METHODIST

Estd:2008

COLLEGE OF ENGINEERING AND TECHNOLOGY

(Affiliated to Osmania University&Approved by AICTE, New Delhi)

LABORATORY MANUAL

BASIC ELECTRICAL ENGINEERING LABORATORY

BE, I&II Semesters (AICTE): 2020-21

NAME: ____

ROLL NO:________________________________

BRANCH:________________________________

SEM:_____________________________

DEPARTMENT OF ELECTRICAL AND ELECTRONCS ENGINEERING

Empowering youth- Architects of Future World

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COLLEGE OF ENGINEERING AND TECHNOLOGY

Estd:2008

VISION

To produce ethical, socially conscious and innovative professionals who would contribute to sustainable technological development of the society.

MISSION

To impart quality engineering education with latest technological developments and interdisciplinary skills to make students succeed in professional practice.

To encourage research culture among faculty and students by establishing state of art laboratories and exposing them to modern industrial and organizational practices.

To inculcate humane qualities like environmental consciousness, leadership, social values, professional ethics and engage in independent and lifelong learning for sustainable contribution to the society.

DEPARTMENT
OF
ELECTRICAL AND ELECTRONICS ENGINEERING

LABORATORY MANUAL

BASIC ELECTRICAL ENGINEERING LABORATORY

Prepared
By
Mr.E.Saidulu,
Assistant Professor

Estd:2008

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COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To become a reputed centre for imparting quality education in Electrical and Electronics Engineering with human values, ethics and social responsibility.

MISSION

- To impart fundamental knowledge of Electrical, Electronics and Computational Technology.
- To develop professional skills through hands-on experience aligned to industry needs.
- To undertake research in sunrise areas of Electrical and Electronics Engineering.
- To motivate and facilitate individual and team activities to enhance personality skills.

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PROGRAM EDUCATIONAL OBJECTIVES

BE-Electrical Engineering graduates shall be able to:

- **PEO1**. Utilize domain knowledge required for analyzing and resolving practical Electrical Engineering problems.
- **PEO2**.Willing to undertake inter-disciplinary projects, demonstrate the professional skills and flair for investigation.
- **PEO3**. Imbibe the state of the art technologies in the ever transforming technical scenario.
- **PEO4**. Exhibit social and professional ethics for sustainable development of the society.

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PROGRAM OUTCOMES

Engineering Graduates will have ability to:

- **PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of electrical and electronics engineering problems.
- **PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex electrical and electronics engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO3. Design/development of solutions:** Design solutions for complex electrical and electronics engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex electrical and electronics engineering activities with an understanding of the limitations.
- **PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional electrical and electronics engineering practice.
- **PO7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **PO.8 Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the electrical and electronics engineering practice.
- **PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES

At the end of BE program Electrical and Electronics Engineering graduates will be able to:

- **PSO1**.Provide effective solutions in the fields of Power Electronics, Power Systems and Electrical Machines using MATLAB/MULTISIM.
- **PSO2.** Design and Develop various Electrical and Electronics Systems, particularly Renewable Energy Systems.
- **PSO3.** Demonstrate the overall knowledge and contribute for the betterment of the society.

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I. PREREQUISITE(S):

Level	Credits	Semester	Prerequisites
UG	1	1	Basic Electrical Engineering

II. SCHEME OF INSTRUCTIONS

Lectures	Tutorials	Practicals	Credits
0	0	2	1

III. SCHEME OF EVALUATION & GRADING

S. No	Component	Duration	Maximum Marks
	Continuous Internal Evaluation (CIE)		
1.	Internal Examination – I and II	1 hour each	25
	CIE (Total)		**25**
2.	**Semester End Examination** (University Examination)	3 hours	**50**
		TOTAL	**75**

%Marks Range	>=90	80 to < 90	70 to < 80	60 to < 70	50 to < 60	40 to < 50	< 40	Absent
Grade	S	A	B	C	D	E	F	Ab
Grade Point	10	9	8	7	6	5	0	-

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COURSE OUTCOMES

After completing this course the student will be able to:

CO. No.	Course Outcome	Taxonomy Level
152.1	Justify the statements of basic electrical circuits.	Evaluate
152.2	Examine the performance of different electrical machines.	Analyze
152.3	Identify the electrical machines requirements.	Apply
152.4	Find the response of different electrical circuits.	Remember
152.5	Determine parameters of electrical machines and equipment.	Evaluate
152.6	Test for efficiency of electrical machines.	Analyze

MAPPING OF COs WITH POs & PSOs

Correlation Level: High – 3; Medium – 2; Low – 1

PO / CO	PO 1	PO2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11	PO 12	PS0 1	PSO 2	PSO 3
C152. 1	3	3	2	3	-	-	-	-	3	-	-	-	2	-	-
C152. 2	3	3	1	2	-	-	-	-	3	-	-	-	2	-	-
C152. 3	3	2		1	-	-	-	-	3	-	-	-	2	-	2
C152. 4	1	-	-	-	-	-	-	-	2	-	-	-	2	-	-
C152. 5	3	3	2	3	-	-	-	-	3	-	-	-	2	-	2
C152. 6	2	3	1	2	-	-	-	-	3	-	-	-	2	-	2
C152	2.5	2.8	1.5	2.2	-	-	-	-	2.83	-	-	-	2	-	2

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LABORATORY CODE OF CONDUCT

1. Students should report to the labs concerned as per the scheduled time table.
2. Students, who report late to the labs, will not be permitted to perform the experiment scheduled for the day.
3. Students to bring a 100 pages note book to enter the readings /observations while performing the experiment.
4. After completion of the experiment, certification of the staff in-charge concerned, in the observation book is necessary.
5. Staff member in-charge shall evaluate for 25 marks, each experiment, based on continuous evaluation which will be entered in the continuous internal evaluation sheet.
6. The record of observations, along with the detailed procedure of the experiment performed in the immediate previous session should be submitted for certification by the staff member in-charge.
7. Not more than three students in a group would be permitted to perform the experiment on the equipment-based lab set up. However only one student is permitted per computer system for computer-based labs.
8. The group-wise division made at the start of the semester should be adhered to, and no mix up with any other group would be allowed.
9. The components required, pertaining to the experiment should be collected from the stores in-charge, after duly filling in the requisition form / log register.
10. After the completion of the experiment, students should disconnect the setup made by them, and return all the components / instruments taken for the purpose, in order.
11. Any damage of the equipment or burn-out of components will be charged at cost as a penalty or the total group of students would be dismissed from the lab for the semester/year.
12. Students should be present in the lab for the total time duration, as scheduled.
13. Students are required to prepare thoroughly, before coming to Laboratory to perform the experiment.
14. Procedure sheets / data sheets provided to the students, if any, should be maintained neatly and returned after the completion of the experiment.

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DO's AND DON'Ts IN THE LABORATORY

Do's:

1. Always check to see that the power switch is OFF before plugging into the outlet.
2. Also, turn instrument or equipment OFF before unplugging from the outlet.
3. The lab timetable must be followed strictly.
4. Be PUNCTUAL for your laboratory session.
5. Experiment must be completed within the given time.
6. Noise must be kept to a minimum.
7. Handle all apparatus with care.
8. All bags most be left at the indicated place.
9. Shoes and apron must be worn at all times.
10. Be as neat as possible. Keep the work area and workbench clear of items not used in the experiment.

Don'ts:

1. No ungrounded electrical or electronic apparatus is to be used in the laboratory unless it is double insulated or battery operated.
2. W hen unplugging a power cord, pull on the plug, not on the cable.
3. Students are strictly PROHIBITED from taking out any items from the laboratory.

Before Leaving Lab:

- Return all the equipment to authority concerned.
- Switch off the main power to the lab bench.
- Please check the laboratory notice board regularly for updates.

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CONTENTS

Expt. No.1.Verification of KVL and KCL, Superposition theorem

(a) Verification of Kirchhoff's Law:

Aim: To verify Kirchhoff's Current law (KCL) and Kirchhoff's Voltage law (KVL).

Apparatus:

S.No	Equipment Name	Type	Range	Qty.
1	Regulated power supply (RPS)	DC supply	(0 – 30) V	1 No
2	Voltmeter (V)	MC	(0 – 30) V	3 No
3	Ammeter (A)	MC	(0 – 20) mA	3 No
4	Resistors (R)			
5	Connecting wires			As per req.
6	Connecting wires			As per req.

Theory:

Kirchhoff's laws relate the currents at various junctions and voltages across various components in a closed circuit. The current law emphasises **the law of conservation of charge** , where as the voltage law establishes **the law of conservation of energy**.

KVL:

It states that **"The algebraic sum of voltages drop (product of current and resistance in each of the component) in any closed path (or mesh) in a network and the algebraic sum of voltage rise of the E.m.f s in that path is zero."**

KCL:

It states that **"The algebraic sum of currents entering and leaving at a node (or junction) is equal to zero."**

Circuit diagrams:

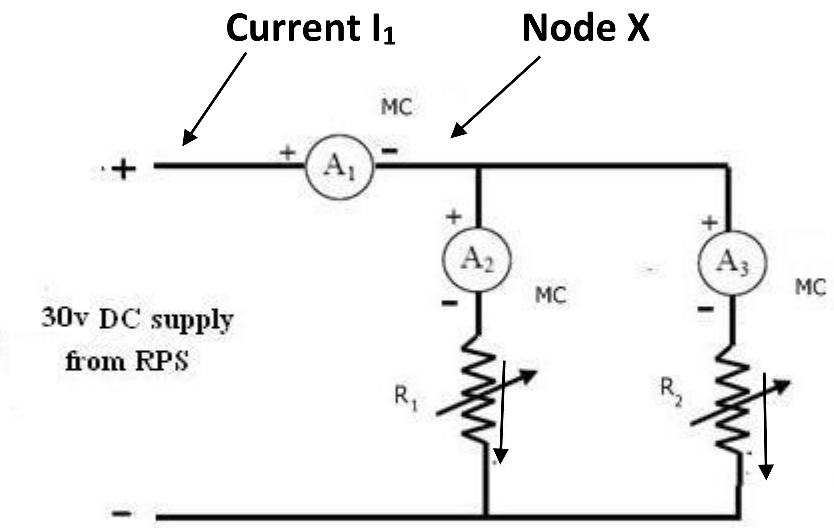


Fig.1

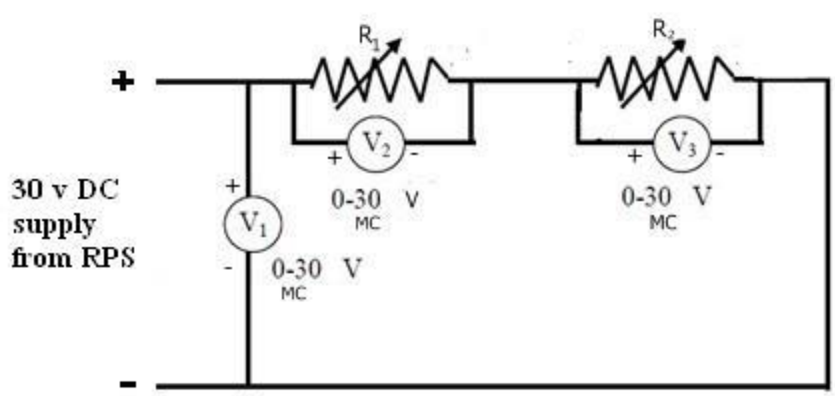


Fig.2

Procedure:

KCL:

1. Arrange all the resistors on the bread board as per the circuit diagram of Fig.1.
2. SET the RPS, between 0 V and 30 V.
3. The ammetermeasures the current flowing through the resistor. Let I_1 be the current, as read byammeter A_1, current I_2 read by ammeter A_2 and current I_3 read by ammeter A_3.
4. Note down the readings of the three ammeters.
5. Increase the RPS in suitable step and complete steps 3, 4, tillRPS is max at 30 V.
6. KCL is verified at the NODE X, when $I_1 = I_2 + I_3$

KVL:

1. Arrange all the resistors on the bread board as per the circuit diagram of Fig.2.
2. SET the RPS, between 0 V and 30 V.
3. Measure the Voltage across the resistors using the Voltmeter.
4. Note down the readings of the three voltmetersV_1, V_2 and V_3
5. By convention, Voltage rise is +ve, and Voltage drop is - ve.
6. Increase the RPS in suitable step and complete steps 3, 4, till RPS is max at 30 V.
7. KVL is verified when V1 = V2 + V3.

Tabular form:

KCL:

S.NO.	Ammeter (A_1)	Ammeter (A_2)	Ammeter (A_3)
1			
2			
3			

KVL:

S.NO.	Voltmeter (V_1)	Voltmeter (V_2)	Voltmeter (V_3)
1			
2			
3			

Precautions:

1. Avoid touching the equipment when the power supply is in ON condition.
2. Avoid loose connections.

Result:

Viva Questions:

1. What is the ohm's law?
2. Define KCL & KVL.
3. What is the use of Regulated power supply?
4. How we will verify the Kirchhoff's laws.
5.

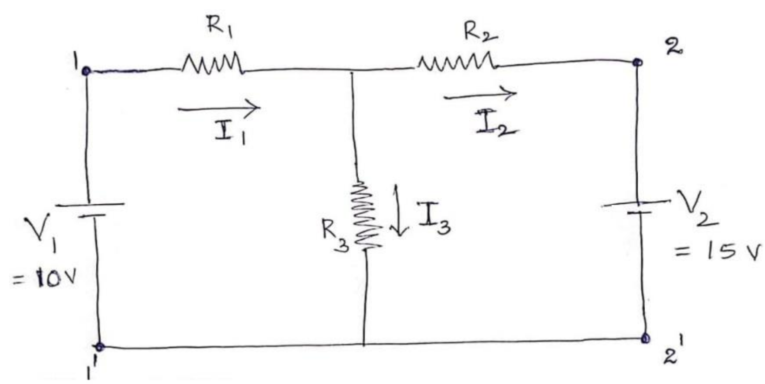
(b) Verification of Superposition Theorem:

Aim: To verify Superposition theorem.

Apparatus:

S.No	Equipment Name	Type	Range	Qty.
1	Regulated power supply (RPS)	DC supply	(0 – 30) V	2 No
2	Ammeter (A)	MC	(0 – 20) mA	3 No
3	Resistors (R)			
4	Breadboard			1 No
5	Connecting wires			As per req.

Circuit Diagram:



Theory: If a network contains two or more sources, then principle of superposition theorem is used to simplify network calculations, which can be stated as follows: In a bilateral network if two or more energy sources are present, then the current at any point is the algebraic sum of all currents , which would flow at that point, if each source was considered separately and all other sources replaced by their internal resistances.

Procedure:

1. Connect D.C power supply across terminals $1\text{-}1^l$ and apply voltage of say V_1=10 volts and similarly across terminals $2\text{-}2^l$ apply voltage of say V_2=15 volts.
2. Measure current flowing through all branches, say these currents are I_1, I_2, and I_3.
3. Now connect only V_1=10 volts across terminals $1\text{-}1^l$ and short circuit terminals $2\text{-}2^l$ that is V_2=0 volts.
4. Measure currents flowing through all branches for V_1=10 volts V_2=0 volts using a milliammeter, let these currents be I_1', I_2', I_3'.
5. Similarly connect only V_2 =15 volts across terminals $2\text{-}2^l$ and short circuit terminals $1\text{-}1^l$ that is V_1=0 volts.
6. Measure current flowing through all branches for V_1=0 volts and V_2=15 volts using a milliammeter, let these currents be I_1'', I2'', I3''.
7. For verifying superposition theorem $\mathbf{I_1= I_1'+ I_1''}$, $\mathbf{I_2= I_2'+ I_2''}$, $\mathbf{I_3=I_3'+I_3''}$.
8. Calculate theoretical values of currents, these values should be approximately equal to measured values of currents.

Tabular form:

S.NO	V_1=10 V V2=15 V	V_1=10 V V_2=0V	V_1=0 V V_2=15V
1	I_1=	I_1'=	I_1''=
2	I_2=	I_2'=	I_2''=
3	I_3=	I_3'=	I_3''=

Theoretical Calculations:

Result:

Viva Questions:

1. Explain statement of superposition theorem?
2. What are the Applications of superposition theorem?
3. How we will compare those theoretical and practical values?
4. Why are we taking two sources in this theorem? Can there be many sources?

Expt. No. 2.Verification of Thevenin's and Norton's Theorem

Aim: ToVerify Thevenin's theorem for the given DC Circuit.

Apparatus:

S.No	Equipment Name	Type	Range	Qty.
1	Regulated power supply (RPS)	DC supply	(0 – 30) V,2A	1 No
2	Voltmeter (V)	MC	(0 – 30) V	2 No
3	Ammeter (A)	MC	(0 – 20) mA	2 No
4	Resistors (R)			
5	Breadboard			1 No
6	multimeter	Digital		1 No
7	Connecting wires			As per req.

Theory:

Thevenin's Theorem:

This theorem is applied to find the correct values of Voltages and currents in a restricted portion of networks rather than in all the branches of the network.

Statement:

"Any linear two terminal network can be replaced by an equivalent network consisting of a voltage source (V_{Th}) in series with a resistance (R_{Th}) .Where, V_{Th} = Open circuit voltage at load terminals. R_{Th} = Equivalent resistance at load terminal when sources are made in operative''.

Circuit Diagrams:

(i)<u>To measure Thevenin's Voltage (V_{TH})</u>:

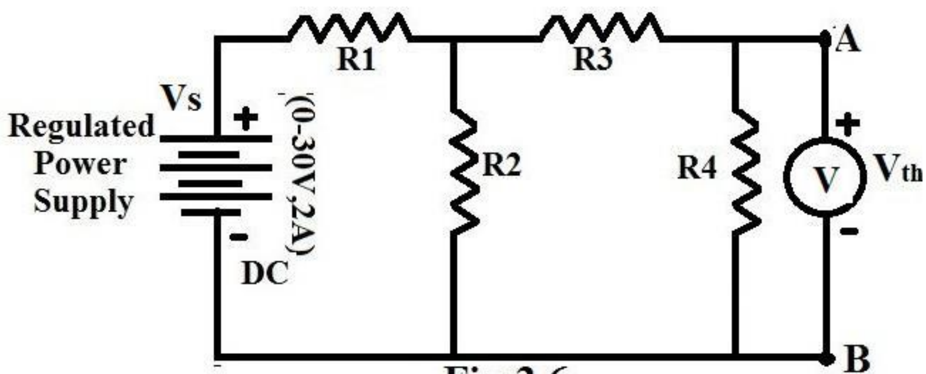


Fig:2.6

(ii)<u>To measure Thevenin's Resistance (R_{TH})</u>:

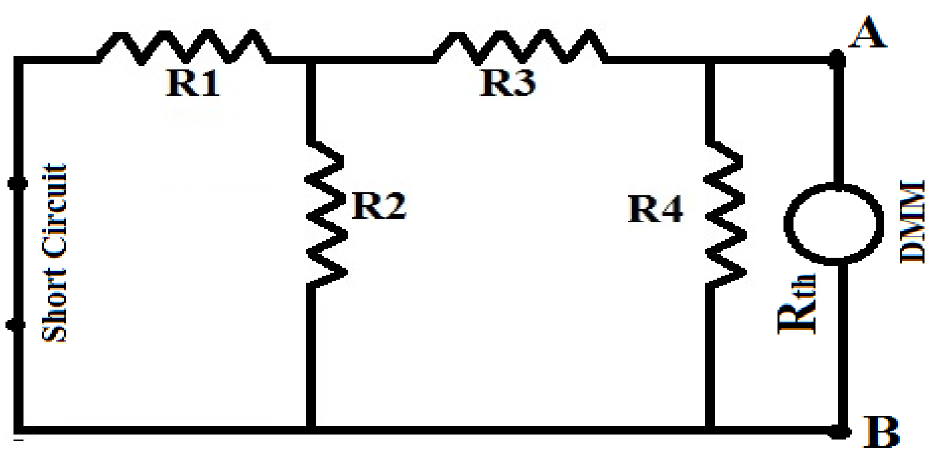


Fig:2.5

(iii)<u>To measure Load Current (I_L)</u>:

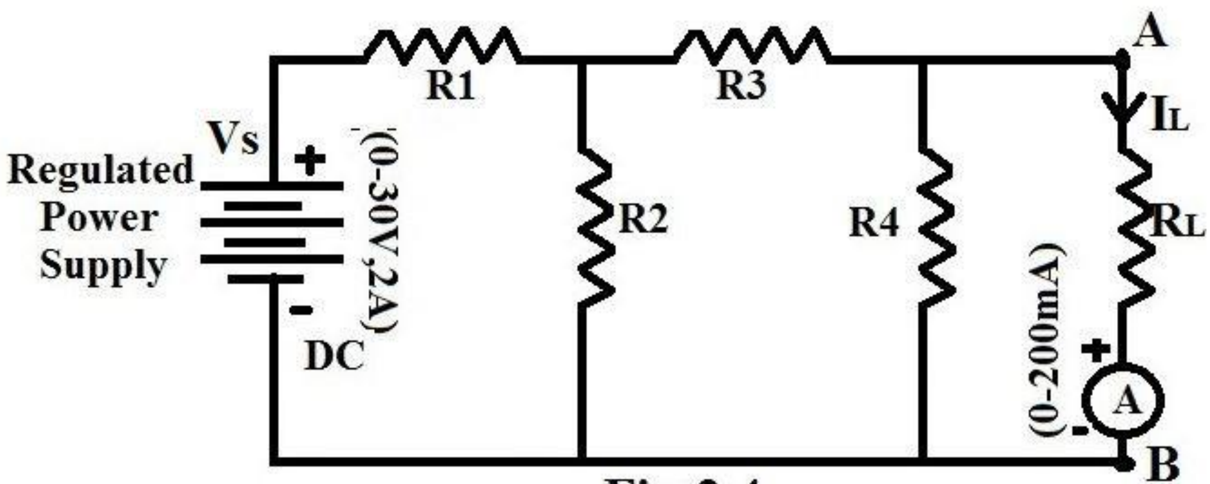


Fig:2.4

(iv)<u>Verification Circuit</u>:

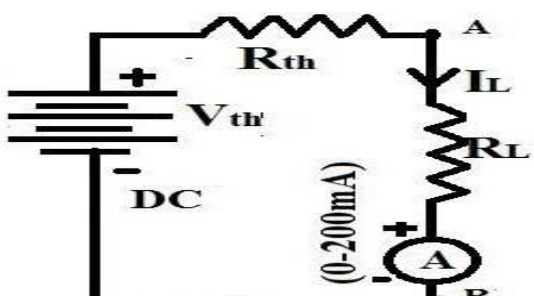


Fig:2.8

<u>Procedure</u>:

1. To find Load Current (I_L), Apply the supply voltage Vs= 5V by using Regulated Power Supply and Find the load current (I_L) through the load resistance with circuit as shown in Fig 2.4.
2. To find Thevenin's Resistance (R_{th}), Short circuit the Voltage Source in the given circuit as shown in Fig 2.5 and find out the Thevenin's resistance across open circuited terminals after removing the Load Resistance with the help Digital Multimeter (DMM).
3. To find Thevenin's Voltage (V_{th}), Apply voltage V_S=5V at the source terminals and remove the load Resistance, find the voltage across the open circuited terminals as shown in Fig: 2.6. Note down the applied voltage and Thevenin's voltage.
4. Verify the Thevenin's Theorem by finding the load current with Thevenin's Equivalent circuit as Shown in Fig: 2.8
5. Repeat the above Procedure for Supply Voltages of 10V, 15V, 20V, 25V and Tabulate the Values.

Theoretical Calculations:

Tabular form:

Thevenin's Theorem:

S.No	Voltage (Volts)	Vth (Volts)	I_L (Amps)	Rth (Ohms)	I_L(Amps) Verification
1	5V,10V,15V,20V, 25V				

Result:

Viva Questions:

1. What is the difference between a current source and a voltage source?
2. Solve the above circuit using Thevenin's theorem?
3. Explain statement of Thevenin's Theorem?
4. Advantages of Thevenin's Theorem?
5. How we will verify this above theorem?

Aim: ToVerify Norton's theorem for the given DC Circuit.

Apparatus:

S.No	Equipment Name	Type	Range	Qty.
1	Regulated power supply (RPS)	DC supply	(0 – 30) V	1 No
2	Voltmeter (V)	MC	(0 – 30) V	1 No
3	Ammeter (A)	MC	(0 – 20) mA	1 No
4	Resistors (R)			
5	Breadboard			1 No
6	Connecting wires			As per req.

Theory:

Norton's Theorem: It states that "Any two terminal network between A and B can be replaced byanequivalentcircuitconsistingofaCurrentSource$I_N$inserieswitharesistance R_N where I_N is the short circuit current across the terminals, R_N is the equivalent resistance at the terminals when Voltage Source is Short Circuited and Current Source is Open Circuited".

Circuit Diagrams:

(i)To measure Norton's Current (I_N):

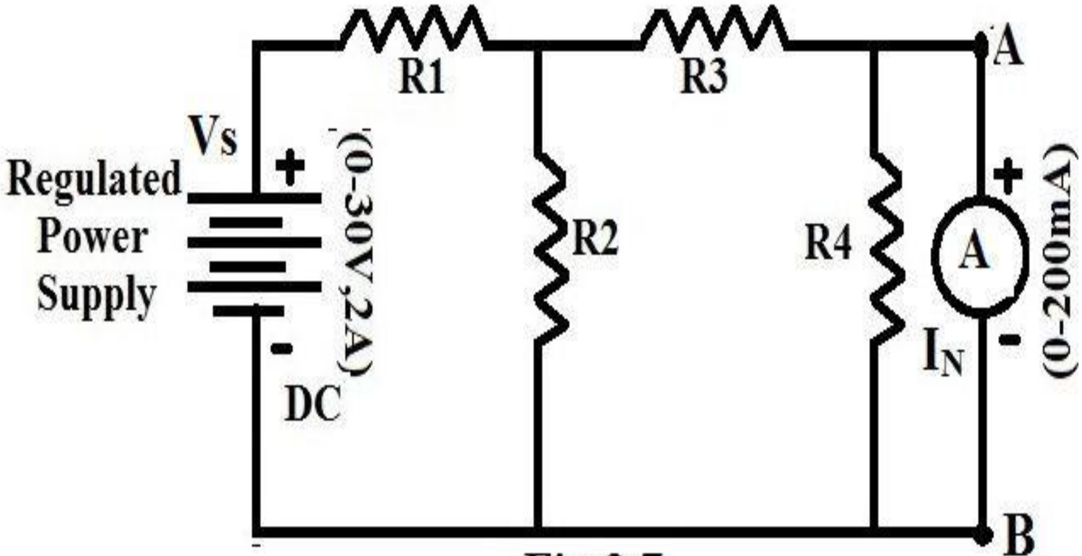


Fig:2.7

(ii)<u>To measure Norton's Resistance (R_N)</u>: $R_{TH} = R_N$

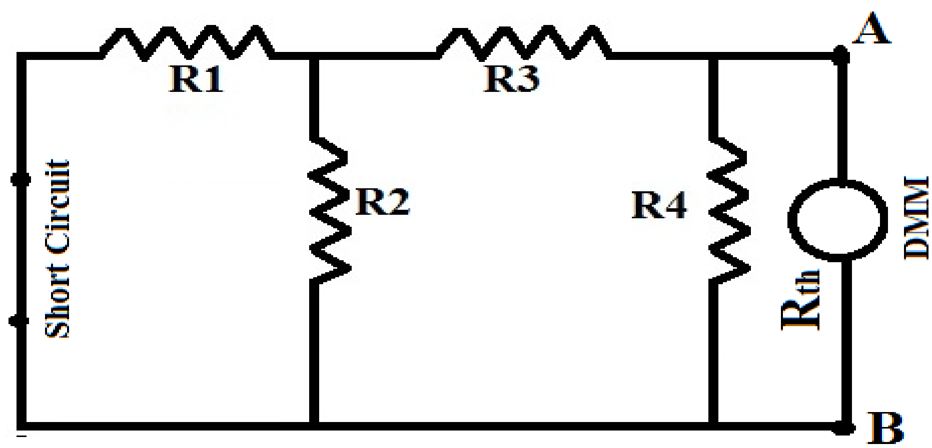


Fig:2.5

(iii)<u>To measure Load Current (I_L)</u>:

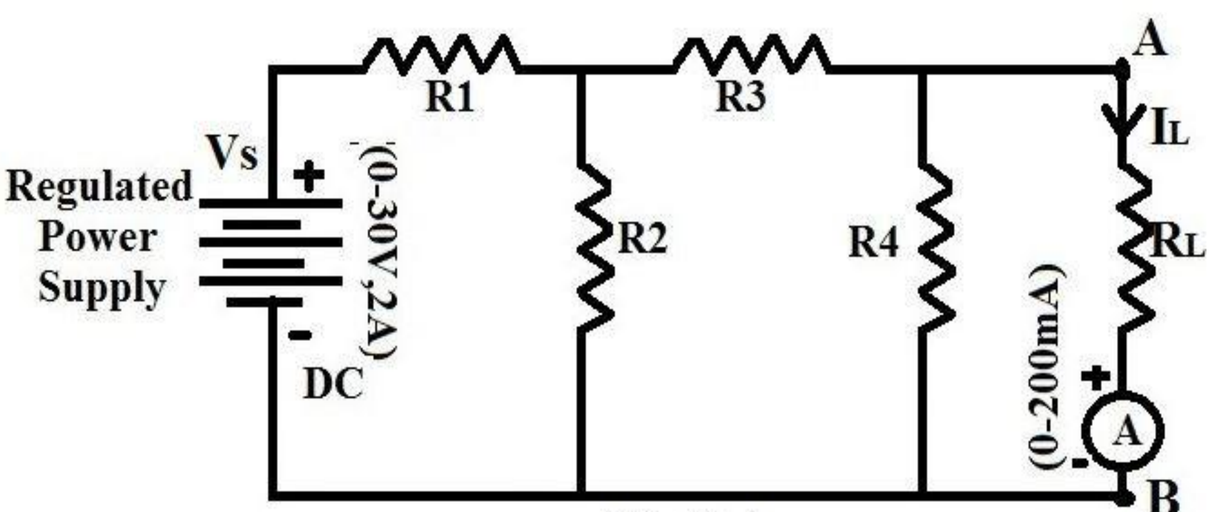


Fig:2.4

(iv) **<u>Verification Circuit</u>:**

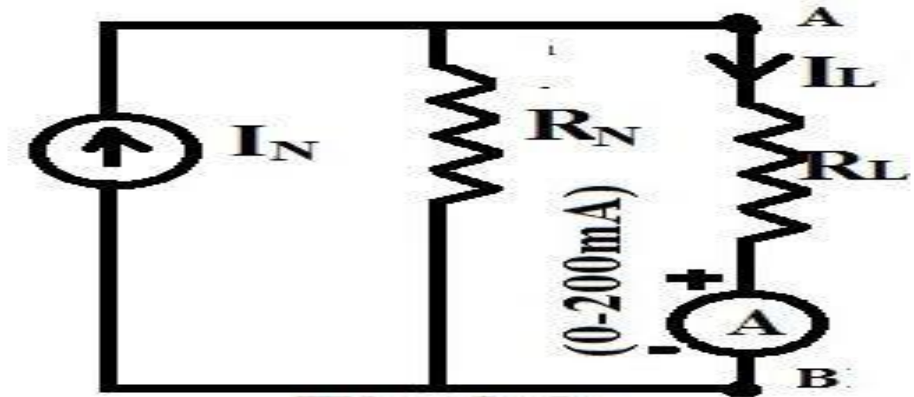


Fig:2.9

<u>Procedure</u>:

1. Connect the circuit as shown in Fig: 2.7 and by applying supply voltage V_S=5Vthrough RPS, determine the short circuit current (I_N or I_{sc}.).
2. Note down Norton's resistance $R_N$as same as Thevenin'sResistance R_{th}.
3. Verify the Norton's Theorem by finding the load current with Norton's Equivalent circuit as shown In Fig: 2.9.
4. Repeat the above Procedure for Supply Voltages of 10V, 15V, 20V, 25V and Tabulate the Values.

<u>Tabular form:</u>

S.No	Vs(V)	I_L(mA)	R_{Th}or R_N(Ohms)	I_N(mA)	I_L (mA) using Norton's circuit
1.	5				
2.	10				
3.	15				
4.	20				
5.	25				

<u>Precautions:</u>

1. Avoid the loose connections.
2. While Conducting the Experiment keep the Current knob of RPS (Regulated Power Supply) at maximum position and Voltage knobs of RPS at minimum position.

<u>Theoretical Calculations</u>:

<u>Result</u>:

<u>Viva Questions:</u>

1. What is the difference between a current source and a voltage source?
2. Solve the above circuit using Norton's theorem?
3. Explain statement of Norton's theorem?
4. Advantages of Norton's theorem?
5. How we will verify this above theorem?

Expt. No. 3.Sinusoidal Steady State Response of R-L and R- C Circuits

Aim: To verify voltage, current, power factor and impedance variations of R-L and R-C circuits to a sinusoidal input at steady state condition.

Apparatus:

S.No	Equipment Name	Range/Rating	Type	Qty.
1	Single Phase Auto Transformer	(0-270/230) V		1
2	Ammeter	(0-2) A	MI	1
3	Voltmeter	(0-300) V (0-150) V	MI MI	2 2
4	Resistance – DRB			1
5	Inductance – DIB			1
6	Capacitance- DCB			1
7	Connecting Wires			As per req.

FG: Function Generator, DRB: Decade Resistance Box,
DIB: Decade Inductance box, DCB: Decade Capacitance Box.

Theory:-

Any circuit behavior depends on the parameters of the elements, such as Resistance(R), Inductance (I) And Capacitance (C), available in it.

In series R- L network, when a voltage V_S is applied then the current Is flows into the circuit which creates a voltage drops across resistance V_R and inductance V_L. In circuits where the source is an alternating voltage / current, these circuits are known as ac circuits. The relationship between the current through each component and the voltage across it differs as:

a) For a Resistor, the Voltage and current are "in Phase" i.e, there is no angular difference between them.
b) For an Inductance, the current "Lags" the applied voltage by an angle "θ" . For a pure inductance the angle of lag is 90 degrees.
c) For a Capacitance, the current "Leads" the applied voltage. In a pure capacitance the angle of lead is 90 degrees.

Circuit diagrams:

(1) For R-L Series circuit:

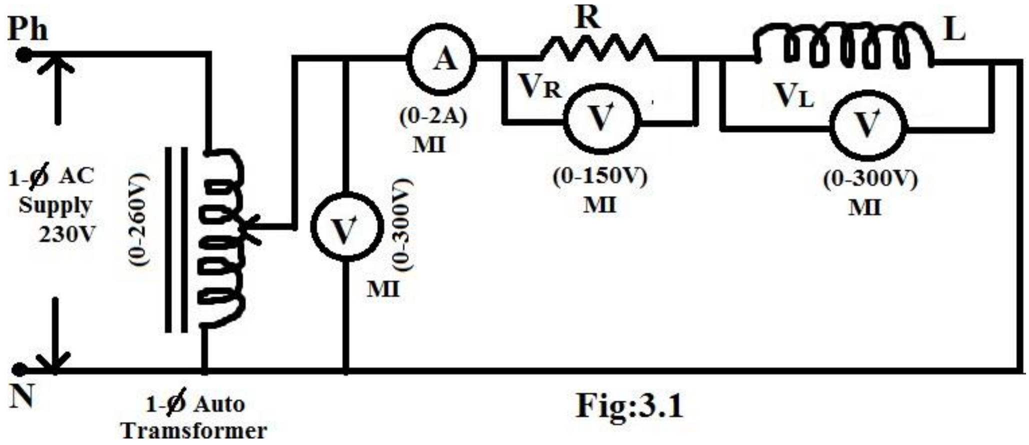


Fig:3.1

(2) For R-C Series circuit:

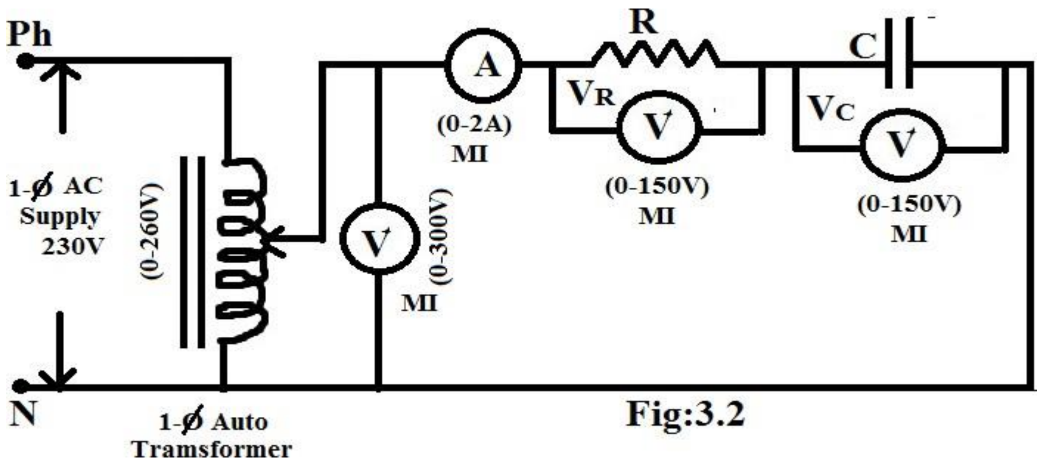


Fig:3.2

Procedure:

For R–L Series circuit:

1. Connect the Series R-L circuit as shown in Fig: 3.1.
2. Apply the suitable voltage to the circuit by using Single Phase auto transformer insteps.
3. Note down the readings of voltmeters and ammeter.
4. Plot V_R Vs V_L Graph and calculate angle.

For series RC Series circuit:

1. Connect the Series R-C circuit as showninFig: 3.2.
2. Apply the suitable voltage to the circuit by using Single Phase auto transformer insteps.
3. Note down the readings of voltmeters andammeter.
4. Plot V_R Vs V_C Graph and calculate angle.

.

Tabular forms:

For R-L Series circuit:

S.NO	V_s	I_s	V_R	V_L	$\|Z\| = \frac{V_s}{I_s}$	$\theta = tan^{-1} (\frac{V_L}{V_R})$
1						
2						
3						

For R-C Series circuit:

S.NO	V_s	I_s	V_R	V_c	$\|Z\| = \frac{V_s}{I_s}$	$\theta = tan^{-1} (\frac{V_C}{V_R})$
1						
2						
3						

Expected Graphs:

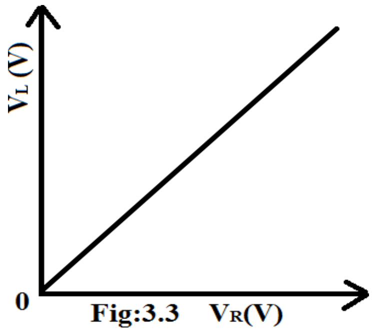


Fig:3.3

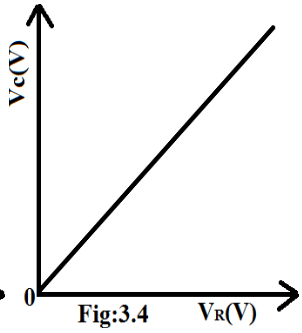


Fig:3.4

Result:

Viva Questions:

1. What do you understand by the terms steady state and transient response?
2. Draw the response of R-L circuit for a unit step input.
3. Draw the response of R-C circuit for a unit step input.
4. What is the difference between function generator and auto-transformer?

Expt. No.4.Loading of a Transformer

Aim: To measure primary and secondary voltage, current and power by connecting load on a single- phase transformer.

Apparatus:

S.No	Equipment Name	Range	Type	Quantity
1	Ammeter	(0 -10A) (0-5A)	MI MI	1 1
2	Voltmeter	(0 – 150 V) (0 – 300 V)	MI MI	1 1
3	Wattmeter	(300V, 5A) (150V, 10A)	UPF UPF	1 1
4	Autotransformer	1∅, (0 – 230V)	-	1
5	Resistive Load	2KW, 230V	-	1
6	Connecting wires	2.5 Sq.mm	Copper	As per req.

Name Plate details:

S.No	Parameter	Primary	Secondary
1	Rated Voltage		
2	Rated Current		
3	Rated Power		

<u>Theory</u>:

A transformer operates on the principle of “**Electromagnetic induction**”. It is a TWO winding equipment, which has “ELECTRICALLY ISOLATED, MAGNETICALLY COUPLED Windings. The Windings are placed on a supporting structure called the CORE which is made up of material of High permeability.

A transformer can be operated to either increase or decrease the voltage on the secondary side, when it is applied to the primary winding. When a transformer is used to “increase” the voltage on its secondary winding with respect to the primary, it is called a **Step-up transformer**.

When it is used to “decrease” the voltage on the secondary winding with respect to the primary it is calleda **Step-down transformer.**

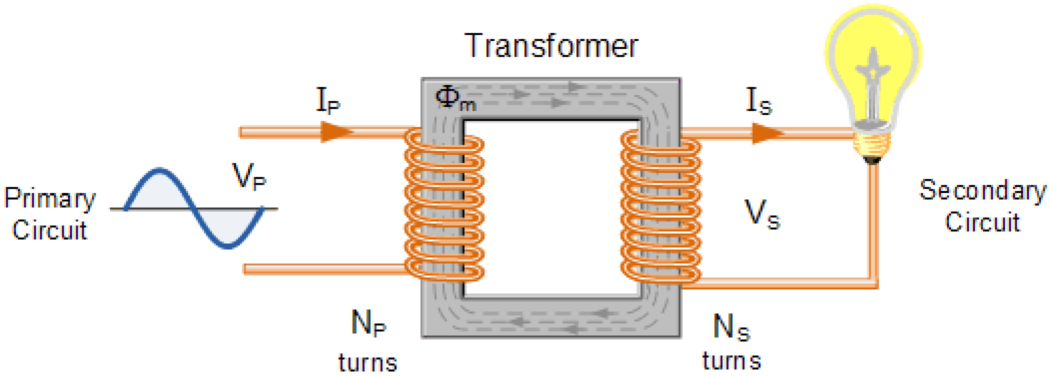
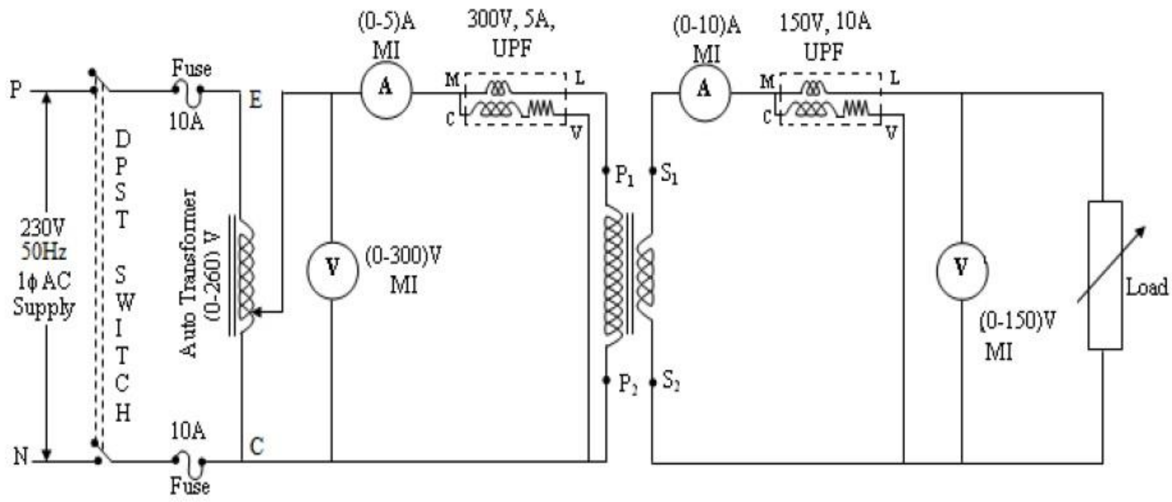


FIG. 1

Where:

V_P is the Primary Voltage
V_S is the Secondary Voltage
N_P is the Number of Primary turns
N_S is the Number of Secondary turns
Φ is the Flux Linkage

Circuit diagram:



Procedure:

1. Connections are to be made as per the circuit diagram.
2. Double Pole Single Throw (DPST) switch is closed.
3. Under no load condition, ammeter, voltmeter and wattmeter readings on both primary side and secondary side are noted down.
4. The load is increased in suitable intervals and for each load intervals, corresponding reading of voltmeter, ammeter and wattmeter on both primary and secondary sides are noted down.
5. The experiment is repeated until the rated current of the transformer (take the minimum rated current of the transformer primary side) has reached.
6. The load is reduced to bring the transformer to the no load condition. The auto-transformer is brought to its minimum position and then the DPST switch is opened.

Tabular form:

S.No	V_p	I_p	W_p (Watts)	V_s	I_s	W_s (Watts)	% Efficiency (η)
1							
2							
3							

Formulae:

1. %Efficiency = $\frac{W_s}{W_p} * \mathbf{100}$

2. Ep / I p = Is / Es   Under NO- Load Condition, Vp approx. =Ep and Vs approx. = Es

3. Vp* Ip* Cos ϕ =   WP   where Cos ϕ is called the NO Load POWER FACTOR.

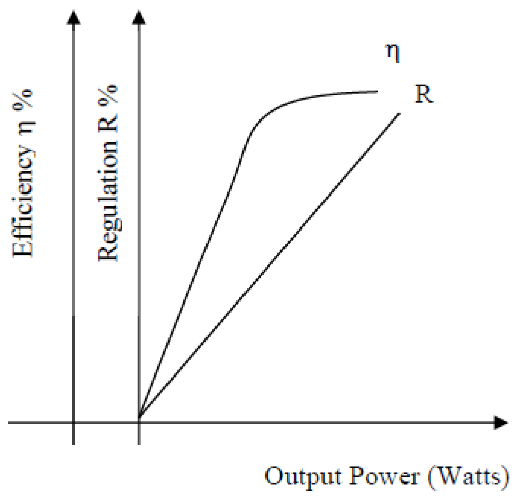
4. The ratio Vp / Ip = Zp   where Zp is called the IMPEDANCE on Primary side. Similarly

Vs/ Is =Zs.

Precautions:

1. Auto Transformer should be kept at minimum position.
2. The transformer should be kept under no load condition.
3. The ‘M’ and ‘C’ terminal of primary and secondary side watt meters should be shorted.
4. The AC supply is applied and removed from the transformer under no load condition.

Expected Graph:



Sample Calculations:

Result:

Viva Questions:

1. What are the applications of a transformer?
2. Define transformer?
3. What do you understand by regulation of a transformer?
4. What is the difference between transformer and auto-transformer?
5. What are the methods of testing a transformer?

Expt. No.5.Verify Voltage and Current Relationships of a Three-Phase Transformer in Star and Delta Connections

Aim: To Verify Voltage and Current relationships of a Three - Phase transformer inStar and Delta connections (line-line voltage, phase-to-neutral voltage, line and phase currents).

Apparatus:

S.No	Equipment Name	Range	Type	Quantity
1	3 Phase Transformer	440 V		1
2	3 Phase Auto Transformer	(0-470/440V),10 A		1
3	Ammeter	(0-10A/20) A	MI	1
4	Voltmeter	(0-300) V & (0-6000)V	MI	2
5	Connecting wires			As per Req.

Theory:a) Three windings used on a common core , each winding supplied with a voltage differing in phase is the construction of a 3 phase transformer.There are various methods available for transforming 3-phase voltages to higheror lower 3-Φ voltages for handling a considerable amount of power. The most common connections are

(*i*) *Y* - *Y* (*ii*) Δ - Δ (*iii*) *Y* - Δ (*iv*) Δ - *Y* .Among them Y - Y & Y - Δ are predominantly used.

Wye - Wye or Y - Y Connection:

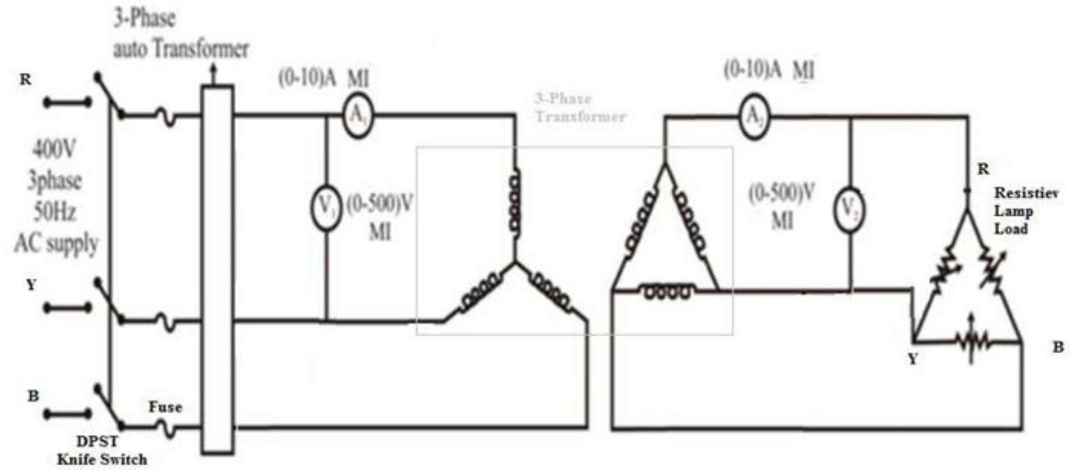
This connection is economical forlarge, low-voltage transformers in which insulationproblem isnot so urgent, because it increases the number of turns/phase. The ratio oftransformationbetween primary and secondary line voltage is the same as that of eachtransformer.

Wye/Delta or Y-Δ Connection:

The main use of thisconnectionis at the substation end of the transmission line where the voltage is to be stepped down. The primary winding is Y-connected with grounded neutral. The ratiobetween the secondary and primary line voltage is 1/3 times the transformation ratio of each transformer. There is a 30° shift between the primary and secondary line voltages which means that a Y −Δ transformer bank cannot be paralleled with either a Y – Y or a Δ − Δ bank.Also, third harmonic currents flow in the Δ to provide a sinusoidalflux.

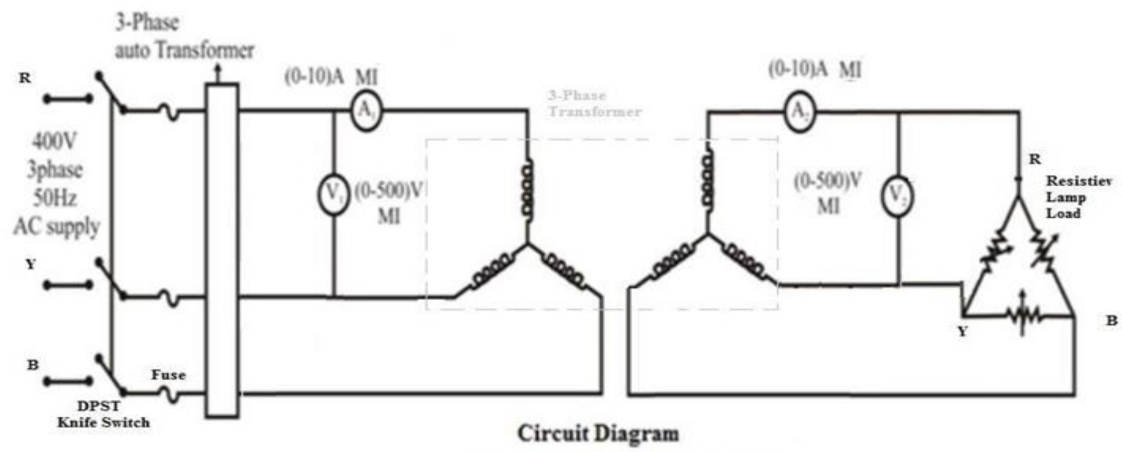
Circuit Diagrams:

Star – Delta Connection:



Circuit Diagram
STAR - DELTA CONNECTION

Star - Star Connection:



Circuit Diagram
STAR - STAR CONNECTION

Procedure:

Star- Delta Connection:

1. Connections are made as shown in the circuit diagram Fig 1.
2. By keeping 3- Ø auto-transformer voltage in zero position and the 3-phase resistive load in off position, the 3-Ø supply switch is closed.
3. By varying the 3- Ø auto-transformer apply the rated voltage of the transformer (400V).
4. By keeping the 3- Ø resistive load in off position &note down the no-load voltages.
5. Apply the load &all the meter readings are noted down.
6. The resistive load is brought back to its initial minimum position and3-Ø auto-transformer to its initial zero output position, the supply switch is opened.

Star –Star connection:

1. Connections are made as shown in the circuit diagramFig.2.
2. By keeping 3- Ø auto-transformer voltage in zero position and the 3- Ø resistive load in off position, the 3- Ø supply switch is closed.
3. By varying the 3-phase auto-transformer apply the rated voltage of the transformer **(440V).**
4. By keeping the 3- Ø resistive load in off position note down the no-load voltage.
5. Apply the load &all the meter readings are noted down.
6. The resistive loads are brought back to its initial minimum position and 3-Ø auto-transformer to its initial zero out-put position, the supply switch is opened.

Tabular Forms:

For Star-Delta connection:

S.NO	Y-Side		Δ-Side	
	Voltage(V1)	Current(I1)	Voltage(V2)	Current(I2)
1				
2				
3				

For Star-Star connection:

S.NO	Δ-Side		Y-Side	
	Voltage(V1)	Current(I1)	Voltage(V2)	Current(I2)
1				
2				
3				

Result:

Viva Questions:

1. Define transformer?
2. What is the difference between 1- phase transformer and 3-phase transformer?
3. What is the relationship between star and delta connected transformers?
4. What is the use 3-phase transformer?
5. Why we are using R- Load in these circuits, why not we use other loads?

Expt. No. 6. Measurement of Phase Voltage/Current, Line Voltage/Current and Power in Balanced Three-Phase Circuit Connected in Star andDelta

Aim: To study the balanced three phase system for star & delta connected load.

Apparatus:

S.No	Equipment Name	Type	Range/Rating	Quantity
1	Three phase Variac		440/0-440V	1
2	Ammeter	MI	10A	1
3	Voltmeter	MI	600V	1
4	R-Load		1 KW,20 A	1
5	Wattmeter Meter	Dynamometer	0-300V/5A, UPF	1
6	Connecting wires		As per requirement	---

Theory:-

Any three phase system, either supply system or load can be connected in two ways either star or delta.

1. Star Connection→ In this connection, the starting or termination ends of all winding are connected together &along with their phase ends this common point is also brought outcalled as neutralpoint.

2. Delta Connection- If the terminating end of one winding is connected tostarting end of other&If connection are continued for all their windings in this fashion weget closed loop. The three supply lines are taken out from three junctions. This is called as three phase delta connectedsystem.

The load can be connected in similar manner. In this experiment we are concerned with balanced load.

Some term related to 3 phase system

i. Line Voltage - The voltage between any two lines of 3 ph loads is called as linevoltage

E.g. VRY, VYB & VBR... For balance system all are equal in magnitude.

ii. **Line Current –** The current in each line is called as line current.

E.g. IR, IY &IB. They areequal in magnitude for balancesystem.

iii. Phase Voltage – The voltage across any branch of three phase load is called as phase voltage.

VRN, VYN, & VBN is phase voltage.

iv. Phase **Current –** current passing through any phase of load is calledas phasecurrent.

For star connection of load:

Line voltage (VL) = √3 phase voltage (Vph) Line current (IL) = Phase current (Iph)

For delta connection of load:

Line voltage (VL) = phase voltage (Vph) Line current (IL) = √3 phase current (Iph)

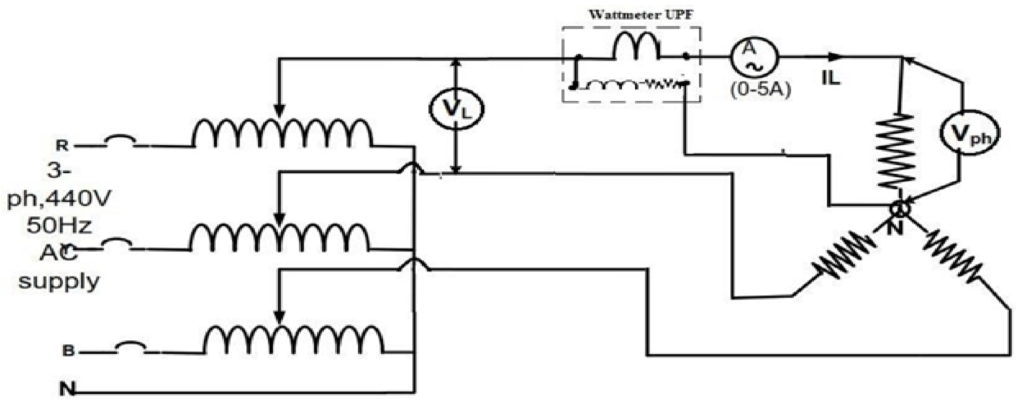
Three phase power is given by,

P= power consumed bytheload= √3VLILcos (Φ)

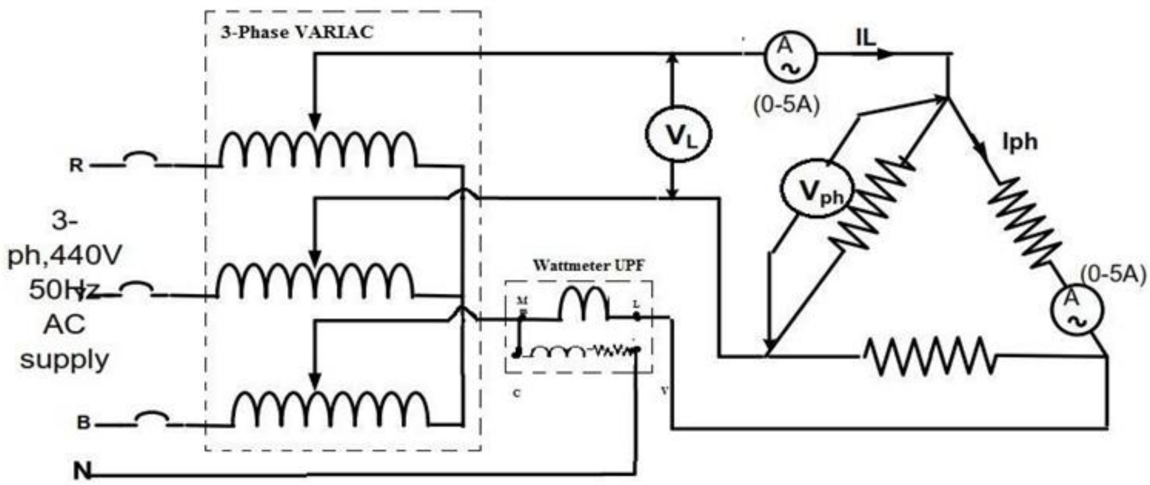
Where Φ is phase angle &it depends on type of load i.e. inductive, capacitive orresistive.

Circuit diagram:

Circuit Diagram: A) For star connected load:



B) For Delta connected load:



Procedure:

1. Connect circuit as shown in the circuit diagram Star.
2. Set3-ph variac to minimum position.
3. Switch on the main supply.
4. Apply a voltage by using 3-phvariac.
5. Note the readings of ammeter, voltmeter & wattmeter.
6. Repeat the above procedure by changing connections to Delta Load.

Tabular Forms:

For Star Connection:				
S.No	**Line Voltage(V_L)**	**Phase Voltage(V_{Ph})**	**Phase Current(I_{Ph})**	**Power** $W=\sqrt{3}\ V_L I_L Cos Ø$
For Delta Connection:				
S.No	**Line Voltage(V_L)**	**Line Current(I_L)**	**Phase Current(I_{Ph})**	**Power** $W=\sqrt{3}\ V_L I_L\ Cos Ø$

Result:

Viva Questions:

1. Define power?
2. What are the relationships between voltages and currents in Star & Delta Connected systems?
3. Explain Balance and unbalanced 3-phase systems?
4. Define Voltage?
5. Define Current?

Expt. No. 7. O.C.C characteristics of a DC Generator

Aim:

To obtain the open circuit magnetization characteristics (OCC) of a separately excited DC Generator and to Observe the following.

a) Maximum Voltage built up.

b) Residual Voltage.

Name Plate Details:

S.No	Parameter	Motor	Generator
1	Armature Voltage		
2	Armature Current		
3	Field Voltage		
4	Field Current		
5	Power		
6	Wound		
7	Rated Speed		

Apparatus:

S. No	Equipment Name	Range	Type	Quantity
1	Voltmeter	(0 – 300)V	MC	1 No
2	Ammeter	(0 – 2)A	MC	1 No
3	Rheostats	500Ω/2A 290Ω/1.2A	Wire Wound Wire Wound	1 No 1 No
4	Tachometer	Digital		1 No

Theory:

This characteristic is also called as no load characteristic through which the generator performance parameters can be determined. This characteristic gives the value of maximum voltage the generator can give and to avoid the failure of excitation, the field winding resistance value which is called as critical field resistance can be determined. Also, the above parameters at various speeds can be determined. The basic set up for determining the above parameters is that the generator is run on separately excited condition. The basic requirement is that the prime mover, the motor, is run at its rated speed and by varying the generator excitation in steps, the generator

Voltage is noted and the procedure is repeated in forward as well as reverse direction so that an observation can be made such the both the induced values will not be same. I_f is increased by suitable steps and the corresponding values of E_g are measured on plotting the relation between I_f & E_g, a curve of the form is shown in fig.

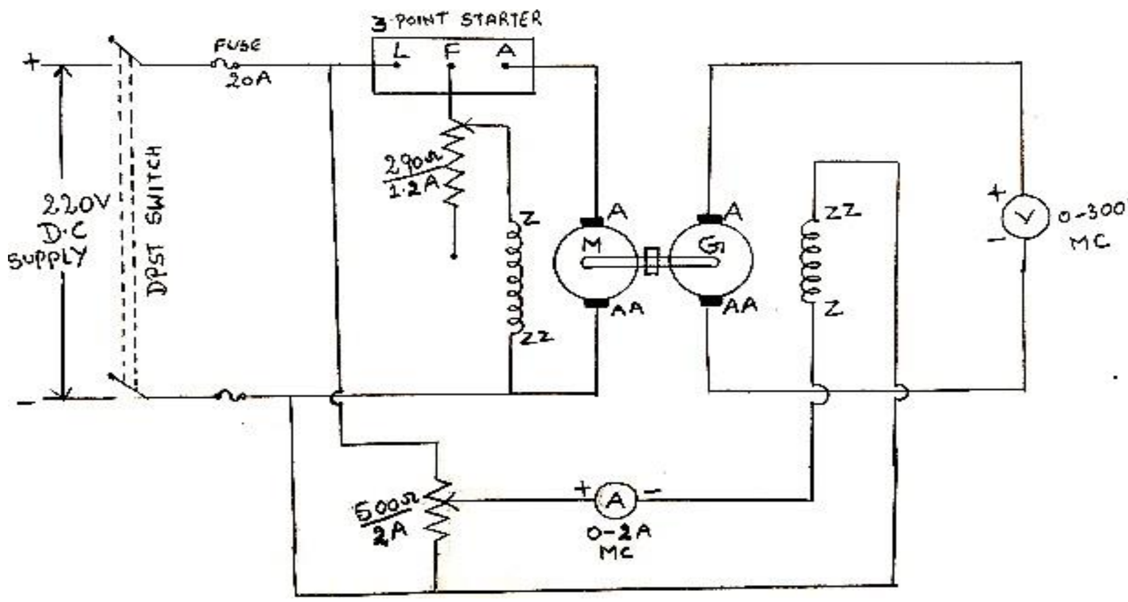
Due to residual magnetism in the poles, some e.m.f is generated even when I_f =0. Hence the curve starts a little way up. The slight curve at the lower and is due to magnetic inertia. At low flux densities, reluctance of iron path being negligible the first part of the curve is practically straight. OCC for higher speed lie above the shown curve & low speed lie below it.

In a D.C. generator, for any given speed, the induced E.m.f in the armature is directly proportional to the flux per pole.

$$E_g = \frac{\emptyset ZNP}{60A} volts$$

Where,
∅ is the flux per pole in webers,
Z is the no. of conductors in the armature,
N is the speed of the shaft in rpm,
P is the no. of poles and
A is the no. of parallel paths.
A = 2 (wave)
A = p (lap)

Circuit diagram:



MAGNETISATION CHARACTERISTICS OF A SEPERATELY EXCITED DC GENERATOR

Fuse Rating:

125%of rated current

Rated current is specified on Name Plate of the Machine.

Procedure:

1. Make the connections as per the circuit diagram. Keep the field regulator in the generator field circuit in the maximum resistance position.
2. Start the motor with the starter and note the speed at which the MG set runs.
3. Adjust the field regulator to run the motor at rated speed.
4. A small reading is observed in the voltmeter even though there is no current due to residual magnetism.
5. Vary the field rheostat in the generator circuit and note down the readings of the armature-induced voltage (E_g) and field current.
6. Plot the graph between induced voltage (E_g) & field current (I_f).

Tabular Forms:

S. No	I_f	E_g (increasing)
1		
2		
3		
4		
5		
6		
7		
8		

Expected Graph:

- Plot the graph between generated voltage (E_g) and Field Current (I_f).

Draw the field resistance line from the origin such that it is tangent to the ascending curve. The critical field resistance is given by the slope of this tangent.

Critical field resistance=Slope of the resistance line which is tangent to the ascending curve.

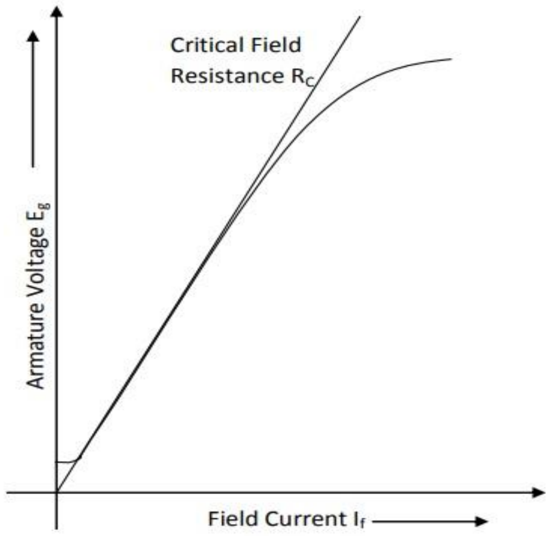
Critical Field Resistance:

The maximum allowed value of the field resistance to a DC shunt generator, above which the voltage fails to build up, is called the Critical Field Resistance.

Critical Speed:

It is the speed below which the machine cannot build up E.m.f.

Expected Graph:



Precautions:

1. Perform the experiment at constant speed.
2. Readings are to be taken for uniformly increasing and then uniformly decreasing field current.

Result:

Viva Questions:

1. What is Residual Voltage?
2. What is Critical Field resistance?
3. What is Critical Speed?
4. What is the difference between separately excited DC Generator and self excited DC Generator.

Expt. No. 8. Synchronous Speed of Two and Four-Pole, 3-ϕ Induction Motors. Direction Reversal by Change of Phase-Sequence of connections

Aim: To verify the speed of 3Φ Induction motor for a) 2- pole Configuration circuit.
b) 4 -pole Configuration circuit & tochange the direction of a three phase induction motor rotation.

Name Plate Details:

S.No	Parameter	Motor
1	Voltage	
2	Current	
5	Power	
6	Wound	
7	Rated Speed	

Apparatus:

S.NO	Equipment Name	Type	Range	Quantity
1	Voltmeter	MI	(0-600)V	1
2	Rheostat	Wire wound	25Ω/5A	3
3	Tachometer	Digital	(0-99999)	1
4	3Φvariac		(0-470/440) V	1

Theory:

The speed with which Stator field revolves is the synchronous speed. It is the speed at which the rotating magnetic field (rmf) rotates. if a three phase induction motor is having 6 poles with 50hz supply frequency then the synchronous speed will be(Ns=120f/p) 1000rpm.Simillarly 4 pole machines must work on 1500 rpm where as 2 Pole machine at3000rpm.

In order for an induction motor to make torque, there must be at least some difference between the stator field (synchronous) speed and the rotor speed. That difference is called “slip.” It is why, when you look at a motor nameplate, the motor rated speeds will always be less than synchronous speed. The direction of rotation of a 3 phase induction motor can be reversed byinterchanging any two of the three motor supply lines.

Let the phase sequence of the three-phase voltage applied to the stator winding is R-Y-B. If this sequence is changed to R-B-Y, it is observed that direction of rotation of the field is reversed i.e., the field rotates counter clockwise rather than clockwise. However, the number of poles and the speed at which the magnetic field rotates remain unchanged. Thus it is necessary only to change the phase sequence in order to change the direction of rotation of the magnetic field. For a three- phase supply, this can be done by interchanging any two of the three lines.

Circuit diagram:

CIRCUIT DIAGRAM:

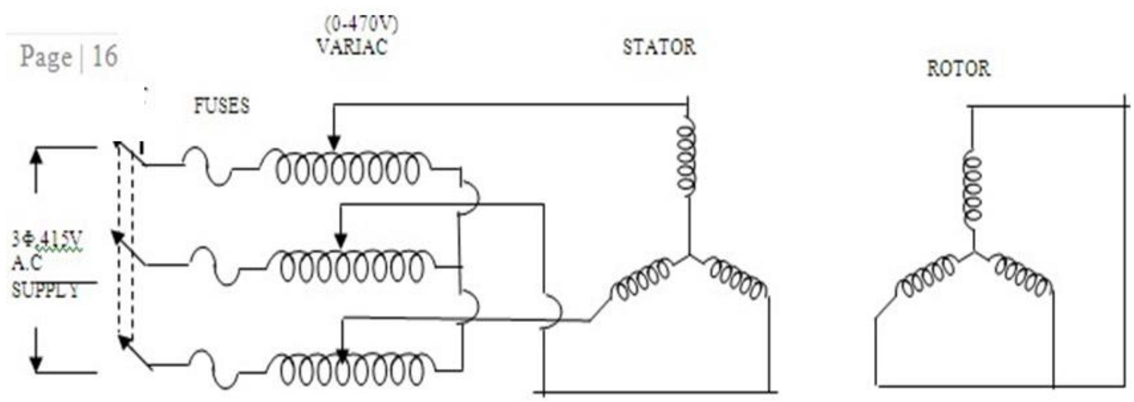


Figure 2 CIRCUIT DIAGRAM FOR INDEPENDENT MOTOR WITH EITHER 4 POLES/2 POLES

Procedure:

(A) For Pole Change:

1. Make the connections as per the circuit diagram.
2. Switch on the supply and apply the rated voltagetomotorbyusing3-phasevariac.
3. Withthehelpoftachometernotethevaluesofspeedwithdifferentpoleconfiguration.
4. Bring back the variac to initial zero position and switch off the supply.
5. Calculate the slip by using given formulas.

(B) For Direction Reversing:

1. Make the connections as per the circuit diagram.
2. Switchonthesupplyandapplytheratedvoltagetomotorbyusing3-phasevariac
3. Speed of the motor is measured by a tachometer.
4. Now the motor is stopped by pushing the stop button and supply to the motor is removed by opening the TPST switch.
5. The two leads of the motor are interchanged to the TPST switch.
6. TPST switch is closed and the motor started again.
7. The direction of rotation of the motor is observed. Speed of motor is again measured by a tachometer.
8. The push button is pushed and the TPST switch is made off.

Tabular Form:

S.NO	Poles	Synchronous Speed (Ns) r.p.m	Rotor Speed (Nr) r.p.m	Slip (%)
1	**2**			
2	**4**			

Observations:

1. The direction of rotation of the motor in second case is found opposite to that in first case.
2. The speed of the motor is same in both cases.

Result:

Viva Questions:

1. Explain the principle of 3-phase induction motor?
2. What are the classifications of 3-phase induction motors?
3. What are the applications of induction motors?
4. What is the difference between 1-phase induction motor and 3-phase induction motor?

Expt. No. 9. Power Factor Improvement of Induction Motor Using StaticCapacitors

Aim: To verify Power factor improvement of Induction Motor using static Capacitors.

Name Plate Details:

S.No	Parameter	Motor
1	Voltage	
2	Current	
5	Power	
6	Wound	
7	Rated Speed	

Apparatus:

S.No	Description	Range	Type	Quantity
1	1- Phase Induction Motor	1H.p		1
2	Ammeter	0-10A/20A	MI	1
3	Voltmeter	0-300	MI	1
4	Wattmeter	0-300/10A	Dynamo	1
5	Connecting wires			As per Requirement
6	Capacitor Bank			1

Theory:

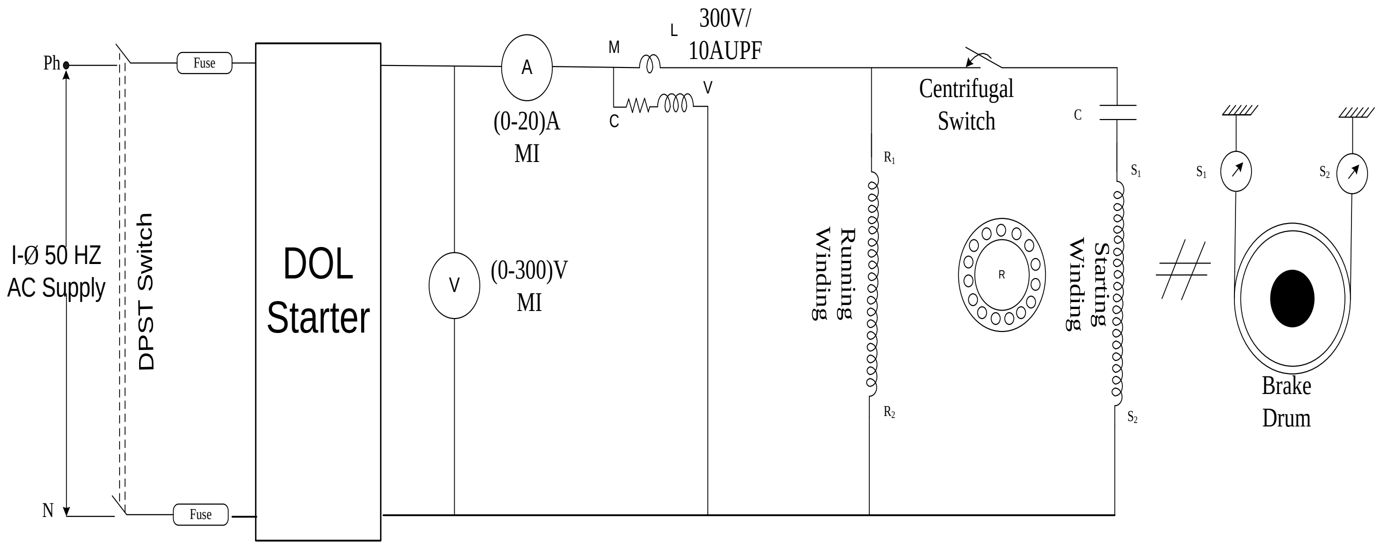
Low power factor is undesirable from economic point of view. Normally, the power factor of the whole load on the supply system in lowerthan0·8.The following are the causes of low power factor:
(i)Most of the A.C. motors are of induction type (1φ and 3φ induction motors) which have low lagging power factor.
(ii)Arc &electric discharge lamps &industrial heating furnaces operate at low lagging p.f.
(iii)The load on the power system is varying being high during morning and evening and low at other times. During low load period, supply voltage is increased which increases the magnetization current. This results in the decreased power factor.

Static capacitor: The power factor can be improved by connecting capacitors in parallel with the equipment operating at lagging power factor. The capacitor (generally known as static) draws a leading current and partly or completely neutralizes the lagging reactive component of load current. This raises the power factor of the load. For three-phase loads, the capacitors can be connected in delta or star as shown in Fig. Static capacitors are invariably used for power factor improvement in factories.

Advantages:

1. They have low losses.
2. They require little maintenance, as there are no rotating parts.
3. They can be easily installed as they are light and require no foundation.
4. They can work under ordinary atmospheric conditions.

Circuit diagram:



Procedure:

1. Connections are made as per circuit diagram.
2. Keep the DOL starter in off position and capacitor bank switch in Zero position & switch on the supply by closing the DPST switch.
3. Push Green button of DOL starter &Take down all the meter readings.
4. Switch the capacitor bank switch toposition'1' and note down all the meter readings.
5. Switch the capacitor bank switch toposition'2' and note down all the meter readings.
6. Bring back the capacitor bank switch to position 0 and switch the motor by pushing red button on DOL starter and remove the connections.

Tabular Form:

S.No	Capacitor Value	Voltage (V)	Current (I)	Power (W)	Power Factor COSθ= $\frac{W}{V_l I_l}$	Reactive power (Q)	Calculated Capacitor value
1							
2							
3							

Theoretical Calculations:

Reactive power supplied $Q=V^2/XC$. (OR) $I^2 * XC$.

Result:

Viva Questions:

1. Why we are using DOL Starter in this experiment?
2. What is the difference between 1-phase auto-transformer and DOL starter?
3. Define power factor?
4. What is the main purpose of starting and running windings in this 1-phase induction motor?
5. Can you define active and reactive powers?

Expt. No. 10. Load Test on A DC Shunt Motor

Aim: To determine the efficiency of a DC shunt motor by conducting brake test.

Apparatus:

S.No	Equipment Name	Type	Range	Qty.
1.	Voltmeter	MC	0 – 300V	1 No
2.	Ammeter	MC	0 – 20A	1 No
3.	Ammeter	MC	0 – 1A	1 No
4.	Rheostat	Wire wound	290Ω/1.2 A	1 No
5.	Tachometer	Digital	(0-2000) rpm	1 No

Name Plate Details:

S.No	Parameter	Motor

Theory:

The precondition to be set for the load test on DC shunt motor is to run the motor at the rated voltage and the rated speed. For Small motors the efficiency can be found directly by a brake test. The loading arrangement done to the motor is that a brake drum is attached to the shaft of the motor and spring balances are connected through which the brake drum is tightened so that the shaft is loaded. This set is said to be called as applied mechanical load. The torque can be determined and speed is measured from which the power output can be calculated. The input to the motor is found by knowing the applied voltage and load current. Hence the efficiency can be known.

Let S1 and S2 are the spring balance readings.

The pull on the brake drum = 9.81 (S1-S2) Newton

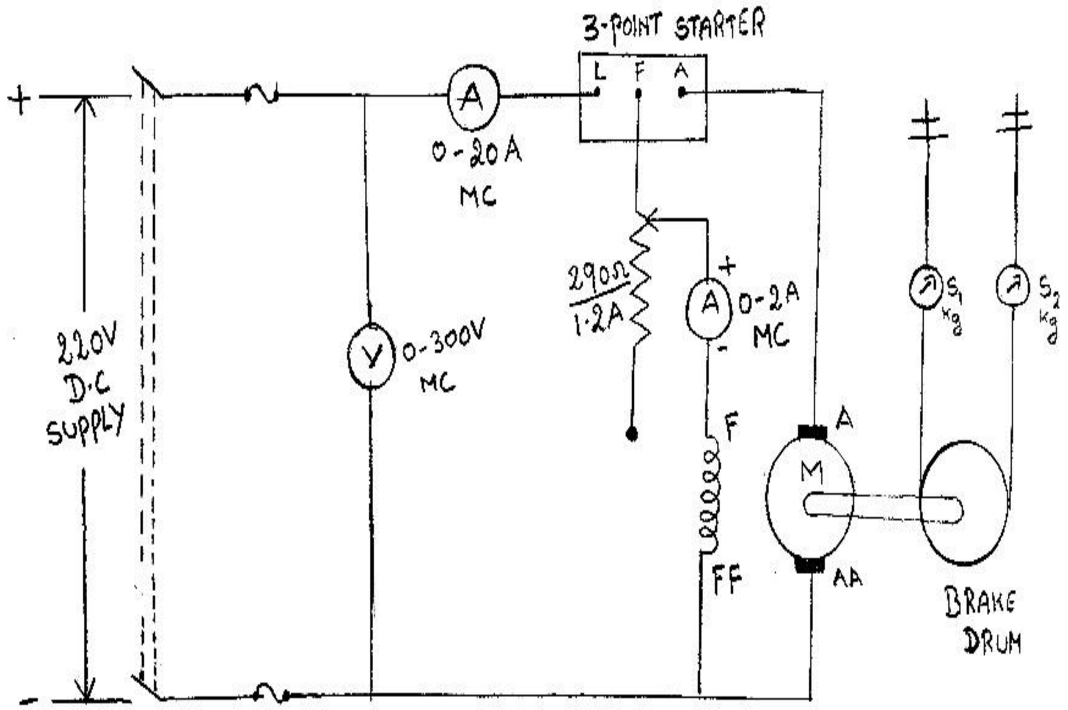
Torque on the drum T_{sh} = 9.81 (S1-S2) r N-m where r is the radius of the drum

Motor power output $P_{sh}=T_{sh}\ 2\pi\ N/60$ watts; where N is the rpm of the motor.

Let input voltage and current be V and I, the power input to the motor is V*I

The efficiency = η = output/ input

Circuit diagram:



Procedure:

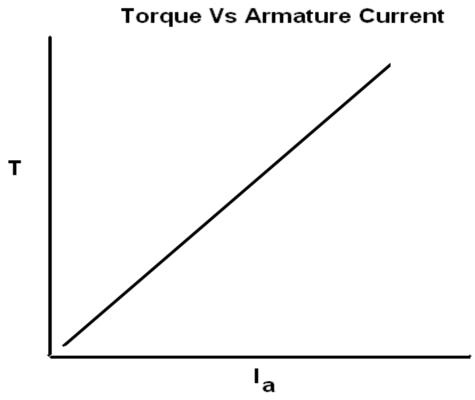
1. Give the connections as per the circuit diagram.
2. Start the motor using the starter.
3. By varying the field rheostat run the motor at rated speed.
4. Increase the load by tightening the brake band and note the observations of the ammeter, voltmeter, tachometer and the applied loads $S_1$and S_2 till rated current is attained. Take at least six readings.
5. Unload the motor by slackening the brake band.
6. Switch off the supply to the motor by opening the DPST switch. Find the radius of the Brake drum.

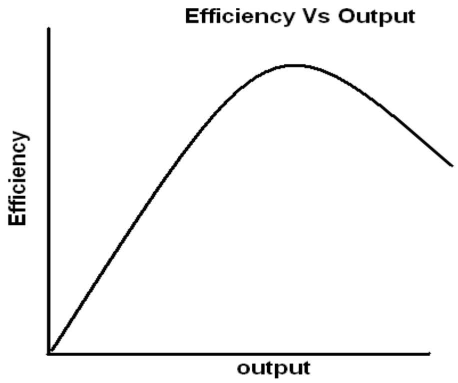
Tabular Form:

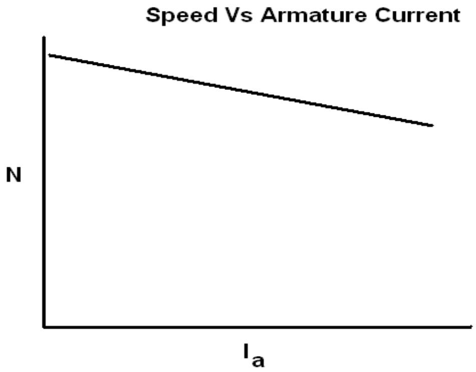
S.No	V (V)	I_L (A)	I_f (A)	N (rpm)	S1 (Kg)	S2 (Kg)	W=S1-S2 (Kg)	T= 9.81 W r (Nm)	Output= 2πNT/60 (watts)	Input= VI_L (Watts)	η = Output/ Input (%)
1											
2											
3											
4											
5											
6											
7											

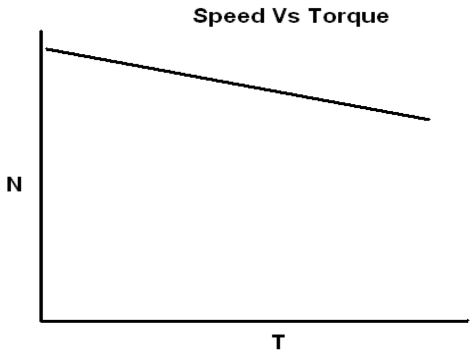
("r" is the radius of the brake drum)

Expected graphs:









<u>Sample Calculations</u>:

<u>Precautions</u>:

1. Before starting the experiment pour some water into the brake drum and also while doing the experiment.
2. Stay away from the brake drum when switching off the motor.

<u>Result</u>:

<u>Viva questions</u>:

1. What are the methods for finding the efficiency?
2. What are the basic requirements to conduct the load test?
3. Compare the load characteristics for different types of DC motors.
4. If two motors are required to drive a common load, how will they share the total load?
5. What are the functions of a DC motor Starter?
6. If starter is not available, how can you start a D.C motor?
7. What is the efficiency range of a D.C motor?
8. Where can you use the D.C shunt motor?
9. Why is it considered as a constant speed motor?

Expt. No. 11. O.C and S.C Test on a 1-ϕ Transformer

Aim: To predetermine the efficiency of a single phase transformer.
To obtain the equivalent circuit of the transformer and
To find the regulation of the transformer.

Name Plate Details:

S.No	Parameter	Transformer

Apparatus:

S.No	Equipment Name	Type	Range	Qty
1	Voltmeter	MI	(0 – 150) V	2 No
2	Ammeter	MI	(0 – 1)A	1 No
3	Ammeter	MI	(0 – 10)A	1 No
4	Wattmeter	LPF	150V/5A	1 No
5	Wattmeter	UPF	150V/10A	1 No
6	Transformer	1- phase	220/110V, 1.8KVA	1 No

Theory:

Open Circuit (or No-Load) Test:

This test is conducted to determine the iron losses (core losses) and parameters R_0 and X_0 of the transformer. In this test, the rated voltage applied to the primary (usually low voltage side) while the secondary is left open circuited. The applied primary voltage V_1 is measured by the voltmeter, the no load current I_0 by ammeter and no- load input power W_0 by wattmeter.

As the normal rated voltage is applied to the primary, therefore, normal Iron losses will occur in the transformer core. Hence wattmeter will record the Iron losses.

Let V_1 = applied rated voltage on L.t side,

I_0 = exciting current (or no-load current).

W_0 = core loss

Then $W_0 = V_1 I_0 \cos\theta_0$

No Load p.f. = $\cos\theta_0 = W_0 / V_1 I_0$.

$I_w = I_0 \cos\theta_0$ and $I_m = I_0 \sin\theta_0$

$R_0 = V_1 / I_w$ and $X_0 = V_1 / I_m$

Short-Circuit Test:

This test conducted to determine R_{01} (or R_{02}), X_{01}(or X_{02}) and full load copper losses of the transformer. In this test, the secondary (usually Lv winding) is short circuited and variable low voltage is applied to the primary. The low input voltage is gradually raised till at voltage V_{sc}, full load current I_1 flows in the primary. Then I_2 in the secondary also has full load value since $I1/ I_2 = N_2 / N_1$ under such conditions copper loss in the windings is the same as that on full load. There is no output from the transformer under short circuit conditions. Therefore, input power is all loss and this loss is entirely copper loss. Hence the wattmeter practically registers the full load copper losses in the transformer windings.

Full load copper loss = W_c

Applied voltage= V_{sc}

Full load primary current = I_1

$W_c = I_1^2 R_{01}$

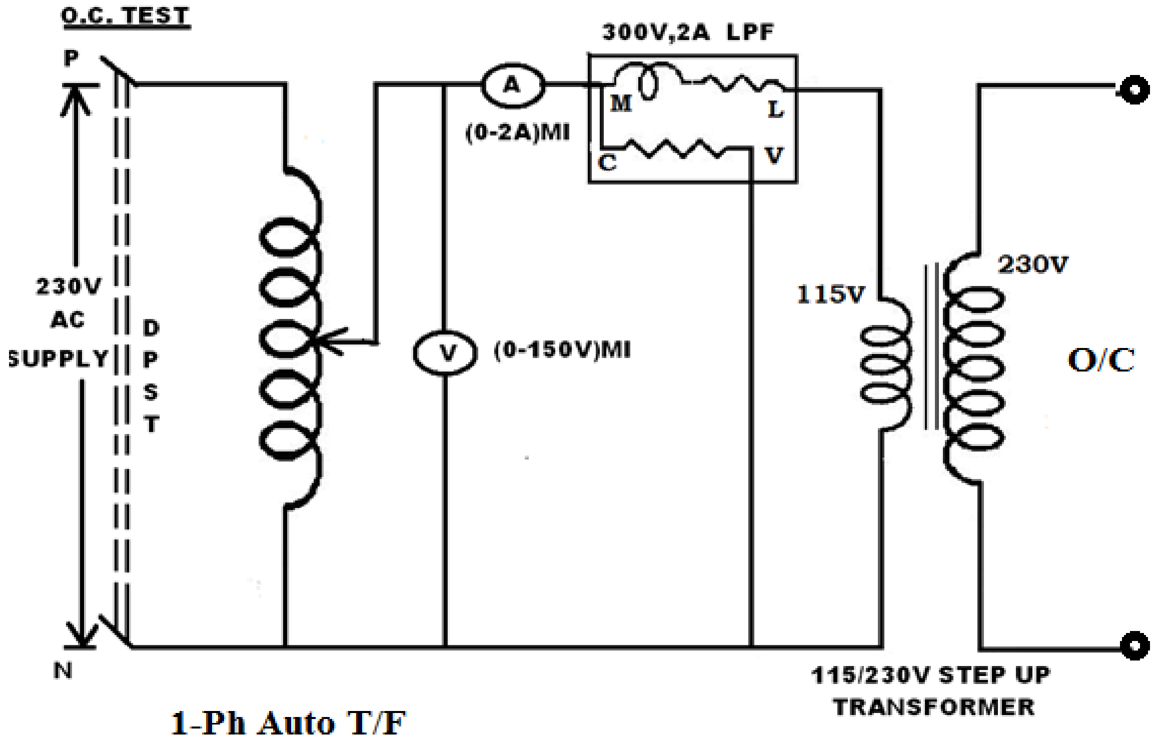
$R_{01} = W_c / I_1^2$, where R_{01} is the total resistance of transformer referred to primary.

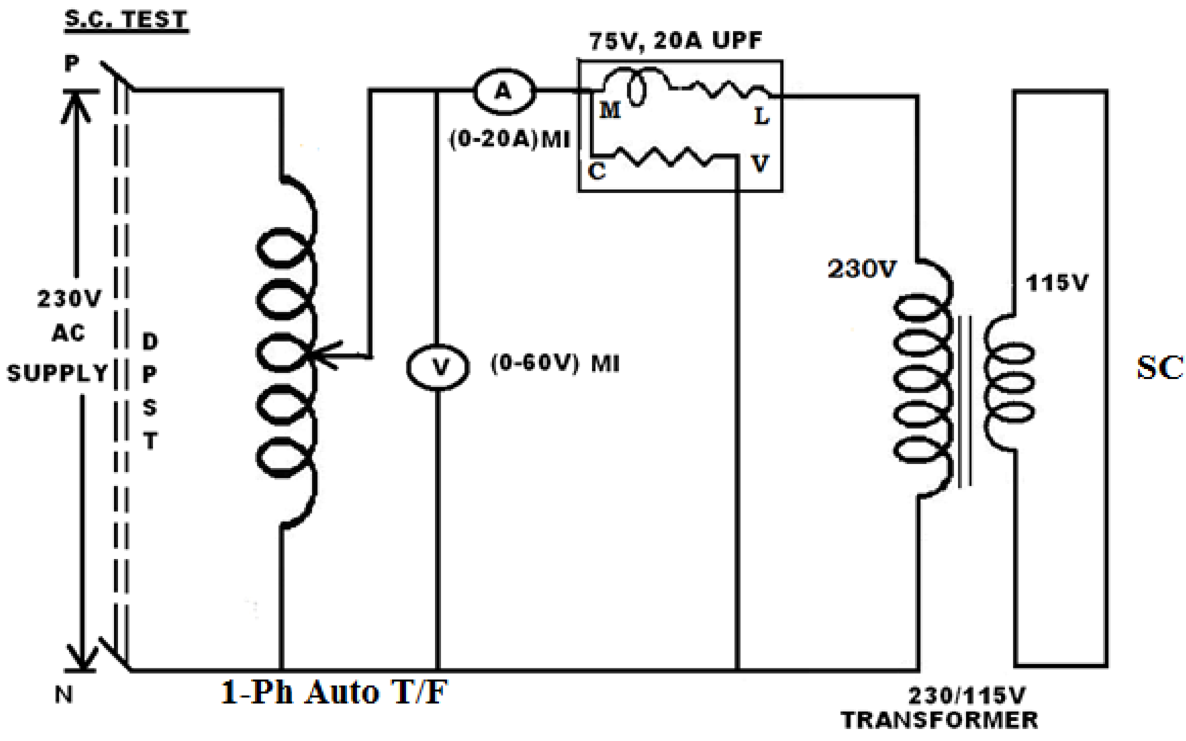
Total impedance referred to primary $Z_{01} = V_{sc} / I_1$

Total leakage reactance referred to primary $X_{01} = \sqrt{Z_{01}^2 - R_{01}^2}$

Thus short circuit test gives full load copper loss, R_{01} and X_{01}

Circuit Diagrams:





Procedure:

(a) Open Circuit Test (O.C Test):

1. Make the connections as per the circuit diagram, the 220V winding of the transformer is kept open
2. Apply the rated voltage, i.e.110V through the auto transformer.
3. Note down the voltmeter V_{oc}, ammeter I_{oc} and wattmeter W_{oc} readings and tabulate
4. Now reduce the voltage given to the transformer to Zero and Switch off the supply.
5. Calculate the values of R_0 and X_0.
6. The wattmeter used in the OC test should be low power factor wattmeter, since it must be able to measure power at low power factor at which the transformer works on no load.

(b) Short Circuit Test (S.C Test):

1. Make the connections as per the circuit diagram and keep the 110V winding of the transformer short circuited.
2. Apply the low voltage side through the auto transformer and increase the voltage gradually till the full load current flows in the 220V winding.
3. Note down the voltmeter, ammeter and wattmeter readings.
4. Reduce the voltage given to the transformer to zero and switch off the supply.
5. Calculate values of R_{01} or R_{02} and X_{01} or X_{02}.
6. Draw the equivalent circuit diagram of the 1-Φ transformer.

Tabular Forms:

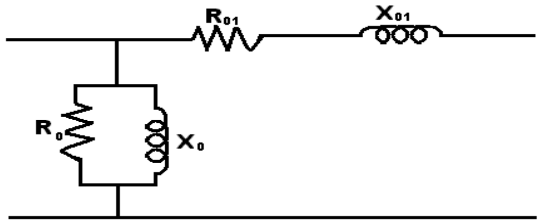
O.C Test:

S.NO	Vo.c (volts)	Io (amps)	P_o (watts)

SC Test:

S.NO	Vs.c (volts)	Isc (amps)	P_{sc} (watts)

To draw Equivalent circuit:



P_0= Iron Loss = $I_0 V_0 \cos Ø_0$

$\cos Ø_0 = P_0/(V_0 X I_0)$, $Ø_0 = \cos^{-1} P_0/(V_0 X I_0)$

$R_0 = V_0/(I_0 \cos Ø_0) = V_0/I_w$

$X_0 = V_0/(I_0 \sin Ø_0) = V_0/I\mu$

P_{sc} = Copper Loss = $I^2_{sc} X R_{01}$

$R_{01} = Psc/I^2_{sc}$

Z_{01}=Vsc/Isc

$$X_{01} = \sqrt{Z_{01}^2 - R_{01}^2}$$

Load at which max efficiency occurs is the same whatever the power factor, However numerical value of "η" decreases with decrease in P.F.

TO CALCULATE THE EFFICIENCY AT U.P.F/0.8 PF/0.6 P.F:

S.No	Load	Load Current I_L (Amps)	Iron Loss P_0 (Watts)	Copper Loss P_{sc} (Watts)	Total Loss P_0+ P_{sc} (Watts)	Output KVA X P.f	Input = Output+ Losses	η= Output /Input
	At U.P.F							
	Full Load							
	½ Load							
	¼ Load							

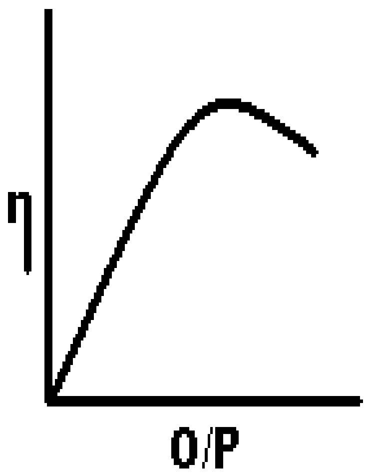
	¾ Load							
	At 0.8 P.F							
	Full Load							
	½ Load							
	¼ Load							
	¾ Load							
	At 0.6 P.F							
	Full Load							
	½ Load							
	¼ Load							
	¾ Load							

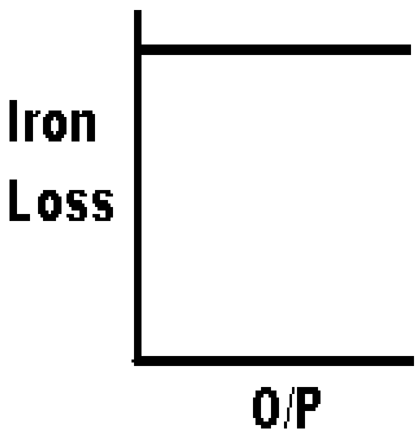
Expected Graphs:

1) Efficiency
2) Iron Loss
3) Cu Loss

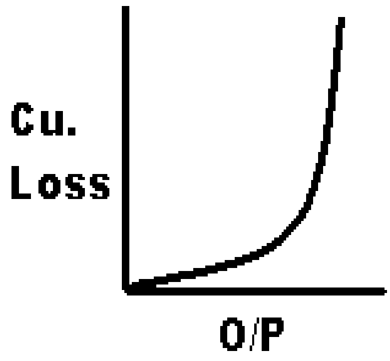
And from the graph find the condition for efficiency to be maximum,

(1) Efficiency: **(2) Iron Loss:**





(3) Cu Loss:



Result:

Viva Questions:

1) Explain why the wattmeter reading in O.C Test is taken as Iron Loss?
2) Explain why the wattmeter reading in S.C Test is taken as Copper Loss?
3) What re the uses of transformers, explain with example?
4) Why the efficiency of the transformer is high as compared to the electrical motor?
5) What are the materials used for making the core and winding of the transformer?
6) Explain why those materials are used?
7) What do you understand by an Auto-transformer?
8) Why transformer rating is in KVA not KW.
9) What is the all day efficiency of a transformer?

Expt. No. 12. Speed Control of DC Shunt Motor

Aim: To control the speed of a DC shunt motor by armature control method and field control method.

Apparatus:

S.No	Equipment Name	Type	Range	Qty.
1.	Voltmeter	MC	(0 – 300)V	1 No
2.	Voltmeter	MC	(0-150)V	1 No
3.	Ammeter	MC	(0 – 2)A	1 No
4.	Ammeter	MC	(0 – 20)A	1 No
5.	Rheostat	Wire Wound	50 Ω /5A	1 No
6.	Rheostat	Wire Wound	290Ω/ 1.2A	1 No
7.	Tachometer	Digital	(0-2000) rpm	1 No

Name Plate Details:

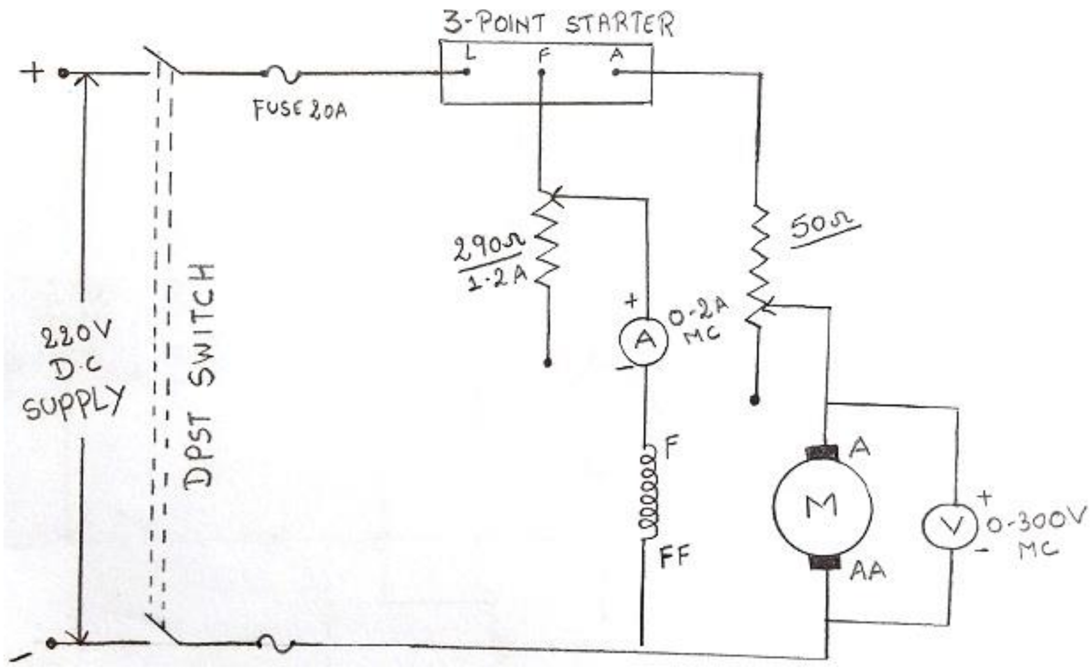
S.NO	Parameter	Motor

Theory:

Speed control methods:

The basic speed control methods are flux control methods, and Armature control method. The advantages of flux control method are that it provides smooth and easy control and above rated speed is possible. As the field winding resistance is high, the field current is small and hence the power loss in the external resistance is very small which makes the method more economical and efficient. As filed current is small, the size of the resistance required is small. The disadvantages of flux control method are that below the rated speed is not possible and at high speeds, the commutation problems are severe. The advantages of armature control methods smooth speed control below the normal speed is possible and the disadvantage is as the entire armature current passes through the external resistance, there is huge power loss. The armature current is more than the field current and the rheostat required is of large size and large power loss results. The above rated speed is not possible by this method.

Circuit Diagram:



Procedure:

Armature Voltage control Method:

1. Connect the circuit as per the circuit diagram given.
2. Run the motor using starter.
3. Keep the field current constant and vary the terminal voltage by varying the resistance in the armature circuit in steps of 5V.
4. Note down the terminal voltage and speed.

Field Control Method:

1. Keep the terminal voltage constant and vary the field current by changing the resistance connected in the field circuit in steps.
2. Note the field current and speed.

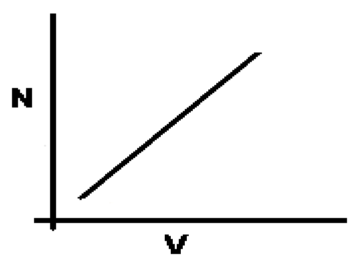
Tabular Forms:

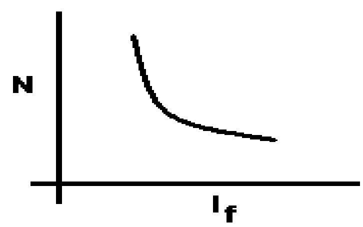
Armature control Method **Field Control Method**

S.No.	V_g (Volts)	N (Speed)	S.No.	If (Amps)	N (Speed)
1.			1.		
2.			2.		
3.			3.		
4			4		
5			5		
6			6		

Expected Graphs:

(a) Speed Vs armature voltage **(b) Speed Vs Field current**





Result:

Viva Questions:

1. Why is it not possible to get higher speeds with armature voltage method?
2. Can lower speeds be obtained by using field control method?
3. What are the disadvantages of armature and field control methods?
4. Explain why the graph of armature speed control of motor is linear?
5. What is the shape of the curve of field control of method motor speed? Explain why it is so?
6. What are the disadvantages of using armature control of speed no load?
7. How do you change the direction of rotation of a D.C. motor?
8. What are the limitations of shunt field control?
9. What is meant by speed control?