MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

Recognized under 2(f) and 12 (B) of UGC ACT 1956

(Affiliated to JNTUH, Hyderabad, Approved by AICTE-Accredited by NBA & NACC-'A' Grade – ISO 9001:2015 Certified)

Maisammaguda, Dhulapally (Post Via. Hakimpet), Secunderabad -500100, Telangana State, India

BASIC ELECTRICAL ENGINEERING
LABORATORY MANUAL

Student Name:………………………………………………….

Roll No:…………………………………………………………

Branch:…………………………….Section……………………

Year ………………………Semester………………………..

FACULTY INCHARGE

PREFACE

Engineering institutions have been continually modernizing and updating their curriculum to keep pace with the technological advancements and to meet the demands of the industry. In recent past, numerous universities brought a significant change in the graduate programs of engineering at first year level .To meet the needs of the light–current engineering industries (electronics, communication, instrumentation, controls, computers, etc.) and to enhance the employability of their graduates. The present course has been designed and developed to ensure that the fundamentals of this course are well understood by students of all circuit branches. Simultaneously, fundamentals of important topics, in major subject areas, have been discussed to provide a foundation for the study of advanced topics, by students of various current engineering disciplines in their subsequent programmes of study. This course ideally meets the requirement of the first level course in ‘Basic Electrical Engineering Laboratory’.

It is firmly believed that this course will help students to overcome their initial apprehensions and initiate a life-long affair with electrical and electronics engineering. It also presents a clear and concise exposition of the principles and applications of electrical and electronics engineering.

Faculty of BEE

MRCET

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design / development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **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.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **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.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **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 multi disciplinary environments.
12. **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.

BASIC ELECTRICAL ENGINEERING LAB

COURSE OUTCOMES

After successfully studying this course, students will:

1. Explain the concept of circuit laws and network theorems and apply them to laboratory measurements.
2. Be able to systematically obtain the equations that characterize the performance of an electric circuit as well as solving both DC Machines and single phase transformer.
3. Acknowledge the principles of operation and the main features of electric machines and their applications.
4. Acquire skills in using electrical measuring devices.

MALLA REDDY COLLEGE OF ENGINEERING AND TECHNOLOGY

I Year B.Tech - ECE/EEE/CSE/IT-II SEM

L	T	P	C
0	0	4	2

(R18A0281) BASIC ELECTRICAL ENGINEERING LAB

OBJECTIVES:

1. To Design Electrical Systems.
2. To Analyze A Given Network By Applying Various Network Theorems.
3. To Expose The Students To The Operation Of DC Generator
4. To Expose The Students To The Operation Of DC Motor and Transformer.
5. To Examine The Self Excitation In DC Generators.

CYCLE – 1

1. Verification of KVL and KCL.
2. Verification of Thevenin's theorem.
3. Verification of Norton's theorem.
4. Verification of Superposition theorem.
5. Verification of Maximum power transfer theorem.
6. Verification of Reciprocity theorem.

CYCLE – 2

7. Magnetization characteristics of DC shunt generator.
8. Swinburne's test on DC shunt machine.
9. Brake test on DC shunt motor.
10. OC & SC tests on single phase transformer.
11. Load test on single phase transformer.

NOTE: Any 10 of Above Experiments Are To Be Conducted

OUTCOMES:

After successfully studying this course, students will:

1. Explain the concept of circuit laws and network theorems and apply them to laboratory measurements.
2. Be able to systematically obtain the equations that characterize the performance of an electric circuit as well as solving both single phase and DC Machines
3. Acknowledge the principles of operation and the main features of electric machines and their applications.
4. Acquire skills in using electrical measuring devices.

INSTRUCTIONS TO STUDENTS

- Before entering the lab the student should carry the following things.
    - Identity card issued by the college.
    - Class notes
    - Lab observation book
    - Lab Manual
    - Lab Record
- Student must sign in and sign out in the register provided when attending the lab session without fail.
- Come to the laboratory in time. Students, who are late more than 15 min., will not be allowed to attend the lab.
- Students need to maintain 100% attendance in lab if not a strict action will be taken.
- All students must follow a Dress Code while in the laboratory
- Foods, drinks are NOT allowed.
- All bags must be left at the indicated place.
- The objective of the laboratory is learning. The experiments are designed to illustrate phenomena in different areas of Physics and to expose you to measuring instruments, conduct the experiments with interest and an attitude of learning
- You need to come well prepared for the experiment.
- Work quietly and carefully
- Be honest in recording and representing your data.
- If a particular reading appears wrong repeat the measurement carefully, to get a better fit for a graph
- All presentations of data, tables and graphs calculations should be neatly and carefully done
- Graphs should be neatly drawn with pencil. Always label graphs and the axes and display units.
- If you finish early, spend the remaining time to complete the calculations and drawing graphs. Come equipped with calculator, scales, pencils etc.
- Do not fiddle with apparatus. Handle instruments with care. Report any breakage to the Instructor. Return all the equipment you have signed out for the purpose of your experiment.

SPECIFIC SAFETY RULES FOR BEE LABORATORY

- You must not damage or tamper with the equipment or leads.
- You should inspect laboratory equipment for visible damage before using it. If there is a problem with a piece of equipment, report it to the technician or lecturer. DONOT return equipment to a storage area
- You should not work on circuits where the supply voltage exceeds 40 volts without very specific approval from your lab supervisor. If you need to work on such circuits, you should contact your supervisor for approval and instruction on how to do this safely before commencing the work.
- Always use an appropriate stand for holding your soldering iron.
- Turn off your soldering iron if it is unlikely to be used for more than 10 minutes.
- Never leave a hot soldering iron unattended.
- Never touch a soldering iron element or bit unless the iron has been disconnected from the mains and has had adequate time to cool down.
- Never strip insulation from a wire with your teeth or a knife, always use an appropriate wire stripping tool.
- Shield wire with your hands when cutting it with a pliers to prevent bits of wire flying about the bench.

CONTENTS

CYCLE – 1

1. VERIFICATION OF KIRCHOFF'S LAWS

AIM: To verify the Kirchhoff's voltage law and Kirchhoff's current law for the given circuit.

APPARATUS REQUIRED:

S.No	Name of the equipment	Range	Type	Quantity
1	RPS	0-30V	-	1N0
2	Voltmeter	0-20 V	Digital	4 NO
3	Ammeter	0-20mA	Digital	4 NO
4	Bread board	-	-	1 NO
5	Connecting wires	-	-	Required number.
6	Resistors	470 Ω		2 NO
		1kΩ		1 NO
		680Ω		1 NO

CIRCUIT DIAGRAMS:

GIVEN CIRCUIT:

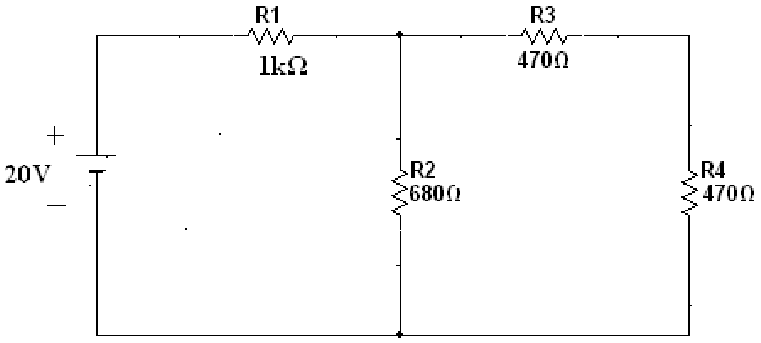


Fig (1)

1. KVL:

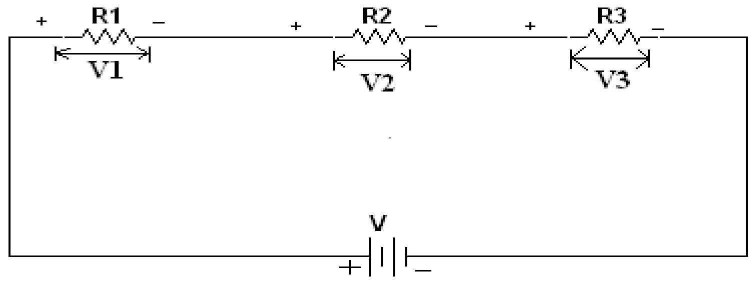
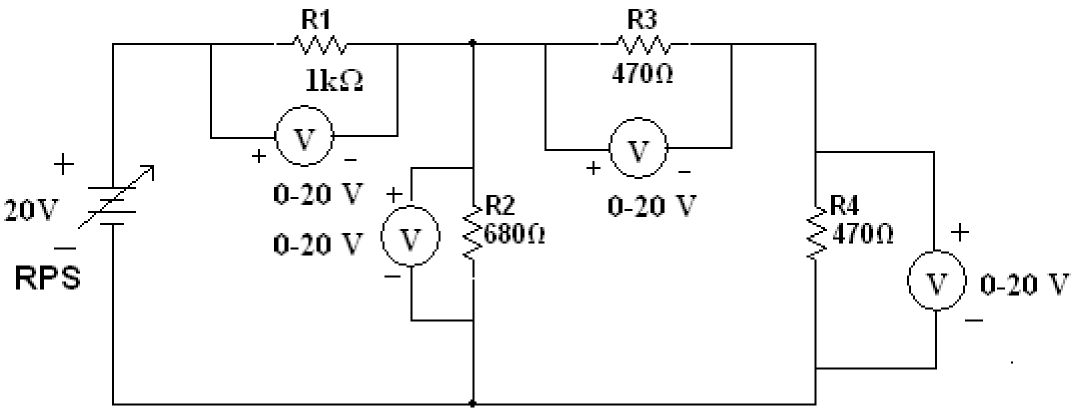


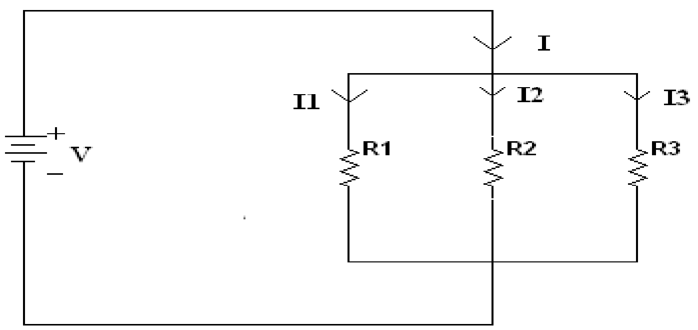
Fig (1a)

PRACTICAL CIRCUIT:



Fig(2a)

2. KCL:



Fig(1b)

PRACTICAL CIRCUIT:

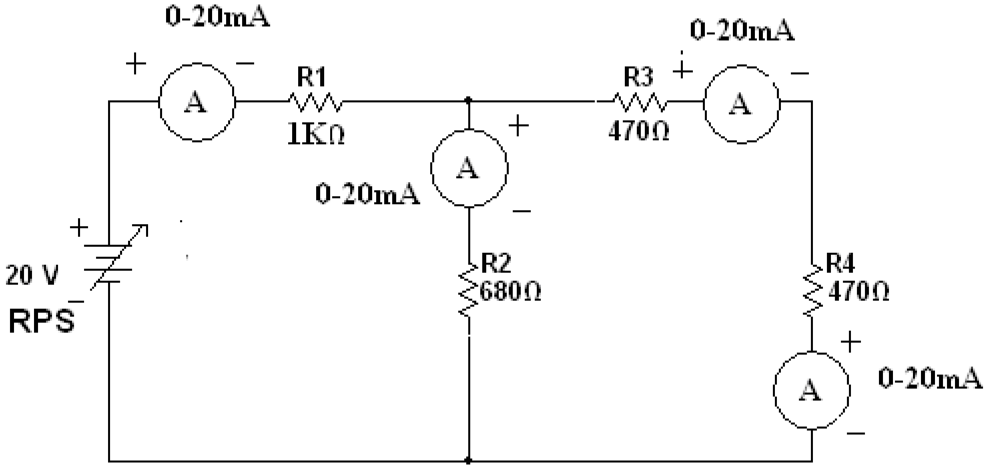


Fig (2b)

THEORY:

a) Kirchhoff's Voltage law states that the algebraic sum of the voltage around any closed path in a given circuit is always zero. In any circuit, voltage drops across the resistors always have polarities opposite to the source polarity. When the current passes through the resistor, there is a loss in energy and therefore a voltage drop. In any element, the current flows from a higher potential to lower potential. Consider the fig (1a) shown above in which there are 3 resistors are in series. According to kickoff's voltage law….

$$\mathbf{V = V_1 + V_2 + V_3}$$

b) Kirchhoff's current law states that the sum of the currents entering a node equal to the sum of the currents leaving the same node. Consider the fig (1b) shown above in which there are 3 parallel paths. According to Kirchhoff's current law...

$$\mathbf{I = I_1 + I_2 + I_3}$$

PROCEDURE:

1. Kirchhoff's Voltage law:
    1. Connect the circuit as shown in fig (2a).
    2. Measure the voltages across the resistors.
    3. Observe that the algebraic sum of voltages in a closed loop is zero.
2. Kirchhoff's current law:
    1. Connect the circuit as shown in fig (2b).
    2. Measure the currents through the resistors.
    3. Observe that the algebraic sum of the currents at a node is zero.

OBSERVATION TABLE:

KVL:

S.NO	Voltage Across Resistor	Theoretical	Practical

KCL:

S.NO	Current Through Resistor	Theoretical	Practical

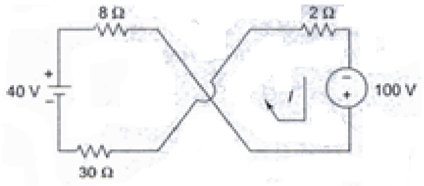
PRECAUTIONS:

1. Avoid loose connections.
2. Keep all the knobs in minimum position while switch on and off of the supply.

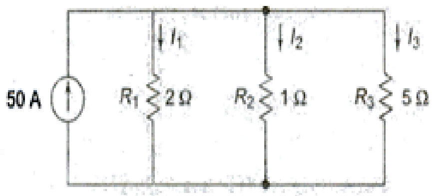
RESULT:

EXERCISE QUESTIONS:

1. In The Circuit Given In Fig Find A)The Current I B)The Voltage Across 30 Ω resistance



2. Determine The Current In All Resistors In The Circuit Shown In Fig.



VIVA QUESTIONS:

1. What is another name for KCL & KVL?
2. Define network and circuit?
3. What is the property of inductor and capacitor?

2. VERIFICATION OF THEVENIN'S THEOREM

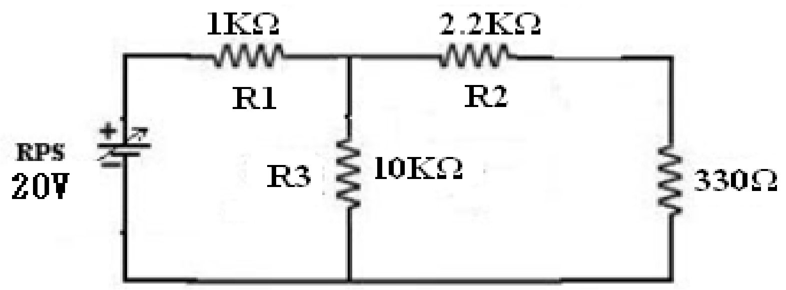
AIM: To verify Theremin's theorem for the given circuit.

APPARATUS REQUIRED:

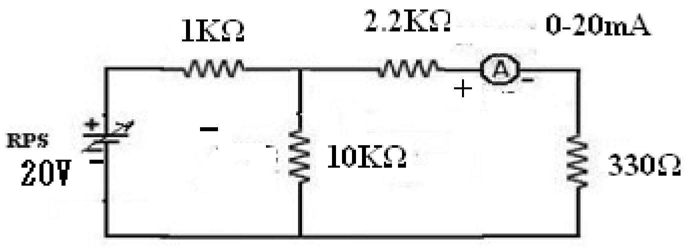
S.No	Name Of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	10K Ω,1K Ω		1 NO
		2.2Ω		1 NO
		330 Ω		1 NO
5	Breadboard	-	-	1 NO
6	DMM	-	Digital	1 NO
7	Connecting wires			Required number

CIRCUIT DIAGRAM:

GIVEN CIRCUIT:

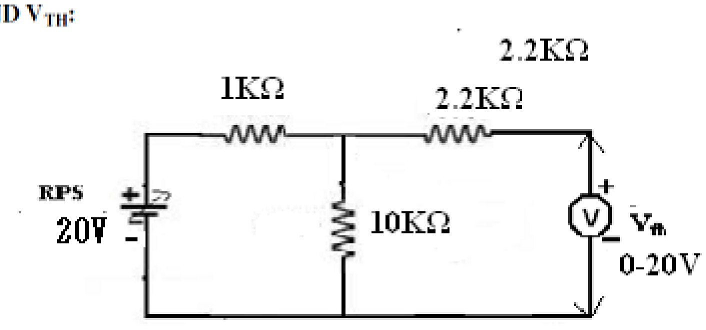


PRACTICAL CIRCUIT DIAGRAMS:
TO FIND I_L:



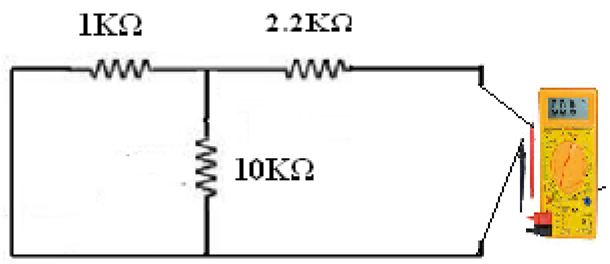
FIG(1)

TO FIND V_{TH}:



FIG(2)

TO FIND R_{th}:



fig(3)

THEORY:

THEVENIN'S THEOREM:

It states that in any lumped, linear network having more number of sources and elements the equivalent circuit across any branch can be replaced by an equivalent circuit consisting of Theremin's equivalent voltage source Vth in series with Theremin's equivalent resistance Rth. Where Vth is the open circuit voltage across (branch) the two terminals and Rth is the resistance seen from the same two terminals by replacing all other sources with internal resistances.

Thevenin's theorem:

The values of VTh and RTh are determined as mentioned in thevenin's theorem. Once the thevenin equivalent circuit is obtained, then current through any load resistance RL connected across AB is given by, $I = \frac{V_{TH}}{R_{TH}+R_L}$

Thevenin's theorem is applied to d.c. circuits as stated below.

Any network having terminals A and B can be replaced by a single source of e.m.f. V_{Th} in series with a source resistance R_{Th}

(i) The e.m.f the voltage obtained across the terminals A and B with load, if any removed i.e., it is open circuited voltage between terminals A and B.

(ii) The resistance R_{Th} is the resistance of the network measured between the terminals A and B with load removed and sources of e.m.f replaced by their internal resistances. Ideal voltage sources are replaced with short circuits and ideal current sources are replaced with open circuits.

To find V_{Th}, the load resistor 'RL' is disconnected, then $VTh = \frac{V}{R_1+R_2} X R3$

To find R_{Th},

$$R_{Th} = R2 + \frac{R_1 R_3}{R_1 + R_3}$$

Thevenin's theorem is also called as "Helmoltz theorem"

PROCEDURE:

1. Connect the circuit as per fig (1)
2. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
3. Note down the response (current, IL) through the branch of interest i.e. AB (ammeter reading).
4. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
5. Disconnect the circuit and connect as per the fig (2).
6. Adjust the output voltage of the regulated power supply to 20V.
7. Note down the voltage across the load terminals AB (Voltmeter reading) that gives Vth.
8. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
9. Disconnect the circuit and connect as per the fig (3).
10. Connect the digital multimeter(DMM) across AB terminals and it should be kept in resistance mode to measure Thevenin's resistance(R_{Th}).

THEORITICAL VALUES:

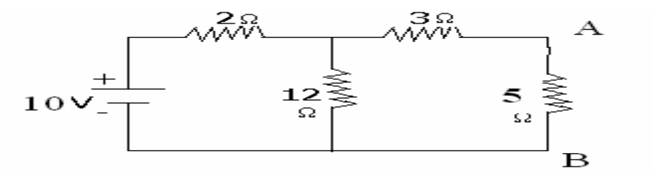
Tabulation for Thevenin's Theorem:

THEORITICAL VALUES	PRACTICAL VALUES
V_{th}= R_{th}= I_L=	V_{th}= R_{th}= I_L=

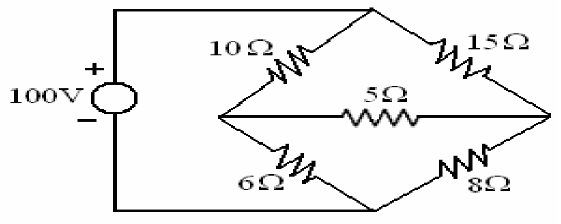
RESULT:

EXERCISE QUESTIONS:

1. Determine current through current 5 ohms resistor using Norton's theorem.



2. Determine the current flowing through the 5 ohm resistor using Thevenin's theorem



VIVA QUESTIONS:

1) The internal resistance of a source is 2 Ohms and is connected with an External Load Of 10 Ohms Resistance. What is Rth ?
2) In the above question if the voltage is 10 volts and the load is of 50 ohms What is the load current and Vth? Verify I_L?
3) If the internal resistance of a source is 5 ohms and is connected with an External Load Of 25 Ohms Resistance. What is Rth?
4) In the above question if the voltage is 20V and the load is of 50 Ohms, What is the load current and I_N ? Verify I_L ?

3. VERIFICATION OF NORTON'S THEOREM

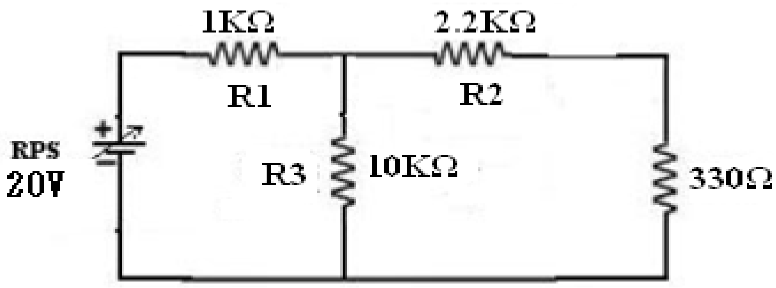
AIM: To verify Norton's theorem for the given circuit.

APPARATUS REQUIRED:

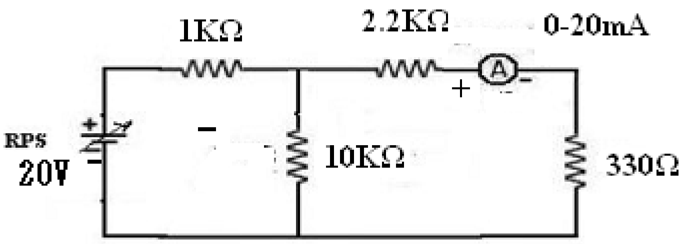
S.No	Name Of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	10K Ω,1K Ω		1 NO
		2.2Ω		1 NO
		330 Ω		1 NO
5	Breadboard	-	-	1 NO
6	DMM	-	Digital	1 NO
7	Connecting wires			Required number

CIRCUIT DIAGRAM:

GIVEN CIRCUIT:



PRACTICAL CIRCUIT DIAGRAMS:
TO FIND I_L:



FIG(1)

TO FIND I_N:

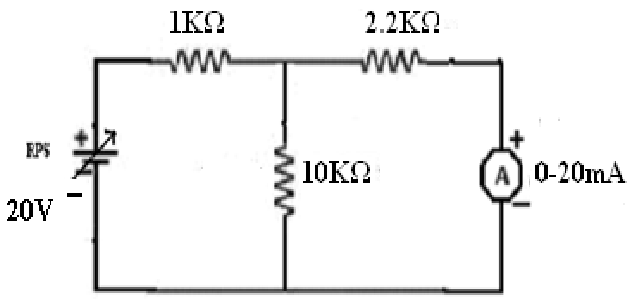
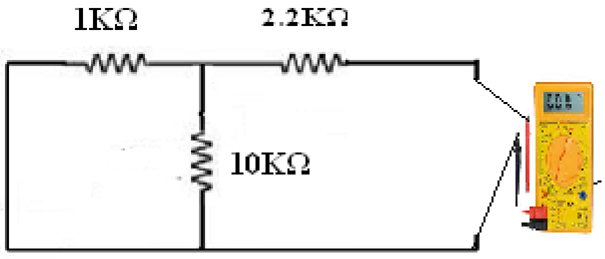


fig (2)

TO FIND R_N:



fig(3)

THEORY:

NORTON'S THEOREM:

Norton's theorem states that in a lumped, linear network the equivalent circuit across any branch is replaced with a current source in parallel a resistance. Where the current is the Norton's current which is the short circuit current though that branch and the resistance is the Norton's resistance which is the equivalent resistance across that branch by replacing all the sources sources with their internal resistances

for source current,

$$I = \frac{V}{R^I} = \frac{V(R_2 + R_3)}{R_1R_2 + R_1R_3 + R_2R_3}$$

FOR NORTON's CURRENT

$$I_N = I \times \frac{R_3}{R_3 + R_2} = \frac{VR_3}{R_1R_2 + R_1R_3 + R_2R_3}$$

Load Current through Load Resistor

$I_L = I_N \times [R_N / (R_N + R_L)]$

PROCEDURE:

1. Connect the circuit as per fig (1)
2. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
3. Note down the response (current, IL) through the branch of interest i.e. AB (ammeter reading).
4. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
5. Disconnect the circuit and connect as per the fig (2).
6. Adjust the output voltage of the regulated power supply to 20V.
7. Note down the response (current, I_N) through the branch AB (ammeter reading).
8. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
9. Disconnect the circuit and connect as per the fig (3).
10. Connect the digital multimeter (DMM) across AB terminals and it should be kept in resistance mode to measure Norton's resistance(R_N).

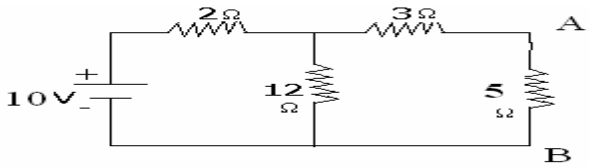
TABULATION FOR NORTON'S THEOREM:

THEORITICAL VALUES	PRACTICAL VALUES
I_N= R_N= I_L=	I_N= R_N= I_L=

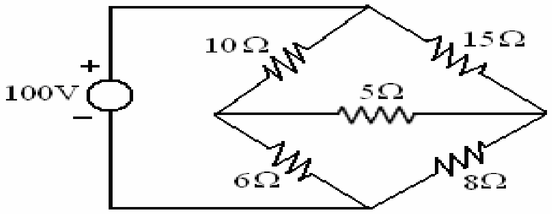
RESULT:

EXERCISE QUESTIONS:

1. Determine current through current 5 ohms resistor using Norton's theorem.



2. Determine the current flowing through the 5 ohm resistor using Thevenin's theorem



VIVA QUESTIONS:

1) The internal resistance of a source is 2 Ohms and is connected with an External Load Of 10 Ohms Resistance. What is Rth?
2) In the above question if the voltage is 10 volts and the load is of 50 ohms. What is the load current and Vth? Verify I_L?
3) If the internal resistance of a source is 5 ohms and is connected with an External Load Of 25 Ohms Resistance. What is Rth?
4) In the above question if the voltage is 20V and the load is of 50 Ohms. What is the load current and I_N ? Verify I_L ?

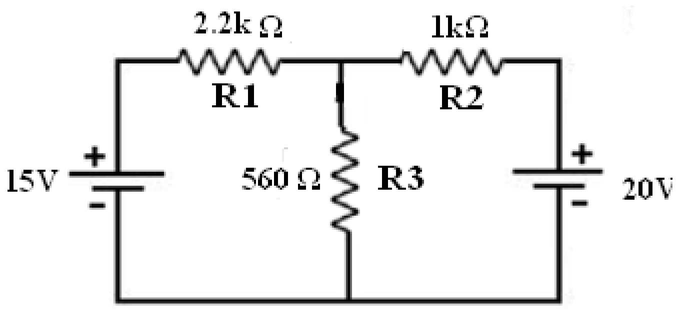
4. VERIFICATION OF SUPERPOSITION THEOREM

AIM: To verify the superposition theorem for the given circuit.

APPARATUS REQUIRED:

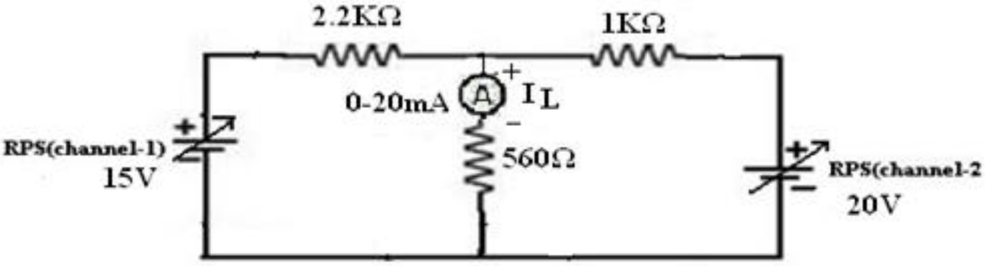
S.No	Name Of The Equipment	Range	Type	Quantity
1	Bread board	-	-	1 NO
2	Ammeter	(0-20) mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	2.2k Ω		1 NO
		1k Ω		1 NO
		560 Ω		1 NO
5	Connecting Wires	-	-	As required

CIRCUIT DIAGRAM:



PRACTICAL CIRCUITS:

When V_1&V_2 source acting(To find I_L):-



Fig(1)

When V_1 Source Acting (To Find I_L^I)

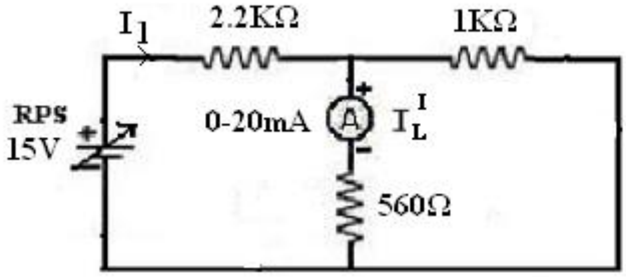


Fig (2)

WhenV_2 source acting (To find I_L^{II}):

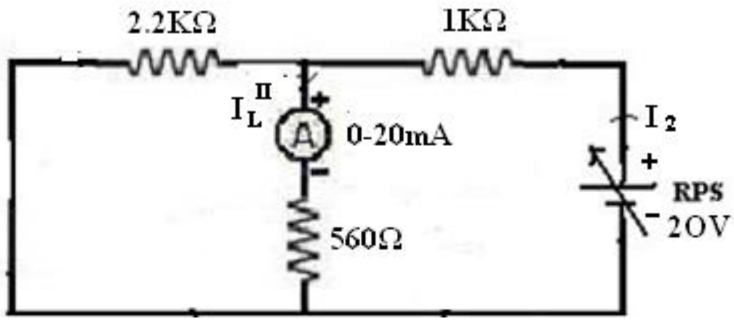


Fig (3)

THEORY:

SUPERPOSITION THEOREM:

Superposition theorem states that in a lumped ,linear, bilateral network consisting more number of sources each branch current(voltage) is the algebraic sum all currents (branch voltages), each of which is determined by considering one source at a time and removing all other sources. In removing the sources, voltage and current sources are replaced by internal resistances.

PROCEDURE:

1. Connect the circuit as per the fig (1).
2. Adjust the output voltage of sources X and Y to appropriate values (Say 15V and20V respectively).
3. Note down the current (I_L) through the 560 0hm resistor by using the ammeter.
4. Connect the circuit as per fig (2) and set the source Y (20V) to 0V.
5. Note down the current ($I_L^{l)}$ through 560ohm resistor by using ammeter.
6. Connect the circuit as per fig(3) and set the source X (15V) to 0V and source Y to 20V.
7. Note down the current (I_L^{ll}) through the 560 ohm resistor branch by using ammeter.
8. Reduce the output voltage of the sources X and Y to 0V and switch off the supply.
9. Disconnect the circuit**.**

THEORITICAL CALCULATIONS

From Fig(2)

$I_1 = V_1/(R_1+(R_2//R_3))$

$I_L^1 = I_1 * R_2/(R_2+R_3)$

From Fig(3)

$I_2 = V_2/(R_2+(R_1//R_3))$

$I_L^{11} = I_2 * R_1/(R_1+R_3)$

$I_L = I_L^1 + I_L^{11}$

TABULAR COLUMNS:

From Fig(1)

S. No	Applied voltage (V_1) Volt	Applied voltage (V_2) Volt	Current I_L (mA)

From Fig(2)

S. No	Applied voltage (V_1) Volt	Current I_L^I (mA)

From Fig(3)

S. No	Applied voltage (V_2) Volt	Current I_L^{II} (mA)

S.No	Load current	Theoretical Values	Practical Values
1	When Both sources are acting, I_L		
2	When only source X is acting, I_L^I		
3	When only source Y is acting, I_L^{II}		

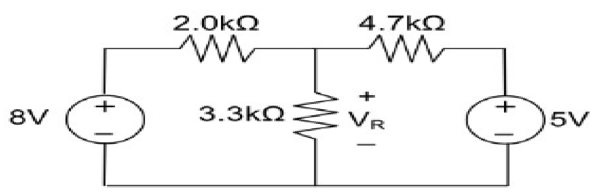
PRECAUTIONS:

1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.

RESULT:

EXERCISE QUESTIONS:

1. Using the superposition theorem, determine the voltage drop and current across the resistor 3.3K as shown in figure below.



VIVA QUESTIONS:

1) What do you mean by Unilateral and Bilateral network? Give the limitations of Superposition Theorem?
2) What are the equivalent internal impedances for an ideal voltage source and for a Current source?
3) Transform a physical voltage source into its equivalent current source.
4) If all the 3 star connected impedance are identical and equal to ZA, then what is the Delta connected resistors

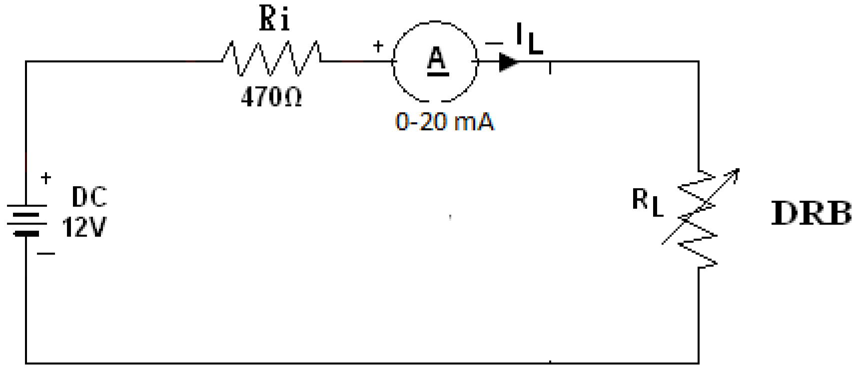
5. MAXIMUM POWER TRANSFER THEOREM

AIM: To Verify The Maximum Power Transfer Theorem For The Given Circuit.

APPARTUS REQUIRED:

SI. No	Equipment	Range	Qty
1	Bread board	-	1 NO
2	DC Voltage source.	0-30V	1 NO
3	Resistors	470 Ω	1 NO
4	Decade resistance box	0-10k Ω	1 NO
5	Ammeter	0-20mA	1 NO
6	Connecting wires	1.0.Sq.mm	As required

CIRCUIT DIAGRAM:



THEORY:
STATEMENT:
It states that the maximum power is transferred from the source to load when the load resistance is equal to the internal resistance of the source.

(or)

The maximum transformer states that "A load will receive maximum power from a linear bilateral network when its load resistance is exactly equal to the Thevenin's resistance of network, measured looking back into the terminals of network.

Consider a voltage source of V of internal resistance R_i delivering power to a load Resistance R_L

Circuit current $= \frac{V}{R_L+R_i}$

Power delivered $P = I^2 R_L$

$= \left[\frac{V}{R_L+R_i}\right]^2 R_L$

for maximum poewer $\frac{d(p)}{dt} = 0$

RL+Ri cannot be zero,

Ri – RL = 0

$R_L == Ri$

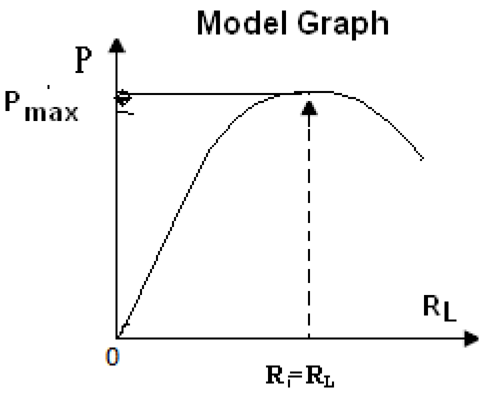
$$P_{max} = \frac{V^2}{4R_L} \text{ watts}$$

PROCEDURE:

1. Connect the circuit as shown in the above figure.
2. Apply the voltage 12V from RPS.
3. Now vary the load resistance (R_L) in steps and note down the corresponding Ammeter Reading
(I_L) in milli amps and Load Voltage (V_L) volts
6. Tabulate the readings and find the power for different load resistance values.
7. Draw the graph between Power and Load Resistance.
8. After plotting the graph, the Power will be Maximum, when the Load Resistance will be equal to source Resistance

TABULAR COLUMN:

S.No	R_L	I_L(mA)	Power(P max)=I_L^2*R_L(mW)
1			
2			
3			
4			
5			
6			
7			
8			



Theoretical Calculations:-

R = (R_i + R_L) =...**Ω**

I_L = V / R =…**mA**

Power = (I_L^2) **R_L** =…**mW**

PRECAUTIONS:

1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.

RESULT:

VIVA QUESTIONS:

1) What is maximum power transfer theorem?
2) What is the application of this theorem?

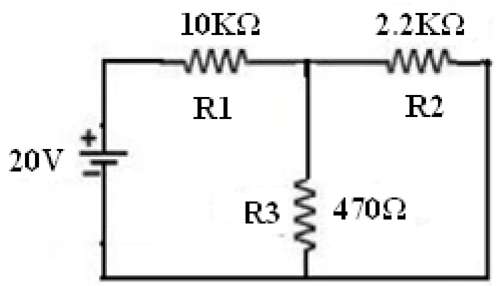
6. VERIFICATION OF RECIPROCITY THEOREM

AIM: To verify reciprocity theorem for the given circuit.

APPARATUS REQUIRED:

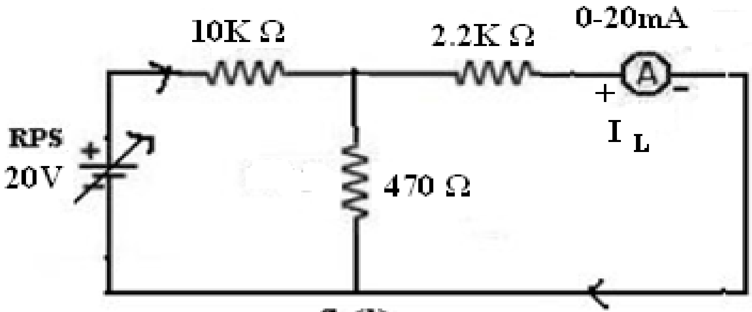
S.No	Name Of The Equipment	Range	Type	Quantity
1	Bread board	-	-	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Connecting Wires	-	-	As required
5	Resistors	2.2k Ω		1 NO
		10k Ω		1 NO
		470 Ω		1 NO

CIRCUIT DIAGRAM:



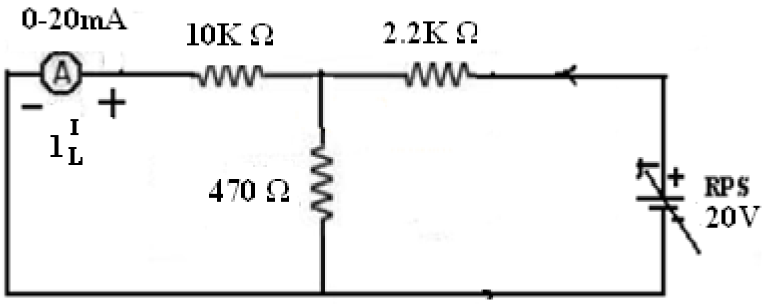
PRACTICAL CIRCUITS:

CIRCUIT-1:



fig(1)

CIRCUIT-2:

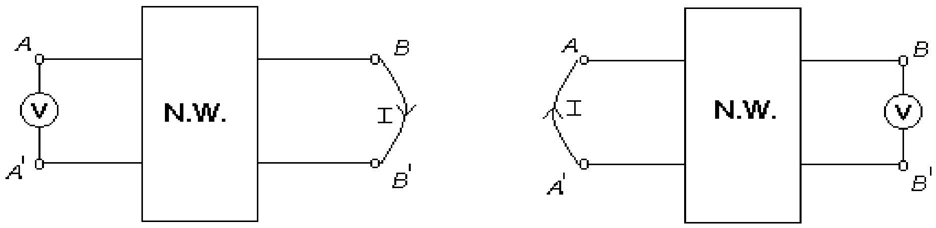


fig(2)

THEORY:

STATEMENT:

In any linear, bilateral, single source network, the ratio of response to the excitation is same even though the positions of excitation and response are interchanged. This theorem permits to transfer source from one position in the circuit to another and may be stated as under



Consider the network shown in Fig. AA^l denotes input terminals and BB^l denotes output terminals. The application of voltage V across AA^l produces current I at BB^l. Now if the positions of the source and responses are interchanged, by connecting the voltage source across BB^l, the resultant current I will be at terminals AA^l. According to the reciprocity theorem, the ratio of response to excitation is the same in both cases.

PROCEDURE:

1. Connect the circuit as per the fig (1).
2. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
3. Note down the current through 2.2K Ω □by using ammeter.
4. Reduce the output voltage of the RPS to 0V and switch-off the supply.
5. Disconnect the circuit and connect the circuit as per the fig (2).
6. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
7. Note down the current through 10K Ω resistor from ammeter.
8. Reduce the output voltage of the RPS to 0V and switch-off the supply.
9. Disconnect the circuit.

THEORITICAL CALCULATIONS :

From Fig(1)

$$I_1 = V/(R_1+(R_2//R_3))$$

$$I_L = I_1 * R_3/(R_2+R_3)$$

From Fig(2)

$$I_2 = V/(R_2+(R_1//R_3))$$

$$I_L^1 = I_2 * R_3/(R_1+R_3)$$

TABULAR COLUMNS:

From fig 1

S. No	Applied voltage (V1) Volt	Current I_L (mA)

From fig 2

S. No	Applied voltage (V2) Volt	Current I_L^I (mA)

OBSERVATION TABLE:

S.No	Parameter	Theoretical Value	Practical Value
1	$I_L/V1$		
2	$I_L^1/V2$		

PRECAUTIONS:
1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.
6. If voltmeter gives negative reading then interchange the terminals connections of a voltmeter

RESULT:

VIVA QUESTIONS:

1) What is reciprocity theorem?
2) Why it is not applicable for unilateral circuit?

CYCLE – 2

1. MAGNETIZATION CHARACTERISTICS OF D.C SHUNT GENERATOR

AIM:
To obtain the no load characteristics of a DC shunt generator and to determine the critical field resistance.

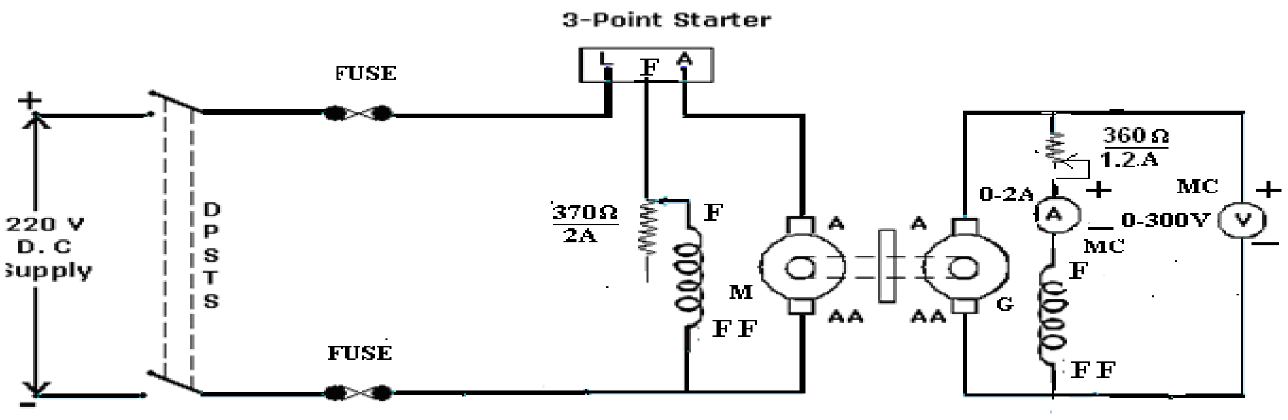
NAME PLATE DETAILS:

S.NO	Characteristics	D.C Motor	D.C Generator
1	Voltage	220V	220V
2	Current	13.6A	20A
3	Speed	1500rpm	1500rpm
4	Power	5HP	3KW

APPARATUS REQUIRED:

S.NO	Name Of The Equipment	Type	Range	Quantity
1	Voltmeters	MC	0-300V	2NO
2	Ammeters	MC	0-2A	1NO
3	Rheostats	WW	370 Ω /2A	2NO
4	Tachometers	Digital	0-10000rpm	1NO

CIRCUIT DIAGRAM:



THEORY:

Magnetization curve is relation between the magnetizing forces and the flux density B. this is also expressed as a relation between the field current and the induced e.m.f , in a D.C machine. Varying the field current and noting corresponding values of induced e.m.f can determine this. For a self-excited machine the theoretical shape of the magnetization Curve is as shown in the figure. The induced e.m.f corresponding to residual magnetism exists when the field current is zero. Hence the curve starts, a little above the origin on y-axis. The field resistance line R_{sh} is a straight-line passing through the origin.

If field resistance is increased so much that the resistance line does not cut the OCC at all then obviously the machine will fail to exite .If the resistance line just lies along the slope, then machine will just excite. The value of the resistance represented by the tangent to the curve is known as critical field resistance Rc for a given speed.

CRITICAL FIELD RESISTANCE: it is the resistance of the field winding of the generator below which generator fail to build up the voltage.

First OCC is plotted from the the readings then tangent is drawn to its initial position .The slope of this curve gives the critical field resistance.

From the graph the critical field resistance Rc = AB/BC.

PROCEDURE:

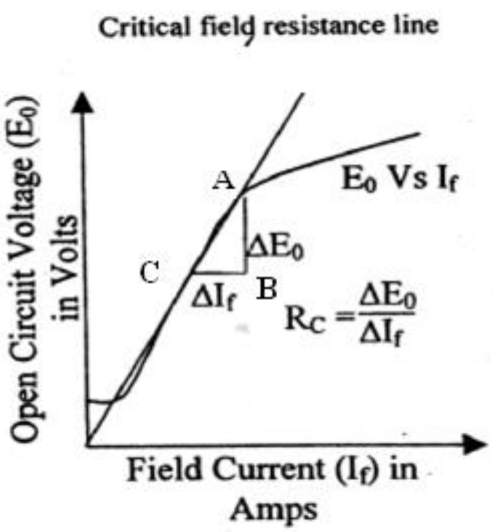
1. Connect the circuit as per the circuit diagram shown in fig.
2. Keep the motor field rheostat Rsh at minimum position and generator field rheostat at maximum position.
3. Check that the belt on the pulley is free so that there is no load on the pulley.
4. Switch on the DPST swatch. Start the motor slowly by using starter.
5. Adjust the current so that the motor runs at its rated speed.
6. Now vary the generator field rheostat to increase the field current and take the no load voltage and field current readings.
7. Take the no load voltage values until field gets saturated.
8. Finally set the field rheostats to initial positions then switch off the supply.
9. Draw the graph between generated voltage and field current. Find the critical field resistance from the tangent line.

TABULAR COLUMN:

Residual Voltage = Speed=

SNO	**I_f(A)**	**E_g(V)**

MODEL GRAPH:
Draw the graph between generated voltage at no load and field current. By taking Generated voltage Eg in volts on Y axis and field current If in amps on X-axis.



PRECAUTIONS:
1) The rheostat is connected such that minimum resistance is included in field circuit of motor.
2) The rheostat is connected such that maximum resistance is included in field circuit of generator.
3) Starter handle is moved slowly.

RESULT:

VIVA QUESTIONS:
1. What is meant by critical field resistance?
2. Residual magnetism is necessary for self excited generators or not.
3. Why this test is conducted at constant speed?

2. SWINBURNE'S TEST ON D.C SHUNT MACHINE

AIM: To perform Swinburne's test on the given D.C machine and predetermine the efficiency at any desired load both as motor and as generator.

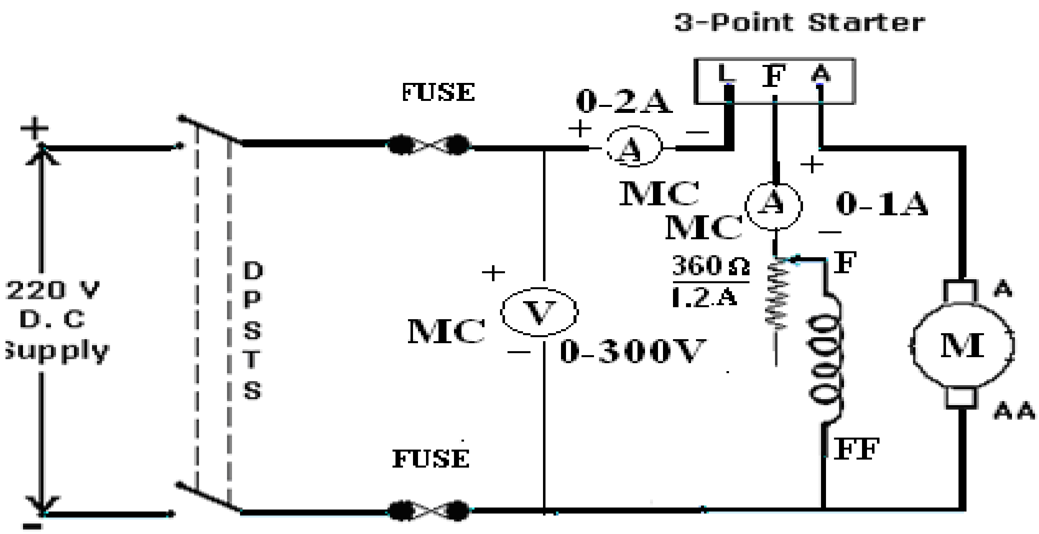
NAME PLATE DETAILS:

S.NO	Characteristic	D.C Motor
1	Voltage	220V
2	Current	20A
3	Speed	1500rpm
4	Power	5HP

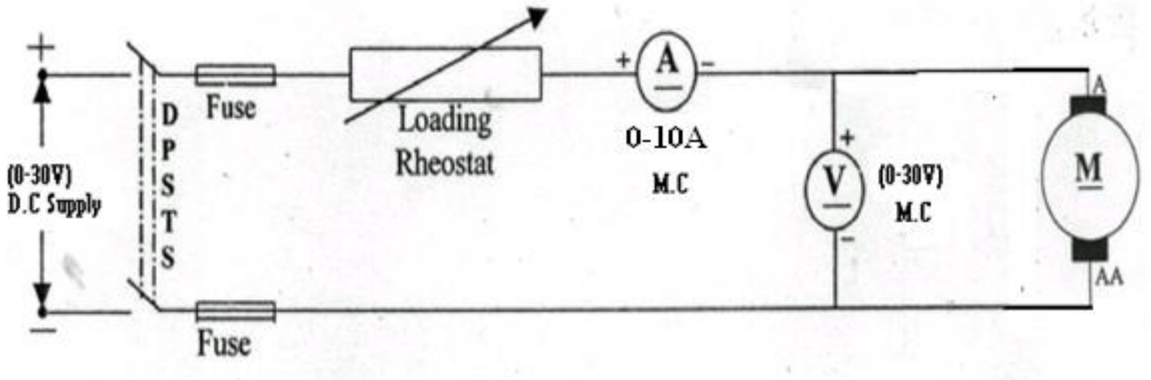
APPARATUS REQUIRED:

S.NO	Name Of The Equipment	Type	Range	Quantity
1	Ammeter	MC	0-2A,0-1A,0-10A	3NO
2	Voltmeter	MC	0-30V,0-300V	2NO
3	Rheostat	WW	370 Ω /2A	1NO
4	Tachometer	Digital	1000rpm	1NO

CIRCUIT DIAGRAM:



CIRCUIT DIAGRAM TO FIND ARMATURE RESISTANCE:



THEORY:

This test is to find out the efficiency of the machine .It is a simple indirect method in which losses are determined separately and from their knowledge, efficiency at any desired load can be predetermined. The only test needed is no-load test. This test cannot be performed on DC series motor. The machine is run as a no load shunt motor at rated speed and with a rated terminal voltage .However, this test is applicable to those machines in which flux is practically constant.

PROCEDURE

1) Make all the connections are as per the circuit diagram.
2) Keep the field rheostat in **minimum** resistance position.
3) Excite the motor with **220V, DC** supply by closing the **DPST** switch and start the Motor by moving the handle of 3-point starter from **OFF** to **ON** position.
4) By adjusting the rheostat in motor field bring the speed of the motor to its rated value. Note down the readings of Ammeter and Voltmeter at no load condition.
5) The necessary calculations to find efficiency of machine as motor & generator at any given value of armature current is done.

TO FIND ARMATURE RESISTANCE (Ra):

1) Connect the circuit per the circuit diagram
2) Keep the rheostat in maximum position.
3) Now excite the motor terminals by 30V supply by closing DPST switch.
4) Note down the readings of Ammeter and voltmeter.

MODEL CALCULATIONS:

Constant losses(Wc) = No load input – No load armature copper losses

$= VI_{L0} - I^2_{ao}Ra$, where Ra is the armature resistance

$I_{ao}=I_L-I_{sh}$

For generator:

$I_a = I_L + I_{sh}$

Output = VI_L

Cu losses = I_a^2 Ra

Total losses =Constant losses + cu losses

Input =Output+ Total losses

%Efficiency (η) = (Output / Input)*100

For motor:

$I_L = I_a + I_{sh}$

Input = VI_L

Cu losses = $I_a^2 R_a$

Total losses =Constant losses + cu losses

Output = Input-Total losses

%Efficiency (η) = (Output / Input)*100

TABULAR COLOUMN:

S.NO	Voltmeter reading V in Volts	Ammeter Reading I in Amps	Ammeter reading I_{sh} in Amps	Speed in RPM

ARMATURE RESISTANCE (Ra):

S.No	Voltage	Current

CALCULATION TABLE:

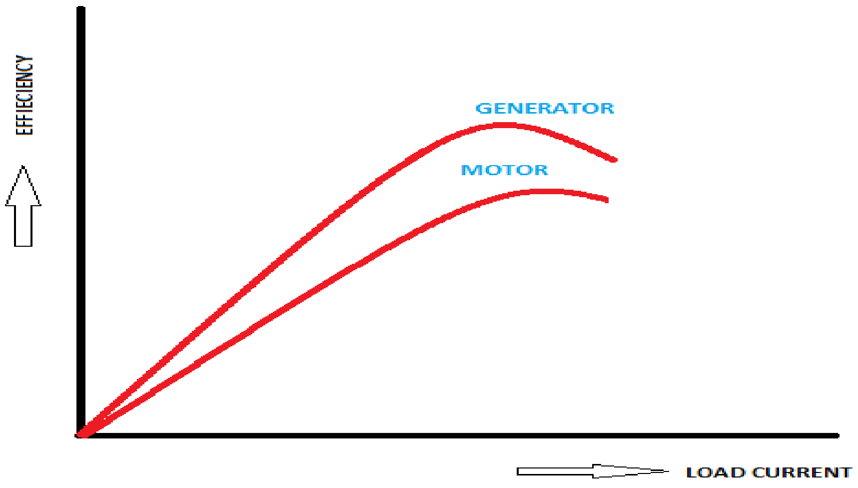
As a Motor:

S.NO	I_L (A)	$I_a=(I_L-I_{sh})$ in A	$W=I_a^2R_a$ in watts	Total losses	%Efficiency

As a Generator:

S.NO	I_L (A)	$I_a=(I_L+I_{sh})$ in A	$W=I_a^2R_a$ in watts	Total losses	%Efficiency

MODEL GRAPH:



PRECAUTIONS:
1. We should start the motor under no load
2. Take the reading without parallax error.
3. The connections must be tight.

RESULT:

VIVA QUESTIONS:

1. Why the magnetic losses calculated by this method are less than the actual value?
2. Is it applied to D.C series machines?
3. Comment on the efficiency determined by this method.

3. BRAKE TEST ON D.C SHUNT MOTOR

AIM:
To conduct the brake test on a D.C shunt motor and to draw its performance curves.

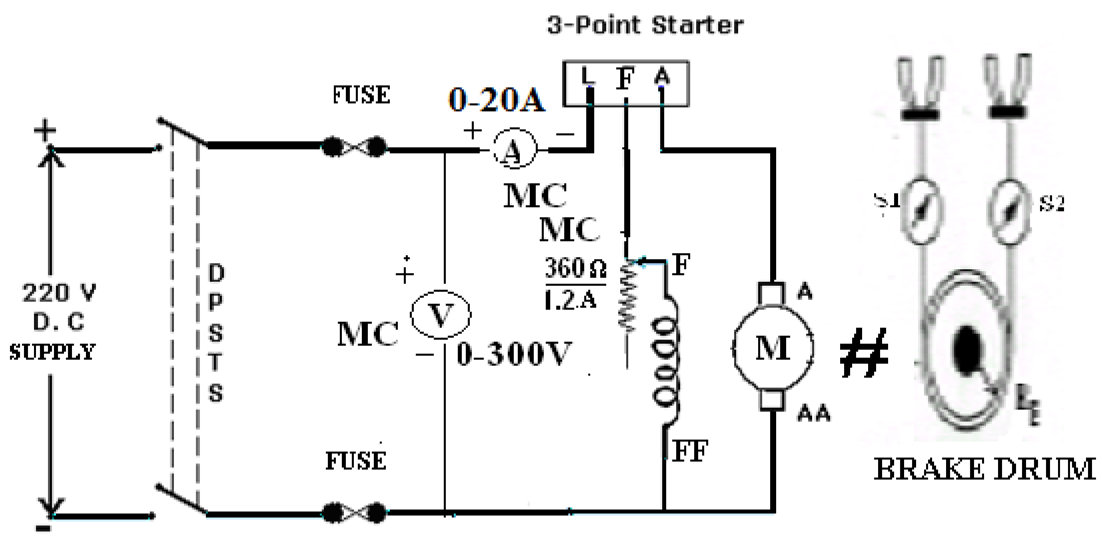
NAME PLATE DETAILS:

S.NO	Characteristic	D.C Motor
1	Voltage	220V
2	Current	20A
3	Speed	1500rpm
4	Power	5HP

APPARATUS REQUIRED:

S.NO	Description	Type	Range	Quantity
1	Ammeter	MC	0-20A	1NO
2	Voltmeter	MC	0-300V	1NO
3	Rheostat	WW	370 Ω /2A	1NO
4	Tachometer	Digital	0-10000rpm	1NO

CIRCUIT DIAGRAM:



THEORY:

This test is direct test to find the efficiency of the DC shunt motor. In this test the motor directly loaded by connecting brakes which are with pulley and motor is subjected to rated load and entire power is wasted. belt around the water cooled pulley has its ends attached to spring balances S1and S2.The belt tightening hand wheels h1 and h2 help in adjusting the load on the pulley so that the load on the motor can be varied.

Output power of the motor = (S1-S2)*Re*9.81*w (watts)
S1, S2 = weights on the pulley.
Re= Effective radius of the pulley.
w=motor speed in rad/sec.
If V is the terminal voltage IL is the line current
Power in put =$V*I_L$ watts.
Efficiency (%η) = (w (S1-S2)*Re*9.81/$V*I_L$)*100

PROCEDURE:

1. All the connections are as per the circuit diagram.
2. **220V**, DC supply is given to the motor by closing **DPST** switch.
3. Move the 3-point starter handle form **'OFF'** to **'ON'** position slowly and motor Starts running.
4. Vary the field rheostat until the motor reaches its rated Speed and take voltmeter and ammeter readings.
5. Apply the land by break drum pulley and for each applications of load the Corresponding Voltmeter (V), Ammeter (I), spring forces S1 & S2 and Speed (N) Readings are noted.
6. Calculate output & efficiency for each reading.
7. Note down all the readings in the tabular form carefully.
8. Remove the load slowly and keep the rheostat as starting position and switch **'OFF'** the supply by using **DPST** switch.

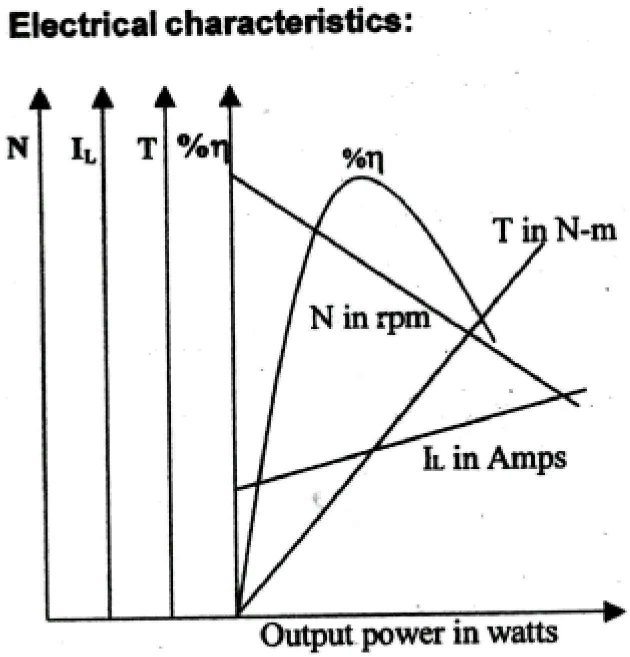
TABULAR COLUMN:

S. NO	Voltage (V)	Current (A)	Input =VI watts	Forces in KG		Net force F = S1~S2 in kg	Torque(T) =F*Re*9.81 (N-M)	Speed in RPM (N)	O/p= 2πNT/60 (Watts)	%Efficiency η=(output/input)*100
				S_1	S_2					

GRAPH:

The graph is drawn between
a) Output in Watts Vs Speed(N) in RPM
b) Output in Watts Vs Torque (T) in N-m
c) Output in Watts Vs Current (I) in A
d) Output in Watts Vs Efficiency (%η)
By taking output in Watts on X axis and speed, Torque, current, Efficiency onY- axis .

MODEL GRAPH:



PRECAUTIONS:

1. Initially 3-point starter should be kept at 'OFF' position and later it must be varied slowly and uniformly from 'OFF' to 'ON' position.
2. The field regulator must be kept at its minimum output position.
3. The brake drum of the motor should filled with cold water.
4. The motor should be started without load.

RESULT:

VIVA QUESTIONS:

1 .Why a 3-point starter is used for starting a D.C shunt motor?
2. If a 3-point starter is not available, how can a D.C motor be started?
3. Explain the function of overload release coil in 3-point starter.

4. OC & SC TESTS ON SINGLE PHASE TRANSFORMER

AIM:
To conduct Open circuit and Short circuit tests on single phase transformer to pre-determine the efficiency, regulation and equivalent parameters.

NAME PLATE DETAILS:

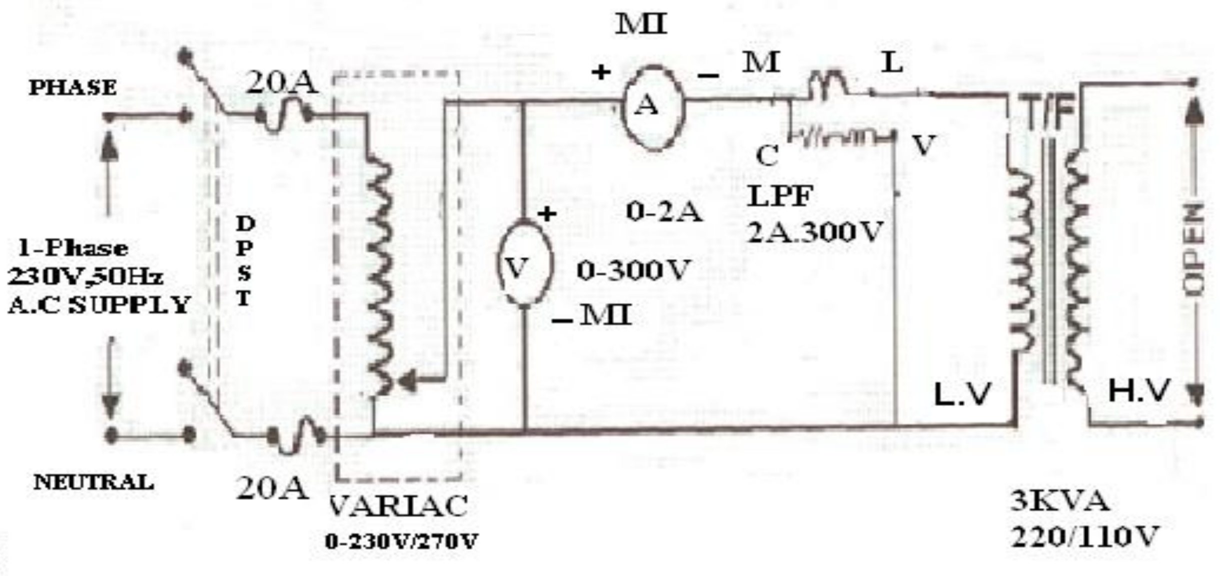
Voltage Ratio	220/110V
Full load Current	13.6A
KVA RATING	3KVA

APPARATUS REQUIRED:

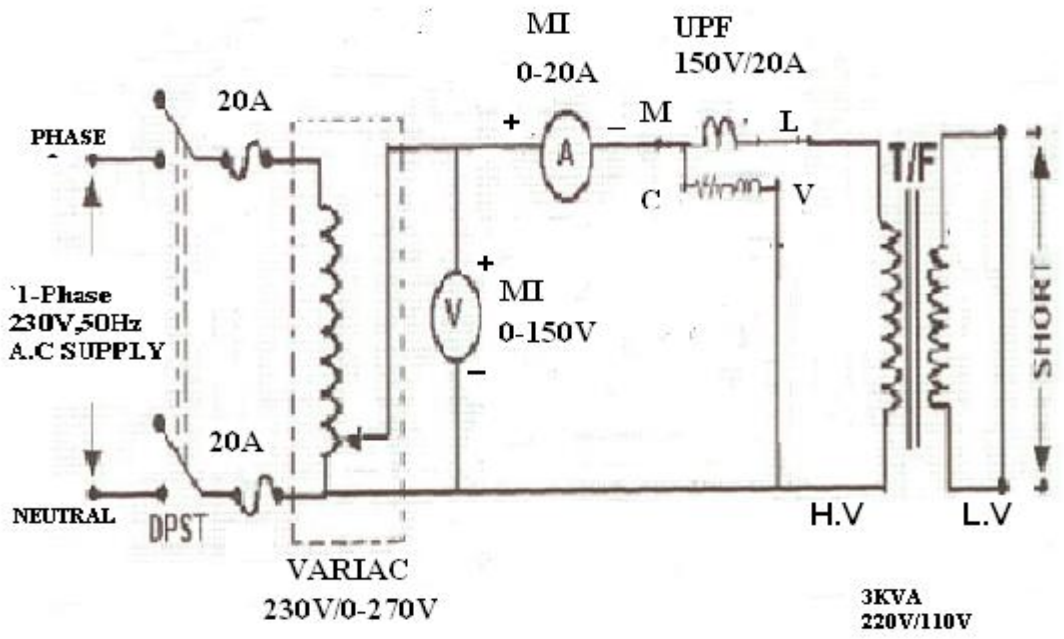
S.NO	Description	Type	Range	Quantity
1	Ammeter	MI	0-20A 0-5A	2NO
2	Voltmeter	MI	0-150V 0-300V	2NO
3	Wattmeter	LPF UPF	2A,!50V 20A,300V	2NO
4	Auto transformer	-	230/0-270V	1NO
5	Transformer	-	220V/110V	1NO

CIRCUIT DIAGRAM:

OPEN CIRCUIT TEST:



SHORT CIRCUIT TEST:



THEORY:
Transformer is a device which transforms the energy from one circuit to other circuit without change of frequency.
The performance of any transformer calculated by conducting tests .OC and SC tests are conducted on transformer to find the efficiency and regulation of the transformer at any desired power factor.

OC TEST:
The objectives of OC test are
1. To find out the constant losses or iron losses of the transformer.
2. To find out the no load equivalent parameters.

SC TEST:
The objectives of OC test are
1. To find out the variable losses or copper losses of the transformer.
2. To find out the short circuit equivalent parameters.
By calculating the losses and equivalent parameters from the above tests the efficiency and regulation can be calculated at any desired power factor.

PROCEDURE (OC TEST):
1. Connections are made as per the circuit diagram
2. Initially variac should be kept in its minimum position
3. Close the DPST switch.
4. By varying Auto transformer bring the voltage to rated voltage
5. When the voltage in the voltmeter is equal to the rated voltage of HV winding note down all the readings of the meters.
6. After taking all the readings bring the variac to its minimum position
7. Now switch off the supply by opening the DPST switch.

PROCEDURE (SC TEST):

1. Connections are made as per the circuit diagram.
2. Short the LV side and connect the meters on HV side.
3. Before taking the single phase, 230 V, 50 Hz supply the variac should be in minimum position.
4. Now close the DPST switch so that the supply is given to the transformer.
5. By varying the variac when the ammeter shows the rated current (i.e. 13.6A) then note down all the readings.
6. Bring the variac to minimum position after taking the readings and switch off the supply.

O.C TEST OBSERVATIONS:

S.NO	V_0(VOLTS)	I_0(AMPS)	W_0(watts)

S.C TEST OBSERVATIONS:

S.NO	V_{SC}(VOLTS)	I_{SC}(AMPS)	W_{SC}(watts)

CALCULATIONS:

(a)Calculation of Equivalent circuit parameters:
Let the transformer be the step down transformer.

(i) Parameters calculation from OC test

$$\cos \phi_0 = \frac{W_o}{V_o I_o} =$$

$$I_w = I_0 \cos \phi_0 =$$

$$R_0 = \frac{V_1}{I_w} =$$

$$I_\mu = I_0 \sin \phi_0 =$$

$$X_0 = \frac{V_1}{I_\mu} =$$

$$K = \frac{V_2}{V_1} =$$

(ii) Parameters calculation from SC test

$$R_{01} = \frac{W_{SC}}{I_{sc}^2} =$$

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

$$Z_{01} = \frac{V_{SC}}{I_{SC}} =$$

(b) Calculations to find efficiency:

For 'n ' fraction of full load

Cupper losses = $n^2 \times W_{sc}$ watts

where W_{sc} = full load copper losses

Constant losses = W_0 watts

Output = n x KVA x cos ϕ [cos ϕ may be assumed]

Input = output + Cu. Loss + constant loss

$$\% \ efficiency = \frac{Output}{Input} x\ 100 =$$

(C)Calculation of Regulation at full load:

$$\% \ Regulation = \frac{I_1 R_{01} \cos\phi \pm I_1 X_{01} \sin\phi}{V_1} x\ 100 =$$

'+' for lagging power factors

'_' for leading power factors

TBULAR COLUMN:

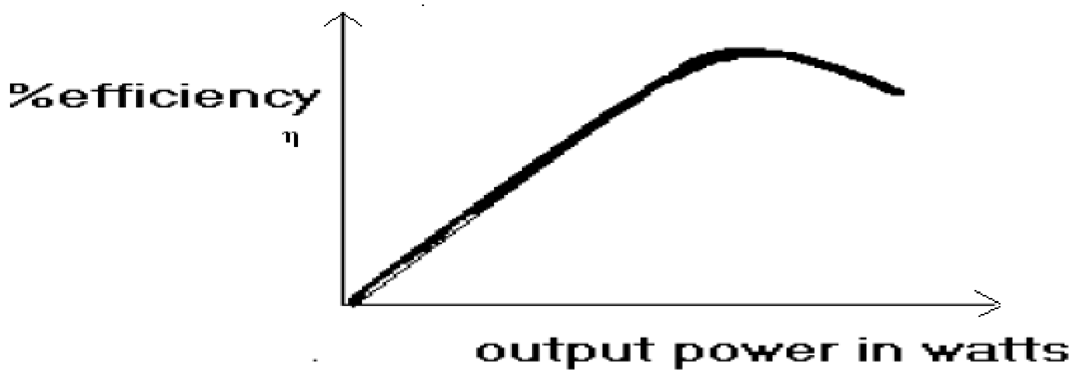
S.NO	% OF LOAD	EFFICIENCY

TABULAR COLUMN:

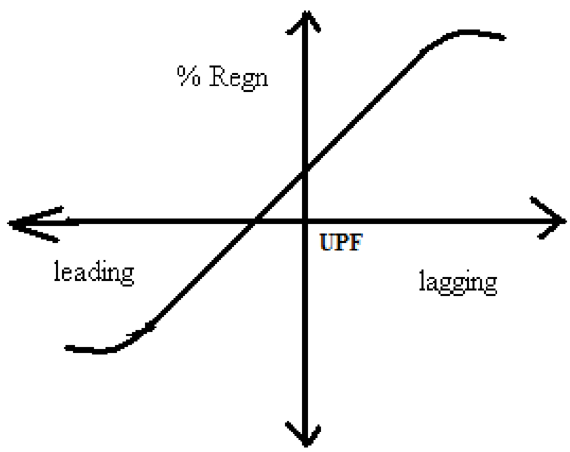
LAGGING POWER FACTOR			LEADING POWER FACTOR		
SNO	PF	%REG	SNO	PF	%REG
1	0.2			0.2	
2	0.3			0.3	
3	0.4			0.4	
4	0.5			0.5	
5	0.6			0.6	
6	0.7			0.7	
7	0.8			0.8	
8	0.9			0.9	
9	UNITY			UNITY	

MODEL GRAPHS:

1. EFFICIENCY VS OUTPUT



2. REGULATION VS POWER FACTOR



RESULT:

VIVA QUESTIONS:

1) What is a transformer?
2) Draw the equivalent circuit of transformer?
3) What is the efficiency and regulation of transformer?

5. LOAD TEST ON SINGLE PHASE TRANSFORMER

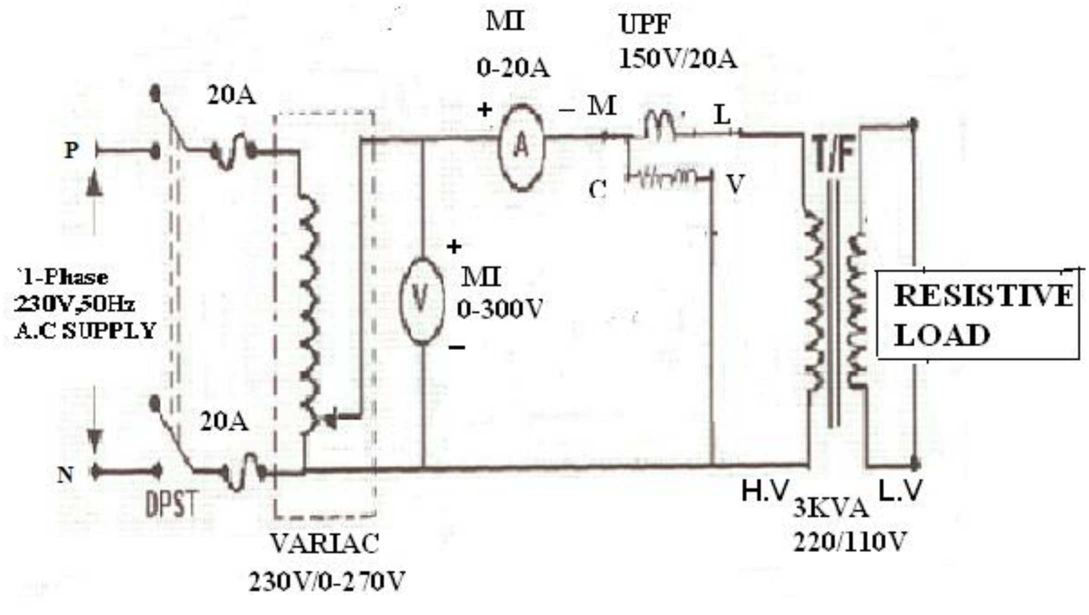
AIM: To find out the efficiency by conducting the load test on Single Phase Transformer.

APPARATUS REQUIRED:

S.NO	APPARATUS	TYPE	RANGE	QUANTITY
1	1-ϕ AUTO Transformer	-	0-230V/270V	01
2	1-ϕ Transformer	Shell type	220/110V	01
3	Voltmeter	MI	0-300V	01
4	Ammeter	MI	0-20A	01
5	Resistive load		0-20A	01
6	Wattmeter	UPF	300V/20A	01
7	Connecting wires			Required number

CIRCUIT DIAGRAM:

RESISTIVE LOAD:



PROCEDURE:

1) Connect the circuit as shown in above fig.
2) Switch on the input AC supply.
3) Slowly vary the auto transformer knob up to rated input voltage of main transformer.
4) Apply the load slowly up to rated current of the transformer.
5) Take down the voltmeter and ammeter readings.
6) Draw the graph between efficiency and output power.

TABULAR COLUMN (RESISTIVE LOAD):

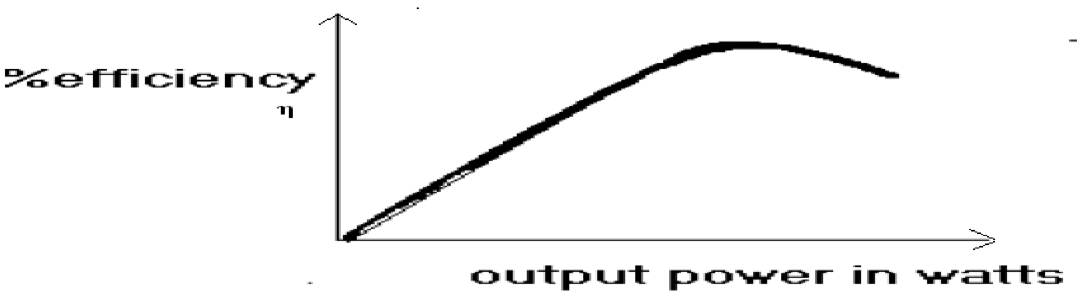
S.NO	Load Current (amps)	Voltage (volts)

OBSERVATION TBLE:

S.NO	% OF LOAD	EFFICIENCY

MODEL GRAPHS:

EFFICIENCY VS OUTPUT



RESULT:

VIVA QUESTIONS:

1) What is load test on transformer and what is the advantage of this test?
2) What is other test to determine the efficiency and regulation of transformer?