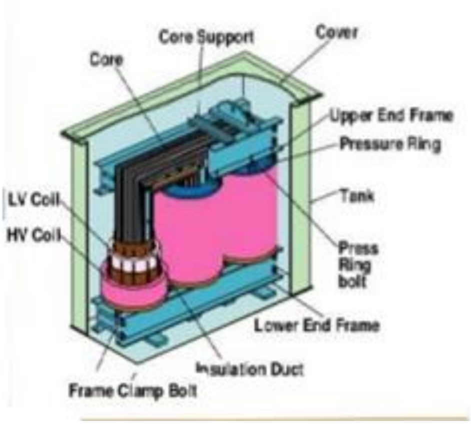
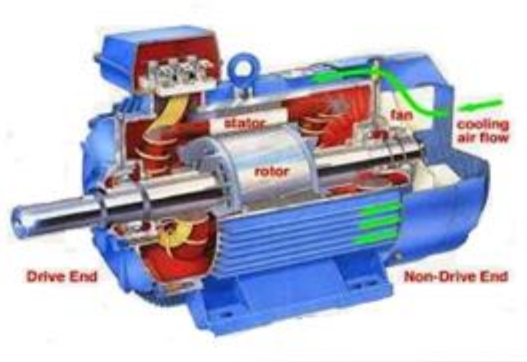
LABORATORY MANUAL

BASIC ELECTRICAL ENGINEERING LAB

I B.TECH -I Semester (COMMON TO ALL)





AY-2022-2023

Prepared by

Dr. Vinod A, Associate Professor

Lab In-charge: Mr.J.Yadagiri, Assistant Professor

MLRS

MARRI LAXMAN REDDY

INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(AN AUTONOMOUS INSTITUTION)

(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)

Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act.1956

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

Basic Electrical Engineering Lab Manual

Subject Code:22X0271
Regulation: R22- MLRS
Class: I.B.Tech (common to all)–I Semester

Prepared by

Dr.Vinod A
Associate Professor

Mr.J.Yadagiri
AssistantProfessor

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

<u>CERTIFICATE</u>

This is to certify that this manual is a bonafide record of practical work in the **Basic Electrical Engineering Lab** in **First Semester of I year B.Tech (Common to all) programme** during the academic year **2022-23**.This manual is prepared by **Dr.Vinod A (Asso.Professor)**, **Mr.J.Yadagiri (Asst.Professor)** Department of Electrical and Electronics Engineering.

PREFACE

This book “deals with basic law’s and theorems along with transformers and their performance characteristics of different AC machines. The manual contains the exercise Basic Electrical Engineering lab manual is intended to teach the Basic Law’s, theorems and AC machines and the performance characteristics of Transformers. Readers of this book need only be familiar with the basics of programs and viva questions for easy & quick understanding of the students. We hope that this practicalmanual will be helpful for students of all branch of engineering students for understanding the subject from the point of view of applied aspects. There is always scope for improvement in the manual. We would appreciate to receive valuable suggestions from readers and users for future use.

By

Dr.Vinod A,
Asso.Professor

Mr.J.Yadagiri,
Asst.Professor

ACKNOWLEDGEMENT

It was really a good experience, working with ***Basic Electrical Engineering*** lab. First we would like to thank Dr.A.Vinod,Professor &HOD of Department of Electrical and Electronics Engineering, Marri Laxman Reddy Institute of Technology & Management for his concern and giving the technical support in preparing the document.

We are deeply indebted and gratefully acknowledge the constant support and valuable patronage of Dr.Ravi Prasad, Director, Marri Laxman Reddy Institute of technology & Management for giving us this wonderful opportunity for preparing the ***Basic Electrical Engineering*** laboratory manual.

We express our hearty thanks to Dr.K.Venkateswara Reddy, Principal, Marri Laxman Reddy Institute of technology & Management, for timely corrections and scholarly guidance.

At last, but not the least I would like to thanks the entire EEE Department faculties those who had inspired and helped us to achieve our goal.

By

Dr.Vinod A,
Asso.Professor

Mr.J.Yadagiri,
Asst.Professor

GENERAL INSTRUCTIONS

1. Students are instructed to come to Basic Electrical Engineering laboratory on time. Late comers are not entertained in the lab.

2. Students should be punctual to the lab. If not, the conducted experiments will not be repeated.

3. Students are expected to come prepared at home with the experiments which are going to be performed.

4. Students are instructed to display their identity cards before entering into the lab.

5. Students are instructed not to bring mobile phones to the lab.

6. Any damage/loss of system parts like Meters, Components during the lab session, it is student's responsibility and penalty or fine will be collected from the student.

7. Students should update the records and lab observation books session wise. Before leaving the lab the student should get his lab observation book signed by the faculty.

8. Students should submit the lab records by the next lab to the concerned faculty members in the staffroom for their correction and return.

9. Students should not move around the lab during the lab session.

10. If any emergency arises, the student should take the permission from faculty member concerned in written format.

11. The faculty members may suspend any student from the lab session on disciplinary grounds.

12. Never copy the output from other students. Write down your own outputs.

Safety precautions:

1. Students are supposed to come to the lab with preparation, proper dress code and the set of tools required (1. Cutter, 2. Tester (small size), 3. Plier (6-Inches)).

2. Dress code:

   Boys: Shoe & Tuck.

   Girls: Apron & Cut shoe.

3. Don’t switch on the power supply without getting your circuit connections verified.
4. Disciplinary action can be taken in the event of mishandling the equipment or switching on the power supply without faculty presence.
5. All the apparatus taken should be returned to the Lab Assistant concerned, before leaving the lab.
6. You have to get both your Observation book and your Record for a particular experiment corrected well before coming to the next experiment.

Guidelines to write your Observation book:

1. Experiment title, Aim, Apparatus, Procedure should be right side.
2. Circuit diagrams, Model graphs, Observations table, Calculations table should be left side.
3. Theoretical and model calculations can be any side as per convenience.
4. Result should always be at the end (i.e. there should be nothing written related to an experiment after its result).
5. You have to write the information for all the experiments in your observation book.
6. You are advised to leave sufficient no of pages between successive experiments in your observation book for the purpose of theoretical and model calculations.

INSTITUTION VISION AND MISSION

VISION

To be as an ideal academic institution by graduating talented engineers to be ethically strong, competent with qualityresearch and technologies

MISSION

To fulfill the promised vision through the following strategic characteristics and aspirations:

- Utilize rigorous educational experiences to produce talented engineers
- Create an atmosphere that facilitates the success of students
- Programs that integrate global awareness, communication skills and Leadership qualities
- Education and Research partnership with institutions and industries to prepare the students for interdisciplinary research

DEPARTMENT VISION, MISSION , PROGRAMME EDUCATIONAL OBJECTIVES AND SPECIFIC OUTCOMES

VISION

To impart high qulality technical knowledge in Electrical and Electronics Engineerimg and to transform them imto globally competent engineers,researchers and entrepreneurs and to make them ethically,emotionally strong enough to meet the technological challenges, to excel globally and thus excel to greater hights in their career.

MISSION

1. To provide the state of the art resources to achieve excellence in all apheres of Electrical Engineering related domains.
2. To bridge the gap between academics and industries through proper teaching and learning processes .
3. To inculcate moral and ethical values & environment among the students through knowledge centric education & research.

PROGRAMME EDUCATIONAL OBJECTIVES

The Programme Educational Objectives (PEOs) that are formulated for the Electrical engineering programme are listed below;

PEO1: Toprovide the sstudents with a sound foundation in the mathematics,science and engineering fundamentals necessarynto become employable.

PEO2: Graduates are able to apply their technical knowledge to take up higher responsibilities in industry,academics and create innovative ideas in the field of Electrical and Electronics Engineering.

PEO3: Equip graduates with the communication skills, leadership qualities and team wirk with multi disciplinary approach and zeal to provide solutions for engineering problems.

PEO4: to inculcate ethical values and aptitude for lifelong learning needed for a successful professional career of the graduates.

PROGRAM SPECIFIC OUTCOMES

PSO 1: The ability to analyze, design, implement and maintenance of the electrical & power systems for various industrial application.

PSO 2: The ability to apply analytical & experimental techniques for optimization of electrical and Power systems.

PSO 3: The ability to analyze electrical/electronic(s) systems with the help of analogous & discreet mathematical tools.

PROGRAMME OUT COMES

The Program Outcomes (POs) of the department are defined in a way that the Graduate Attributes are included, which can be seen in the Program Outcomes (POs) defined. The Program Outcomes (POs) of the department are as stated below:

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

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

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

PO4. 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. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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

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

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

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

PO10. 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. 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. 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.

COURSE OBJECTIVES & OUTCOMES

COURSE OBJECTIVES:

To analyze a given network by applying various electrical laws and networktheorems

- To know the response of electrical circuits for different excitations
- To calculate, measure and know the relation between basic electrical parameters.
- To analyze the performance characteristics of DC and AC electrical machines

COURSE OUTCOMES:

Upon the completion of AC Machines practical course, the student will be able to attain the following:

- Get an exposure to basic electricallaws.
- Understand the response of different types of electrical circuits to different excitations.
- Understand the measurement, calculation and relation between the basic electrical parameters
- Understand the basic characteristics of transformers and electricalmachines.

Department of Electrical & Electronics Engineering

22X0271: BASIC ELECTRICAL ENGNIEERING LAB

LIST OF EXPERIMENTS/DEMONSTRATIONS:

1. Verification of OhmsLaw
2. Verification of KVL andKCL
3. Verification of superposition theorem.
4. Verification of Thevenin's and Norton's theorem.
5. Resonance in series RLCcircuit.
6. Calculations and Verification of Impedance and Current of RL, RC and RLCseries circuits.
7. Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single PhaseTransformer.
8. Performance Characteristics of a Separately/Self Excited DC Shunt/CompoundMotor.
9. Torque-Speed Characteristics of a Three-phase InductionMotor.

Any two experiments from the given list

10. Three Phase Transformer: Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta-star, Star-Star)
11. Load Test on Single Phase Transformer (Calculate Efficiency and Regulation.
12. Measurement of Active and Reactive Power in a balanced Three-phase circuit.
13. No-Load Characteristics of a Three-phase Alternator

Ex No:
Date :

1. VERIFICATION OF OHM'S LAW

AIM: To verify Ohm's law (V=IR) where current through a resistor is proportional to the voltage across it.

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-20) V	Digital	1
2	Ammeter	(0-200) mA	Digital	1
3	Regulated power supply	(0-15) V	Dual	1
4	Multimeter	---------	Digital	1
5	Bread Board	---------	---------	1
6	Resistors	1kΩ,1.5kΩ, 6.8kΩ	Fixed	Each one
7	Connecting wires	As required		

THEORY:

The most fundamental law in electricity is ohm's law or V=IR. Where V is voltage, which means the potential difference between two terminals. Electrical resistance, measured in ohms, is the measure of the amount of current repulsion in a circuit.

According to the Ohm's law, "The current flowing through a conductor is directly proportional to the potential difference across its ends provided the physical conditions (temperature, dimensions, pressure) of the conductor remains the same." If I be the current flowing through a conductor and V be the potential difference across its ends, then according to Ohm's Law,

$$I \, \alpha \, V$$

$$V \; \alpha \; I \text{ or } V=IR$$

Where, R is the constant of proportionality. It is known as resistance of the conductor. R depends upon the material, temperature and dimensions of the conductor. In S.I. units, the potential difference V is measured in volt and the current I in ampere, the resistance R is measured in ohm.

How do we establish the current-voltage relationship?

Ans: To establish the current-voltage relationship, it is to be shown that the ratio V / I remains constant for a given resistance, therefore a graph between the potential difference(V) and the current (I) must be a straight line.

For a wire of uniform cross-section, the resistance depends on the length l and the area of cross-section A. It also depends on the temperature of the conductor. At a given temperature the resistance,

$$R = \rho \frac{l}{A}$$

Where ρ is the specific resistance or resistivity and is characteristic of the material of wire.

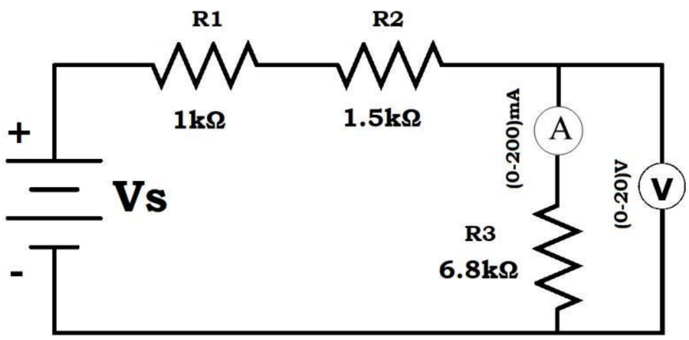
Hence, the specific resistance or resistivity of the material of the wire,

$$\rho = \frac{RA}{l}$$

If 'r' is the radius of the wire, then the cross sectional area, $A = \pi r^2$. Then the specific resistance or resistivity of the material of the wire is,

$$\rho = \frac{\pi r^2 R}{l}$$

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the circuit shown in above *Fig.*
2. Measure the actual value of each resistor and record in *Table 1*.
3. Beginning at 0 V, increase the power supply so that the voltage across R_3 in steps of 1V until 6 V. Measure and record the resulting current in *Table 1*for each increment of voltage.

4. Plot the graphs of I verses V for results in *Table 1*(Assign I to the vertical axis and V to the horizontal axis).
5. Construct a right angle triangle on the graph and from this, re-determinethe slope and hence evaluate the conductance, G.
6. From this information, evaluate the resistance, R. Record G and R for the graph in the appropriate column in *Table 2*.
7. Compare these experimentally obtained values with those measured values recorded in the respective tables

THEORETICAL CALCULATIONS:

Voltage across a resistor = I x R

OBSERVATION TABLE: Table-1

R = 6.8kΩ	**Measured Resistance, R =**							
R = 1 kΩ	**Measured Resistance, R =**							
R = 1.5 kΩ	**Measured Resistance, R =**							
Voltage Across R_3	**(V)**	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Current (Measured values)	**(mA)**							
Current (Theoreticalvalues)	**(mA)**							

Table-2

	Slope (G)	R (1/G)
Measured Values		
Theoretical Values		

PRECAUTIONS:

1. Loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

RESULT:

APPLICATIONS:

1. A resistor is used to control the rate of current flowing through these components.
2. The **Ohm's law** is used to calculate the rating of current which should be used in the typical circuit.

VIVA QUESTIONS:

1. Has Ohm's law been verified?
2. What are the facts supporting this decision?
3. State the factors affecting resistance of a material with a uniform cross-sectional area?
4. What are the common types of fixed and variable resistors? State usage ofeach type.
5. If the resistor from the experiment above is changed to 10 kΩ, deduce whatwill happen to the slope of I-V graph. What effect on the conductance G?
6. Define electric current.
7. What is meant by the term electric potential difference?
8. Give example of a good non-metallic conductor.
9. What is SI unit of resistance? Define it.
10. What is an ohmic resistance?
11. What is the shape of V v/s I graph for an ohmic conductor?
12. How is the resistance of a conductor affected by rise in temperature?

13. Can a voltmeter measure e.m.f.?
14. What is the resistance of an ideal voltmeter?
15. Define electric current?
16. What is SI unit of electric current?
17. What is meant by the term electric potential difference?
18. What is a conductor?
19. Give example of a good non-metallic conductor.
20. State Ohm's law.
21. What is meant by the term electric resistance?
22. State the factors on which the resistance of a conductor depends.
23. Define the term resistivity. Give its SI unit.
24. What is an ohmic resistance?
25. What is a non-linear device? Give an example.
26. Give example of a material whose resistance decreases with rise in temperature.
27. How is ammeter connected in a circuit?
28. How is a voltmeter connected in a circuit?
29. What do you mean by e.m.f. of a cell?
30. What do you mean by terminal voltage?

Ex No:
Date :

2. VERIFICATION OF KVL & KCL

AIM: To verify Kirchhoff's Voltage Law and Kirchhoff's Current Law theoretically and practically.

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-20) V	Digital	4
2	Ammeter	(0-200) mA	Digital	3
3	Regulated power supply	(0-15) V	Dual	1
4	Multimeter	---------	Digital	1
5	Kit Board	---------	---------	1
6	Resistors	1Kω	Fixed	3
7	Connecting wires	As required		

THEORY:

We saw in the Resistors tutorial that a single equivalent resistance, (R_T) can be found when two or more resistors are connected together in either series or parallel or combinations of both, and that these circuits obey Ohm's Law.

However, sometimes in complex circuits such as bridge or T networks, we cannot simply use Ohm's Law alone to find the voltages or currents circulating within the circuit. For these types of calculations we need certain rules which allow us to obtain the circuit equations and for this we can use Kirchhoff's Circuit Law.

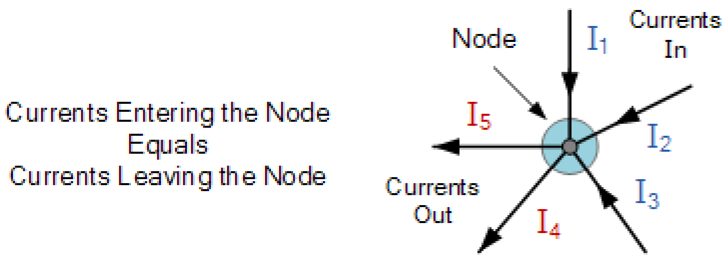
In 1845, a German physicist, Gustav Kirchhoff developed a pair or set of rules or laws which deal with the conservation of current and energy within electrical circuits. These two rules are commonly known as: Kirchhoff's Circuit Laws with one of Kirchhoff's laws dealing with the current flowing around a closed circuit, Kirchhoff's Current Law, (KCL) while the other law deals with the voltage sources present in a closed circuit, Kirchhoff's Voltage Law, (KVL).

This law is also called Kirchhoff's point rule, Kirchhoff's junction rule (or nodal rule), and Kirchhoff's first rule. It states that, "In any network of conductors, the algebraic sum of currents meeting at a point (or junction) is zero".

1. Kirchhoff's First Law – The Current Law, (KCL)

Kirchhoff's Current Law or KCL, states that the "total current or charge entering a junction or node is exactly equal to the charge leaving the node as it has no other place to go except to leave, as no charge is lost within the node". In other words the algebraic sum of ALL the currents entering and leaving a node must be equal to zero, I(exiting) + I(entering) = 0. This idea by Kirchhoff is commonly known as the **Conservation of Charge**.

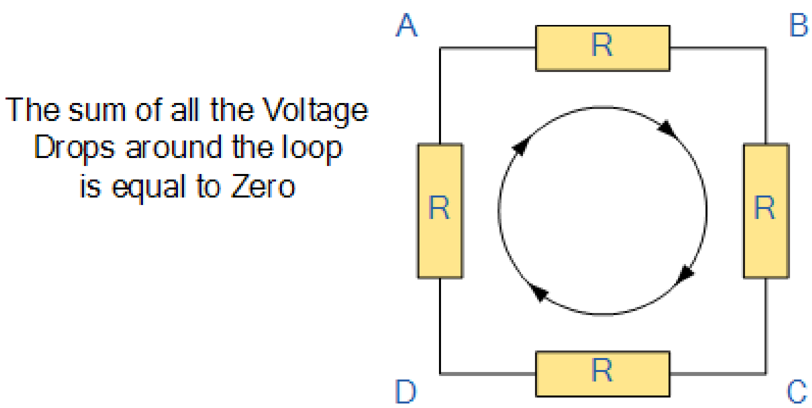
Kirchhoff's Current Law



$$I_1 + I_2 + I_3 + (-I_4 + -I_5) = 0$$

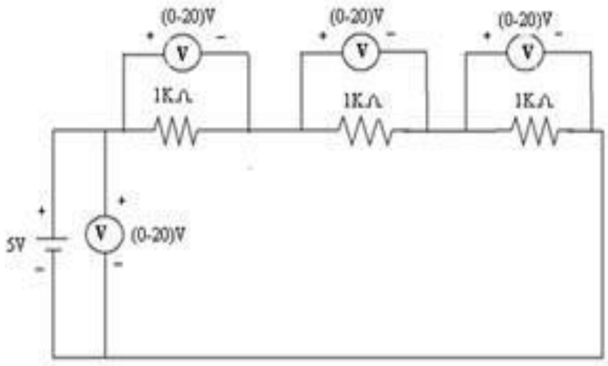
2. Kirchhoff's Second Law – The Voltage Law, (KVL)

Kirchhoff's Voltage Law or KVL, states that "in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop" which is also equal to zero. In other words the algebraic sum of all voltages within the loop must be equal to zero. This idea by Kirchhoff is known as the **Conservation of Energy**.

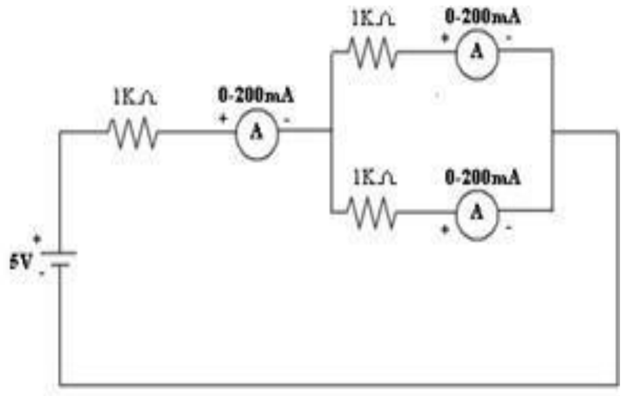


$$V_{AB} + V_{BC} + V_{CD} + V_{DA} = 0$$

CIRCUIT DIAGRAM:



(a) Circuit diagram for KVL



(b) Circuit diagram for KCL

PROCEDURE:

1) To verify KVL, Connections are made as shown in the Fig-(a)
2) Supply is given to the circuit and the readings of the voltmeters are noted down.
3) Kirchhoff's Voltage law can be verified by $V_S=V_1+V_2+V_3$ (v).
4) To verify KCL, Connections are made as shown in the Fig-(b)
5) Supply is given to the circuit and the readings of the Ammeters are noted down.
6) Kirchhoff's Current law can be verified by $I=I_1+I_2$ (A).

OBSERVATION TABLE:

	Kirchhoff's Voltage Law					Kirchhoff's Current law			
	V_s(V)	V_1(V)	V_2(V)	V_3(V)	$V_1+V_2+V_3$(V)	I(A)	I_1(A)	I_2(A)	I_1+I_2(A)
Theoretical Values									
Practical Values									

PRECAUTIONS:

1. Loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

RESULT:

APPLICATIONS:

1. Kirchhoff's Laws are applications of two fundamental conservation laws: the Law of Conservation of Energy, and the Law of Conservation of Charge.
2. The current distribution in various branches of a circuit can easily be found out by applying Kirchhoff Current law at different nodes or junction points in the circuit.
3. After that Kirchhoff Voltage law is applied, each possible loop in the circuit generates algebraic equation for every loop.

VIVA QUESTIONS:

1. What is the statement of KVL?
2. What is the statement of KCL?
3. What is the statement of Ohm’s law?
4. Give the limitations of Kirchhoff’s laws?
5. What is the Condition of Ohm’s law?
6. Please Define Ohm’s Law for A.C (Alternating Current)?
7. What is Voltage Divider Rule?
8. What is Current Divider Rule (CDR)?
9. Differentiate between Kirchhoff’s First law and Kirchhoff’s Second law?
10. What is the function of Capacitor in Electrical Circuits?
11. Why Inductors are installed in electrical Circuits?
12. Briefly explain the purpose of Inductor in an electric circuit?
13. What do you mean by dependent and independent voltage sources?
14. Differentiate between ideal and non-ideal voltage sources?
15. What does the term “Voltage Regulation” means?
16. What is DC Current source? Differentiate between ideal and non ideal current sources?
17. What is the difference between power and energy?
18. Define steady state?

19. Initial conditions of capacitors?
20. Explain how an inductor and capacitors behaves when AC&DC are given?
21. Initial conditions of inductance?
22. What is the difference between Voltage Divider Rule and current divider rule?
23. What is the function of an inductor in electrical circuits?
24. What is dependent voltage source?
25. What is independent voltage source?
26. On what bases KCL is based on?
27. Kirchhoff's current law is applied at?
28. Kirchhoff's voltage law is based on?
29. Which law can be best suited for the analysis of circuit with more number of loops?
30. Mathematically KVL can written as?
31. What is an ideal current source?
32. How can a current source will be practically represented?
33. How can a voltage source will be practically represented?
34. What is a constant voltage source?
35. With some initial change at t=0+, a capacitor will act as?
36. Potential difference in electrical terminology is known as?
37. Why inductors are installed in electrical Circuits?
38. What is an ideal voltage soure?
39. What is a non ideal voltage source?
40. What is meant by a power?
41. What is meant by current?
42. What is meant by a energy?
43. What is the difference between power and energy?
44. What is Kirchhoff's second law?
45. How to calculate energy stored in an inductance?
46. How could you measure voltage in series?
47. What is the difference between inductor and capacitor?
48. Could you measure current in parallel?
49. What is the difference between voltages or potential difference?
50. How to calculate energy stored in capacitance?

Ex No:

Date :

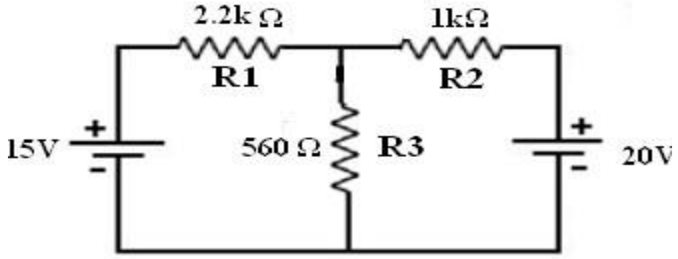
3. VERIFICATION OF SUPERPOSITION THEOREM

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

APPARATUS REQUIRED:

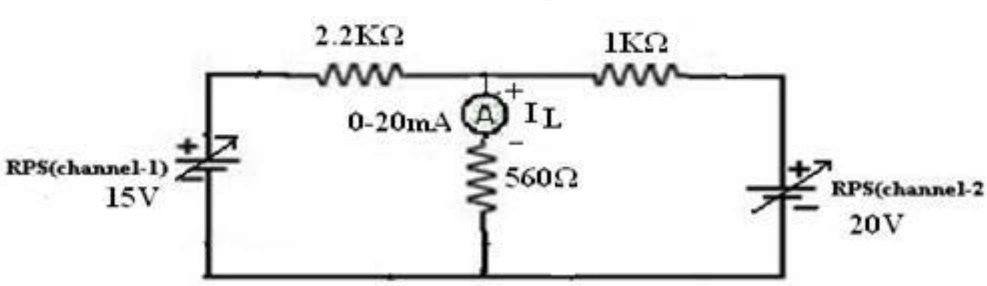
S.No	Name Of The Equipment	Range	Type	Quantity
1	Bread board	-	-	1 NO
2	Ammeter	(0-20) mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	2.2k Ω		1 NO
		1k Ω		1 NO
		560 Ω		1 NO
5	Connecting Wires	-	-	As required

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})

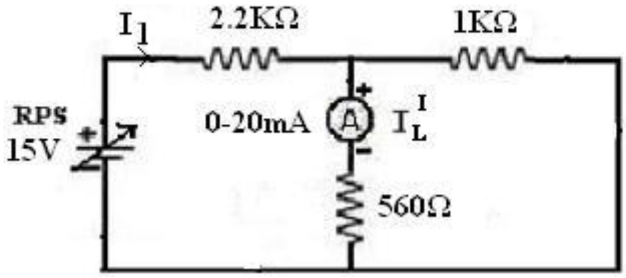


Fig (2)

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

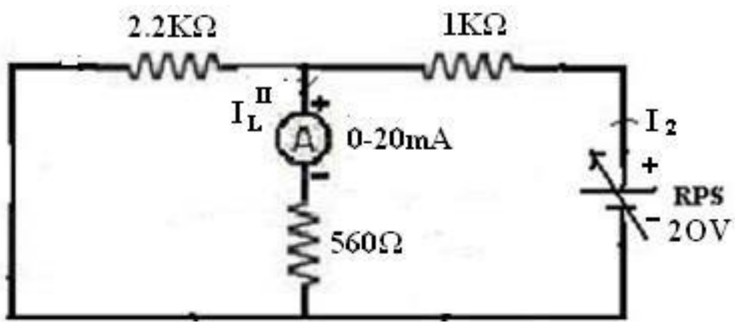


Fig (3)

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^{I}) 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^{II}) 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. 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^{1}		
3	When only source Y is acting, I_L^{11}		

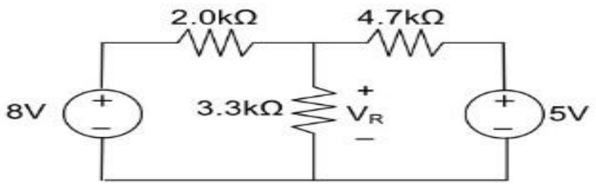
PRECAUTIONS:

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?
2. Give the limitations ofSuperposition Theorem?
3. What are the equivalent internal impedances for an ideal voltage source and for a Current source?
4. Transform a physical voltage source into its equivalent current source.If all the 3 star connected impedance are identical and equal to ZA, then what is the Delta connected resistors

Ex No:

Date :

4.a) VERIFICATION OF THEVENIN'S THEOREM

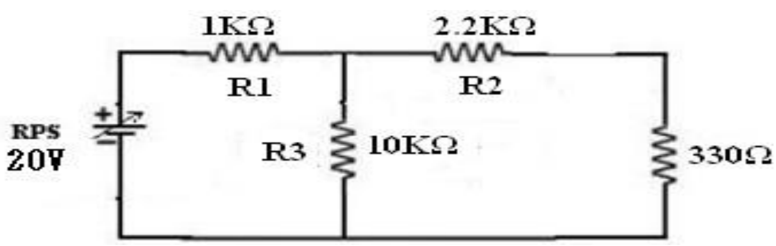
AIM: To verify Thevenin's theorem for the given circuit.

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

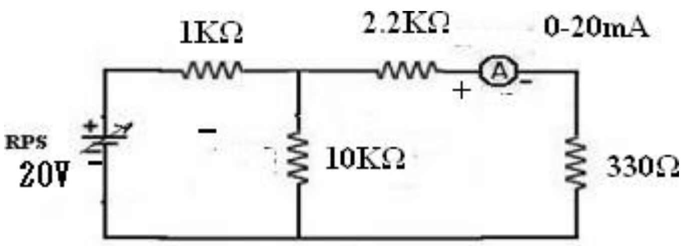
CIRCUIT DIAGRAM:

GIVEN CIRCUIT:



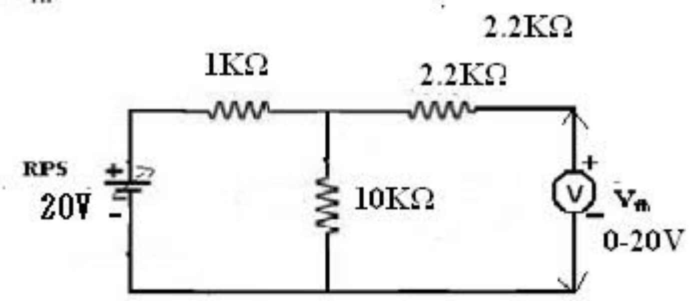
PRACTICAL CIRCUIT DIAGRAMS:

TO FIND I_L:



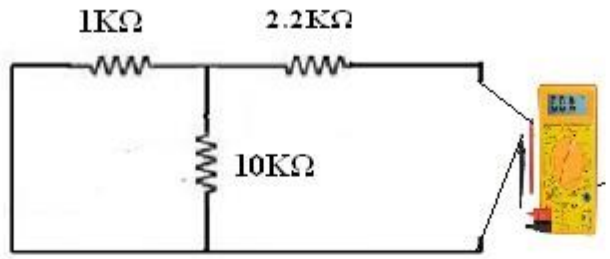
FIG(1)

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 inresistance mode to measure Thevenin's resistance(R_{Th}).

THEORITICAL VALUES:

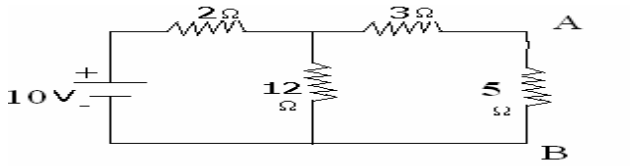
Tabulation for Thevenin's Theorem:

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

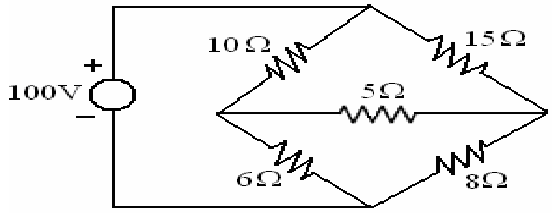
RESULT:

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 ?

Ex No:

Date :

4.b)VERIFICATION OF NORTON'S THEOREM

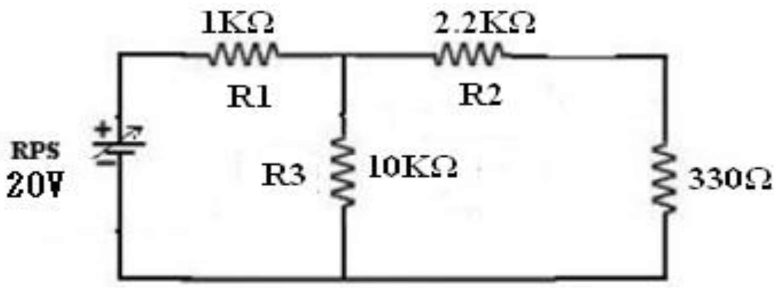
AIM: To verify Norton's theorem for the given circuit.

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

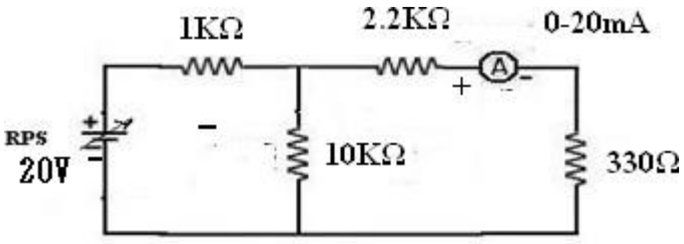
CIRCUIT DIAGRAM:

GIVEN CIRCUIT:



PRACTICAL CIRCUIT DIAGRAMS:

TO FIND I_L:



FIG(1)

TO FIND I_N:

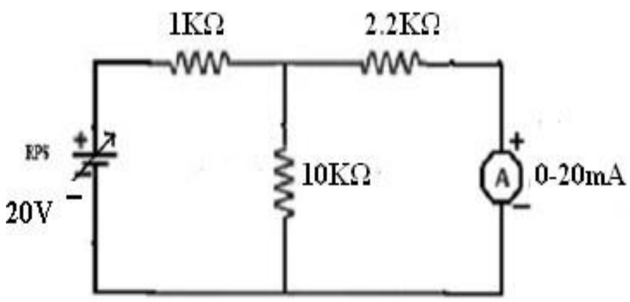
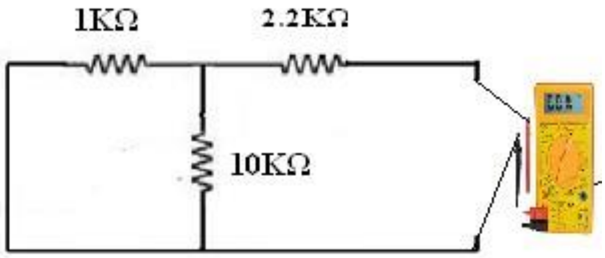


fig (2)

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).

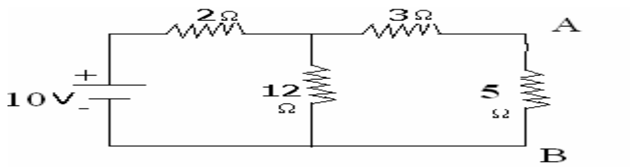
TABULATION FOR NORTON'S THEOREM:

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

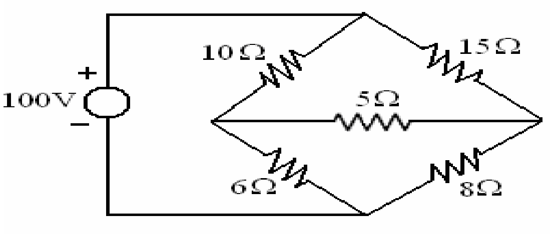
RESULT:

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 Of10 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 Of25 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 ?

Ex No:

Date :

5. RESONANCE IN SERIES RLC CIRCUIT

AIM: To verify Resonant Frequency, Bandwidth & Quality factor of R-L-C Series Resonant circuits.

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	CRO	(0-20)MHz	Dual	1
2	Series Resonance Kit	---------	---------	1
3	Connecting wires	As required		

THEORY:

The voltage across the inductor is $V_L = I X_L$ The voltage across the capacitor is $V_C = IX_C$ The voltage across the resistor is $V_R = IR$

Phase relations among these voltages are shown in Figure 1. The voltage across the resistor is in phase with the current. The voltage across the inductor leads the current by 90 degrees. The voltage across the capacitor lags the current by 90 degrees.

The total voltage across the resistor, inductor and capacitor should be equal to the emf supplied by the generator.

$$\vec{E} = \vec{V}_R + \vec{V}_C + \vec{V}_L$$

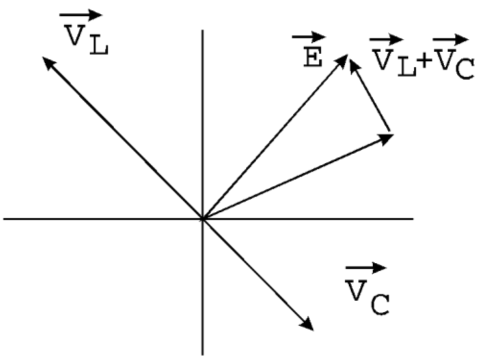


Figure 1

From Figure 2 we can see that $E = \sqrt{V_R^2 + (V_L - V_C)^2}$

If we divide both sides of this equation by current, we get

$$\mathbf{E/I = Z = R^2 + (X_L - X_C)^2}$$

Where (X_L - X_C) is called the total reactance and Z is called the impedance of the circuit.

We know that the capacitive reactance $X_C = 1/\omega C$, and the inductive reactance $X_L = \omega L$ depend on frequency. The value of frequency when $X_L = X_C$, $\omega L = 1/\omega C$, or $\omega = 1/\sqrt{LC} = \omega_0 = 2\ f_0$

The frequency f_0 is called the resonance frequency of the circuit. At this frequency, the impedance is smallest and the maximum value of the current (and the voltage across the resistor V_R) can be obtained. At this frequency, the circuit is said to be at resonance. At resonance, the current is in phase with the generator voltage.

If we measure voltage across the resistor, depending on frequency, we will obtain a resonance curve of the circuit as shown in Figure2. A resonance curve can be characterized by the resonance width Δf, the frequency difference between the two points on the curve where the power is half its maximum value or voltage is $V_{max}/\sqrt{LC} = 0.707\ V_{max}$

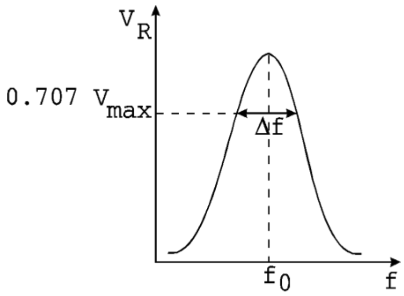
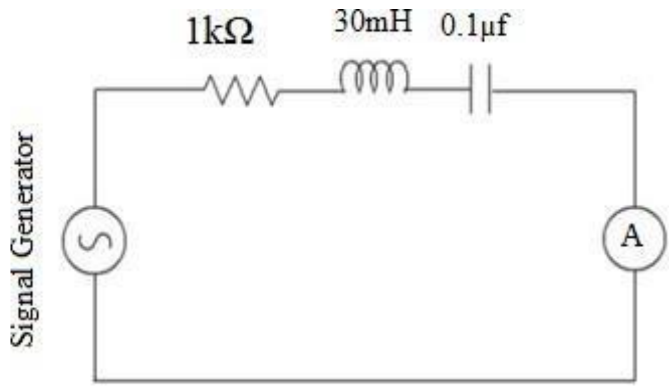


Figure 2

When the width is small compared with the resonance frequency, the resonance is sharp; that is, the resonance curve is narrow. The circuit can be characterized by the quality factor $Q = f_0/\Delta f$.

If resistance is small and resonance is sharp, the quality factor is large. When the resistor is large, the quality is small. Q is a measure of the rate at which energy is dissipated in the circuit if the AC voltage source across the series circuit was removed.

CIRCUIT DIAGRAM



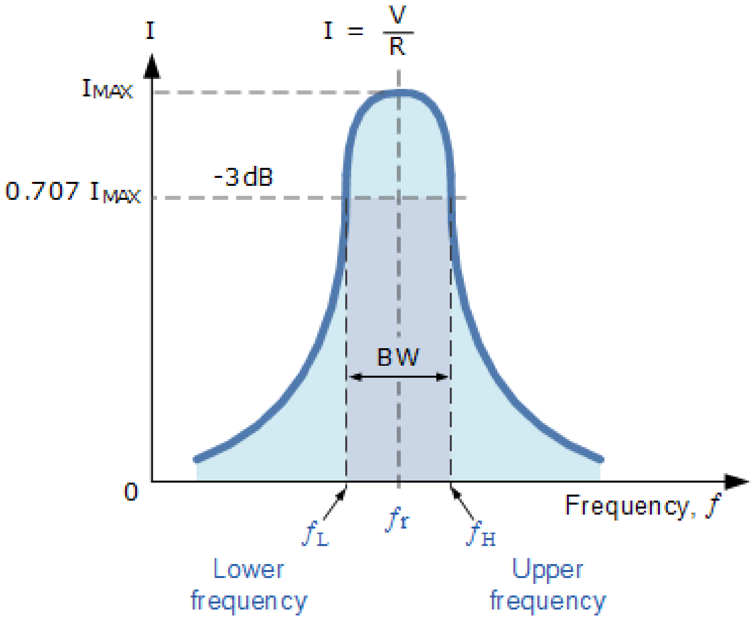
FORMULAE REQUIRED:

Resonant frequency, $f_o = \dfrac{1}{2\pi\sqrt{LC}}$

Quality factor, $Q = X_L / R = 2\pi f_o L/R$

Bandwidth, BW = fo/Q

MODEL GRAPH:



PROCEDURE:

1. Circuit is connected as shown in the fig.
2. A fixed voltage is applied to the circuit through function generator.
3. The frequency is varied in steps and the corresponding ammeter reading is noted down as I_s.
4. A graph is drawn between frequency f and current Is. Resonant frequency (f_o)and half power frequencies (f_1, f_2) are marked on the graph.
5. Bandwidth = (f_2-f_1.) & Quality factor are found from the graph.
6. Practical values of resonant frequency, Q-factor and bandwidth are comparedwith theoretical values.

OBSERVATION TABLE:

S.No.	Frequency	Current(Is)	S.No.	Frequency	Current(Ip)

RESULT TABLE:

	Series Resonance	
	Theoretical	Practical
Resonant frequency(f_0)Hz		
Bandwidth(BW)		
Quality factor(Q)		

PRECAUTIONS:

1. Loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

RESULT:

APPLICATIONS:

All mains operated appliances have switches that are connected to the live wire (the wire that carries current into the appliance). When a switch is in series with a device, it controls the device, allowing us to switch it on and off.

For example, often lawnmowers have two switches in series with each other so that both switches need to be pressed before the mower will turn on lighting circuits.

In the lighting circuit all the lamps are connected in parallel.

VIVA QUESTIONS:

1. Define resonance?
2. Difference between series & parallel resonance?
3. Define band width?
4. Define quality factor?
5. What is the relation between bandwidth & quality factor?
6. What is the lower &upper cutoff frequency?
7. What is the formula for RC series network using laplace transform?
8. Explain initial conditions of capacitance?
9. Explain types of elements?
10. Which capacitor is preferred for high voltage and frequency?
11. What are the materials used for resistor?
12. What happens to voltage when current through the inductor is constant?
13. How will you define capacitance?
14. When we use 3 terminal resistors?
15. What are the materials used for inductance coil?
16. Define Resonance and 3dB points?
17. What is phase difference between voltage and current in inductor and capacitor?
18. Define Selectivity, Bandwidth and Q-factor?
19. For RLC circuit what is the power factor at the lowest frequency?
20. What are the expressions for admittance, conductance and suceptance andalso write its units?
21. What is meant by resonance?
22. What do you mean by sharpness of resonance?
23. What is resonance frequency?

24. What are forced vibrations?

25. What is bandwidth of series circuit?

26. Define quality factor of a series circuit.

27. Why should maximum value of current be divided by √2 for finding bandwidth?

28. Why is the series circuit called as acceptor circuit

29. Why parallel resonance circuit is called a rejecter circuit?

30. What is the importance of series resonance circuits?

31. What is the Q (Quality factor) of a series circuit that resonates at 6 kHz, has equal reactance of 4 kilo-ohms each, and a resistor value of 50 ohms?

32. What is the range between f1 and f2 of an RLC circuit that resonates at 150kHz and has a Q of 30?

33. What is the quality factor?

34. What effect will a parallel tank have upon final filter current?

35. How much current will flow in a series RLC circuit when V_T = 100 V, X_L = 160, X_C = 80, and R =60?

36. At resonance, the term bandwidth includes all frequencies that allow what percentage of maximum current to flow?

37. What is the true power consumed in a 30 V series RLC circuit if Z = 20 ohms and R = 10 ohms?

38. At any resonant frequency, what voltage is measured across the two series reactive components?

39. Series RLC impedance or voltage totals must always be calculated by?

40. What is the high cutoff frequency for an RLC circuit that resonates at 2000Hz and has a bandwidth of 250 Hz?

41. What is the band pass (F1 – F2) of an RLC filter that resonates at 150 kHzand has a coil Q of 30?

42. What is the power factor?

43. What is the phase angle?

44. What would be the power factor for an RLC circuit that acts inductively?

45. Voltage lags current in an RLC circuit when it acts:

46. Series RLC voltage or impedance totals must be calculated by When XC = XL the circuit:?

47. How much current will flow in a series RLC circuit when V_T = 100 V, X_L =

160, X_C = 80, and R = 60?

48. When a full band of frequencies is allowed to pass through a filter circuit tothe output, the resonant circuit is called a:?

49. At resonance, the term bandwidth includes all frequencies that allow what percentage of maximum current to flow?

Ex No:

Date :

6. CALCULATIONS AND VERIFICATION OF IMPEDANCE AND CURRENT OF R-L,R-C AND R-L-C SERIES CIRCUITS

AIM: To calculate and verify the Impedance and Current of R-L, R-C, R-L-C Series circuits.

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	Function Generator	(0-100)MHz	Digital	1
2	Decade Resistance Box	---------	---------	1
3	Decade Inductance Box	---------	---------	1
4	Decade Capacitance Box	---------	---------	1
5	CRO	(0-20)MHz	Dual	1
6	Voltmeter	(0-20)V	Digital	1
7	Ammeter	(0-10)A	Digital	1
8	CRO Probes	---------	---------	1
9	Connecting wires	As required		

THEORY:

SERIES RL CIRCUIT:

Consider a simple RL circuit in which resistor, R and inductor, L are connected in series with a voltage supply of V volts. Let us think the current flowing in the circuit is I (amp) and current through resistor and inductor is I_R and I_L respectively. Since both resistance and inductor are connected in series, so the current in both the elements and the circuit remains the same. i.e $I_R = I_L = I$. Let V_R and V_l be the voltage drop across resistor and inductor.

The impedance of series RL circuit opposes the flow of alternating current. The impedance of series RL Circuit is nothing but the combine effect of resistance (R) and inductive reactance (X_L) of the circuit as a whole. The impedance Z in ohms is given by, $Z = (R^2 + X_L^2)^{0.5}$ and from right angle triangle, phase angle $\theta = \tan^{-1}(X_L/R)$.

In series RL circuit, the values of frequency f, voltage V, resistance R and Inductance L are known and there is no instrument for directly measuring the value of inductive reactance and impedance; so, for complete analysis of seriesRL circuit, follow these simple steps:

Step 1. Since the value of frequency and inductor are known, so firstly calculate the value of inductive reactance X_L: $X_L = 2\pi fL$ ohms.

Step 2. From the value of X_L and R, calculate the total impedance of the circuit which is given

by $Z = \sqrt{(R^2 + X_L^2)}$

Step 3. Calculate the total phase angle for the circuit $\theta = \tan^{-1}(X_L/R)$.

RC SERIES CIRCUIT:

The following steps are used to draw the phasor diagram of RC Series circuit.

1. Take the current I (r.m.s value) as a reference vector.
2. Voltage drop in resistance $V_R = IR$ is taken in phase with the current vector
3. Voltage drop in capacitive reactance $V_C = IX_C$ is drawn 90 degrees behind the current vector, as current leads voltage by 90 degrees in pure capacitive circuit)
4. The vector sum of the two voltage drops is equal to the applied voltage V (r.m.s value).

Now, $V_R = I_R$ and $V_C = IX_C$ Where, $X_C = I/2\pi fC$

$$Z = \sqrt{(R^2 + X_C^2)}$$

R-L-C SERIES CIRCUIT: $Z = \sqrt{(R^2 + (X_L - X_C)^2)}$

CIRCUIT DIAGRAM:

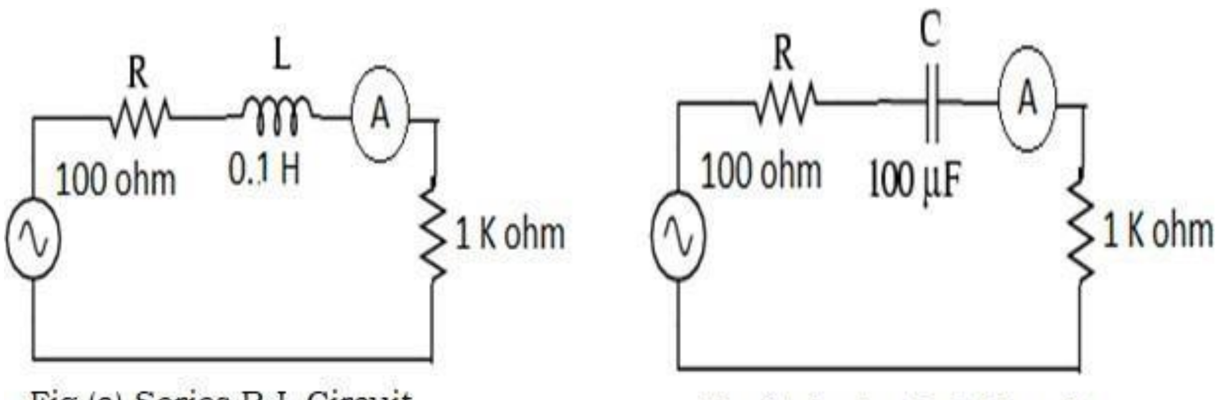


Fig.(a) Series R-L Circuit

Fig.(b) Series R-C Circuit

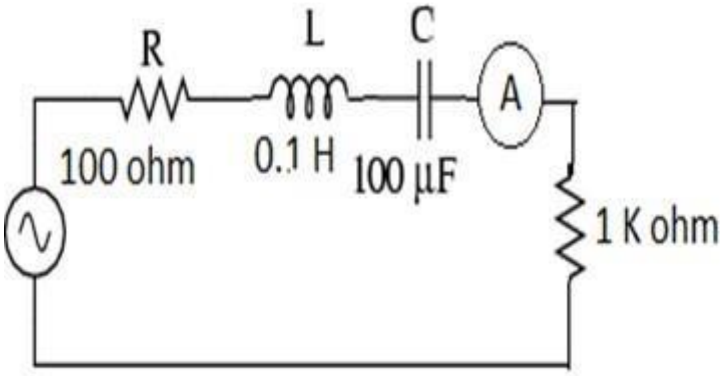


Fig.(c) Series R-L-C Ciruit

PROCEDURE:

1. Give the connections as per the circuit diagram.
2. Connect the CRO probe at point A to get voltage waveform and at B to get the current waveform.
3. Adjust vertical deflection of each channel such that the waveform fills the whole screen.
4. Adjust the sweep rate and the horizontal position control until one half cycle ofthe waveform spans 9 divisions on the scope's scale.
5. Since one half cycle covers 9 divisions, it means each major division on the scope represents 200.
6. Since each major division consists of 5 smaller divisions, each smaller division represents 20/5 = 40.
7. Phase difference between two waveforms is determined by simply counting the number of small divisions between corresponding points on the 2 waveforms.
8. Phase Angle φ= (no.of divisions) * (degree / divisions).
9. Power Factor is given by Cosφ.

Series R-L Circuit:

1. Connections are made as shown in the fig-(a).
2. Input voltage (Square wave) is set to a particular value.
3. The waveform of voltage across inductor is observed on CRO and the waveformis drawn on a graph sheet.

The time constant is found from the graph and verified with the theoreticalvalue.

OBSERVATION TABLE:

	Series R-L Circuit	
	Theoretical	Practical
Impedance		

PRECAUTIONS:

1. Loose connections are to be avoided.
2. Readings should be taken carefully without parallax error.

RESULT:

APPLICATIONS:

1. The two fundamental applications/operations of RC circuits are as: filter circuits, in the frequency domain; as timing circuits, in the time domain.
2. Whenever current flows through the coil, lines of magnetic flux are generated around it. This magnetic flux opposes changes in the current due to induced emf. that component is inductor.

VIVA QUESTIONS:

1. Define the terms
   i) Time response ii) Frequency response
2. Define the terms
   i) Transient state ii) Steady state response
3. Define damping ratio?
4. Define Transient time?
5. What is the locus of voltage phaser across R in series RLC circuit?
6. Define quality factor of a series circuit?
7. What do you mean by Conductivity?

8. Define resonance?

What is the phase difference between voltage and current in a capacitor? Which is leading?

1. What is the phase difference between voltage and current in a inductor? Which is leading?
2. What is the effect of resistance in RLC circuit?
3. For RLC circuit what is power factor at lowest power frequency?
4. Explain the different regions of frequency response?
5. Define bandwidth?
6. Define cutoff frequency?
7. Differentiate between transient state, transient time and transient response?
8. Define natural response and natural frequency?
9. Define time constants for RC and RL circuits?
10. What is meant by rise time, settling time and delay time?
11. What is meant by damping ratio?
12. What is meant by resonance?
13. What do you mean by sharpness of resonance?
14. What is resonance frequency?
15. What are forced vibrations?
16. What is bandwidth of series circuit?
17. State the frequency for RC phase shift oscillator?
18. Why should maximum value of current be divided by √2 for finding bandwidth?
19. Why is the series circuit called as acceptor circuit?
20. Why parallel resonance circuit is called a rejecter circuit?
21. What is the importance of series resonance circuits?
22. What is the phase difference between voltage and current in a inductor? Which is leading?
23. What is the effect of resistance in RLC circuit?
24. For RLC circuit what is power factor at lowest power frequency?
25. What is the locus of voltage phaser across R in series RLC circuit?
26. Define bandwidth?
27. Define cutoff frequency?
28. Differentiate between transient state, transient time and transient response?
29. Define natural response and natural frequency?

30. Define time constants for RC and RL circuits?
31. What is meant by rise time, settling time and delay time?
32. What is meant by damping ratio?
33. Define Selectivity, Bandwidth and Q-factor?
34. For RLC circuit what is the power factor at the lowest frequency?
35. What are the expressions for admittance, conductance and suceptance andalso write its units?
36. What is meant by resonance?
37. What do you mean by sharpness of resonance?
38. What is resonance frequency?
39. What are forced vibrations?
40. What is bandwidth of series circuit?
41. Define quality factor of a series circuit.

Ex No:
Date :

7. MEASUREMENT OF VOLTAGE, CURRENT AND REAL POWER IN PRIMARYAND SECONDARY CIRCUITS OF A SINGLE PHASE TRANSFORMER

AIM: To determine the parameters of Voltage, current and power on primary and secondary of a given single phase transformer.

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	M.I	1
2	Voltmeter	(0-150)V	M.I	1
3	Ammeter	(0-2)A	M.I	1
4	Ammeter	(0-20)A	M.I	1
5	Wattmeter	(0-150)V/(0-2.5)A	LPF	1
6	Wattmeter	(0-150)V/(0-10)A	UPF	1
7	Connecting wires	As required		

TRANSFORMER SPECIFICATIONS:

Transformer Rating :(inKVA) ________________________

Winding Details:

LV (inVolts): ________________________

L.V.side current:________________________

HV (in Volts): ________________________

HV side Current: ________________________

Type (Shell/Core):________________________

AUTO TRANSFORMER SPECIFICATIONS:

Input Voltage (in Volts):_______________

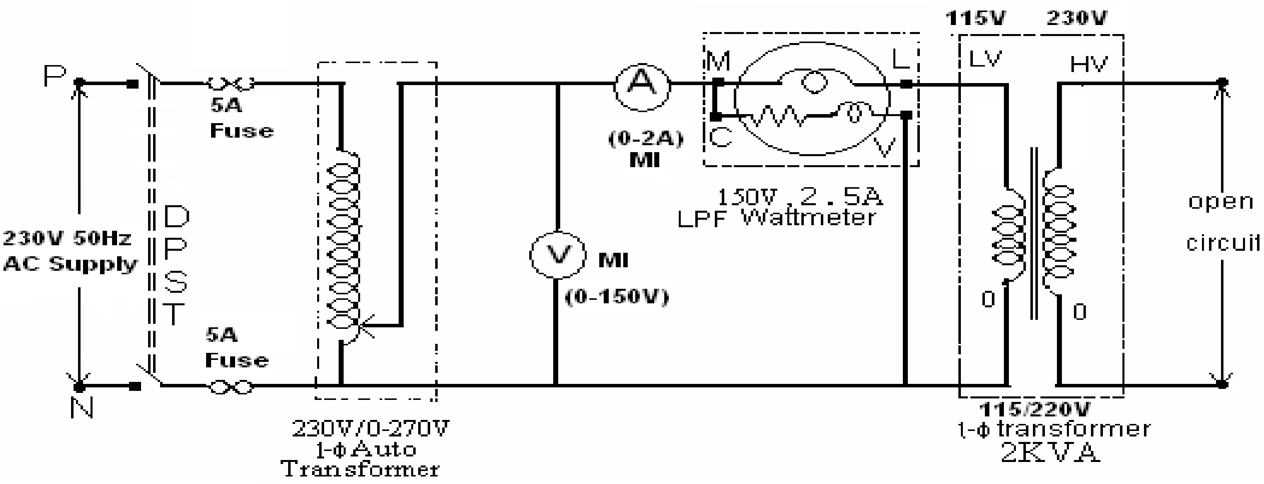
Output Voltage (in Volts): _____________

Frequency (in Hz):_____________________

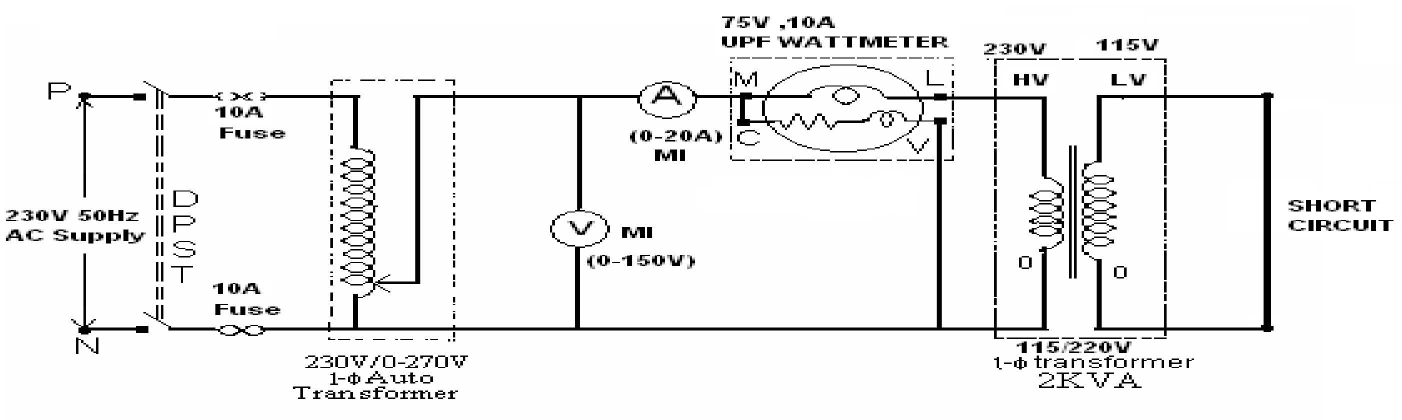
Current rating (in Amp):_______________

CIRCUIT DIAGRAM:

OPEN CIRCUIT:



SHORT CIRCUIT:



PROCEDURE:

OPEN CIRCUIT TEST:

1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment
3. Switch ON the supply. Now apply the rated voltage to the Primary winding by using Variac
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then Variac is set to zero output position and switch OFF the supply.
6. Calculate Ro and Xo from the readings.

SHORT CIRCUIT TEST:

1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment.
3. Switch ON the supply. Now apply the rated Current to the Primary winding by using Variac
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then Variac is set to zero output position and switch OFF the supply.
6. Calculate Ro_1 and Xo_1 from the readings.

OBSERVATION TABLE:

For O.C.TEST

S.No	Voltmeter Reading(V_{oc})	Ammeter Reading(I_o)	Wattmeter Reading(W_{oc})	R_0	X_0

For S.C.TEST

S.No	Voltmeter Reading(Vsc)	Ammeter Reading(Isc)	Wattmeter Reading(Wsc)	R_{01}	X_{01}	Z_{01}

PRECAUTIONS:

1. Connections must be made tight.
2. Before making or breaking the circuit, supply must be switched off.

RESULT:

APPLICATIONS:

1. Step-down localized power distribution.
2. Television sets to regulate voltage.
3. Low voltage electronic devices.

4. Step-up power in home inverters.
5. Non-urban areas where electrical demand is lower.
6. Commercial and residential lighting and heating equipment.

VIVA QUESTIONS:

1. Explain the regulation of a transformer.
2. What is the condition for maximum efficiency of a transformer?
3. Explain all day efficiency and commercial efficiency of a transformer.
4. What are the various losses of a transformer?
5. What is oil immersed type transformer?
6. What are step up transformers?
7. What are step down transformers?
8. What are isolation transformers?
9. Why stepped cores are used?
10. What is yoke section of transformers?
11. What is the purpose of laminating the core in a transformer?
12. What is the purpose of laminating the core in a transformer?
13. Why the cross-section of iron is less than total cross section area of Core?
14. What is stack factor?
15. What are the properties of ideal transformer?
16. What are the functions of no-load current of a transformer?
17. What is the condition for zero voltage regulation?

1. What is the condition for maximum voltage regulation?
2. What are the factors affecting voltage regulation?
3. What is eddy current loss in transformer?
4. The main purpose of using core in transformer is to
5. Transformer works on the principle of?
6. If dc voltage is applied to the primary of a transformer it may?
7. Which of the following will improve the mutual coupling between primary and secondary of a transformer?
8. Which type of core is used for a high-frequency transformer?
9. Transformer oil used in transformer provides
10. Enamel layer is coated over the lamination of a transformer core to
11. In a transformer, the oil must be free from

12. In a transformer, the magnetic coupling between the primary and secondary circuit can be increased by
13. If the density in the core of a transformer is increased
14. The power factor in a transformer
15. which of the following transformer will be largest is size?
16. A transformer transforms
17. A transformer does not change the following
18. In a transformer, the magnitude of the mutual flux is?
19. Thickness of laminations of trans-former core is usually of the order of
20. The size of transformer core depends on
21. In power transformers, breather is used to
22. In a transformer, conservator consists of
23. In a transformer, the resistance between its primary and secondary should be
24. Which is minimized by laminating the core of a transformer?
25. Transformer windings are tapped in the middle because?
26. Which of the following materials is used to absorb moisture from air enteringthe transformer?
27. Which of the following acts as a protection against high voltage surges due to lightening and switching?

A tap changer is used on a transformer for?

1. Over currents in a transformer affect?
2. Highest rating transformers are likely to find application in?
3. Transformer ratings are usually expressed in terms of
4. The noise in transformer due to vibration of laminations set by magnetic forces, is called?

The maximum load that a power transformer can carry is limited by its

Ex No:

Date :

8. PERFORMANCE CHARACTERISTICS OF A SEPARATELY/SELF EXCITED DC SHUNT/COMPOUND MOTOR.

AIM:

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

NAME PLATE DETAILS:

S. No	Parameter	DC Motor
1	Voltage	
2	Current	
3	Speed	
4	Power rating	
5	Exciting Voltage	
6	Exciting Current	
7	Winding	

APPARATUS:

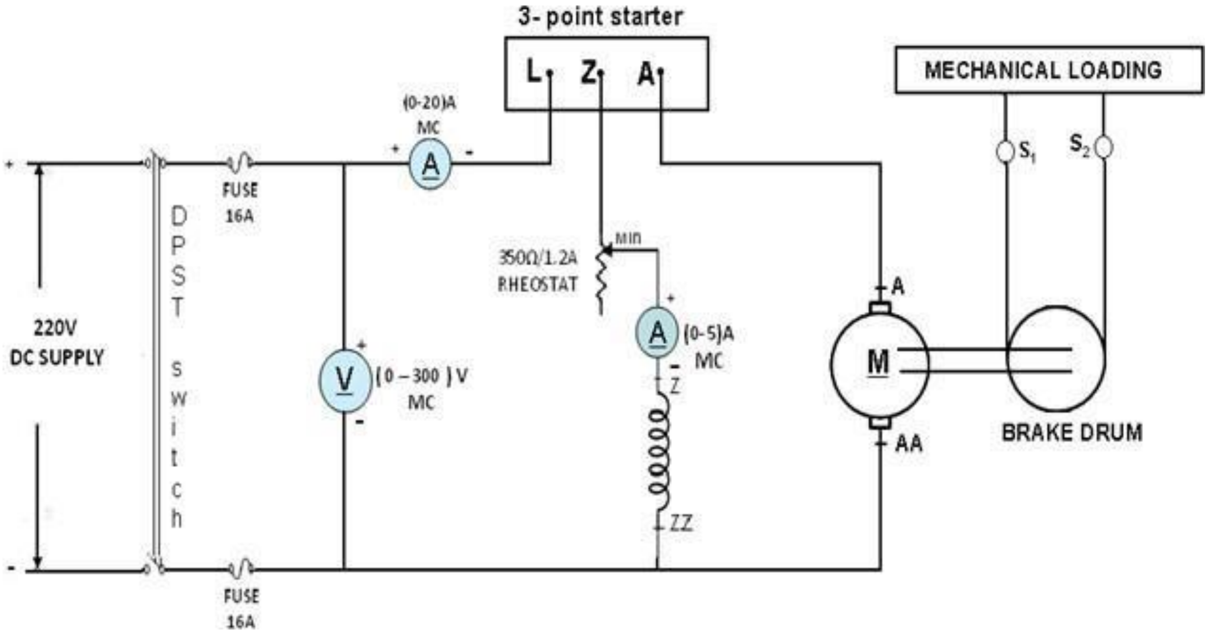
S.No.	Name of the Equipment	Range	Type	Quantity
1	Ammeter	(0 -20) A	MC	1
2	Ammeter	(0 -5) A	MC	1
3	Voltmeter	(0 -300) V	MC	1
4	Rheostat	350Ω/ 1.2A	WW	2
5	Tachometer	(0 -9999)rpm	Digital	1
8	Connecting wires	As required		

THEORY:

It is a direct method and consists of applying a brake to a water cooled pulley mounted on the motor shaft. The brake band is fixed with the help of wooden blocks gripping the pulley. One end of the band is fixed to earth via a spring balance S and the other is connected to a suspended weight W. The motor is running and the load on the motor is adjusted till it carries its full load current.

The simple brake test can be used for small motors only, because in the case of large motors, it is difficult to dissipate the large amount of heat generated at the brake.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connections are made as shown in Fig.
2. The rheostat in the motor field is kept in the minimum position and the tensions S_1 and S_2 are in zero position.
3. Rated voltage is applied by closing the DPST switch and the motor is started with the help of 3-point starter and brought to rated speed by adjusting its field rheostat.
4. No – load readings of voltmeter and ammeters are noted down.
5. By gradually applying the load using the brake drum, the readings of voltmeter, ammeters, Speed, tensions S1 and S2 of spring balances are noted down at every load.
6. The graph between

(a) Output & Speed (b) Output& Efficiency
(c) Output & Torque (d) Output & Armature current

are plotted.

OBSERVATION TABLE:

S. No	V_L (V)	I_L (A)	I_F (A)	I_A (A)	Speed (rpm)	S_1 (K_g)	S_2 (K_g)	Torque (N-m)	Input (W) V x I	Output (W)= 2*MNT*/60	Efficiency Output/Input

MODEL CALCULATION:

FORMULAE:

Torque T = $9.81*(S_1-S_2)*R$ N-m

Output = 2*M*NT / 60

Input = $V*I_L$

Efficiency = Output /Input

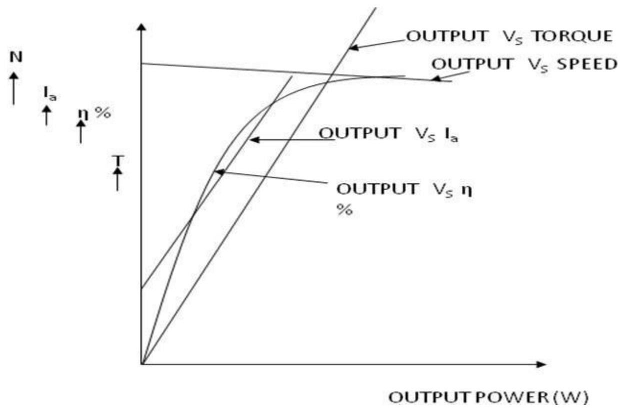
Radius of the brake drum = R in mts

Spring balance readings = S_1 and S_2 in kgs

PRECAUTIONS:

1. Loose connections are to be avoided.
2. The rheostat in the motor field circuit is kept in minimum position.
3. Tensions are checked for zero position.
4. Readings should be taken without any parallax errors.

MODEL GRAPH:



RESULT:

APPLICATIONS:

DC shunt motor is also called as constant speed motor.
In other words, if we assume that the supply voltage is constant then flux also becomes constant. At the rated speed the back emf also becomes nearly constant if the load is same.

The various applications of DC shunt motor are in

1. Lathe Machines,
2. Centrifugal Pumps,
3. Fans,
4. Blowers,
5. Conveyors,
6. Lifts,
7. Weaving Machine,
8. Spinning machines, etc.

VIVA QUESTIONS:

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.

If two motors are required to drive a common load, how will they share the totalload?

4.What are the different types of a DC Motor?

6.What is the purpose of a three point starter?

7.What is field flashing?

8. Why do we use starter for dc machine?

9. What are the different losses in dc machine?

10. Drawbacks of Brake test?

11.What is meant by torque? or Define torque.

12. How can we reduce the eddy current loss in the electrical machine?

13.In DC generators, the series field winding has low resistance while the shuntfield winding has high resistance. Why?

14.Why series motor cannot be started on no-load?

15.Which type of motor is used in trains, what is the rating of supply used?

16.What is magnetic circuit?

17.Define magnetic flux? 18.Define magnetic flux density?19.Define magneto motive force?20.Define reluctance?

21.What is retentivity?

22.Define permeance?

23.Define magnetic flux intensity?24.Define permeability?

25.Define relative permeability?

26.What is mean by leakage flux?

27.What is leakage coefficient?

28.State faradays law of electromagnetic induction29.State Lenz law?

30.Define self inductance?

31.Define mutual inductance?

32.Define coefficient coupling?

33.Give the expression for hysteresis loss and eddy current loss?

34.What is dynamically induced emf?

35.What is fringing effect? 36.What is statically induced emf?

37.How eddy current losses are minimized?

38.What are the magnetic losses?

39. Types of induced emf?

What is the significance of winding factor? 41.Write the energy balance equation for motor?

Ex No:

Date :

9. TORQUE-SPEED CHARACTERISTICS OF A THREE-PHASE INDUCTION MOTOR.

AIM:

To conduct a brake test on the given 3-Φ squirrel cage Induction motor and todraw its speed-torque characteristics

NAME PLATE DETAILS:

S. No	**Parameter**	3-Φ INDUCTION MOTOR
1	Voltage	
2	Current	
3	Speed	
4	Power rating	

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	Ammeter	(0 -20) A	MI	1
2	Voltmeter	(0 -600) V	MI	1
3	Wattmeter	600V/10A	UPF	2
4	Tachometer	(0 -9999)rpm	Digital	1
5	Connecting wires	As required		

THEORY:

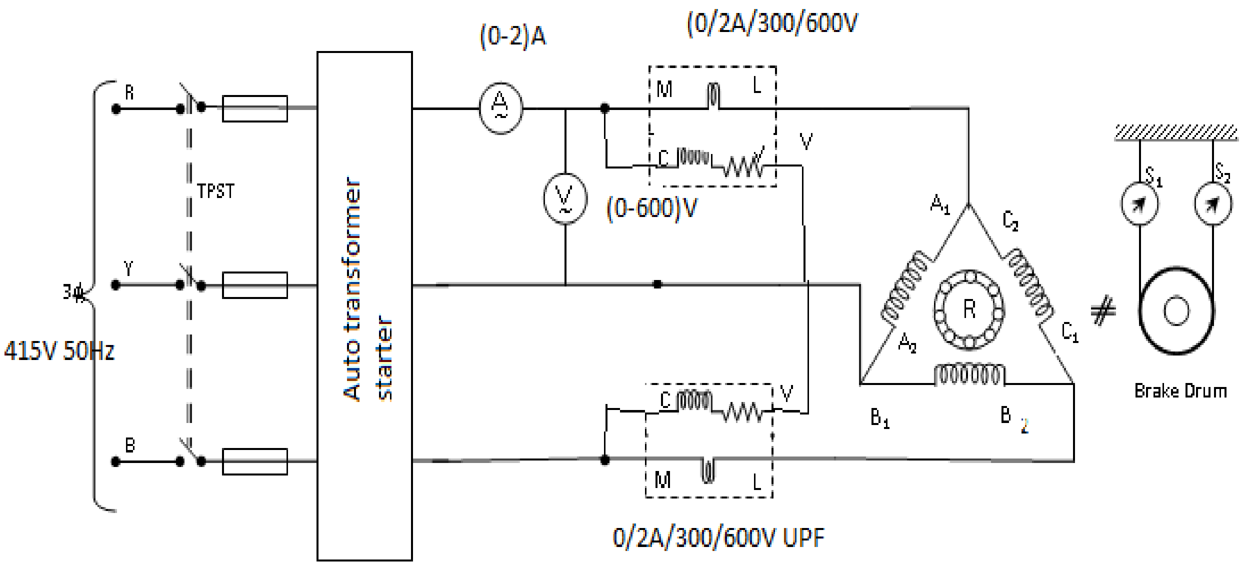
Torque Speed Characteristic is the curve plotted between the torque and the speed of the induction motor. The equation of the torque is given as shown below.

$$\frac{ksR_2 E_2^2}{R_2^2 + (sX_2)^2}$$

At the maximum torque, the speed of the rotor is expressed by the equationshown below.

$$N_M = N_s(1 - s_M).$$

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. The TPST switch is closed and the motor is started using auto transformer starter to run at rated voltage
3. At no load the speed, current, voltage and power are noted.
4. By applying the load, for various values of current the above-mentioned readings are noted.
5. The load is later released and the motor is switched off and the graph is drawn.

MODEL CALCULATION:

FORMULAE:

Torque T = $9.81*(S_1-S_2)*R$ N-m

Output = 2ΠNT / 60

Input = W_1+W_2

Efficiency = Output /Input

Radius of the brake drum = R in mts

Spring balance readings = S_1 and S_2 in kgs

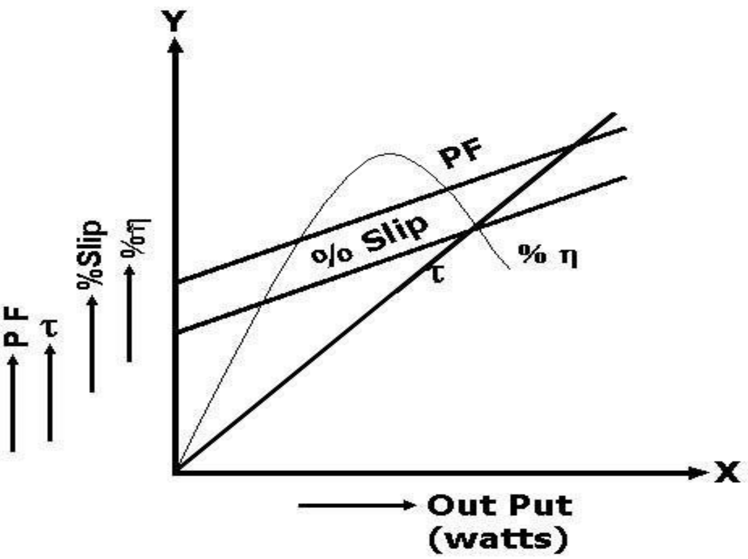
OBSERVATION TABLE:

S. No	V_L (V)	I_L (A)	Speed (rpm)	S_1 (Kg)	S_2 (Kg)	Torque (N-m)	Input (W) W_1+W_2	Output (W)= 2□□□/60	Efficiency Output/Input	% Slip

PRECAUTIONS:

1. Loose connections are to be avoided.
2. The rheostat in the motor field circuit is kept in minimum position.
3. Tensions are checked for zero position.
4. Readings should be taken without any parallax errors.

MODEL GRAPH:



RESULT:

APPLICATIONS:

1. Applications of Polyphase Wound Rotor Induction Motors
   1. Wound rotor motors are suitable for loads requiring high starting torqueand where a lower starting current is required.
   2. The Wound rotor induction motors are also used for loads having high inertia, which results in higher energy losses.
   3. Used for the loads which require a gradual buildup of torque.
   4. Used for the loads that require speed control.
   5. The wound rotor induction motors are used in conveyors, cranes, pumps, elevators and compressors.
   6. The maximum torque is above 200 percent of the full load value while the full load slip may be as low as 3 percent. The efficiency is about 90 %.
2. Applications of Polyphase Cage Rotor Induction Motors

Many polyphase cage induction motors are available in the market to meet the demand of the several industrial applications and various starting and running condition requirement. They are classified according to the Class.

Class A Motors

Class A motors have normal starting torque, high starting current and low operating slip (0.005-0.015). The design has low resistance single cage rotor. The efficiency of the motor is high at full load. Applications of Class A motors are fans, blowers, centrifugal pumps, etc.

Class B Motors

Class B motors have normal starting torque, low starting current and low starting current and low operating slip. The motor is designed, in such a way to withstand the high leakage reactance; as a result, the starting current is reduced. The starting torque is maintained by use of a double cage or deep bar rotor.

The Class B motors are most commonly used motor and used for full voltage starting. The applications and the starting torque are same as that of Class A motors.

Class C Motors

The class C motors have high starting torque and low starting current. Suchmotors are of the double cage and deep bar and has higher rotor resistance. The loads are compressors, conveyors, reciprocating pumps, crushers, etc.

Class D Motors

Class D motors have the highest starting torque as compared to all the other class of motors. The bars of the rotor cage are made up of brass. These types of motors have low starting current and high operating slip. The value of full load operating slip varies between 8 to 15%. Thus, the efficiency of the motor is low.

These motors are suitable for driving intermittent loads which require frequent acceleration and high loads. For example – punch presses, bulldozers and die stamping machines. When the motor is driving the high impact loads, it is coupled to a flywheel to provide kinetic energy.

VIVA QUESTIONS:

1. What is a cogging torque?
2. What is an armature?
3.What is commutator?
4. What is a rotor?
5.How an induction motor is started? why the starter is used?
6.What is the difference between dc motors and the induction motors?
7.What techniques is used to produce a desired speed?
8.How many types of rotor are there? 9.How many types of induction motor?10.What is the slip?
11. Why the speed of the physical rotor and the speed of the rotating magneticfield in the stator must be different?
12. Why stator windings are arranged around the rotor?
13. What is the basic difference between synchronous motor and an induction motor?
14. Why an induction motor sometimes called rotating transformer?
15. How to supply power to rotor?
16. Name the two windings of a single-phase induction motor.
17.What is the use of shading ring in a pole motor?

18.Why is the efficiency of a 3-phase induction motor less than of a transformer?

19.What are the types of starters?

20.State the advantages of capacitor start run motor over capacitor start motor.21..Explain why single-phase induction motor is not self-starting one.

What kind of motor is used in mixie?

23.. State the application of an induction generator? 24..How can varying supply frequency control speed?

25.How is speed control achieved by changing the number of stator poles?

26.Define-Slip frequency

27.What is the application of shaded pole induction motor?

28.What is Universal motor?

29. What are types of 3- phase induction motor?

30. Why the rotor slots of a 3-phase induction motor are skewed?

31.Why the induction motor is called asynchronous motor?

32. What are slip rings?

33. What is the general working principle of Induction motor?

34.What are the various methods of measuring slip?

35. What is the general working principle of Induction motor?

36. What is the advantage of skewed stator slots in the rotor of Induction motors?

37.What are the various methods of speed control in three phase induction motors?

38. What is meant by crawling in the induction motor?

39. Why an Induction Motor sometimes called Rotating transformer?

40. What is the basic difference between Synchronous motor and an InductionMotor?

41. What is the slip?

42.What is a Rotor Speed?

43.What is a Stator?

44.Give the conditions for maximum torque for 3-phase induction motor? 45.What is reason for inserting additional resistance in rotor circuit of a slip ringinduction motor?

46.List out the methods of speed control of cage type 3-phase induction motor?

47.Mention different types of speed control of slip ring induction motor?

48.What are the advantages of 3-phase induction motor?49.What does crawling of induction motor mean?

Ex No:
Date :

10. THREE PHASE TRANSFORMER: VERIFICATION OF RELATIONSHIP BETWEEN VOLTAGES AND CURRENTS (STAR-DELTA, DELTA-DELTA, DELTA-STAR, STAR-STAR)

AIM:

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

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-600)V	M.I	1
2	Ammeter	(0-10)A	M.I	1
3	Wattmeter	(0-600)V/(0-10)A	LPF	1
4	3-Φ Autotransformer	415V/(0-470)V	Core	1
5	Resistive Load	415V,10A	Resistive	1
6	Connecting wires	As required		

TRANSFORMER SPECIFICATIONS:

Transformer Rating :(inKVA) ________________________

Winding Details (For Y-connected Transformer):

LV (inVolts): ________________________

L.V.side current:________________________

HV (in Volts): ________________________

HV side Current: ________________________

Type (Shell/Core):________________________

Winding Details (For Δ-connected Transformer):

LV (inVolts): ____________________

L.V.side current:________________

HV (in Volts): _______________________

HV side Current: ______________________

Type (Shell/Core):___________________________

AUTO TRANSFORMER SPECIFICATIONS:

Input Voltage (in Volts):_________________

Output Voltage (in Volts): _________________

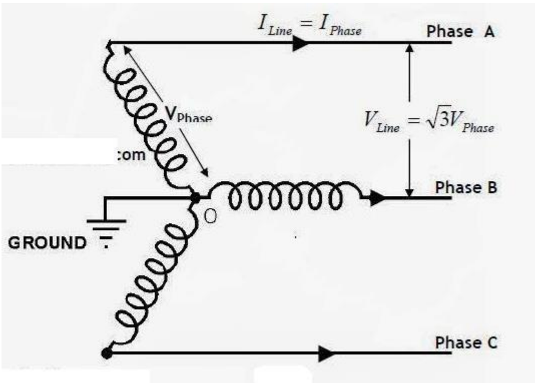
Frequency (in Hz):_______________________

Current rating (in Amp):___________________

THEORY:

1. Star Connection (Y) System is also known as Three Phase Four Wire System (3- Phase 4 Wire) and it is the most preferred system for AC power distribution while for transmission, Delta connection is generally used.

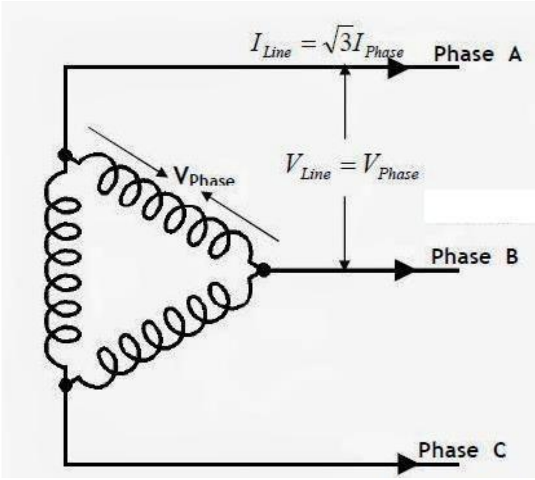
In Star (also denoted by Y) system of interconnection, the starting ends or finishing ends (similar ends) of three coils are connected together to form the neutral point. or Star Connection is obtained by connecting together similar ends of the three coils, either "Starting" or "Finishing". The other ends are joined to the line wires. The common point is called the neutral or Star Point, which is represented by N. (As shown in fig 1)



In Star Connection $V_L = \sqrt{3}\ V_{Ph}$ and $I_L = I_{Ph}$

2. Delta or Mesh Connection (Δ) System is also known as Three Phase Three Wire System (3-Phase 3 Wire) and it is the most preferred system for AC power transmission while for distribution, Star connection is generally used.

In Delta (also denoted by Δ) system of interconnection, the starting ends of the three phases or coils are connected to the finishing ends of the coil. Or the starting end of the first coil is connected to the finishing end of the second coil and so on (for all three coils) and it looks like a closed mesh or circuit as shown in fig.



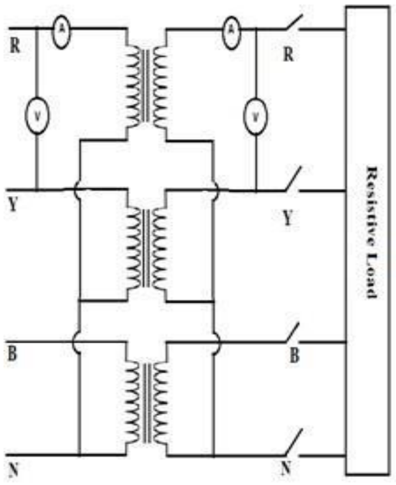
In more clear words, all three coils are connected in series to form a close mesh or circuit. Three wires are taken out from three junctions and the all outgoing currents from junction assumed to be positive.

In Delta connection, the three windings interconnection looks like a short circuit, but this is not true, if the system is balanced, then the value of the algebraic sum of all voltages around the mesh is zero in Delta connection.

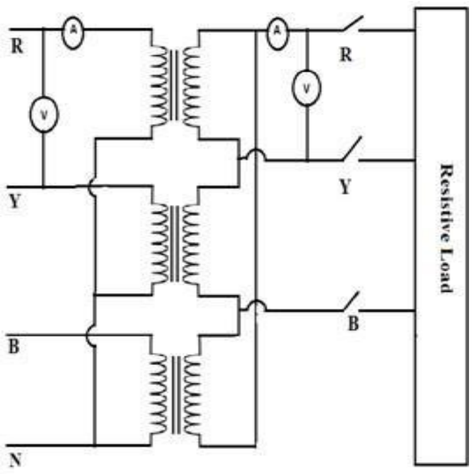
When a terminal is open in Δ, then there is no chance of flowing currents with basic frequency around the closed mesh.

In Delta connection, the Line Voltage is equal to the Phase Voltage, i.e $V_L=V_{Ph}$ and $I_L=\sqrt{3}I_{Ph}$

CIRCUIT DIAGRAM:



Star-Star Connection of Transformer



Star-Delta Connection of Transformer

PROCEDURE:

1. Connect circuit as shown in the circuit diagram.
2. Set Variac to minimum position.
3. Switch on the main supply.
4. Note the readings of ammeter, voltmeter.
5. Note more readings by changing supply voltage.

OBSERVATION TABLE:

S.No	Connection	Star Connection					Delta Connection				
		V_L	V_{ph}	I_L	I_{Ph}	Real Power $\sqrt{3}$□□□□□□ □Φ	V_L	V_{ph}	I_L	I_{Ph}	Real Power $\sqrt{3}$□□□□□□ □Φ
1	□ − □										
2	□ − Δ										
3	Δ − □										
4	Δ − Δ										

MODEL CALCULATION:

FORMULAE:

Line voltage V_L =

Line current I_L =

Phase voltage V_{ph} =

Phase current I_{ph}

Real power (P) = √3□▯□▯□□□Φ

PRECAUTIONS:

1. Ensure the minimum position of three phase autotransformer during power onand off.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.

RESULT:

APPLICATIONS:

1. Star-Star Connection of three phase transformer:

1. This Type of Transformer is rarely used due to problems with unbalanced loads.
2. It is economical for small high voltage transformers as the number of turnsper phase and the amount of insulation required is less.

2. Star-Delta Connection of three phase transformer:

1. It is commonly employed for power supply transformers.
2. This type of connection is commonly employed at the substation end of the transmission line. The main use with this connection is to step down the voltage. The neutral available on the primary side is grounded. It can be seen that there is phase difference of 30° between primary and secondary line voltages.
3. Commonly used in a step-down transformer, Y connection on the HV side reduces insulation costs the neutral point on the HV side can be grounded, stable with respect to unbalanced loads. As for example, at the end of a transmission line. The neutral of the primary winding is earthed. In this system, line voltage ratio is 1/√3 Times of transformer turn-ratio and secondary voltage lags behind primary voltage by 30°. Also third harmonic currents flow in the to give a sinusoidal flux.

3. Delta – Star Connection of three phase transformer:

1. Commonly used in a step-up transformer: As for example, at the beginning of a HT transmission line. In this case neutral point is stable and will not float in case of unbalanced loading. There is no distortion of flux because existence of a Δ -connection allows a path for the third-harmonic components. The line voltage ratio is √3 times of transformer turn-ratio and the secondary voltage leads the primary one by 30°. In recent years, this arrangement has become very popular for distribution system as it provides 3- Ø, 4-wire system.

Commonly used in commercial, industrial, and high-density residential locations: To supply three-phase distribution systems. An example would be a distribution transformer with a delta primary, running on three 11kV phases with no neutral or earth required, and a star (or wye) secondary providing a 3- phase supply at 400 V, with the domestic voltage of 230 available between each phase and an earthed neutral point.

2. Used as Generator Transformer: The Δ-Y transformer connection is used universally for connecting generators to transmission systems because of two very important reasons. First of all, generators are usually equipped with sensitive ground fault relay protection. The Δ-Y transformer is a source of ground currents for loads and faults on the transmission system, yet the generator ground fault protection is completely isolated from ground currents on the primary side of the transformer. Second, rotating machines can literally be.

3. Delta – Delta Connection of three phase transformer:

1. Suitable for large, low voltage transformers.
2. This Type of Connection is normally uncommon but used in some industrial facilities to reduce impact of SLG faults on the primary system
3. It is generally used in systems where it need to be carry large currents on low voltages and especially when continuity of service is to be maintained even though one of the phases develops fault.

VIVA QUESTIONS:

1. What is the power factor of a transformer at no load?
2. What is the normal phase difference between the voltage and the no-load current in a transformer?
3. What are the essential parts of a transformer?

4. What is the name of the winding to which supply is given?

5. What is the name of the winding from which the supply is taken for load connections?

6. Which material is used for the core of a transformer and why?

7. What is the use of iron core in a transformer?

8. How is magnetic leakage reduced?

9. Why iron cores of transformers are laminated?

10. What determines the thickness of the lamination or stamping?

11. Why are the laminations insulated from each other?

12. What is stacking factor? What is its approximate value?

13. What is called grain-oriented laminations?
What is the permissible maximum flux density in transformer core?

14. What is the phase relationship between the primary and secondary voltagesof a transformer?

15. What is turn ratio of a transformer?

16. What is voltage ratio of a transformer?

17. What current flows in the transformer primary when it’s secondary is open?

18. What is the formula for calculating no-load current?

19. Why is the frequency not changed during transformation of electrical energyin a transformer?

21 What is the emf equation of a transformer?

22. What are the two basic types of transformers?

23. What are the types of transformers according to the arrangement of iron cores?

24. What magnetic circuit is formed in Berry-type constructions and why?

25. What is called limb of a transformer?

26. Why are LT windings placed near the core?

27. What are the types of windings according to the construction?

28. What is the difference between cylindrical-type and sandwich-type winding?

29. What are the types of transformers?
30 .What do you mean by step-up transformers?

31. What is an ideal transformer?

32. What do you mean by power transformer?

33. What do you mean by distribution transformers?

34. What do you mean by lighting transformer?

35. How does a transformer contribute towards the widespread popularity of AC system over DC?

36. The required thickness of lamination in a transformer decreases when

37. Oil in transformers is used to -

38. What is the principle of operation of a Transformer?

39. What is the function of a Transformer?

40. What are the different types of a Transformer?

41. What are the different parts of a Transformer?

42. What are the different types of measuring instruments?

What is the principle of operation of a Transformer?

31. What is meant by efficiency?

32. What is the purpose of Auto transformer (or Dimmer stat)?

33. Define regulation?

What do you mean by step-down transformers?

Ex No:

Date :

11. LOAD TEST ON SINGLE PHASE TRANSFORMER(CALCULATE EFFICIENCY AND REGULATION)

AIM: To perform conduct Load test on the given 1-Φ Transformer and to calculateits, Efficiency and Regulation.

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-150)V	M.I	1
2	Voltmeter	(0-75)V	M.I	1
3	Ammeter	(0-2)A	M.I	1
4	Ammeter	(0-20)A	M.I	1
5	Wattmeter	(0-150)V/(0-2.5)A	LPF	1
6	Wattmeter	(0-150)V/(0-10)A	UPF	1
7	Autotransformer	230V/(0-270)V	Core	1
8	Connecting wires	As required		

TRANSFORMER SPECIFICATIONS:

Transformer Rating :(inKVA) ______________________

Winding Details:

LV (inVolts): ______________________

L.V.side current:______________________

HV (in Volts): ______________________

HV side Current: ______________________

Type (Shell/Core):______________________

AUTO TRANSFORMER SPECIFICATIONS:

Input Voltage (in Volts):_________________

Output Voltage (in Volts): _________________

Frequency (in Hz):_______________________

Current rating (in Amp):___________________

THEORY:

In a practical transformer there are two types of losses:

(1) Cu loss

(2) Core/Iron loss.

Therefore output of a transformer is always less than input of the transformer. Here transformer is loaded with a variable resistive load. Input to the transformercan be found out by using a wattmeter and output can also be measured by a wattmeter or with the help of voltmeter and ammeter.

Input power to transformer = Reading of wattmeter or V_1I_1

Output power from transformer = V_2I_2

% efficiency η = (Output Power / Input Power) × 100%

$= (V_2I_2 / V_1I_1) \times 100\%$

Voltage regulation (V.R) is the change in the magnitude of secondary voltage fromno load to desired load.

This change is expressed as a percentage of the no load voltage.

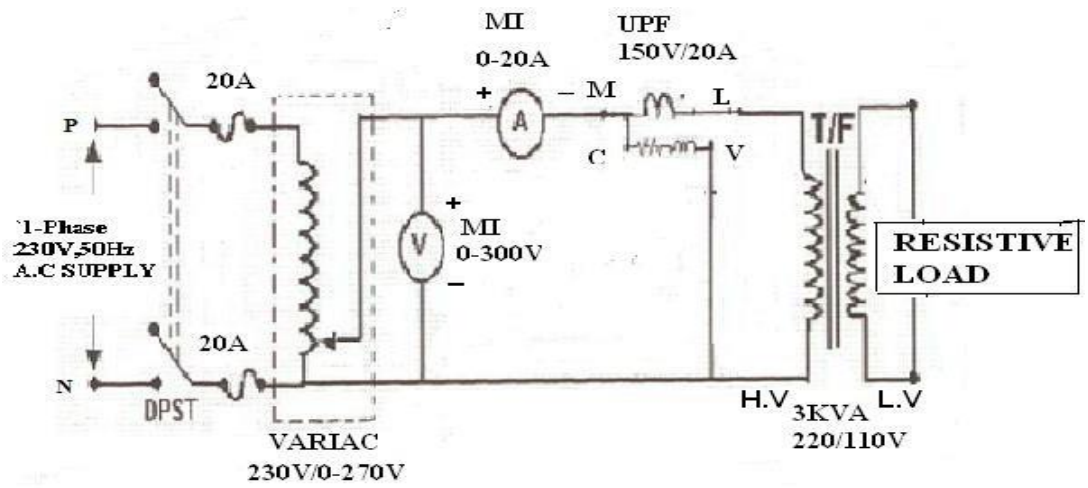
$\% V.R. = E_2\text{-}V / E_2 * 100 \%$

Where: E2 = No load voltage

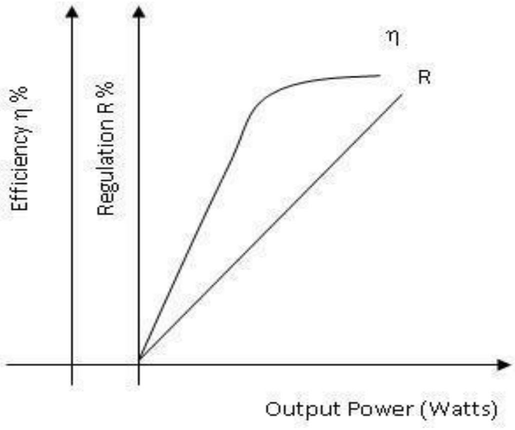
V2 = any load voltage

This voltage regulation is because of resistance and leakage reactance of the transformer.

CIRCUIT DIAGRAM:



MODEL GRAPH:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. By varying the Auto transformer, rated voltage is applied to the input side ofthe transformer and should be maintained constant throughout the experiment.
3. By varying the load in steps, readings of ammeter, voltmeter, and wattmeterare noted down in each step.
4. Efficiency and Regulations are calculated in each step and tabulated.
5. Graphs are drawn Output Vs Efficiency and Regulation.

MODEL CALCULATION:

FORMULAE:

Input Power = W1 x Multiplication factor Output

Power = W2 x Multiplication factor

Efficiency η % = Output Power / Input Power ×100

% Voltage Regulation = V_{NL}-V_{FL}/V_{NL} *100

OBSERVATION TABLE:

S.No	Secondary Voltage	Primary Voltage	Input Power	Output Power	Efficiency = Output-Input

PRECAUTIONS:

1. The Dimmer stat should be kept at minimum O/P position initially.
2. Rated voltage should be maintained on the Primary of the Transformer.
3. The Dimmer stat should be varied slowly & uniformly.

RESULT:

APPLICATIONS:

1. Step-down localized power distribution.
2. Television sets to regulate voltage.
3. Low voltage electronic devices.
4. Step-up power in home inverters.
5. Non-urban areas where electrical demand is lower.
6. Commercial and residential lighting and heating equipment.

VIVA QUESTIONS:

1. Explain the regulation of a transformer.
2. What is the condition for maximum efficiency of a transformer?
3. Explain all day efficiency and commercial efficiency of a transformer.
4. What are the various losses of a transformer?
5. What is oil immersed type transformer?
6. What are step up transformers?
7. What are step down transformers?
8. What are isolation transformers?
9. Why stepped cores are used?
10. What is yoke section of transformers?
11. What is the purpose of laminating the core in a transformer?
12. What is the purpose of laminating the core in a transformer?
13. Why the cross-section of iron is less than total cross section area of Core?
14. What is stack factor?
15. What are the properties of ideal transformer?
16. What are the functions of no-load current of a transformer?

17. What is the condition for zero voltage regulation?

18. What is the condition for maximum voltage regulation?

19. What are the factors affecting voltage regulation?

20. What is eddy current loss in transformer?

21. The main purpose of using core in transformer is to

22. Transformer works on the principle of?

23. If dc voltage is applied to the primary of a transformer it may?

Which of the following will improve the mutual coupling between primary andsecondary of a transformer?

1. Which type of core is used for a high-frequency transformer?
2. Transformer oil used in transformer provides
3. Enamel layer is coated over the lamination of a transformer core to
4. In a transformer, the oil must be free from
5. In a transformer, the magnetic coupling between the primary and secondary circuit can be increased by
6. If the density in the core of a transformer is increased
7. The power factor in a transformer
8. which of the following transformer will be largest is size?
9. A transformer transforms
10. A transformer does not change the following
11. In a transformer, the magnitude of the mutual flux is?
12. Thickness of laminations of trans-former core is usually of the order of
13. The size of transformer core depends on
14. In power transformers, breather is used to
15. In a transformer, conservator consists of
16. In a transformer, the resistance between its primary and secondary should be
17. Which is minimized by laminating the core of a transformer?
18. Transformer windings are tapped in the middle because?
19. Which of the following materials is used to absorb moisture from air enteringthe transformer?
20. Which of the following acts as a protection against high voltage surges due to lightening and switching?
21. A tap changer is used on a transformer for?
22. Over currents in a transformer affect?

23. Highest rating transformers are likely to find application in?

24. Transformer ratings are usually expressed in terms of

25. The noise in transformer due to vibration of laminations set by magnetic forces, is called?

The maximum load that a power transformer can carry is limited by its

Ex No:

Date :

12. MEASUREMENT OF ACTIVE AND REACTIVE POWER IN A BALANCED THREE-PHASE CIRCUIT

AIM:

To measure the active and reactive power using (single phase wattmeter) for the given balanced three phase network.

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-600)V	M.I	1
2	Ammeter	(0-10)A	M.I	1
3	Wattmeter	(0-600)V/(0-10)A	LPF	1
4	Wattmeter	(0-600)V/(0-10)A	UPF	2
5	3-Φ Autotransformer	415V/(0-470)V	Core	1
6	3-Φ Resistive Load	415V,10A	Resistive	1
7	3-Φ Inductive Load	415V,10A	Inductive	1
8	Connecting wires	As required		

THEORY:

ACTIVE POWER:

A three phase balanced voltage is applied on a balanced three phase load when the current in each of the phase lags by an angle Φ behind corresponding phase voltages. Current through current coil of $W_1=I_r$, current through current coil of $W_2=I_B$, while potential difference across voltage coil of $W_1=V_{RN}-V_{YN}=V_{RY}$ (line voltage), and the potential difference across voltage coil of $W_2= V_{RN}-V_{YN}=V_{BY}$. Also, phase difference between I_R and V_{RY} is (300+ Φ).While that between I_B and V_{BY} is (300- Φ).Thus reading on wattmeter W_1 is given by $W_1=V_{RY} I_Y \cos(300+ \Phi)$ While reading on wattmeter W_2 is given by $W_2=V_{BY} I_B \cos(300- \Phi)$ since the load is balanced,

$|I_R|=|I_Y|=|_{IB}|=I$ and $|V_{RY}|=|V_{BY}|=V_L W_1=V_L I \cos(300+ \Phi)$ $W_2=V_L I \cos(300- \Phi)$.

Thus total power P is given by

$W= W_1 +W_2 = V_L I \cos(300+ \Phi) + V_L I \cos(300- \Phi) =$

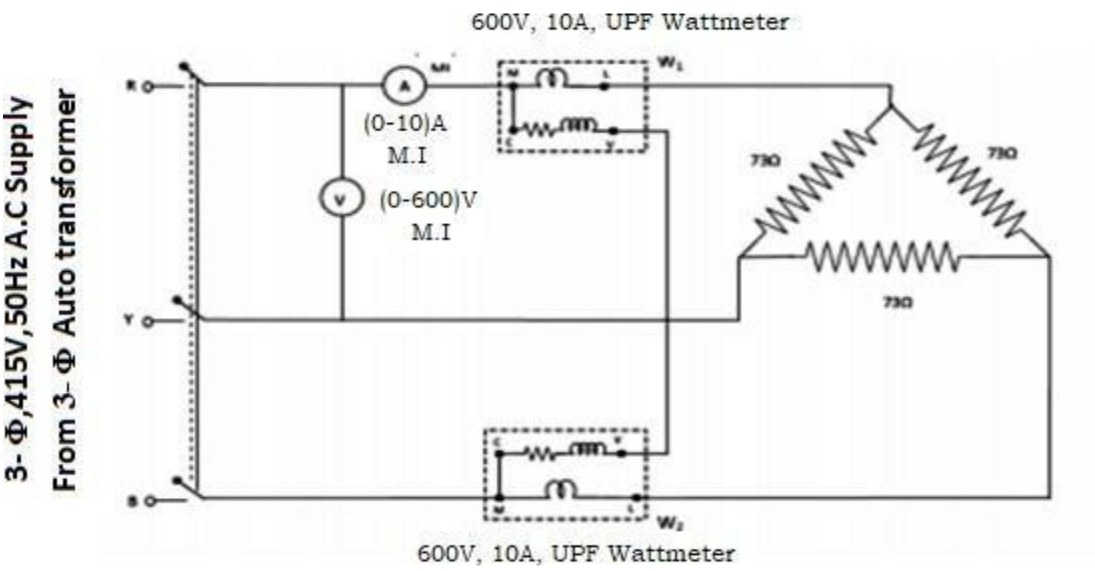
$V_L I [\cos(300+ \Phi) + \cos(300- \Phi)] = [\sqrt{3}/2 *2\cos \Phi] V_L I = \sqrt{3} VLI\cos \Phi$.

REACTIVE POWER:

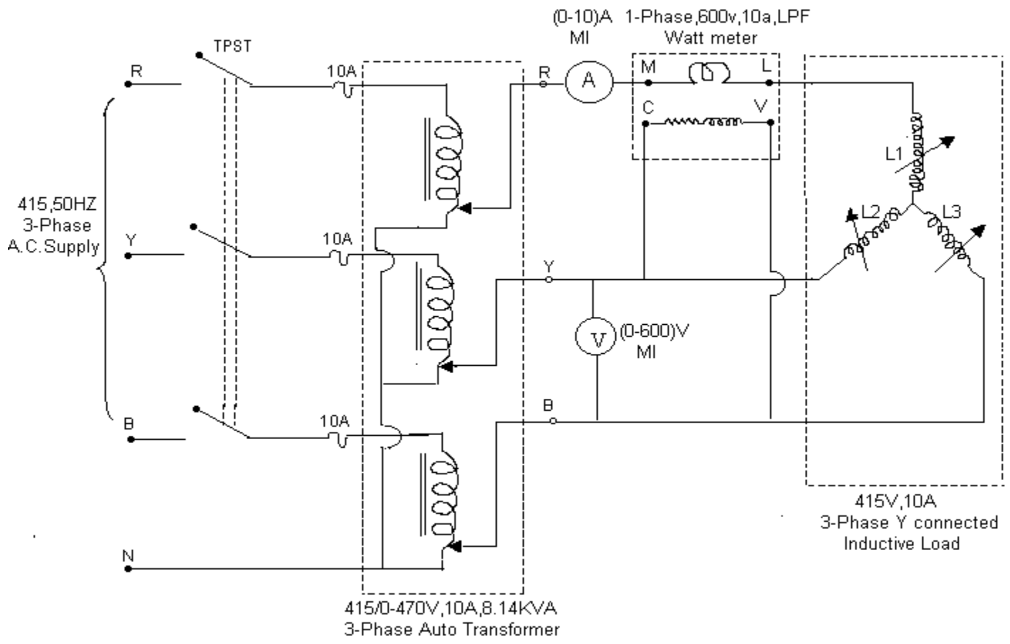
Reactive power measurement in 3-Φ circuits using 1- Φ wattmeter can be done only for balanced 3- Φ loads. By connecting the current coil of the wattmeter in one line and the pressure coil across the other two lines of 3- Φ circuit, current through the current coil and voltage across the pressure coil are determined. Now as the current in the current coil lags the voltage by an angle of 90°, the wattmeter reads a value proportional to the reactive power of the circuit.

CIRCUIT DIAGRAM:

ACTIVE POWER (DELTA CONNECTED LOAD):



RE-ACTIVE POWER (STAR CONNECTED LOAD):



PROCEDURE:

ACTIVE POWER:

1. Connect the circuit as shown in the figure.
2. Ammeter is connected in series with wattmeter whose other end is connected toone of the loads of the balanced loads.
3. The Y-phase is directly connected to one of the nodes of the 3-ph supply.
4. A wattmeter is connected across Y & B phase, the extreme of B-phase isconnected to the third terminal of the balanced 3-ph load.
5. Another wattmeter is connected across R &Y phase, the extreme of R-phase is connected to the third terminal of the balanced three phases load.
6. Verify the connections before switching on the 3-ph power supply.

REACTIVE POWER:

1. Connect the circuit as per the circuit diagram.
2. Keep the variac of the auto-transformer in minimum position.
3. Close supply TPST switch and vary the auto-transformer slowly and apply rated voltage i.e.230V.
4. Vary the load gradually and at different loads, note down readings of ammeter, Voltmeter and Wattmeter.

5. Draw the phasor diagram.

OBSERVATION TABLE:

For ideal inductive load Φ = 90^0 --> Sin Φ = 1

S.No.	Voltage(V)	Current(I)	Wattmeter(W)	Reactive Power(Q)= $\sqrt{3}V_L I_L \sin\phi$ (VAR)

MODEL

CALCULATION:

FORMULAE:

Load voltage V_L =

Load current I_L =

Watt meter reading W =

Reactive power (measured value) = $\sqrt{3}W$ =

Reactive power (actual value) = $\sqrt{3}V_L I_L \sin\phi$ =

$$\% \text{ error} = \frac{\text{measured value} - \text{actual value}}{\text{actual value}} x100$$

PRECAUTIONS:

1. Avoid making loose connections.
2. Readings should be taken carefully without parallax error.
3. Ensure the minimum position of three phase autotransformer during power onand off.
4. Set the ammeter pointer at zero position.
5. Take the readings without parallax error.

RESULT:

VIVA QUESTIONS:

1.Define phase, line & neutral.

2.Define Phase Voltages & Phase Currents.

3.Define line voltage and line current.

4.Define line to neutral voltages and line to netural current.

5.Write the relationship of line and phase voltage and current in star.

6.Write the relationship of line and phase voltage and current in delta.

7.Draw the phasor diagram of delta connection.

8. Define balanced load. 9.Define unbalanced load. 10.Types of unbalanced load.

11. Write 3 phase power equation.

12. Write the power factor calculation of two wattmeter method.
Draw two wattmeter methods for measurement of power in 3 phase systems.14.Comparisons of star and delta connections.

15. Compute the instantaneous three-phase power consumed by the load. 16.Why three-phase power systems are used instead of single-phase ones? 17.List the advantages of analyzing power systems using a per-unit system.18.Reactive power

is expressed in?

19.The expression of true power (P_{true}). 20.The

equation of reactive power is?

21. In a three-phase system, the voltages are separated by

22. In a three-phase system, when the loads are perfectly balanced, the neutral current is?

In a certain three-wire Y-connected generator, the phase voltages are 2 kV.The magnitudes of the line voltages are?

Ex No:
Date :

13. NO-LOAD CHARACTERISTICS OF A THREE-PHASE ALTERNATOR

AIM:

To find no-load parameters of 3-phase alternator Voltage and Current.

NAME PLATE DETAILS:

S. No	**Parameter**	DC Motor	3-phase alternator
1	Voltage		
2	Current		
3	Speed		
4	Power rating		
5	Exciting Voltage		
6	Exciting Current		
7	Winding		

APPARATUS:

S.No.	Name of the Equipment	Range	Type	Quantity
1	Ammeter	(0 -10) A	MI	1
2	Ammeter	(0-5)A	MC	1
3	Voltmeter	(0 -600) V	MI	1
4	Rheostat	400Ω/1.7A	WW	1
5	Rheostat	145Ω/1.7A	WW	1
6	Tachometer	(0 -9999)rpm	Digital	1
7	Connecting wires	As required		

THEORY:

The regulation of Alternator is defined as "the rise in terminal voltage" when full load is removed divided by rated terminal voltage with speed and excitation of alternator remaining unchanged. The experiment involves the determination of the following characteristics and parameters:

1. The open -circuit characteristic (the O.C.C).
2. The short-circuit characteristic (the S.C.C).
3. The effective resistance of the armature winding (Ra).

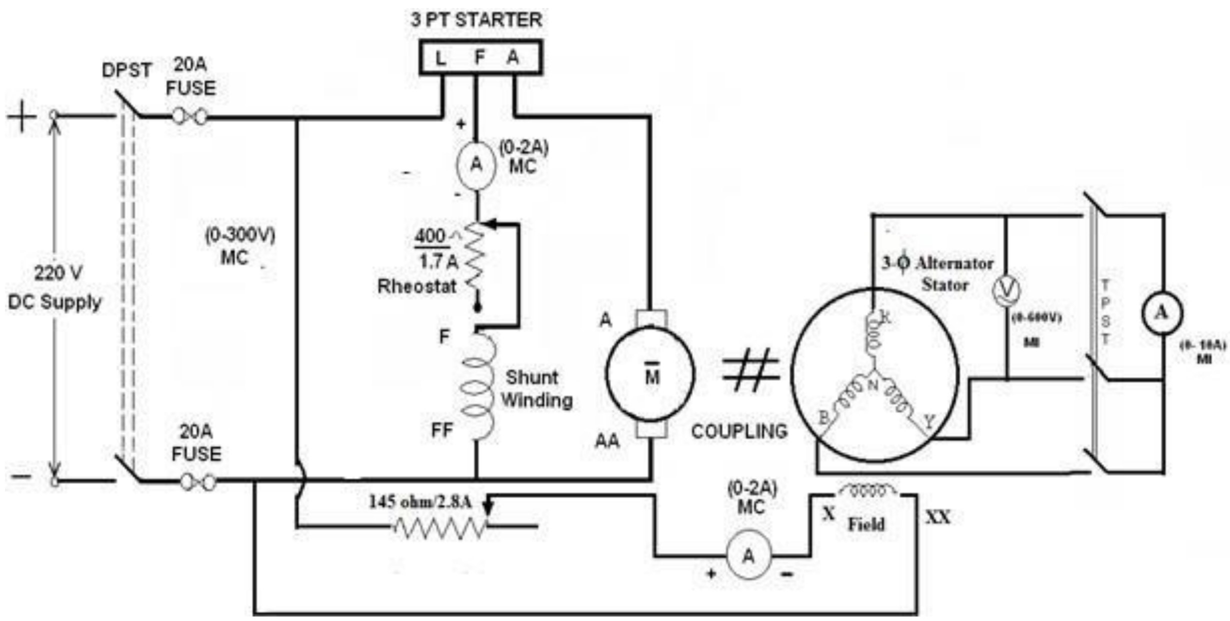
The open circuit and short circuit characteristics of a 3-Φ alternator is plotted on Per phase basis. To find out the synchronous impedance from these characteristics, open circuit voltage, (E_0) and short circuit current (I_{sc},) corresponding to a particular value of field current is obtained. Then, synchronous impedance per phase (Zs) is given by – $Z_S = \frac{E_0}{I_{sc}}$

At higher values of field current, saturation occurs and the synchronous Impedance of the machine decreases. The value of 'Zs' calculated for the unsaturated region of the O.C.C is called the unsaturated value of the synchronous impedance. If 'Ra' is the effective resistance of the armature per phase, the synchronous reactance 'Xs' is given by – $X_S = \sqrt{(Z_a^2 - R_a^2)}$

If 'V' is the magnitude of the rated voltage of the machine whose regulation is to be calculated for a load current 'I' at a power factor angle (Φ)then the corresponding magnitude of the open circuit voltage 'E_0' is given by E_0=V+IZs

Percentage of regulation = $\frac{(E_0 - V)}{V} X100.$

CIRCUIT DIAGRAM:



PROCEDURE:

OPEN CIRCUIT TEST:

1. Make the connections as per the circuit diagram.

Before starting the experiment, the potential divider network in the alternator field circuit is maximum and field regulator rheostat of motor circuit is set minimum resistance position.

2. Switch ON the supply and close the DPST switch. The DC motor is startedby moving starter handle.
3. Adjust the field rheostat of DC motor to attain rated speed (equal to synchronous speed of an alternator)
4. By decreasing the field resistance of Alternator, the excitation current of alternator is increased gradually in steps.
5. Note the readings of field current, and its corresponding armature voltagein a tabular column
6. The voltage readings are taken upto and 10% beyond the rated voltage ofthe machine.

SHORT CIRCUIT TEST:

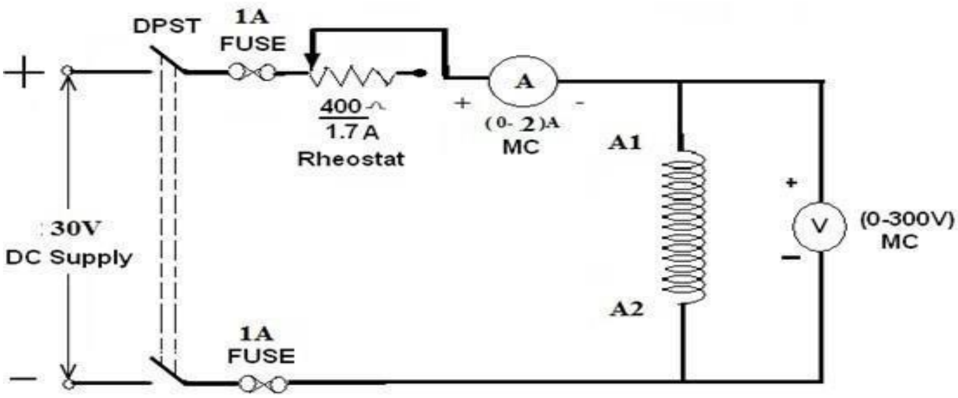
1. Make the connections as per the circuit diagram.
2. Before starting the experiment, the potential divider network in the alternator field circuit is maximum and field regulator rheostat of motor circuit is set

minimum resistance position.

3. Switch ON the supply and close the DPST switch. The DC motor is started by moving starter handle.
4. Close the TPST Switch in the circuit diagram.
5. Adjust the field rheostat of DC motor to attain rated speed (1500 rpm).
6. By decreasing the field resistance of Alternator, the excitation current of alternator is increased gradually in steps.
7. Note the readings of field current, and its corresponding short circuit current in a tabular column.
8. The readings are taken within the limits of alternator current rating.

Draw the graph between E_0vs I_f. and $I_a$vs I_f.

CONNECTION DIAGRAM TO FIND Ra:



PROCEDURE TO FIND ARMATURE RESISTANCE OF ALTERNATOR:

1.Connections are made as per the circuit diagram.

2.Switch ON the supply. By varying the rheostat, take different readings of ammeter and voltmeter in a tabular column.

3.From the above readings, average resistance Ra of armature is found out.

OBSERVATION TABLE

Sl no.	Armature current I(amp)	Armature voltage Va (volts)	Rdc=V / I

PROCEDURE TO FIND SYNCHRONOUS IMPEDANCE FROM OC AND SCTESTS:

1. Plot open circuit voltage, short circuit current verses field current on a graphsheet.
2. From the graph, the synchronous impedance for the rated value of excitation is calculated.
3. The excitation emf is calculated at full load current which is equal to the terminal voltage at No-load.
4. The voltage regulation is calculated at rated terminal voltage.

MODEL

CALCULATION:

FORMULAE:

Zs = Voc/Isc for the same If and speed $X_s = \sqrt{Z_s^2 - R_s^2}$

Generated emf of alternator = $\sqrt{(V_{ph}\cos\Phi + I_a R_a)^2 + (V_{ph}\sin\Phi \pm I_a X_s)^2}$

+ Sign for lagging power factor loads

- Sign for leading power factor loads

The percentage regulation of alternator for a given p.f. is

% Reg = E_0-V/V

Where

E_0 – Generated emf of alternator (or excitation voltage per phase)V – Full load, rated terminal voltage per phase

OBSERVATION TABLE:

S.No.	OC Test		SC Test	
	Field current (I_f)	OC voltage per phase(Voc)	Field current (I_f)	SC current per phase(I_{SC})

PRECAUTIONS:

1. Loose connections are to be avoided.

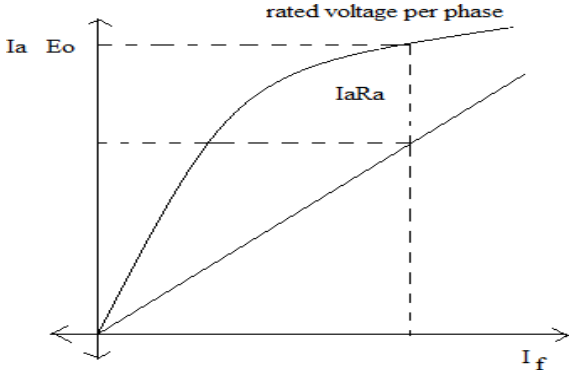
2. The rheostat in the motor field circuit is kept in minimum position.

3. Tensions are checked for zero position.

4. Readings should be taken without any parallax errors.

MODEL GRAPH:

Draw the graph between I_f V_S E_0 per phase



RESULT:

APPLICATIONS:

1. Salient pole synchronous generators are mostly used in hydro power plants.
2. Non-salient pole rotors are used in nuclear, gas and thermal power plants.

VIVA QUESTIONS:

1.What is meant by voltage
regulation? 2.What is meant by
Synchronous Impedance?3.What is
OC test?
4.What is SC test?
5.What is meant by mmf or field ampere turns?
6.What is basic the principle of operation of an
alternator7.Why an alternator is called
synchronous generator 8.List the different types
of alternators
9.List the advantages of rotating field system in alternators
10.Why the pole shoes of salient pole machines are
chamfered
11.Which type of alternators are used in hydro electric power plants
12.Differentiate between full pitched and short pitched winding.
13.List the advantages of short pitched
winding.14.What is meant by armature
reaction?
15. What is meant by predetermination of regulation?
16. Why almost all large size Synchronous machines are constructed with
rotatingfield system type?
17. Name the types of Alternator based on their rotor
construction.18.Why do cylindrical Alternators operate with
steam turbines?

19. What are the advantages of salient pole type construction used forSynchronous machines?

20. How does electrical degree differ from mechanical degree?

21. Frequency generated in an 8-pole alternator that rotates at 750 r.p.m is?22.Define pole pitch?

What is short pitch winding?

23. Define pitch factor or coil span factor?

24. Why is short pitch winding preferred over full-pitch winding ?26.What is distributed winding?

27. What is slot angle β?

28. Why are Alternators rated in kVA and not in kW? 29.What is meant by armature reaction in Alternators?30.Alternator operates on the principle of?

31.In modern alternators, the rotating part is?

32.Salient pole field structure has the advantages of?

33. What are the two types of turbo-alternators?

34. How do you compare the two? 35.What is direct-connected alternator?

36. What is the difference between direct-connected and direct-coupled units?37.Why Alternator is called Synchronous generator?

38.Why a 3-phase synchronous machine will always run at synchronous speed?39.What are the essential features of synchronous machine?

40. Why almost all large size Synchronous machines are constructed with rotatingfield system type?

41. Write down the equation for frequency of emf induced in an Alternator?42.How are alternators classified?

43. Why do cylindrical Alternators operate with steam turbines?

44. Which type of pole generators are used in Hydro-electric plants and why?45.State three important features of turbo alternator rotors?

46. What are the advantages of salient pole type of construction

used forsynchronous machines?

47. Mention the uses of damper windings in a synchronous machine?48.Why is the stator core of Alternator laminated?

49. How does electrical degree differ from mechanical degree? What is the relation between electrical degree and mechanical degree?

About the Authors

Dr.Vinod A

Associate Professor, Department of Electrical and Electronics Engineering,
Marri Laxman Reddy Institute of Technology and Management, Dundigal, Telangana

Dr. Vinod A is currently working as an Associate Professor in the Department of Electrical and Electronics Engineering, Marri Laxman Reddy Institute of Technology and Management, Dundigal since 2019 and has 8 years experience in teaching. He received his Ph.D fromNIT Silchar, Assam in 2019. He hasgot various publications in reputed international journals and conferences. His research interests are Power Electronics induced Renewable Energy Sources, automatic generation control and soft computing techniques dependent electrical hybrid vehicles.

Mr. YADAGIRI J

Assistant Professor, Department of Electrical and Electronics Engineering,
Marri Laxman Reddy Institute of Technology and Management, Dundigal, Telangana

Mr. YADAGIRI Jis currently working as an Assistant Professor in the Department of Electrical and Electronics Engineering, Marri Laxman Reddy Institute of Technology and Management, Dundigal since 2022.

He also worked as Assistant Professor in various reputed institutes like Brilliant Gropu of Technical institutions; He received Master of Technology (M.Tech) from Hasvita Institute of Engineering and Technology, RR Dist. Telangana in 2013. He got 2 publications in various international journals and conferences. His research interests are Power Electronics and Elcrtical Vehicles with Renewable Energy Sources, and real time applications of Renewable Energy Sources.