		MA3303	EE3311		EE3311	
THU	MA3303	EE3301		CS3354	EE3302		EE3303	EC3301		GE3361	
FRI	EE3303	CS3354		EC3301	T & P (A)		EE3301	EC3311		EC3311	
SAT	EC3301	EE3302		EE3303	EE3301		EE3302	MA3303		CS3354	NPTEL

SUB CODE	NAME OF THE SUBJECT	CATEGORY	CREDITS	NAME OF THE STAFF	DEPT	PERIODS/WEEK
	TUTORIAL (T), ELECTIVE (E)					
MA3303	Probability and Complex Functions	BSC	4	Dr.R.Geetha	Maths	6
EE3301	Electromagnetic Fields	PCC	4	Ms.P.Thirumagal	EEE	6
EE3302	Digital Logic Circuits	PCC	3	Mr.R.Sathyaraj	ECE	6
EC3301	Electron Devices and Circuits	PCC	3	Mrs.A.Prabha	EEE	5
EE3303	Electrical Machines-1	PCC	3	Dr.P.Narasimman	EEE	5
CS3354	Data Structure and OOPS	PCC	3	Mrs.S.Priyadharsini	CSE	5
EC3311	Electronic Devices and Circuits Laboratory	PCC	1.5	Mrs.A.Prabha	EEE	3
EE3311	Electrical Machines Laboratory-1	PCC	1.5	Dr.P.Narasimman	EEE	3
CS3363	Data Structure and OOPS Laboratory	PCC	1.5	Mrs.S.Priyadharsini	CSE	3
GE3361	Professional Development	EEC	1	Mr.P.Raajeshwaran	English	2

CLASS CO-ORDINATOR	NAME OF THE REPRESENTATIVES	ROLL NO
Mrs.A.Prabha	S.Thusari	22
CLASS COMMITTEE CHAIR PERSON	Mr.S.R.Karthikeyan	

VALUE ADDITION INTIATIVES (VAI) - REGULAR HOURS					
LIB/NET	Library / Internet	VAI	Mrs.A.Prabha	EEE	01
NPTEL	NPTEL Swayam Courses	VAI	Mrs.A.Prabha	EEE	01
T&P (A)	Training & Placement - Aptitude	VAI	Ms.P.Suganya	T&P	01
T&P(SS)	Training & Placement - Softskill	VAI	Dr.B.Barankumar	T&P	01

23/8/22 **DEPT. TTC** 23/8/22 **HOD** 23/8/2022 **PRINCIPAL**

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ACADEMIC YEAR 2022 – 2023 / ODD SEMESTER

LABORATORY MANUAL

(Version: 1)

PREPARED BY

Dr. P.NARASIMMAN, AP / EEE

Name of the Student : ______________________

Register Number : ______________________

Year / Semester : II / III

	KINGS COLLEGE OF ENGINEERING *(NAAC Accredited Institution)* *(Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai)*	TÜVRheinland CERT ISO 9001

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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SEMESTER: III

LAB MANUAL (EE3311)
(Version:1)

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AP / EEE

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TOTAL:45 PERIODS

13/9/22

SIGNATURE OF STAFF INCHARGE

13/9/22

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE PLAN

Sub. Code: EE3311	**Branch/Year/Sem:** B.E EEE / II / III
Sub. Name: Electrical Machines Laboratory-I	**Batch** : 2021-2025
Staff Name: Dr.P.Narasimman	**Academic Year** : 2022-23 (Odd)

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13. Three Phase Resistive Loading Bank

Ex. No.	Date	Title of the Experiment	No. of Hrs. required	Cumulative No. of periods
CYCLE : I				
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CONTENT BEYOND THE SYLLABUS

1. Load Characteristics of DC Series Generator.

Virtual Lab

http://em-iitr.vlabs.ac.in/

INTERNAL ASSESSMENT DETAILS

Model	
Portions	Cycle I & II Experiments
Date	

Prepared by

P. Narasimman 13/9/22

Dr.P.Narasimman

Verified By

13/9/22

HOD/ EEE

Approved by

13/9/2022

PRINCIPAL

Verified 13/9/22

Ex. No :		STUDY OF DC MOTOR STARTERS
Date :		

AIM:

To study the working principle of DC motor starters.

NECESSITY OF STARTERS

When a supply voltage is applied to a motor the starting current is high because of very low armature resistance.

The starting current is much more than the full load current

The excessive current will blow out fuses and may damage the brushes etc

To avoid this excessive starting current, a resistance is inserted in series with the armature and is gradually cut out as the motor gains speed and develop the back e.m.f. which regulates the speed.

Equipments used for protection of dc motors, for the following reasons:

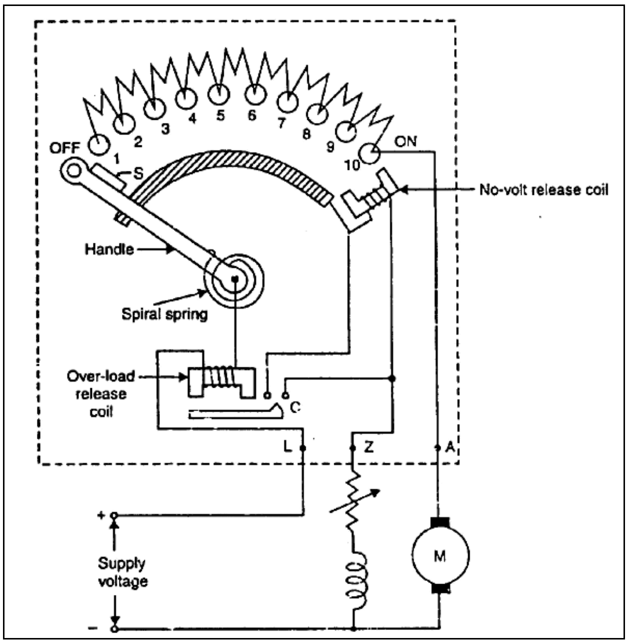
- Protect motor against damage due to short circuits in equipment
- Protect motor against damage from long-term overloads
- Protect motor against damage from excessive starting currents
- Provide a convenient manner in which to control the operating speed of motor

THREE POINT STARTER

The internal wiring for such a starter is shown in the figure. The three terminals of the starting box are marked as L, F, A. One line is directly connected to one armature terminal and one field terminal which are tied together. The other line is connected to point L which is further connected to the starting arm, through the over –current (or over load) release M.

To start the motor, the main switch is first closed and then the starting arm is slowly moved to the right. As soon as the arm makes contact with stud no.1, the field circuit is directly connected across the line and at the same time full starting resistance R_S is placed in series with the armature. The starting current drawn by the armature=$V/(R_A+R_S)$ where R_S is the starting resistance. As the arm is further moved, the starting resistance is gradually cut out till, when the arm reaches the running position, the resistance is all cut out. The arm moved over the various studs against a strong spring which tends to restore it to OFF position. There is a soft iron piece S attached and held by an electromagnet E energized by the shunt current. It is variously known as "HOLD-ON" coil, LOW-VOLTAGE (or NO-VOLTAGE) realize.

It will be seen that as the arm is moved from stud 1 to the last stud, the field current has to travel back through that portion of the starting resistance that has been cut out of the armature circuit. This results in slight decrease of shunt current. But as the value of starting resistance is very small as compared to shunt field resistance, this slight decrease in I is negligible.



Three Point Starter

The normal function of HOLD-ON coil is to hold the arm in the full running position when the motor is in running position. But, in case of failure or disconnecting of the supply or break in the field circuit, it is de-energized thereby releasing the arm which is pulled back by the spring to the OFF position. This prevents the stationary armature from being put across the lines again when the supply when the supply is restored after temporary shutdown. This would have happened if the arm were left in the full null position. One great advantage of connecting the HOLD-ON coil in series with the shunt field is that, should the field circuit become open, the starting arm immediately springs back to the OFF position thereby preventing the motor from running away.

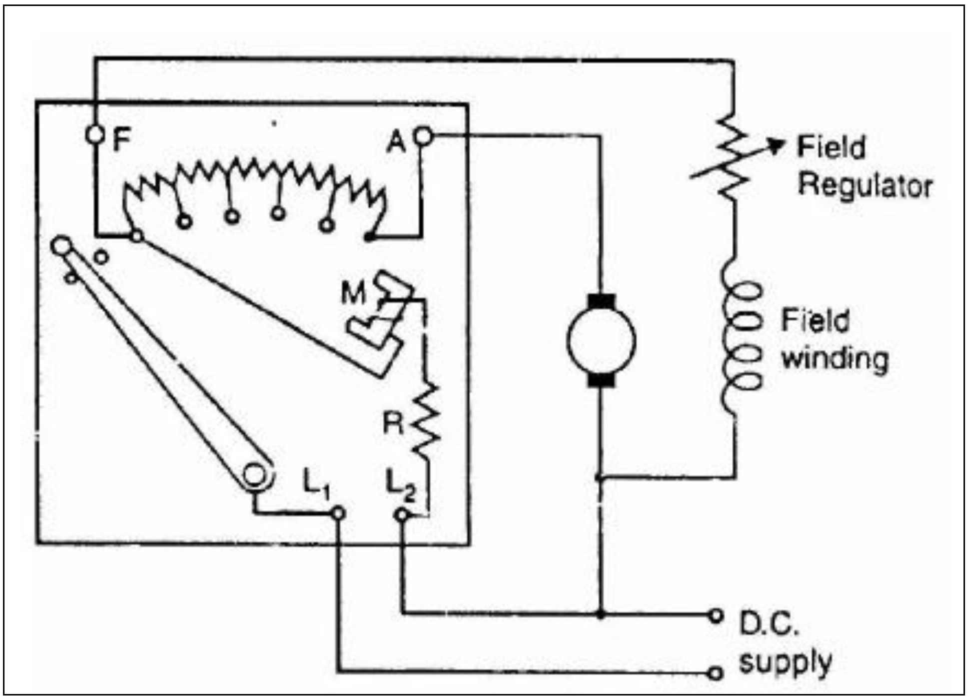
The over-current release consists of electromagnet connected in the supply line. If the motor becomes over-loaded beyond a certain predetermined value, then D is lifted and short-circuits the electromagnet. Hence, the arm is released and returns to OFF position.

The form of over-load protection described above is becoming obsolete, because it cannot be made either as accurate or as reliable as a separate well-designed circuit breaker with a suitable time element attachment. Many a times a separate magnetic contractor with an overload relay is also used.

Often the motors are protected by thermal overload relay in which a bimetallic strip is heated by the motor is itself heating up. Above a certain temperature, this relay trips and opens the line contractor thereby isolating the motor from the supply.

It is desired to control the speed the motor in addition, and then a field rheostat is connected in the field circuit as shown in the figure. The motor speed can be increased by weakening the flux ($N \propto 1/\phi$) obviously, there is a limit to the speed increase obtained in this way, although speed ranges of three or four are possible. If too much resistance is 'cut-in' by the field rheostat, then field current is reduced very much so that it is unable to create enough electromagnetic pull to overcome the spring tension. Hence, the arm is pulled back to OFF position. It is this undesirable feature of a three-point starter which it makes it unsuitable for use with variable speed motors. This has resulted in wide range application of four point starters.

FOUR POINT STARTER



Such a starter with its internal winding is shown connected to a long –shunt compound motor in fig4.when compared to the three-point starter, it will be noticed that one important change has been made i.e., the HOLD-ON coil has been taken out of the shunt field and has been connected directly across the line through a protecting resistance as shown. When the arm touches stud no.1, then the line current divides into three parts,

- One part passes through starting resistance R_S, series field and motor armature
- The second part passes through the shunt field and its field rheostat.
- The third part passed through the HOLD-ON coil and current protecting resistance R.

It should be particularly noted that with this arrangement any change of current in the shunt field circuit does not at all affect the current passing through the HOLD-ON coil because the two circuits are independent of each other. It means that the electromagnetic pull exerted by the HOLD-ON coil will always be sufficient and will prevent the spring from restoring the starting arm to OFF position no matter how the field rheostat or regulator is adjusted.

RESULT:

Thus the working principle of DC motor starters were studied.

VIVA QUESTIONS:

1. What is a starter?

2. What is the necessity of starter?

3. Classify the DC motor starters.

4. What is the main disadvantage of 3 point starter?

5. What are the advantages of using starters?

Ex. No :		OPEN CIRCUIT & LOAD CHARACTERISTICS OF DC SHUNT GENERATOR – CRITICAL RESISTANCE & CRITICAL SPEED
Date :		

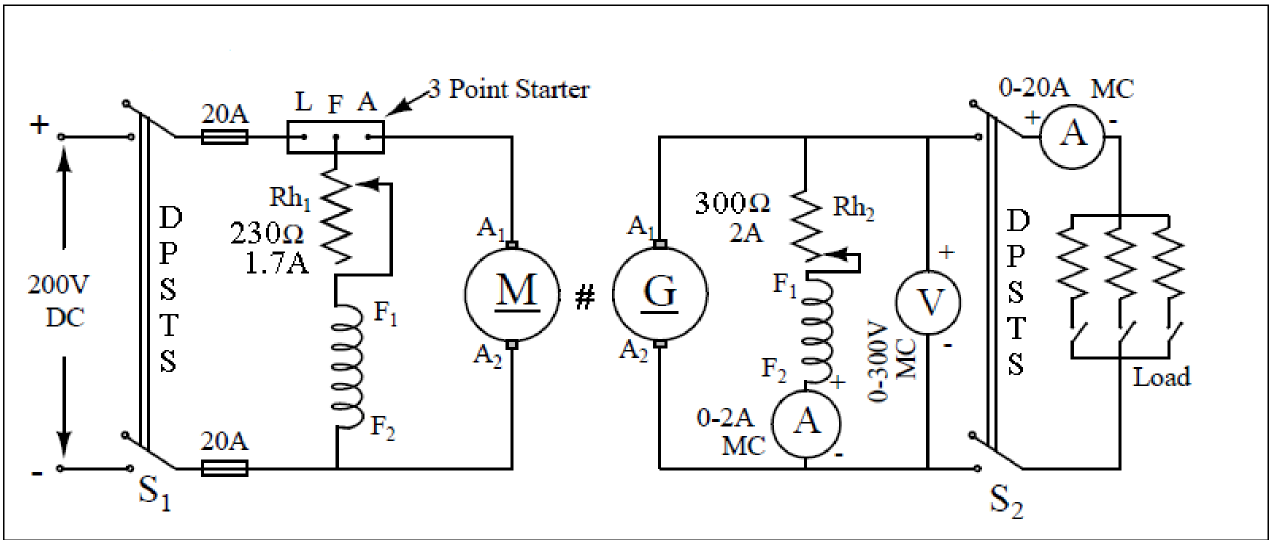
AIM:

To draw the open circuit and load characteristics of self excited DC shunt generator by conducting open circuit test and load test on it.

APPARATUS REQUIRED:

S.NO.	APPARATUS REQUIRED	TYPE	RANGE	QUANTITY
1	Ammeter	Moving coil(MC)	(0-2)amps, (0-5)amps	Each 1
2	Ammeter	Moving coil(MC)	(0-20)amps	1
3	Voltmeter	Moving coil(MC)	(0-10)volts	1
4	Voltmeter	Moving coil(MC)	(0-300)volts	1
5	Rheostat	Wire wound	230 ohms/1.7amps	1
6	Rheostat	Wire wound	300 Ω/2amps, 50/5 amps	Each 1
7	Resistive load	-	3kilo watts (kw)	1
8	Tachometer	Digital	-	1
9	Connecting wires	-	-	Required

CIRCUIT DIAGRAM:



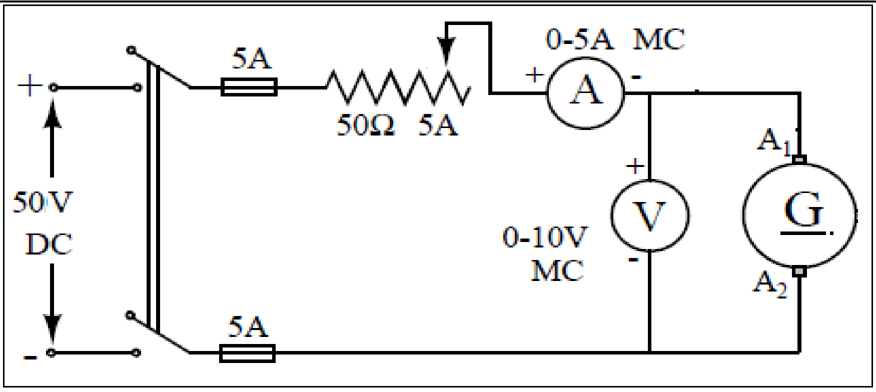
Circuit diagram for open circuit and load characteristics of DC Shunt generator

FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

NAME PLATE DETAILS

PARAMETER	DC SHUNT MOTOR	DC SHUNT GENERATOR
Rating(kw)		
Voltage(volts)		
Current(amps)		
Speed(rpm)		
Excitation volt		
Excitation Current		



Circuit Diagram to find the Armature Resistance.

FORMULA:

$E_g = V + I_a R_a \ (volts)$

$I_L = I_a + I_f \ (amps)$

$R_a = \frac{V_a}{I_a} (\text{ohm})$

Where

E_g - Generated emf at load condition in volts V - Terminal voltage in volts

I_a - Armature resistance in ohm I_L - Load current in amps

I_f - Field current in amps V_a - Armature voltage in volts

PRECAUTIONS:

- All the(Double pole single through) DPST switch should be kept open
- Motor field rheostat should be in minimum position only
- Generated field rheostat should be in maximum position only
- All the switches in resistive load should be in off position
- In the measurement of armature resistance, rheostat should be in maximum resistance position.

PROCEDURE:

A. OPEN CIRCUIT TEST:

1. Make the connection as per the circuit diagram
2. Close the(Double pole single through)DPST switch1
3. Start the motor using three point starter.
4. By adjusting motor field rheostat set the motor-generator to its rated speed
5. Note down the generator voltage indicated by the voltmeter in table.
6. Adjust the generator field rheostat and note down the field current (I_f) & generator emf (E_o) indicated by the ammeter and voltmeter respectively
7. Repeat the same procedure until the voltmeter reads rated voltage of dc shunt Generator and determine the critical resistance value.

TABULATION FOR OPEN CIRCUIT TEST ON DC SHUNT GENERATOR

S.No.	Field current I_f in amps	Generated emf E_o in volts

B. LOAD TEST:

1. Now close the(Double pole single through) DPST switch2.
2. Adjust the resistive load and note down the corresponding load current I_L and terminals voltage indicated by the ammeter and voltmeter respectively.
3. Repeat the same procedure till the load current reaches the rated load current.

TABULATION FOR LOAD TEST ON DC SHUNT GENERATOR

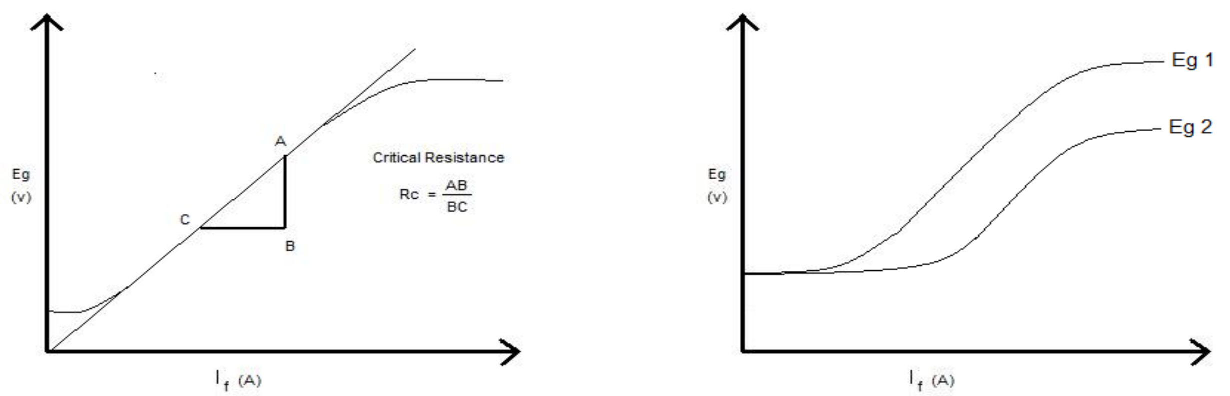
S.No.	Load current (I_L in amps)	Terminal voltage (V_t in volts)	Armature current (I_a in amps)	Generated voltage (E_g in volts)

FIND THE ARMATURE RESISTANCE

S.No	Armature Current(I_a) (amps)	Armature Voltage(V_a) (volts)	Armature Resistance Ra=Va / Ia (ohms)

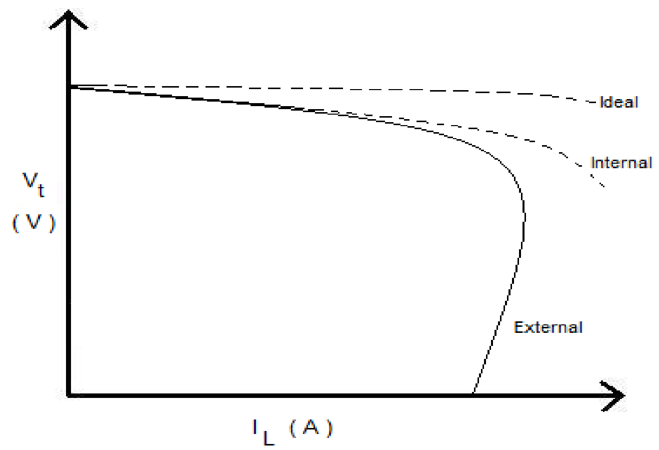
MODEL GRAPH:

<u>Find out the Critical Resistance open circuit characteristics</u>



Graph Representing the Magnetization or Open Circuit of Self Excited DC Shunt Generator.

Load Characteristics



Graph Representing The Load Characteristics of Self Excited DC Shunt Generator.

CALCULATIONS:

RESULT:

Thus the open circuit and load characteristics test was conducted on DC Shunt generator and the performance curves were drawn.

VIVA QUESTIONS:

1. What is the standard direction of rotation of a DC generator?

2. What is meant by voltage buildup of a generator?

3. What is critical resistance of a shunt generator? How it is determined?

4. What do you mean by critical speed of a shunt generator?

5. Why is the resistance of the field winding of a DC Shunt generator kept below the critical field resistance?

Ex. No :		LOAD CHARACTERISTICS OF DC COMPOUND GENERATOR WITH DIFFERENTIAL AND CUMULATIVE CONNECTIONS
Date :		

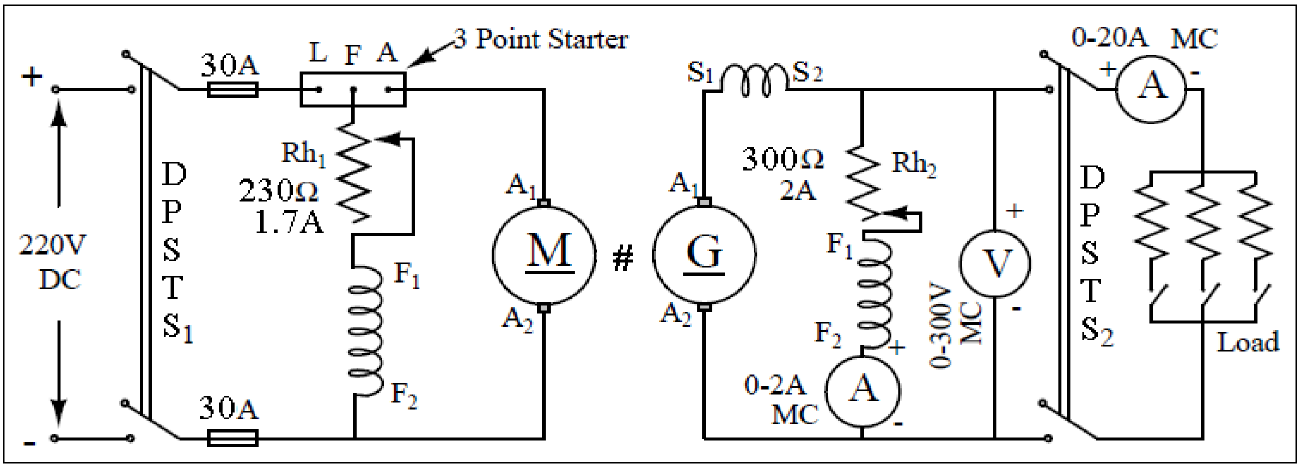
AIM:

To draw the open circuit and load characteristics of DC Compound generator by conducting open circuit test and load test on it.

APPARATUS REQUIRED:

S.NO.	APPARATUS REQUIRED	TYPE	RANGE	QUANTITY
1	Ammeter	Moving coil(MC)	(0-2)amps,(0-5)amps	Each 1
2	Ammeter	Moving coil(MC)	(0-20)amps	1
3	Voltmeter	Moving coil(MC)	(0-10)volts	1
4	Voltmeter	Moving coil(MC)	(0-300)volts	1
5	Rheostat	Wire wound	300 ohms/2amps, 5 ohms/5amps	Each 1
6	Rheostat	Wire wound	300 ohms, 2amps	1
7	Resistive load	-	3 kilowatts(kw)	1
8	Tachometer	Digital	-	1
9	Connecting wires	-	-	Req

CIRCUIT DIAGRAM:



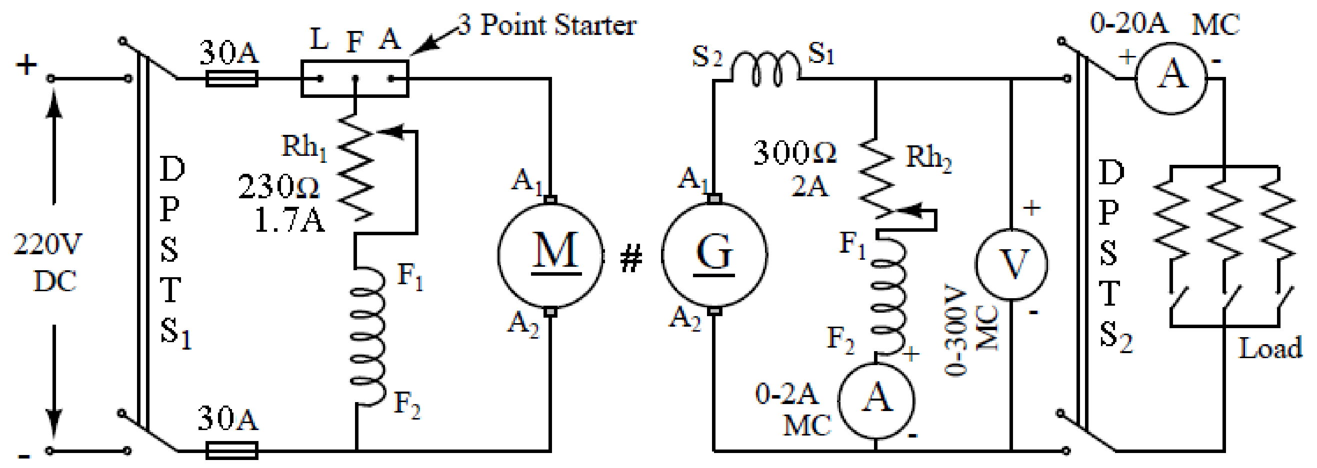
DC Compound Generator – Cumulative

FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

NAME PLATE DETAILS

PARAMETER	DC SHUNT MOTOR	DC COMPOUND GENERATOR
Rating(kw)		
Voltage(volts)		
Current(amps)		
Speed(rpm)		
Excitation volt		
Excitation Current		



DC Compound Generator – Differential

PRECAUTIONS:

- All the(Double pole single through) DPST switch should be kept open
- Motor field rheostat should be in minimum position only
- Generated field rheostat should be in maximum position only
- All the switches in resistive load should be in off position
- In the measurement of armature resistance, rheostat should be in maximum resistance position.

PROCEDURE:

LOAD TEST (Cumulative Compound) :

1. Now close the(Double pole single through) DPST switch2.
2. Adjust the resistive load and note down the corresponding load current I_L and terminal voltage indicated by the ammeter and voltmeter respectively.
3. Repeat the same procedure till the load current reaches the rated load current.

TABULATION FOR LOAD TEST OF DC CUMULATIVE COMPOUND GENERATOR

S.No.	Load current (I_L in amps)	Terminal voltage (V_t in volts)

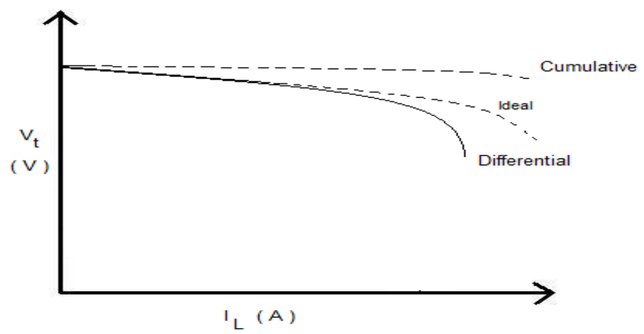
LOAD TEST (Differential Compound) <u>Series winding terminal S1 &S2 are interchanged</u>

1. Now close the (Double pole single through) DPST switch2.
2. Adjust the resistive load and note down the corresponding load current I_L and terminal voltage indicated by the ammeter and voltmeter respectively.
3. Repeat the same procedure till the load current reaches the rated load current.

TABULATION FOR LOAD TEST OF DC DIFFERENTIAL COMPOUND GENERATOR

S.No.	Load current (I_L in amps)	Terminal voltage (V_t in volts)

MODEL GRAPH:



Graph representing the load characteristics of DC compound Generator.

RESULT:

Thus the open circuit and load test was conducted and the performance curves were drawn.

VIVA QUESTIONS:

1. What is the location of series field winding in a compound generator?
2. What is the necessity of compound generator?
3. Why do we use over-compounded generators in power stations?
4. What happens if a dc machine is operated at a speed below the rated speed?
5. Can a dc machine be operated under conditions different from those on the name plate?

Ex. No :		LOAD TEST ON DC SHUNT MOTOR
Date :		

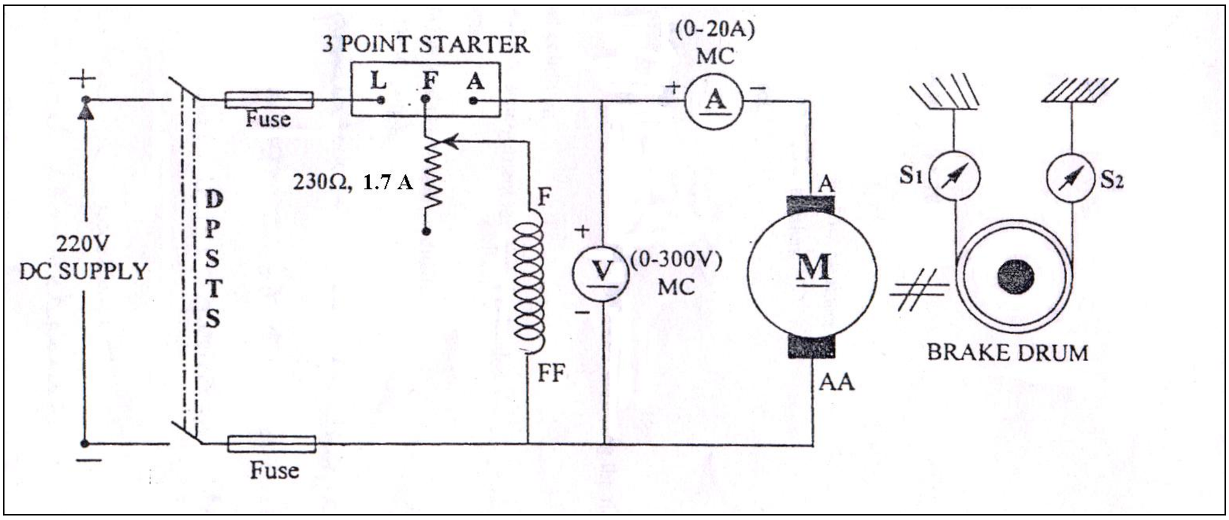
AIM:

To conduct the load test on a given DC shunt motor and to draw its performance curves.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	Ammeter	Moving coil(MC)	(0-20) amps	1
2	Voltmeter	Moving coil(MC)	(0-300) volts	1
3	Rheostat	Wire wound	230ohms,1.7amps	1
4	Tachometer	Digital	-	1
5	Connecting wires	-	-	Req

CIRCUIT DIAGRAM:



NAME PLATE DETAILS

PARAMETER	DC SHUNT MOTOR
Rating(kw)	
Voltage(volts)	
Current(amps)	
Speed(rpm)	

FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

FORMULA:

$Torque, T = (S_1 - S_2) \times \left(R + \frac{t}{2}\right) \times 9.81\ Nm.$

Where R-radius of brake drum in m.

t- thickness of the belt in m.

S_1, S_2-spring balance reading in Kg.

$Input\ Power, P_i = V_L I_L\ Watts$, Where, V_L-load voltage in volts, I_L-load current in amps

$Output\ Power, P_o = \frac{2\pi NT}{60}\ Watts$,Where,$N$-Speed of the armature in rpm, T-Torque in Nm.

$$\%\ Efficiency = \frac{Output\ Power}{Input\ Power} \times 100$$

PRECAUTIONS:

- The motor field rheostat should be kept at minimum resistance position.
- At the time of starting the motor should be in no load condition.
- The motor should be run in anticlockwise direction.

PROCEDURE:

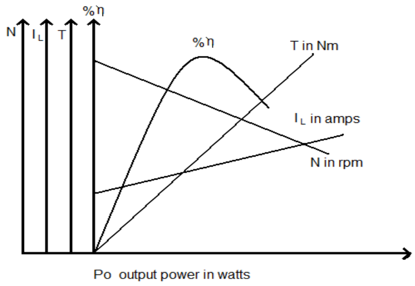
1. Connections are given as per the circuit diagram.
2. Using the three point starter the motor is started to run at the rated speed by adjusting the field rheostat if necessary.
3. The meter readings are noted at no load condition.
4. By using the break drum with spring balance arrangement the motor is loaded and the corresponding readings are noted up to the rated current.
5. After the observation of all the readings the load is released gradually.
6. The motor is switched off.

TABULATION

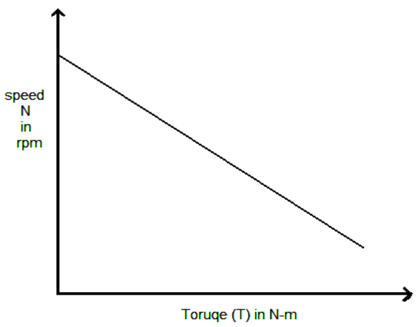
OBSERVATION: Radius of a brake drum= m

S.No	V_a (volts)	I_L (amps)	I_F (amps)	N(rpm)	Spring Balance		S_1- S_2 (kg)	Torque (Nm)	Input(watts)	Output (watts)	Efficiency %η
					S_1	S_2					

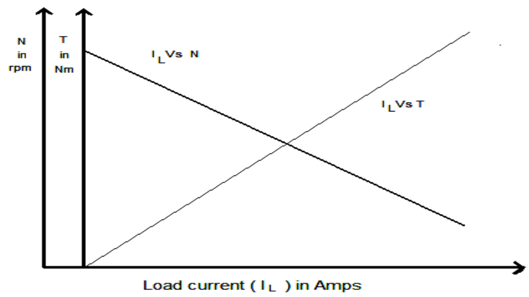
MODEL GRAPH:



Graph Representing the Load Characteristics of DC Shunt Motor.



Mechanical Characteristics



Electrical Characteristics

CALCULATIONS:

RESULT:

Thus the load test was conducted on DC Shunt motor and the performance curve was drawn.

VIVA QUESTIONS:

1. How may the direction of rotation of a dc motor be reversed?

2. What will happen if both armature and field currents are reversed?

3. What will happen if both currents are reversed?

4. What happens when a dc shunt motor is connected across an ac supply?

5. What will happen if a shunt motor is directly connected to the supply line?

Ex. No :		LOAD TEST ON DC COMPOUND MOTOR
Date :		

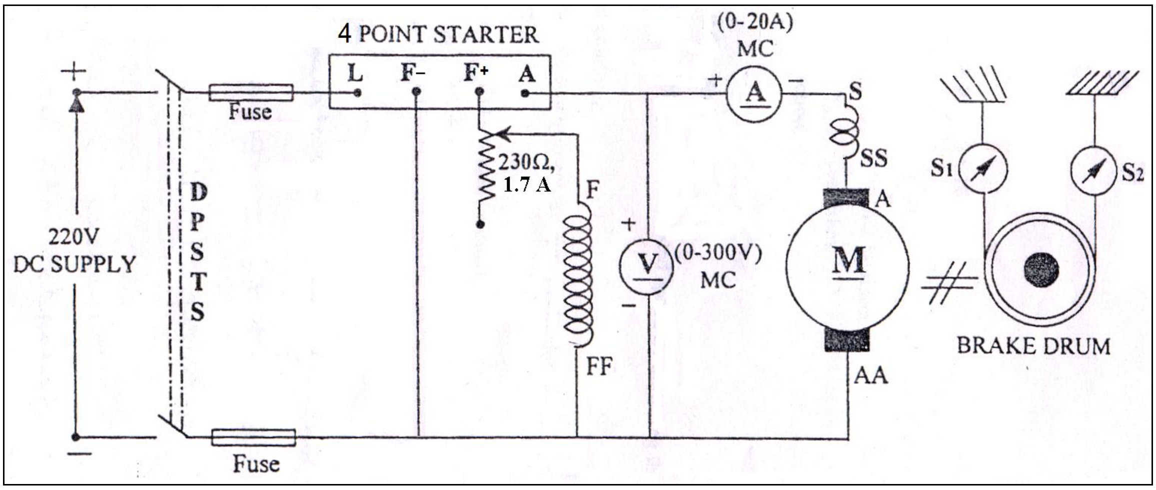
AIM:

To conduct load test on DC compound motor and to draw its performance characteristics.

APPARATUS REQUIRED:

S.No	Name of the Equipment	Type	Range	Quantity
1	DC compound motor	-	-	1
2	Rheostat	Wire Wound	230ohms/1.7amps	1
3	Voltmeter	Moving coil (MC)	(0-300) volts	1
4.	Ammeter	Moving coil(MC)	(0-20) volts	1
5	Connecting wires	-	-	As required

CIRCUIT DIAGRAM:



NAME PLATE DETAILS

PARAMETER	DC COMPOUND MOTOR
Rating(kw)	
Voltage(volts)	
Current(amps)	
Speed(rpm)	

FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

FORMULA :

$$Torque, T = (S_1 - S_2) \times \left(R + \frac{t}{2}\right) \times 9.81\ Nm$$

Where R -radius of brake drum in m

t - thickness of the belt in m

S_1, S_2-spring balance reading in Kg

$$Input\ Power, P_i = V_L I_L\ Watts$$

Where V_L-load voltage in volts

I_L-load current in amps

$$Output\ Power, P_o = \frac{2\pi NT}{60}\ Watts$$

Where N-Speed of the armature in rpm

T-Torque in N-m

$$\%\ Efficiency = \frac{Output\ Power}{Input\ Power} \times 100$$

DESCRIPTION:

The characteristics of a compound motor will depend upon whether the series and shunt fields are assisting each other (cumulative) or are opposing each other (differential). In the cumulative connections, the characteristics will be in between those of shunt and series motors whereas for latter, they tend towards those of series motors. Compound motors are used for driving heavy machine tools for intermittent loads, shears, purchasing machines etc.

PRECAUTIONS:

- The motor field rheostat should be kept at minimum resistance position
- At the time of starting the motor should be in no load condition
- The motor should be run in anticlockwise direction

PROCEDURE:

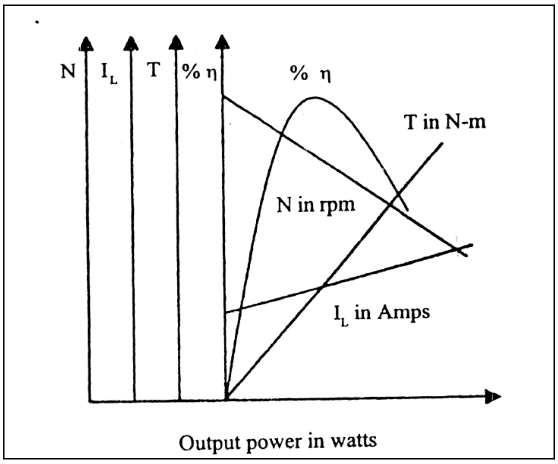
1. Connections are given as per the circuit diagram shown in Fig.
2. Rated voltage is given to the circuit.
3. The field rheostat is adjusted to get the rated speed.
4. Load on the motor is varied and the corresponding voltage, current and speed are noted for different loads on the motor in table.
5. The load is applied until the rated current of the motor is reached.
6. The load is then released and the supply is switched off.
7. Water is applied to the brake drum then and there to avoid heating of the brake drum.

TABULATION

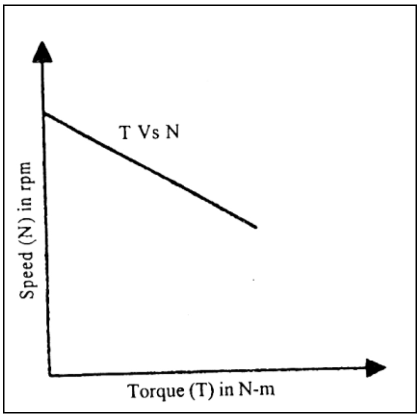
OBSERVATION: Radius of a brake drum= m

S.No	V_a (volts)	I_L (amps)	I_F (amps)	N(rpm)	Spring Balance		S_1- S_2 (kg)	Torque N-m	Input (watts)	Output (watts)	Efficiency %η
					S_1	S_2					

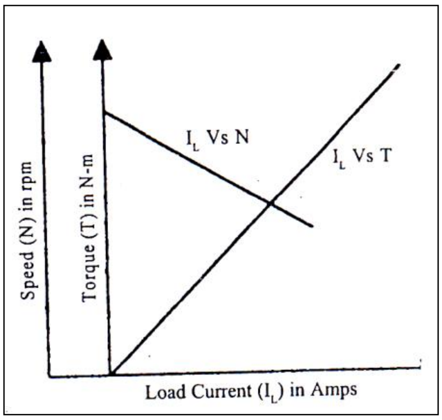
MODEL GRAPH:



Graph Representing the Load Characteristics of DC Compound Motor.



(a). Mechanical Characteristics



(b). Electrical Characteristics

CALCULATIONS:

RESULT:

Thus the load test on DC compound motor was conducted and the performance characteristics were drawn.

VIVA QUESTIONS:

1. What do you mean by a compound wound motor?

2. What are the types of compound motor connections?

3. What are the types of compound motor?

4. A Metallic Sphere Is Charged Negatively. Will Its Mass Increases, Decreases or Remains Same?

5. Suggest a method to determine the power factor by using various meters available.

Ex. No :		LOAD TEST ON DC SERIES MOTOR
Date :		

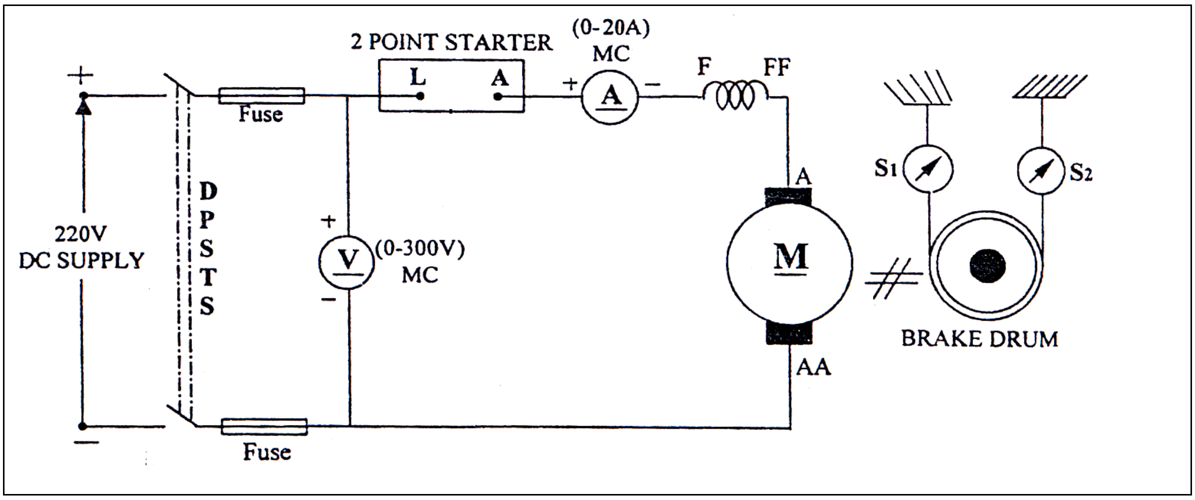
AIM:

To conduct the load test on a given DC series motor and to draw its performance curves.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1	Ammeter	Moving coil (MC)	(0-20)amps	1
2	Voltmeter	Moving coil (MC)	(0-300)volts	1
3	Tachometer	Digital	-	1
4	Connecting wires	-	-	Required

CIRCUIT DIAGRAM:



NAME PLATE DETAILS

PARAMETER	DC SERIES MOTOR
Rating(kw)	
Voltage(volts)	
Current(amps)	
Speed(rpm)	

FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

FORMULA :

$$Torque, T = (S_1 - S_2) \times \left(R + \frac{t}{2}\right) \times 9.81\ Nm$$

Where R -radius of brake drum in m

t - thickness of the belt in m

S_1, S_2-spring balance reading in Kg

$$Input\ Power, P_i = V_L I_L\ Watts$$

Where V_L-load voltage in V

I_L-load current in A

$$Output\ Power, P_o = \frac{2\pi NT}{60}\ Watts$$

Where N-Speed of the armature in rpm

T-Torque in Nm

$$\%\ Efficiency = \frac{Output\ Power}{Input\ Power} \times 100$$

PRECAUTIONS:

- The motor field rheostat should be kept at minimum resistance position.
- At the time of starting the motor should be in no load condition.
- The motor should be run in anticlockwise direction.

PROCEDURE:

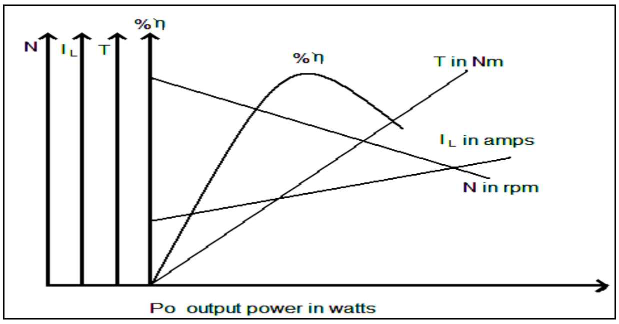
1. Connections are given as per the circuit diagram
2. Initially apply some load.
3. Using the two point starter the motor is started to run
4. The meter readings are noted
5. By using the break drum with spring balance arrangement the motor is loaded and the corresponding readings are noted up-to the rated current
6. After the observation of all the readings the load is released gradually not fully
7. The motor is switched off.

TABULATION

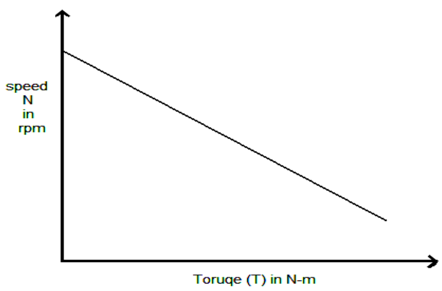
OBSERVATION: Radius of a brake drum=------m

S.No	V_a (volts)	I_L (amps)	I_F (amps)	N (rpm)	Spring Balance		S_1- S_2 (kg)	Torque (N-m)	Input (watts)	Output(watts)	Efficiency %η
					S_1	S_2					

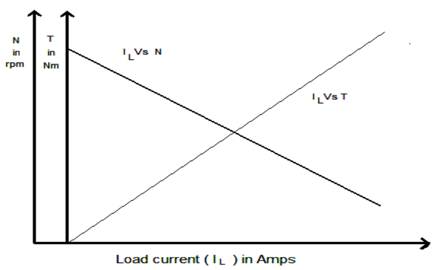
MODEL GRAPH:



Graph representing the load characteristics of dc series motor.



Mechanical Characteristics



Electrical Characteristics

CALCULATIONS:

RESULT:

Thus the load test on dc series motor was conducted and the performance curves were drawn.

VIVA QUESTIONS:

1. Why the DC series motor should not operate without load?

2. Can A DC Series Motor operate on Ac Supply?

3. Why DC Series motor is called as Variable speed motor?

4. What are the applications of dc series motor?

5. Why is DC series motor not suitable for belt driven loads?

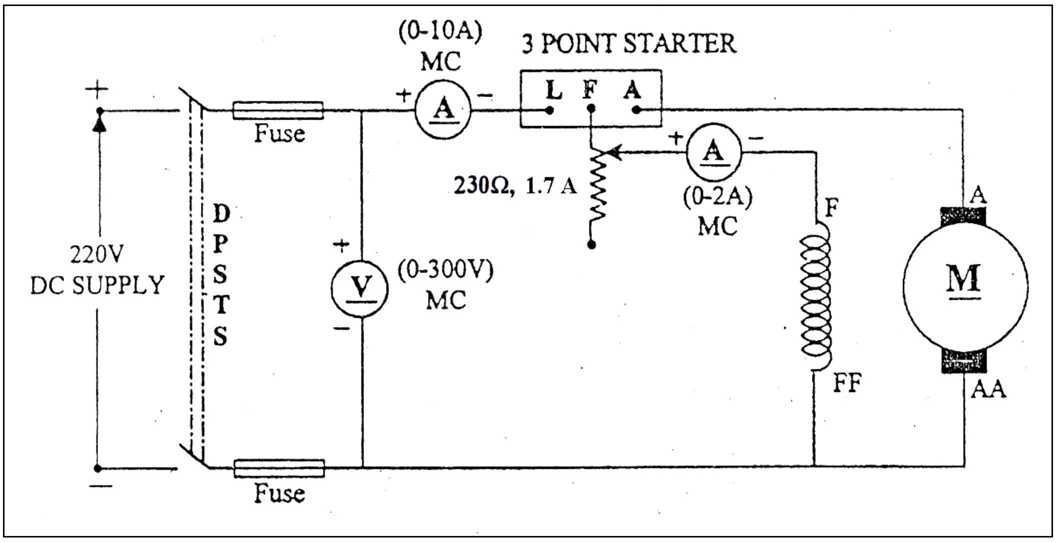
Ex. No :		SWINBURNE'S TEST
Date :		

AIM:
To predetermine the efficiency of a given DC shunt machine by Swinburne's test and to draw the characteristics curves.

APPARATUS REQUIRED:

S.No	Name of the Apparatus	Type	Range	Quantity
1.	Ammeter	Moving coil(MC)	(0-2)amps, (0-5)amps	Each 1
2.	Ammeter	Moving coil(MC)	(0-10)amps	1
3.	Voltmeter	Moving coil(MC)	(0-300)volts,(0-10)volts	Each 1
4.	Rheostat	Wire Wound	300 Ω/2amps, 50Ω/5amps	Each 1
5.	Tachometer	Digital	-	1
6.	Connecting wires	-	-	Required

CIRCUIT DIAGRAM:

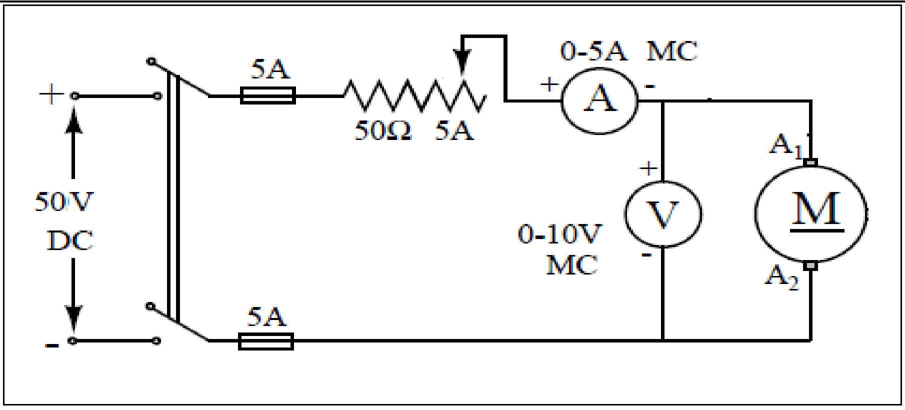


The Circuit Diagram for Swinburne's Test

FUSE RATING:
For Load Test Fuse Rating=125% of rated current.

NAME PLATE DETAILS

PARAMETER	DC SHUNT MOTOR
Rating(kw)	
Voltage(volts)	
Current(amps)	
Speed(rpm)	



Circuit Diagram to find the Armature Resistance.

FORMULAE:

1. Armature Resistance (R_a) = 1.6×R_{dc} in Ohm.
Where 1.6 Adds the Skin Effect
R_{dc} =Resistance Of The Armature Coil When It Is Energized
By DC Supply
2. Constant Loss (W_{co}) = (VI_o – $I_{ao}^2 R_a$) in W
Where V = Terminal Voltage in V
I_o = No Load Current in A
I_{ao} = No Load Armature Current In A.
3. Armature Current (I_a) = (I_l + I_f)In A.
Where +ve is Used For Generator
- ve is Used For Motor.
4. Copper Loss (W_{Cu}) =$I_a^2 R_a$ in W.
5. Total Loss (W_{total}) = Constant Loss +Copper Loss in W.

6. Input Power for Motor (W_i)/Output Power for Generator (W_o)= W_i/W_o W
7. Output Power For Motor (W_o) = (Input Power - Total Losses) in W
8. Input Power For Generator (W_i) = (Output Power +Total Losses)in W.
9. Percentage of Efficiency= (Output Power / Input Power) × 100

DESCRIPTION:

Swinburne's test is also called no load or losses method. It is the simplest indirect method where losses are measured separately and then the efficiency is predetermined at any desired load conditions. This method is economical since power required to test a large machine is very small and no cooling circuit is required as in load test. This method is not suitable for DC series motor as it cannot be operated under no load condition.

PRECAUTIONS:

- The Motor Field Rheostat Should Be Kept At Minimum Resistance Position.
- The Motor Should Be At No Load Condition Throughout The Experiment.

PROCEDURE:

1. Connections are given as per the circuit diagram shown in Fig.
2. By using the three point starter the motor is started to run at the rated speed.
3. The meter readings are noted at no load condition.
4. The motor is switched off using the DPST switch.
5. After that the armature resistance test is conducted as per the circuit diagram and the voltage and current are noted for various resistive loads.
6. After the observation of readings the load is released gradually.

TABULATION:

S.No	Terminal Voltage (volts)	No Load Current (amps)	Field Current (amps)	No Load Armature Current(I_{ao}) (amps)	Constant Loss (watts)

TABULATION TO FIND ARMATURE RESISTANCE:

S.No	Armature Current(I_a) (amps)	Armature Voltage(V_a) (volts)	Armature Resistance $R_a=V_a / I_a$ (Ohms)

RESULTANT TABULATION TO FIND OUT THE EFFICIENCY OF THE MACHINE WHEN RUNNING AS MOTOR/GENERATOR

Armature Resistance (R_a) = ohm Rated Current (I_r) = amps
Constant Loss (W_{co}) = watts Field Current (I_f) = amps
Terminal Voltage (V) = volts

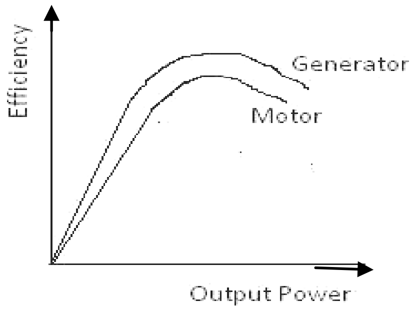
RUNNING AS A MOTOR

S.NO	Fraction of load (X)	Load current I_L=Xxl$_r$ (amps)	Armature current $I_a= I_L I_r$ (watts)	Armature cu loss $W_{cu}=I_a^2R_a$ (watts)	Total loss W_{Total} (watts)	Input power $W_i=VI_L$ (watts)	Output power $W_o=W_i-W_{Total}$ (watts)	Efficiency Ŋ $=W_o/W_i$ %
1	¼							
2	½							
3	¾							
4	1							

RUNNING AS A GENERATOR

S.NO	Fraction of load (X)	Load current I_L=Xxl$_r$ (amps)	Armature current $I_a= I_L I_r$ (watts)	Armature cu loss $W_{cu}=I_a^2R_a$ (watts)	Total loss W_{Total} (watts)	Input power $W_i=VI_L$ (watts)	Output power $W_o=W_i-W_{Total}$ (watts)	Efficiency Ŋ $=W_o/W_i$ %
1	¼							
2	½							
3	¾							
4	1							

MODEL GRAPH:



Performance Characteristics

CALCULATIONS:

RESULT:

Thus the efficiency of a given DC shunt machine is calculated by conducting Swinburne's test.

VIVA QUESTIONS:

1. In which type of dc machine, Swinburne's test is applicable?

2. What are the advantages of Swinburne's test?

3. What are the causes of overheating of a dc motor?

4. Why is shaft torque less than armature torque in a dc motor?

5. What is the necessity of a starter in a dc motor?

Ex. No :		SPEED CONTROL OF DC SHUNT MOTOR
Date :		

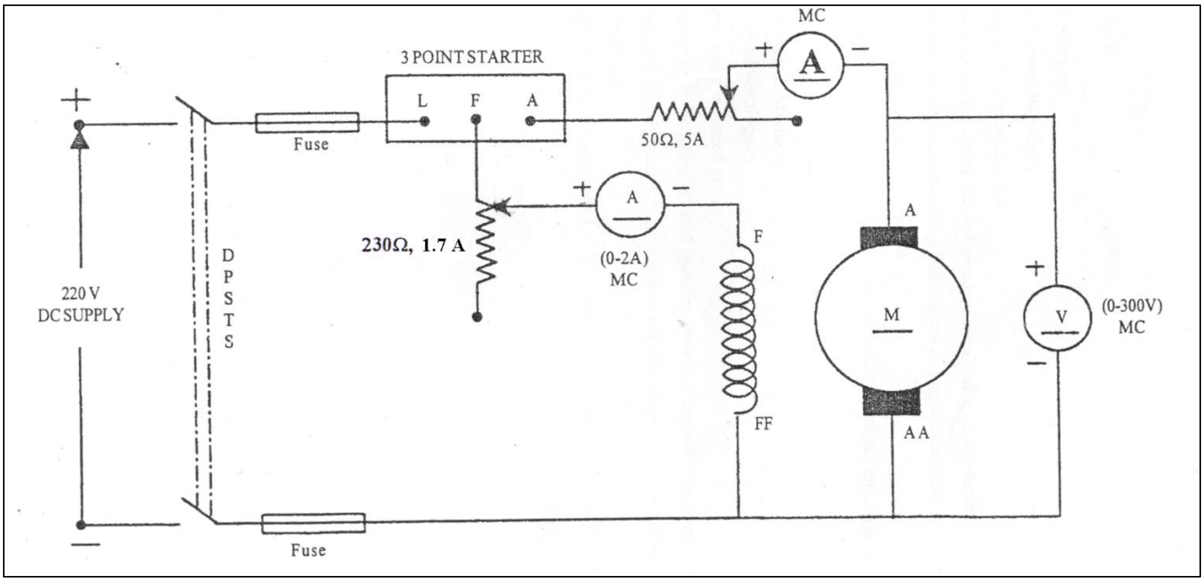
AIM:

To conduct an experiment to control the speeds of the given DC shunt motor by field and armature control method and to draw its characteristic curves.

APPARATUS REQUIRED:

S.No	Name of the apparatus	Type	Range	Quantity
1.	Ammeter	Moving coil(MC)	(0-2)amps	1
2	Ammeter	Moving coil(MC)	(0-5)amps	1
3.	Voltmeter	Moving coil(MC)	(0-300)volts	1
4.	Rheostat	Wire wound	(230Ω,1.7 amps)	1
5.	Rheostat	Wire wound	(50Ω,5amps)	1
6.	Tachometer	Digital	-	1
7.	Connecting wires	-	-	Req

CIRCUIT DIAGRAM:



FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

NAME PLATE DETAILS

PARAMETER	DC SHUNT MOTOR
Rating(kw)	
Voltage(volts)	
Current(amps)	
Speed(rpm)	

PRECAUTIONS:

- The motor field rheostat should be kept at minimum resistance position.
- The motor armature rheostat should be kept at maximum resistance position.
- The motor should be in no load condition throughout the experiment.
- The motor should be run in anticlockwise direction.

PROCEDURE:

FIELD CONTROL METHOD (FLUX CONTROL METHOD)

1. Connections are given as per circuit diagram.
2. Using the three point starter the motor is started to run.
3. The armature rheostat is adjusted to run the motor at rated speed by means of applying the rated voltage.
4. The field rheostat is varied gradually and the corresponding field current and speed are noted up to 120% of the rated speed by keeping the armature current as constant.
5. The motor is switched off using the DPST switch after bringing all the rheostats to their initial position.

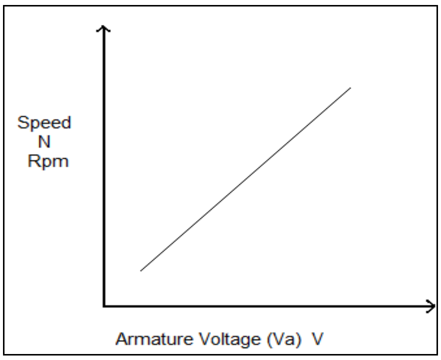
ARMATURE CONTROL METHOD (VOLTAGE CONTROL METHOD)

1. Connections are given as per circuit diagram
2. Using the three point starter the motor is started to run.
3. The armature rheostat is adjusted to run the motor at rated speed by means of applying the rated voltage.
4. The armature rheostat is varied gradually and the corresponding armature voltage and speed are noted up to the rated voltage.
5. The motor is switched off using the DPST (Double pole single throw) switch after bringing all the rheostats to their initial position.

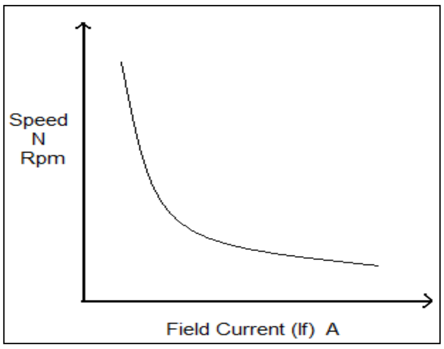
TABULATION FOR SPEED CONTROL OF DC SHUNT MOTOR

S.NO	Armature Control Method		Field Control Method	
	Field Current (I_f) =		Armature Voltage (V_a) =	
	Armature Voltage (V_a) volts	Speed (N) Rpm	Field Current (I_f) amps	Speed (N) Rpm

MODEL GRAPH:



Armature Control Method



Field Control Method

RESULT:

Thus the speed of the DC shunt motor is controlled by conducting field control and armature control method.

VIVA QUESTIONS:

1. Why is the speed of a shunt motor practically constant?

2. What will happen if a shunt motor running at no load has its shunt winding opened accidentally?

3. When will you say the motor is running at base speed?

4. Why a dc shunt motor is found suitable to drive fans?

5. What happens when the load is increased in shunt motor?

Ex. No :		HOPKINSON'S TEST ON DC MOTOR – GENERATOR SET
Date :		

AIM:

To Perform Hopkinson's Test on two identical DC machine and to predetermine the efficiency of the motor and generator at 25%,50%,75%,100% and 125% of rated current.

APPARATUS REQUIRED:

S.No	Name of the Equipment	Type	Range	Quantity
1	Rheostat	Wire wound	230Ω/1.7amps, 300Ω/2amps	Each 1
2	Voltmeter	Moving colis(MC)	(0-300)volts	2
3	Ammeter	Moving colis(MC)	(0-2)amps	1
4.	Ammeter	Moving colis(MC)	0-20)amps	2
5.	Connecting wires	-		As required

FORMULAE:

1.Armature copper loss in generator=$I_a{}^2R_a$in ohms

2.Armature copper loss in motor=$(I_1+ I_2)^2 R_a$in ohms

3.Total power drawn from the supply=VI_1in watts

Let the sum of iron losses and mechanical losses of each machine be then

4.VI_1=2 W_C+ $I_a{}^2R_a$+=$(I_1+ I_2)^2 R_a$watts

5.W_C=1/2[2 W_C+ $I_a{}^2R_a$+=$(I_1+ I_2)^2 R_a$] watts

Efficiency of motor:

1.Shunt field copper loss of motor= VI_3 watts

2.Total losses of motor= W_C +$(I_1+ I_2)^2 R_a$+ VI_3watts

3.Power output to motor(P_{IM})=armature input + shunt field input

=V$(I_1+ I_2)$+ + VI_3watts

4. Motor losses (W))=Armature cu loss+ shunt field cu loss+ stray losses

=W_C +$(I_1+ I_2)^2 R_m$+ VI_3watts

5. %η= P_{IM} – W_M / P_{IM} *100

Efficiency of generator:

1.Generator output(P_{go})=VI_2watts

2.Generator losses(Wg)=armature cu loss+ shunt field cu loss+ stray loss

= W_C +$I_2{}^2 R_a$+ VI_4watts

3.%η= P_{go} / $P_{go}{}^2$+ W_g *100

CIRCUIT DIAGRAM:

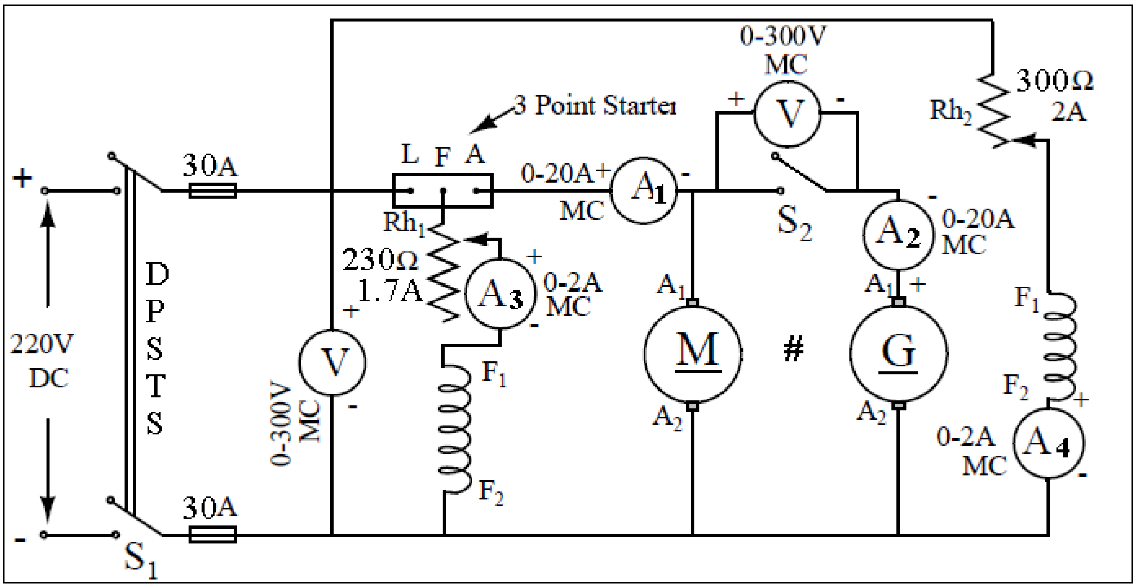


Fig. Circuit Diagram For Hopkinson's Test

FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

NAME PLATE DETAILS

PARAMETER	DC SHUNT MOTOR
Rating(kw)	
Voltage(volts)	
Current(amps)	
Speed(rpm)	

DESCRIPTION:

It is also called regenerative of back-to-back test. For this test two identical machines are used. The two machines are mechanically coupled and are so adjusted electrically that one of them act as motor and another as generator. The mechanical output of the motor drives the generator and the electrical output of the generator is used in supplying the greater part of the input to the motor in addition to the power drawn from the supply mains. The machine with small excitation acts as motor and with large excitation acts as generator. Since the machines can be tested under full load conditions for long duration, the performance of the machines regarding commutation and temperature rise can bestudied.

PRECAUTIONS:

- Motor Field rheostat should be in minimum resistance position and generator Field rheostat should be in maximum resistance position at the time of starting.
- The SPDT switch is closed when the machines are exactly out of phase (i.e.) the voltmeter should indicate zero.

PROCEDURE:

1.Note the name plate details and justify the range of meters selected.

2.Make the connections as per the circuit diagram.

3.Keep the SPST switch open, give the supply to the motor and start it with the help of three point starters.

4. Adjust the field of the motor to the rated value by varying the rheostat provided in the motor field circuit.

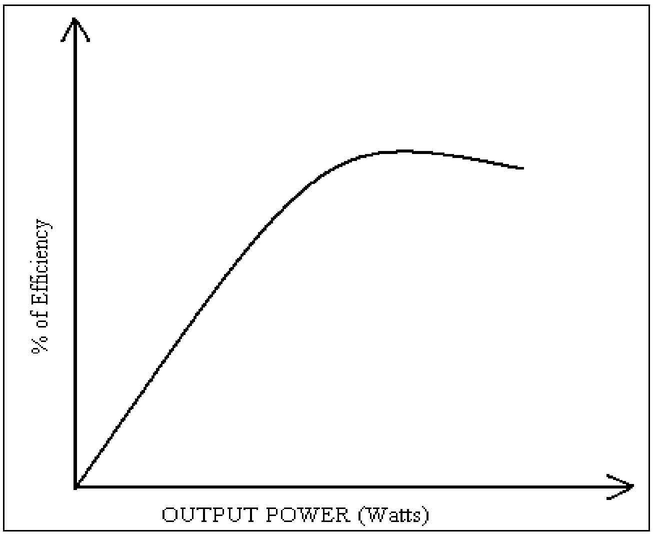
5. Adjust the rheostat in the field circuit of generator, so that the generated voltage of the generator is equal to the supply voltage.

6. Check the voltage across adjust the switch S. In case of wrong polarity the voltmeter across the switch 'S' will record twice the supply voltage. In such a case, switch off the mains and reverse the armature terminals of the generator. Repeat steps 3,4 & 5. Now the voltmeter will indicate zero voltage. Close the switch 'S' after ensuring that the voltmeter reads zero. Under this condition, the machine working as a generator is just floating (i.e) neither drawing any current from nor giving into the lines.

TABULATION:

S.No	Voltage (V) (volts)	Current(I_1) (amps)	Current(I_2) (amps)	Current(I_3) (amps)	Current(I_4) (amps)

MODEL GRAPH:



Model Graph For Hopkinson's Test

CALCULATIONS:

RESULT:

Thus the Hopkinson's test was conducted on two identical DC machines and their efficiencies were predetermined.

VIVA QUESTIONS:

1. How may the number of parallel paths in an armature be increased?

2. How are brushes connected in a DC generator?

3. What is the best way of minimizing eddy currents in an armature?

4. How should the armature be laminated for purpose?

5. What causes sparking at the brushes?

Ex. No :		LOAD TEST ON SINGLE PHASE TRANSFORMER
Date :		

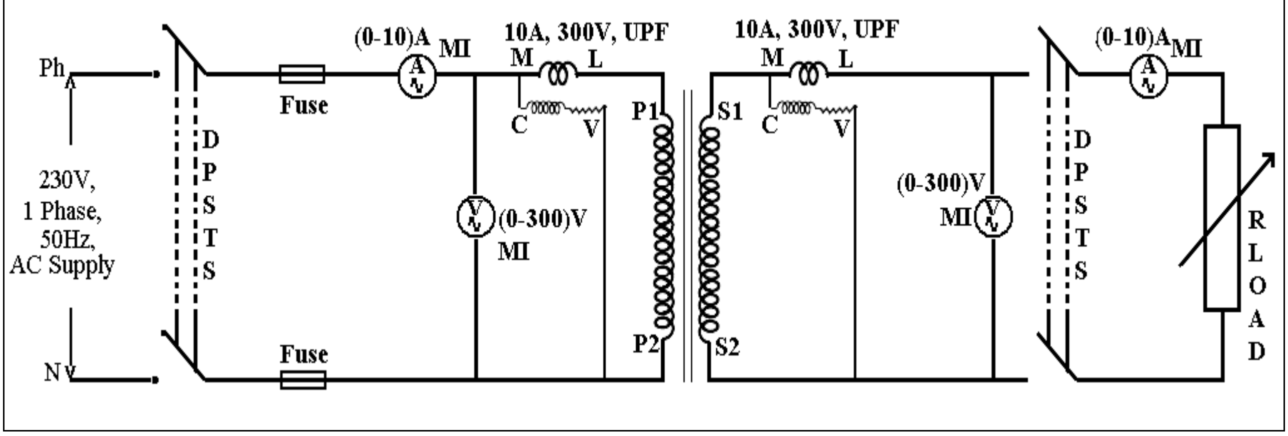
AIM:

To conduct the load test on a given single phase transformer and to draw its performance curves.

APPARATUS REQUIRED:

S.No	Name of The Apparatus	Type	Range	Quantity
1	Ammeter	Moving Iron(MI)	(0-10) amps	2
2	Voltmeter	Moving Iron(MI)	(0-300) volts	2
3	Wattmeter	Unity power factorUPF	(300volts, 10amps)	2
4	Resistive Load	-	2 kilo watts(kW)	1
5	Connecting wires	-	-	Required

CIRCUIT DIAGRAM:



NAME PLATE DETAILS

FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

PARAMETER	TRANSFORMER	
	Primary	Secondary
Rating(kw)		
Voltage(volts)		
Current(amps)		

FORMULAE:

$$Input\ Power = (Wattmeter\ reading \times Multiplication\ Factor)\ in\ W$$

Where,

$$Multiplication\ Factor = \frac{(Rating\ of\ Pressure\ coil \times Rating\ of\ current\ Coil \times Power\ Factor)}{Full\ scale\ Reading}$$

$$Output\ Power = V_{sec} \times I_{sec} \times \cos\emptyset \quad in\ W$$

$$\%\ Efficiency = \frac{Output\ Power}{Input\ Power} \times 100$$

$$\%\ Regulation = \frac{V_{NL} - V_{LOAD}}{V_{NL}} \times 100$$

V_{NL} = No load voltage in volts.

V_{LOAD} = Load voltage in volts.

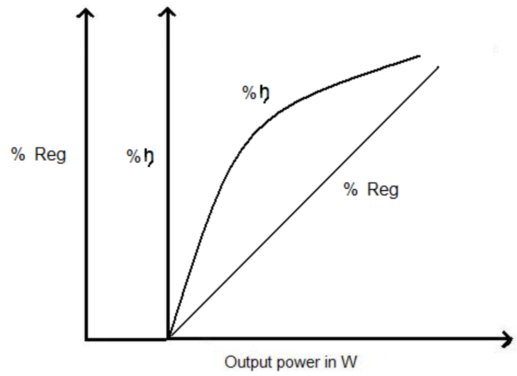
PRECAUTIONS:

- At the time of starting transformer should be at no load condition.
- High voltage and low voltage sides of the transformer should be properly used as primary or secondary respective experiments.

PROCEDURE:

1. The circuit diagram for load test on single-phase transformer is shown in fig
2. Connections are given as per the circuit diagram.
3. The DPST Switch on the primary side is closed and the DPST Switch on the Secondary side is opened.
4. The Autotransformer is adjusted to energize the transformer with rated primary voltage.
5. The Voltmeter and Ammeter readings are noted and tabulated at no load condition.
6. The DPST switch on the secondary side is closed.
7. The transformer is loaded up to 130% of the Rated load, corresponding Ammeter, Voltmeter and Wattmeter readings are noted and tabulated.
8. After the observation of all the readings the load is released gradually to its initial position.
9. The Autotransformer is brought to its initial position.
10. The Supply is switched off.

MODEL GRAPH:



TABULATION FOR LOAD TEST OF SINGLE PHASE TRANSFORMER

S.No	Pri. Voltage (V_{Pri}) volts	Pri. Current (I_{Pri}) amps	Sec. Voltage (V_{Sec}) volts	Sec. Current (I_{Sec}) amps	Input Wattmeter readings (watts)		Output Wattmeter readings (watts)		Input Power watts	Output Power watts	% η	%Reg
					Obs	Act	Obs	Act				

CALCULATIONS:

RESULT:

Thus the load test on single-phase transformer was conducted and performance characteristics curves were drawn.

VIVA QUESTIONS:

1. What is a transformer?

2. What is the principle of operation of transformer?

3. What is transformation ratio?

4. What is an ideal transformer?

5. How will you relate the EMF induced in the transformer with the frequency of the applied voltage?

Ex. No :		LOAD TEST ON THREE PHASE TRANSFORMER
Date :		

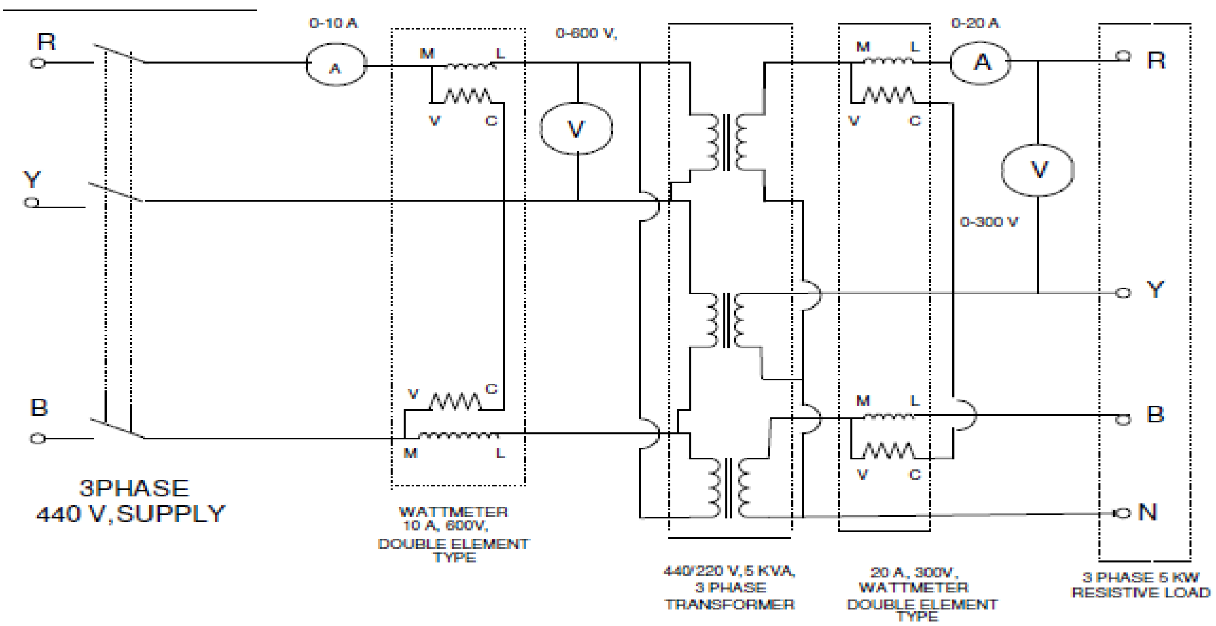
AIM:

To conduct the load test on a given three phase transformer and to determine its efficiency and regulation.

APPARATUS REQUIRED:

S.No	Name of The Apparatus	Type	Range	Quantity
1	Voltmeter	Moving Iron(MI)	0-600 volts	1
2	Voltmeter	Moving Iron(MI)	0-300 volts	1
3	Ammeter	Moving Iron(MI)	0-10 amps	1
4	Ammeter	Moving Iron(MI)	0-20amps	1
5	Wattmeter	Unity poer factor(UPF), Double element	600volts/10amps, 300volts/20amps	Each 1
6	Resistive load	Wire Wound	3ph 415volts,5kW	1
7	Transformer	Inductive	3ph 440/220volts	1
8	Connecting wires	-	-	Required

CIRCUIT DIAGRAM:



FUSE RATING:
For Load Test Fuse Rating=125% of rated current.

NAME PLATE DETAILS

PARAMETER	TRANSFORMER	
	Py	Sy
Rating(kw)		
Voltage(volts)		
Current(amps)		

PRECAUTIONS:

All the switches should be kept open.

The auto transformer should be kept at minimum potential position.

PROCEDURE:

1) Connect the circuit as shown in figure.
2) Keep load on transformer at off position.
3) Keeping dimmer stat at zero position, switch on 3-Phase supply.
4) Now increase dimmer stat voltage for 440 volts.
5) Note down the no-load readings.
6)Then increase the load in steps till rated current of the transformer & note down corresponding readings.
7) Calculate efficiency & regulation for each reading.

FORMULAE:

Input power = $W_1 + W_2$Watts
Output power = $\sqrt{3}\, V_2\, I_2$Watts
%Efficiency = (output / Input) x 100
%Regulation = $(V_{NL} - V_L) / V_L$

TABULATION FOR LOAD TEST OF THREE PHASE TRANSFORMER

M.F =   M.F =

S.No	V_1 *Volts*	I_1 *Amps*	W_1 *Watts*		V_2 *Volts*	I_2 *Amps*	W_2 *Watts*		*Efficiency*	**Regulation**
			OBS	*ACT*			*OBS*	*ACT*		

CALCULATIONS:

RESULT:

Thus the load test on three phase transformer was conducted and its efficiency and regulation were determined.

VIVA QUESTIONS :

1. Why are three phase loads generally delta connected?

2. If it is not mentioned whether the load is star or delta, which connection will you assume?

3. How are loads connected in a three phase system?

4. Why should lighting load be always supplied by three phase, four wire system?

5. Why there is no fuse on the neutral wire of ac mains?

Ex. No :		OPEN CIRCUIT TEST AND SHORT CIRCUIT TEST ON SINGLE PHASE TRANSFORMER
Date :		

AIM:

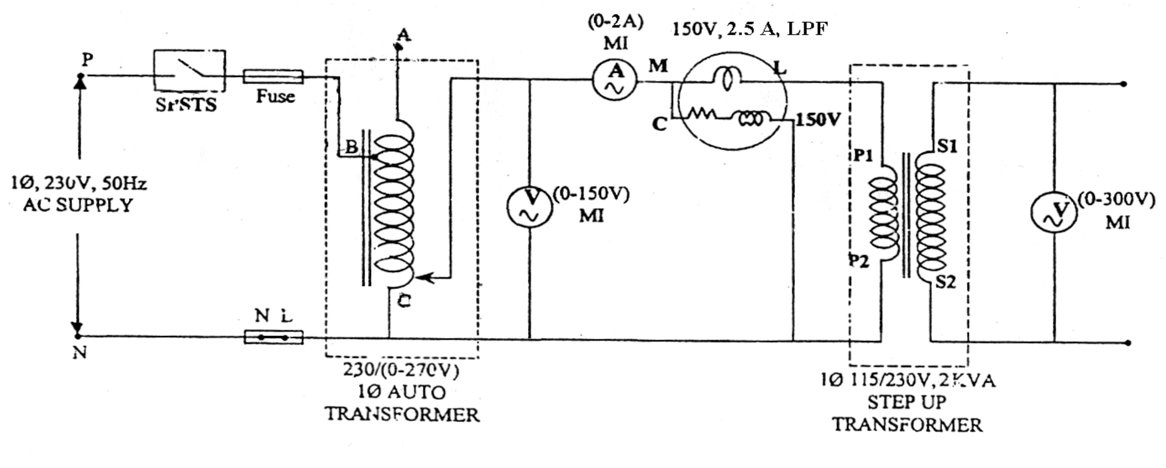
To predetermine the efficiency and regulation of a given single Phase transformer by conducting the open circuit test and short circuit test also to draw its Equivalent circuit.

APPARATUS REQUIRED:

S. No	Name of the apparatus	Type	Range	Quantity
1	Ammeter	Moving Iron(MI)	(0-2) amps	1
2	Ammeter	Moving Iron(MI)	(0-10)amps, (0-20)amps	Each 1
4	Voltmeter	Moving Iron(MI)	(0-150)volts	1
5	Voltmeter	Moving Iron(MI)	(0-300)volts	1
6	Voltmeter	Moving Iron(MI)	(0-75)volts	1
7	Wattmeter	Low power factorLPF	(150volts,1amp)	1
8	Wattmeter	Unity power factorUPF	(150volts,10amps)	1
9	Auto transformer	1Phase	230/(0-270) volts	1
10	Transformer	1Phase	1kVA,(115/230)volts	1
11	Connecting wires	-	-	Required

CIRCUIT DIAGRAM

Open circuit test:



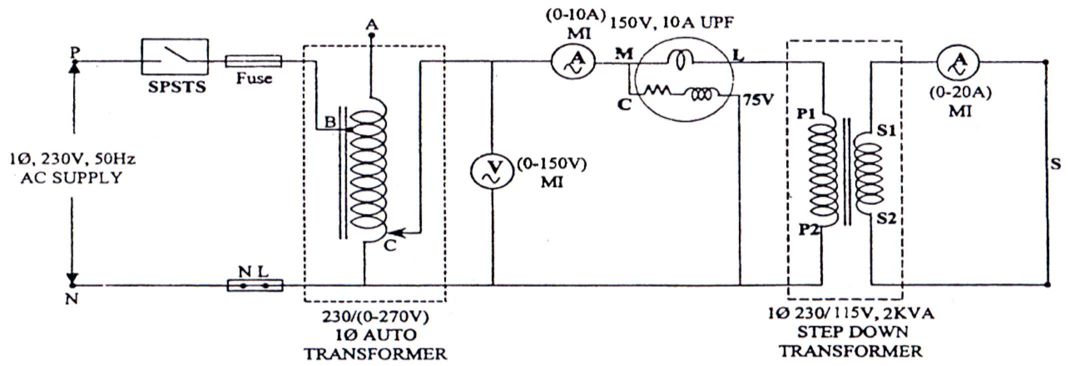
NAME PLATE DETAILS

PARAMETER	TRANSFORMER	
	Py	Sy
Rating(kw)		
Voltage(volts)		
Current(amps)		

FUSE RATING:

For No Load Test Fuse Rating=10% of rated current.
For Load Test Fuse Rating=125% of rated current.

Short circuit test:



FORMULAE:

OPEN CIRCUIT TEST:

$$No\ load\ power\ factor\ (\cos\emptyset_0) = \frac{W_{oc}}{V_{oc}\ I_{oc}}\ W$$

Where, Woc - open circuit power in watts

V_{oc} - open circuit voltage in volts

I_{oc} - open circuit current in amps

$$No\ load\ working\ component\ Resistance\ (R_0) = \frac{V_{oc}}{I_{oc} \times \cos\emptyset}\ \Omega$$

$$No\ load\ magnetising\ component\ reactance\ (X_o) = \frac{V_{oc}}{I_{oc} \times \sin\emptyset}\ \Omega$$

SHORT CIRCUIT TEST:

$$Equivalent\ impedance\ referred\ to\ Hv\ side\ (Z_{02}) = \frac{V_{sc}}{I_{sc}}\ \Omega$$

Where, V_{oc}- short circuit voltage in volts

I_{oc} - short circuit current in amps

$$Equivalent\ resistance\ referred\ to\ Hv\ side\ (R_{02}) = \frac{W_{sc}}{I_{sc}^2}\ \Omega$$

Where, Wsc-short circuit power in watts

$$Equivalent\ reactance\ referred\ to\ Hv\ side\ (X_{02}) = (Z_{02}^2 - R_{02}^2)\ \Omega$$

$$Transformer\ ratio\ (K) = \frac{V_2}{V_1}$$

Where, V_1 = Primary voltage in volts

V_2 =Secondary voltage in volts

$$Equivalent\ resistance\ referred\ to\ Lv\ side\ (R_{01}) = \frac{R_{02}}{K^2}\ \Omega$$

$$Equivalent\ reactance\ referred\ to\ Lv\ side\ (X_{01}) = \frac{X_{02}}{K^2}\ \Omega$$

TO DETERMINE THE EFFICIENCY AND REGULATION:

$$\textbf{Output Power} = (X \times KVA \times \cos\emptyset)\ W$$

Where, X = Fraction of load

KVA = Power Rating of Transformer

Cosϕ = power factor

$$\textbf{Copper loss} = (X_2 \times W_{sc})\ W$$

Where, W_{sc} - copper loss in short circuit condition

$$Total\ \textbf{loss} = (Copper\ loss + Iron\ loss)\ \textbf{W}$$

$$\%\eta = \frac{Output\ power}{(Output\ Power + Losses)} \times 100$$

$$\% Regulation = X \times I_{sc} \frac{[R_{02} \times \cos\emptyset + X_{02} \times \sin\emptyset]}{V_{oc}} \times 100$$

where, + for lagging & - for lagging

PRECAUTIONS:

- At the time of starting transformer should be at no load condition.
- High voltage and low voltage sides of the transformer should be properly used a primary secondary respective for the experiments.

PROCEDURE:

OPEN CIRCUIT TEST:

1. Connections are made as per the circuit diagram.
2. The Double Pole Single Through (DPST) Switch on the primary side is closed.
3. The autotransformer is adjusted to energize the transformer with rated voltage on the low voltage(LV) side.
4. The voltmeter, Wattmeter and Ammeter Readings are noted at no load condition.
5. The auto transformer is brought to its initial position.
6. The supply is switched off.

SHORT CIRCUIT TEST:

1. Connections are made as per the circuit diagram
2. The DPST Switch on the primary side is closed
3. The autotransformer is adjusted to energize the transformer with rated current on the high voltage(HV) side.
4. The voltmeter, Wattmeter and Ammeter Readings are noted at short circuit condition
5. The auto transformer is brought to its initial position and switch off the power supply.

TABULATION FOR OPEN CIRCUIT TEST:

Multiplication Factor =

S.No	Open Circuit Primary Current (I_{OC}) amps	Open Circuit Primary Voltage (V_{OC}) volts	Open Circuit Power (W_{OC}) watts		Open Circuit Secondary Voltage (V_{2S}) volts
			Obs	Act	

TABULATION FOR SHORT CIRCUIT TEST

Multiplication Factor =

S.No	Short Circuit Primary Current (I_{SC}) amps	Short Circuit Primary Voltage (V_{SC}) volts	Short Circuit Power (W_{SC}) watts		Short Circuit Secondary Current (I_{2o}) amps
			Obs	Act	

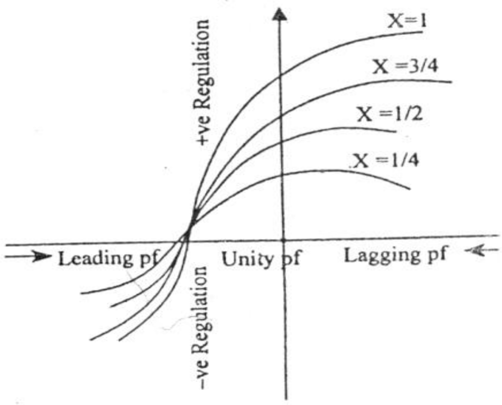
RESULTANT TABULATION TO FIND OUT THE EFFICIENCY

Core (or) Iron loss (W_i) = kVA Rating of Transformer =

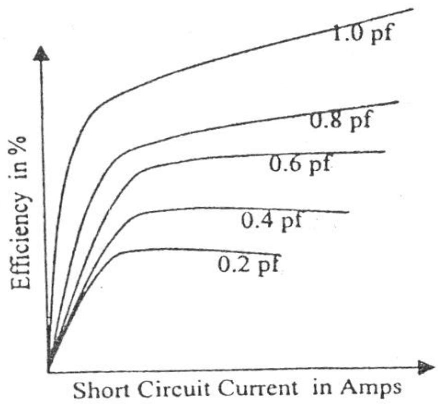
Rated Short Circuit Current (I_{SC}) = Short Circuit Power (W_{SC}) =

Fraction of Load (X)	Short circuit current (I_{SC})	Output Power = X x kVA x Cos ϕ in watts					Copper Loss (X^2 x W_{SC})	Total Loss $W_T = W_I + W_{SC}$	% ŋ
		0.2	0.4	0.6	0.8	1			
¼									
½									
¾									
1									

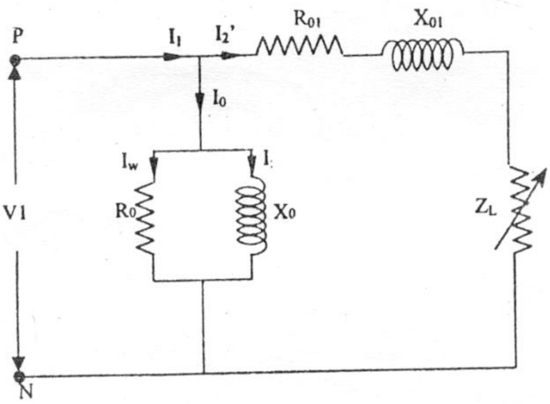
MODEL GRAPH:



Output power vs Regulation



Efficiency vs Short circuit Current



Equivalent circuit of single phase transformer

CALCULATIONS:

RESULT:

Thus the efficiency and regulation of a single phase transformer was calculated by conducting the open circuit and short circuit test and the equivalent circuit was drawn.

VIVA QUESTIONS:

1. Give the condition for maximum efficiency of the transformer.

2. What do you mean by voltage regulation of a transformer?

3. Why the rating of transformer is in kVA?

4. What is all day efficiency?

5. How will you reduce the eddy current loss in the core?

Ex. No :		POLARITY TEST ON SINGLE PHASE TRANSFORMER
Date :		

AIM:

To determine the polarity of a single phase transformer.

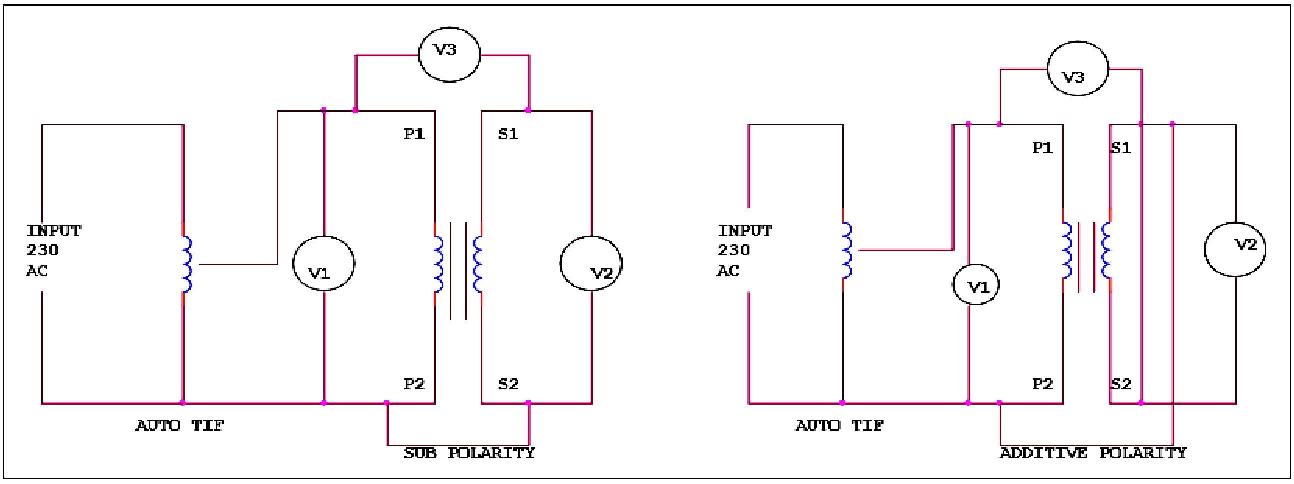
APPARATUS REQUIRED:

S.NO.	APPARATUS REQUIRED	TYPE	RANGE	QUANTITY
1	Voltmeter	Moving Iron(MI)	(0-300)volts	3
2	Auto Transformer	1Phase	230/(0-270)volts	1
3	Transformer	1Phase	1kVA (230/230)volts	1
4	Connecting wires	-	-	Req

THEORY:

It is essential to know the relative polarity at any instant of primary and secondary terminals for making correct connections. When the two transformers are to be connected in parallel to share the load on the system. The marking is correct if voltage $V_3$is less than V_1, such a polarity is termed as subtractive polarity. The standard practice is to have subtractive polarity because it reduces the voltage stress between adjacent loads. In case $V_3 > V_1$, the emf induced in primary and secondary have additive relation and transformer is said to have additive polarity

CIRCUIT DIAGRAM:



NAME PLATE DETAILS

PARAMETER	TRANSFORMER	
	Py	Sy
Rating(kw)		
Voltage(volts)		
Current(amps)		

FUSE RATING:

For No Load Test Fuse Rating=10% of rated current.

PROCEDURE:

1.Connect the circuit as shown in the diagram.

2. Switch on the single phase a.c. supply.

3. Record the voltages V_1, V_2 and V_3 .In case $V_3<V_1$ polarity is subtractive.

4. Repeat the step 3 after connecting terminals as shown in figure of additive polarity. In case $V_3>V_1$ polarity is additive.

5. Switch off the a.c. supply.

TABULATION:

SUB-POLARITY

S.No	V_1(volts)	V_2(volts)	$V_3=V_2-V_1$(volts)

ADD-POLARITY

S.No	V_1(volts)	V_2(volts)	$V_3=V_1+V_2$(volts)

RESULT:

Thus the polarity of a single phase transformer was determined.

VIVA QUESTIONS:

1. Why correct polarity is important in parallel operation of transformers?
2. What are the different types of testing of transformer?
3. What is polarity test in transformer?
4. Compare two winding transformer and auto transformer.
5. Is possible for any voltage winding in a transformer to serve as its primary?

Ex. No :		SUMPNER'S TEST ON SINGLE PHASE TRANSFORMER
Date :		

AIM:

To predetermine the percentage efficiency and percentage regulation of the given two identical single phase transformers by conducting Sumpner's test or back to back test.

FUSE RATING:

Primary rated current = $\frac{\text{kVA rating}}{\text{Primary voltage}}$

Secondary rated current = $\frac{\text{kVA rating}}{\text{Secondary voltage}}$

OPEN CIRCUIT TEST:

25% of rated L.V. winding current= ________________ amps.

SHORT CIRCUIT TEST:

125% of rated HV winding current= ______________ amps.

APPARATUS REQUIRED:

S.No	Name of the equipment	Type	Range	Quantity
1	Ammeter	Moving Iron(MI)	(0-2)amps	1
2	Ammeter	Moving Iron(MI)	(0-10)amps	1
4	Voltmeter	Moving Iron(MI)	(0-150)volts	1
5	Voltmeter	Moving Iron(MI)	(0-300)volts	2
6	Voltmeter	Moving Iron(MI)	(0-75)volts	1
7	Wattmeter	Low power factor(LPF)	(300volts,2.5amps)	1
8	Wattmeter	Unity power factor(UPF)	(150volts,10amps)	1
9	Auto transformer	1Phase	230/(0-270) volts	2
10	Transformer	1Phase	2kVA,(230/230)volts	2
11	Connecting wires	-	-	Required

FORMULAE:

W_1 connected in the circuit of the primaries measures the total core losses of both the transformers

Then the iron losses of each transformer=1/2 W_0 ($\because W_1 = W_0$)

$= W_1$

W_2 is connected in the secondary circuit measures the total full load copper losses of the two transformers.

Hence, full load copper losses of each transformer W_{cu}=1/2 W_{sc} ($W_2 = W_{sc}$)

EFFICIENCY AT FULL LOAD:

Let the output is KVA of each transformer be P_0

Total losses of each transformer under full load operation=1/2 W_0+1/2W_C

Percentage efficiency at full load = $\frac{P_0 * 1000 * \cos\phi * 100}{P_o * 1000 * \cos\phi + 1/2 W_0 + 1/2 W_{CU}}$

EFFICIENCY AT HALF FULL LOAD:

Power output at half full load=1/3 P_0 (constant)

Copper losses at half full load=$(1/2)^2(1/2)\ W_{CU}=(1/8)\ W_{CU}$

Percentage efficiency at half full load= $\frac{(1/2)\ P_0*1000*\cos\phi*100}{(1/2)\ P_0*1000*\cos\phi+1/2W_0+1/2W_{CU}}$

Efficiency at other loads can be calculated in a similar way.

CIRCUIT DIAGRAM:

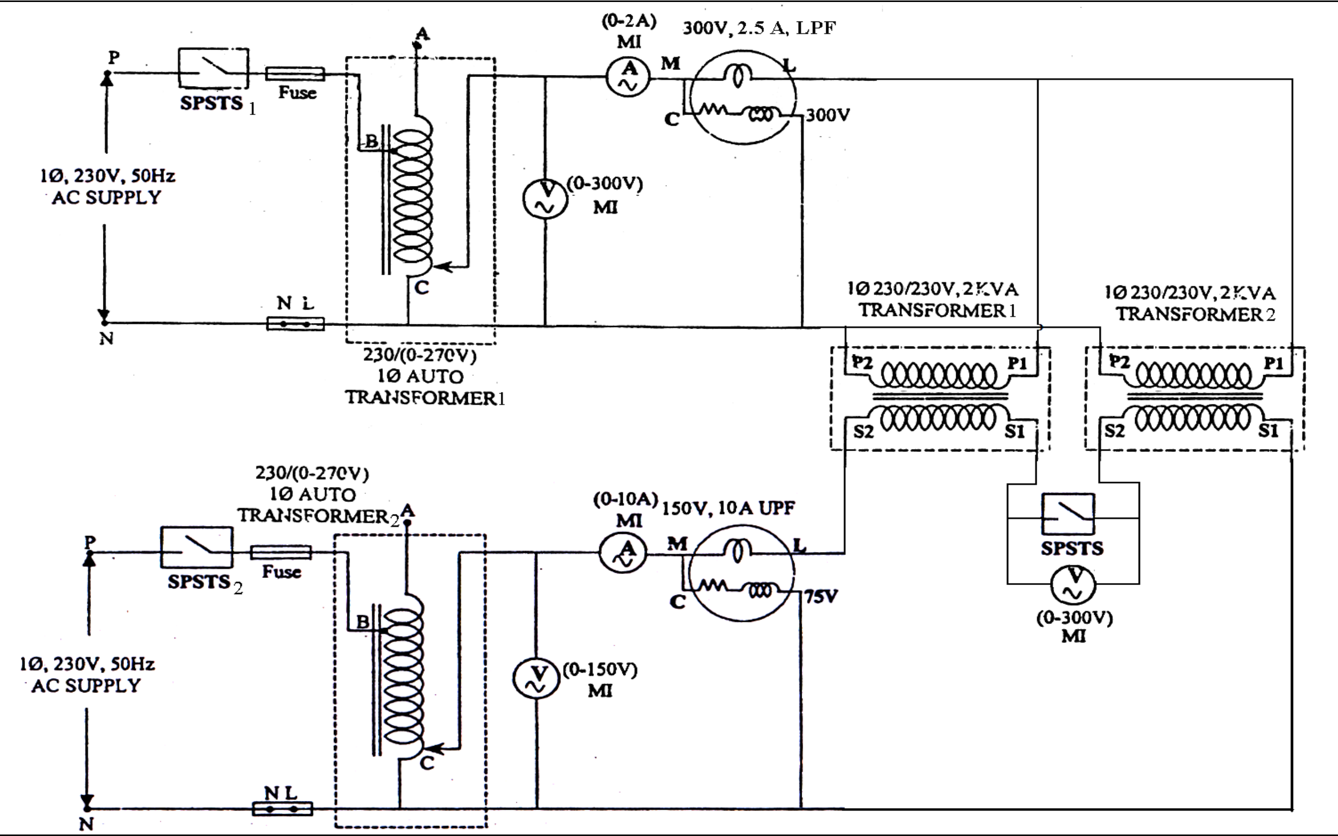


Fig. Circuit Diagram for Sumpner's Test on A Single Phase Transformer

FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

For No Load Test Fuse Rating=10% of rated current.

NAME PLATE DETAILS

PARAMETER	TRANSFORMER	
	Py	Sy
Rating(kw)		
Voltage(volts)		
Current(volts)		

TABULATION:

S.No	Primary side			Secondary side		
	V_0 (volts)	I_0 (amps)	W_0 (watts)	V_{sc} (volts)	I_{sc} (amps)	W_{sc} (watts)

S. No	Load (amps)	Copper loss (watts)	Constant loss (watts)	Total loss (watts)	O/p (watts)	%n

PRECAUTION:

- ➢ The autotransformer must be kept at minimum potential position at the time of starting.

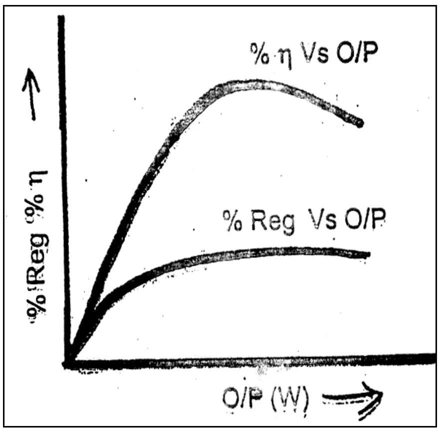
DESCRIPTION:

Sumpner's or back to back test provides the data for finding the regulation, efficiency and heating under load conditions and is employed only when two identical transformers are available. One transformer is loaded on the other and both are connected to supply. The power taken from the supply is that necessary for supplying the losses of both transformers and the negligibly small loss in the control circuit.

PROCEDURE:

1. The nameplate details are noted down and the range of meters selected is justified.
2. Connections are made as per the circuit diagram
3. Observing the precautions, the DPST switch is closed.
4. Autotransformer is adjusted to set rated primary voltage
5. Now, the voltage across the secondaries must read zero. in case the voltage reads twice the rated voltage of each transformer, the DPST switch is opened and the connection at the secondary terminals of one of the transformers is interchanged.
6. Now, close the other two switches.
7. The autotransformer is adjusted so that the current flowing in the secondaries is full load secondary current of each transformer.
8. All the meter readings are noted down.
9. The DPST switches are opened.

MODEL GRAPH:



CALCULATIONS:

RESULT:

Thus the Sumpner's test was conducted on two identical transformers and the efficiency was found out at different loaded conditions.

VIVA QUESTIONS:

1. What are the advantages of back to back test in determining efficiency of a transformer?

2. Why the iron losses are constant at all loads in a transformer?

3. What would happen if a power transformer designed for operation on 50 Hz were connected to 5Hz of the same voltage?

4. What is a current transformer?

5. What is a potential transformer?

Ex. No :		SEPARATION OF NO LOAD LOSSES IN SINGLE PHASE TRANSFORMER
Date :		

AIM:

To separate the no load losses in the given transformer as Hysteresis and eddycurrent losses at a given frequency.

APPARATUS REQUIRED:

S.No	Name of the equipment	Type	Range	Quantity
1	Voltmeter	Moving Iron(MI)	(0-300) volts	1
2	Rheostat	Wire Wound	(300ohms,2amps)	1
4	Rheostat	Wire Wound	(230ohms,1.7amps)	1
5	Rheostat	Wire Wound	(100 ohms,4amps)	1
6	Wattmeter	Low power factor (LPF)	(300volts,2.5amps)	1
7	Transformer	inductive	230/230 volts	1

FORMULAE:

Frequency, $f = (P*N_S) / 120$ in Hertz

P = No.of Poles& Ns = Synchronous speed in rpm.

Hysteresis Loss $W_h = A * f$ in Watts A = Constant (obtained from graph)

Eddy Current Loss $W_e = B * f^2$ in Watts B = Constant (slope of the tangentdrawn to the curve)

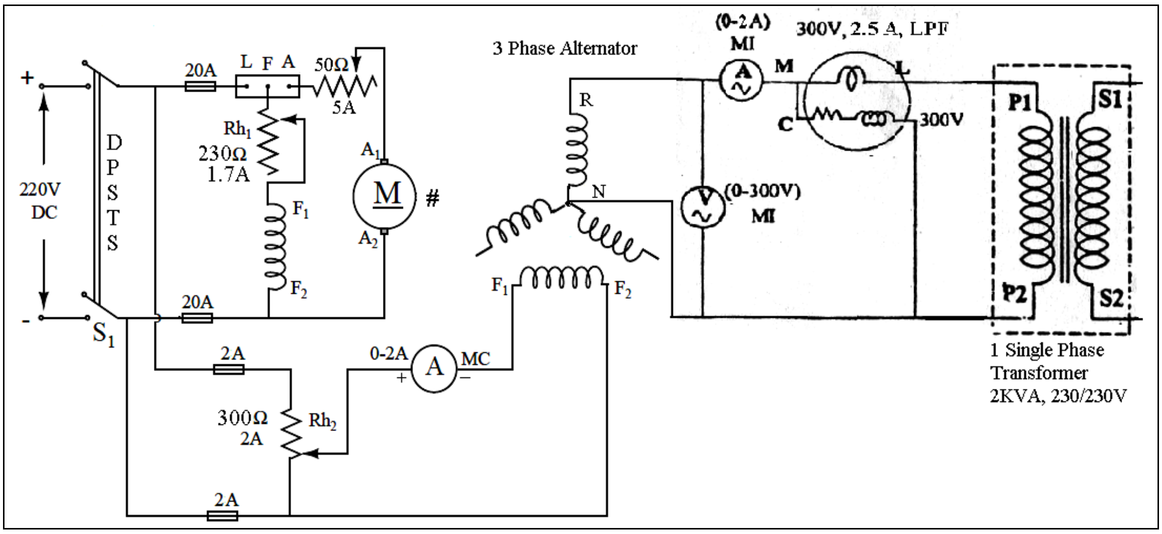
Iron Loss $W_i = W_h + W_e$ in Watts

$W_i / f = A + (B * f)$

Here the Constant A is distance from the origin to the point where the line cuts theY- axis in the graph between W_i / f and frequency f.

The Constant B is $\Delta(W_i / f) / \Delta f$

CIRCUIT DIAGRAM:



FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

NAME PLATE DETAILS

PARAMETER	TRANSFORMER		DC MOTOR	ALTERNATOR
	Py	Sy		
Rating(kw)				
Voltage(volts)				
Current(amps)				
Speed(rpm)	----	----		
Excitation	----	----		

PRECAUTIONS:

- The potentiometer connected to a alternator field is at minimum voltage position(zerovoltage)
- The field rheostat of DC motor field is kept at minimum position.
- The rheostat connected to DC motor armature is kept at minimum resistance position.
- The HV side of transformer is connected between any one of the terminals of alternator and neutral.

DESCRIPTION:

Consider a practical transformer on no load i.e. the secondary of the transformer is kept open. The primary will draw a small current I_0 to supply (i)iron losses (ii)a very small amount of copper loss in the primary.No load input power, $W_0=V_1I_0 \cos\phi$.

At no load, copper loss in the primary is I_0^2R.since I_0 is very small, this loss is neglected. Therefore the no load primary input power is practically equal to the iron loss in the transformer.

PROCEDURE:

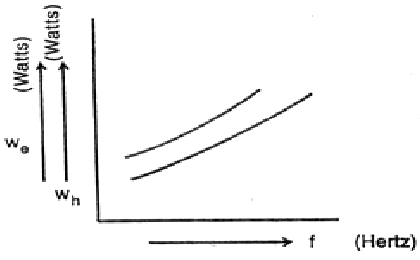
1. Connections are made as per the circuit diagram shown in fig.
2. Observing the precautions the DPST switch is closed.
3. The internal resistance connected to armature is decreased gradually and brought to minimum resistance position.
4. The field rheostat is adjusted to get rated speed of the motor
5. The field rheostat of alternator is adjusted to get rated voltage of transformer.
6. The readings are observed at rated speed of motor and rated voltage of transformer, initially and the ratio (V/N) is maintained constant as shown in table.
7. Now the rheostat connected to armature is adjusted to vary the frequency of alternator.
8. The readings are observed at constant (V/N).the field rheostat of alternator is adjusted to maintain (V/N) constant.
9. The equipments are brought back to their original position and supply is switched off.

TABULATION:

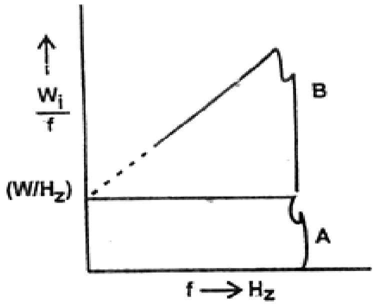
S.No	Speed N	Voltage V	Power W_I		Frequency f	W_i/f
			Observed	Actual		
	rpm	volts	watts	watts	Herts(Hz)	W/Hz

S.No	A*10^{-2}meter	W_h=A_f(watts)	B*10^{-2}meter	W_e=Bf^2(waats)	F (Hz)

MODEL GRAPH:



Core Losses Vs Frequency



Loss Vs Frequency

CALCULATIONS:

RESULT:

Thus the core losses were separated and the corresponding curves were drawn.

VIVA QUESTIONS:

1. What are the losses in a transformer?

2. What is meant by core losses?

3. What is meant by Hysteresis losses?

4. What is meant by eddy current losses?

5. What are the methods to reduce the losses?

Ex. No :		STUDY OF THREE PHASE TRANSFORMER CONNECTIONS
Date :		

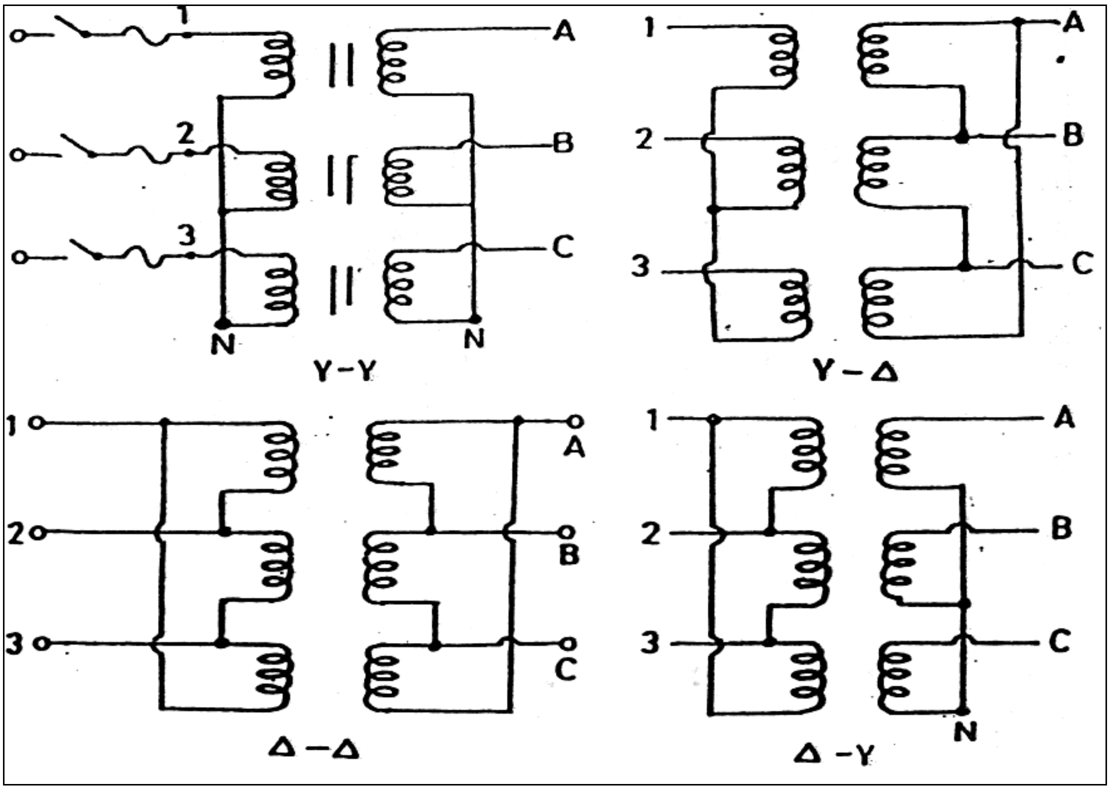
AIM:
To study the three phase transformer connections in
(i)star-star (ii) delta-star (iii)delta-delta (iv)star-delta.

DESCRIPTION:
The necessity of the three phase system in generation, transmission and distribution is well known to us. Combination of the electrical system and the electromagnetic system of three identical single phase transformers into a single system makes it possible to get a three phase transformer as a single unit, therefore it is interesting to study the different connections in different possible manners.

THEORY OF 3-PHASE TRANSFORMER CONNECTIONS:
(i)Primary in star and secondary in star
(ii)Primary in delta and secondary in star
(iii)Primary in delta and secondary in delta
(iv)Primary in star and secondary in delta.

PROCEDURE:
1.Connect the circuit connections as shown in the fig.
2.Measure the line voltage and phase voltages and tabulate as shown in the table.
3.For a ratio of 'n' and primary line voltage 'v' the various phase and line voltages will be as shown in the table, actual values would be furnished in table.

CONNECTION DIAGRAM:



Connection diagrams of three transformers

TABULATION:

Tabulation For Transformer Connection-various line and phase voltages

		Primary voltages (V)						Secondary voltages (V)					
		Line Voltages in volts			Phase Voltages in volts			Line Voltages in volts			Phase Voltages in volts		
Primary	**Secondary**	V_{23}	V_{12}	V_{31}	V_{1N}	V_{2N}	V_{3N}	V_{AB}	V_{BC}	V_{CA}	V_{AN}	V_{BN}	V_{CN}
Star	Star	V	V	V	V/√3	V/√3	V/√3	V\n	V\n	V\n	V/√3n	V/√3n	V/√3n
Star	Delta	V	V	V	V/√3	V/√3	V/√3	V/√3n	V/√3n	V/√3n	V/√3n	V/√3n	V/√3n
Delta	Delta	V	V	V	V	V	V	V\n	V\n	V\n	V\n	V\n	V\n
Delta	Star	V	V	V	V	V	V	√3V\n	√3V\n	√3V\n	V\n	V\n	V\n

Tabulation For Transformer Connection-various line and phase voltages

		Primary voltages (V)						Secondary voltages (V)					
		Line Voltages in volts			Phase Voltages in volts			Line Voltages in volts			Phase Voltages in volts		
Primary	**Secondary**	V_{23}	V_{12}	V_{31}	V_{1N}	V_{2N}	V_{3N}	V_{AB}	V_{BC}	V_{CA}	V_{AN}	V_{BN}	V_{CN}
Star	Star												
Star	Delta												
Delta	Delta												
Delta	Star												

RESULT:

Thus the phase transformer connections were studied.

VIVA QUESTIONS:

1. The three phase system has only two types of connections viz. star connection and delta connection. Why?
2. What are the advantages and disadvantages of three phase transformer over three single phase transformer?
3. List the applications of transformers.
4. Can 50 Hz Transformers be used at Higher Frequencies?
5. What will happen if the primary of a transformer is connected to dc supply?

Ex. No :		LOAD CHARACTERISTICS OF DC SERIES GENERATOR
Date :		

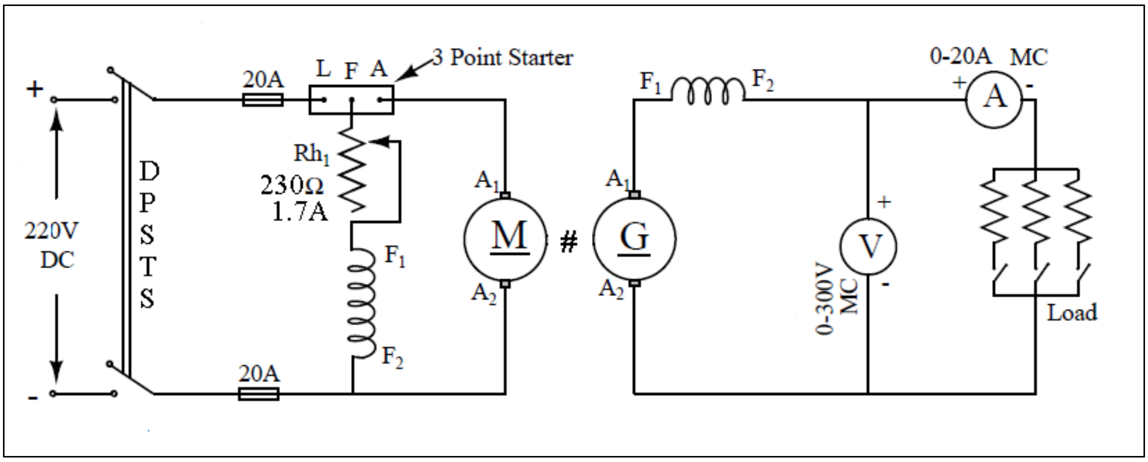
AIM:

To draw the load characteristics of DC series generator by conducting load test on it.

APPARATUS REQUIRED:

S.NO.	APPARATUS REQUIRED	TYPE	RANGE	QUANTITY
1	Ammeter	Moving coil(MC)	(0-20)amps	1
2	Voltmeter	Moving coil(MC)	(0-300)volts	1
3	Rheostat	Wire wound	230 Ω,1.7amps	1
4	Resistive load	-	3kw	1
5	Tachometer	Digital	-	1
6	Connecting wires	-	-	Req

CIRCUIT DIAGRAM:



FUSE RATING:

For Load Test Fuse Rating=125% of rated current.

NAME PLATE DETAILS

PARAMETER	DC SHUNT MOTOR
Rating(kw)	
Voltage(volts)	
Current(amps)	
Speed(rpm)	

FORMULAE:

$$E_g = V + I_a R_a \ (Volts)$$
$$I_L = I_a + I_f \ (amps)$$
$$R_a = \frac{V_a}{I_a} \text{ohms}$$

Where

E_g - Generated emf at load condition in volts V - Terminal voltage in volts

I_a - Armature resistance in ohm I_L - Load current in amps

I_f - Field current in amps V_a - Armature voltage in volts

PRECAUTIONS:

- All the Double Pole Single Through (DPST) switch should be kept open
- Motor field rheostat should be in minimum position only
- All the switches in resistive load should be in off position
- In the measurement of armature resistance, rheostat should be in maximum resistance position.

PROCEDURE:

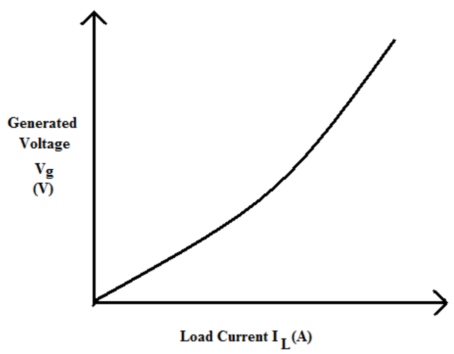
LOAD TEST:

1. Make the connection as per the circuit diagram
2. Close the DPST switch1
3. Start the motor using three point starter.
4. By adjusting motor field rheostat set the motor-generator to its rated speed
5. Now close the DPST switch2.
6. Adjust the resistive load and note down the corresponding load current I_L and terminal voltage indicated by the ammeter and voltmeter respectively.
7. Repeat the same procedure till the load current reaches the rated load current

TABULATION

S.No.	Load current (I_L in amps)	Terminal voltage (V_t in volts)	Generated voltage (E_g in volts)

MODEL GRAPH:



Graph Representing the Load Characteristics of DC Series Generator.

CALCULATIONS:

RESULT:

Thus the load test was conducted on DC series generator and the performance curve was drawn.

VIVA QUESTIONS:

1. Why series generator not generally used?
2. What does the name plate of a DC generator generally indicate?
3. Which losses occur in a DC generator?
4. Why the field winding of a series DC machine does has less number of turns than that of DC shunt machine?
5. Why is the efficiency of a DC generator not determined by direct loading?

Observation

Roll No.:

S. No.	Date	Title	Page No.	Teacher's Sign/Remarks
1.	22/8/22	LOAD TEST ON DC SHUNT MOTOR	2	(10) P.Vanny 3/9/22
2.	24/8/22	LOAD TEST ON DC SERIES MOTOR.	7	(10) P.Vanny 3/9/22
3.	3/9/22	SPEED CONTROL OF DC SHUNT MOTOR.	10	(10) P.Vanny
4	14/9/22	LOAD TEST ON SINGLE PHASE TRANSFORMER	14	(10) P.Vanny
5	24/8/22	LOAD TEST ON DC COMPOUND MATOR	19	(10) P.Vanny
6	14/9/22	Open Circuit of Load Characteristics of DC shunt generator & Ciritical resistance	22	(10) P.Vanny

S.No	Date	Title	Page.	Mark	Signature
7	14/9/22	Swinburne's Test	24	10	P. [illegible]
8	28/11/22	Load characteristics of DC compound generator with different and cumulative connections	26	10	P. [illegible]
9	7/12/22	open circuit test and short circuit test on single phase transformer	28	10	P. [illegible]
10	1/12/22	hopkinsons test on DC motor-generator	30	10	P. [illegible]
11	7/9/22	Load test on three Phase transformer	32	10	P. [illegible]
12	15/12/22	Speration of on load losses in single phase transformer	34	10	P. [illegible]

Completed

P. [illegible]

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

BONAFIDE CERTIFICATE

Register Number: 821121105014

This is to certify that, the record work was done by the candidate Mr./~~Ms.~~ K. RUTHRAN of II Year, III Semester, B.E. Electrical and Electronics Engineering for ***EE3311 – Electrical Machines Laboratory- I*** during the academic year 2022-2023 (Odd Semester).

P. Narasamy 20/1/23

Staff in-Charge

28/01/2023

Head of the Department

This record is submitted for Anna University, Chennai, practical examination held on 30/01/2023 at Kings College of Engineering, Punalkulam.

P. Narasamy 30/1/23

Internal Examiner

30/01/23

External Examiner

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EE3311 – Electrical Machines Laboratory- I

Ex. No	Date	Title of the Experiment	Page No.	Mark	Signature
1(a)	22/08/22	Study of DC Motor starter	76	10	[illegible]
1 (b)	22/08/22	Study of three phase transformer connections	82	10	[illegible]
2.	22/08/22	Speed control of DC shunt motor	13	10	[illegible]
3.	24/08/22	Load test on DC shunt motor	2	10	[illegible]
4.	03/09/22	Load test on DC series motor	8	10	[illegible]
5.	04/09/22	Load test on single phase transformer	20	10	[illegible]
6.	07/09/22	Load test on three phase transformer	64	10	[illegible]
7.	14/09/22	Swinburne's test	38	10	[illegible]
8.	21/09/22	Open circuit and load characteristic of DC shunt generator - critical resistance & speed	32	10	[illegible]
9.	28/11/22	Load characteristic of DC compound generator with differential & cumulative connection	44	10	[illegible]
10.	28/11/22	Load test on DC compound motor	26	10	[illegible]
11.	1/12/22	Hopkinson's test on DC motor, generator set	58	10	[illegible]
12.	7/12/22	Open circuit & short circuit test on single phase transformer	50	10	[illegible]
13.	15/12/22	Sumpner's test on single phase transformer	86	10	[illegible]
14.	17/12/22	Separation of no load losses in single phase transformer	70	10	[illegible]
		[Content Beyond Syllabus]			
15	19/12/22	Load characteristics of DC series generator	92	–	[illegible]

Signature of Staff Incharge

B.E / B.Tech. PRACTICAL END SEMESTER EXAMINATIONS, NOVEMBER/DECEMBER 2022

Third Semester

EE3311 - ELECTRICAL MACHINES LABORATORY - I

Regulation s 2021

Time : 3 Hours Max. Marks 100

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

1. Conduct the following experiment on the given DC machine whose field and armature windings are connected in parallel

   i obtain the magnetization characteristics at 1250 rpm

   ii critical speed of the given machine.

2. Conduct a suitable experiments on the given DC generator in which the field and armature windings are connected in parallel and is excited by a DC source. Plot the terminal characteristics of the machine.

3. Obtain the load characteristics of the DC machine which delivers electrical power when the flux produced by both the field winding aid each other.

4. Obtain the load characteristics of the DC machine which delivers electrical power when the flux produced by both the field winding oppose each other.

5. Obtain the following performance characteristics at 25%, 50%, 75% and 100 % of the given DC machine which converts electrical energy into mechanical energy and having constant speed

   i Output power Vs speed

   ii Output power Vs efficiency

6. Obtain the mechanical characteristics of the given DC machine which converts electrical energy into mechanical energy. The DC machine has both shunt field and series field winding.

7. Obtain the mechanical characteristics of the given DC machine which converts electrical energy into mechanical energy and the machine has the higher starting torque.

8. Conduct a suitable test on the given DC machine and pre determine its efficiency while operating as motor and generator.

9. Obtain the flux control characteristics of the given DC shunt motor when its armature voltage is i Va = Vr and ii Va = 0.8 Vr also explain the function of three point starter.

10. Obtain the rheostatic control characteristics of the given DC shunt motor when its field current is i If = I fn and ii If = 1.1 I fn also explain the function of four point starter.

11. Conduct a suitable test on the given two identical machines and determine their efficiency as motor and generator.

12. Conduct a suitable test on the given single phase static device and determine the performance characteristic curve.

13. Conduct a suitable test on the given three phase static device and determine the performance characteristic curve.

14. Obtain the equivalent circuit parameters for the given single phase static device which works on the principle of mutual induction referred to supply side.

15. By conducting a suitable test on the given pair of identical transformers plot the performance characteristic curve.

16. By conducting a suitable test on the given static device, separate the iron loss components when it is operating at rated voltage on 50 Hz. Supply.

17. By conducting a suitable test on the given single phase static device draw the load characteristics at 50%, 75%, 100% and 125 % of loading and determine the efficiency of the device.

18. By conducting a suitable test on the given static device find the eddy current loss and hysteresis loss when it is operating at rated voltage on 50 Hz. Supply.

19. Conduct a load test on the given static three phase machine which works under the principle of mutual induction and plot the characteristics curve also draw the various combinations of its connection.

20. By conducting a suitable test on the given DC machine obtain the speed control characteristics by i field control method and ii armature resistance control method.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Model Lab Exam - Mark Statement

Year /Sem: II/III

Staff Name: Dr.P.Narasimman **Subject Code: EE3311**

Subject Name: Electrical Machines -I Lab **Date:19.12.2022**

S. NO.	STUDENT NAME	MARKS
1	ABIBHARATHI A	81
2	AKASH P	77
3	ARAVINDHAN R	78
4	DHESINGH J	76
5	GAYATHRI K C	92
6	GOKUL M	85
7	GOPINATH S	87
8	HARISHMA R	84
9	JEGADEESAN R	86
10	KARTHIKEYAN S	82
11	MEENA P	84
12	MILTON INFANT RAI P	88
13	PRAVEEN V C	75
14	RUTHRAN K	93
15	SARAVANAKUMAR M	82
16	SHANMUGAESWARAN S	83
17	SIVANANTHAM S	85
18	SIVANESAN C	88
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21	THAVATHEESH S	83
22	THUSARI S	89
23	VAISHNAVI V	84
24	VIDHYA M	88
25	VIJAY V	84

S. NO.	STUDENT NAME	MARKS
26	YOGESH C	79
27	YUVARAJ A	AB
28	MONISHAN A	76
29	PARTHASARATHY B	81
30	PANDIYARAJAN R	80
31	PRAGADEESHWARAN S	79
32	VEERASELVAN V	87
33	UDHAYAM S	83

P. [signature] 19/12/22.

Staff Incharge

[signature] 19/12/22

HoD/EEE

MODEL LAB Exam

NAME: M. Gokul

Roll NO: 21EE06

Reg NO: 821121105006

Date: 19/12/2022

Subject code: EE 3311 Date: 19.12.2022

Subject NAME: Electrical Machines I

S.N	Description	Mark	obtained Marks
1.	Aim, Apparatus Required	10	10
2.	Circuit diagram	30	25
3.	Procedure, connection diagram	30	27
4.	Result, graph	20	17
5.	VIVA - voce	10	06
			85

Internal Examiner External Examiner.

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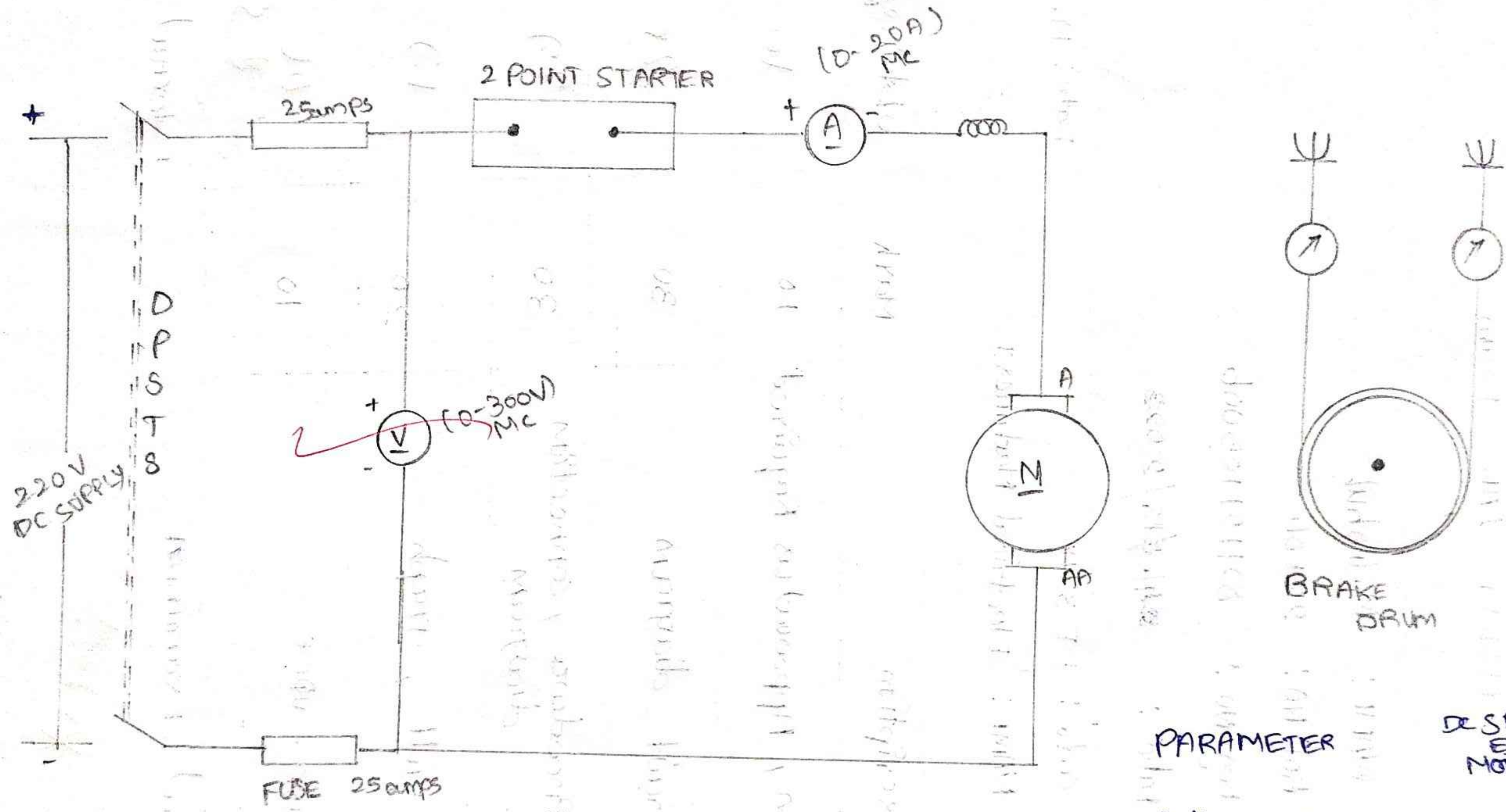


Name plate Details

Fuse Rating

For load test Fuse Rating = 125% of rated current

PARAMETER	DC SERIES MOTOR
Rating (Kw)	3.5Kw
Voltage (volts)	220volts
Current (amps)	20.0amps
Speed (rpm)	1500rpm

Aim:

To conduct the load test on a given DC series motor and to draw its performance curves

Apparatus Required

S. No	Name of the Apparatus	Type	Range	Quantity
1.	Ammeter	Moving coil (MC)	(0-20) amps	1
2.	Voltmeter	Moving coil (MC)	(0-300) volts	1
3.	Tachometer	Digital	-	1
4.	Connecting wires	-	-	Req

Formula:-

For load test fuse Rating = 125% of rated current

Torque, $T = (S_1 - S_2) \times (R + t/2) \times 9.81$ N/m

where R - radius of brake drum in m

t - thickness balance reading in kg

Input power, $P_1 = V_L I_L$ watts

TABULATION

OBSERVATION: Radius of a brake drum = ... m

S. NO	Va (volts)	I_L (amps)	I_F (amps)	N (rpm)	Spring Balance S_1	Spring Balance S_2	S_1-S_2 (kg)	Torque (N-M)	Input (watts)	output (watts)	Efficiency % η
1.	210	6.8		2841	8	4	4	4.28	1428.0	1272.69	89.18
2.	208	9.0		2209	16	10	6	6.42	1872.0	1484.35	79.29
3.	204	11.4		1936	20	15	5	5.35	2325.6	1084.09	46.61
4.	22	14.8		1842	25	20	5	5.35	2986.6	1031.45	34.50
5.	200	18.0		1475	32	24	8	8.56	3600.0	1321.52	36.70

where, V_L = load voltage in V

I_L = load current in A

output power, $P_o = \frac{2\pi NT}{60}$ watts

where N- speed of the armature in rpm

T - Torque in Nm

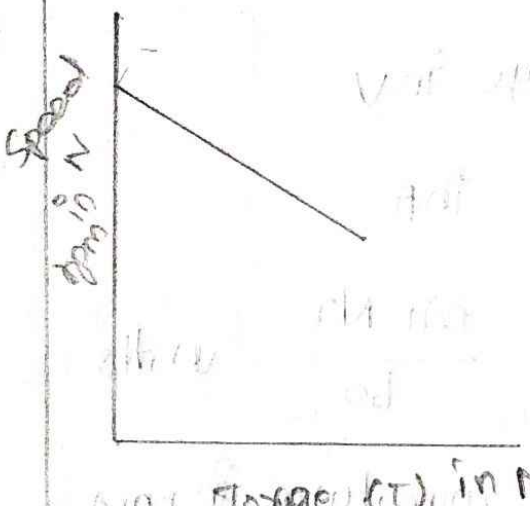
$\%$ Efficiency $= \frac{\text{Output power}}{\text{Input power}} \times 100$

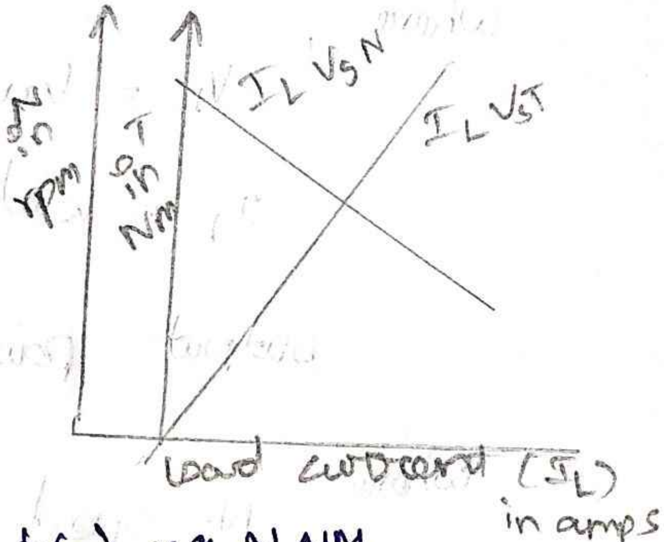
PRECAUTIONS:

* The motor field rheostat should be kept at minimum resistance position.
* At the time of starting the motor should be is no load condition.
* the motor should be run in anticlock wise direction

PROCEDURE:

* Connection are given as per the circuit diagram
* Initially apply some load.
* Using the two point starter the motor is started to run
* The meter readings are noted.
* By using the break with spring balance arrangment the motor is loaded and the corresponding reading are noted up-to the rated current.
* After the observation of all the reading the load is released gradually not fully.





Torque $= (S_1 - S_2) \times (R + t/2) \times 9.81$ NM

$= (32 - 24) \times (0.1066 + 0.0025) \times 9.81$

$= 8 \times 0.1091 \times 9.81$

Torque (T) $= 8.56$ NM

output power $P_o = \frac{2\pi NT}{60}$ watts

$= \frac{2 \times 3.14 \times 1475 \times 8.56}{60}$

$= \frac{79.291.28}{60}$

$= 1321.52$ watts

Input power $P_i = V_L I_L$

$= 200 \times 18$

$= 3600$ watts

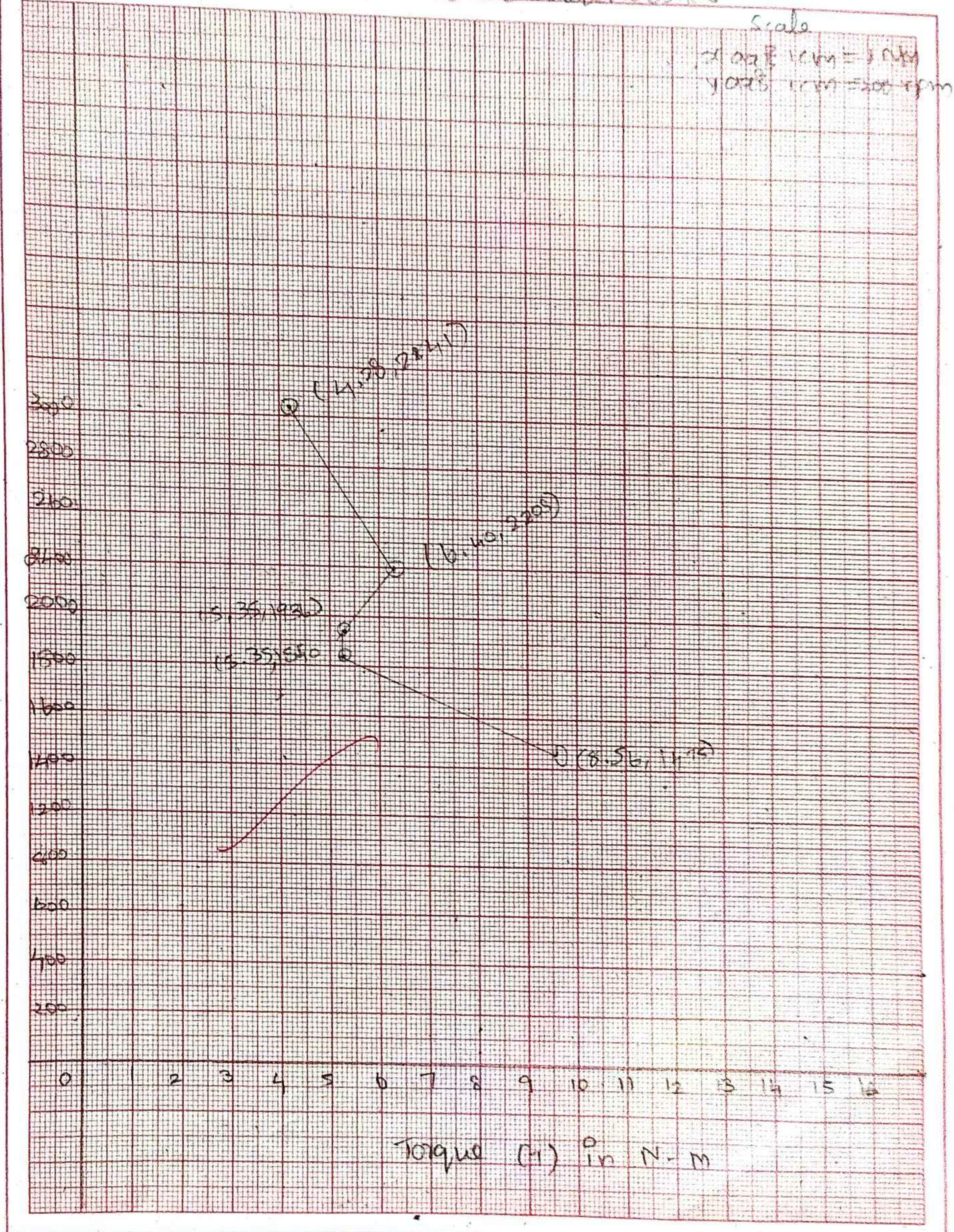
% Efficiency $= \frac{\text{output Power}}{\text{Input power}} \times 100$

$= \frac{1321.52}{3600} \times 100$

$= 0.3670 \times 100$

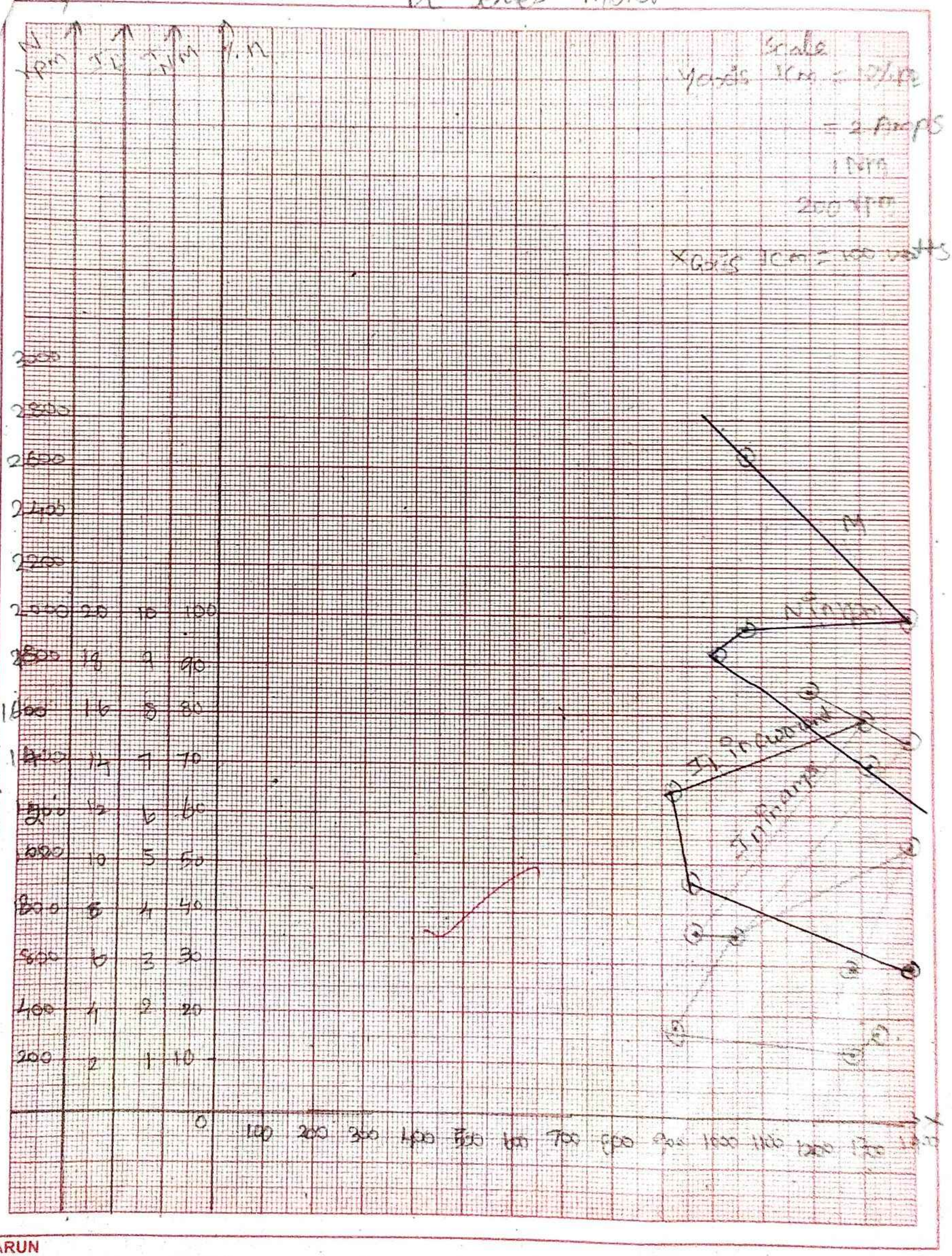
$= 36.70\%$

Mechanical characteristics

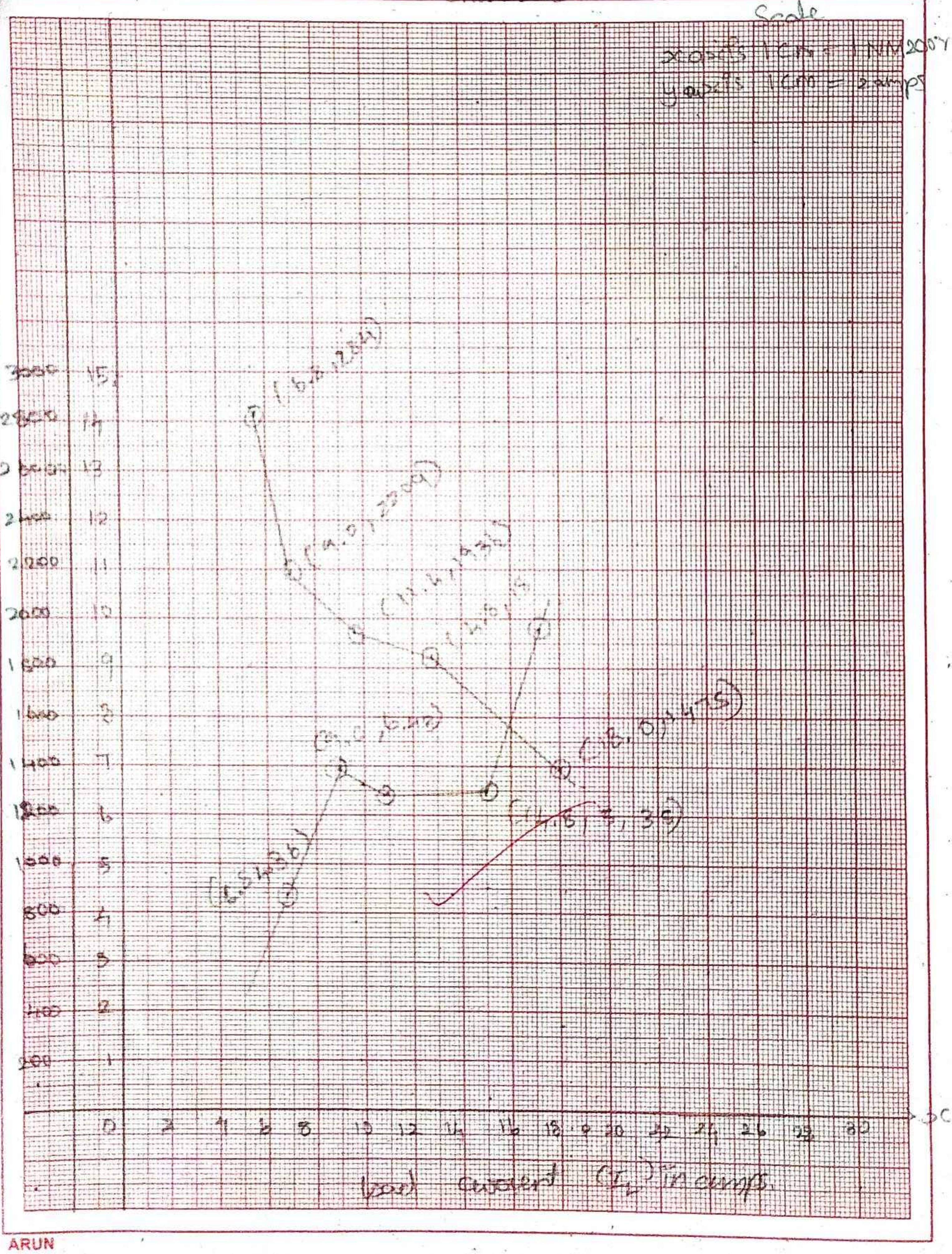


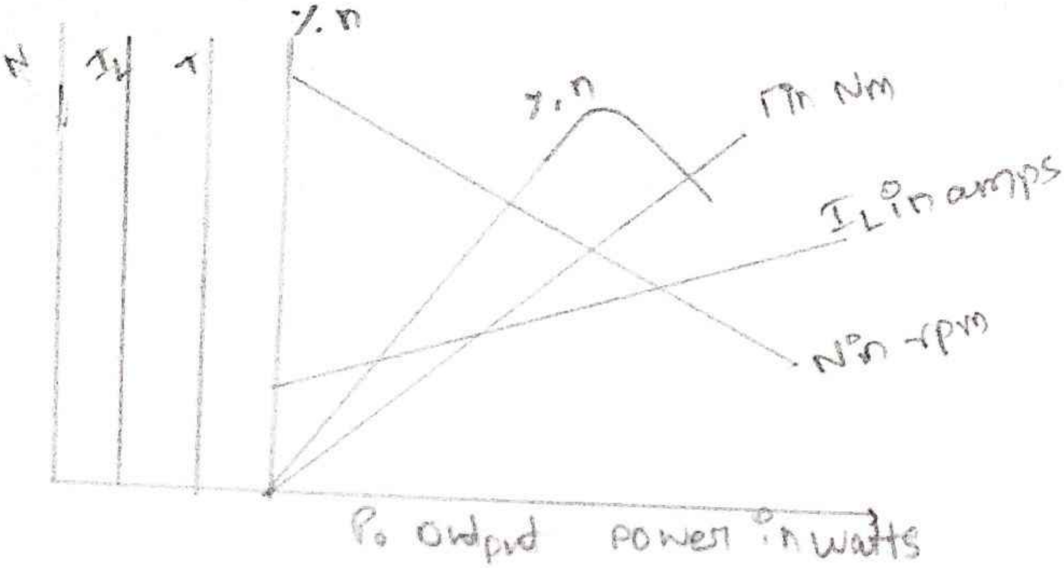
ARUN

The load characteristics of DC series motor



electrical characteristics





RESULT:-

Thus the load test on dc series motor was conducted and performance curves were drawn.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ACADEMIC YEAR :2022-2023 (ODD SEMESTER)

Course File

Format B

CONTENT BEYOND THE SYLLABUS

TITLE : Load Characteristics of DC Series generator

OBJECTIVE : To draw the load Characteristics of DC series generator by Conducting load test on it

METHODOLOGY : Experiment /Virtual lab.

EVALUATION : Questioning

DATE OF COMPLETION : 19/12/22

P. Nammy

Staff Incharge Signature

Load characteristics of DC series generator:

Aim:

To draw the load characteristics of DC series generator by conducting load test on it

Apparatus required:

S.no	Apparatus required	type	range	Quantity
1.	Ammeter	Moving coil	(0-20) amps	1
2.	Voltmeter	Moving coil	(0-300) volts	1
3.	Rheostat	wire wound	230Ω, 1.7 amps	1
4.	Resistive load	-	3kw	1
5.	Tachometer	Digital	-	1
6.	Connecting wire	-	-	Required

Formulae:

$E_o = V + I_o R_o$ (volts)

$I_L = I_a + I_F$ (amps)

$R_a = V_a / I_a$ ohms

Precaution:

* All the above double single pole through (DPSTS) switch should be kept open
* Motor field rheostat should be minimum position.
* All the switches are resistive load should be in off position
* In armature resistive, rheostat should be in maximum resistance position.

Teacher's Signature: ....

Tabulation :

S.no	Load current (amps)	Terminal voltage (V)	Generated voltage (V)
1.	1 A	100V	101.1 V
2.	2 A	133V	135.2 V
3.	3.3 A	153 V	156.63 V
4.	4.3 A	170 V	174.73 V
5.	6 A	183 V	189.6 V
6	10 A	205 V	216 V
7.	12 A	210 V	223.2 V

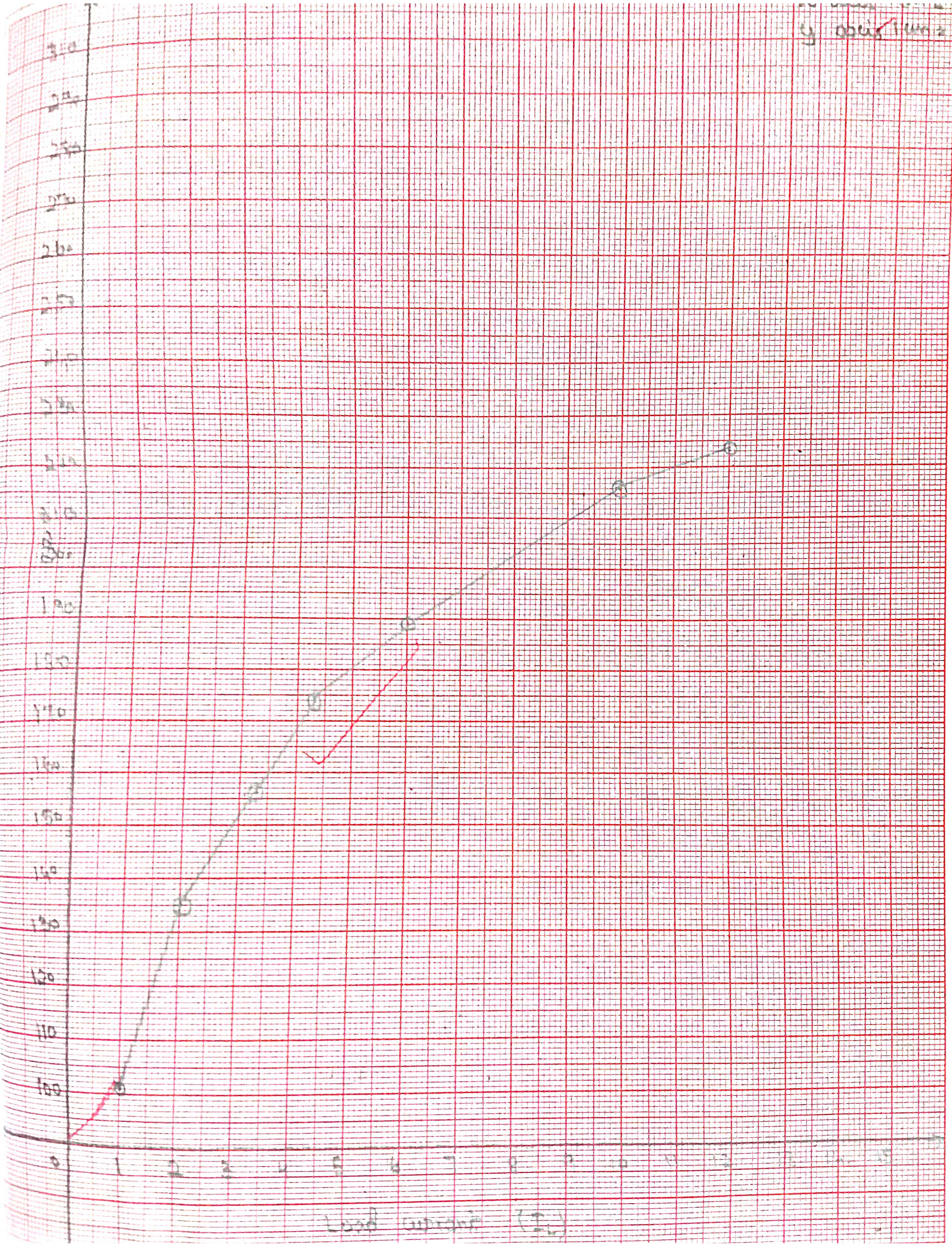
Model calculation:

$$E_0 = V + I_0 R_0$$

$$= 100 + (1 \times 1.1)$$

$$= 100 + 1.1$$

$$E_0 = 101.1\,V$$



y axis 1cm =
100
110
120
130
140
150
0
1
2
3
4
5
6
7
8
Load current (IL)

Procedure:

* Make the condition as per the circuit diagram
* Close the DPST switch 1
* Start the motor using three point start
* By adjusting motor field rheostat set the motor generator to its rated speed
* Now close the DPST switch 2
* Adjust the resistive load and note down corresponding load current I_L and terminal voltage indicated by ammeter and voltmeter respectively
* Repeat the same procedure till load current reaches rated load current.

P. Nanny

Result:

Thus the load test was conducted on DC series generator and the performance curve was drawn.

Teacher's Signature: ....