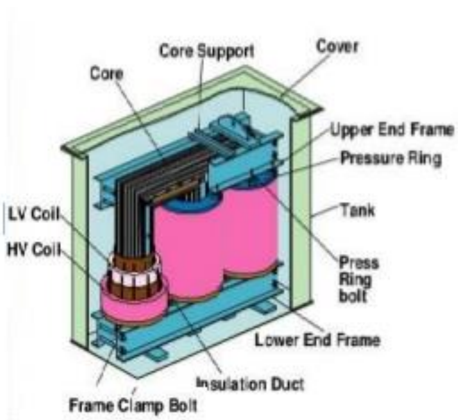
LABORATORY MANUAL
BASIC ELECTRICAL ENGINEERING

I B.TECH -I Semester (Common for EEE,CSE&IT)
I B.TECH -II Semester (Common for ECE&EIE)



AY-2018-2019

Prepared by

A.MUNEIAH Associate Professor

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY & MANAGEMENT
(Approved by AICTE-New Delhi, Accredited by NAAC with 'A' & Affliated to JNTU, Hyderabad)
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Basic Electrical Engineering Lab Manual

Subject Code:**EE108ES/EE208ES**
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Class: I.B.Tech(EEE,CSE&IT)–I Semister
I.B.Tech(ECE&EIE) –II Semister

Prepared by
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

CERTIFICATE

This is to certify that this manual is a bonafide record of practical work in the **Basic Electrical EngineeringLab**in **First Semester of I yearB.Tech (EEE,CSE& IT)** and**II semester of I year B.Tech (ECE&EIE)programme** during the academic year **2018-19**.Thismanual is prepared by **Mr.R.Saidulu (Asst.Professor)**Department of Electrical and Electronics Engineering.

INDEX

PREFACE

This book "Basic Electrical Engineering" lab manual is intended to teach the circuit analysis and the performance characteristics of electrical machines. Readers of this book need only be familiar with thebasic circuit elements and their behaviour for different inputs like AC,DC and magnetic circuits. The manual contains the exercise programs and viva questions for easy & quick understanding of the students. We hope that this practicalmanual will be helpful for students of all circuit branches of engineering(EEE,ECE,CSE,IT) 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

A.MUNEIAH
Associate Professor

ACKNOWLEDGEMENT

It was really a good experience, working with ***Basic Electrical Engineering*** lab. First we would like to thank Dr.Isaac,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.R.Kotaiah, 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

Mr.R.saidulu,
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.

Instructions to the students to conduct an experiment:

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.

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 STRUCTURE, OBJECTIVES & OUTCOMES

Laboratory subjects – Internal and external evaluation– Details of marks

Basic Electrical Engineering lab will have a continuous evaluation during 1st semester for 25 sessional marks and 75 end semester examination marks.

Out of the 25 marks for internal evaluation, day-to-day work in the laboratory shall be evaluated for 15 marks and internal practical examination shall be evaluated for 10 marks conducted by the laboratory teacher concerned.

The end examination will be evaluated for a maximum of 75 marks.The end semester examination shall be conducted with an external examiner and internal examiner. The external examiner shall be appointed by the principal / Chief Controller of examinations

Course Objectives:

- To analyze a given network by applying various electrical laws and network theorems.
- To know the response of electrical circuits for different excitations.
- To calculate, Measure and know the relation between basic electrical parametres.
- To analyze the performance characteristics of DC and AC electrical machines.

Course Outcomes:

- Get an exposure to basic electrical laws.
- 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 the basic characteristics of transformer and electrical mahiens.

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Department of Electrical & Electronics Engineering

	L	T/P/D	C
I YEAR.B.Tech. (EEE,CSE&IT)- I SEM			
I YEAR. B.Tech. (ECE&EIE)-II SEM	**0**	**-/3/-2**	

EE108ES/EE208ES: BASIC ELECTRICAL ENGINEERING LAB

LIST OF EXPERIMENTS/DEMONSTRATIONS:(All 15 Experiments to be done)

1.Verification of Ohms Law.

2.Verification of KVL and KCL.

3.Transient Response of Series RL and RC circuits using DC excitation.

4.Transient Response of RLC Series circuit using DC excitation.

5.Resonance in series RLC circuit.

6.Calculations and Verification of Impedance and Current of RL, RC and RLC series Circuits.

7.Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single Phase Transformer.

8.Load Test on Single Phase Transformer (Calculate Efficiency and Regulation).

9.Three Phase Transformer: Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta-star, Star-Star) .

10.Measurement of Active and Reactive Power in a balanced Three-phase circuit.

11.Performance Characteristics of a Separately/Self Excited DC Shunt/Compound Motor.

12.Torque-Speed Characteristics of a Separately/Self Excited DC Shunt/CompoundMotor.

13.Performance Characteristics of a Three-phase Induction Motor.

14.Torque-Speed Characteristics of a Three-phase Induction Motor.

15.No-Load Characteristics of a Three-phase Alternator.

Expt No: 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.	Voltmeters	0-20V	Digital	4
2.	Ammeters	0-200mA	Digital	3
3.	DC Power Supply	0-15V	Dual	1
4.	Two digital Multimeters	………..	Digital	4
5.	Bread board	……….	…….	1
6.	Connecting wires	………..	………..	as per need
7.	Resistors	1.0kΩ, 1.5kΩ, 6.8kΩ		

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 charges. 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,

$$I \propto V$$

$$V \propto I \text{ or } V=IR$$

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?

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.

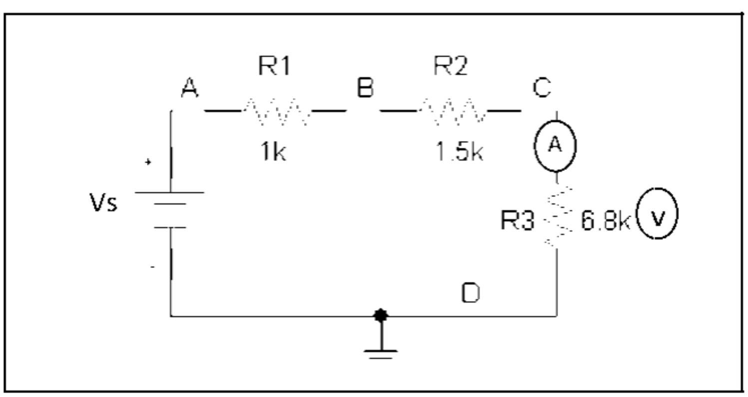
Hence, the specific resistance or resistivity of the material of the wire,

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

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 *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 rightangle triangle on the graph and from this, re-determine the 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 resisitor = I X R

Observations 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 (Theoretical values)	**(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 of each type.
5. If the resistor from the experiment above is changed to 10 kΩ, deduce what will 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 ohmicresistance ?
11. What is the shape of V v/s I graph for an ohmicconductor ?
12. How is the resistance of a conductor affected by rise in temperature ?
13. State the principle of potentiometer?
14. What do you mean by potential gradient ?
15. Why do we prefer a potentiometer to a voltmeter for measurement of e.m.f.?

16. Can a voltmeter measure e.m.f. ?
17. How is the sensitivity affected by potential gradient ?
18. Should an ammeter have a low or a high resistance and why ?
19. What is the resistance of an ideal voltmeter ?
20. The resisstance coils in a resistance box are doubly wound as shown. Why?
21. Define electric current ?
22. What is SI unit of electric current ?
23. What is meant by the term electric potential difference ?
24. What is a conductor ?
25. Give example of a good non-metallic conductor.
26. State Ohm's law.
27. What is meant by the term electric resistance ?
28. What is SI unit of resistance ? Define it.
29. State the factors on which the resistance of a conductor depends.
30. Define the term resistivity. Give its SI unit.
31. Name an element which in different allotropic forms acts as a good conductor and a good insulator.
32. What is an ohmicresistance ?
33. What is the shape of V v/s I graph for an ohmicconductor ?
34. What is a non-linear device ? Give an example.
35. How is the resistance of a conductor affected by rise in temperature ?
36. Give example of a material whose resistance decreases with rise in temperature.
37. How can you convert a galvanometer into an ammeter ?
38. How is ammeter connected in a circuit ?
39. How can you convert a galvanometer into a voltmeter ?
40. How is a voltmeter connected in a circuit?
41. What is a potentiometer ?
42. State the principle of potentiometer.
43. What do you mean by potential gradient ?
44. What is the S.I. unit of potential gradient ?
45. What do you mean by e.m.f. of a cell ?
46. What do you mean by terminal voltage ?
47. Why do we prefer a potentiometer to a voltmeter for measurement of e.m.f. ?
48. Why do we get the null point ?
49. Can a voltmeter measure e.m.f. ?
50. How is an ammeter connected in a circuit ?

EXERCISE PROBLEMS :

1. If I = 2 A R = 55 ohms What is the value of E?
2. Resistance of an electric iron 50 Ω.4.2A Current flows through the resistance. Find the voltage between two points.
3. Filament resistance of an electric bulb is 660 Ω. Potential difference of two points 220V. Find the

current through the filament flowing.

4. An electric heater draws 3.5 A from a 110 V source. The resistance of the heating element is approximately.
5. If 750 µA is flowing through 11 kΩ of resistance, what is the voltage drop across the resistor?
6. The formula to find *I* when the values of *V* and *R* are known is?
7. A resistor is connected across a 50 V source. What is the current in the resistor if the color code is red, orange, orange, silver?
8. Approximately how many milliamperes of current flow through a circuit with a 40 V source and 6.8 kΩ of resistance?
9. What is the voltage source for a circuit carrying 2 A of current through a 36 Ω resistor?
10. What is the approximate resistance setting of a rheostat in which 650 mA of current flows with a 150 V source?
11. How much voltage is needed to produce 2.5 A of current through a 200 Ω resistor?
12. When there is 12 mA of current through a 1.2 kΩ resistor, the voltage across the resistor is?
13. A resistance of 3.3 MΩ is connected across a 500 V source. The resulting current is approximately?
14. You are measuring the current in a circuit that is operated on an 18 V battery. The ammeter reads 40 mA. Later you notice the current has dropped to 20 mA. How much has the voltage changed?
15. The current through a flashlight bulb is 40 mA and the total battery voltage is 4.5 V. The resistance of the bulb is approximately?
16. If you wish to increase the amount of current in a resistor from 120 mA to 160 mA by changing the 24 V source, what should the new voltage setting be?
17. How much resistance is needed to draw 17.6 mA from a 12 volt source?
18. How much current is produced by a voltage of 18 kV across a 15 kΩ resistance?
19. Four amperes of current are measured through a 24 Ω resistor connected across a voltage source. How much voltage does the source produce?
20. Twelve volts are applied across a resistor. A current of 3 mA is measured. What is the value of the resistor?

Exp.No: 2

Verification of KVL and KCL.

Aim: To verify Kirchhoff's Voltage Law and Kirchhoff's Current Law theoretically andpactically.

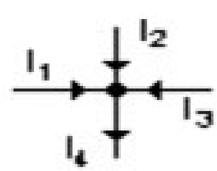
Apparatus:

S.No	Name of the equipment	Range	Type	Quantity
1.	Voltmeters	0-20V	Digital	4
2.	Ammeters	0-200mA	Digital	3
3.	DC Power Supply	0-15V	Dual	1
4.	Multimeter	………..	Digital	4
5.	Kit board	……….	…….	1
6.	Connecting wires	………..	………..	as per need

Theory:

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".

Calculations:



$$I_1 + I_2 + I_3 = I_4$$

Kirchhoff's Laws

Kirchhoff's current law and voltage law, defined by Gustav Kirchhoff, describe the relation of values of currents that flow through a junction point and voltages in an electrical circuit loop, in an electrical circuit.

- **Kirchhoff's Current Law (KCL)**
- **Kirchhoff's Voltage Law (KVL)**

Kirchhoff's Current Law (KCL):

This is Kirchhoff's first law.

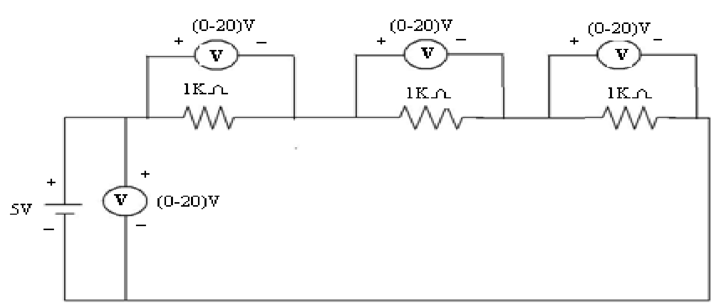
The sum of all currents that enter an electrical circuit junction is 0. When the currents enter the junction has positive sign and the current that leave the junction have negative sign: Another way to look at this law is that the sum of currents that enter a junction is equal to the sum of currents that leave the junction:

Kirchhoff's Voltage Law (KVL):

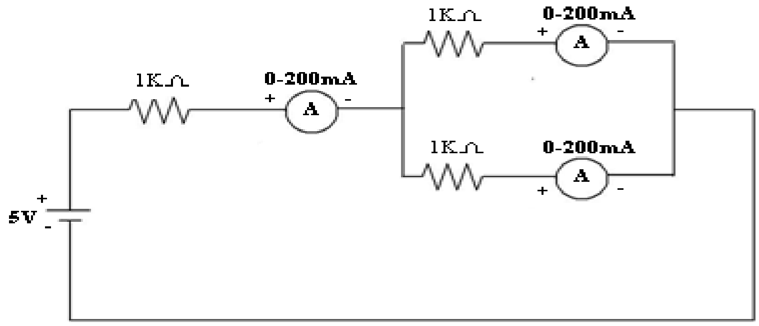
This is Kirchhoff's second law.

The directed sum of the electrical potential differences(voltage) around any closed network is zero.

Circuit Diagram of KVL:



Circuit Diagram of KCL:



Procedure:

1. To verify KVL, Connections are made as shown in the Fig-1
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-2.
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).

Observations Table:

	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. Making 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 id 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.kirchhoffs current law is applied at?

28.kirchhoffs 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 an 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 kirchhoffs 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?

EXERCISE PROBLEMS :

1. Two resistors each of 4Ω & 12Ω are connected in parallel and the parallel combination is connected in series with a 2 Ω resistor. If this circuit is connected across a 100V supply, find the total current drawn.

2. In a Wheatstone bridge ABCD is arranged as follows AB=1Ω, BC=2 Ω, CD=3 Ω , DA=4 Ω. A 4 volt battery is connected in between A and C. Find the current using KVL.

3. In a Wheatstone bridge ABCD is arranged as follows AB=2Ω, BC=4 Ω, CD=6 Ω , DA=8 Ω. A 6 volt battery is connected in between A and C. Find the current using KVL.

4. In a Wheatstone bridge ABCD is arranged as follows AB=3Ω, BC=6Ω, CD=8 Ω, DA=10Ω. An 8volt battery is connected in between A and C. Find the current using KVL.

5. Two batteries A& B having emf's 12V and 8V resp and internal resistances of 2Ω and 1 Ω resp, are connected in parallel across 10 Ω resistor calculate the current in each of the battery applying KVL.

6. Two resistors each of 8Ω & 10Ω are connected in parallel and the parallel combination is connected in series with a 4 Ω resistor. If this circuit is connected across a 50V supply, find the total current drawn.

7. A Wheatstone bridge ABCD is arranged as follows AB=6Ω, BC=4 Ω, CD=2 Ω, DA=1 Ω. A 6 volt battery is connected in between A and C. Find the current using KVL.

8. A Wheatstone bridge ABCD is arranged as follows AB=10Ω, BC=8 Ω , CD=6 Ω , DA=4 Ω. A 10 volt battery is connected in between A and C. Find the current using KVL.

9. A Wheatstone bridge ABCD is arranged as follows AB=3Ω, BC=6Ω, CD=9 Ω, DA=12Ω. A 12 volt battery is connected in between A and C. Find the current using KVL.

10. Three batteries A,B&C having emf's 15V,12V & 12V resp and internal resistances of 3Ω,4Ω and 2 Ω resp, are connected in parallel across 15Ω resistor calculate the current in each of the battery applying KVL.

11. Two resistors each of 6Ω & 10Ω are connected in parallel and the parallel combination is connected in series with a 6Ω resistor. If this circuit is connected across a 100V supply, find the total current drawn.
12. A Wheatstone bridge ABCD is arranged as follows AB=2Ω, BC=2 Ω, CD=1 Ω , DA=4 Ω. A 5 volt battery is connected in between A and C. Find the current using KVL.
13. A Wheatstone bridge ABCD is arranged as follows AB=5Ω, BC=6 Ω, CD=5Ω , DA=6 Ω. A 12 volt battery is connected in between A and C. Find the current using KVL.
14. A Wheatstone bridge ABCD is arranged as follows AB=6Ω, BC=5Ω, CD=5 Ω, DA=12Ω. An 8volt battery is connected in between A and C. Find the current using KVL.
15. Two batteries A& B having emf's 12V and 15V resp and internal resistances of 5Ω and 4Ω resp, are connected in parallel across 12 Ω resistor calculate the current in each of the battery applying KVL.
16. Two resistors each of 2Ω & 12Ω are connected in parallel and the parallel combination is connected in series with a 2 Ω resistor. If this circuit is connected across a 50V supply, find the total current drawn.
17. A Wheatstone bridge ABCD is arranged as follows AB=5Ω, BC=5 Ω, CD=2Ω, DA=4Ω. A 10volt battery is connected in between A and C. Find the current using KVL.
18. A Wheatstone bridge ABCD is arranged as follows AB=10Ω, BC=8 Ω , CD=6 Ω , DA=4 Ω. A 10 volt battery is connected in between A and C. Find the current using KVL.
19. A Wheatstone bridge ABCD is arranged as follows AB=3Ω, BC=6Ω, CD=9 Ω, DA=12Ω. A 12 volt battery is connected in between A and C. Find the current using KVL.
20. Two batteries A& B having emf's 15V and 22V resp and internal resistances of 4Ω and 2 Ω resp, are connected in parallel across 15Ω resistor calculate the current in each of the battery applying KVL.

<u>Exp. No:3</u>

<u>TransientResponse of Series RL and RC circuits</u>

Aim: To draw the time response of first order series RL and RC network for periodic Non-Sinusoidal function and verify the time constant.

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.	CRO probes			1
7.	Connecting wires			As required

Theory:

RL SERIES:

Theoretical Calculations:

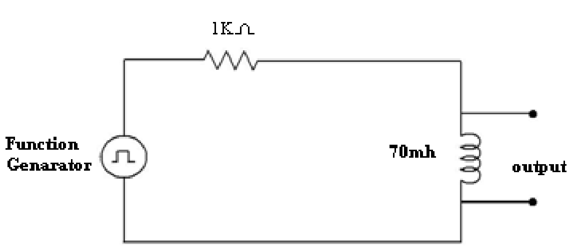
Formulae required:

For RL Series circuit, Time constant, $\tau = L/R$

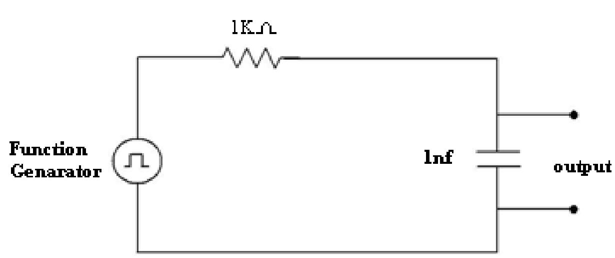
For RC Series circuit, Time constant, $\tau = RC$

Circuit diagrams:

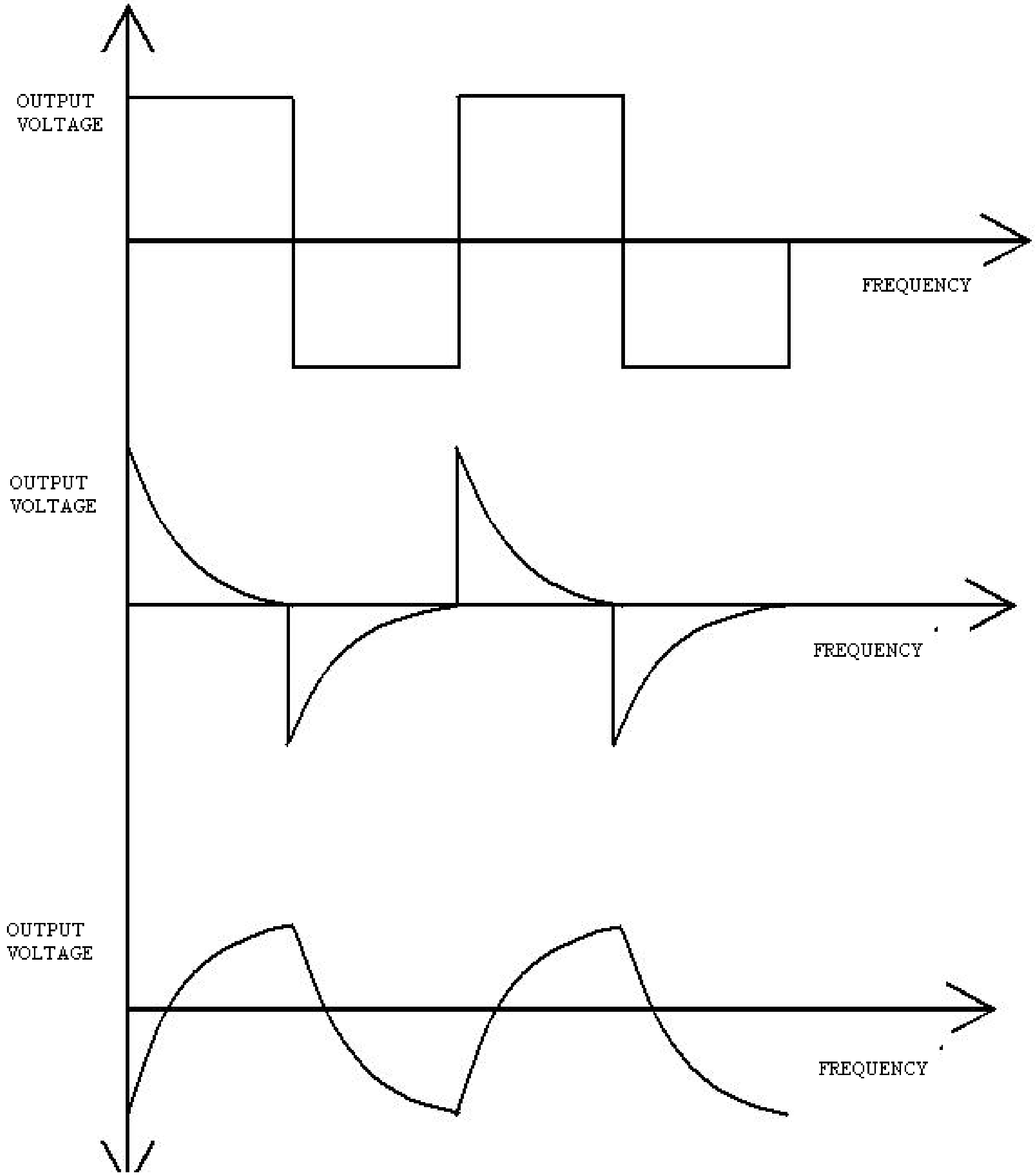
Series RL Circuit



Series RC Circuit



Model Graph:


OUTPUT
VOLTAGE
FREQUENCY
OUTPUT
VOLTAGE
FREQUENCY
OUTPUT
VOLTAGE
FREQUENCY

Procedure:

Series RL Circuit:

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

Series RC Circuit:

1. Connections are made as shown in the fig-2.
2. Input voltage (Square wave) is set to a particular value.
3. The waveform of voltage across the capacitor is observed on CRO and the waveform is drawn on a graph sheet.
4. The time constant is found from the graph and verified with the theoretical value.

Result table:

	Series RL Circuit		Series RC Circuit	
	Theoretical	Practical	Theoretical	Practical
Time Constant(τ)				

Precautions:

1. Making 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 inductors
3. What they are used for besides spark plugs. any help would be greatly appreciated or a nudge in the right direction

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?
7. what do you mean by a Conductivity?
8. Define resonance?
9. What is the phase difference between voltage and current in a capacitor? Which is leading?
10. What is the phase difference between voltage and current in a inductor? Which is leading?
11. What is the effect of resistance in RLC circuit?
12. For RLC circuit what is power factor at lowest powerfrequency ?
13. What is the locus of voltage phaser across R in series RLC circuit?
14. Define bandwidth?
15. Define cuttoff frequency?
16. Differentiate between transient state, transient time and transient response?
17. Define natural response and natural frequency?
18. Define time constants for RC and RL circuits?
19. What is meant by rise time, settling time and delay time?
20. What is meant by damping ratio?

21. What is time constant?

22. What are the time constants of series RL and RC circuits?

23. Deduce the transient response source free series RC circuit?.

24. Explain about properties of Exponential Response of RLC circuits.

25. Deduce the transient response source free series RL circuit?

26.Explain about Source free RL and RC Circuits?.

27. Explain the complete response of source free series RL Circuits?.

28. Explain about Natural & Forced Response of RLC Circuits.

29. Explain the complete response of source free parallel RC Circuits?.

30. Define Admittance ?

31. The impedances of parallel circuit are Z1= (6+j8) ohms and Z2 = (8-j6) ohms. If the applied voltage is 120V, find (i) current and power factor of each branch

32.overall current? For above data.

33. Power consumed by each impedance? From above data.

34. Draw the phasor diagram for above data?.

35. Explain the phasor relation for R,L,C elements.

36. A resistor of 50Ω, inductance of 100mH and a capacitance of 100μF are connected in series across 200V, 50Hz supply. Determine the Impedance?

36.Current flowing through the circuit (for above data)

37. Power factor?

38.Voltage across R,L &C (for the above data).

39. Power in watts (for above data)

40. Explain the phasor relation for series RL and RC circuit?.

41. A 120V AC circuit contain 10 Ω resistance and 30 Ω inductive reactance in series. What is average power of this circuit?

42. Explain the phasor relation for parallel RL circuit?

43. A parallel RLC circuit is supplied with a voltage source of 230 V, 50Hz. Determine circuit current and power factor if R=40Ω, L=0.2H and C=50µF?.

44. Define power factor, apparent power, active power and reactive power?.

45. The impedances of parallel circuit are Z1= (4+j6) ohms and Z2 = (12-j8) ohms. If the applied voltage is 220V, find (i) current and power factor of each branch?

46.What is overall current for the above data?

47. Expresion for energy stored d by an inductor inductor?

48. Expresion for energy stored d by an inductor capacitor?

49.Draw the phasor diagram for a pure inductive circuit?

50. Explain the phasor relation for a pure capacitive circuit?

EXCERSISE PROBLEMS:

1.To draw the time response of first order series RL and RC network (R=1KΩ, L=30mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
2.To draw the time response of first order series RL and RC network (R=2KΩ, L=40mh,c=0.021µf)for periodic Non-Sinusoidal function and verify the time constant.
3. To draw the time response of first order series RL and RC network (R=3KΩ, L=30mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
4.To draw the time response of first order series RL and RC network (R=1KΩ, L=40mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
5.To draw the time response of first order series RL and RC network (R=1KΩ, L=40mh,c=0.31µf)for periodic Non-Sinusoidal function and verify the time constant.
6.To draw the time response of first order series RL and RC network (R=1KΩ, L=40mh,c=0.11µf)for periodic Non-Sinusoidal function and verify the time constant.

7.To draw the time response of first order series RL and RC network (R=2KΩ, L=40mh,c=0.02µf)for periodic Non-Sinusoidal function and verify the time constant.
8.To draw the time response of first order series RL and RC network (R=1KΩ, L=33mh,c=0.21µf)for periodic Non-Sinusoidal function and verify the time constant.
9.To draw the time response of first order series RL and RC network (R=3KΩ, L=40mh,c=0.21µf)for periodic Non-Sinusoidal function and verify the time constant.
10.To draw the time response of first order series RL and RC network (R=2KΩ, L=35mh,c=0.36µf)for periodic Non-Sinusoidal function and verify the time constant.
11. To draw the time response of first order series RL and RC network (R=2KΩ, L=60mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
12. To draw the time response of first order series RL and RC network (R=4KΩ, L=80mh,c=0.021µf)for periodic Non-Sinusoidal function and verify the time constant.
13. To draw the time response of first order series RL and RC network (R=6KΩ, L=60mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
14.To draw the time response of first order series RL and RC network (R=2KΩ, L=80mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
15.To draw the time response of first order series RL and RC network (R=2KΩ, L=80mh,c=0.31µf)for periodic Non-Sinusoidal function and verify the time constant.
16.To draw the time response of first order series RL and RC network (R=2KΩ, L=80mh,c=0.11µf)for periodic Non-Sinusoidal function and verify the time constant.
17.To draw the time response of first order series RL and RC network (R=4KΩ, L=80mh,c=0.02µf)for periodic Non-Sinusoidal function and verify the time constant.
18.To draw the time response of first order series RL and RC network (R=2KΩ, L=66mh,c=0.21µf)for periodic Non-Sinusoidal function and verify the time constant.
19.To draw the time response of first order series RL and RC network (R=6KΩ, L=80mh,c=0.21µf)for periodic Non-Sinusoidal function and verify the time constant.
20.To draw the time response of first order series RL and RC network (R=4KΩ, L=70mh,c=0.36µf)for periodic Non-Sinusoidal function and verify the time constant.

Expt. No:4

Transient response of Series RLC circuit

Aim: To draw the time response of first order series RLC network for periodic Non-Sinusoidal function and verify the time constant.

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.	CRO probes			1
7.	Connecting wires			As required

Theory:

In theory, there are three cases for the way a series RLC circuit will respond when the switch is closed at time t=0. In this lab, only the underdamped case will be dealt with. For this case, the current in the circuit is described by:

Theoretical Calculations: $i = \frac{V_0}{\omega_d L} e^{-\tau t} \sin \omega_d t$

Where $\omega_d = \sqrt{(\omega_0^2 - \tau^2)}$

$\omega_0 = \frac{1}{\sqrt{LC}}$ and $\tau = \frac{R}{2L}$

Formulae required:

For RLC Series circuit, Time constant, $\tau = \frac{R}{2L}$

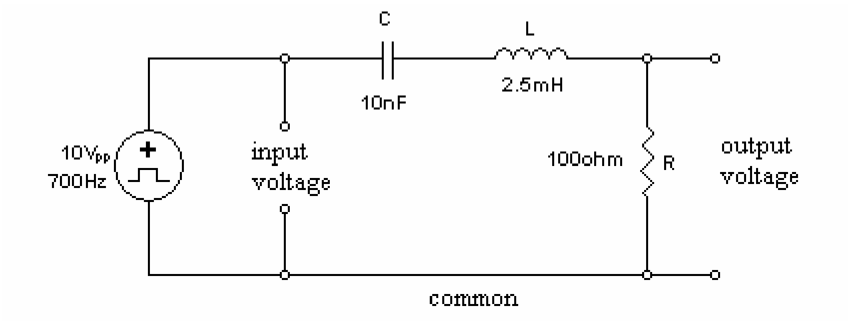
The current in the circuit oscillates due to the sine component, but the maximum value it can reach is decaying due to the negative exponential. The envelope that the current must fall within is described by:

$$i = \frac{V_0}{\omega_d L} e^{-\tau t}$$

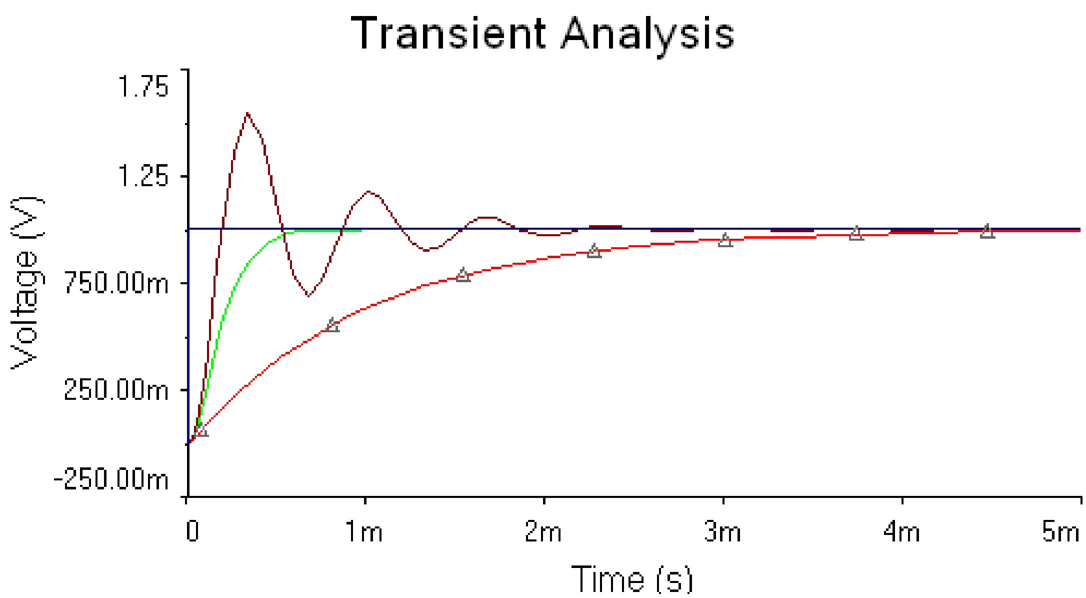
The quantity τ is referred to as the time constant of the envelope. It is determined by taking the natural logarithm of both sides of the above equation:

$$\ln|i| = \ln \frac{V_0}{\omega_d L} e^{-\tau t}$$

Circuit diagrams:



Model Graph:



Procedure:

Series RLC Circuit:

1. Connect the circuit shown in **Figure**, with channels 1 and 2 of the oscilloscope set to measure input voltage and output voltage, respectively.
2. Set the function generator to deliver a square wave
3. Display the input and output voltages on the oscilloscope. Set the voltage and time scales for maximum resolution. Adjust the time scale so that a complete waveform is displayed on the screen.
4. Observe and record the input and output waveforms.
5. Measure at least three positive and three negative peaks of the waveform, and the time at which each peak occurs. Measure the times at which the current is zero and determine the frequency *fd* of these damped oscillations.
6. Switch the function generator to give a sine wave output. Adjust the frequency until the current (represented by the voltage across the resistor) is in phase with the input voltage. **Under this condition, the current is a maximum.**
7. Measure this frequency with the DMM. This is the **resonant frequency *fo*** of the circuit.
8. The time constant is found from the graph and verified with the theoretical value.

Result table:

	Series RL Circuit	
	Theoretical	Practical
Time Constant(τ)		

Precautions:

1. Making 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 inductors .
3. What they are used for besides spark plugs. any help would be greatly appreciated or a nudge in the right direction.

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. Explain htedifferent regions in frequency response?

6.State the frequency response for RC phase shift oscillator?

7. what do you mean by a Conductivity?

8. Define resonance?

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

10. What is the phase difference between voltage and current in a inductor? Which is leading?

11. What is the effect of resistance in RLC circuit?

12. For RLC circuit what is power factor at lowest powerfrequency ?

13. What is the locus of voltage phaser across R in series RLC circuit?

14. Define bandwidth?

15. Define cuttoff frequency?

16. Differentiate between transient state, transient time and transient response?

17. Define natural response and natural frequency?

18. Define time constants for RC and RL circuits?

19. What is meant by rise time, settling time and delay time?

20. What is meant by damping ratio?

21. Define the terms

   i) Time response ii) Frequency response

22. Define the terms

i) Transient state ii) Steady state response

23. Define damping ratio?

24. Define Transient time?

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

26.Why is the series circuit called as acceptor circuit

27. what do you mean by a Conductivity?

28. Define resonance?

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

31. What is the phase difference between voltage and current in a inductor? Which is leading?

32. What is the effect of resistance in RLC circuit?

33. For RLC circuit what is power factor at lowest powerfrequency ?

34. What is the locus of voltage phaser across R in series RLC circuit?

35. Define bandwidth?

36. Define cuttoff frequency?

37. Differentiate between transient state, transient time and transient response?

38. Define natural response and natural frequency?

39. Define time constants for RC and RL circuits?

40. What is meant by rise time, settling time and delay time?

41. What is meant by damping ratio?

42. Define Selectivity, Bandwidth and Q-factor?

43. For RLC circuit what is the power factor at the lowest frequency?

44. What are the expressions for admittance, conductance and suceptance and also write its units?

45.What is meant by resonance?

46.What do you mean by sharpness of resonance

47.What is resonance frequency?

48.What are forced vibrations?

49.What is bandwidth of series circuit?

50.Define quality factor of a series circuit.

EXCERSISE PROBLEMS:

1.To draw the time response of first order series RL and RC network (R=1KΩ, L=30mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
2.To draw the time response of first order series RL and RC network (R=2KΩ, L=40mh,c=0.021µf)for periodic Non-Sinusoidal function and verify the time constant.
3. To draw the time response of first order series RL and RC network (R=3KΩ, L=30mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
4.To draw the time response of first order series RL and RC network (R=1KΩ, L=40mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
5.To draw the time response of first order series RL and RC network (R=1KΩ, L=40mh,c=0.31µf)for periodic Non-Sinusoidal function and verify the time constant.
6.To draw the time response of first order series RL and RC network (R=1KΩ, L=40mh,c=0.11µf)for periodic Non-Sinusoidal function and verify the time constant.
7.To draw the time response of first order series RL and RC network (R=2KΩ, L=40mh,c=0.02µf)for periodic Non-Sinusoidal function and verify the time constant.
8.To draw the time response of first order series RL and RC network (R=1KΩ, L=33mh,c=0.21µf)for periodic Non-Sinusoidal function and verify the time constant.
9.To draw the time response of first order series RL and RC network (R=3KΩ, L=40mh,c=0.21µf)for periodic Non-Sinusoidal function and verify the time constant.
10.To draw the time response of first order series RL and RC network (R=2KΩ, L=35mh,c=0.36µf)for periodic Non-Sinusoidal function and verify the time constant.
11. To draw the time response of first order series RL and RC network (R=2KΩ, L=60mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
12. To draw the time response of first order series RL and RC network (R=4KΩ, L=80mh,c=0.021µf)for periodic Non-Sinusoidal function and verify the time constant.
13. To draw the time response of first order series RL and RC network (R=6KΩ, L=60mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
14.To draw the time response of first order series RL and RC network (R=2KΩ, L=80mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.
15.To draw the time response of first order series RL and RC network (R=2KΩ, L=80mh,c=0.31µf)for periodic Non-Sinusoidal function and verify the time constant.
16.To draw the time response of first order series RL and RC network (R=2KΩ, L=80mh,c=0.11µf)for periodic Non-Sinusoidal function and verify the time constant.
17.To draw the time response of first order series RL and RC network (R=4KΩ, L=80mh,c=0.02µf)for periodic Non-Sinusoidal function and verify the time constant.
18.To draw the time response of first order series RL and RC network (R=2KΩ, L=66mh,c=0.21µf)for periodic Non-Sinusoidal function and verify the time constant.

19. To draw the time response of first order series RL and RC network (R=6KΩ, L=80mh,c=0.21μf)for periodic Non-Sinusoidal function and verify the time constant.
20. To draw the time response of first order series RL and RC network (R=4KΩ, L=70mh,c=0.36μf)for periodic Non-Sinusoidal function and verify the time constant.

Expt. No: 5

Series Resonance

Aim: To verify Resonant Frequency, Bandwidth & Quality factor of RLC 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 per need

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.

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

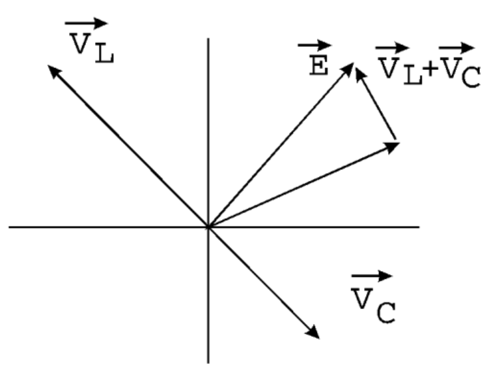


Figure 1

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 will get **$E/I = Z = R^2 + (X_L - X_C)^2$,**

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 $V_{max}/\sqrt{LC} = 0.707\ V_{max}$

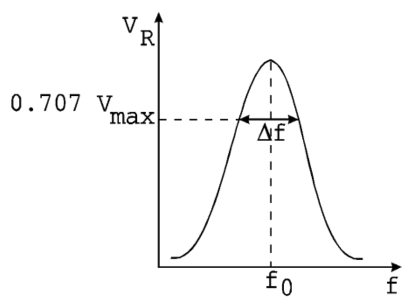


Figure 2

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.

Theoretical Calculations: (Formulae Required) :

1. Resonant frequency, $f_o = \dfrac{1}{2\pi\sqrt{LC}}$
2. Quality factor, $Q = X_L/R = 2\pi f_o L/R$
3. Bandwidth, $BW = f_o/Q$

Procedure:

1. Circuit is connected as shown in the fig (1).
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 I_S. 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 $Q = \frac{f_0}{BW}$ are found from the graph.
6. Practical values of Resonant Frequency, Q-factor and Bandwidth are compared with theoretical values.

Circuit Diagram of Series Resonance:

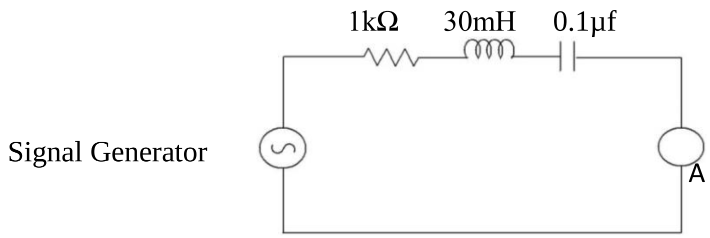
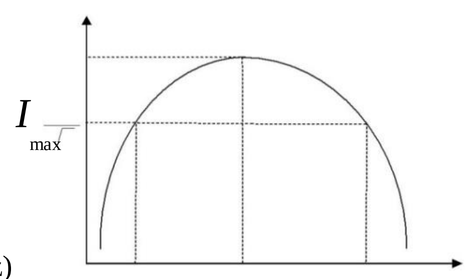


Fig-1

Model Graph:



$I_{max}/\sqrt{2}$

f_1 f_0 f_2 f(Hz)

Fig-2

Observations:

S.No.	Frequency (Hz)	Current(I_S)A

S.No.	Frequency (Hz)	Current(I_P)A

Result Table:

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

Precautions:

1. Making 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 material 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 resistor?
15. What are the material 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 and also 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 f_1 and f_2 of an *RLC* circuit that resonates at 150 kHz 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 Ω, X_C = 80 Ω, and *R* =60 Ω ?
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 2000 Hz and has a bandwidth of 250 Hz?
41. What is the band pass (F_1 – F_2) of an RLC filter that resonates at 150 kHz and 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
47. When $X_C = X_L$ the circuit:?
48. How much current will flow in a series *RLC* circuit when V_T = 100 V, X_L = 160 Ω, X_C = 80 Ω, and *R* = 60 Ω ?
49. When a full band of frequencies is allowed to pass through a filter circuit to the output, the resonant circuit is called a:?
50. At resonance, the term bandwidth includes all frequencies that allow what percentage of maximum current to flow?

EXERCISE PROBLEMS :

1. To find the Resonant Frequency, Bandwidth & Quality factor of RLC Series Resonant circuits. (R=1KΩ, L=70mh, C=0.01μf).

2.To find the Resonant Frequency, Bandwidth & Quality factor of RLCSeries circuit. (R=1KΩ, L=30mh, C=0.01μf).

3.To find the Resonant Frequency, Bandwidth & Quality factor of RLCSerieslcircuit. (R=1KΩ, L=30mh, C=0.01μf).

4.To find the Resonant Frequency and Bandwidth of RLC Series circuit (R=2KΩ, L=30mh, C=0.01μf).

5.To find the Resonant Frequency and Bandwidth of RLC Parallel circuit (R=1KΩ, L=30mh, C=0.1μf).

6.To find the Resonant Frequency and Bandwidth of RLC Series circuit (R=1KΩ, L=100mh, C=0.1μf).

7.To find the Resonant Frequency and Bandwidth of RLC Series circuit (R=1KΩ, L=100mh, C=0.01µf).

8.To find the Resonant Frequency and Bandwidth of RLC Series circuit (R=5KΩ, L=100mh, C=0.001µf).

9.To find the Resonant Frequency and Bandwidth & band width of RLC Series circuit (R=1KΩ, L=70mh, C=0.01µf).

10.To find the Resonant Frequency and Bandwidth of RLC Series circuit (R=2KΩ, L=100mh, C=0.1µf).

11.To find the Resonant Frequency, Bandwidth & Quality factor of RLC Series Resonant circuits. (R=2KΩ, L=35mh, C=0.01µf).

12.To find the Resonant Frequency, Bandwidth & Quality factor of RLCSeries circuit. (R=2KΩ, L=60mh, C=0.01µf).

13.To find the Resonant Frequency, Bandwidth & Quality factor of RLCSerieslcircuit. (R=2KΩ, L=60mh, C=0.01µf).

14.To find the Resonant Frequency and Bandwidth of RLC Series circuit (R=4KΩ, L=60mh, C=0.01µf).

15.To find the Resonant Frequency and Bandwidth of RLC Series circuit (R=2KΩ, L=60mh, C=0.1µf).

16.To find the Resonant Frequency and Bandwidth of RLC Series circuit (R=2KΩ, L=200mh, C=0.1µf).

17.To find the Resonant Frequency and Bandwidth of RLC Series Parallel circuit (R=2KΩ, L=200mh, C=0.01µf).

18.To find the Resonant Frequency and Bandwidth of RLC Series circuit (R=5KΩ, L=100mh, C=0.001µf).

19.To find the Resonant Frequency and Bandwidth & band width of RLC Series circuit (R=2KΩ, L=35mh, C=0.01µf).

20. To find the Resonant Frequency and Bandwidth of RLCSeriescircuit (R=4KΩ, L=200mh, C=0.1µf).

Expt No: 6

CALCULATIONS AND VERIFICATION OF IMPEDANCE AND CURRENT OF RL, RC AND RLC SERIES CIRCUITS

AIM: To calculate and verify the Impedance and Current of RL,RC,RLC 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.	CRO probes			1
7.	Connecting wires	-	-	As required
8	Volt meter	(0-20 V)	DIGITAL	1
9	Ammeter	(0-10)A	DIGITAL	1

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 series RL 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

- Take the current I (r.m.s value) as a reference vector
- Voltage drop in resistance VR = IR is taken in phase with the current vector
- Voltage drop in capacitive reactance VC = IXC is drawn 90 degrees behind the current vector, as current leads voltage by 90 degrees in pure capacitive circuit)
- The vector sum of the two voltage drops is equal to the applied voltage V (r.m.s value).

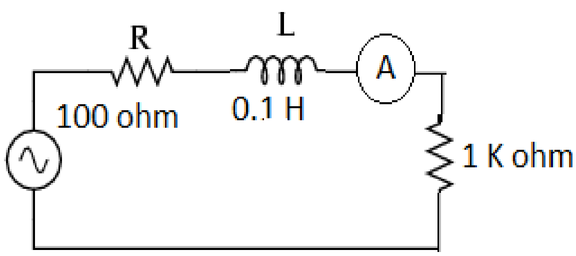
Now, $V_R = I_R$ and $V_C = IX_C$ Where, $X_C = I/2\pi fC$

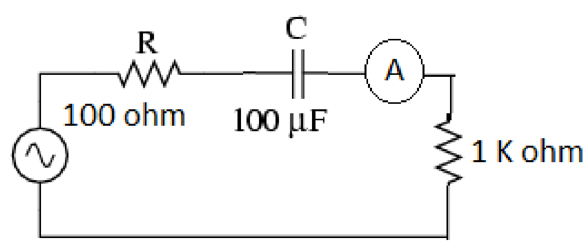
$$Z = \sqrt{\left(R^2 + X_C{}^2\right)}$$

RLC SERIES CIRCUIT: $Z = \sqrt{\left(R^2 + (X_L - X_C{}^2)\right)}$

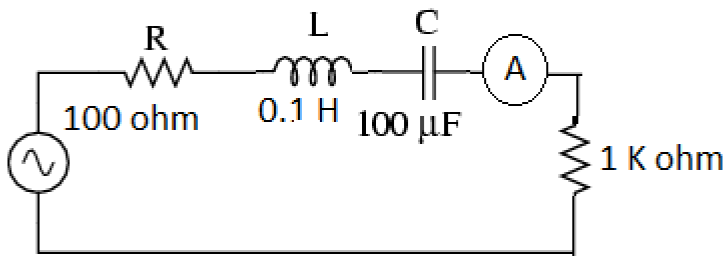
Circuit diagrams:

R-L circuit: **R_C Circuit:**





RLC SERIES:



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 of the 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 divisionrepresents 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.

Result table:

	Series RL Circuit	
	Theoretical	Practical
Impedance		

Precautions:

1. Making 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 inductors .
3. What they are used for besides spark plugs. any help would be greatly appreciated or a nudge in the right direction.

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 a Conductivity?
8. Define resonance?
9. What is the phase difference between voltage and current in a capacitor? Which is leading?
10. What is the phase difference between voltage and current in a inductor? Which is leading?
11. What is the effect of resistance in RLC circuit?
12. For RLC circuit what is power factor at lowest powerfrequency ?
13. Explain the different regions of frequency response?
14. Define bandwidth?
15. Define cuttoff frequency?
16. Differentiate between transient state, transient time and transient response?
17. Define natural response and natural frequency?
18. Define time constants for RC and RL circuits?
19. What is meant by rise time, settling time and delay time?

20. What is meant by damping ratio?
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.Statebthe frequency for RC phase shift oscillator?
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 phase difference between voltage and current in a inductor? Which is leading?
32. What is the effect of resistance in RLC circuit?
33. For RLC circuit what is power factor at lowest powerfrequency ?
34. What is the locus of voltage phaser across R in series RLC circuit?
35. Define bandwidth?
36. Define cuttoff frequency?
37. Differentiate between transient state, transient time and transient response?
38. Define natural response and natural frequency?
39. Define time constants for RC and RL circuits?
40. What is meant by rise time, settling time and delay time?
41. What is meant by damping ratio?
42. Define Selectivity, Bandwidth and Q-factor?
43. For RLC circuit what is the power factor at the lowest frequency?
44. What are the expressions for admittance, conductance and suceptance and also write its units?
45.What is meant by resonance?
46.What do you mean by sharpness of resonance
47.What is resonance frequency?

48.What are forced vibrations?

49.What is bandwidth of series circuit?

50.Define quality factor of a series circuit.

<u>EXCERSISE PROBLEMS:</u>

1.To draw the time response of first order series RL and RC network (R=1KΩ, L=30mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.

2.To draw the time response of first order series RL and RC network (R=2KΩ, L=40mh,c=0.021µf)for periodic Non-Sinusoidal function and verify the time constant.

3. To draw the time response of first order series RL and RC network (R=3KΩ, L=30mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.

4.To draw the time response of first order series RL and RC network (R=1KΩ, L=40mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.

5.To draw the time response of first order series RL and RC network (R=1KΩ, L=40mh,c=0.31µf)for periodic Non-Sinusoidal function and verify the time constant.

6.To draw the time response of first order series RL and RC network (R=1KΩ, L=40mh,c=0.11µf)for periodic Non-Sinusoidal function and verify the time constant.

7.To draw the time response of first order series RL and RC network (R=2KΩ, L=40mh,c=0.02µf)for periodic Non-Sinusoidal function and verify the time constant.

8.To draw the time response of first order series RL and RC network (R=1KΩ, L=33mh,c=0.21µf)for periodic Non-Sinusoidal function and verify the time constant.

9.To draw the time response of first order series RL and RC network (R=3KΩ, L=40mh,c=0.21µf)for periodic Non-Sinusoidal function and verify the time constant.

10.To draw the time response of first order series RL and RC network (R=2KΩ, L=35mh,c=0.36µf)for periodic Non-Sinusoidal function and verify the time constant.

11. To draw the time response of first order series RL and RC network (R=2KΩ, L=60mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.

12. To draw the time response of first order series RL and RC network (R=4KΩ, L=80mh,c=0.021µf)for periodic Non-Sinusoidal function and verify the time constant.

13. To draw the time response of first order series RL and RC network (R=6KΩ, L=60mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.

14.To draw the time response of first order series RL and RC network (R=2KΩ, L=80mh,c=0.01µf)for periodic Non-Sinusoidal function and verify the time constant.

15.To draw the time response of first order series RL and RC network (R=2KΩ, L=80mh,c=0.31µf)for periodic Non-Sinusoidal function and verify the time constant.

16.To draw the time response of first order series RL and RC network (R=2KΩ, L=80mh,c=0.11µf)for periodic Non-Sinusoidal function and verify the time constant.

17.To draw the time response of first order series RL and RC network (R=4KΩ, L=80mh,c=0.02µf)for periodic Non-Sinusoidal function and verify the time constant.

18. To draw the time response of first order series RL and RC network (R=2KΩ, L=66mh,c=0.21μf)for periodic Non-Sinusoidal function and verify the time constant.
19. To draw the time response of first order series RL and RC network (R=6KΩ, L=80mh,c=0.21μf)for periodic Non-Sinusoidal function and verify the time constant.
20. To draw the time response of first order series RL and RC network (R=4KΩ, L=70mh,c=0.36μf)for periodic Non-Sinusoidal function and verify the time constant.

Exp No: 7

MEASUREMENT OF VOLTAGE,CURRENT AND REAL POWER IN PRIMARY AND 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.	equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-300)V (0-150)V	1 no 1 no
2	Ammeter	MI	(0-2)A (0-20)A	1 no 1 no
3	Wattmeter	Dynamo type	(0-150)V LPF (0-2.5)A	1 no
4	Wattmeter	Dynamo type	(0-150)V UPF (0-10)A	1 no
5	Connecting Wires			Required

Transformer Specifications:

Transformer Rating :(inKVA)________________________

WindingDetails:

LV(inVolts):_________________________

LVsidecurrent:_______________________

HV (inVolts):_________________________

HVsideCurrent:________________________

Type(Shell/Core):________________________

Auto transformer Specifications:

Input Voltage(inVolts):_________________

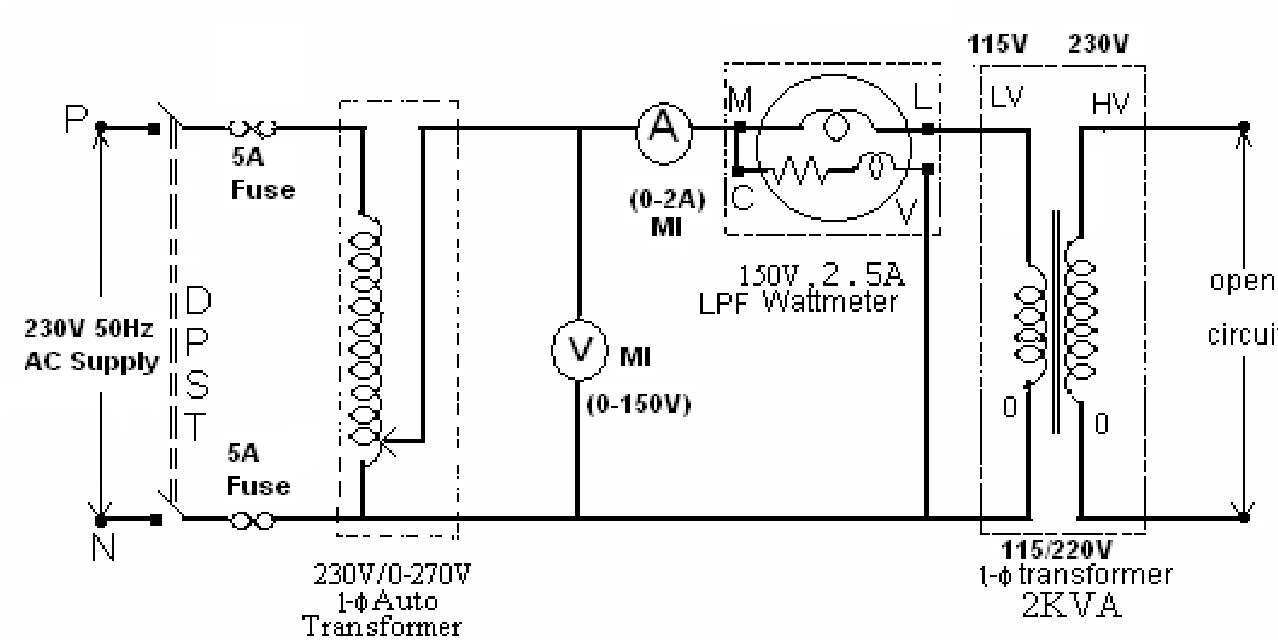
Output Voltage(inVolts):_________________

frequency(inHz):________________________

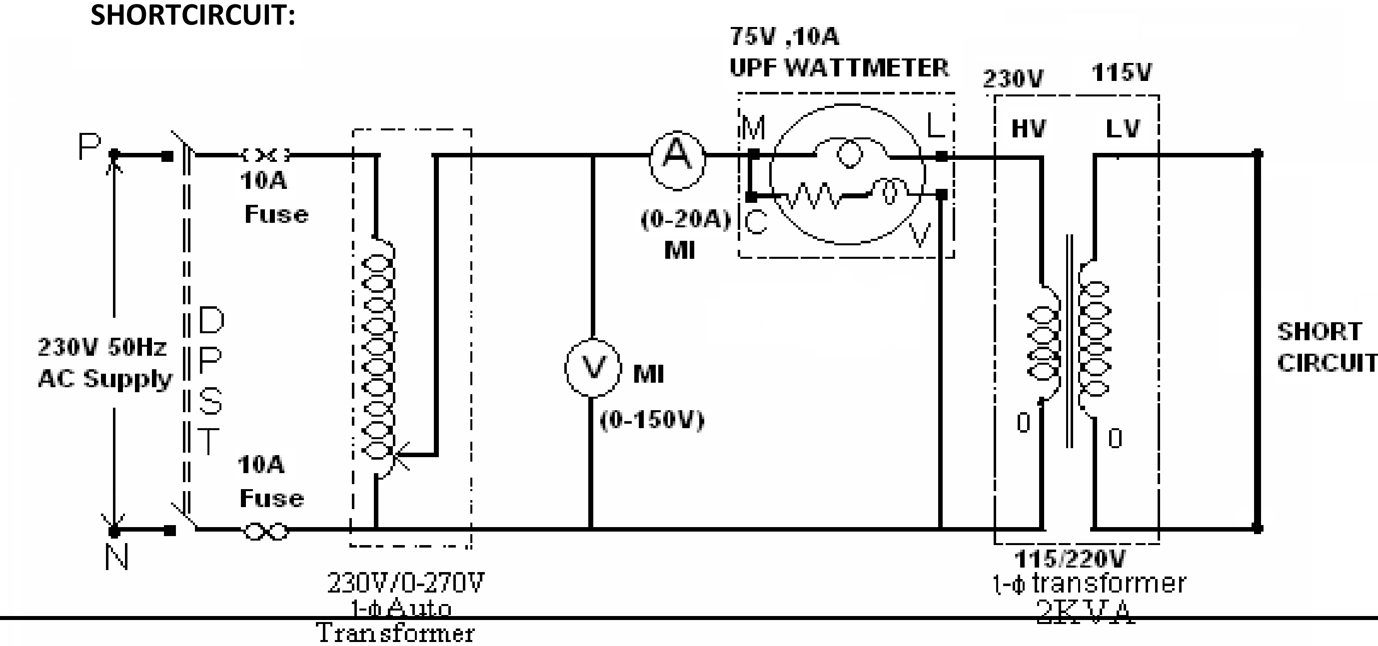
Current rating (inAmp):___________________

CIRCUIT DIAGRAM:

OPEN CIRCUIT:



SHORTCIRCUIT:



PROCEDURE:

Open circuit test:

1. Connections are made as per the circuitdiagram.
2. Ensure that variacis 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 usingVariac
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then Variacis set to zero output position and switch OFF thesupply.
6. Calculate $\mathbf{R_o}$ and$\mathbf{X_o}$ from thereadings.

Short Circuit Test:

1. Connections are made as per the circuitdiagram.
2. Ensure that variacis 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 usingVariac
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then Variacis set to zero output position and switch OFF thesupply.
6. Calculate $\mathbf{R_{o1}}$ and $\mathbf{X_{o1}}$ from thereadings.

OBSERVATIONS:

I) For OCtest

Sl no.	Voltmeter reading (V_o)	Ammeterreading (I_o)	Wattmeter reading W_o	R_o	X_o	Cos ϕ_o

I) For SCtest:

Sl no.	Voltmeter reading (V_{SC})	Ammeter reading (I_{SC})	Wattmeter reading W_{SC}	R_{o1}	Z_{o1}	X_{o1}

Power= VI COSΦ

PRECAUTIONS:

(i) Connections must be madetight

(ii) Before making or breaking the circuit, supply must be switchedoff

RESULT:

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 In 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?
24) Which of the following will improve the mutual coupling between primary and secondary of a transformer ?
25) Which type of core is used for a high-frequency transformer
26) Transformer oil used in transformer provides
27) Enamel layer is coated over the lamination of a transformer core to
28) In a transformer, the oil must be free from
29) In a transformer, the magnetic coupling between the primary and secondary circuit can be increased by
30) If the density in the core of a transformer is increased
31) The power factor in a transformer
32) Which of the following transformer will be largest is size?
33) A transformer transforms
34) A transformer does not change the following
35) In a transformer, the magnitude of the mutual flux is?

36) Thickness of laminations of trans-former core is usually of the order of
37) The size of transformer core depends on
38) In power transformers, breather is used to

39) In a transformer, conservator con-sists of
40) In a transformer, the resistance between its primary and secondary should be
41) Which is minimized by laminating the core of a transformer?
42) Transformer windings are tapped in the middle because?
43) Which of the following materials is used to absorb moisture from air entering the transformer ?
44) Which of the following acts as a protection against high voltage surges due to lightening and switching?
45) A tap changer is used on a trans-former for?
46) Overcurrents in a transformer affect?
47) Highest rating transformers are likely to find application in?
48) Transformer ratings are usually expressed in terms of
49) The noise in transformer due to vibration of laminations set by magnetic forces, is called?
50) The maximum load that a power transformer can carry is limited by its

EXCERSIE PROBLEMS

1. A 2400 V/400 V single-phase transformer takes a no-load current of 0.5 A and the core loss is 400 W. Determine the values of the magnetizing and core loss components of the no-load current. Draw to scale the no-load phasor diagram for the transformer.
2. A 400 kVA transformer has a primary winding resistance of 0.5 and a secondary winding resistance of 0.001 . The iron loss is 2.5 kW and the primary and secondary voltages are 5 kV and 320 V respectively. If the power factor of the load is 0.85, determine the efficiency of the transformer (a) on full load, and (b) on half load.
3. A200Kva rated transformer has a full load copper loss of 15kW and an iron loss of 1kW Determine the transformer efficiency at full load and0.85 power factor
4. What kVA rating is required for a transformer that must handle a maximum load current of 8 A with a secondary voltage of 2 kV?
5. The primary winding of a transformer has 110 V ac across it. What is the secondary voltage if the turns ratio is 8?
6. The mutual inductance when $k = 0.65$, $L_1 = 2$ H, and $L_2 = 5$ H is
7. If 25 W of power are applied to the primary of an ideal transformer with a turns ratio of 10, the power delivered to the secondary load is
8. A transformer with a 110 V primary has a 15:1 turns ratio. The load resistance, R_L, is What is the approximate voltage across the load?
9. How many primary volts must be applied to a transformer with a turns ratio of 0.1 to obtain a secondary voltage of 9 V?
10. A certain transformer has a turns ratio of 1 and a 0.85 coefficient of coupling. When 2 V ac is applied to the primary, the secondary voltage is

11. The primary coil of a transformer is connected to a 60 V ac source. The secondary coil is connected to a 330 load. The turns ratio is 3:1. What is the secondary voltage?
12. A certain amplifier has 600 internal resistance looking from its output. In order to provide maximum power to a 4 speaker, what turns ratio must be used in the coupling transformer?
13. The primary of a transformer is connected to a 6 V battery. The turns ratio is 1:3 and the secondary load, R_L, is 100. The voltage across the load is
14. To step 120 V ac up to 900 V ac, the turns ratio must be
15. When a 200 load resistor is connected across the secondary winding of a transformer with a turns ratio of 4, the source "sees" a reflective load of
16. In a certain transformer, the input power to the primary is 120 W. If 8.5 W are lost to the winding resistance, what is the output power to the load, neglecting any other issues?
17. When a 6 V battery is connected across the primary of a transformer with a turns ratio of 8, the secondary voltage is
18. What is the coefficient of coupling for a transformer in which 4% of the total flux generated in the primary does not pass through the secondary?
19. A transformer has a 1:6 turns ratio and a secondary coil load resistance of 470. The load resistance as seen by the source is
20. If 25 W of power are applied to the primary of an ideal transformer with a turns ratio of 10, the power delivered to the secondary load is

Expt. No.8
LOAD TEST ON A 1-Φ TRANSFORMER

AIM: To perform conduct Load test on the given 1-ΦTransformer and to calculate its, Efficiency and Regulation.

APPARATUS REQUIRED:

S.No	Apparatus	Range	Type	Qty
1	Voltmeters	0-150V, 0-75V	M.I	1, 1 No
2	Ammeters	0-2A, 0-15A	M.I	1,1 No
3	Wattmeter	2A, 150V, 60W, LPF 15A, 50V, 600W, UPF	Dynamo meter	1, 1 No
4	Auto T/F	230V/0-270V	1-φ wire wound	1 No

Name plate details:

1-φ TRANSFORMER	
Capacity	2KVA
I/P voltage	220V
I/P current	26A
O/P voltage	220V
O/P current	13A
Frequency	50Hz

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 transformer can 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

Output power from transformer = V2I2 [QCosΦ2 = load P.F = 1]

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

= (V2I2 / W1) × 100%

Voltage regulation (V.R) is the change in the magnitude of secondary voltage from no load to desired load. This change is expressed as a percentage of the no load voltage.

% V.R. = *100 %

= *100%

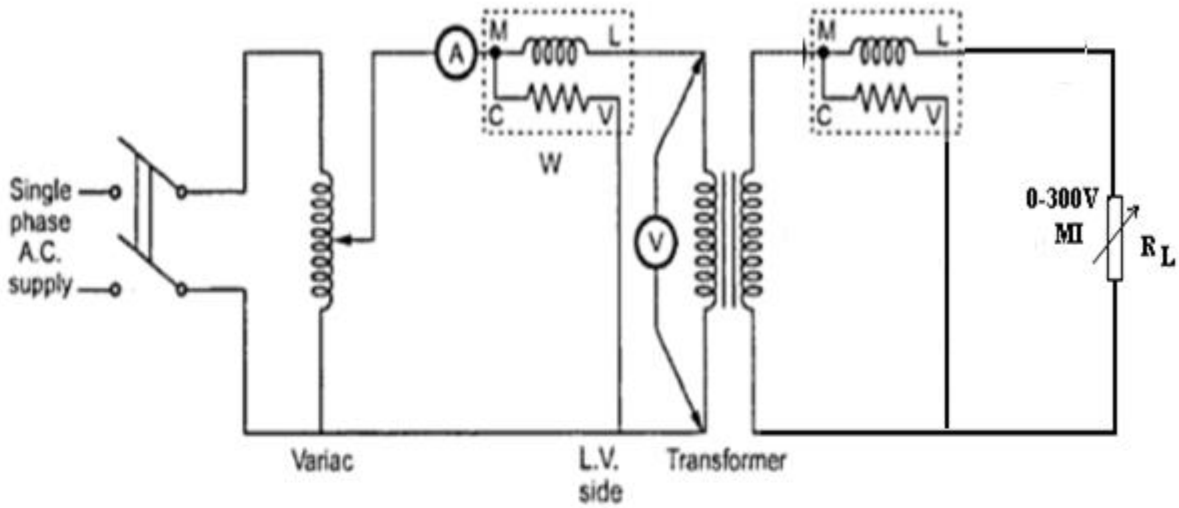
= E_2/E_2-V

Where: - E2 = No load voltage

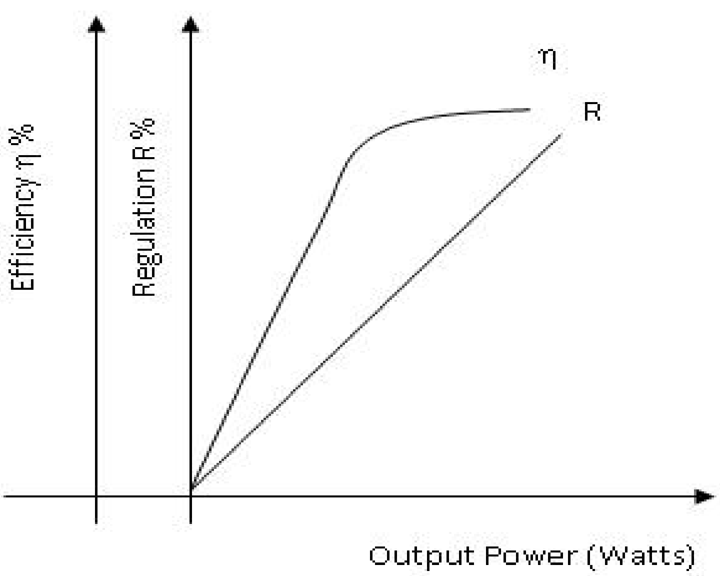
V2 = any load voltage

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

CIRCUIT DIAGRAM:



MODEL GRAPHS:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. By varying the Auto transformer, rated voltage is applied to the input side of the transformer and should be maintained constant throughout the experiment.
3. By varying the load in steps, readings of ammeter, voltmeter, and wattmeter are 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 = W_1 x Multiplication factor

Output Power = W_2 x Multiplication factor

Efficiency η % = Output Power ÷Input Power ×100

V_{NL} - V_{FL} (Secondary)

Regulation R % = ________________________ x 100%

V_{NL}

TABULAR COLUMN:

Rated Secondary Voltage, V_2=230V

S.NO	Sec voltage V^1(v)	Voltage (v)	Sec current I_2(A)	Input power(w)	Output power= $V_2 \times I_2$ (w)	Efficiency η =P_{output}/P_{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:

The most important uses and application of Transformer are:

1. It can rise or lower the level of level of Voltage or Current (when voltage increases, current decreases and vice virsa because **P =V x I**, and Power is same) in an AC Circuit.
2. It can increase or decrease the value of capacitor, an inductor or resistance in an AC circuit. It can thus act as an impedance transferring device.
3. It can be used to prevent DC from passing from one circuit to the other.

It can isolate two circuits electrically

Viva Questions:

1. What is the principle of operation of a Transformer?
2. What is the function of a Transformer?
3. What are the different types of a Transformer?
4. What are the different parts of a Transformer?

5. What are the different types of measuring instruments?

6. What is the principle of operation of a DC Generator?

7. What are the main parts of a DC Generator and their functions?

8. What is the function of a DC Generator?

9. What are the different types of a DC Generator?

10. What is the principle of operation of a DC Motor?

11. What is the function of a DC Motor?

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

13. What is the purpose of a Three point starter?

14. What is the purpose of a fuse?

15. Why the field rheostat should be kept in minimum position?

16. What is the purpose of changing the voltage level in AC Transmission?

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

18. What is the function of a Transformer?

19. What are the different types of a Transformer?

20. What are the different parts of a Transformer?

21. What are the different types of measuring instruments?

22. What is meant by “Pre determination” with respect to electrical machines?

23. What is meant by efficiency and regulation?

24. Can we start the motor without using three point starter? If so, how?

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

26. The efficiency of transformer compared with that of electric motors of the same rating is?

27. The no load current taken by a transformer lags the applied voltage approximately by?

28. In a two winding transformer, the primary and the secondary induced emfs E1 and E2 are always?

29. Distribution transformers are designed to have maximum efficiency at about?

30. Use of silicon steel for laminations in a transformer reduces?

31. Special silicon steel is used for the laminations of transformer, because it has?

32. In a transformer, spiral winding is suitable only for windings?

33. The magnetic flux in a transformer follows a path of?

34. Use of higher flux density in trans-former design?

35.A transformer is connected to a constant voltage supply. As the supply frequency increases, the magnetic flux in the core?

36. Circular coil sections are generally used in transformer because they?

37. Good transformer oil should contain water less than?

38. The secondary of transformer is never kept open circuited under actual operating conditions to?

39.The end winding of a power transformer is given extra insulation to protect it against?

40. The main reason why open circuit test is performed on the low voltage winding of the transformer is that it?

41.. For short circuit and open circuit tests of a transformer, the instru-ments are connected on?

42. Two transformers operating in parallel share the load depending on their?

43. Incorrect polarity in parallel operation of two transformers results in?

44. In parallel operation of trans-formers, to reduce copper loss?

45. The induction reactance of a trans-former depends on?

46. When the secondary of the trans-former is loaded, the flux in the transformer constant will?

47.Electric power is transferred from one coil to the other coil in a transformer

48. A transformer operates

49. In an ideal transformer on no-load, the primary applied voltage is balanced by?

50. In a transformer, the no load current in terms of full load current is of the order of?

EXERCISE PROBLEMS

1. A 230/2300V transformer takes no load current of 5A at 0.25pf lagging. Find i) the core loss ii) magnetizing current?
2. A 3300/220v, 30 KVA, 1ϕ transformer takes no load current at 1.5Awhen the low voltage winding is open. The iron loss component is 0.4A. Find i) no load input power ii) magnetizing component iii) power factor of no load current
3. A25KVA transformer has 500 turns on the primary and 50turns on the secondary winding. The primary is connected to 3000v 50Hz supply. Find the full load primary and secondary currents, the secondary emf And the maximum flux in the core .Neglect leakage drops and no load primary current.
4. The efficiency of a 400KVA 1ϕtransformer is 98.77% when delivering full load at 0.8pf and 99.13% at half full load at unity power factor. Calculate i) Iron losses ii) $1/4^{th}$ copper loss
5. Calculate the % regulation of a transformer in which the % resistance drop is 1% and % reactance drop is 5% when the power factor 0.8 lagging ii) unity iii) 0.8leading.
6. In a 50KVA transformer, the iron loss is 500MW and full load copper loss is 800W. Find the efficiency at full load and half full load at 0.8pf lag.
7. A 50Hz, 1Ø, 100 KVA transformers has full load copper loss of 1300W and its iron loss is 860W. Calculate: The efficiency at full load, 0.8 power factor.
8. A 50Hz, 1Ø, 150 KVA transformers has full load copper loss of 1200W and its iron loss is 760W. Calculate the efficiency at full load, 0.8 power factors.
9. The efficiency of a 30KVA 1ϕtransformer is 97.77% when delivering full load at 0.8pf and 98.13% at half full load at unity power factor. Calculate i) Iron losses ii) copper loss iii) efficiency.
10. A 230/150V transformer takes no load current of 5A at 0.25pf lagging. Find i) the core loss ii) magnetizing current?
11. A 200/2200V transformer takes no load current of 6A at 0.25pf lagging. Find i) the core loss ii) magnetizing current?
12. A 300/20v, 3KVA, 1ϕ transformer takes no load current at 1Awhen the low voltage winding is open. The iron loss component is 0.4A. Find i) no load input power ii) magnetizing component iii) power factor of no load current
13. A 2KVA transformer has 400 turns on the primary and 60turns on the secondary winding. The primary is connected to 300v 50Hz supply. Find the full load primary and secondary currents, the secondary emf And the maximum flux in the core .Neglect leakage drops and no load primary current.
14. The efficiency of a 40KVA 1ϕtransformer is 98.77% when delivering full load at 0.8pf and 99.13% at half full load at unity power factor. Calculate i) Iron losses ii) $1/4^{th}$ copper loss
15. Calculate the % regulation of a transformer in which the % resistance drop is 1% and % reactance drop is 5% when the power factor 0.8 lagging ii) unity iii) 0.8leading.

16. In a 5KVA transformer, the iron loss is 50MW and full load copper loss is 80W. Find the efficiency at full load and half full load at 0.8pf lag.

17. A 50Hz, 1Ø, 10 KVA transformers has full load copper loss of 130W and its iron loss is 86W. Calculate: The efficiency at full load, 0.8 power factor.
18. A 50Hz, 1Ø, 150 KVA transformers has full load copper loss of 120W and its iron loss is 76W. Calculate the efficiency at full load, 0.8 power factors.

19. The efficiency of a 30KVA 1ϕtransformer is 97.77% when delivering full load at 0.8pf and 98.13% at half full load at unity power factor. Calculate i) Iron losses ii) copper loss iii) efficiency.

20. A 230/150V transformer takes no load current of 2A at 0.25pf lagging. Find i) the core loss ii) magnetizing current?

Expt No: 9

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

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

RESOURCES :

Sl.No	Apparatus	Range	Type	Qty

1	Voltmeter	(0-600V)	M I	1 no.
2	Wattmeter	1ϕ,600V,10A, LPF	D.M.T	1 no.
3	Ammeter	0-10A,	M I	1 no.
4	3ϕ autotransformer	415/0-470V, 10A, 8.14KVA		1no.
5	rheostats	10A, 415V		3 no.

PRECAUTIONS:

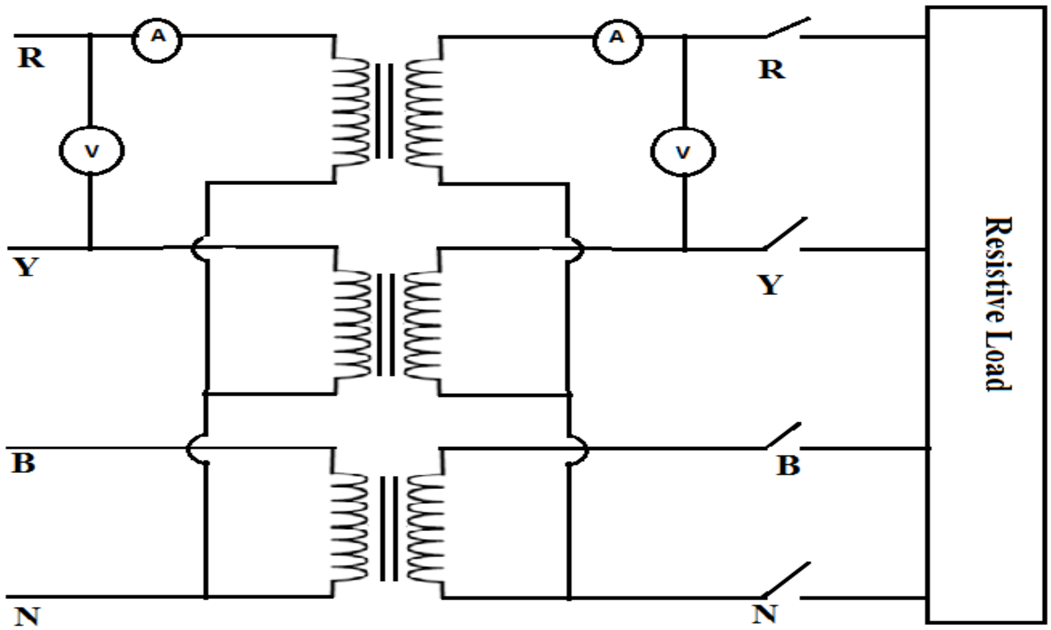
1. Ensure the minimum position of Three phase autotransformer during power on and off.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.

PROCEDURE:

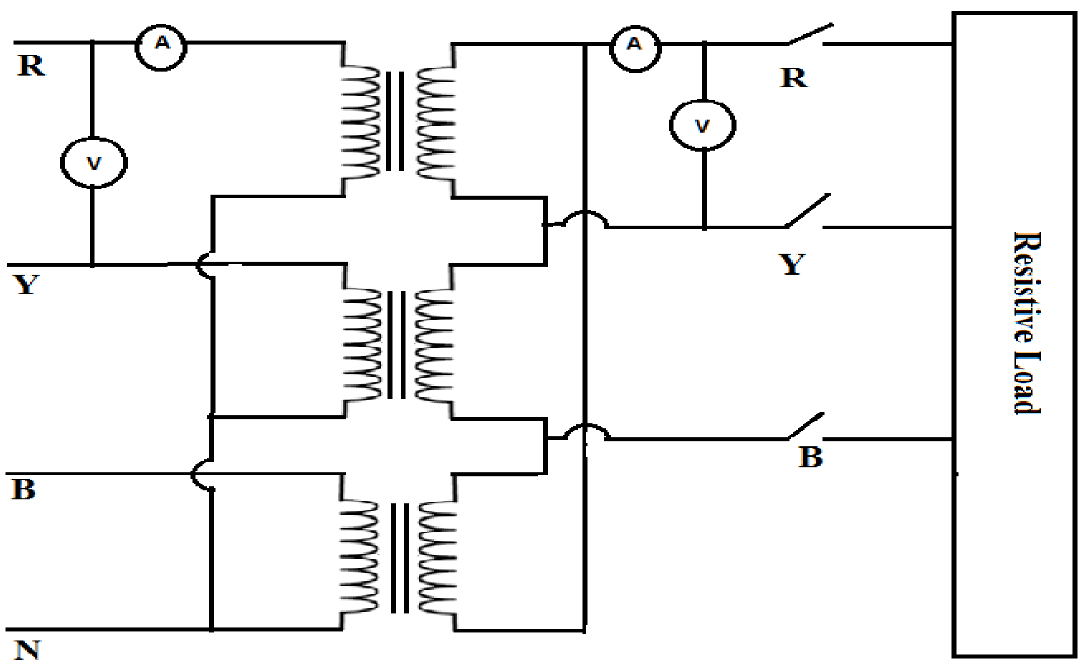
1. Connect circuit as shown in the circuit diagram.
2. Set demerstat to minimum position.
3. Switch on the main supply .
4. Note the readings of ammeter, voltmeter & multifunction meter.
5. Note more readings by changing supply voltage.

Circuit Diagram:

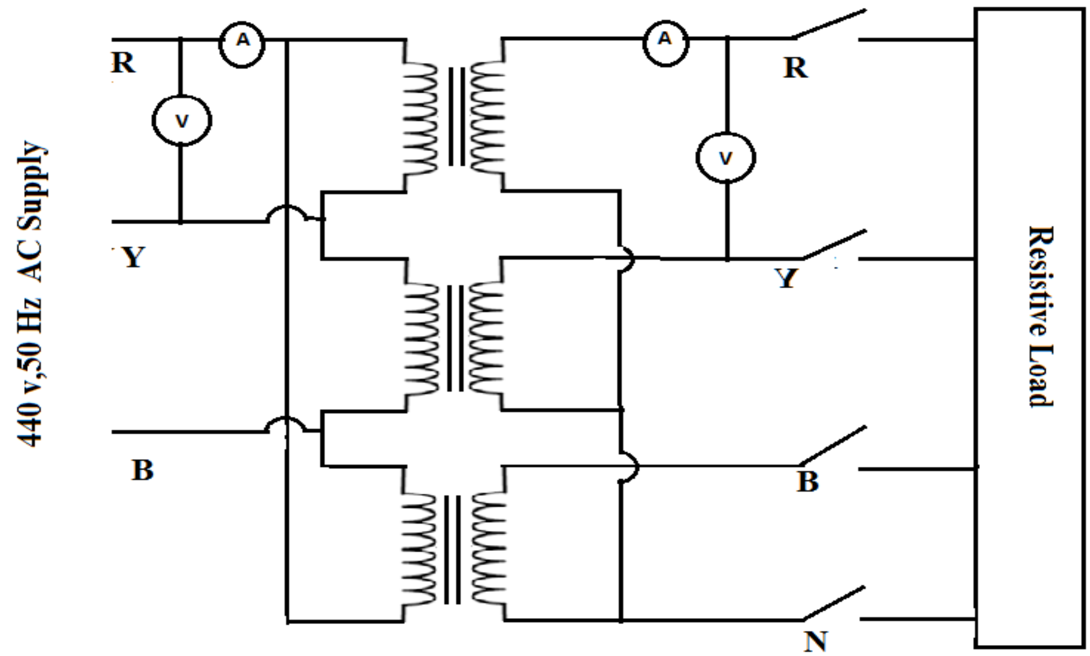
A) For star-Star connection:



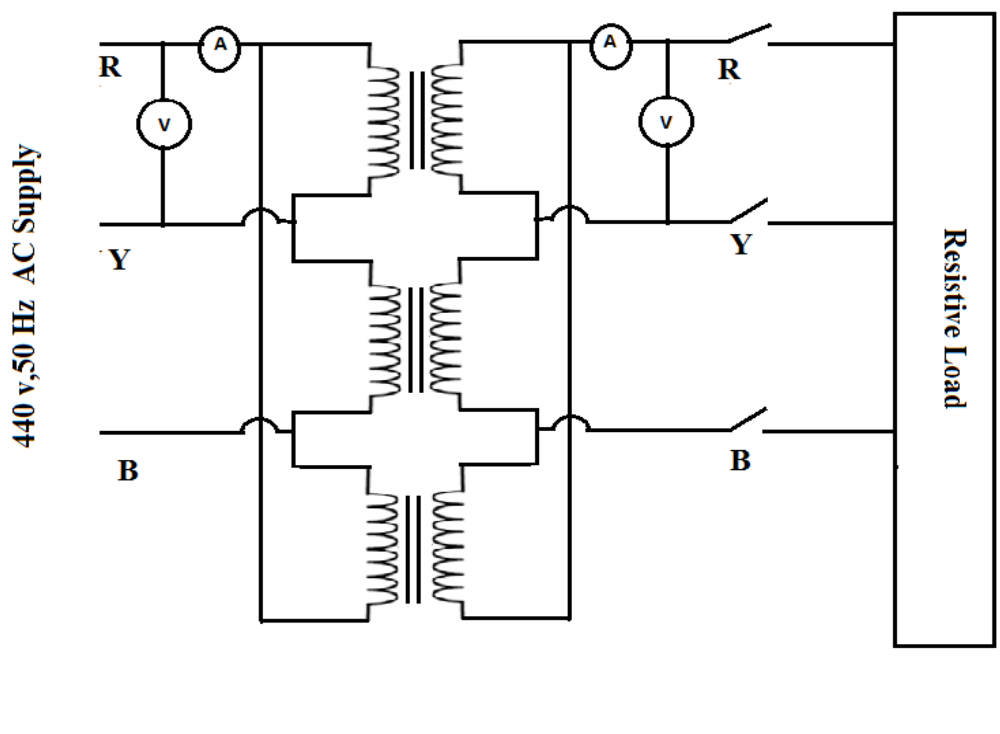
B) STAR-DELTA:



C) DELTA-STAR:



D) DELTA-DELAT:



THEORY:

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

(i) **Star Connection→** In this connection, the starting or termination ends of all winding are connected together & along with their phase ends this common point is also brought out called as neutral point.

(ii) **(ii) Delta Connection →** If the terminating end of one winding is connected to starting end of other & If connection are continued for all their windings in this fashion we get closed loop. The three supply lines are taken out from three junctions. This is called as three phase delta connected system. The load can be connected in similar manner. In this experiment we are concerned with balanced load.

The load is said to be balanced when

i. Voltages across three phases are equal & phases are displaced by 120° electrical.
ii. The impedance of each phase of load is same.
iii. The resulting current in all the three phases are equal & displaced by 120° electrical from each other.
iv. Active power & reactive volt amperes of each is equal.

Some terms related to 3 ph system:

i. **Line Voltage** - The voltage between any two line of 3 ph load is called as line voltage e.g. VRY,VYB& VBR.. For balance system all are equal in magnitude.
ii. **Line Current** – The current in each line is called as line current e.g. IR, IY, & IB. They are equal in magnitude for balance system.
iii. **Phase Voltage** – The voltage across any branch of three phase load is called as phase voltage. VRN, VYN, & VBN are phase voltage
iv. **Phase Current** – current passing through any phase of load is called as phase current.

For star connection of load:

Line voltage (VL) = √3 phase voltage (Vph)

Line current (IL) = Phase current (Iph)

For delta connection of load:

Line voltage (VL)= phase voltage (Vph)

Line current (IL)= √3 phase current(Iph)

The three phase power is given by, P= power consumed by the load = √3VL IL cos(φ)

Where

φ is phase angle & it depends on type of load i.e. inductive, capacitive or resistive.

OBSERVATIONS:

For each configuration:

S.No	Voltage V_L volts	Current I_L amp	Voltage V_{ph}volts	Current I_{ph} amp	Realpower(P)= $\sqrt{3}V_L I_L COS\phi$
1					
2					
3					
4					

SAMPLE CALCULATIONS:

Line voltage V_L =

Line current IL =

Phase voltage V_{ph} =

Phase current Iph

Real power (P) = $\sqrt{3}V_L I_L \cos\phi$ =

RESULT:

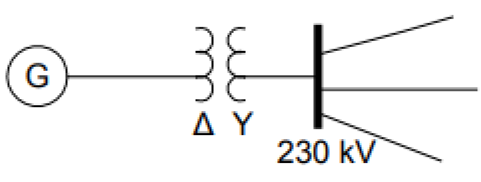
VIVA QUESTIONS:

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 are iron cores in transformers made 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?
14. What is the permissible maximum flux density in transformer core?
15. What is the phase relationship between the primary and secondary voltages of a transformer?
16. What is turn ratio of a transformer?
17. What is voltage ratio of a transformer?
18. What current flows in the transformer primary when its secondary is open?
19. What is the formula for calculating no-load current?
20. Why is the frequency not changed during transformation of electrical energy in 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?
43. What is the principle of operation of a Transformer?
44. What is meant by "Pre determination" with respect to electrical machines?
45. What is meant by efficiency?
46. Can we start the motor without using three point starter? If so, how?
47. What is the purpose of Auto transformer (or Dimmer stat)?
48. Define regulation?
49.What do you mean by step-down transformers?
50. How many types transformers?

EXERCISE PROBLEMS:

1) A transformer with a 110 V primary has a 15:1 turns ratio. The load resistance, R_L, is 120 Ω. What is the approximate voltage across the load?
2) the primary winding of a transformer has 110 V ac across it. What is the secondary voltage if the turns ratio .
3) To step 110 V ac down to 20 V ac, the turns ratio must be.
4) The mutual inductance when k = 0.65, L_1 = 2 μH, and L_2 = 5 μH is.
5) If 25 W of power are applied to the primary of an ideal transformer with a turns ratio of 10, the power delivered to the secondary load is.
6) How many primary volts must be applied to a transformer with a turns ratio of 0.1 to obtain a secondary voltage of 9 V?
7) A certain transformer has a turns ratio of 1 and a 0.85 coefficient of coupling. When 2 V ac is applied to the primary, the secondary voltage is
8) The primary coil of a transformer is connected to a 60 V ac source. The secondary coil is connected to a 330 Ω load. The turns ratio is 3:1. What is the secondary voltage?
9) A certain amplifier has 600 Ω internal resistance looking from its output. In order to provide maximum power to a 4 Ω speaker, what turns ratio must be used in the coupling transformer?
10) The primary of a transformer is connected to a 6 V battery. The turns ratio is 1:3 and the secondary load, R_L, is 100 Ω. The voltage across the load is
11) To step 120 V ac up to 900 V ac, the turns ratio must be
12) When a 200 Ω load resistor is connected across the secondary winding of a transformer with a turns ratio of 4, the source "sees" a reflective load of
13) In a certain transformer, the input power to the primary is 120 W. If 8.5 W are lost to the winding resistance, what is the output power to the load, neglecting any other issues?
14) When a 6 V battery is connected across the primary of a transformer with a turns ratio of 8, the secondary voltage is
15) What is the coefficient of coupling for a transformer in which 4% of the total flux generated in the primary does not pass through the secondary?
16) A transformer has a 1:6 turns ratio and a secondary coil load resistance of 470 Ω. The load resistance as seen by the source is
17) The transformer of the picture is connected to a transmission line of 230kV. As you can see the transformer is delta-star connected. Its turns ratio is a=1:10. I had a go at the solution but when checking the solution manual I found something wrong. In my solution for the right side of the transformer and for single phases the voltage is



18) A 500-kVA, 3-phase, 50 Hz transformer has a voltage ratio (line voltages) of 33/11 kV and is delta/star connected. The resistances per phase are: high voltage 35 Ω, low voltage 0.876 Ω and the iron loss is 3050 W. Calculate the value of efficiency at full-load and one-half of full-load respectively (a) at unity pf and (b) 0.8 pf

19) A 100 kVA,3-phase, 50 Hz, 3,300/400 V transformer is Δ-connected on HV side and Y-connected on LV side. The resistance of the HV winding is 3.5 Ω per phase and that of the LV winding 0.02 Ω per phase. Calculate the iron losses of the transformer at normal voltage and frequency if its full-load efficiency be 95.8 % at 0.8 pf lagging

20) a 3-phase, 1300 MVA, 24.5 kV / 345 kV, 60 Hz generator step-up transformer has a leakage impedance of 11.5%determine the equivalent circuit of this transformer on a per-phase basis calculate the voltage across the generator terminals when the high voltage side of the transformer delivers 810 MVA at 370 kV with a 0.90 lagging power factor

<u>Exp.No: 10</u>

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

AIM: To measure the active and reactivepowerusing (single phase wattmeter) for the given balanced three phase network.

APPARATUS:

ACTIVE POWER:

S.No	Name of the equipment	Range	Type	Quantity
1	Wattmeter	0-10A/600V	MI	2
2	Rheostats	0-200 ohms	Wire wound	3
--	Connecting wires	-	-	As required

REACTIVE POWER:

Sl.No	Apparatus	Range	Type	Qty
1	Voltmeter	(0-60V)	M I	1 no.
2	Wattmeter	1ϕ,600V,10A, LPF	D.M.T	1 no.
3	Ammeter	0-10A,	M I	1 no.
4	3ϕ autotransformer	415/0-470V, 10A, 8.14KVA		1no.
5	3ϕ loading inductor	10A, 415V		1 no.

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 w1=Ir, 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 coilof $W_2= V_{RN}-V_{YN}=V_{BY}$.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 $W1=V_{RY}I_YCos(300+ Φ)$While reading on wattmeter W2 is given by $W2=V_{BY}I_BCos(300- Φ)$Since the load is balanced,

$|I_R|=|I_Y|=|I_B|=I$ and $|V_{RY}|=|V_{BY}|=V_L$ $W1=V_LICos(300+\Phi)$ $W2=V_LICos(300-\Phi)$.

Thus total power P is given by

$W= W_1 + W_2 = V_LICos(300+\Phi) + V_LICos(300-\Phi) =$

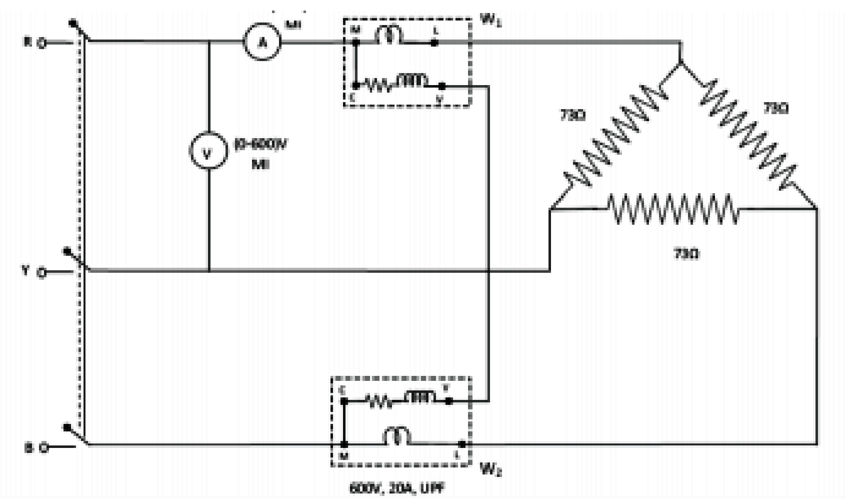
$V_LI[Cos(300+\Phi) + Cos(300-\Phi)] = [\sqrt{3}/2 * 2Cos\,\Phi]V_LI = \sqrt{3}V_LICos\,\Phi$.

REACTIVE POWER:

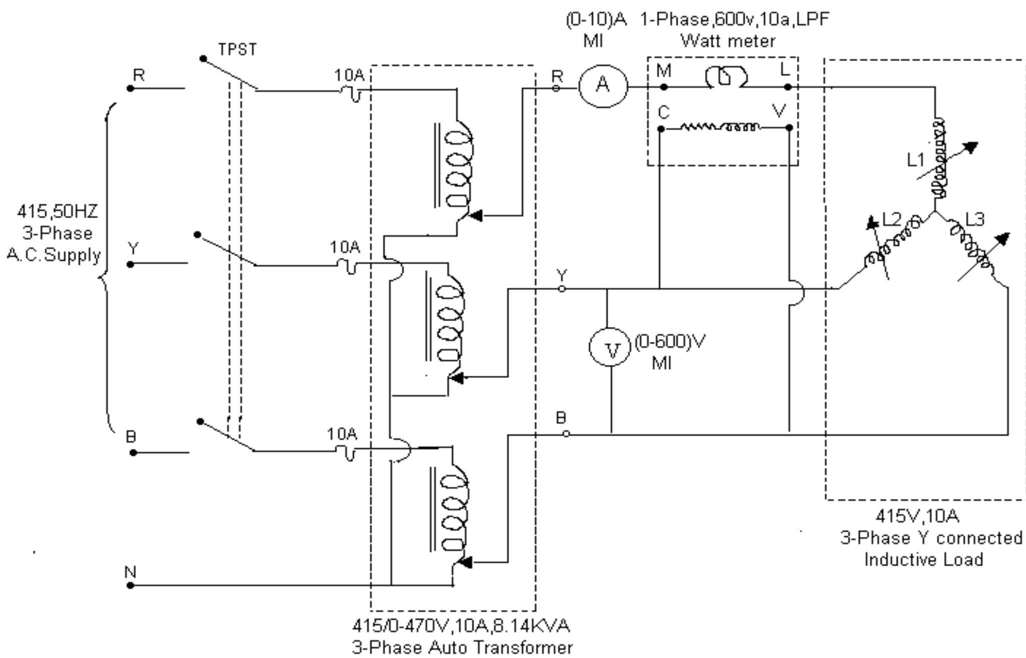
Reactive power measurement in 3-ϕ circuits using 1-ϕ wattmeter can be done only for balanced 3-ϕ loads. By connecting the current coil of the wattmeter in one line and the pressure coil across the other two lines of 3-ϕ circuit, current through the current coil and voltage across the pressure coil are 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):



REACTIVE POWER:



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 to one 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 is connected to the third terminal of the balanced 3-ph load.
5. Another wattmeter is connected across R &Yphase, 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

OBSERVATIONS:

For ideal inductive load $\phi = 90^0$ --> Sinϕ= 1

S.No.	Voltage(V_L) volts	Current (I_L)amp	Wattmeter (W)	Reactive Power(Q)= $\sqrt{3}V_L I_L \sin\phi (VAR)$
1				
2				
3				
4				
5				

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 on and off.
4. Set the ammeter pointer at zero position.
5. Take the readings without parallax error.

SAMPLE CALCULATIONS:

Load voltage V_L =

Load current IL =

Watt meter reading W =

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

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

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

RESULT:

PRE LAB QUESTIONS:-

1. What is meant by Reactive power?

2. What is the difference between balanced and unbalanced loads?

LAB ASSIGNMENT:

Calculate the active & apparent power for the given circuit

POST LAB QUESTIONS:-

1. What is meant by complex power?

VIVA QUESTIONS:

1. Define phase, line & neutral?
2. Deifne 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?
13. 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}) is?
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?
23. In a Δ-connected source driving a Δ-connected load, the load and line voltages are?
24. In a certain three-wire Y-connected generator, the phase voltages are 2 kV. The magnitudes of the line voltages are?
25. In a Δ-connected source feeding a Y-connected load?

EXERCISE PROBLEMS:

1. In a wye connected circuit, if the line-to-line voltage is 346 V, what is the line-to-neutral voltage?
2. Three resistors each having a resistance of 11ohm are connected in delta acrossa 3-phase 440 V line. What is the line current?
3. A 3-phase transformer delivers 120 kVA to a 3-phase load at a line-to-line voltage of 2400 V. Calculate the current per line.
4. What is the phase sequence of a balanced three-phase circuit for which Van= 160∠30°V and Vcn= 160∠-90°V? Find Vbn.
5. Determine the phase sequence of a balanced three-phase circuit in which Vbn= 208∠130°V and Vcn= 208∠10°V. Obtain Van.
6. For a Y-connected load, the time-domain expressions for three line-to-neutral voltages at the terminals are:vAN= 150 cos (ωt+ 32º)V vBN= 150 cos (ωt– 88º) V vCN= 150 cos (ωt+ 152º) V .Write the time-domain expressions for the line-to-line voltages .i). vAN,vBC, andvCA
7. In a balanced three-phase Y-Y system,the source is an abc sequence of voltages and Van= 100∠20°V rms. The line impedance per phase is 0.6 +j1.2 **Ω**, while the per-phase impedance of the load is 10 + j14 **Ω**. Calculate the line currents and the load voltages.

8. A balanced Y-Y four-wire system has phase voltages °∠120Van= ,Vbn=120∠−120°V and Vcn=120∠120°v.The load impedance per phase is 19+ j13**Ω**, and the line impedance per phase is1 +j2 **Ω** Solve for the line currents and neutral current.

9. A three-phase balanced system with a line voltage of 202 V rms feeds a delta-connected load with Zp= 25 ∠60°Ω (a)Find the line current. (b) Determine the total power supplied to the load using two wattmeters connected to the Aand Clines.
10. A balanced delta-connected source has phase voltage Vab= 416∠30°V and a positive phase sequence. If this is connected to a balanced delta-connected load, find the line and phase currents. Take the load impedance per phase as 60∠30°Ωand line impedance per phase as 1 + j1 Ω.
11. A Δ-connected source supplies power to a Y-connected load in a three-phasebalanced system. Given that the line impedance is 2 + j1 Ωper phase while the load impedance is 6 + j4 Ωper phase, find the magnitude of the line voltage at the load. Assume the source phase voltage Vab= 208∠0V rms.
12. A balanced three-phase Y-Δsystem has Van= 120∠0°V rms and ZΔ=51+j45ΩIf the line impedance per phase is 0.4 + j1.2 Ω,find the total complex power delivered to the load. A balanced delta-connected load is supplied by a 60-Hz three-phase source with a line voltage of 240 V. Each load phase draws 6 kW at a lagging power factor of 0.8. Find: (a) the load impedance per phase (b) the line current (c) the value of capacitance needed to be connected in parallel witheach load phase to minimize the current from the source
13. A three-phase source delivers 4800 VA to a wye-connected load with a phase voltage of 208 V and a power factor of 0.9 lagging. Calculate the source line current and the source line voltage.
14. A balanced wye-connected load with a phase impedance of 10 – j16 Ωis connected to a balanced three-phase generator with a line voltage of 220 V.Determine the line current and the complex power absorbed by the load.
15. Three equal impedances, 60 + j30 Ωeach, are delta-connected to a 230-V rms, three-phase circuit. Another three equal impedances, 40 + j10 Ωeach, are wye-connected across the same circuit at the same points. Determine: (a) the line current (b) the total complex power supplied to the two loads (c) the power factor of the two loads combined .
16. A 4200-V, three-phase transmission line has an impedance of 4 + j10 per phase. If it supplies a load of 1 MVA at 0.75 power factor (lagging), find:
    (a) the complex power
    (b) the power loss in the line
    (c) the voltage at the sending end
17. The total power measured in a three-phase system feeding a balanced wye-connected load is 12 kW at a power factor of 0.6 leading. If the line voltage is 208 V, calculate the line current ILand the load impedance ZY.
18. A balanced delta-connected load draws 5 kW at a power factor of 0.8 lagging. If the three-phase system has an effective line voltage of 400 V, find the line current.
19. A three-phase line has an impedance of 1 + j3Ωper phase. The line feeds a balanced delta-connected load, which absorbs a total complex power of 12 + j5 k VA. If the line voltage at the load end has a magnitude of 240 V, calculate the magnitude of the line voltage at the source end and the source power factor.
20. A balanced wye-connected load is connected to the generator by a balanced transmission line with an impedance of 0.5 + j2Ωper phase. If the load is rated at 450 kW, 0.708 power factor lagging, 440-V line voltage, find the line voltage at the generator.

Expt. No.11

BRAKE TEST ON DC SHUNT MOTOR

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

APPARATUS:

S. No	Apparatus	Type	Range	Quantity
1	Voltmeter	MC	(0 – 300)V	1 No
2	Ammeter	MC	(0 – 20)A	1 No
3	Rheostat	Wire wound	370Ω/1.7A	1 No
4	Ammeter	MC	(0 – 2)A	1 No
5	Tachometer	DIGITAL	0-9999 rpm	1 No
	Connecting wires	--------	------------	As required

THEORY:

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

Let ‘S1’ and ‘S2’ are the spring balance readings.

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

Torque on the drum= T_{sh} = 9.81 (S1-S2) r Nw-m Where ‘r’ is the radius of the drum

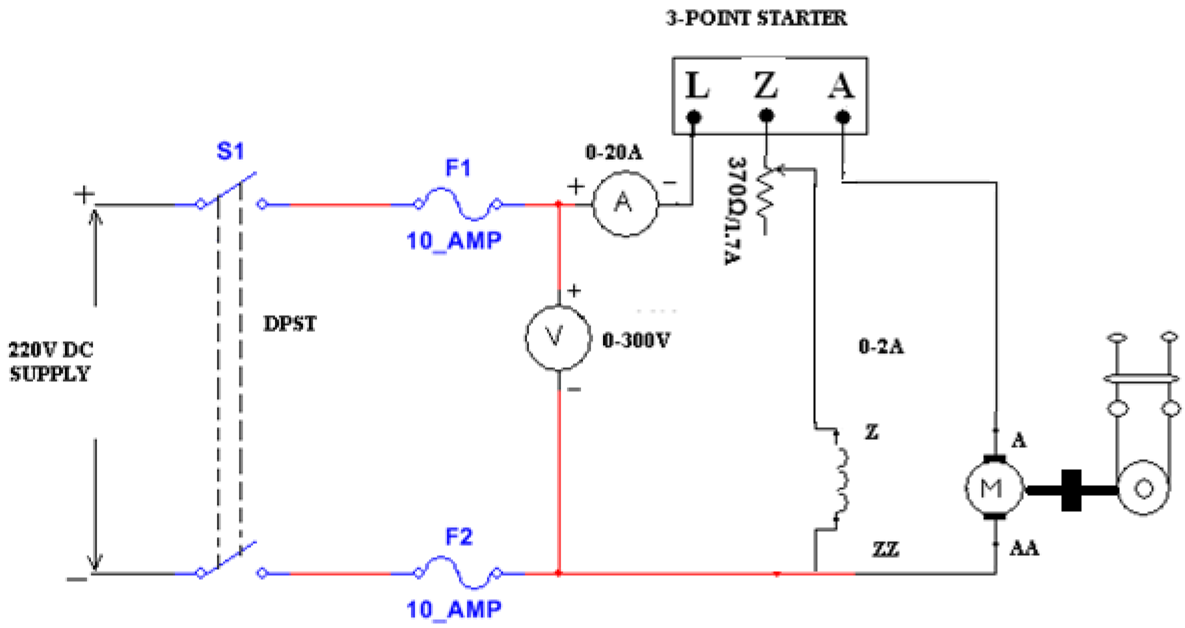
Motor power output = T_{sh} * 2π N/60 watts; where N is the rpm of the motor

Let input voltage and current are V and I

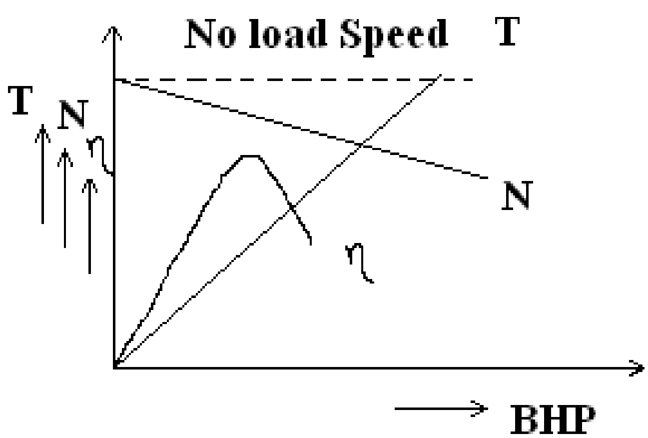
Power input to the motor is V*I

The efficiency = η = output/ input

CIRCUIT DIAGRAM:



MODEL GRAPH:



PROCEDURE:

1. Connections are made as shown in the circuit diagram.
2. Field rheostat is kept in minimum position and the motor is started with the help of 3-Point starter, and is brought to rated speed by adjusting field rheostat.
3. By varying the load in steps, readings of ammeters, voltmeter, tachometer, spring balances, are noted down.
4. Performance curves are to be drawn after completing the calculations.

PRECAUTION:

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

TABULAR COLUMN:

S no.	V (Volt)	I_L (Amp)	N (rpm)	S1 (Kg)	S2 (Kg)	W=S1-S2 (Kg)	T= 9.81 W r (Nm)	Output= 2πNT/60 (watts)	Input= VI_L (Watts)	η = output/ Input (%)

("r" is the radius of the drum)

RESULT:

APPLICATIONS:

Lathe Machines, Centrifugal Pumps, Fans, Blowers, Conveyors, Lifts, Weaving Machine, Spinning machines

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.
4. If two motors are required to drive a common load, how will they share the total load?
5. What are the different types of a DC Motor?
6. What is the purpose of a three point starter?
7. When DC Generator fails to build up the voltage, what are the reasons?
8. What is field flashing?
9. Why do we use starter for dc machine?
10. Factor that has to be considered while choosing the resistor?
11. What are the different losses in dc machine?
12. Drawbacks of Brake test?
13. What happens if DC supply is applied to the transformer?
14. What is the application of equivalent circuit of a single phase transformer?
15. What is synchronous speed?
16. What is meant by torque? or Define torque?
17. How can we reduce the eddy current loss in the electrical machine?
18. In DC generators, the series field winding has low resistance while the shunt field winding has high resistance. Why?
19. Why series motor cannot be started on no-load?

20. Which type of motor is used in trains, what is the rating of supply used?
21. What is magnetic circuit?
22. Define magnetic flux?
23. Define magnetic flux density?
24. Define magneto motive force?
25. Define reluctance?
26. What is retentivity?
27. Define permeance?
28. Define magnetic flux intensity?
29. Define permeability?
30. Define relative permeability?
31. What is mean by leakage flux?
32. What is leakage coefficient?
33. State faradays law of electromagnetic induction
34. State Lenz law?
35. Define self inductance?
36. Define mutual inductance?
37. Define coefficient coupling?
38. Give the expression for hysteresis loss and eddy current loss?
39. What is dynamically induced emf?
40. What is fringing effect?
41. State two types of IM?
42. State ohms law for magnetic circuits?
43. What is statically induced emf?
44. How eddy current losses are minimized?
45. State types of electrical machines?
46. What is mean by stacking factor?
47. What are the magnetic losses?
48. Types of induced emf?
49. What is the significance of winding factor?
50. Write the energy balance equation for motor?

EXERCISE PROBLEMS :

1. In a brake test the effective load on the branch pulley was 38.1Kg, the effective diameter of the pulley 63.5cm and speed 12rps the motor took 49A at 220V. Calculate the output power
2. The following readings are obtained when doing a load test on a DC shunt motor using a brake drum

Spring balance		Voltage	Speed	I_L	I_F	Diameter of the drum
S1	S2					
10Kg	35Kg	200V	950rpm	30A	1A	40cm

Calculate the efficiency.

3. In a brake test, on a DC shunt motor the tension on the two sides of the brakes are 2.9Kg and 0.17Kg. Radius of the pulley was 7cm. Input current was 2A at 230V. The motor speed was 1500rpm find the torque.
4. A 10 KW DC shunt motor has the effective load on the branch pulley was 18.1Kg, the effective diameter of the pulley 53.5cm and speed 1500rpm the motor took 50A at 220V. Calculate the efficiency.
5. The following readings are obtained when doing a load test on a DC shunt motor using a brake drum :
   Spring balance 5Kg and 3Kg Diameter of the drum 12cm
   Line current 14A and applied voltage is 240V. Find output power and BHP.
6. A 4 pole, 10KW DC shunt motor delivers 5A and having armature and shunt field resistances are 0.1Ω and 50Ω resp. Find the generated voltage of the motor, the supply voltage is 220V and brush drop is 1V per brush.
7. In a given dc machine, if p=8, Z=400, N=300rpm and Ø=100mwb, calculate the generated emf when the winding is a) lap connected b) wave connected.
8. The armature of dc machine has a armature resistance of 0.1Ω and is connected a supply of 230v. Calculate the generated emf when it is running as a) generator giving 80A b) motor taking 60A.
9. A 8 pole lap wound dc generator has 960 conductors, a flux of 40mwb and is driven at 400rpm find induced emf.
10. A 230v dc shunt motor takes 5A at no load and runs at 1000rpm. Calculate the speed when loaded and taking a current of 30A. The armature and field resistance are 0.4 and 230Ω.
11. In a brake test the effective load on the branch pulley was 38.1Kg, the effective diameter of the pulley 63.5cm and speed 15rps the motor took 50A at 230V. Calculate the output power
12. A 4 pole lap wound dc generator has 960 conductors, a flux of 40mwb and is driven at 600rpm find induced emf.
13. In a brake test, on a DC shunt motor the tension on the two sides of the brakes are 2.9Kg and 0.17Kg. Radius of the pulley was 9cm. Input current was 5A at 230V. The motor speed was 1500rpm find the torque.

14. A 10 KW DC shunt motor has the effective load on the branch pulley was 18.1Kg, the effective diameter of the pulley 53.5cm and speed 1500rpm the motor took 50A at 220V. Calculate the efficiency.
15. The following readings are obtained when doing a load test on a DC shunt motor using a brake drum :
    Spring balance 6Kg and 3Kg Diameter of the drum 12cm
    Line current 14A and applied voltage is 240V. Find output power and BHP.
16. A 8 pole, 12KW DC shunt motor delivers 5A and having armature and shunt field resistances are 0.1Ω and 25Ω resp. Find the generated voltage of the motor, the supply voltage is 220V and brush drop is 1V per brush.
17. In a given dc machine, if p=8, Z=400, N=300rpm and Ø=100mwb, calculate the generated emf when the winding is a) lap connected b) wave connected.
18. The armature of dc machine has a armature resistance of 0.1Ω and is connected a supply of 230v. Calculate the generated emf when it is running as a) generator giving 80A b) motor taking 60A.
19. A 6 pole lap wound dc generator has 960 conductors, a flux of 30mwb and is driven at 600rpm find induced emf.
20. A 230v dc shunt motor takes 5A at no load and runs at 1500rpm. Calculate the speed when loaded and taking a current of 30A. The armature and field resistance are 0.2 and 230Ω.

Expt No: 12

STUDY THE CHARACTERISTICS OF DC SHUNT MOTOR

OBJECTIVE : To draw the Speed vs. Torque characteristics of a D.C. shunt motor .

RESOURCES :

Sl.No	Apparatus	Range	Type	Qty
1	Motor		DC	1 no.
2	Ammeter	0-10A	MC	1 no.
3	Voltmeter	415/0-470V	MC	1 no.
4	Tachometer		DIGITAL	1no.

PRECAUTIONS:

1. Ensure the minimum position of Three phase autotransformer during power on and off.

2. Set the ammeter pointer at zero position.

3. Take the readings without parallax error.

4. Avoid loose connections.

MODEL GRAPH:

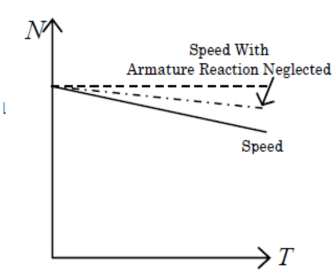


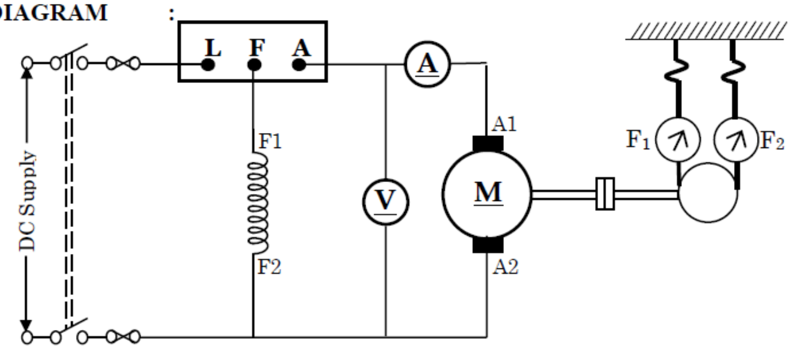
FIG. 3. TORQUE – SPEED CHARACTERISTIC

PROCEDURE:

1. Connect the circuit diagram as shown in Fig. .
2. Switch ON the power supply and start the motor with help of 3 point starter.
3. Gradually increase the load (mechanical or break load) step by step.
4. Note down the voltage, current, tension F_1 and F_2, speed N for every step.

5. Disconnect the motor from power supply.
6. Calculate the efficiency of motor.
7. Draw the three characteristics of dc shunt motor .

CIRCUIT DIAGRAM :



THEORY:

Since the torque is proportional to armature current in a dc shunt motor the speed torque characteristic of such a motor will be identical to speed-current characteristic. The speed-torque characteristic of dc shunt motor

OBSERVATIONS:

Sl No	Voltage V (volt)	Current I (amp)	Force (Kgf)			Speed N (rpm)
			F_1	F_2	$F = F_1 - F_2$	
1						
2						
3						
4						
5						

SAMPLE CALCULATIONS:

Input to the motor = VI
Output of the motor = $Torque X \omega$

Where torque = $F X \frac{d}{2} X 9.81$ and $\omega = 2\pi f$, $f = \frac{N}{60}$

Efficiency = Output/Inpu

RESULT: Draw the torque-current, speed-current and speed torque characteristic of d.c. shunt motor

PRE LAB QUESTIONS:-

1. What is meant by Armature reaction?

2. What is the difference between rotor stator?

LAB ASSIGNMENT:

Calculate the active & apparent power for the given circuit

POST LAB QUESTIONS:-

1. What is meant by complex power?

VIVA QUESTIONS:

1.Why should the field rheostat be kept in the position of minimum resistance?

2.What is the loading arrangement used in a dc motor?

3.How can the direction of rotation of a DC shunt motor be reversed?

4.What are the mechanical and electrical characteristics of a DC shunt motor?

5.What are the applications of a DC shunt motor?

6.How does the speed of a DC shunt motor vary with armature voltage and field current?

7.Compare the resistance of the armature and field winding.

8.What is the importance of speed control of DC motor in industrial applications?

9.Which is of the two methods of speed control is better and why?

10.Why is the speed of DC shunt motor practically constant under normal load condition

11. What are the factors affecting the speed of a DC shunt motor?

12.What are the losses in a DC machine?

13. Why is the field copper loss negligible at no load?
14.Why does the armature resistance increase when the motor is running

15.How can the mechanical losses be reduced

16. How can the core losses be minimized

17. What is meant by residual magnetism

18. What is critical field resistance

19. What is meant by saturation?

21. What are the reasons for the drooping load characteristics?
22. What is fringing effect?

23. State two types of IM?

24. State ohms law for magnetic circuits?

25. What is statically induced emf?

26. How eddy current losses are minimized?

27. State types of electrical machines?

28. What is mean by stacking factor?

29. What are the magnetic losses?

30. Types of induced emf?

31. What is the significance of winding factor?

32. Write the energy balance equation for motor?

33. What is torque?

34. Factor that has to be considered while choosing the resistor?

35. What are the different losses in dc machine?

36. Drawbacks of Brake test?

37. What happens if DC supply is applied to the transformer?

38. What is the application of equivalent circuit of a single phase transformer?

39. What is synchronous speed?

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

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

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

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

44. Define magnetic flux density?

45. Define magneto motive force?

46. Define reluctance?

47. What is retentivity?

48. Define permeance?

49. Define magnetic flux intensity?

50. Define permeability?

EXERCISE PROBLEMS :

1. Initially a d.c shunt motor having a $r_{a=0.5ohms\ and}$ $Rf_{=}$220 ohms is running at 1000 rpm drawing 20 A from 220 V supply.If the field resistance is increased by 5%,calculate the new steady state armature current and speed of the motor. Assume the load torque to be constant.
2. A 220 V d.c series motor has armatu re and field resistances of 0.15 Ω and 0.10 Ω respectively. It takes a current of 30 A from the supply while running at 1000 rpm. If an external resistance of 1 Ω is inserted in series with the motor, calculate the new steady state armature current and the speed. Assume the load torque remains constant.
3. A 220 V shunt motor has armature and field resistance of 0.2 Ωand 220 Ω respectively. The motor is driving a constant load torque and running at 1000 rpm drawing 10 A current from the supply. Calculate the new speed and armature current if an external armature resistance of value 5 Ω is inserted in the armature circuit. Neglect armature reaction and saturation.
4. A separately excited D.C. generator has armature circuit resistance of 0.1 ohm and the total brush-drop is 2 V. When running at 1000 r.p.m., it delivers a current of 100 A at 250 V to a load of constant resistance. If the generator speed drop to 700 r.p.m., with field-currentunal- tered, find the current delivered to load.
5. A 25-kW, 250-V, d.c. shunt generator has armature and field resistances of 0.06 Ω and 100Ω respectively. Determine the total armature power developed when working (i) as a generator delivering 25 kW output and (ii)as a motor taking 25 kW input.
6. A 4 pole, 32 conductor, lap-wound d.c. shunt generator with terminal voltage of 200 volts delivering 12 amps to the load has r_a= 2 and field circuit resistance of 200 ohms. It is driven at 1000 r.p.m. Calculate the flux per pole in the machine. If the machine has to be run as a motor with the same terminal voltage and drawing 5 amps from the mains, maintaining the same magnetic field, find the speed of the machine.
7. A d.c. motor takes an armature current of 110 A at 480 V. The armature circuit resistance is 0.2 Ω . The machine has 6-poles and the armature is lap-connected with 864

conductors. The flux per pole is 0.05 Wb. Calculate (i) the speed and (ii) the gross torque developed by the armature.

8. A 250-V, 4-pole, wave-wound d.c. series motor has 782 conductors on its armature. It has armature and series field resistance of 0.75 ohm. The motor takes a current of 40 A. Estimate its speed and gross torque developed if it has a flux per pole of 25 mWb.
9. A given d.c. machine develops the same e.m.f. in its armature conductors whether running as a generator or as a motor. Only difference is that this armature e.m.f. is known as back e.m.f. when the machine is running as a motor.
10. Determine developed torque and shaft torque of 220-V, 4-pole series motor with 800 conductors wave-connected supplying a load of 8.2 kW by taking 45 A from the mains. The flux per pole is 25 mWb and its armature circuit resistance is 0.6 Ω.

11. A 25-kW, 230-V shunt motor has an armature resistance of 0.124 Ω and a field-circuit resistance of 95 Ω. The motor delivers rated output power at rated voltage when its armature current is 73.5 A. When the motor is operating at rated voltage, the speed is observed to be 1150 r/min when the machine is loaded such that the armature current is 41.5 A
12. A 115-volt shunt motor has an armature whose resistance is 0.22 ohm. Assuming a voltage across the brush contacts of 2 volts, what armature current will flow(a) when the counter emf is 108 volts ? (b) if the motor load is increased so that the counter emf drops to 106 volts ?
13. A six-pole, 30-slot dc commutator generator has a lapwound armature winding. The armature constant, K_a is 9.55.The generator is operated with a separately excited field such that the field flux per pole is 0.04weber/pole. The is driven at a speed of 3000 rpm. The no load armature voltage is 418.9 Vabovegenerator is now operated as a motor. The flux is 0.04weber/pole. It is desired to supply a load requiring a torque of 50n–m at 4000 rpm. Armature circuit resistance is0.075 ohm. Calculate (a) the back emf, (b) the required armature current and voltage to supply this load.
14. The armature of a 230–volt shunt motor has a resistance of 0.18 ohm. If the armature current is not to exceed 76amp, calculate: (a) the resistance that must be inserted series with the armature at the instant of starting; (b) the value towhich this resistance can be reduced when the armature accelerates until E_c is 168 volts; (c) the armature current at the instant of starting if no resistance is inserted in the armature circuit. (Assume a 2-volt drop at the brushes.)
15. A 5-hp, 120-volt shunt motor has an armature resistance of 0.10 ohm, and a full-load armature current of 40 amp.Determine the value of the series resistance to add to the armature to limit the initial starting current to 150% of normal.
16. (i) A 120 V dc shunt motor has an armature resistance of 0.2 ohms and a brush volt drop of 2 V. The rated full-load armature current is 75 A. Calculate the current at the instant of starting, and the percent of full load.ii) Calculate the various values (taps) of starting resistance to limit the current in the motor of Part (i) to(a) 150 percent rated load at the instant of starting.(b) 150 percent rated load, when the counter emf is 25 percent of the armature voltage, V.(c) 150 percent rated load, when the counter emf is 50 percent of the armature voltage, V_a.(iii) Find the counter emf at full load, without startingresistance.
17. A shunt motor is running at 1200 rpm for a load which requires an armature current of 50 amp from a 230-volt source. At no load the armature current is 5 amp. If the effect of armature reaction has reduced the air-gap flux 2 percentfrom no load to full load, determine the no-load speed. The armature resistance is 0.15 ohm.

18. The rated line current of a 230-volt shunt motor is 56 amp. If the shunt-field circuit resistance is 230 ohms and the armature circuit resistance is 0.15 ohm, what would be the line current, assuming that the motor, at standstill, isconnected across rated voltage ? How much external resistance must be connected in the armature circuit to limit the current at starting to 125 percent full-load armature current ?
19. In a motor the armature resistance is 0.1 ohm. When connected across 110-volt mains the armature takes 20 amp, and its speed is 1,200 rpm. Determine its speed when the armature takes 50 amp from the same mains, with thefield increased 10 percent.
20. A 25-hp 240-volt series motor takes 93 amp when driving its rated load at 800 rpm. The armature resistance is 0.12 ohm, and the series-field resistance is 0.08 ohm. At what speed will the motor operate if the load is partially removed so that the motor takes 31 amp ? Assume that the flux is reduced by50 percent for a current drop of 66 2/3 percent and that the brush drop is 2 volts at both loads.

Expt. No.13

BRAKE TEST ON 3ϕ- INDUCTION MOTOR

AIM: To conduct a brake test on the given 3ϕ-Slip ring Induction motor and to draw its performance Characteristics.

APPARATUS:

S.No	Equipment	Range	Type	Qty
1	Ammeter	(0-2)A	MI	1No
2	Voltmeter	(0-600)V	MI	1No
3	Wattmeter	0-50V/300V/600V/10A	UPF	2NO
4	Tachometer	*****	Digital	1No
5	Connecting wires			

Precautions:

a) There should not be loose and wrong connections in the circuit

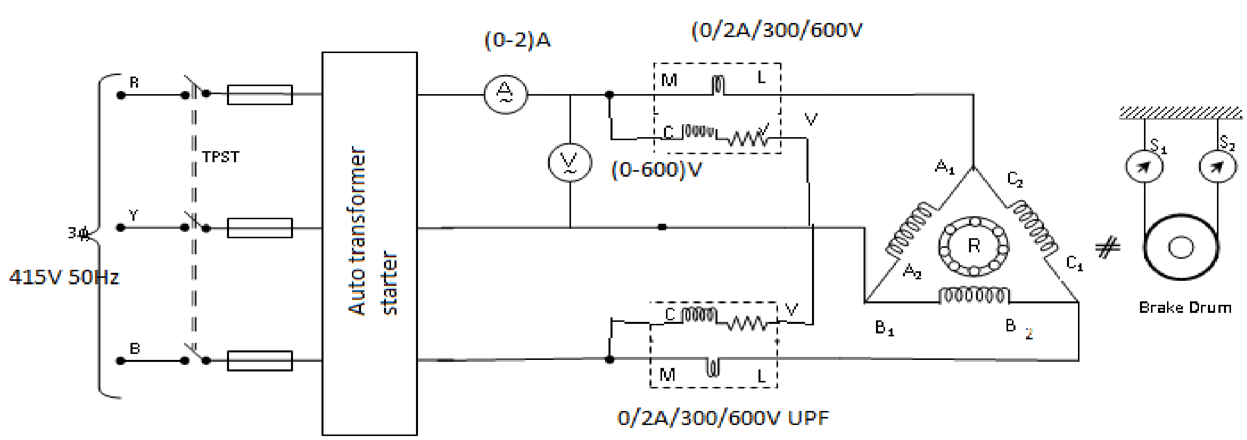
b) Three phase auto transformer should be in minimum output voltage position

c) Initially there should be no load on the motor

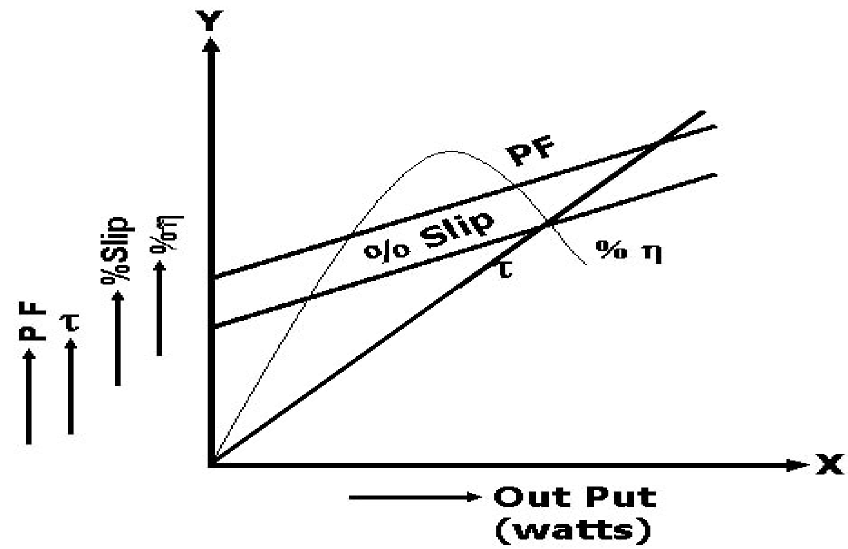
d) Apply water into brake drum during operation to control the heat of the brake drum.

f) Before making or breaking the circuit, supply must be switched OFF.

CIRCUIT DIAGRAM:-



Expected graphs:-



THEORY:

As a general rule, conversion of electrical energy to mechanical energy takes place in to the rotating part on electrical motor. In DC motors, electrical power is conduct directly to the armature, i.e, rotating part through brushes and commutator. Hence, in this sense, a DC motor can be called as ‘conduction motor’. However, in AC motors, rotor does not receive power by conduction but by induction in exactly the same way as secondary of a two winding T/F receives its power from the primary. So, these motors are known as Induction motors. In fact an induction motor can be taken as rotating T/F, i.e, one in which primary winding is stationary and but the secondary is free. The starting torque of the Induction motor can be increase by improving its p.f

by adding external resistance in the rotor circuit from the stator connected rheostat, the rheostat resistance being progressively cut out as the motor gathers speed. Addition of external resistance increases the rotor impedance and so reduces the rotor current. At first, the effect of improved p.f pre dominates the current-decreasing effect of impedance. So, starting torque is increased. At time of starting, external resistance is kept at maximum resistance position and after a certain time, the effect of increased impedance pre dominates the effect of improved p.f and so the torque starts decreasing. By this during running period the rotor resistance being progressively cut-out as the motor attains its speed. In this way, it is possible to get good starting torque as well as good running torque.

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.

TABULAR COLUMN:

S no.	V (Volt)	I_L (Amp)	N (rpm)	S1 (Kg)	S2 (Kg)	W=S1-S2 (Kg)	T= 9.81 W r (Nm)	Output =2πNT/60 (watts)	Input=W1+W2 (Watts)	η = output/ Input (%)	%Slip= $(N_s$-N)/N

MODEL CALCULATION:

1. Radius, R = 105mm
2. T= 9.81 W r N-m
3. W=S1-S2 kg
4. Output=2πNT/60 watts
5. Input= W1+W2 watts
6. η =output/input%
7. slip=(N_s-N)/N

Result:

Application:

A three-phase induction motor is used to adopt and apply so many cases. I give some introduce real application in the manufacturing parts as bellows;

1. A three-phase induction motor is operated without any VFDs(Variable Frequency Drive). In case of this, speed and torque that is happened are continuously same from start to stop when it does not consider a starting torque. The cost that is composed like this is very cheap. The examples that are similar to this are supply and return fans of AHU (Air Handling Unit), circulation water pumps of HVAC, feed water pump of fire extinguish and so on.
2. There are so many types of VFD (Variable Frequency Drive) in the market and they are really well-made, cheaper and small. Therefore, most of electrical engineers and customers want to adopt VFD in order to saving energy and control more accuracy.

VIVA:

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 Magnetic Field 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.
22. 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 crawing in the induction motor?
39. Why an Induction Motor sometimes called Rotating transformer?
40. What is the basic difference between Synchronous motor and an Induction Motor?
41. What is the SLIP?
42. How many types of Induction Motor ?
43. What is a Rotor Speed?
44. What is a Stator?
45. Give the conditions for maximum torque for 3-phase induction motor?
46. What is reason for inserting additional resistance in rotor circuit of a slip ring induction motor?
47. List out the methods of speed control of cage type 3-phase induction motor?
48. Mention different types of speed control of slip ring induction motor?
49. What are the advantages of 3-phase induction motor?
50. What does crawling of induction motor mean?

EXERCISE PROBLEMS:

1. 3 Φ 6 pole induction motor to 50 Hz supply, the voltage induced in the rotor bars is 4v, when the rotor is at stand still. Calculate the voltage a frequency induced in the rotor bars at 300 rpm.

2. A 6 pole induction motor is fed by 3Φ 50Hz supply and running with a full load slip of 3%. Find the full load speed of induction motor and also the frequency of rotor emf.

3. A 3Φ 6 pole induction motor is connected to 50 Hz supply the voltage induced in the rotor bars is 4 v. When the rotor is standstill calculate the voltage and frequency induced in the rotor bars at 300 rpm.

4. A 6 pole induction motor is fed by 3Φ 50Hz supply and running with a full load slip of 3%. Find the full load speed of induction motor and also the frequency of rotor emf.

5. A 3Φ 6 pole induction motor is connected to 50 Hz supply the voltage induced in the rotor bars is 4 v. When the rotor is standstill calculate the voltage and frequency induced in the rotor bars at 300
6. 3 Φ 6 pole induction motor to 50 Hz supply, the voltage induced in the rotor bars is 4v. When the rotor is at standstill. Calculate the voltage a frequency induced in the rotor bars at 300 rpm.
7. A slip ring induction motor runs at 290rpm at full load, when connected to 50Hz supply. Determine the no of poles and slip.
8. A 4 pole 3ϕ induction motor operates from a supply whose frequency is 50Hz .Calculate the speed of the rotor when the slip is 0.04.
9. A 4pole 3ϕ induction motor operates from a supply whose frequency is 50Hz .Calculate the frequency of the rotor currents when the slip is 0.03.
10. 3ϕ induction motor is wound for 4 poles and is supplied from 50Hz system .Calculate i) The synchronous speed ii) a rotor speed when the slip is 4%.
11. 3 Φ 4 pole induction motor to 50 Hz supply, the voltage induced in the rotor bars is 4v, when the rotor is at stand still. Calculate the voltage a frequency induced in the rotor bars at 300 rpm.
12. A 6 pole induction motor is fed by 3Φ 50Hz supply and running with a full load slip of 5%. Find the full load speed of induction motor and also the frequency of rotor emf.
13. A 3Φ 6 pole induction motor is connected to 50 Hz supply the voltage induced in the rotor bars is 6 v. When the rotor is standstill calculate the voltage and frequency induced in the rotor bars at 400 rpm.
14. A 6 pole induction motor is fed by 3Φ 50Hz supply and running with a full load slip of 3.5%. Find the full load speed of induction motor and also the frequency of rotor emf.
15. A 3Φ 6 pole induction motor is connected to 50 Hz supply the voltage induced in the rotor bars is 5v. When the rotor is standstill calculate the voltage and frequency induced in the rotor bars at 200
16. 3 Φ 6 pole induction motor to 50 Hz supply, the voltage induced in the rotor bars is 4v. When the rotor is at standstill. Calculate the voltage a frequency induced in the rotor bars at 500 rpm.
17. A slip ring induction motor runs at 190rpm at full load, when connected to 50Hz supply. Determine the no of poles and slip.
18. A 6 pole 3ϕ induction motor operates from a supply whose frequency is 50Hz .Calculate the speed of the rotor when the slip is 0.44.

19. A 4pole 3ϕ induction motor operates from a supply whose frequency is 50Hz .Calculate the frequency of the rotor currents when the slip is 0.3.

20. 3ϕ induction motor is wound for 4 poles and is supplied from 50Hz system .Calculate i) The synchronous speed ii) a rotor speed when the slip is 2%.

Expt No: 14

SPEED -TORQUE CHARACTERSTICS ON 3- ϕ SQUIRREL CAGE INDUCTION MOTOR

AIM: To determine the efficiency of 3- ϕ induction motor by performing load test. To obtain the performance curves for the same.

Apparatus:

Sl.No.	Equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-600)V	1 no
2	Ammeter	MI	(0-10)A	1 no
3	Wattmeter	Electro dynamo meter	10A/600V UPF 10A/600V LPF	1 no 1 no
4	Tachometer	Digital	0-9999 RPM	1 no
5	Connecting Wires	*****	*****	Required

NAME PLATE DETAILS:

Power rating	
Voltage	
Current	
Speed(RPM)	

Frequency	
PF	

3- ϕ Auto transformerDetails:

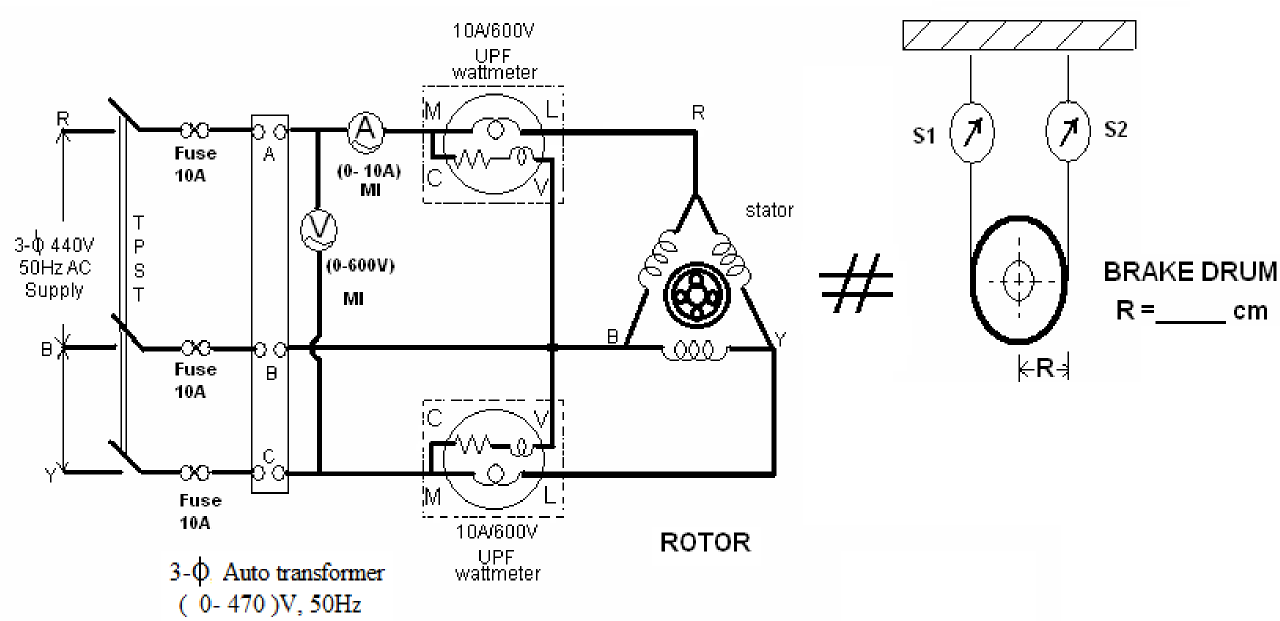
InputVoltage:--------------------------------Volts)

OutputVoltage:---------------------------(Volts)

Current : ---------------------------------(Amp)

Frequency:------------------------------------(HZ)

CIRCUIT DIAGRAM:



THEORY:

Torque Speed Characteristic is the curve plotted between the torque and the speed of the induction motor. As we have already discussed the torque of the induction motor in the topic Torque Equation of an Induction motor.The equation of the torque is given as shown below.

$$\tau = \frac{ksR_2E_{20}^2}{R_2^2 + (s(X_{20}^2)}$$

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

$N_M = N_s(1 - s_M)$.

PROCEDURE:

1. Connections are made as per the circuitdiagram.
2. Ensure that the 3- ϕ variacis kept at minimum output voltage position and belt is freelysuspended.
3. Switch ON the supply. Increase the variac output voltage gradually until rated voltage is observed in voltmeter. Note that the induction motor takes large current initially, so, keep an eye on the ammeter such that the starting current current should not exceed 7Amp
4. By the time speed gains rated value, note down the readings of voltmeter, ammeter, and wattmeter atno-load.
5. Now the increase the mechanical load by tightening the belt around the brake drum gradually insteps.
6. Note down the various meters readings at different values of load till theammeter shows the ratedcurrent.
7. Reduce the load on the motor finally, and switch OFF thesupply.

MODEL CALCULATIONS:

Input power drawn by the motor W = ($W_1 \pm W_2$) watts

Shaft Torque, T_{sh}= 9.81 (S_1-S_2)*RN-m R = Radius of drum inmts.

Output power in watts = $\frac{2\pi N T_{sh}}{60}$ *watts*

% *efficiency*= $\frac{\text{Output}}{\text{Input}}$

% *slip*=$(N_S - N)/N_S$

power factor of the induction motorcosφ = $\frac{W}{\sqrt{3} V_L I_L}$

PRECAUTIONS:

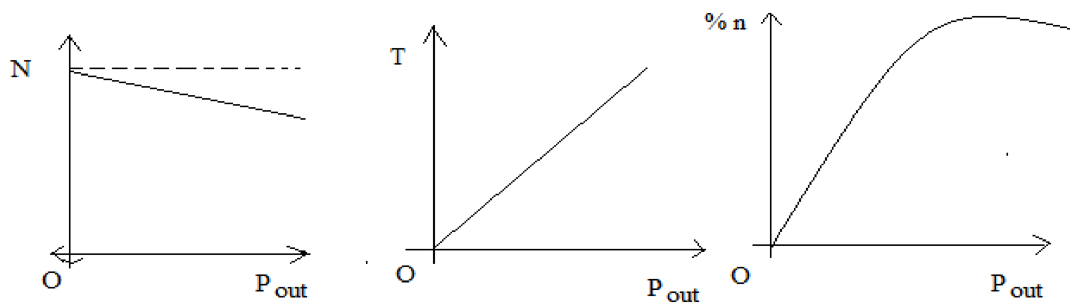
1. Connections must be madetight
2. Before making or breaking the circuit, supply must be switchedoff

OBSERVATIONS:

S.No	V (Volts)	I (Amps)	Power (Watts)		Speed (RPM)	Torque (N-m)	Spring balance(Kg)		%slip	Cos Ø	Input Power (W1+W2)	Output Power(W)	% η
			W1	W2			S1	S2					

MODEL GRAPHS:

1. Speed or slip Vs outputpower
2. Torque Vs outputpower



RESULT:

VIVA Questions:

1. What is the general working principle of Induction motor?
2. What are the various methods of measuring slip?
3. What is the general working principle of Induction motor?
4. What is the advantage of skewed stator slots in the rotor of Induction motors?
5. What are the various methods of speed control in three phase induction motors?
6. What is meant by crawing in the induction motor?
7. Why an Induction Motor sometimes called Rotating transformer?

8. What is the basic difference between Synchronous motor and an Induction Motor?
9. What is the SLIP?
10. How many types of Induction Motor ?
11. What is a Rotor Speed?
12. What is a Stator?
13. How many types of Rotor are there?
14. How an Induction Motor is started? Why the Starter is Used?
15. What is Commutator?
16. What are the three methods of determining voltage regulation?
17. What does crawling of induction motor mean?
18. Name the two windings of a single-phase induction motor.
19. What is the use of shading ring in a pole motor?
20. Why is the efficiency of a 3-phase induction motor less than of a transformer?
21. What are the types of starters?
22. State the advantages of capacitor start run motor over capacitor start motor.
23. .Explain why single-phase induction motor is not self-starting one.
24. What kind of motor is used in mixie?
25. . State the application of an induction generator?
26. .How can varying supply frequency control speed?
27. How is speed control achieved by changing the number of stator poles?
28. Define-Slip frequency
29. what is the application of shaded pole induction motor?
30. What is Universal motor?
31. What are types of 3- phase induction motor?
32. Why the rotor slots of a 3-phase induction motor are skewed?
33. Why the induction motor is called asynchronous motor?
34. What are slip rings?
35. Write an expression for the slip of an induction motor.
36. What is cogging of an induction motor?
37. Give the conditions for maximum torque for 3-phase induction motor?
38. What is reason for inserting additional resistance in rotor circuit of a slip ring induction motor?
39. List out the methods of speed control of cage type 3-phase induction motor?
40. Mention different types of speed control of slip ring induction motor?
41. What are the advantages of 3-phase induction motor?

42. What does crawling of induction motor mean?
43. State the application of an induction generator?
44. Name the two windings of a single-phase induction motor.
45. Why is the efficiency of a 3-phase induction motor less than of a transformer?
46. Name the tests to be conducted for predetermining the performance of 3-phase induction machine.
47. What are the informations obtained from no-load test in a 3-phase I M?
48. What are the informations obtained from blocked rotor test in a3-phase I M?
49. What are the advantages and disadvantages of circle diagram method of predetermining the performance of 3–phase I M?
50. What are the advantages and disadvantages of direct load test for 3–phase I M?

EXECISE PROBLEMS:

1. A 3 φ 4 pole 50 hz induction motor runs at 1460 r.p.m. find its %age slip.
2. A 12 pole 3 φ alternator driver at speed of 500 r.p.m. supplies power to an 8 pole 3 φ induction motor. If the slip of motor is 0.03p.u, calculate the speed.
3. A motor generates set used for providing variable frequency ac supply consists of a 3-φ synchronous and 24 pole 3 φ synchronous generator. The motor generate set is fed from 25hz, 3 φ ac supply. A 6 pole 3 φ induction motor is electrically connected to the terminals of the synchronous generator and runs at a slip of 5%. Find
   i) the frequency of generated voltage of synchronous generator
   ii) the speed at which induction motor is running
4. A 3-φ 4 pole induction motor is supplied from 3φ 50Hz ac supply. Find
   (1) synchronous speed
   (2) rotor speed when slip is 4%
   (3) the rotor frequency when runs at 600r.p.m.
5. A 12 pole 3-φ alternator is coupled to an engine running at 500r.p.m. If supplied a 3φ induction motor having full speed of 1440r.p.m.Find the %age slip, frequency of rotor current and no of poles of rotor.
6. A three-phase, 440 V, 1000 rpm slip ring induction motor is operating with 4 % slip. Stator current is30 A. Determine the stator current if the speed of the motor is reduced to 500 rpm using stator voltagecontrol method.

7. An inverter feeds a 4-pole 3-phase squirrel cage induction motor rated for 400 V, 50 Hz supply.Determine the approximate output required for the inverter for the motor speeds of (i) 900 rpm(ii) 1800 rpm.

8. A 4-pole, 3-phase, 50 Hz induction motor runs at 1440 rev/min at full load. Calculate (a) the synchronous speed, (b) the slip and (c) the frequency of the rotor induced e.m.f.'s.

9. A 12-pole, 3-phase, 50 Hz induction motor runs at 475 rev/min. Calculate (a) the slip speed, (b) the percentage slip and (c) the frequency of the rotor currents.

10. The frequency of the supply to the stator of a 6-pole induction motor is 50 Hz and the rotor frequency is 2 Hz. Determine (a) the slip, and (b) the rotor speed in rev/min.

11. The power supplied to a three-phase induction motor is 50 kW and the stator losses are 2 kW. If the slip is 4%, determine (a) the rotor copper loss, (b) the mechanical power developed by the rotor, (c) the output power of the motor if friction and windage losses are 1 kW, and (d) the efficiency of the motor, neglecting rotor iron losses.

12. A 400 V, three-phase, 50 Hz, 2-pole, star-connected induction motor runs at 48.5 rev/s on full load. The rotor resistance and reactance per phase are 0.4 Ω and 4.0 Ω respectively, and the effective rotor-stator turns ration is 0.8:1. Calculate (a) the synchronous speed, (b) the slip, (c) the full load torque, (d) the power output if mechanical losses amount to 500 W, (e) the maximum torque, (f) the speed at which maximum torque occurs, and (g) the starting torque.

13. By using external rotor resistance, the speed of the induction motor in problem 1 is reduced to 40% of its synchronous speed. If the torque and stator losses are unchanged, calculate (a) the rotor copper loss, and (b) the efficiency of the motor.

14. A motor generates set used for providing variable frequency ac supply consists of a 3-φ synchronous and 24 pole 3 φ synchronous generator. The motor generate set is fed from 25hz, 3 φ ac supply. A 6 pole 3 φ induction motor is electrically connected to the terminals of the synchronous generator and runs at a slip of 5%. Find
   i)thefrequency of generated voltage of synchronous generator
   ii) the speed at which induction motor is running.

15. A 3-φ 4 pole induction motor is supplied from 3φ 50Hz ac supply.Find (1)synchronousspeed. (2)rotorspeed when slip is 4%. (3) the rotor frequency when runs at 600r.p.m.

16. A 12 pole 3-φ alternator is coupled to an engine running at 500r.p.m. If supplied a 3φ induction motor having full speed of 1440r.p.m. Find the %age slip, frequency of rotor current and no of poles of rotor.

17. The rotor of 3φ induction motor rotates at 900r.p.m. when states is connected to 3φ supply .find the rotor frequency.

18. A 3 φ 50Hz induction motor has a full load speed of 960 r.p.m(a) find slip. (b) No of poles. (c) Frequency of rotor induced e.m.f. (d) Speed of rotor field w.r.t. rotor structure. (e) Speed of rotor field w.r.t. Stator structure. (f) Speed of rotor field w.r.t. stator field.

19. A 6 pole 3 φ 50Hz induction motor is running at full load with a slip of 4%. The rotor is star connected and its resistance and stand still reactance are 0.25 ohm and 1.5 ohm per phase. The e.m.f between slip ring is 100V. Find the rotor current per phase and p.f, assuming the slip rings are short circuited.

20. A 500 V, 3 φ, 50 Hz induction motor develops an output of 15 KW at 950 r.p.m. If the input p.f. is 0.86 lagging, Mechanical losses are 7.30 W and stator losses 1500W, Find
i) the slip. ii) the rotor Cu loss. iii) the motor input. iv) the line current.

21. A 6 pole 3φ induction motor develops 30hp including 2 hp mechanical losses at a speed of 950 r.p.m. on 550V, 50Hz Mains. The P.F. is 0.88 lagging.Find: 1) Slip
2) Rotor Cu loss.3) Total input if stator losses are 2kw.4) Efficiency .5) Line current.

22. A 4 pole 50 Hz 3 φ induction motor running at full load, develops a torque of 160N-m, when rotor makes 120 complete cycles per minute, find what power output.

23. The power input to a 500V 50Hz, 6 pole, 3 φ squirrel case inductor motor running at 975 r.p.m. is 40kw. The stator losses are 1 kw and friction and windage losses are 2kw. Find:1) Slip. 2) Rotor Cu loss. 3) Brake hp.

24. A 500 V, 3 φ, 50 Hz induction motor develops an output of 15 KW at 950 r.p.m. If the input p.f. is 0.86 lagging, Mechanical losses are 7.30 W and stator losses 1500W, Find
i) the slip . ii) the rotor Cu loss. iii) the motor input. iv) the line current.

25. A 3-φ 4 pole induction motor is supplied from 3φ 50Hz ac supply. Find
(1) synchronous speed. (2) rotor speed when slip is 4%
(3) the rotor frequency when runs at 600r.p.m.

26. A 3 φ 50Hz induction motor has a full load speed of 960 r.p.m(a) find slip. (b) No of poles. (c) Frequency of rotor induced e.m.f.(d) Speed of rotor field w.r.t. rotor structure. (e) Speed of rotor field w.r.t. Stator structure. (f) Speed of rotor field w.r.t. stator field.

27. A 6 pole 3 φ 50Hz induction motor is running at full load with a slip of 4%. The rotor is star connected and its resistance and stand still reactance are 0.25 ohm and 1.5 ohm per phase. The e.m.f between slip ring is 100V. Find the rotor current per phase and p.f, assuming the slip rings are short circuited.

Expt. No.15

NO LOAD TEST ON 3-PHASE ALTERNATOR

AIM:

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

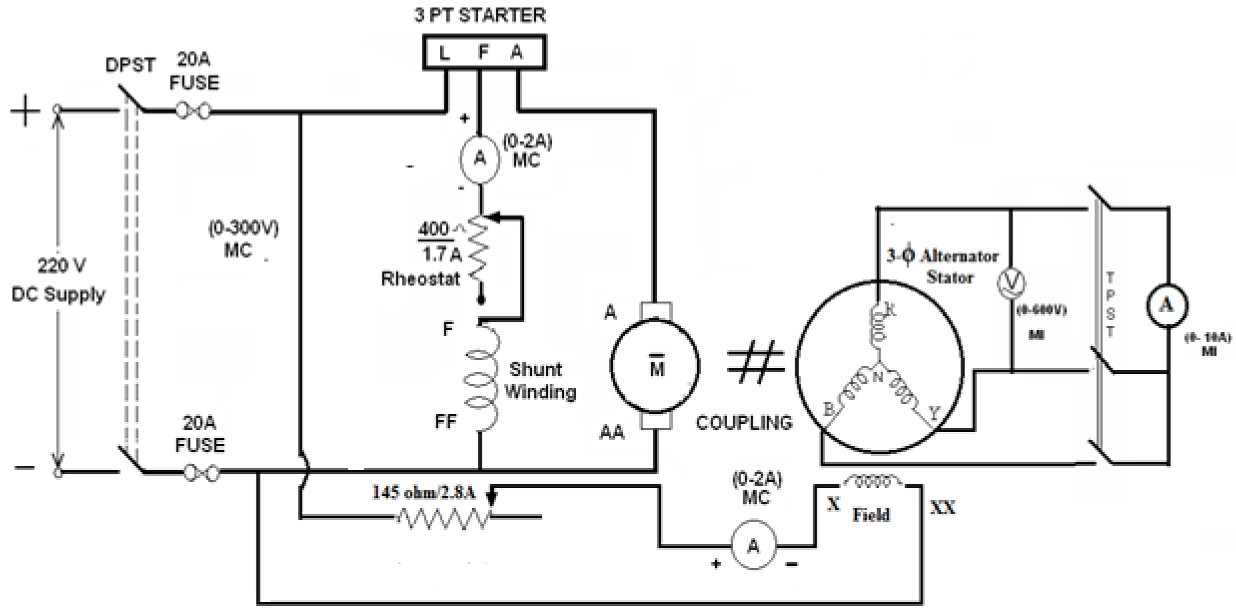
APPARATUS REQUIRED:

Sl. No.	Equipment	Type	Range	Quantity
1	Voltmeter	MI	(0-300/600)V	1 no
2	Ammeter	MI	(0-5/10)A	1 no
3	Ammeter	MI	(0-2.5/5)A	1 no
3	Rheostat	Wire-wound	400 Ω /1.7A 145Ω /2A	1 no 2 no
4	Tachometer	Digital	*****	1 no
5	Connecting Wires	*****	*****	Required

NAME PLATE DETAILS:

DC Motor(prime mover)	3- ϕ Alternator
KW :	Power Rating:
Voltage :	PF :
Current :	Line voltage:
Speed :	Speed
Exctn : Shunt	Exctn Voltage:
Voltage :	Rated Current :
Field current:	

CIRCUIT DIAGRAM:



Note: 1.Open TPST switch for open circuit test

2. Close TPST switch for short circuit test.

THEORY:

The regulation of Alternator is defined as “the rise in terminal voltage ” when fullload is removed divided by rated terminal voltage withspeed and excitation of alternator remaining unchanged. The experiment involves the determination of the following characteristics andparameters:

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,(E0) and short circuit current (Isc,) 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 synchronousimpedance. 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 ‘E0’ is given byE0=V+IZs

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

PROCEDURE:

Open Circuit Test:

1. Make the connections as per the circuitdiagram.
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 starterhandle.
4. Adjust the field rheostat of DC motor to attain rated speed (equal to synchronous speed ofalternator)
5. By decreasing the field resistance of Alternator, the excitation current of alternatoris increased gradually in steps.
6. Note the readings of field current, and its corresponding armature voltage in a tabularcolumn
7. The voltage readings are taken upto and 10% beyond the rated voltage of the machine.

Short Circuit Test:

1. Make the connections as per the circuitdiagram.
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 starterhandle.

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 alternatoris increased gradually in steps.
7. Note the readings of field current, and its corresponding short circuit current in a tabularcolumn.
8. The readings are taken within the limits of alternator current rating.
9. Final draw the graphs between
   I. E_0vs $I_{f.}$
   II. $I_a$vs $I_{f.}$

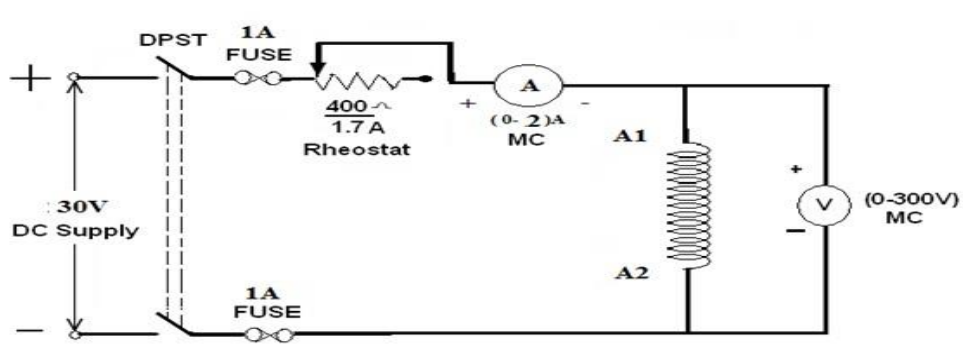
OBSERVATIONS:

S.No.	OC test	
	Field current in Amp.(I f)	OC voltage per phase(Vo)

Procedure to find Armature resistance of alternator:

1. Connections are made as per the circuitdiagram.
2. Switch ON the supply. By varying the rheostat, take different readings of ammeter and voltmeter in a tabularcolumn.
3. From the above readings, average resistance Ra of a armature is foundout.

CONNECTION DIAGRAM TO FIND Ra:



OBSERVATIONS:

Sl no.	Armature current I(amp)	Armature voltage Va (volts)	R_{dc}=V / I

Procedure to find synchronous impedance from OC and SC tests:

1. Plot open circuit voltage, short circuit current verses field current on a graph sheet.
2. From the graph, the synchronous impedance for the rated value of excitation is calculated.
3. The excitation emfis calculated at full load current which is equal to the terminal voltage at Noload.
4. The voltage regulation is calculated at rated terminalvoltage.

MODEL CALCULATIONS:

Zs= Voc/Isc for the same If and speed Xs = Zs-Ra

Generated emf of alternator on no load is

$E_0 =$

+ for lagging p.f.
- for leading p.f.

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

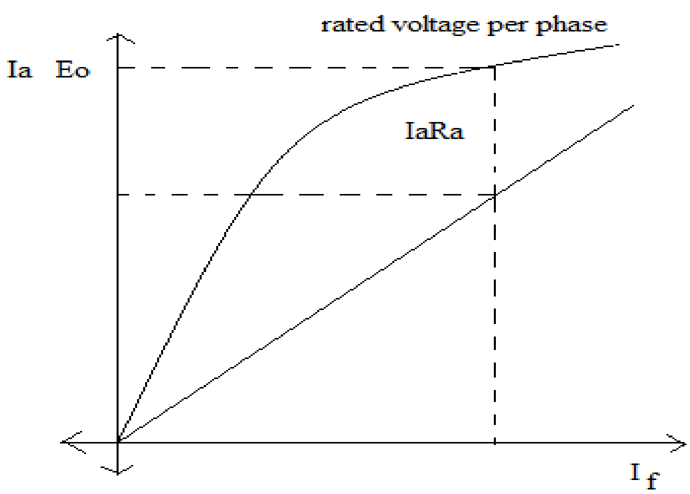
% Re $g = E_0 - V/V$
Where

E_0 – generated emf of alternator (or excitation voltage per phase)

V – full load, rated terminal voltage per phase

MODEL GRAPHS:

Draw the graph between I_f V_S E_0 per phase



PRECAUTIONS:

(i) Connections must be madetight

(ii) Before making or breaking the circuit, supply must be switchedoff

RESULT:

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 alternator
7. 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 rotating field 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 for Synchronous machines?
20. How does electrical degree differ from mechanical degree?
21. Frequency generated in a 8-pole alternator that rotates at 750 r.p.m is?
22. Define pole pitch?
23. What is short pitch winding?
24. Define pitch factor or coil span factor?
25. 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 rotating field system type?
41. Write down the equation for frequency of emf induced in an Altenator?
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 for synchronous 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?
50. What is the relation between electrical degree and mechanical degree?

<u>EXERCISE PROBLEMS</u>:

1. Calculate the distribution factor of a 3-phase winding with 120° phase –spread when the winding is 1) uniformly distributed.2)occupies6 slots per poles?

2. Calculate the open circuit voltage of a 3phase, star-connected alternator, 4 pole, 60Hz, 120 slots with each slot having 6 conductors in two layers. The machine is running at 1800rpm with a flux per pole of 125 millimeter. The coil span is 12.

3. Calculate the open circuit voltage of a 3phase, star-connected alternator, 6 pole, 60Hz, 60 slots with each slot having 6 conductors in two layers. The machine is running at 1800rpm with a flux per pole of 120 milliWeber. The coil span is 6.

4. A 750kVA, 2300V, delta-connected, 3-phase alternator has had open and short circuit tests performed and the following date were obtained: Short Circuit test Field current = 31.5A Line current = rated Open-circuit test Field-current = 31.5A Line voltage=1050V The dc resistance across the terminals was measured at 0.38 ohm. Calculate the V.R. at 0.8pf lagging.

5. A 500kVA, 2000V, delta-connected, 3-phase alternator has had open and short circuit tests performed and the following date were obtained: Short Circuit test Field current = 15.5A Line

current = rated Open-circuit test Field-current = 15.5A Line voltage=1000V The dc resistance across the terminals was measured at 0.38 ohm. Calculate the V.R. at 0.8pf lagging.

6. Calculate the distribution factor of a 3-phase winding with 60° phase –spread when the winding is 1) uniformly distributed.2)occupies 8 slots per poles.
7. Calculate the open circuit voltage of a 3phase, star-connected alternator, 4 pole, 60Hz, 120 slots with each slot having 6 conductors in two layers. The machine is running at 1800rpm with a flux per pole of 125 milliWeber. The coil span is 12.
8. A single phase alternator, 50kVA, 460V supplies the rated load at 0.88 pf lagging. The dc resistance across the terminals ais 0.5 ohm and the synchronous reactance is 2.5 ohm. Calculate the angle of the power.
9. A single phase alternator, 25kVA, 460V supplies the rated load at 0.88 pf lagging. The dc resistance across the terminals ais 0.05 ohm and the synchronous reactance is 0.5 ohm. Calculate the angle of the power.
10. A single phase alternator, 200kVA, 430V supplies the rated load at 0.8 pf lagging. The dc resistance across the terminals ais 0.2 ohm and the synchronous reactance is 3.5 ohm. Calculate the angle of the power.
11. Calculte the distribution factor of a 3-phase winding with 90° phase –spread when the winding is 1) uniformly distributed.2)occupies 12 slots per poles.
12. Find the number of armature conductors in series per phase required for 3 phase, 10 pole alternator when driven at a speed of 600 RPM. Armature has 90 slots and armature winding is star connected to give induced emf of 11KV between lines. Assume flux per pole as 16 mwb.
13. A single phase alternator, 400kVA, 430V supplies the rated load at 0.6 pf lagging. The dc resistance across the terminals ais 0.3 ohm and the synchronous reactance is 3.0 ohm. Calculate the angle of the power.
14. Find the number of armature conductors in series per phase required for 3 phase, 8 pole alternator when driven at a speed of 500 RPM. Armature has 40 slots and armature winding is star connected to give induced emf of 10KV between lines. Assume flux per pole as 10 mwb.
15. Find the number of armature conductors in series per phase required for 3 phase, 8 pole alternator when driven at a speed of 1000 RPM. Armature has 40 slots and armature winding is star connected to give induced emf of 20KV between lines. Assume flux per pole as 5 mwb.
16. A single phase alternator, 1200kVA, 430V supplies the rated load at 0.8 pf lagging. The dc resistance across the terminals ais 0.25ohm and the synchronous reactance is 7.5 ohm. Calculate the angle of the power.

17. Calculte the distribution factor of a 3-phase winding with 110° phase –spread when the winding is 1) uniformly distributed.2)occupies 10 slots per poles.

18. Calculte the distribution factor of a 3-phase winding with 120° phase –spread when the winding is 1) uniformly distributed.2) occupies 18 slots per poles.

19. A 750kVA, 2000V, delta-connected, 3-phase alternator has had open and short circuit tests performed and the following date were obtained: Short Circuit test Field current = 15.5A Line current = rated Open-circuit test Field-current = 15.5A Line voltage=1000V The dc resistance across the terminals was measured at 0.5 ohm. Calculate the V.R. at 0.6pf lagging.

20. Calculate the open circuit votlage of a 3phase, star-connected alternator, 4 pole, 60Hz, 120 slots with each slot having 6 conductors in two layers. The machine is running at 1800rpm with a flux per pole of 125 milliWeber. The coil span is 12.