STATE BOARD OF TECHNICAL EDUCATION & TRAINING

ANDHRA PRADESH :: VIJAYAWADA

DIPLOMA IN ELECTRICAL & ELECTRONICS ENGINEERING

III SEMESTER

ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB (EE-310)

MANUAL (AS PER C-20 CURRICULUM)

INTRODUCTION

1.0 INTRODUCTION

The Curriculum of Technical Education should invariably provide for knowledge, attitudes and skills required by the technicians /technologists in the country. In this context the laboratory courses form a vital portion in the entire curriculum of technician education. The laboratory courses shall therefore be so designed and delivered that they help the students acquire attitudes and motor skills that are essential to function effectively as technicians/technologists.

The planning, organization and implementation of lab courses need a detailed description of tasks to be performed by the students. Well thought out instructional objectives to a large extent give these descriptions. The analysis of tasks (by identifying the activities the students are expected to do) help prepare the objectives meticulously. In other words the objectives would be clearer, when the task analysis is done to spell out the sub tasks for each objective.

A survey of the practices currently followed in the technical/technician education shows an urgent need to plug in gaps in instructional procedures. The reasons for these gaps are ambiguity in the minds of the teachers regarding tasks to be performed, levels of competency to be achieved by the students and the weightage to be allocated for each task. This aids in scientific design of instructional plan (optimizing the resources, budgeting the time & content).

The task analysis, teaching points and the structured scheme of evaluation are very important in focusing the instruction on specific skill of desired outcome and in evaluating the same. The Instruction and evaluation in Laboratory courses are different from that of cognitive lessons in the sense that adequate importance and hence weightage needs to be given for all three domains of learning viz. cognitive, psychomotor and affective. Since both training and evaluation of traits of affective domain are practically difficult, a few traits (called values) most relevant and essential to occupations/professions after the Course may be identified for the purpose. It is imperative to integrate these values during instruction and evaluation and also overtly notify the same to the students.

A technician, in addition to performing a skill needs to prepare a report of testing that includes the description of procedure, details of measurements made, reasoning based inferences and so on.,. The current practice of record writing has failed to achieve this purpose as most of the time students end up with making copies of available material.

Therefore, for sensitizing the need for the changes in laboratory instruction, the present hand book has been prepared to meet the above requirements. As such the hand book comprises four parts that intend to :

- Present task analysis, teaching points which can be used for effective design of instruction
- Provide a scheme of evaluation with rationally allocated weightage to each significant skill component
- Offer a set of questions designed at different levels of competencies for assessment enabling the teacher to set the question paper with balanced levels of competencies
- Present pre set worksheets that cultivate the habit of systematic recording of observations and writing the technical report.
- Provide all important data related to particular laboratory activity at one point in the form of annexure

1.1. STRUCTURE OF THE BOOK

The hand book is presented in four parts viz., Laboratory sheets, Worksheet, Experimental Methodology and Annexure. The description of each part is given in the following sections

Part I. Laboratory Sheet

The information provided in this part is useful for the teacher for designing the instruction, planning & organization of the experiment and for scientific evaluation of the students. The major features of the Laboratory sheet are further explained below.

1. **Objective**

   It indicates the **Task** to be performed and completed by the student during the specified duration of time.

2. **Task Analysis**

   It is the process of identifying the component activities (sub tasks) to be carried out by the student in order to achieve the stipulated objective. As the task analysis aim at fitting the instructional objectives into various classes of behaviour, it would help the teacher to determine any particular type of behaviour the student has learnt / failed to perform.

   The task analysis would help the teacher in identifying the specific activities to be performed by the students. This could also be used as some kind of check list to compare with activities planned for the laboratory. Further it would give clue to the teacher to make students think originally & act independently. It includes both psychomotor learning and the related cognitive information and hence the task analysis is presented as Knowledge and skill parts.

   A. Knowledge Part: That includes the cognitive aspects of the task.

   B. Skill Part: That includes Psychomotor & Affective aspects of the task.

3. **Teaching Points:**

This includes the points based on the SKILL identified with suggested duration for each point and total duration which helps the teacher for the time and content budgeting during instruction.

4. **Need and Scope:**

The purpose, application and scope of the task to be performed are normally included in this sub section.

5. **Planning and Organisation:**

It lists actions to be taken to perform various activities and hence useful in planning the instruction and organizing the resources and equipment

6. **Scheme of Valuation:**

The information provided in this section helps the teacher to devise a tool for rational measurement assessment of the competencies accomplished by the student.

Part II. Work Sheet

It is designed for the student, where in the student enters his personal data of identification, details of the experiment, stepwise procedure, observations made during experiment, a sample calculation, free hand typical graph, graph from experimental data and inference with discussion.

Part III. Experimental Methodology

This section furnishes information with regard to standard procedure to conduct the experiment along with the description of equipment/apparatus and the basic theory/concept involved in the conduct of the experiment. Thus this section is very useful for both teacher and student as well to conduct the experiment systematically. Thus this section is presented in four sub section as described below:

- **Description**

It gives the detailed description of apparatus / tools / equipment / materials to be used for the task.

- **Theory / Concept**

It gives the concept of the task to be performed with formulae and units.

- **Procedure**

It provides the idea of step wise procedure to perform the task.

- **Observation and Calculation**

  It includes sample observation, sample graph, sample calculation for reference

Part IV. Annexure

All important and useful information that may help in accomplishment of tasks like conversion tables for units, technical & scientific data like material properities, standard trend or characteristic curves (graphs) etc are compiled and presented at one place in this section.

1.2. WHO IS TO USE AND HOW TO USE.

The hand book is so designed that it can be beneficially used by different sections of the technical education viz., the teacher, the student, the examiner and the administrator convenient to individual's requirements. A few uses of this hand book each stakeholder could make is outlined in the following sections.

1. Teacher

A. The **laboratory sheet** is designed keeping the teacher in mind for the teacher has key responsibility of imparting the skills to the student and hence the information given in the lab sheets may be useful for planning & organizing the experimental set up and designing an effective instruction. Thus the teacher may

Plan and organize as per *section 4*,
Instruct the students as per *section 2***,**
Demonstrate each sub task as per *section1.B.*and
Evaluate the students as per *section 5***,** according to the level of competency.

Values: The values in a person are an important personality trait that needs to be nurtured in the learning environment. Further it is also a driving component in any individual to deliver the best and hence this component is also included in the evaluation. However only five key dimensions, that are important in the teaching-learning environment, are taken into consideration for nurturing and evaluation. A little information about these five dimensions is given below as a guideline for the teacher while assessing students.

1. Co-operation: It is the voluntary arrangement in which two or more students engage in a mutually beneficial exchange, instead of competition. Cooperation can happen where resources adequate for both students exist or are created by their interaction.

2. Co-ordination: It is the unification, integration, synchronization of the effect of group members so as provide unity of action in the pursuit of common goals. It is an integral element and required in each & every function and at each & every stage & therefore it cannot be separated.

3. **Communication;** Communication skill is the set of skills that enables a student to convey information so that it is received and understood.

4. **Sharing:** A part or portion belonging to, distributed to, contributed by, owed by a person or a group **Or** To participate in, use, enjoy or experience jointly or in turns.

5. **Leadership:** Students with the following leadership qualities are almost always the ones that rise above the crowd.

   1. Trustworthiness: This refers to integrity.

   2. Inspiration: Guides, leads and inspiring others to want to participate in the process of moving towards the vision.

   3. Self awareness: It is the individual awareness of him or her self - their abilities and the impact that they have on others.

   4. Acceptance of responsibility: True leaders are accepting responsibility for all that comes their way and taking ownership and responsibilities for getting things back on track. Blaming, justifying and excuse making just is not in their responsibility.

B. The **Experimental methodology** is designed for both teacher and student. The teacher can refer the experimental methodology for the details of equipment/apparatus/ materials/tools, procedure to be followed, observations to be made, graphs to be drawn and calculations to be done for the task to be performed

2. Student

The Worksheet is designed keeping in view the needs, deficiencies and the adolescent characteristics of the student for student.

The students submit the filled in work sheet given by the teacher on the day of experiment after referring to experimental methodology and listening to instructions of teacher. The design of the worksheet is made user friendly and the contents are so logically sequenced that the student finds it easy to understand and develop the skill of recording and report writing skill. It also helps the student to actively participate in skill learning. More importantly the student gets immediate meaningful feedback of his performance since the competency wise assessment is done and that too on the same day.

2. Examiner

The examiner may find this hand book very useful as Laboratory sheets and Scheme of evaluation provides information with regard to various competencies (skills) the students is expected to acquire during the course of study and the relative weightages of each competency. This information helps him to design a well balance question paper/measurement tool for assessment.

C20 – EE310

ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB

LAB SHEETS

Sno	Experiment Title	Date of Experiment	Page Number
1	**Verification of Ohm's Law and limitations of Ohm's Law**		1
2	**Verification of Kirchhoff's Voltage Law and Current Law**		7
3	**Verification of Super Position Theorem**		13
4	**Verification of Thevenin's Theorem**		19
5	**Verification of Maximum Power Transfer Theorem**		25
6	**Calibration of Dynamometer type Wattmeter**		31
7	**Calibration of Single Phase Induction type Energymeter**		37
8	**Determination of Q-factor and Power factor of an Inductive Coil**		43
9	**Determination of Idle & Energy components of Current in a Single Phase Inductive Circuit**		49
10	**Measurement of Power in Single Phase circuit by 3-Voltmeter method**		55
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LABSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Objective of the experiment : To verify the Ohm's Law and the limitations of it.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	1
2	Digital Multimeter	DCV: 200mV - 2000mV - 20V - 200V - 1000V DCA: 20uA - 2000uA - 20mA - 200mA - 10A R: 200 ohm - 2000 ohm - 20K - 200K - 2000K	2
3	Resistor	1 kilo ohm, 1 watt	1
4	Breadboard		1
5	Connecting Wires	100 mA	Required number

Task Analysis :

(a) Knowledge

1. Working of the resistor.
2. Working of the regulated power supply.
3. Using the digital multimeter.
4. Using the breadboard.
5. Factors affecting the characteristics of a resistor.
6. Precautions to be taken while handling the equipment.

1. Verification of Ohm's Law and Limitations of Ohm's Law

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.
	B	Using the correct range of Voltmeters and Ammeters.
	C	Identifying the Sources of Energy.
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages
	B	Adjusting the range of Ammeter to read the currents accurately.
	C	Adjusting the range of Voltmeter to read the voltages accurately.
Precise Operations / Activities	A	Recording the values of voltages.
	B	Recording the values of currents.
	C	Calculating the values of resistance.
	D	Changing the temperature around the resistor.
	E	Recording the values of resistance with temperature effect.

LABSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the Ohm's Law.	3
2	Explaining the limitations of Ohm's Law.	3
3	Explaining the functioning of Regulated Power Supply.	3
4	Interpreting the Colour Coding of the Resistor.	3
5	Explaining the usage of Digital Multimeter.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

LABSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Need and Scope of Experiment :

This experiment is essential to understand the Ohm's law, limitations of the Ohm's law and the characteristics of resistor. With this knowledge, the circuits can be analyzed for their performance and as well as for the faults.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

LABSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	10
	B	Using the correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	10
	B	Adjusting the range of Ammeter to read the currents accurately.	3	
	C	Adjusting the range of Voltmeter to read the voltages accurately.	3	
Precise Operations / Activities	A	Recording the values of voltages.	5	25
	B	Recording the values of currents.	5	
	C	Calculating the values of resistance.	5	
	D	Changing the temperature around the resistor.	5	
	E	Recording the values of resistance with temperature effect.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

LABSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Viva Questions :

1. Can we apply the Ohm's law to Semiconductors? If so, why?
2. Which type of Temperature Coefficient of Resistance a Resistor has?
3. What are the applications of Resistor?
4. How many types of Colour Coding of Resistors are available? What are those?
5. What is the significance specific resistance on the characteristics of a Resistor?

Assessment Questions :

1. (a) Draw the circuit diagram to verify the Ohm's law and its limitations.
   (b) Conduct the test to verify the Ohm's law and its limitations.
   (c) Find out what happens when the temperature around a resistor is decreased and the voltage across the resistor is increased.

LABSHEET

2. Verification of Kirchhoff's Voltage Law and Current Law

Objective of the experiment : To verify Kirchhoff's Voltage Law and Current Law in the DC Circuit.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	1
2	Digital Multimeter	DCV: 200mV - 2000mV - 20V - 200V - 1000V DCA: 20uA - 2000uA - 20mA - 200mA - 10A R: 200 ohm - 2000 ohm - 20K - 200K - 2000K	4
3	Resistor	1 kilo ohm, ½ watt 2.2 kilo ohm, ½ watt 4.7 kilo ohm, ½ watt	1 1 1
4	Breadboard		1
5	Connecting Wires	100 mA	Required number

Task Analysis :

(a) Knowledge

1. Ohm's law in the DC networks.
2. Working of the regulated power supply.
3. Using the digital multimeter.
4. Using the breadboard.
5. Directions of voltages and currents in the elements of a circuit.
6. Precautions to be taken while handling the equipment.

2. Verification of Kirchhoff's Voltage Law and Current Law

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.
	B	Using the correct range of Voltmeters and Ammeters.
	C	Identifying the Sources of Energy.
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages
	B	Adjusting the range of Ammeters to read the currents accurately.
	C	Adjusting the range of Voltmeters to read the voltages accurately.
Precise Operations / Activities	A	Recording the values of voltages across the elements in a loop.
	B	Summing up the values of all the voltages in the loop.
	C	Recording the values of currents in the elements connected to a node.
	D	Summing up the values of currents in the elements connected to the node.
	E	Checking the Kirchhoff's Voltage Law and Current Law.

2. Verification of Kirchhoff's Voltage Law and Current Law

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the Kirchhoff's Voltage Law.	3
2	Explaining the Kirchhoff's Current Law.	3
3	Explaining the functioning of Regulated Power Supply.	3
4	Interpreting the Colour Coding of the Resistor.	3
5	Explaining the usage of Digital Multimeter.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

2. Verification of Kirchhoff's Voltage Law and Current Law

Need and Scope of Experiment :

This experiment is essential to understand the Kirchhoff's Voltage law and Kirchhoff's Current law. With this knowledge, the circuits can be analyzed for their performance and as well as for the faults.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

2. Verification of Kirchhoff's Voltage Law and Current Law

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	10
	B	Using the correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	10
	B	Adjusting the range of Ammeters to read the currents accurately.	3	
	C	Adjusting the range of Voltmeters to read the voltages accurately.	3	
Precise Operations / Activities	A	Recording the values of voltages across the elements in a loop.	5	25
	B	Summing up the values of all the voltages in the loop.	5	
	C	Recording the values of currents in the elements connected to a node.	5	
	D	Summing up the values of currents in the elements connected to the node.	5	
	E	Checking the Kirchhoff's Voltage Law and Current Law.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

2. Verification of Kirchhoff's Voltage Law and Current Law

Viva Questions :

1. Can we apply Kirchhoff's Voltage law to an open loop? Justify.
2. What is the minimum number of elements to form a node?
3. What happens if all the elements of a closed loop are voltage sources?
4. Can we apply Kirchhoff's laws to AC Circuits? Justify.
5. How to interpret the direction of current in an element with respect to the direction of voltage across it?

Assessment Questions :

1. (a) Draw the circuit diagram to verify the Kirchhoff's Voltage law and Kirchhoff's Current law.
   (b) Conduct the test to verify the Kirchhoff's Voltage law and Kirchhoff's Current law.
   (c) Find out what happens when the terminals of the voltage source are reversed while using Kirchhoff's laws.

LABSHEET

3. Verification of Super Position Theorem

Objective of the experiment : To verify the Super Position Theorem in a DC Circuit.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	2
2	Digital Multimeter	DCV: 200mV – 2000mV – 20V – 200V – 1000V DCA: 20uA – 2000uA – 20mA – 200mA – 10A R: 200 ohm – 2000 ohm – 20K – 200K – 2000K	3
3	Resistor	1 kilo ohm, ½ watt 2.2 kilo ohm, ½ watt 4.7 kilo ohm, ½ watt	1 1 1
4	Breadboard		1
5	Connecting Wires	100 mA	Required number

Task Analysis :

(a) Knowledge

1. Ohm's law in the resistive networks.
2. Kirchhoff's laws in the resistive networks.
3. Working of the regulated power supply.
4. Using the digital multimeter.
5. Using the breadboard.
6. Directions of voltages and currents in the elements of a circuit.
7. Precautions to be taken while handling the equipment.

3. Verification of Super Position Theorem

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.
	B	Using the correct range of Voltmeters and Ammeters.
	C	Identifying the Sources of Energy.
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages
	B	Replacing the Sources with their equivalent resistances.
	C	Adjusting the range of meters to read the voltages and currents accurately.
Precise Operations / Activities	A	Calculating the theoretical values of load currents.
	B	Summing up the theoretical values of load currents.
	C	Recording the practical values of load currents.
	D	Summing up the practical values of load currents.
	E	Comparing the practical values of load currents with theoretical values.

3. Verification of Super Position Theorem

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the Super Position Theorem.	3
2	Explaining the equivalent resistances of voltage source and current source.	3
3	Explaining the functioning of Regulated Power Supply.	3
4	Interpreting the Colour Coding of the Resistor.	3
5	Explaining the usage of Digital Multimeter.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

LABSHEET

3. Verification of Super Position Theorem

Need and Scope of Experiment :

This experiment is essential to understand the Super Position Theorem. With this knowledge, the circuits can be analyzed for their performance and as well as for the faults.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

3. Verification of Super Position Theorem

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	10
	B	Using the correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	10
	B	Replacing the Sources with their equivalent resistances.	4	
	C	Adjusting the range of meters to read the voltages and currents accurately.	2	
Precise Operations / Activities	A	Calculating the theoretical values of load currents.	5	25
	B	Summing up the theoretical values of load currents.	5	
	C	Recording the practical values of load currents.	5	
	D	Summing up the practical values of load currents.	5	
	E	Comparing the practical values of load currents with theoretical values.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

3. Verification of Super Position Theorem

Viva Questions :

1. Which is better: Kirchhoff's Laws or Super Position Theorem? Justify.
2. What is the minimum number of active elements to apply Super Position Theorem? Why?
3. Can we find the currents using the Super Position Theorem, if all the elements of a circuit are passive? Why?
4. Can we find the current in a Voltage Source using the Super Position Theorem? Justify.
5. What happens when the Super Position Theorem is applied to an open loop circuit?

Assessment Questions :

1. (a) Draw the circuit diagram to verify the Super Position Theorem.

   (b) Conduct the test to verify the Super Position Theorem.

   (c) Find out what happens when the terminals of one voltage source are reversed while working with Super Position Theorem.

LABSHEET

4. Verification of Thevenin's Theorem

Objective of the experiment : To verify the Thevenin's Theorem in a DC Circuit.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	1
2	Digital Multimeter	DCV: 200mV - 2000mV - 20V - 200V - 1000V DCA: 20uA - 2000uA - 20mA - 200mA - 10A R: 200 ohm - 2000 ohm - 20K - 200K - 2000K	3
3	Resistor	1 kilo ohm, ½ watt 2.2 kilo ohm, ½ watt 4.7 kilo ohm, ½ watt	1 1 1
4	Variable Resistor	10 kilo ohm, ½ watt	1
5	Breadboard		1
6	Connecting Wires	100 mA	Required number

Task Analysis :

(a) Knowledge

1. Kirchhoff's laws in the DC networks.
2. Super Position Theorem in the DC networks.
3. Working of the regulated power supply.
4. Using the digital multimeter.
5. Using the breadboard.
6. Directions of voltages and currents in the elements of a circuit.
7. Precautions to be taken while handling the equipment.

4. Verification of Thevenin's Theorem

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.
	B	Using the correct range of Voltmeters and Ammeters.
	C	Identifying the Sources of Energy.
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages
	B	Replacing the Sources with their equivalent resistances.
	C	Adjusting the range of meters to read the voltages and currents accurately.
Precise Operations / Activities	A	Recording the value of load current before applying Thevenin's circuit.
	B	Recording the value of Thevenin's Voltage.
	C	Recording the value of Thevenin's Resistance.
	D	Recording the value of load current after applying Thevenin's circuit.
	E	Comparing the values of load current recorded in both cases.

4. Verification of Thevenin's Theorem

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the Thevenin's Theorem.	3
2	Explaining the Thevenin's Resistance.	3
3	Explaining the Thevenin's Voltage.	3
4	Explaining the functioning of Regulated Power Supply.	3
5	Explaining the usage of Digital Multimeter.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

LABSHEET

4. Verification of Thevenin's Theorem

Need and Scope of Experiment :

This experiment is essential to understand the Thevenin's Theorem. With this knowledge, the circuits can be analyzed for their performance and as well as for the faults.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

4. Verification of Thevenin's Theorem

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	10
	B	Using the correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	10
	B	Replacing the Sources with their equivalent resistances.	4	
	C	Adjusting the range of meters to read the voltages and currents accurately.	2	
Precise Operations / Activities	A	Recording the value of load current before applying Thevenin's circuit.	5	25
	B	Recording the value of Thevenin's Voltage.	5	
	C	Recording the value of Thevenin's Resistance.	5	
	D	Recording the value of load current after applying Thevenin's circuit.	5	
	E	Comparing the values of load current recorded in both cases.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

4. Verification of Thevenin's Theorem

Viva Questions :

1. Which one is better: Thevenin's Theorem or Super Position Theorem? Justify.
2. What is the Thevenin's Resistance?
3. What is the equivalent resistance of a Ideal Voltage Source?
4. What happens when the fixed terminal of a variable resistor is shorted with its variable terminal?
5. What is the value of Thevenin's Resistance when the load resistor is replaced with a short circuit?

Assessment Questions :

1. (a) Draw the circuit diagram to verify the Thevenin's Theorem.
   (b) Conduct the test to verify the Thevenin's Theorem.
   (c) Find out what happens when the voltage source is replaced with the open circuit while using Thevenin's Theorem.

LABSHEET

5. Verification of Maximum Power Transfer Theorem

Objective of the experiment : To verify the Maximum Power Transfer Theorem in a DC Circuit.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	1
2	Digital Multimeter	DCV: 200mV – 2000mV – 20V – 200V – 1000V DCA: 20uA – 2000uA – 20mA – 200mA – 10A R: 200 ohm – 2000 ohm – 20K – 200K – 2000K	3
3	Resistor	1 kilo ohm, ½ watt 2.2 kilo ohm, ½ watt 4.7 kilo ohm, ½ watt	1 1 1
4	Variable Resistor	10 kilo ohm, ½ watt	2
5	Breadboard		1
6	Connecting Wires	100 mA	Required number

Task Analysis :

(a) Knowledge

1. Thevenin's Theorem in the DC networks.
2. Super Position Theorem in the DC networks.
3. Working of the regulated power supply.
4. Using the digital multimeter.
5. Using the breadboard.
6. Directions of voltages and currents in the elements of a circuit.
7. Precautions to be taken while handling the equipment.

5. Verification of Maximum Power Transfer Theorem

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.
	B	Using correct range of Voltmeters and Ammeters.
	C	Identifying the Sources of Energy.
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages
	B	Replacing the Sources with their equivalent resistances.
	C	Adjusting the range of meters to read the voltages and currents accurately.
Precise Operations / Activities	A	Recording the value of load power before applying Thevenin's circuit.
	B	Recording the value of Thevenin's Voltage.
	C	Recording the value of Thevenin's Resistance.
	D	Recording the value of load power after applying Thevenin's circuit.
	E	Comparing the values of load power recorded in both cases.

5. Verification of Maximum Power Transfer Theorem

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the Maximum Power Transfer Theorem.	3
2	Explaining the Thevenin's Resistance and Thevenin's Voltage.	3
3	Explaining the advantages of Maximum Power Transfer Theorem.	3
4	Explaining the functioning of Regulated Power Supply.	3
5	Explaining the usage of Digital Multimeter.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

5. Verification of Maximum Power Transfer Theorem

Need and Scope of Experiment :

This experiment is essential to understand the Maximum Power Transfer Theorem. With this knowledge, the circuits can be analyzed for their performance and as well as for the faults.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

5. Verification of Maximum Power Transfer Theorem

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	10
	B	Using correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	10
	B	Replacing the Sources with their equivalent resistances.	4	
	C	Adjusting the range of meters to read the voltages and currents accurately.	2	
Precise Operations / Activities	A	Recording the value of load power before applying Thevenin's circuit.	5	25
	B	Recording the value of Thevenin's Voltage.	5	
	C	Recording the value of Thevenin's Resistance.	5	
	D	Recording the value of load power after applying Thevenin's circuit.	5	
	E	Comparing the values of load power recorded in both cases.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

5. Verification of Maximum Power Transfer Theorem

Viva Questions :

1. What are the applications of Maximum Power Transfer Theorem?
2. At what value of the load resistance, half power is transferred from the source.
3. How much amount of maximum power can be transferred to the load, if the load voltage is halved?
4. Can we apply Maximum Power Transfer Theorem to AC Circuits? Why?
5. What is impedance matching?

Assessment Questions :

1. (a) Draw the circuit diagram to verify the Maximum Power Transfer Theorem.

   (b) Conduct the test to verify the Maximum Power Transfer Theorem.

   (c) Find out the amount of power transferred when the value of load resistance becomes the half of Thevenin's Resistance of the remaining circuit.

LABSHEET

6. Calibration of Dynamometer type Wattmeter

Objective of the experiment : To calibrate the given Dynamometer type Wattmeter.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Dynamometer type Wattmeter	1-Phase 500V 10A UPF	1
2	Moving Iron Voltmeter	1-Phase 0-300V	1
3	Moving Iron Ammeter	1-Phase 0-10A	1
4	Incandescent Lamp Load / Rheostatic Load	1-Phase 300V 0-10A	1
5	Connecting Wires	300V 10A	Required Number

Task Analysis :

(a) Knowledge

1. Functioning of Dynamometer type Wattmeter.
2. Functioning of Moving Iron Voltmeter.
3. Functioning of Moving Iron Ammeter.
4. Multiplication Factor of Measuring Instruments.
5. Working of Lamp Load / Rheostatic Load.
6. Directions of voltages and currents in the circuit.
7. Precautions to be taken while handling the equipment.

6. Calibration of Dynamometer type Wattmeter

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.
	B	Using correct range of Voltmeters and Ammeters.
	C	Identifying the Multiplication Factor of the wattmeter.
Manipulation of Apparatus	A	Setting up the lamp load to the required load currents.
	B	Adjusting the range of meters to read the voltages, currents and powers accurately.
	C	Setting up the trip circuit to protect the experimental set up from over loading.
Precise Operations / Activities	A	Applying the load gradually without over loading.
	B	Recording the values of voltages, currents and powers.
	C	Calculating the powers from the wattmeter by considering its multiplication factor.
	D	Calculating the powers from the readings of voltmeter and ammeter.
	E	Comparing the values of powers recorded in both cases.

6. Calibration of Dynamometer type Wattmeter

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the working of Dynamometer type Wattmeter.	3
2	Explaining the procedure of calibration.	3
3	Explaining the purpose of calibration of meters.	3
4	Explaining the functioning of each equipment used in the experiment.	3
5	Explaining the procedure of calculating the multiplication factor of meters.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

LABSHEET

6. Calibration of Dynamometer type Wattmeter

Need and Scope of Experiment :

This experiment is essential to calibrate the given Dynamometer type Wattmeter. With this knowledge, either adjustments can be made in the internal circuit of the Dynamometer type Wattmeter or readings can be adjusted by considering percentage error at the particular load condition.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

6. Calibration of Dynamometer type Wattmeter

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	10
	B	Using correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Multiplication Factor of the wattmeter.	2	
Manipulation of Apparatus	A	Setting up the lamp load to the required load currents.	4	10
	B	Adjusting the range of meters to read the voltages, currents and powers accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the load gradually without over loading.	5	25
	B	Recording the values of voltages, currents and powers.	5	
	C	Calculating the powers from the wattmeter by considering its multiplication factor.	5	
	D	Calculating the powers from the readings of voltmeter and ammeter.	5	
	E	Comparing the values of powers recorded in both cases.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

6. Calibration of Dynamometer type Wattmeter

Viva Questions :

1. Which type of Measuring Instrument is required to calibrate the new ones?
2. What should we do if the pointer in the Dynamometer type Wattmeter moves anticlockwise?
3. How can we find the multiplication factor of the Dynamometer type Wattmeter?
4. Can we calibrate the Dynamometer type Wattmeter by using inductive load? Justify.
5. How can we measure current by using a Dynamometer type Wattmeter?

Assessment Questions :

1. (a) Draw the circuit diagram to calibrate the given Dynamometer type Wattmeter.
   (b) Conduct the test to calibrate the given Dynamometer type Wattmeter.
   (c) Find out what happens when the connections to the current coil of the Dynamometer type Wattmeter are reversed.

LABSHEET

7. Calibration of Single Phase Induction type Energymeter

Objective of the experiment : To calibrate the given Single Phase Induction type Energymeter.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Single Phase Induction type Energymeter	1-Phase 300V 25A	1
2	Moving Iron Voltmeter	1-Phase 0-300V	1
3	Moving Iron Ammeter	1-Phase 0-10A	1
4	Incandescent Lamp Load / Rheostatic Load	1-Phase 300V 0-10A	1
5	Connecting Wires	300V 10A	Required Number
6	Stop Watch	with minutes and seconds counter	1

Task Analysis :

(a) Knowledge

1. Functioning of Single Phase Induction type Energymeter.
2. Functioning of Moving Iron Voltmeter.
3. Functioning of Moving Iron Ammeter.
4. Significance of Meter Constant of Energymeter.
5. Working of Lamp Load / Rheostatic Load.
6. Directions of voltages and currents in the circuit.
7. Using Stop Watch.
8. Precautions to be taken while handling the equipment.

7. Calibration of Single Phase Induction type Energymeter

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.
	B	Using correct range of Voltmeters and Ammeters.
	C	Identifying the Meter Constant of the Energymeter.
Manipulation of Apparatus	A	Setting up the lamp load to the required load currents.
	B	Adjusting the range of meters to read the voltages, currents and energy accurately.
	C	Setting up the trip circuit to protect the experimental set up from over loading.
Precise Operations / Activities	A	Applying the load gradually without over loading.
	B	Recording the values of voltages, currents and energies.
	C	Calculating the energy from the energymeter by considering its meter constant.
	D	Calculating the energy from the readings of voltmeter ammeter and timer.
	E	Comparing the values of energies recorded in both cases.

7. Calibration of Single Phase Induction type Energymeter

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the working of Single Phase Induction Type Energymeter.	3
2	Explaining the procedure of calibration.	3
3	Explaining the purpose of calibration of meters.	3
4	Explaining the functioning of each equipment used in the experiment.	3
5	Explaining the procedure of calculating the meter constant of Energymeter and multiplication factors of meters.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

7. Calibration of Single Phase Induction type Energymeter

Need and Scope of Experiment :

This experiment is essential to calibrate the given Single Phase Induction type Energymeter. With this knowledge, either adjustments can be made in the internal circuit of the Single Phase Induction type Energymeter or readings can be adjusted by considering percentage error at the particular load condition.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

7. Calibration of Single Phase Induction type Energymeter

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	10
	B	Using correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Meter Constant of the Energymeter.	2	
Manipulation of Apparatus	A	Setting up the lamp load to the required load currents.	4	10
	B	Adjusting the range of meters to read the voltages, currents and energy accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the load gradually without over loading.	5	25
	B	Recording the values of voltages, currents and energies.	5	
	C	Calculating the energy from the energymeter by considering its meter constant.	5	
	D	Calculating the energy from the readings of voltmeter ammeter and timer.	5	
	E	Comparing the values of energies recorded in both cases.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

7. Calibration of Single Phase Induction type Energymeter

Viva Questions :

1. What are possible causes of error in Single Phase Induction type Energymeter?
2. How can the Meter Constant be achieved in Single Phase Induction type Energymeter?
3. Suggest the remedy to suppress creeping in Single Phase Induction type Energymeter.
4. Can we use Single Phase Induction type Energymeter to measure the energy in a DC Circuit? Justify.
5. How can measure the power by using an Energymeter?

Assessment Questions :

1. (a) Draw the circuit diagram to calibrate the given Single Phase Induction type Energymeter.
   (b) Conduct the test to calibrate the given Single Phase Induction type Energymeter.
   (c) Find out what happens when the connections to the current coil of the Single Phase Induction type Energymeter are reversed.

LABSHEET

8. Determination of Q-factor and Power factor of an Inductive Coil

Objective of the experiment : To determine the Quality factor and Power factor of a Single Phase Inductive Coil.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Dynamometer type Wattmeter	1-Phase 150V 2A LPF	1
2	Moving Iron Voltmeter	1-Phase 0-300V	1
3	Moving Iron Ammeter	1-Phase 0-1A	1
4	Single Phase Transformer as Inductive Load	115 / 230 V 1 kVA	1
5	Single Phase Auto-Transformer	0-270V 2KVA	1
6	Connecting Wires	500V 5A	Required Number

Task Analysis :

(a) Knowledge

1. Functioning of Auto-Transformer.
2. Functioning of Moving Iron Voltmeter.
3. Functioning of Moving Iron Ammeter.
4. Functioning of Dynamometer type Wattmeter.
5. Multiplication Factor of Measuring Instruments.
6. Characteristics of Inductive load.
7. Quality factor and Power factor.
8. Precautions to be taken while handling the equipment

8. Determination of Q-factor and Power factor of an Inductive Coil

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.
	B	Using correct range of Voltmeters, Ammeter and Wattmeter.
	C	Setting the auto-transformer to its initial position.
Manipulation of Apparatus	A	Acquiring the name plate details of the inductive load used.
	B	Adjusting the range of meters to read the voltages and current accurately.
	C	Setting up the trip circuit to protect the experimental set up from over loading.
Precise Operations / Activities	A	Applying the voltage gradually to the RL Series Circuit without over loading.
	B	Recording the values of voltage, current and power from the meters.
	C	Calculating the power factor from the readings of voltage, current and power.
	D	Calculating the Resistance, Impedance and Inductive Reactance from the readings of voltage, current and power.
	E	Calculating the Quality factor from Inductive Reactance and Resistance.

8. Determination of Q-factor and Power factor of an Inductive Coil

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the procedure of measuring power in an Inductive Circuit.	3
2	Explaining the significance of quality factor.	3
3	Explaining the significance of power factor.	3
4	Explaining the functioning of each equipment used in the experiment.	3
5	Explaining the procedure of calculating the multiplication factor of meters.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

8. Determination of Q-factor and Power factor of an Inductive Coil

Need and Scope of Experiment :

This experiment is essential to measure the Quality factor and Power factor of a Single Phase Inductive Circuit. With this knowledge, active power, reactive power, power factor and performance of the inductive circuit can be measured at different load conditions.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

8. Determination of Q-factor and Power factor of an Inductive Coil

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	10
	B	Using correct range of Voltmeters, Ammeter and Wattmeter.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the inductive load used.	4	10
	B	Adjusting the range of meters to read the voltages and current accurately.	3	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	3	
Precise Operations / Activities	A	Applying the voltage gradually to the RL Series Circuit without over loading.	5	25
	B	Recording the values of voltage, current and power from the meters.	5	
	C	Calculating the power factor from the readings of voltage, current and power.	5	
	D	Calculating the Resistance, Impedance and Inductive Reactance from the readings of voltage, current and power.	5	
	E	Calculating the Quality factor from Inductive Reactance and Resistance.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

8. Determination of Q-factor and Power factor of an Inductive Coil

Viva Questions :

1. What is the significance of Quality factor on the performance of a circuit?
2. What is the significance of Power factor on the performance of a circuit?
3. Which power factor is better: lagging or leading? Why?
4. How can unity power factor be achieved?
5. Relate Quality factor with Power factor.

Assessment Questions :

1. (a) Draw the circuit diagram to determine the Quality factor and Power factor of a Single Phase Inductive Circuit.
   (b) Conduct the test to determine the Quality factor and Power factor of a Single Phase Inductive Circuit.
   (c) Explain the significance of Quality factor and Power factor on the performance of an Inductive Circuit.

LABSHEET

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Objective of the experiment : To determine the Idle and Energy components of current in a Single Phase Inductive circuit.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Dynamometer type Wattmeter	1-Phase 150V 2A LPF	1
2	Moving Iron Voltmeter	1-Phase 0-300V	1
3	Moving Iron Ammeter	1-Phase 0-1A	1
4	Single Phase Transformer as Inductive Load	115 / 230 V 1 kVA	1
5	Single Phase Auto-Transformer	0-270V 2KVA	1
6	Connecting Wires	500V 5A	Required Number

Task Analysis :

(a) Knowledge

1. Functioning of Auto-Transformer.
2. Functioning of Moving Iron Voltmeter.
3. Functioning of Moving Iron Ammeter.
4. Functioning of Dynamometer type Wattmeter.
5. Multiplication Factor of Measuring Instruments.
6. Characteristics of Inductive load.
7. Components of Currents and Power factor.
8. Precautions to be taken while handling the equipment

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.
	B	Using correct range of Voltmeters, Ammeter and Wattmeter.
	C	Setting the auto-transformer to its initial position.
Manipulation of Apparatus	A	Acquiring the name plate details of the inductive load used.
	B	Adjusting the range of meters to read the voltages and current accurately.
	C	Setting up the trip circuit to protect the experimental set up from over loading.
Precise Operations / Activities	A	Applying the voltage gradually to the RL Series Circuit without over loading.
	B	Recording the values of voltage, current and power from the meters.
	C	Calculating the power factor from the readings of voltage, current and power.
	D	Calculating the idle component of current from the readings of voltage, current and power.
	E	Calculating the energy component of current from the readings of voltage, current and power.

LABSHEET

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the procedure of measuring power in an Inductive Circuit.	3
2	Explaining the components of current.	3
3	Explaining the significance of power factor.	3
4	Explaining the functioning of each equipment used in the experiment.	3
5	Explaining the procedure of calculating the multiplication factor of meters.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Need and Scope of Experiment :

This experiment is essential to measure the Idle and Energy components of Current in a Single Phase Inductive Circuit. With this knowledge, active power, reactive power and power factor of an inductive circuit can be measured at different load conditions.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	10
	B	Using correct range of Voltmeters, Ammeter and Wattmeter.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the inductive load used.	4	10
	B	Adjusting the range of meters to read the voltages and current accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the voltage gradually to the RL Series Circuit without over loading.	5	25
	B	Recording the values of voltage, current and power from the meters.	5	
	C	Calculating the power factor from the readings of voltage, current and power.	5	
	D	Calculating the idle component of current from the readings of voltage, current and power.	5	
	E	Calculating the energy component of current from the readings of voltage, current and power.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Viva Questions :

1. What is the significance of Idle component of current on the performance of a circuit?
2. What is the significance of Energy component of current on the performance of a circuit?
3. What happens, if the Idle component of current is absent in an inductive circuit?
4. What happens, if the Idle component of current is absent in a capacitive circuit?
5. What happens, if the Idle component of current becomes equal to the energy component of current?

Assessment Questions :

1. (a) Draw the circuit diagram to determine the Idle and Energy components of current passing through the Single Phase Inductive Circuit.

   (b) Conduct the test to determine the Idle and Energy components of current passing through the Single Phase Inductive Circuit.

   (c) Explain the significance of Idle and Energy components of current passing through the Single Phase Inductive Circuit, on its performance.

LABSHEET

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Objective of the experiment : To measure the active power and power factor of a single phase RL series circuit by using Three Voltmeter method.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Moving Iron Voltmeter	1-Phase 0-300V	1
2	Moving Iron Voltmeter	1-Phase 0-150V	2
3	Moving Iron Ammeter	1-Phase 0-10A	1
4	Rheostat	0-45 ohm 5A	1
5	Single Phase Transformer as Inductive Load	115 / 230 V 1 kVA	1
6	Single Phase Auto-Transformer	0-270V 2KVA	1
7	Connecting Wires	300V 5A	Required Number

Task Analysis :

(a) Knowledge

1. Functioning of Auto-Transformer.
2. Functioning of Moving Iron Voltmeter.
3. Functioning of Moving Iron Ammeter.
4. Multiplication Factor of Measuring Instruments.
5. Types of loads.
6. Characteristics of Inductive load.
7. Types of Powers and Power factor.
8. Precautions to be taken while handling the equipment

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.
	B	Using correct range of Voltmeters and Ammeter.
	C	Setting the auto-transformer to its initial position.
Manipulation of Apparatus	A	Acquiring the name plate details of the rheostat used.
	B	Adjusting the range of meters to read the voltages and current accurately.
	C	Setting up the trip circuit to protect the experimental set up from over loading.
Precise Operations / Activities	A	Applying the voltage gradually to the RL Series Circuit without over loading.
	B	Recording the values of three voltages and one current from the meters.
	C	Calculating the active power from the voltmeters readings and the value of resistance of the rheostat.
	D	Calculating the power factor from the voltmeters readings and the value of resistance of the rheostat.
	E	Calculating the reactive power of circuit.

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the procedure of measuring power in an Inductive Circuit with three Moving Iron Voltmeters.	3
2	Explaining the types of powers.	3
3	Explaining the significance of power factor.	3
4	Explaining the functioning of each equipment used in the experiment.	3
5	Explaining the procedure of calculating the multiplication factor of meters.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Need and Scope of Experiment :

This experiment is essential to measure the power in a Single Phase RL Series Circuit using Three Voltmeter method. With this knowledge, active power, power factor and reactive power of an inductive circuit can be measured at different load conditions.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	10
	B	Using correct range of Voltmeters and Ammeter.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the rheostat used.	4	10
	B	Adjusting the range of meters to read the voltages and current accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the voltage gradually to the RL Series Circuit without over loading.	5	25
	B	Recording the values of three voltages and one current from the meters.	5	
	C	Calculating the active power from the voltmeters readings and the value of resistance of the rheostat.	5	
	D	Calculating the power factor from the voltmeters readings and the value of resistance of the rheostat.	5	
	E	Calculating the reactive power of circuit.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Viva Questions :

1. Does Moving Iron Voltmeter have more advantages to Moving Coil Voltmeter? Why?
2. How can be the range of a Moving Iron Voltmeter extended?
3. List the methods of providing damping torque in Moving Iron Voltmeters.
4. What happens when a strong magnetic field is interfered with Moving Iron Voltmeter?
5. How much amount of power can be transferred with the auto-transformer via conduction, while measuring the power by using Three Voltmeter method?

Assessment Questions :

1. (a) Draw the circuit diagram to measure the power in a Single Phase Inductive Circuit by using Three Voltmeter method.
   (b) Conduct the test to measure the power in a Single Phase Inductive Circuit by using Three Voltmeter method.
   (c) Find out what happens when the UDC Power Supply is given to the Single Phase Inductive Circuit while measuring the power using Three Voltmeter method.

LABSHEET

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Objective of the experiment : To measure the active power and power factor of a single phase RL parallel circuit by using Three Ammeter method.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Moving Iron Voltmeter	1-Phase 0-150V	1
2	Moving Iron Ammeter	1-Phase 0-10A	1
3	Moving Iron Ammeter	1-Phase 0-5A	2
4	Rheostat	0-45 ohm 5A	1
5	Single Phase Transformer as Inductive Load	115 / 230 V 1 kVA	1
6	Single Phase Auto-Transformer	0-270V 2KVA	1
7	Connecting Wires	300V 10A	Required Number

Task Analysis :

(a) Knowledge

1. Functioning of Auto-Transformer.
2. Functioning of Moving Iron Voltmeter.
3. Functioning of Moving Iron Ammeter.
4. Multiplication Factor of Measuring Instruments.
5. Types of loads.
6. Characteristics of Inductive load.
7. Types of Powers and Power factor.
8. Precautions to be taken while handling the equipment

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.
	B	Using correct range of Voltmeter and Ammeters.
	C	Setting the auto-transformer to its initial position.
Manipulation of Apparatus	A	Acquiring the name plate details of the rheostat used.
	B	Adjusting the range of meters to read the voltage and, currents accurately.
	C	Setting up the trip circuit to protect the experimental set up from over loading.
Precise Operations / Activities	A	Applying the voltage gradually to the RL Parallel Circuit without over loading.
	B	Recording the values of three currents and one voltage from the meters.
	C	Calculating the active power from the ammeters readings and the value of resistance of the rheostat.
	D	Calculating the power factor from the ammeters readings and the value of resistance of the rheostat.
	E	Calculating the reactive power of circuit.

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the procedure of measuring power in an Inductive Circuit with three Moving Iron Ammeters.	3
2	Explaining the types of powers.	3
3	Explaining the significance of power factor.	3
4	Explaining the functioning of each equipment used in the experiment.	3
5	Explaining the procedure of calculating the multiplication factor of meters.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Need and Scope of Experiment :

This experiment is essential to measure the power in a Single Phase RL Parallel Circuit using Three Ammeter method. With this knowledge, active power, power factor and reactive power of an inductive circuit can be measured at different load conditions.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	10
	B	Using correct range of Voltmeter and Ammeters.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the rheostat used.	4	10
	B	Adjusting the range of meters to read the voltage and, currents accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the voltage gradually to the RL Parallel Circuit without over loading.	5	25
	B	Recording the values of three currents and one voltage from the meters.	5	
	C	Calculating the active power from the ammeters readings and the value of resistance of the rheostat.	5	
	D	Calculating the power factor from the ammeters readings and the value of resistance of the rheostat.	5	
	E	Calculating the reactive power of circuit.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Viva Questions :

1. Which one is better to measure the power of a single phase inductive circuit: Three Ammeter method or Three Voltmeter method? Justify.
2. Can we measure the power, if the voltmeter used is of moving coil type, while measuring power of a single phase inductive circuit with Three Ammeter method? Justify.
3. What are the methods used to measure the power of a single phase RL Parallel circuit?
4. Why does the scale of a moving iron ammeter used in Three Ammeter method, cramped?
5. Why does the impedance of a moving iron ammeter used in Three Ammeter method, maximum?

Assessment Questions :

1. (a) Draw the circuit diagram to measure the power in a Single Phase Inductive Circuit by using Three Ammeter method.
   (b) Conduct the test to measure the power in a Single Phase Inductive Circuit by using Three Ammeter method.
   (c) Find out what happens when the DC Power Supply is given to the Single Phase Inductive Circuit while measuring the power using Three Ammeter method.

LABSHEET

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Objective of the experiment : To measure the active power, reactive power and power factor of a three phase balanced load by using Two Wattmeter method.

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1	Dynamometer type Wattmeter	1-Phase 500V 5A UPF	2
2	Moving Iron Voltmeter	1-Phase 0-500V	1
3	Moving Iron Ammeter	1-Phase 0-5A	1
4	Three Phase Induction Motor	415V 5A	1
5	Three Phase Auto-Transformer	0-500V 10A	1
6	Connecting Wires	500V 10A	Required Number

Task Analysis :

(a) Knowledge

1. Functioning of Dynamometer type Wattmeter.
2. Functioning of Moving Iron Voltmeter.
3. Functioning of Moving Iron Ammeter.
4. Multiplication Factor of Measuring Instruments.
5. Types of loads.
6. Characteristics of Inductive load.
7. Types of Powers and Power factor.
8. Precautions to be taken while handling the equipment

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

(b) Skill

Category of Skill	Sub Task	
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.
	B	Using correct range of Voltmeter, Ammeter and Wattmeters.
	C	Setting the auto-transformer to its initial position.
Manipulation of Apparatus	A	Acquiring the name plate details of the three phase load used.
	B	Adjusting the range of meters to read the voltage, current and powers accurately.
	C	Setting up the trip circuit to protect the experimental set up from over loading.
Precise Operations / Activities	A	Applying the voltage gradually to the three phase load without over loading.
	B	Recording the values of one voltage, one current and two powers from the meters.
	C	Calculating the active power from the readings of two wattmeters.
	D	Calculating the power factor from the readings of two wattmeters.
	E	Calculating the reactive power from the readings of two wattmeters.

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Teaching Points :

Sno	Teaching Point	Suggested Time (mins)
1	Explaining the procedure of measuring power in a Three Phase Inductive Circuit with two Dynamometer type Wattmeters.	3
2	Explaining the types of powers.	3
3	Explaining the significance of power factor.	3
4	Explaining the functioning of each equipment used in the experiment.	3
5	Explaining the procedure of calculating the multiplication factor of meters.	2
6	Explaining the precautions to be taken.	1
	Total Time (mins)	**15**

Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

LABSHEET

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Need and Scope of Experiment :

This experiment is essential to measure the power in a Three Phase Balanced Circuit using Two Wattmeter method. With this knowledge, active power, power factor and reactive power of an inductive circuit can be measured at different load conditions.

Planning and Organization :

Action	Activity
Check for	the meters.
	the circuit construction.
	the students entry behaviour.
	the first aid kit.
	the wires of standard colours and gauges.
For the design of instruction	Read the teaching points carefully.

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Total
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	10
	B	Using correct range of Voltmeter, Ammeter and Wattmeters.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the three phase load used.	4	10
	B	Adjusting the range of meters to read the voltage, current and powers accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the voltage gradually to the three phase load without over loading.	5	25
	B	Recording the values of one voltage, one current and two powers from the meters.	5	
	C	Calculating the active power from the readings of two wattmeters.	5	
	D	Calculating the power factor from the readings of two wattmeters.	5	
	E	Calculating the reactive power from the readings of two wattmeters.	5	
Values	A	Co-Operation	1	5
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	**50**

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Viva Questions :

1. Which method is better to measure the three phase power: One Wattmeter method, Two Wattmeter method and Three Wattmeter method? Justify.
2. While using Two Wattmeter method, If the two wattmeters are showing the same reading, what is the power factor of the load?
3. While using Two Wattmeter method, If one of wattmeters is showing zero reading, what is the power factor of the load?
4. How can we measure the reactive power of a three phase load using one wattmeter only?
5. What happens, if the terminals of current coil of a wattmeter are interchanged while measuring the power in a three phase circuit using Two Wattmeter method.

Assessment Questions :

1. (a) Draw the circuit diagram to measure the power in a Three Phase Inductive Circuit by using Two Wattmeter method.
   (b) Conduct the test to measure the power in a Three Phase Inductive Circuit by using Two Wattmeter method.
   (c) Find out what happens when the pointer of a Wattmeter moves in anticlockwise direction while measuring the power in a Three Phase Inductive Circuit by using Two Wattmeter method.

C20 – EE310

ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB

WORK SHEETS

SBTET, AP

Sno	Experiment Title	Date of Experiment	Page Number
1	**Verification of Ohm's Law and limitations of Ohm's Law**		1
2	**Verification of Kirchhoff's Voltage Law and Current Law**		7
3	**Verification of Super Position Theorem**		13
4	**Verification of Thevenin's Theorem**		19
5	**Verification of Maximum Power Transfer Theorem**		25
6	**Calibration of Dynamometer type Wattmeter**		31
7	**Calibration of Single Phase Induction type Energymeter**		37
8	**Determination of Q-factor and Power factor of an Inductive Coil**		43
9	**Determination of Idle & Energy components of Current in a Single Phase Inductive Circuit**		49
10	**Measurement of Power in Single Phase circuit by 3-Voltmeter method**		55
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WORKSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Procedure :

WORKSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Readings :

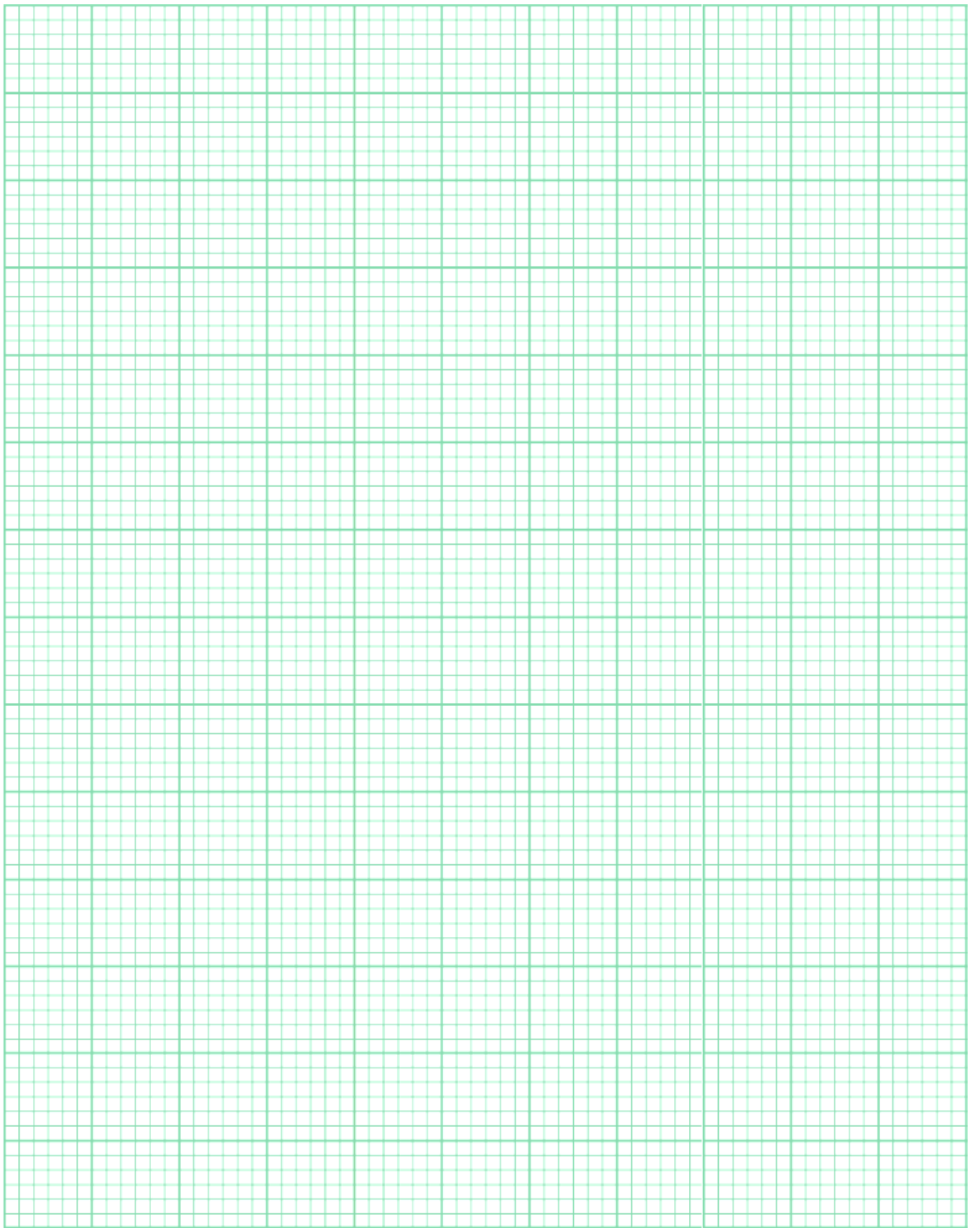
when the temperature is kept constant			
Sno	**Voltage applied across the resistor (volts)**	**Current passing through the Resistor (amps)**	**Resistance (ohms)**
1			
2			
3			
4			
5			
6			
7			
8			

when the temperature is varied			
Sno	**Voltage applied across the resistor (volts)**	**Current passing through the Resistor (amps)**	**Resistance (ohms)**
1			
2			
3			
4			
5			
6			
7			
8			

WORKSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Graph :



WORKSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Inference and Interpretation :

WORKSHEET

1. Verification of Ohm's Law and Limitations of Ohm's Law

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	
	B	Using the correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	
	B	Adjusting the range of Ammeter to read the currents accurately.	3	
	C	Adjusting the range of Voltmeter to read the voltages accurately.	3	
Precise Operations / Activities	A	Recording the values of voltages.	5	
	B	Recording the values of currents.	5	
	C	Calculating the values of resistance.	5	
	D	Changing the temperature around the resistor.	5	
	E	Recording the values of resistance with temperature effect.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

2. Verification of Kirchhoff's Voltage Law and Current Law

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

2. Verification of Kirchhoff's Voltage Law and Current Law

Procedure :

WORKSHEET

2. Verification of Kirchhoff's Voltage Law and Current Law

Readings :

Kirchhoff's Voltage Law			
Voltage across Resistor - 1 (volts)	**Voltage across Resistor - 2 (volts)**	**Voltage across Resistor - 3 (volts)**	**RPS Output Voltage (volts)**

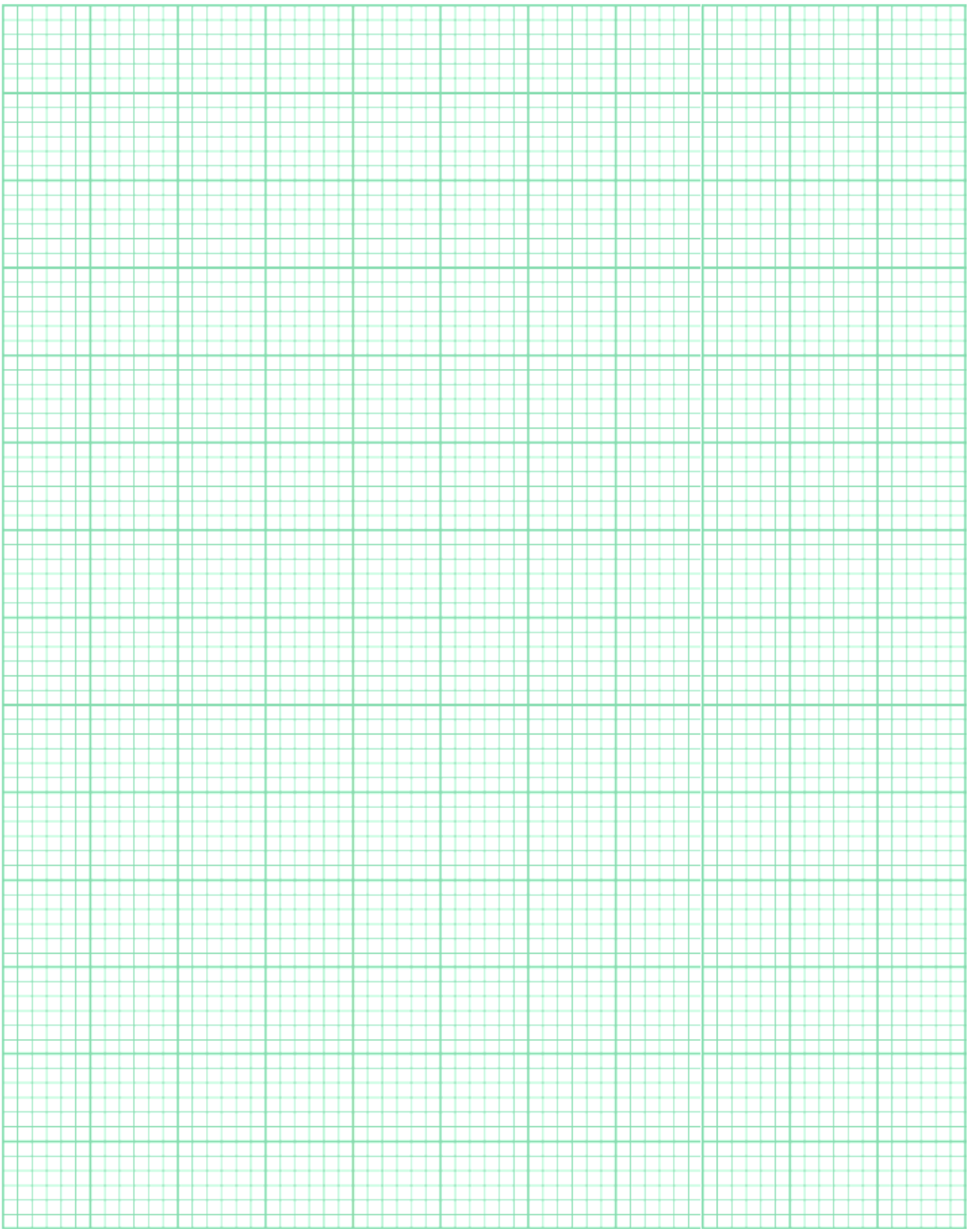
Sum of the voltages =

Kirchhoff's Current Law			
Current in Resistor - 1 (amps)	**Current in Resistor - 2 (amps)**	**Current in Resistor - 3 (amps)**	**Sum of the Currents (amps)**

WORKSHEET

2. Verification of Kirchhoff's Voltage Law and Current Law

Graph :



WORKSHEET

2. Verification of Kirchhoff's Voltage Law and Current Law

Inference and Interpretation :

WORKSHEET

2. Verification of Kirchhoff's Voltage Law and Current Law

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	
	B	Using the correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	
	B	Adjusting the range of Ammeters to read the currents accurately.	3	
	C	Adjusting the range of Voltmeters to read the voltages accurately.	3	
Precise Operations / Activities	A	Recording the values of voltages across the elements in a loop.	5	
	B	Summing up the values of all the voltages in the loop.	5	
	C	Recording the values of currents in the elements connected to a node.	5	
	D	Summing up the values of currents in the elements connected to the node.	5	
	E	Checking the Kirchhoff's Voltage Law and Current Law.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

3. Verification of Super Position Theorem

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

3. Verification of Super Position Theorem

Procedure :

WORKSHEET

3. Verification of Super Position Theorem

Readings :

when Source-1 and Source-2 are present		
Source-1 Voltage (volts)	**Source-2 Voltage (volts)**	**Current in Load Resister (amps)**

when Source-1 only is present		
Source-1 Voltage (volts)	**Source-2 Voltage (volts)**	**Current in Load Resistor (amps)**

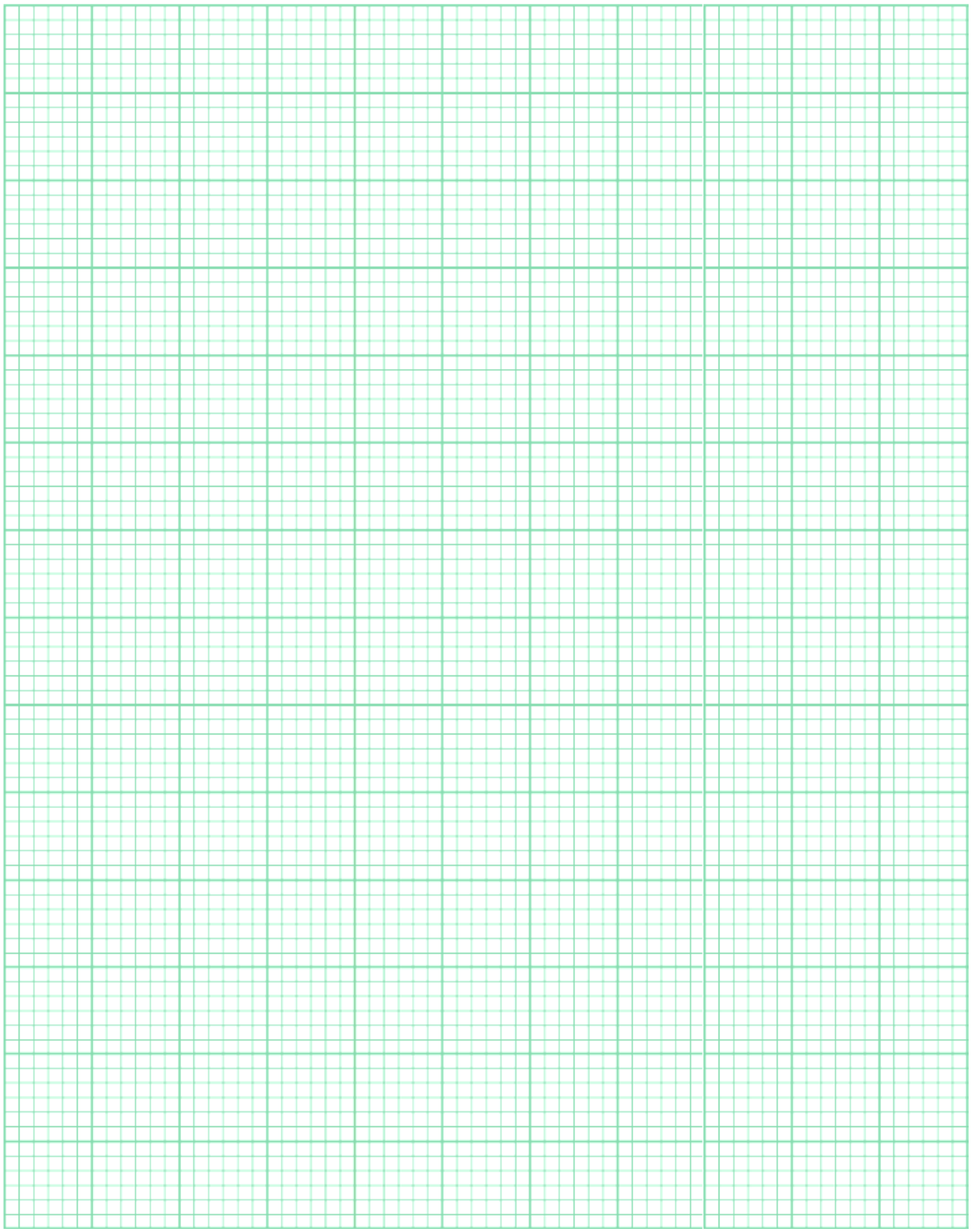
when Source-2 only is present		
Source-1 Voltage (volts)	**Source-2 Voltage (volts)**	**Current in Load Resistor (amps)**

Verification		
Current in Load Resister (amps) due to Source-1	**Current in Load Resister (amps) due to Source-2**	**Current in Load Resistor (amps) due to Source-1 and Source-2**

WORKSHEET

3. Verification of Super Position Theorem

Graph :



WORKSHEET

3. Verification of Super Position Theorem

Inference and Interpretation :

WORKSHEET

3. Verification of Super Position Theorem

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	
	B	Using the correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	
	B	Replacing the Sources with their equivalent resistances.	4	
	C	Adjusting the range of meters to read the voltages and currents accurately.	2	
Precise Operations / Activities	A	Calculating the theoretical values of load currents.	5	
	B	Summing up the theoretical values of load currents.	5	
	C	Recording the practical values of load currents.	5	
	D	Summing up the practical values of load currents.	5	
	E	Comparing the practical values of load currents with theoretical values.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

4. Verification of Thevenin's Theorem

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

4. Verification of Thevenin's Theorem

Procedure :

WORKSHEET

4. Verification of Thevenin's Theorem

Readings :

Before applying Thevenin's theorem	
Source Voltage (volts)	Current in Load Resister (amps)

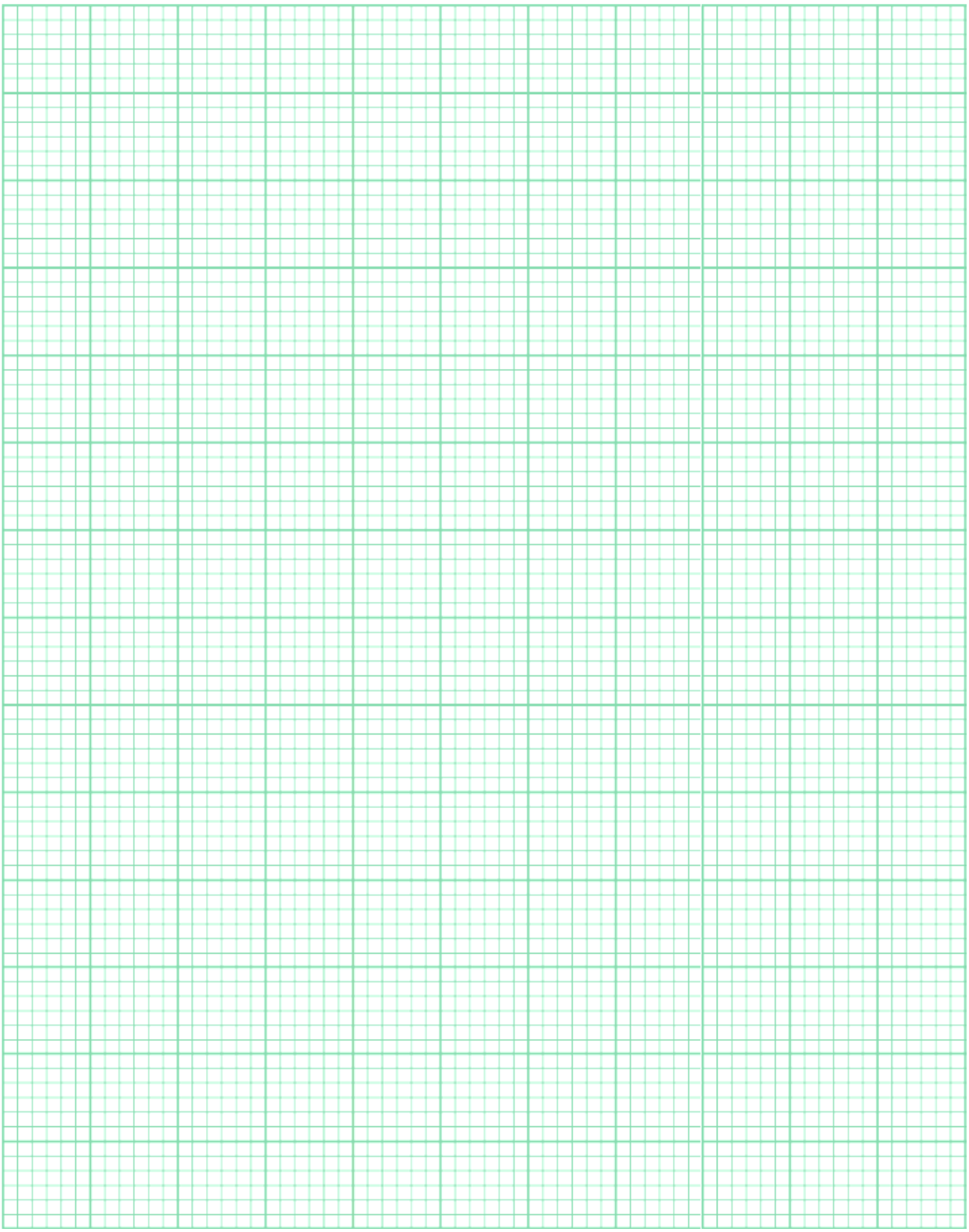
After applying Thevenin's theorem	
Thevenin's Voltage (volts)	Thevenin's Resistance (ohms)

Verification			
Thevenin's Voltage (volts)	Thevenin's Resistance (ohms)	Load Resistance (ohms)	Current in Load Resistor (amps)

WORKSHEET

4. Verification of Thevenin's Theorem

Graph :



WORKSHEET

4. Verification of Thevenin's Theorem

Inference and Interpretation :

WORKSHEET

4. Verification of Thevenin's Theorem

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	
	B	Using the correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	
	B	Replacing the Sources with their equivalent resistances.	4	
	C	Adjusting the range of meters to read the voltages and currents accurately.	2	
Precise Operations / Activities	A	Recording the value of load current before applying Thevenin's circuit.	5	
	B	Recording the value of Thevenin's Voltage.	5	
	C	Recording the value of Thevenin's Resistance.	5	
	D	Recording the value of load current after applying Thevenin's circuit.	5	
	E	Comparing the values of load current recorded in both cases.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

5. Verification of Maximum Power Transfer Theorem

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

5. Verification of Maximum Power Transfer Theorem

Procedure :

WORKSHEET

5. Verification of Maximum Power Transfer Theorem

Readings :

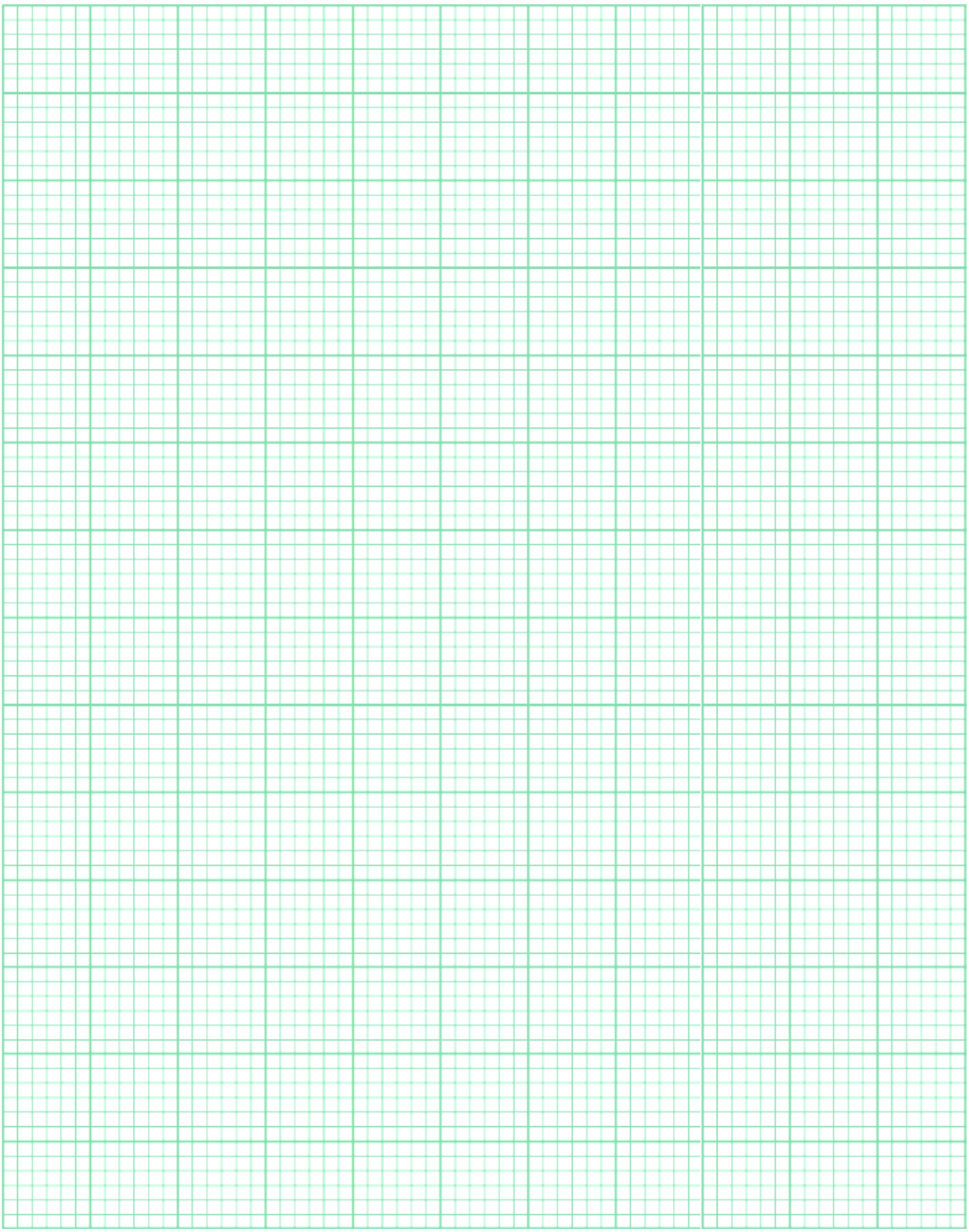
Before applying Maximum Power Transfer theorem			
Source Voltage (volts)	**Current in Load Resistor (amps)**	**Actual Load Resistance (ohms)**	**Power in Load Resistance (watts)**

After applying Maximum Power Transfer theorem			
Thevenin's Voltage (volts)	**Thevenin's Resistance (ohms)**	**Load Resistance equal to Thevenin's Resistance (ohms)**	**Maximum Power transferred to Load Resistance (watts)**

WORKSHEET

5. Verification of Maximum Power Transfer Theorem

Graph :



WORKSHEET

5. Verification of Maximum Power Transfer Theorem

Inference and Interpretation :

WORKSHEET

5. Verification of Maximum Power Transfer Theorem

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals.	5	
	B	Using correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Sources of Energy.	2	
Manipulation of Apparatus	A	Setting up the Regulated Power Supplies to required voltages	4	
	B	Replacing the Sources with their equivalent resistances.	4	
	C	Adjusting the range of meters to read the voltages and currents accurately.	2	
Precise Operations / Activities	A	Recording the value of load power before applying Thevenin's circuit.	5	
	B	Recording the value of Thevenin's Voltage.	5	
	C	Recording the value of Thevenin's Resistance.	5	
	D	Recording the value of load power after applying Thevenin's circuit.	5	
	E	Comparing the values of load power recorded in both cases.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

6. Calibration of Dynamometer type Wattmeter

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

6. Calibration of Dynamometer type Wattmeter

Procedure :

WORKSHEET

6. Calibration of Dynamometer type Wattmeter

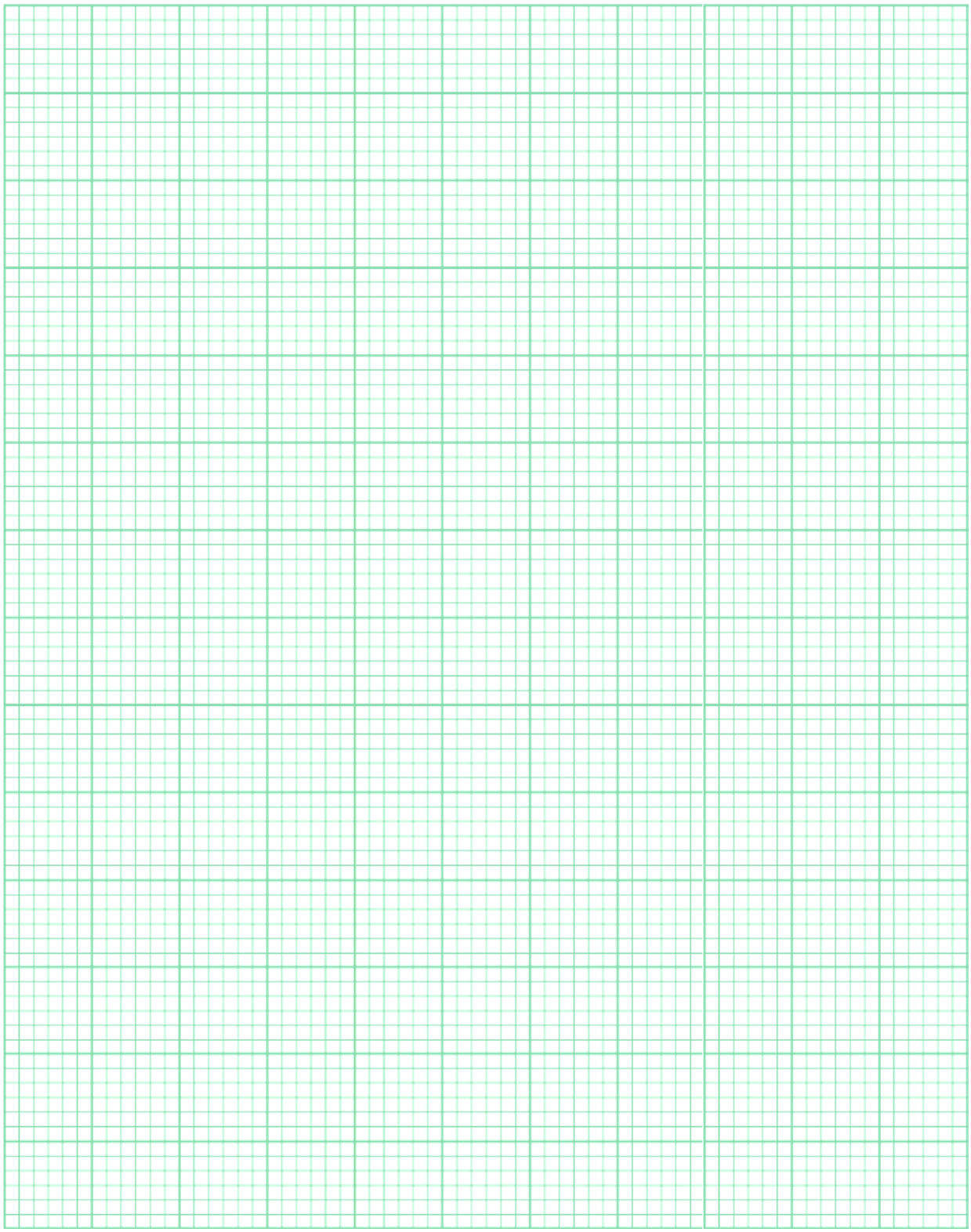
Readings :

Sno	Voltage applied across the lamp load V (volts)	Current passing through the lamp load I (amps)	Power measured by the Wattmeter W (watts)	Power measured by the Voltmeter and Ammeter Setup P = VI (watts)	Error E = P- W (watts)	% Error % E = Ex100 / P
1						
2						
3						
4						
5						
6						
7						
8						

WORKSHEET

6. Calibration of Dynamometer type Wattmeter

Graph :



WORKSHEET

6. Calibration of Dynamometer type Wattmeter

Inference and Interpretation :

WORKSHEET

6. Calibration of Dynamometer type Wattmeter

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	
	B	Using correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Multiplication Factor of the wattmeter.	2	
Manipulation of Apparatus	A	Setting up the lamp load to the required load currents.	4	
	B	Adjusting the range of meters to read the voltages, currents and powers accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the load gradually without over loading.	5	
	B	Recording the values of voltages, currents and powers.	5	
	C	Calculating the powers from the wattmeter by considering its multiplication factor.	5	
	D	Calculating the powers from the readings of voltmeter and ammeter.	5	
	E	Comparing the values of powers recorded in both cases.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

7. Calibration of Single Phase Induction type Energymeter

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

7. Calibration of Single Phase Induction type Energymeter

Procedure :

WORKSHEET

7. Calibration of Single Phase Induction type Energymeter

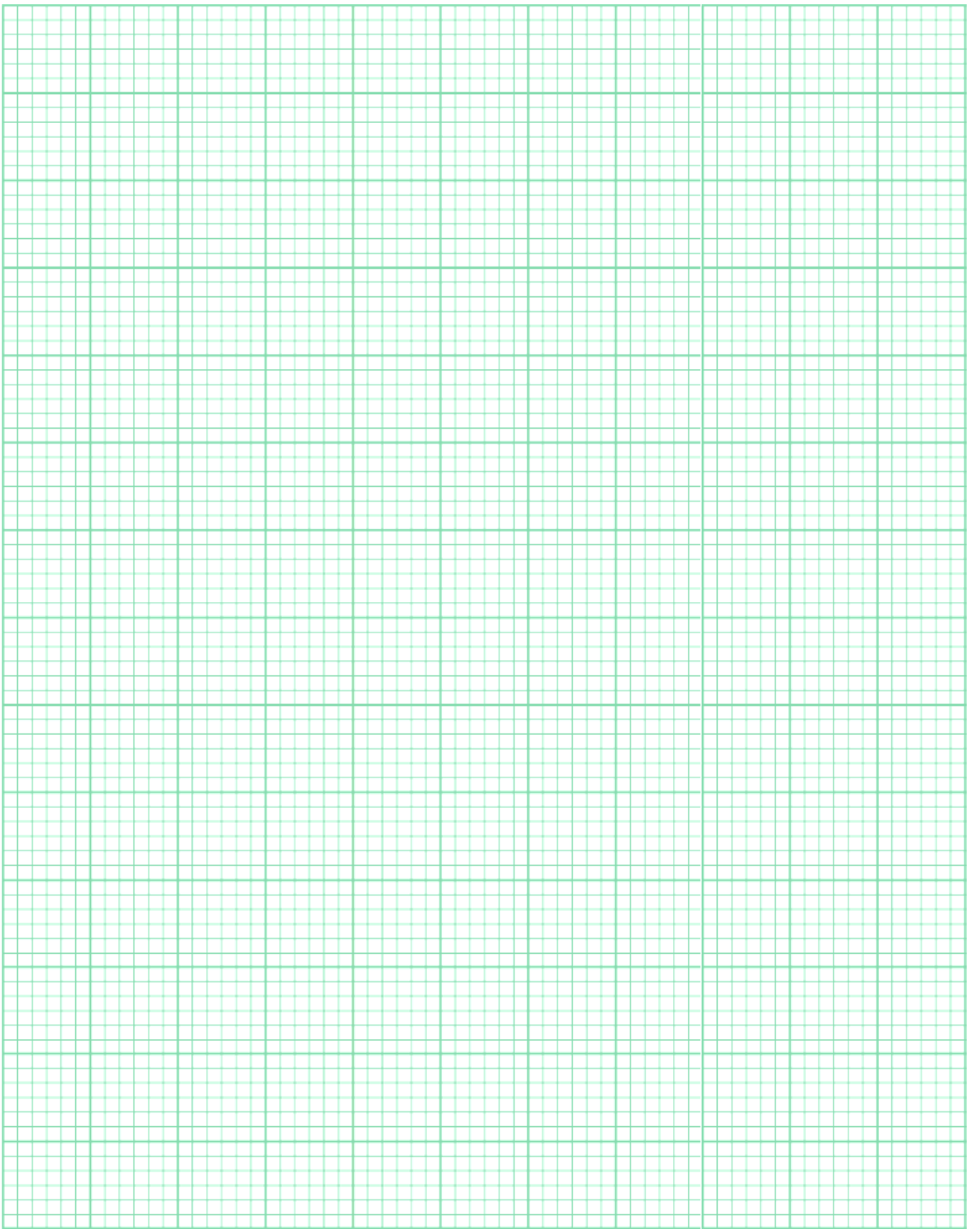
Readings :

Meter Constant (M) = revolutions / unit							
Sno	**Voltage applied across the lamp load V (volts)**	**Current passing through the lamp load I (amps)**	**Time taken by the disc to complete ——(N) revolutions T (sec)**	**Energy measured by the Voltmeter and Ammeter Setup Et = VIT / (3600X1000) (kWh)**	**Energy measured by the Energymeter Em = M/N (kWh)**	**Error E = Et – Em (kWh)**	**% Error % E = Ex100 / Et**
1							
2							
3							
4							
5							
6							
7							
8							

WORKSHEET

7. Calibration of Single Phase Induction type Energymeter

Graph :



WORKSHEET

7. Calibration of Single Phase Induction type Energymeter

Inference and Interpretation :

WORKSHEET

7. Calibration of Single Phase Induction type Energymeter

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	
	B	Using correct range of Voltmeters and Ammeters.	3	
	C	Identifying the Meter Constant of the Energymeter.	2	
Manipulation of Apparatus	A	Setting up the lamp load to the required load currents.	4	
	B	Adjusting the range of meters to read the voltages, currents and energy accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the load gradually without over loading.	5	
	B	Recording the values of voltages, currents and energies.	5	
	C	Calculating the energy from the energymeter by considering its meter constant.	5	
	D	Calculating the energy from the readings of voltmeter ammeter and timer.	5	
	E	Comparing the values of energies recorded in both cases.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

8. Determination of Q-factor and Power factor of an Inductive Coil

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

8. Determination of Q-factor and Power factor of an Inductive Coil

Procedure :

WORKSHEET

8. Determination of Q-factor and Power factor of an Inductive Coil

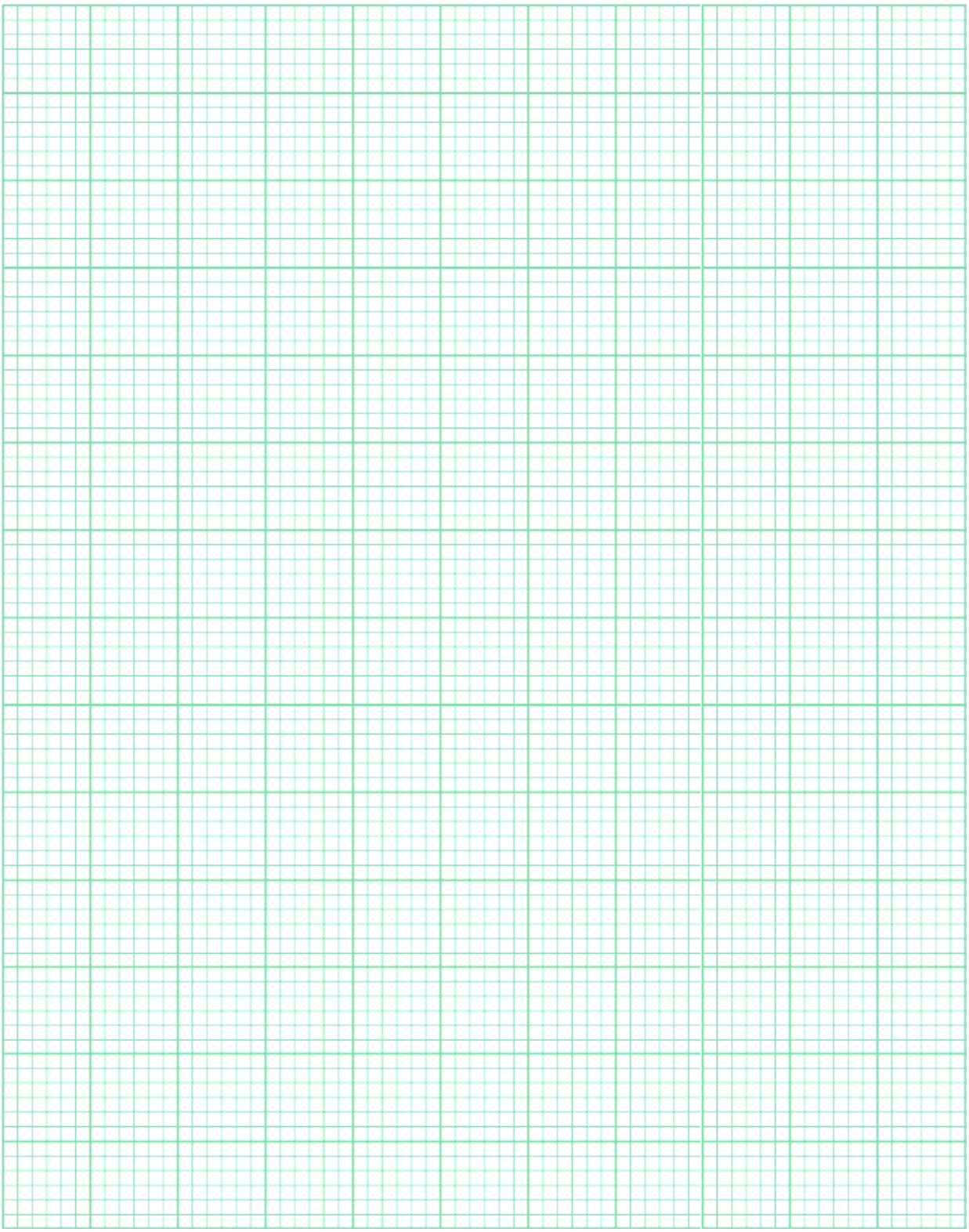
Readings :

Sno	Voltmeter Reading V (volts)	Ammeter Reading I (amps)	Wattmeter Reading P (watts)	Power factor Cos ϕ = P / (VI)	tan ϕ	Impedance Z = V / I (ohms)	Quality factor = tan ϕ
1							
2							
3							
4							

WORKSHEET

8. Determination of Q-factor and Power factor of an Inductive Coil

Graph :



WORKSHEET

8. Determination of Q-factor and Power factor of an Inductive Coil

Inference and Interpretation :

WORKSHEET

8. Determination of Q-factor and Power factor of an Inductive Coil

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	
	B	Using correct range of Voltmeters, Ammeter and Wattmeter.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the inductive load used.	4	
	B	Adjusting the range of meters to read the voltages and current accurately.	3	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	3	
Precise Operations / Activities	A	Applying the voltage gradually to the RL Series Circuit without over loading.	5	
	B	Recording the values of voltage, current and power from the meters.	5	
	C	Calculating the power factor from the readings of voltage, current and power.	5	
	D	Calculating the Resistance, Impedance and Inductive Reactance from the readings of voltage, current and power.	5	
	E	Calculating the Quality factor from Inductive Reactance and Resistance.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Procedure :

WORKSHEET

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

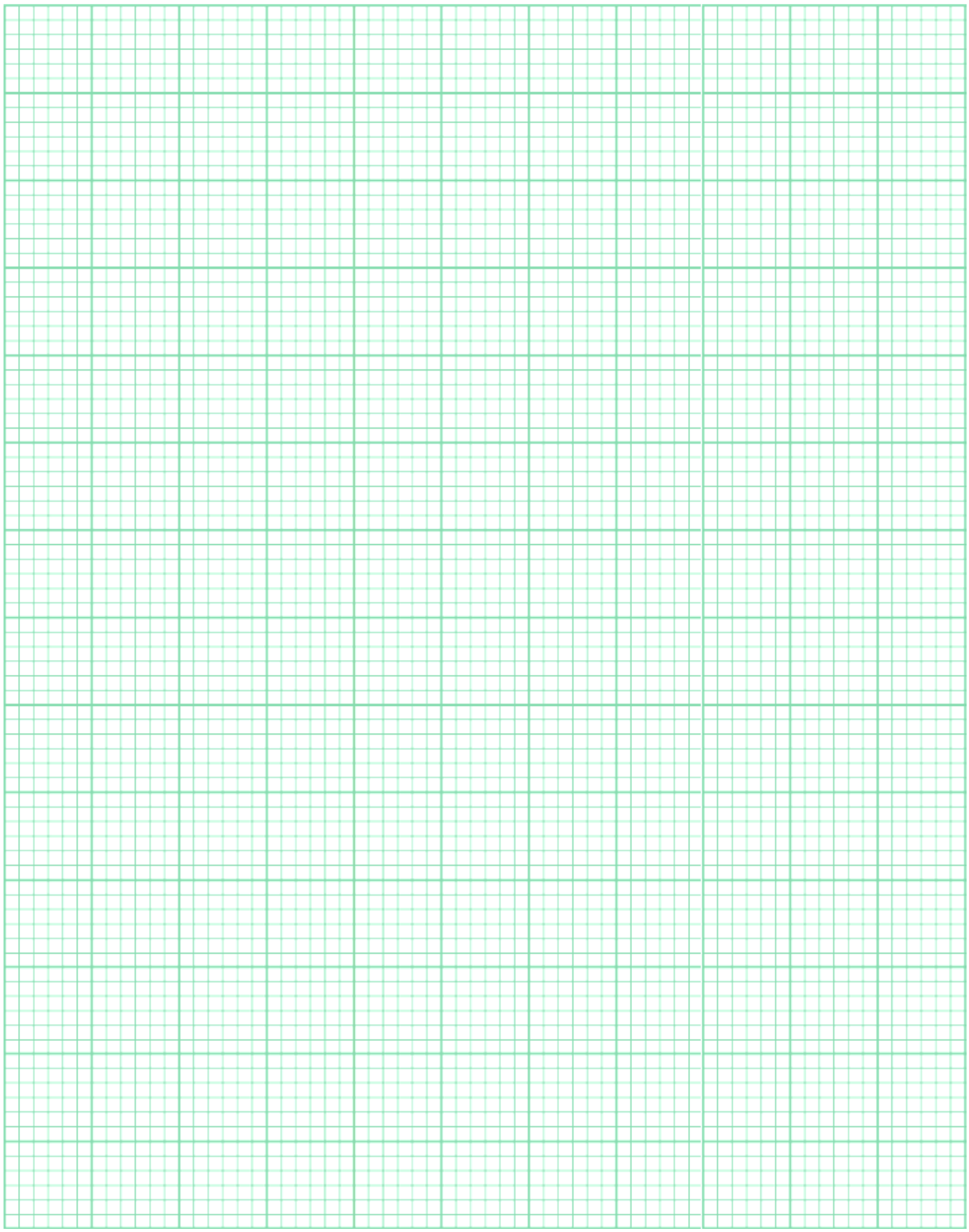
Readings :

Sno	Voltmeter Reading V (volts)	Ammeter Reading I (amps)	Wattmeter Reading P (watts)	Cos ϕ = P / (VI)	Sin ϕ	Idle Component of Current = I Sin ϕ (amps)	Energy Component of Current = I Cos ϕ (amps)
1							
2							
3							
4							

WORKSHEET

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Graph :



WORKSHEET

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Inference and Interpretation :

WORKSHEET

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	
	B	Using correct range of Voltmeters, Ammeter and Wattmeter.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the inductive load used.	4	
	B	Adjusting the range of meters to read the voltages and current accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the voltage gradually to the RL Series Circuit without over loading.	5	
	B	Recording the values of voltage, current and power from the meters.	5	
	C	Calculating the power factor from the readings of voltage, current and power.	5	
	D	Calculating the idle component of current from the readings of voltage, current and power.	5	
	E	Calculating the energy component of current from the readings of voltage, current and power.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Procedure :

WORKSHEET

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

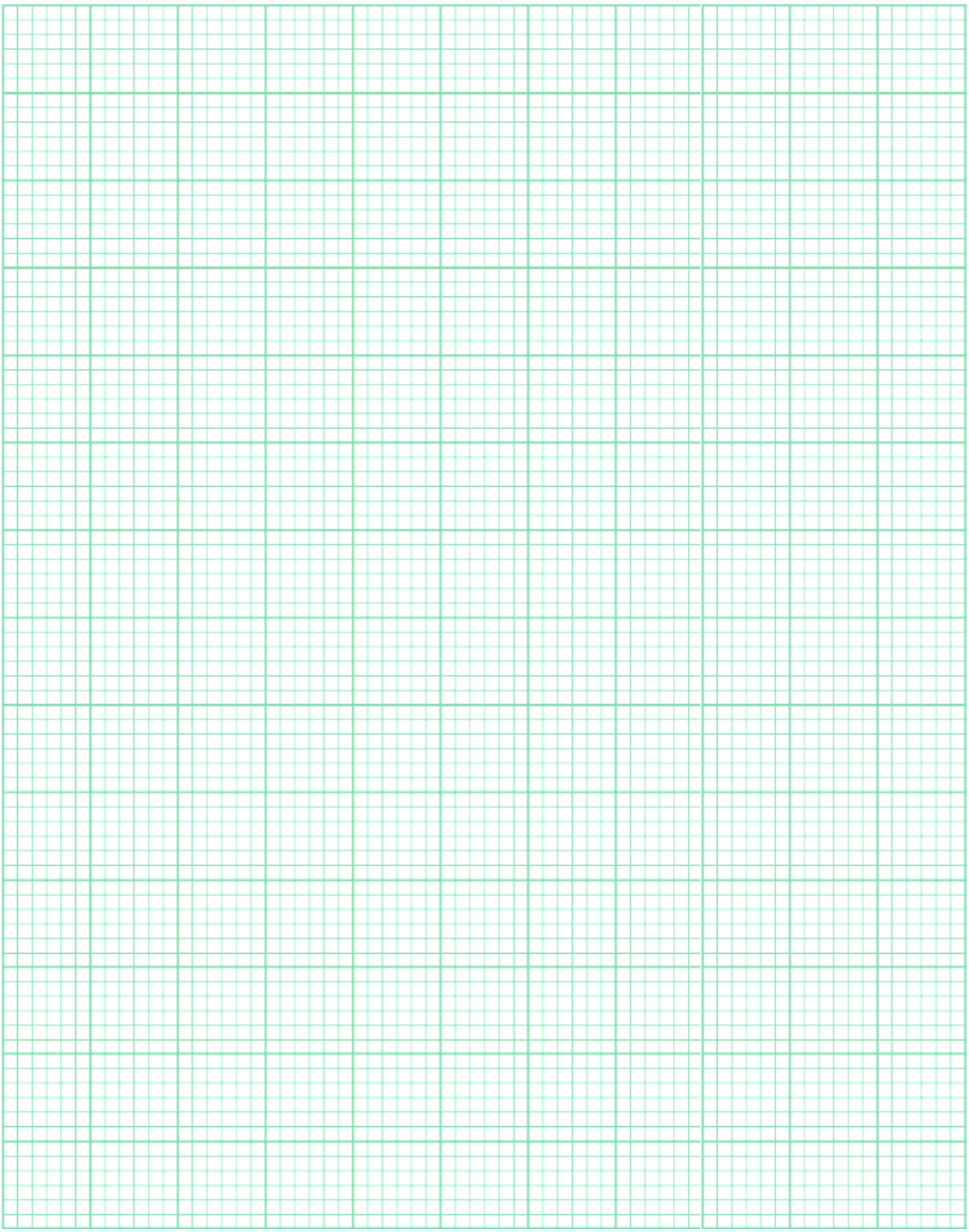
Readings :

Resistance of the Rheostat =_____ohms					
Sno	**Ammeter Reading (amps)**	**Voltmeter-1 Reading (volts)**	**Voltmeter-2 Reading (volts)**	**Voltmeter-3 Reading (volts)**	**Power consumed by the RL load (watts)**
1					
2					
3					
4					

WORKSHEET

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Graph :



WORKSHEET

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Inference and Interpretation :

WORKSHEET

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	
	B	Using correct range of Voltmeters and Ammeter.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the rheostat used.	4	
	B	Adjusting the range of meters to read the voltages and current accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the voltage gradually to the RL Series Circuit without over loading.	5	
	B	Recording the values of three voltages and one current from the meters.	5	
	C	Calculating the active power from the voltmeters readings and the value of resistance of the rheostat.	5	
	D	Calculating the power factor from the voltmeters readings and the value of resistance of the rheostat.	5	
	E	Calculating the reactive power of circuit.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Procedure :

WORKSHEET

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

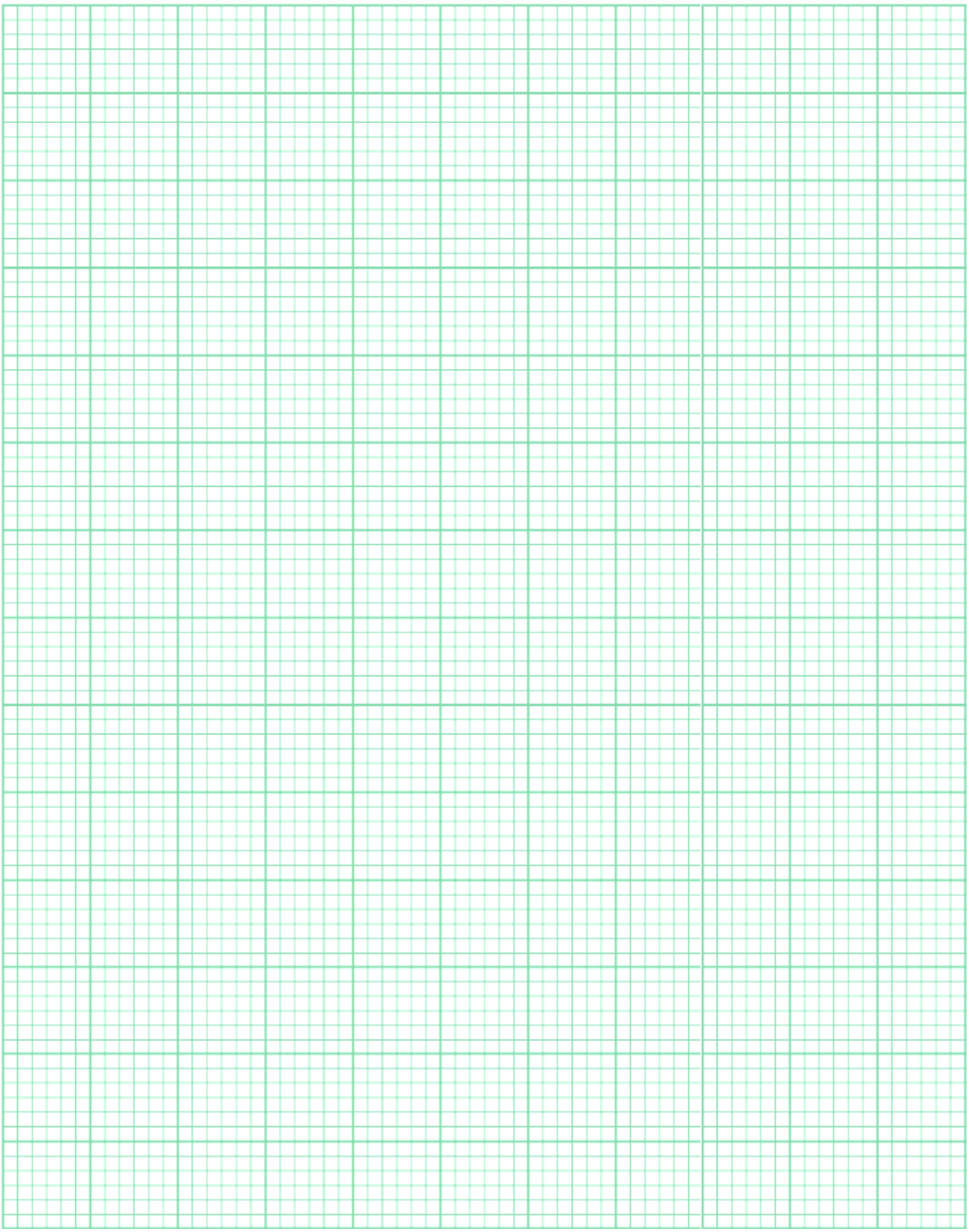
Readings :

Resistance of the Rheostat =_____ohms					
Sno	**Voltmeter Reading (volts)**	**Ammeter-1 Reading (amps)**	**Ammeter-2 Reading (amps)**	**Ammeter-3 Reading (amps)**	**Power consumed by the RL load (watts)**
1					
2					
3					
4					

WORKSHEET

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Graph :



WORKSHEET

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Inference and Interpretation :

WORKSHEET

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	
	B	Using correct range of Voltmeter and Ammeters.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the rheostat used.	4	
	B	Adjusting the range of meters to read the voltage and, currents accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the voltage gradually to the RL Parallel Circuit without over loading.	5	
	B	Recording the values of three currents and one voltage from the meters.	5	
	C	Calculating the active power from the ammeters readings and the value of resistance of the rheostat.	5	
	D	Calculating the power factor from the ammeters readings and the value of resistance of the rheostat.	5	
	E	Calculating the reactive power of circuit.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

WORKSHEET

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Name of the student :	Date of the experiment
PIN :	
Institution :	

Objective of the experiment :

Apparatus Required :

Sno	Apparatus Name	Specifications	Quantity
1			
2			
3			
4			
5			
6			

Circuit Diagram :

WORKSHEET

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Procedure :

WORKSHEET

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

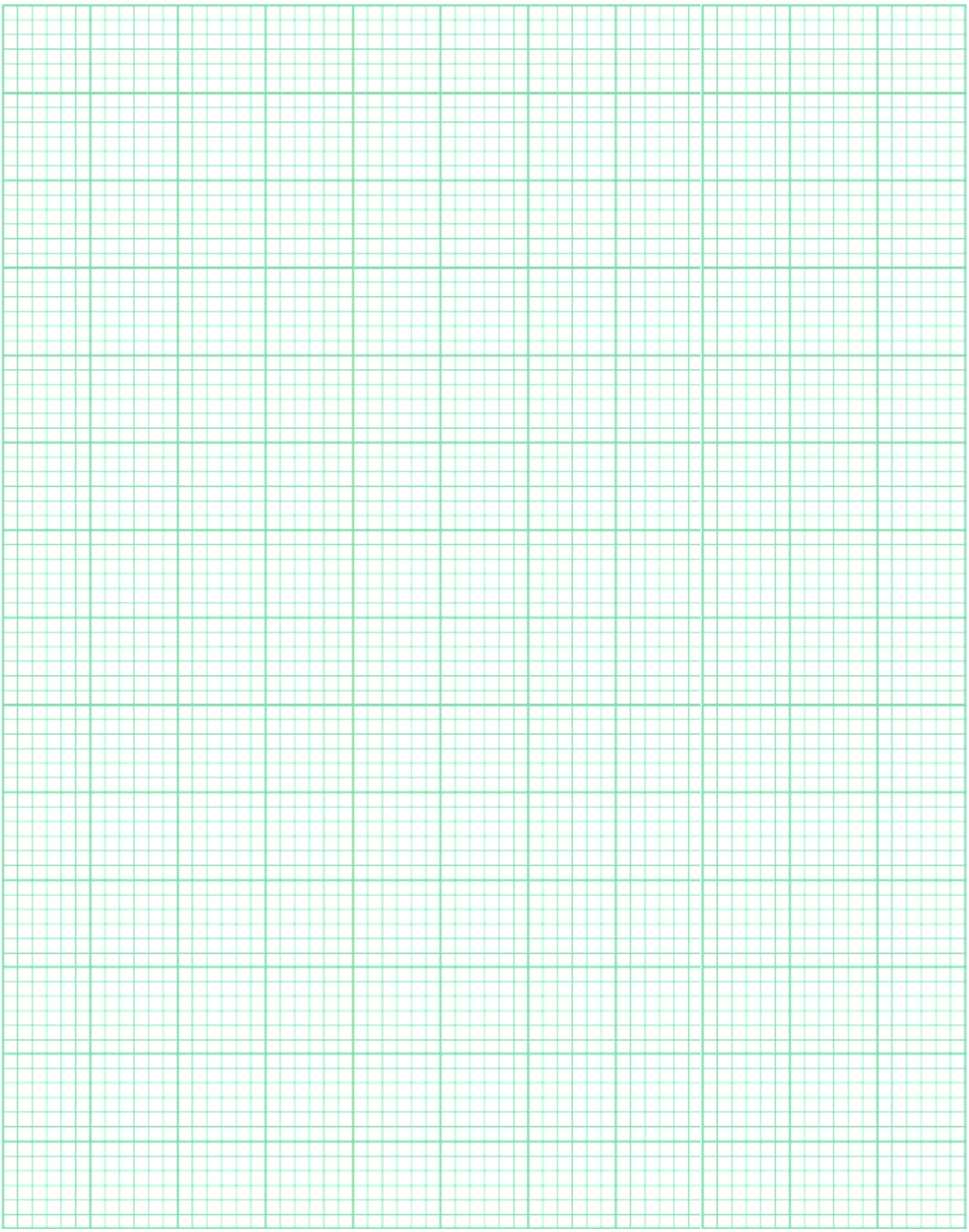
Readings :

Sno	Voltmeter Reading (volts)	Ammeter Reading (amps)	Wattmeter-1 Reading (watts)	Wattmeter-2 Reading (watts)	Active Power of the load (watts)	Power factor of the load	Reactive Power of the load (var)
1							
2							
3							
4							

WORKSHEET

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Graph :



WORKSHEET

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Inference and Interpretation :

WORKSHEET

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Scheme of Evaluation :

Category of Skill	Sub Task		Individual Competency Level Weightage	Marks Awarded
Handling of Apparatus	A	Drawing circuit diagram and identifying various terminals of the measuring instruments.	5	
	B	Using correct range of Voltmeter, Ammeter and Wattmeters.	3	
	C	Setting the auto-transformer to its initial position.	2	
Manipulation of Apparatus	A	Acquiring the name plate details of the three phase load used.	4	
	B	Adjusting the range of meters to read the voltage, current and powers accurately.	4	
	C	Setting up the trip circuit to protect the experimental set up from over loading.	2	
Precise Operations / Activities	A	Applying the voltage gradually to the three phase load without over loading.	5	
	B	Recording the values of one voltage, one current and two powers from the meters.	5	
	C	Calculating the active power from the readings of two wattmeters.	5	
	D	Calculating the power factor from the readings of two wattmeters.	5	
	E	Calculating the reactive power from the readings of two wattmeters.	5	
Values	A	Co-Operation	1	
	B	Co-Ordination	1	
	C	Communication	1	
	D	Sharing	1	
	E	Leadership	1	
Total Marks			**50**	

Signature of the Lab in-charge

C20 – EE310

ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB

Experimental Methodologies

SBTET, AP

Sno	Experiment Title	Date of Experiment	Page Number
1	**Verification of Ohm's Law and limitations of Ohm's Law**		1
2	**Verification of Kirchhoff's Voltage Law and Current Law**		5
3	**Verification of Super Position Theorem**		9
4	**Verification of Thevenin's Theorem**		13
5	**Verification of Maximum Power Transfer Theorem**		17
6	**Calibration of Dynamometer type Wattmeter**		21
7	**Calibration of Single Phase Induction type Energymeter**		25
8	**Determination of Q-factor and Power factor of an Inductive Coil**		29
9	**Determination of Idle & Energy components of Current in a Single Phase Inductive Circuit**		33
10	**Measurement of Power in Single Phase circuit by 3-Voltmeter method**		37
11	**Measurement of Power in Single Phase circuit by 3-Ammeter method**		41
12	**Measurement of Power in Three Phase Balanced circuit by 2-Wattmeter method**		45

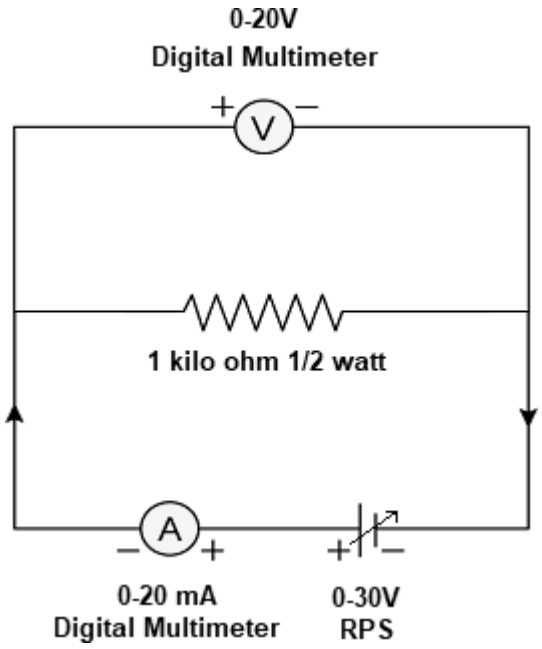
EXPERIMENTAL METHODOLOGY

1. Verification of Ohm's Law and Limitations of Ohm's Law

Objective of the experiment : To verify the Ohm's Law and the limitations of it.

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	1
2	Digital Multimeter	DCV: 200mV - 2000mV - 20V - 200V - 1000V DCA: 20uA - 2000uA - 20mA - 200mA - 10A R: 200 ohm - 2000 ohm - 20K - 200K - 2000K	2
3	Resistor	1 kilo ohm, 1 watt	1
4	Breadboard		1
5	Connecting Wires	100 mA	Required number

Circuit Diagram :



EXPERIMENTAL METHODOLOGY

1. Verification of Ohm's Law and Limitations of Ohm's Law

Theory :

Ohm's Law:

- At constant temperature, current passing through a resistor is directly proportional to the voltage applied across that resistor.
- i.e. when Temperature = Constant, Current a Voltage.
- Voltage / Current = Constant
- The ratio of Voltage to Current is called as Resistance.

Limitations of Ohm's Law:

- If the temperature is variable, then Ohm's law will not be applicable.
- Ohm's law is not applicable for unilateral electrical elements like diodes and transistors as they allow the current to flow through in one direction only.
- For non-linear electrical elements with parameters like capacitance, resistance etc the voltage and current won't be constant with respect to time making it difficult to use Ohm's law.

Procedure :

Ohm's Law:

- Constructs the circuit as per the circuit diagram.
- Keeps the temperature constant.
- Applies voltage in steps to the resistor.
- Observes the values of voltage and current at each step.
- Plots the graph between voltage and current.
- Calculates the slope of the curve which gives rise to resistance.

Limitations of Ohm's Law:

- Constructs the circuit as per the circuit diagram.
- Varies the temperature with the help of a heating element.
- Applies voltage to the resistor.
- Observes the values of voltage and current at each value of temperature.
- Plots the graph between voltage and current.
- Observes and infers the difference between the graphs which are drawn with constant temperature and without constant temperature.

EXPERIMENTAL METHODOLOGY

1. Verification of Ohm's Law and Limitations of Ohm's Law

Observations :

when the temperature is kept constant			
Sno	**Voltage applied across the resistor (volts)**	**Current passing through the Resistor (amps)**	**Resistance (ohms)**
1			
2			
3			
4			
when the temperature is varied			
Sno	**Voltage applied across the resistor (volts)**	**Current passing through the Resistor (amps)**	**Resistance (ohms)**
1			
2			
3			
4			

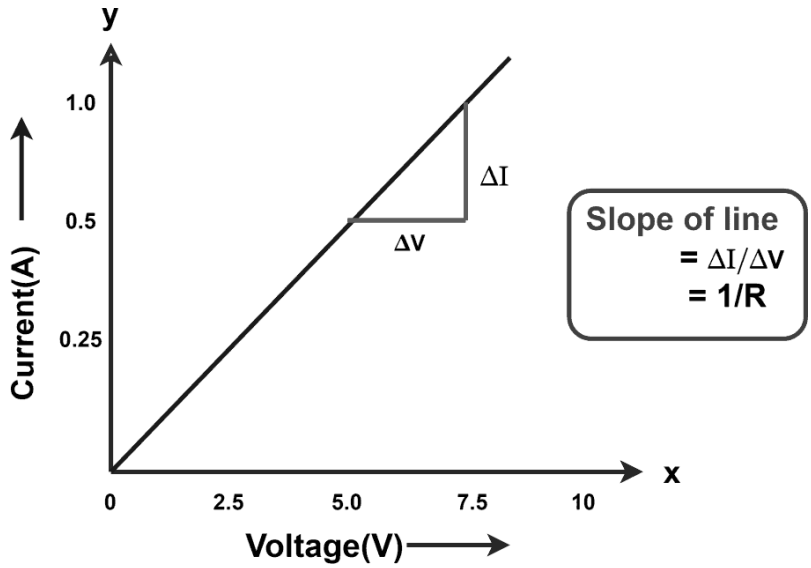
Specimen Calculations :

Resistance = Voltage / Current ohms

EXPERIMENTAL METHODOLOGY

1. Verification of Ohm's Law and Limitations of Ohm's Law

Model Graphs :



Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

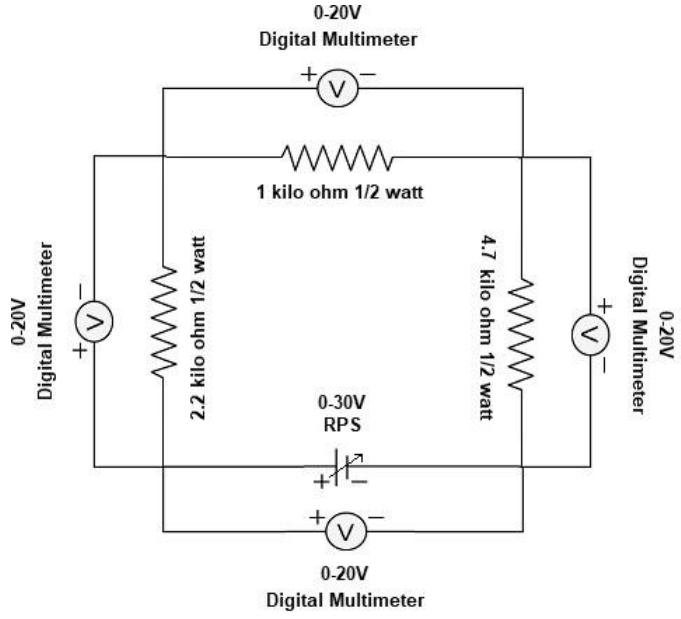
EXPERIMENTAL METHODOLOGY

2. Verification of Kirchhoff's Voltage Law and Current Law

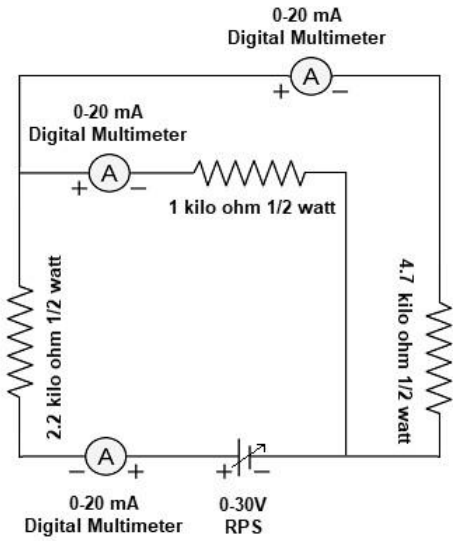
Objective of the experiment : To verify Kirchhoff's Voltage Law and Current Law in the DC Circuit.

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	1
2	Digital Multimeter	DCV: 200mV - 2000mV - 20V - 200V - 1000V DCA: 20uA - 2000uA - 20mA - 200mA - 10A R: 200 ohm - 2000 ohm - 20K - 200K - 2000K	4
3	Resistor	1 kilo ohm, ½ watt 2.2 kilo ohm, ½ watt 4.7 kilo ohm, ½ watt	1 1 1
4	Breadboard		1
5	Connecting Wires	100 mA	Required number

Circuit Diagram :



Kirchhoff's Voltage Law



Kirchhoff's Current Law

2. Verification of Kirchhoff's Voltage Law and Current Law

Theory :

Kirchhoff's Voltage Law:

- In a closed loop, sum of the voltages is zero.
- i.e. in the closed loop, sum of the voltage sources is equal to the sum of voltage drops.
- RPS Output Voltage + V1 + V2 + V3 = 0.

Kirchhoff's Current Law:

- At a node, sum of the currents is zero.
- i.e. at the node, sum of the incoming currents is equal to the sum of the outgoing currents.
- I1 + I2 + I3 = 0.

Procedure :

Kirchhoff's Voltage Law:

- Constructs the circuit as per the circuit diagram.
- Applies power supply to the circuit.
- Observes and tabulates the values of voltages across the each element in the circuit.
- Calculates the sum of voltages and checks the resultant is zero or not.

Kirchhoff's Current Law:

- Constructs the circuit as per the circuit diagram.
- Applies power supply to the circuit.
- Observes and tabulates the values of currents passing through the each element in the circuit.
- Calculates the sum of currents and checks the resultant is zero or not.

2. Verification of Kirchhoff's Voltage Law and Current Law

Observations :

Kirchhoff's Voltage Law			
Voltage across Resistor - 1 (volts)	**Voltage across Resistor - 2 (volts)**	**Voltage across Resistor - 3 (volts)**	**RPS Output Voltage (volts)**

Sum of the voltages =

Kirchhoff's Current Law			
Current in Resistor - 1 (amps)	**Current in Resistor - 2 (amps)**	**Current in Resistor - 3 (amps)**	**Sum of the Currents (amps)**

Specimen Calculations :

- Kirchhoff's Voltage Law

  RPS Output Voltage + V1 + V2 + V3 = 0

- Kirchhoff's Current Law

  I1 + I2 + I3 = 0

EXPERIMENTAL METHODOLOGY

2. Verification of Kirchhoff's Voltage Law and Current Law

Model Graphs :

No graph is required.

Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

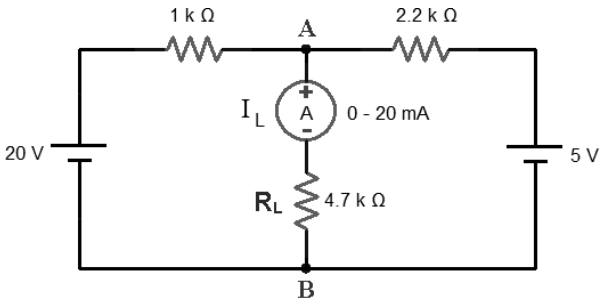
EXPERIMENTAL METHODOLOGY

3. Verification of Super Position Theorem

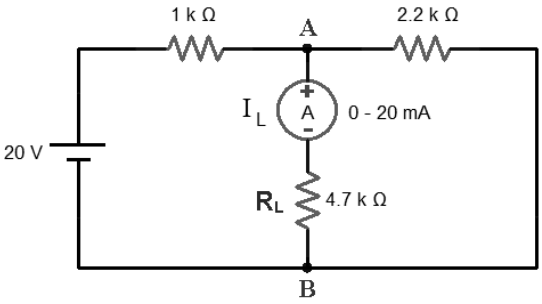
Objective of the experiment : To verify the Super Position Theorem in a DC Circuit.

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	2
2	Digital Multimeter	DCV: 200mV - 2000mV - 20V - 200V - 1000V DCA: 20uA - 2000uA - 20mA - 200mA - 10A R: 200 ohm - 2000 ohm - 20K - 200K - 2000K	3
3	Resistor	1 kilo ohm, ½ watt 2.2 kilo ohm, ½ watt 4.7 kilo ohm, ½ watt	1 1 1
4	Breadboard		1
5	Connecting Wires	100 mA	Required number

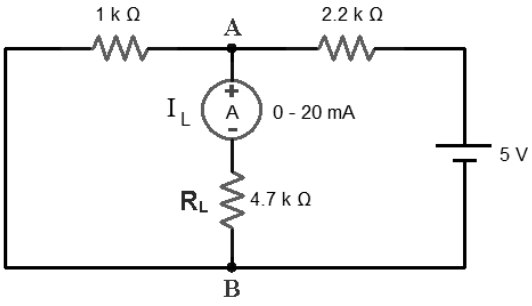
Circuit Diagram :



when both the sources 20 V and 5 V are connected



when only 20 V source is connected



when only 5 V source is connected

EXPERIMENTAL METHODOLOGY

3. Verification of Super Position Theorem

Theory :

- In any linear, bilateral multisource network the response (voltage or current) in any element is equal to the algebraic sum of the responses caused by each source acting alone while all other independent sources are replaced by their internal impedances.

- If the internal impedances of the sources are unknown then the independent voltage sources must be replaced by short circuit while the independent current sources must be replaced by an open circuit.

- The suspension theorem does not apply to the power as power is proportional to square of the current, which is not a linear function.

Procedure :

- Make the connections as per circuit diagram
- Switch 'ON' the supply.
- Adjust the output voltage of sources 'X' and 'Y' to 20 V and 5 V respectively
- Note down the Current I_L through the branch of interest i.e. AB.
- Now set the voltage source 'X' to 20 V and source 'Y' to 0 V.
- Note down the ammeter reading (Current I_L).
- Now set the voltage source 'Y' to 5 V and source 'X' to 0 V.
- Note down the corresponding ammeter reading (Current I_L).
- Reduce the output voltage of the sources 'X' and 'Y' to 0 V and switch 'OFF' the supply.
- Disconnect the circuit.

EXPERIMENTAL METHODOLOGY

3. Verification of Super Position Theorem

Observations :

when Source-1 and Source-2 are present		
Source-1 Voltage (volts)	**Source-2 Voltage (volts)**	**Current in Load Resister (amps)**
when Source-1 only is present		
Source-1 Voltage (volts)	**Source-2 Voltage (volts)**	**Current in Load Resistor (amps)**
when Source-2 only is present		
Source-1 Voltage (volts)	**Source-2 Voltage (volts)**	**Current in Load Resistor (amps)**
Verification		
Current in Load Resister (amps) due to Source-1	**Current in Load Resister (amps) due to Source-2**	**Current in Load Resistor (amps) due to Source-1 and Source-2**

Specimen Calculations :

I_L when both sources are present = I_L when 20V source is present + I_L when 5V source is present

EXPERIMENTAL METHODOLOGY

3. Verification of Super Position Theorem

Model Graphs :

No graph is required.

Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

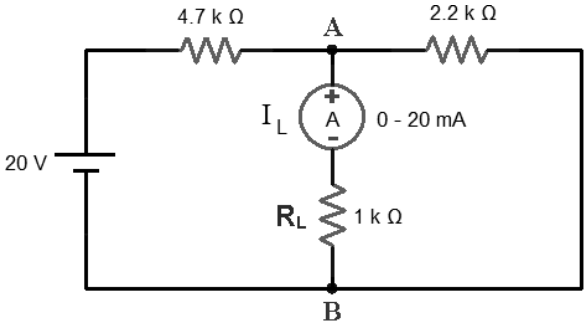
EXPERIMENTAL METHODOLOGY

4. Verification of Thevenin's Theorem

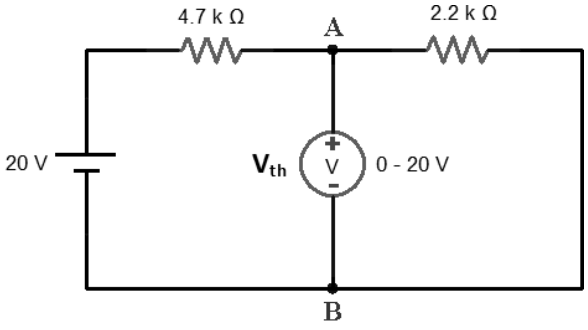
Objective of the experiment : To verify the Thevenin's Theorem in a DC Circuit.

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	1
2	Digital Multimeter	DCV: 200mV - 2000mV - 20V - 200V - 1000V DCA: 20uA - 2000uA - 20mA - 200mA - 10A R: 200 ohm - 2000 ohm - 20K - 200K - 2000K	3
3	Resistor	1 kilo ohm, ½ watt 2.2 kilo ohm, ½ watt 4.7 kilo ohm, ½ watt	1 1 1
4	Variable Resistor	10 kilo ohm, ½ watt	1
5	Breadboard		1
6	Connecting Wires	100 mA	Required number

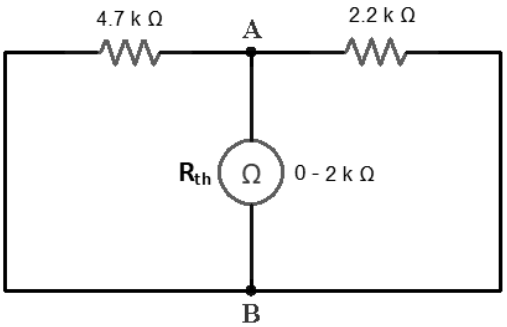
Circuit Diagram :



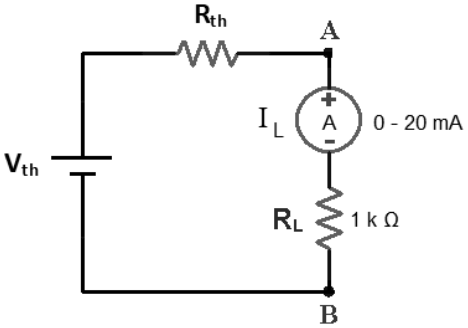
to find load current without Thevenin's theorem



to find Thevenin's Voltage



to find Thevenin's Resistance



to find load current with Thevenin's theorem

4. Verification of Thevenin's Theorem

Theory :

- Thevenin's Theorem states that any linear, active network with two open terminals can be replaced by an equivalent circuit consists of Thevenin's equivalent voltage source Vth in series with Thevenin's equivalent resistance R_{th}.
- To find a current I_L through load resistance R_L connected in a linear network, the following steps are followed…
- Step-1 : Find V_{th} across load terminals by removing R_L.
- Step-2 : Find R_{th} across load terminals by removing R_L and replacing the Voltage Source with a short circuit.
- Step-3 : Find the load current I_L by dividing the V_{th} with the sum of R_{th} and R_L.

Procedure :

- Connects the circuit as per the circuit diagram to find load current without Thevenin's theorem.
- Switches ON the power supply.
- Adjusts the output voltage of the RPS to 20 V
- Notes down the Current I_L through the branch of interest i.e. AB.
- Reduces the RPS output voltage to 0 V and Switches OFF the power supply.
- Disconnects the circuit and connects as per the circuit diagram to find Thevenin's Voltage.
- Adjusts the RPS output voltage to 20 V.
- Notes down the voltage across the load terminals A and B that gives V_{th}.
- Reduces the RPS output voltage to 0 V and Switches OFF the power supply.
- Disconnects the circuit and connects as per the circuit diagram to find Thevenin's Resistance.
- Notes down the ohmmeter reading across the load terminals A and B that gives R_{th}.
- Reduces the RPS output voltage to 0 V and Switches OFF the power supply.
- Disconnects the circuit and connects as per the circuit diagram to find load current with Thevenin's theorem.
- Adjusts the RPS output voltage to the Thevenin's Voltage Vth.
- Notes down the Current I_L through the branch of interest i.e. AB.
- Reduces the RPS output voltage to 0 V and Switches OFF the power supply.
- Disconnects the circuit.

EXPERIMENTAL METHODOLOGY

4. Verification of Thevenin's Theorem

Observations :

Before applying Thevenin's theorem	
Source Voltage (volts)	**Current in Load Resister (amps)**
After applying Thevenin's theorem	
Thevenin's Voltage (volts)	**Thevenin's Resistance (ohms)**

Verification			
Thevenin's Voltage (volts)	**Thevenin's Resistance (ohms)**	**Load Resistance (ohms)**	**Current in Load Resistor (amps)**

Specimen Calculations :

Before applying Thevenin's Theorem,

$$I_L = \left[\frac{20}{4.7 + \left(\frac{1 \times 2.2}{1 + 2.2}\right)}\right] \times \left(\frac{2.2}{1 + 2.2}\right)$$

After applying Thevenin's Theorem,

$$I_L = \left[\frac{V_{th}}{R_{th} + R_L}\right]$$

EXPERIMENTAL METHODOLOGY

4. Verification of Thevenin's Theorem

Model Graphs :

No graph is required.

Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

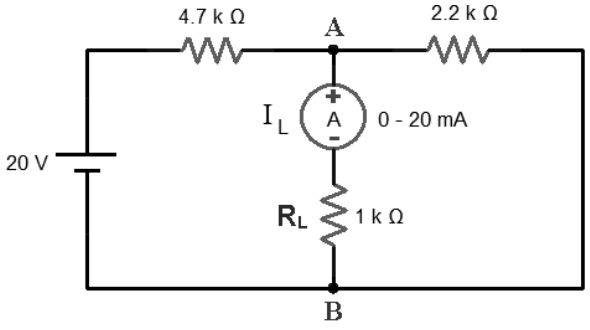
EXPERIMENTAL METHODOLOGY

5. Verification of Maximum Power Transfer Theorem

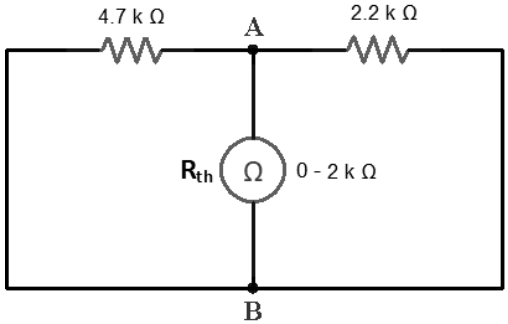
Objective of the experiment : To verify the Maximum Power Transfer Theorem in a DC Circuit.

Sno	Apparatus Name	Specifications	Quantity
1	Regulated Power Supply	0-30V, 1 A	1
2	Digital Multimeter	DCV: 200mV - 2000mV - 20V - 200V - 1000V DCA: 20uA - 2000uA - 20mA - 200mA - 10A R: 200 ohm - 2000 ohm - 20K - 200K - 2000K	3
3	Resistor	1 kilo ohm, ½ watt 2.2 kilo ohm, ½ watt 4.7 kilo ohm, ½ watt	1 1 1
4	Variable Resistor	10 kilo ohm, ½ watt	2
5	Breadboard		1
6	Connecting Wires	100 mA	Required number

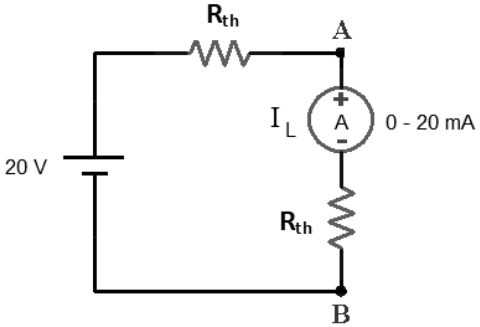
Circuit Diagram :



to find the power transferred to the load resistor R_L



to find Thevenin's Resistance



to find the maximum power transferred by the source

5. Verification of Maximum Power Transfer Theorem

Theory :

- The maximum power transfer theorem states that, to obtain maximum external power from a source with a finite internal resistance, the resistance of the load must equal the resistance of the source as viewed from its output terminals.
- To find the amount of maximum power that can be transferred by a source, the following steps are followed…
- Step-1 : Find the Thevenin's Resistance R_{th} across the load terminals by removing R_L and replacing the Voltage Source with a short circuit.
- Step-2 : Find the load current I_L by dividing the Source Voltage with the $2R_{th}$.
- Step-3 : Find the maximum power transferred as $I_L^2 R_{th}$.

Procedure :

- Connects the circuit as per the circuit diagram to find power transferred to the load resistor R_L.
- Switches ON the power supply.
- Adjusts the output voltage of the RPS to 20 V.
- Notes down the Current I_L through the branch of interest i.e. AB.
- Calculate the power transferred to the load resistor R_L.
- Reduces the RPS output voltage to 0 V and Switches OFF the power supply.
- Disconnects the circuit and connects as per the circuit diagram to find Thevenin's Resistance.
- Notes down the ohmmeter reading across the load terminals A and B that gives R_{th}.
- Reduces the RPS output voltage to 0 V and Switches OFF the power supply.
- Disconnects the circuit and connects as per the circuit diagram to find maximum power transferred by the source.
- Adjusts the output voltage of the RPS to 20 V.
- Notes down the Current I_L through the branch of interest i.e. AB.
- Calculate the maximum power transferred by the source to the new load resistor R_{th}.
- Reduces the RPS output voltage to 0 V and Switches OFF the power supply.
- Disconnects the circuit.

5. Verification of Maximum Power Transfer Theorem

Observations :

Before applying Maximum Power Transfer theorem			
Source Voltage (volts)	**Current in Load Resistor (amps)**	**Actual Load Resistance (ohms)**	**Power in Load Resistance (watts)**

After applying Maximum Power Transfer theorem			
Thevenin's Voltage (volts)	**Thevenin's Resistance (ohms)**	**Load Resistance equal to Thevenin's Resistance (ohms)**	**Maximum Power transferred to Load Resistance (watts)**

Specimen Calculations :

Power transferred to the Load Resistance of 1 kilo ohm,

$$_{L} = \left[\frac{20}{4.7 + \left(\frac{1 \times 2.2}{1+2.2}\right)}\right] \times \left(\frac{2.2}{1+2.2}\right) \text{ amps}$$

$$Power\ transferred = {I_L}^2 \times (1 \times 10^3) \text{ watts}$$

After replacing Load Resistance with Thevenin's Resistance,

$$I_L = \left[\frac{20}{2 \times R_{th}}\right] \text{ amps}$$

$$Maximum\ Power\ transferred = {I_L}^2\ R_{th} \text{ watts}$$

5. Verification of Maximum Power Transfer Theorem

Model Graphs :

No graph is required

Precautions :

1. Disconnecting the Regulated Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements.

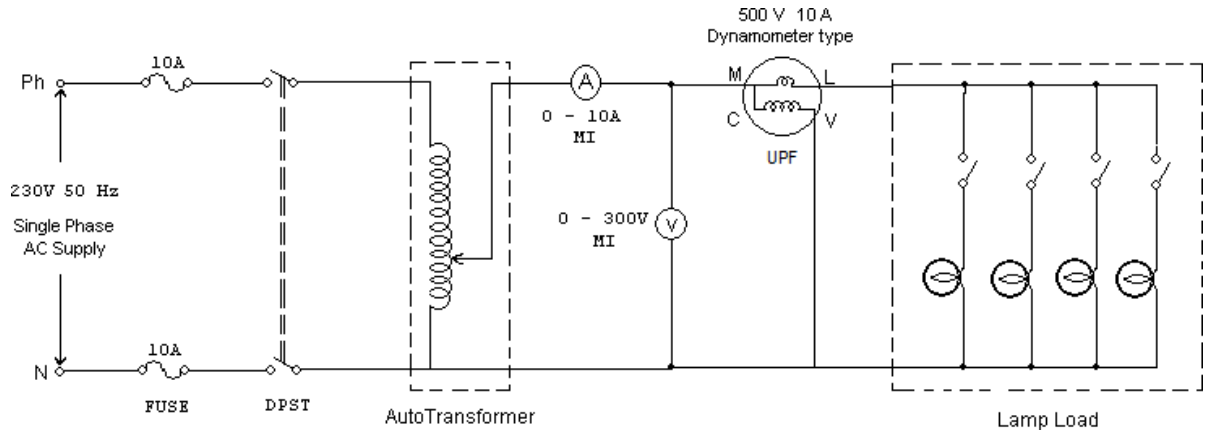
EXPERIMENTAL METHODOLOGY

6. Calibration of Dynamometer type Wattmeter

Objective of the experiment : To calibrate the given Dynamometer type Wattmeter.

Sno	Apparatus Name	Specifications	Quantity
1	Dynamometer type Wattmeter	1-Phase 500V 10A UPF	1
2	Moving Iron Voltmeter	1-Phase 0-300V	1
3	Moving Iron Ammeter	1-Phase 0-10A	1
4	Incandescent Lamp Load / Rheostatic Load	1-Phase 300V 0-10A	1
5	Connecting Wires	300V 10A	Required Number

Circuit Diagram :



6. Calibration of Dynamometer type Wattmeter

Theory :

- Calibration is a comparison between a known measurement (the standard) and the measurement using the instrument being tested.
- Typically, the accuracy of the standard should be ten times the accuracy of the measuring device being tested.
- Calibration of measuring instruments has two objectives: it checks the accuracy of the instrument and it determines the traceability of the measurement.
- In practice, calibration also includes repair of the device if it is out of calibration.
- A report is provided by the calibration expert, which shows the error in measurements with the measuring device before and after the calibration.

Procedure :

- Constructs the circuit as per the circuit diagram.
- Turns OFF all the loads initially.
- Connects the power supply and reads the initial readings.
- Turns ON the loads one by one.
- Checks the current drawn by the load is within the safe limit.
- If so, Notes down the readings of Voltmeter, Ammeter and Wattmeter at every loading condition.
- Repeats the above three steps till the current reaches the maximum load current.
- Turns OFF all the loads one by one.
- Turns OFF the power supply to the circuit.
- Disconnects the circuit.
- Performs the calculation to get percentage error at different loading conditions.

6. Calibration of Dynamometer type Wattmeter

Observations :

Sno	Voltage applied across the lamp load V (volts)	Current passing through the lamp load I (amps)	Power measured by the Wattmeter W (watts)	Power measured by the Voltmeter and Ammeter Setup P = VI (watts)	Error E = P- W (watts)	% Error % E = Ex100 / P
1						
2						
3						
4						
5						
6						
7						
8						

Specimen Calculations :

Power measured by the Voltmeter and Ammeter Setup (P) = VI watts

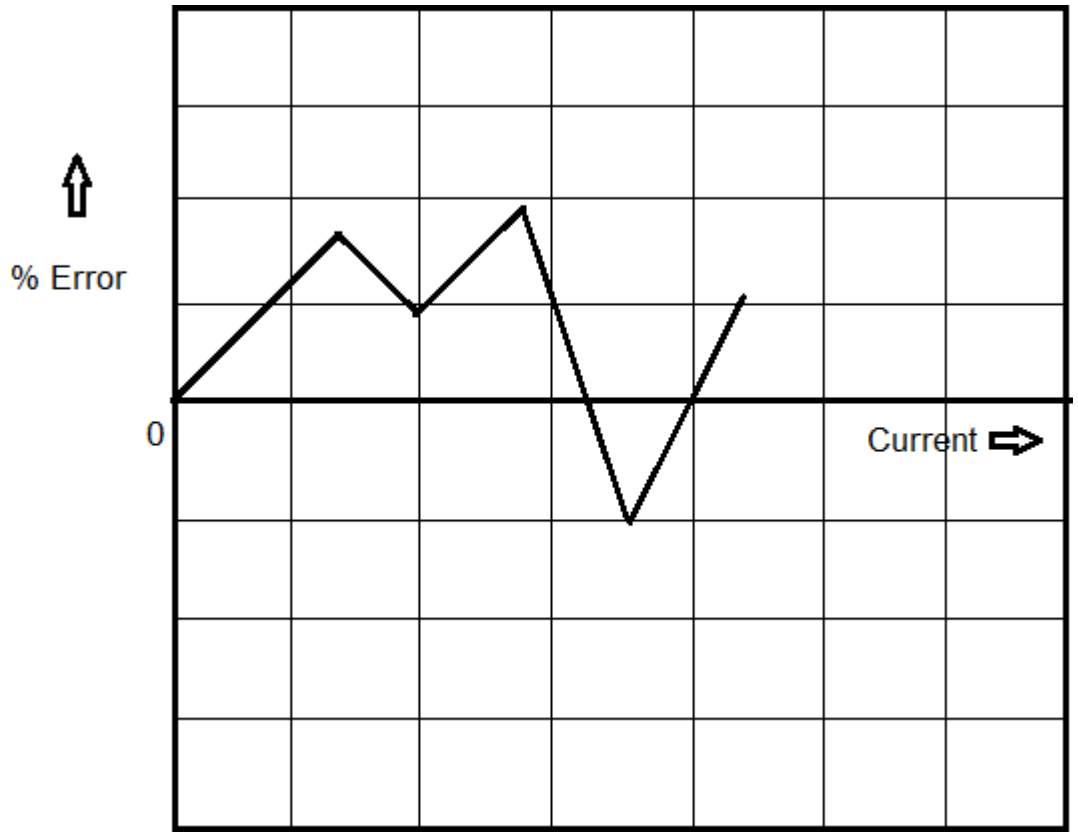
Power measured by the Wattmeter = W watts

Error (E) = P-W watts

% Error = (Ex100) / P

6. Calibration of Dynamometer type Wattmeter

Model Graphs :



Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

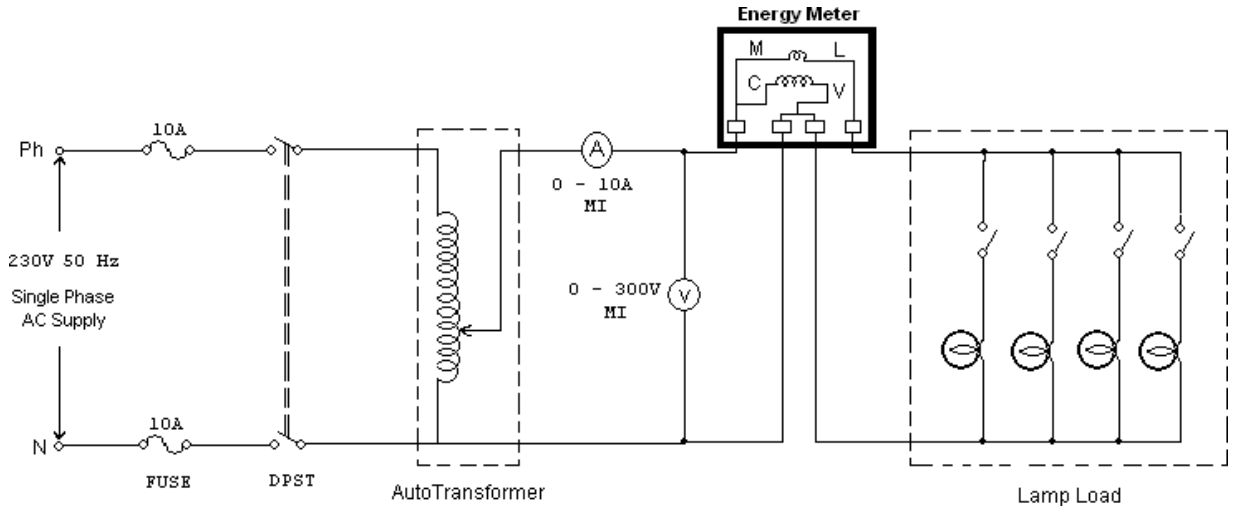
EXPERIMENTAL METHODOLOGY

7. Calibration of Single Phase Induction type Energymeter

Objective of the experiment : To calibrate the given Single Phase Induction type Energymeter.

Sno	Apparatus Name	Specifications	Quantity
1	Single Phase Induction type Energymeter	1-Phase 300V 25A	1
2	Moving Iron Voltmeter	1-Phase 0-300V	1
3	Moving Iron Ammeter	1-Phase 0-10A	1
4	Incandescent Lamp Load / Rheostatic Load	1-Phase 300V 0-10A	1
5	Connecting Wires	300V 10A	Required Number
6	Stop Watch	with minutes and seconds counter	1

Circuit Diagram :



7. Calibration of Single Phase Induction type Energymeter

Theory :

- Calibration is a comparison between a known measurement (the standard) and the measurement using the instrument being tested.
- Typically, the accuracy of the standard should be ten times the accuracy of the measuring device being tested.
- Calibration of measuring instruments has two objectives: it checks the accuracy of the instrument and it determines the traceability of the measurement.
- In practice, calibration also includes repair of the device if it is out of calibration.
- A report is provided by the calibration expert, which shows the error in measurements with the measuring device before and after the calibration.

Procedure :

- Constructs the circuit as per the circuit diagram.
- Turns OFF all the loads initially.
- Connects the power supply and reads the initial readings.
- Turns ON the loads one by one.
- Checks the current drawn by the load is within the safe limit.
- If so, Notes down the readings of Voltmeter, Ammeter and Timer for 'N' revolutions of Disc in the Energymeter, at every loading condition.
- Repeats the above three steps till the current reaches the maximum load current.
- Turns OFF all the loads one by one.
- Turns OFF the power supply to the circuit.
- Disconnects the circuit.
- Performs the calculation to get percentage error at different loading conditions.

7. Calibration of Single Phase Induction type Energymeter

Observations :

Meter Constant (M) = revolutions / unit							
Sno	**Voltage applied across the lamp load V (volts)**	**Current passing through the lamp load I (amps)**	**Time taken by the disc to complete ——(N) revolutions T (sec)**	**Energy measured by the Voltmeter and Ammeter Setup Et = VIT / (3600X1000) (kWh)**	**Energy measured by the Energymeter Em = M/N (kWh)**	**Error E = $E_S - E_m$ (kWh)**	**% Error % E = Ex100 / E_S**
1							
2							
3							
4							
5							
6							

Specimen Calculations :

Energy measured by the Voltmeter, Ammeter and Timer Setup (E_S) = (VIT) / (3600 x 1000) kWh

Meter Constant of the Energymeter = M

Considered Number revolutions made by the disc of the Energymeter = N

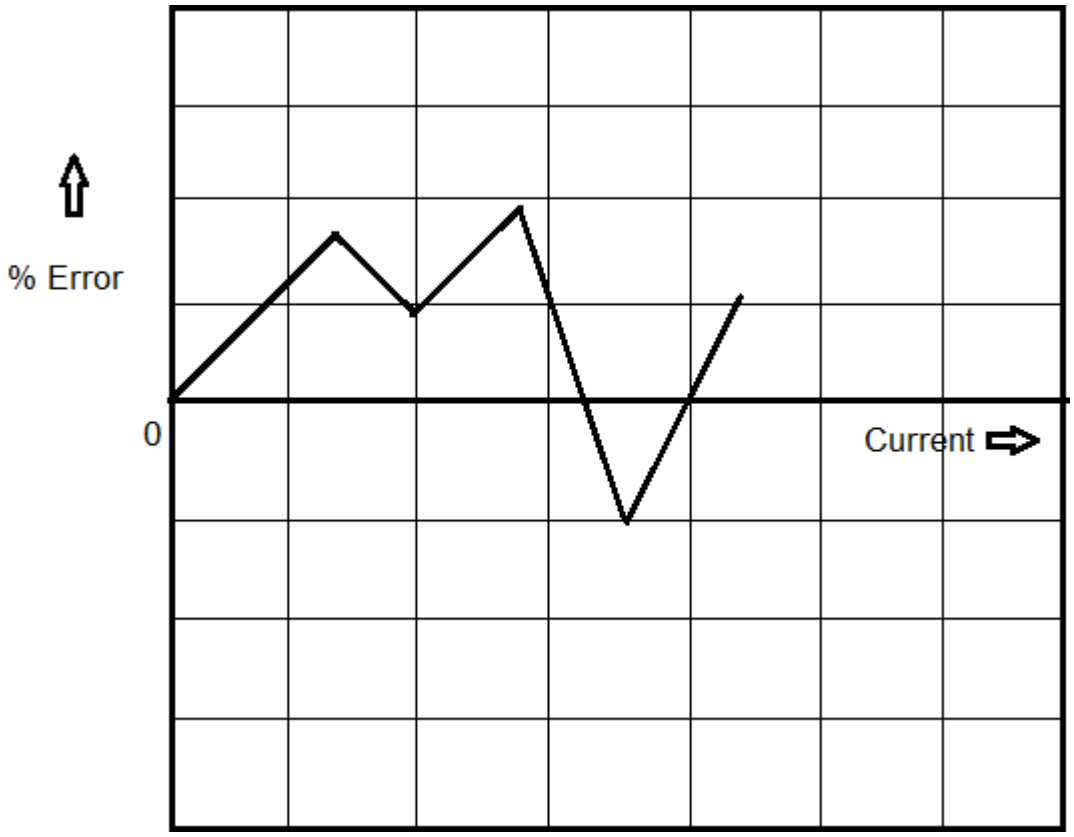
Energy measured by the Energymeter (E_m) = M / N kWh

Error (E) = $E_S - E_m$ kWh

% Error = (Ex100) / E_S

7. Calibration of Single Phase Induction type Energymeter

Model Graphs :



Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

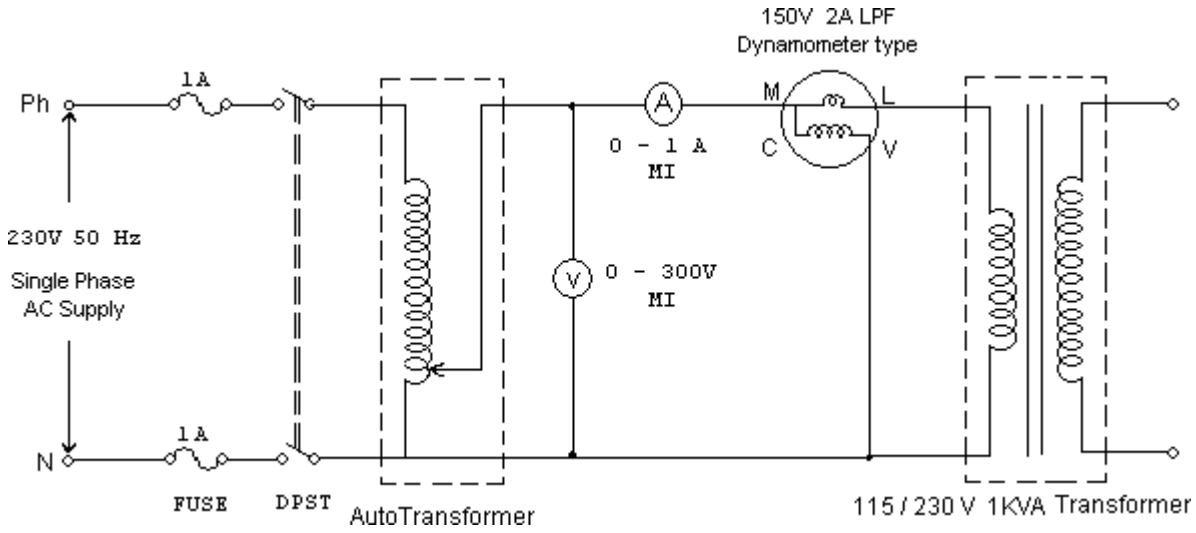
EXPERIMENTAL METHODOLOGY

8. Determination of Q-factor and Power factor of an Inductive Coil

Objective of the experiment : To determine the Quality factor and Power factor of a Single Phase Inductive Coil.

Sno	Apparatus Name	Specifications	Quantity
1	Dynamometer type Wattmeter	1-Phase 150V 2A LPF	1
2	Moving Iron Voltmeter	1-Phase 0-300V	1
3	Moving Iron Ammeter	1-Phase 0-1A	1
4	Single Phase Transformer as Inductive Load	115 / 230 V 1 kVA	1
5	Single Phase Auto-Transformer	0-270V 2KVA	1
6	Connecting Wires	500V 5A	Required Number

Circuit Diagram :



8. Determination of Q-factor and Power factor of an Inductive Coil

Theory :

- Quality factor:

  The quality factor *Q* for the circuit is the electric energy stored in the circuit divided by the energy dissipated in one period.

  The quality factor of an RL circuit at an operating frequency is defined as the ratio of reactance of the coil and its resistance.

- Power factor:

  It is the ratio of active power of an electrical circuit to its apparent power. The Power Factor is an indicator of the quality of design and management of an electrical installation. It relies on two very basic notions: active and apparent power.

  The active power P (kW) is the real power transmitted to loads such as motors, lamps, heaters, and computers. The electrical active power is transformed into mechanical power, heat or light.

Procedure :

- Constructs the circuit as per Circuit Diagram.
- Initially keeps the Moving contact of the auto-transformer to zero position.
- Connects the Single Phase AC supply to the circuit.
- Applies voltage across the two-winding transformer's primary by rotating the moving contact of the auto-transformer.
- Notes down the corresponding Voltmeter, Ammeter and Wattmeter readings.
- Turns OFF the power supply to the circuit.
- Disconnects the circuit.
- Calculates the Quality factor and Power factor of the circuit.

8. Determination of Q-factor and Power factor of an Inductive Coil

Observations :

Sno	Voltmeter Reading V (volts)	Ammeter Reading I (amps)	Wattmeter Reading P (watts)	Power factor Cos ϕ = P / (VI)	tan ϕ	Impedance Z = V / I (ohms)	Quality factor = tan ϕ
1							
2							
3							
4							

Specimen Calculations :

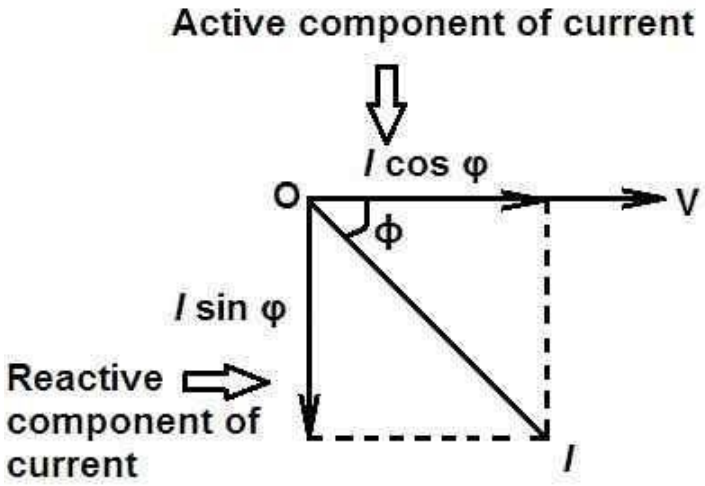
- Power factor of the coil (Cos ϕ) = P / (VI)
- Impedance of the coil (Z) = V / I ohms
- Quality factor of the coil (Q) = X_L / R

  = (Z Sin ϕ) / (Z Cos ϕ)

  = tan ϕ

8. Determination of Q-factor and Power factor of an Inductive Coil

Model Graphs :



Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

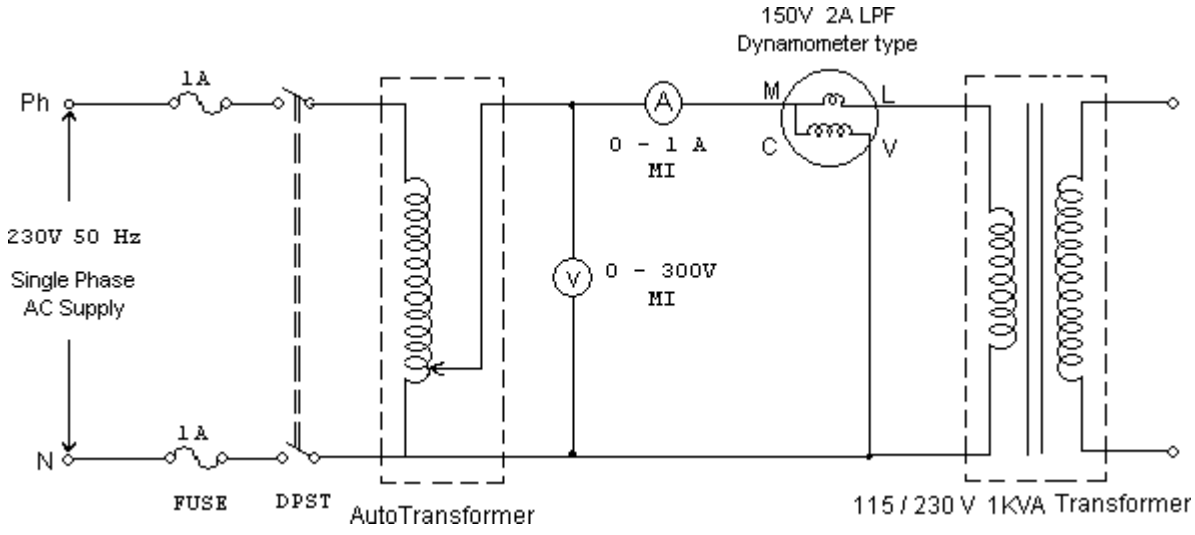
EXPERIMENTAL METHODOLOGY

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Objective of the experiment : To determine the Idle and Energy components of current in a Single Phase Inductive circuit.

Sno	Apparatus Name	Specifications	Quantity
1	Dynamometer type Wattmeter	1-Phase 150V 2A LPF	1
2	Moving Iron Voltmeter	1-Phase 0-300V	1
3	Moving Iron Ammeter	1-Phase 0-1A	1
4	Single Phase Transformer as Inductive Load	115 / 230 V 1 kVA	1
5	Single Phase Auto-Transformer	0-270V 2KVA	1
6	Connecting Wires	500V 5A	Required Number

Circuit Diagram :



EXPERIMENTAL METHODOLOGY

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Theory :

- A Single-Phase AC Circuit deals with three types of powers. They are….
- Apparent Power (S) = V.I in Volt-Amps
- Active Power (P) = V.I.Cos ø in Watts
- Reactive Power (Q) = V.I.Sin ø in Volt-Amp reactive
- From the above equations, it is observed that current (I) has two components.
- One is I.Cos ø which helps in energy (in watt-sec) equation
- Other one is I.Sin ø which is idle.

Procedure :

- Constructs the circuit as per Circuit Diagram.
- Initially keeps the Moving contact of the auto-transformer to zero position.
- Connects the Single Phase AC supply to the circuit.
- Applies voltage across the two-winding transformer's primary by rotating the moving contact of the auto-transformer.
- Notes down the corresponding Voltmeter, Ammeter and Wattmeter readings.
- Turns OFF the power supply to the circuit.
- Disconnects the circuit.
- Calculates the idle and energy components of current.

EXPERIMENTAL METHODOLOGY

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Observations :

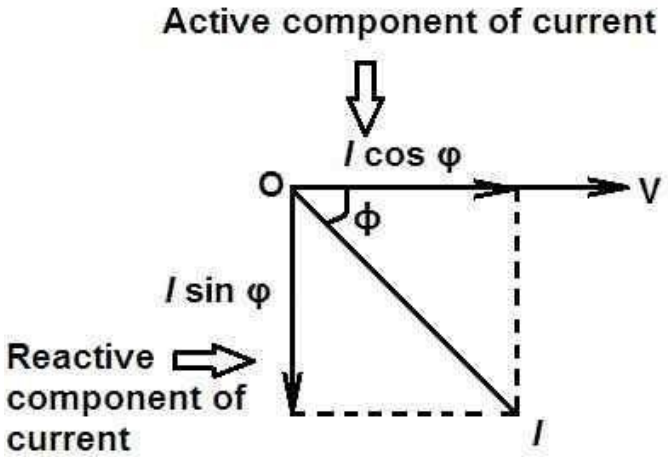
Sno	Voltmeter Reading V (volts)	Ammeter Reading I (amps)	Wattmeter Reading P (watts)	Cos ϕ = P / (VI)	Sin ϕ	Idle Component of Current = I Sin ϕ (amps)	Energy Component of Current = I Cos ϕ (amps)
1							
2							
3							
4							

Specimen Calculations :

- Power factor (Cos ø) = P/ (VI)
- Energy component of current = I Cos ø amps
- Idle component of current = I Sin ø amps

9. Determination of Idle and Energy components of Current in a Single Phase Inductive Circuit

Model Graphs :



Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

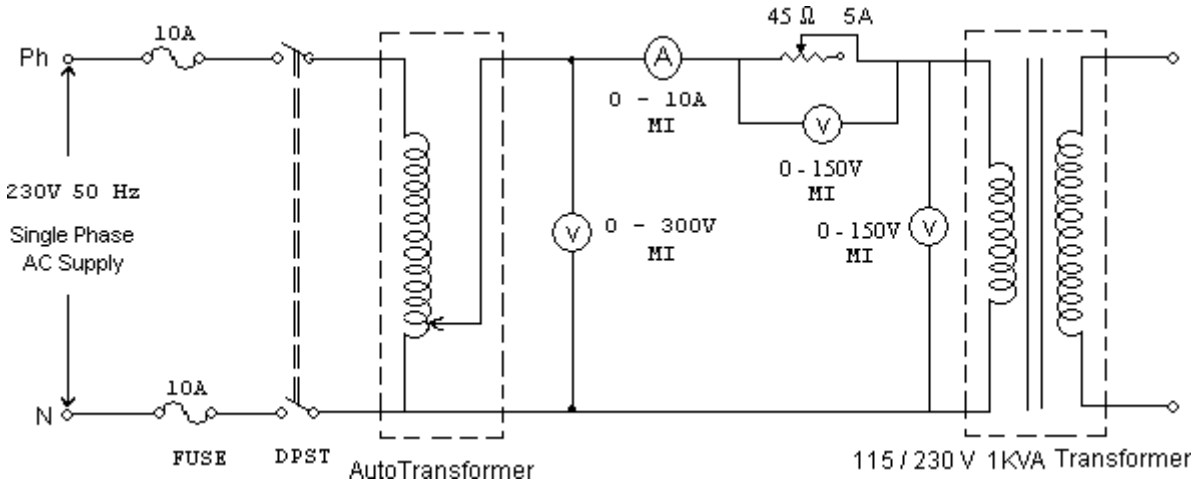
EXPERIMENTAL METHODOLOGY

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Objective of the experiment : To measure the active power and power factor of a single phase RL series circuit by using Three Voltmeter method.

Sno	Apparatus Name	Specifications	Quantity
1	Moving Iron Voltmeter	1-Phase 0-300V	1
2	Moving Iron Voltmeter	1-Phase 0-150V	2
3	Moving Iron Ammeter	1-Phase 0-10A	1
4	Rheostat	0-45 ohm 5A	1
5	Single Phase Transformer as Inductive Load	115 / 230 V 1 kVA	1
6	Single Phase Auto-Transformer	0-270V 2KVA	1
7	Connecting Wires	300V 5A	Required Number

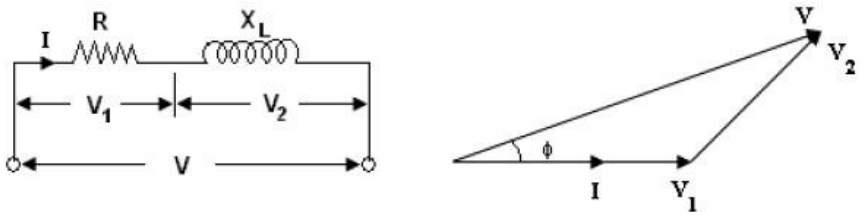
Circuit Diagram :



10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Theory :

- Three Voltmeter method:



Power Factor (Cos ϕ) = $(V^2 - (V_1^2 + V_2^2)) / (2V_1V_2)$

Power consumed by the Inductor (P_L) = $(V^2 - (V_1^2 + V_2^2)) / (2R)$

Procedure :

- Constructs the circuit as per Circuit Diagram.
- Initially keeps the Moving contact of the auto-transformer to zero position and rheostat at maximum resistance position.
- Connects the Single Phase AC supply to the circuit.
- Applies rated voltage across the two-winding transformer's primary by rotating the moving contact of the auto-transformer.
- Notes down the corresponding Voltmeters and Ammeter readings.
- Turns OFF the power supply to the circuit.
- Disconnects the circuit.
- Calculates the power and power factor of the circuit.

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Observations :

Resistance of the Rheostat =_____ohms					
Sno	**Ammeter Reading (amps)**	**Voltmeter-1 Reading (volts)**	**Voltmeter-2 Reading (volts)**	**Voltmeter-3 Reading (volts)**	**Power consumed by the RL load (watts)**
1					
2					
3					
4					

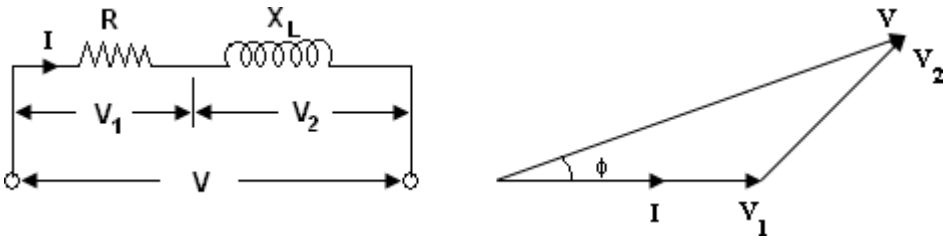
Specimen Calculations :

Power consumed by the Inductor (P_L) = $(V^2 - (V_1^2 + V_2^2)) / (2R)$

Power Factor ($\cos \phi$) = $(V^2 - (V_1^2 + V_2^2)) / (2V_1V_2)$

10. Measurement of Power in Single Phase Circuit by 3 – Voltmeter method

Model Graphs :



Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

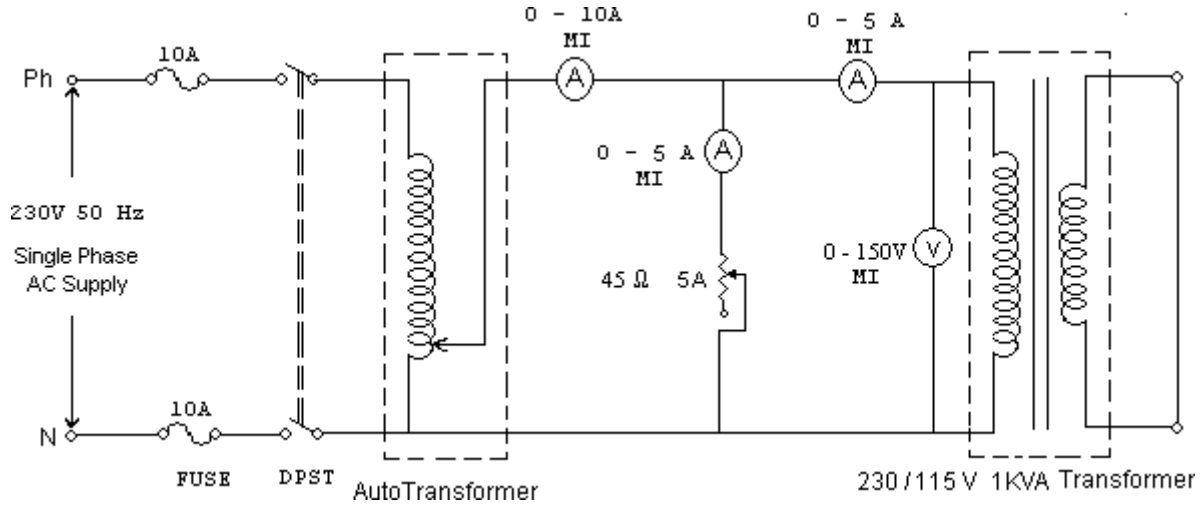
EXPERIMENTAL METHODOLOGY

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Objective of the experiment : To measure the active power and power factor of a single phase RL parallel circuit by using Three Ammeter method.

Sno	Apparatus Name	Specifications	Quantity
1	Moving Iron Voltmeter	1-Phase 0-150V	1
2	Moving Iron Ammeter	1-Phase 0-10A	1
3	Moving Iron Ammeter	1-Phase 0-5A	2
4	Rheostat	0-45 ohm 5A	1
5	Single Phase Transformer as Inductive Load	115 / 230 V 1 kVA	1
6	Single Phase Auto-Transformer	0-270V 2KVA	1
7	Connecting Wires	300V 10A	Required Number

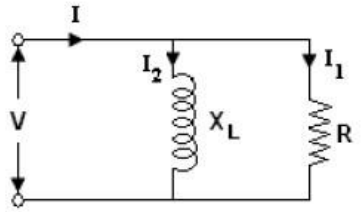
Circuit Diagram :

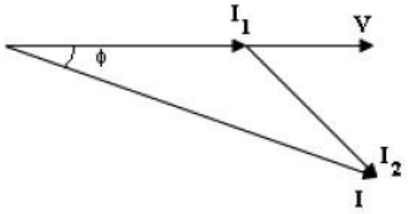


11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Theory :

- Three Ammeter method:





Power Factor (Cos ϕ) = $(I^2 - (I_1^2 + I_2^2)) / (2I_1I_2)$

Power consumed by the Inductor (P_L) = $(I^2 - (I_1^2 + I_2^2)) / (2R)$

Procedure :

- Constructs the circuit as per Circuit Diagram.
- Initially keeps the Moving contact of the auto-transformer to zero position and rheostat at maximum resistance position.
- Connects the Single Phase AC supply to the circuit.
- Applies sufficient voltage across the two-winding transformer's primary by rotating the moving contact of the auto-transformer, without exceeding the rated current of the two-winding transformer's primary.
- Notes down the corresponding Voltmeter and Ammeters readings.
- Turns OFF the power supply to the circuit.
- Disconnects the circuit.
- Calculates the power and power factor of the circuit.

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Observations :

Resistance of the Rheostat =_____ohms					
Sno	**Voltmeter Reading (volts)**	**Ammeter-1 Reading (amps)**	**Ammeter-2 Reading (amps)**	**Ammeter-3 Reading (amps)**	**Power consumed by the RL load (watts)**
1					
2					
3					
4					

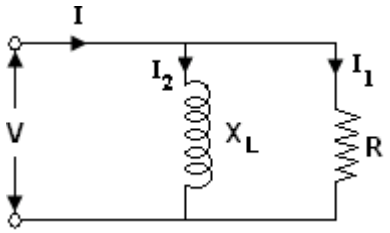
Specimen Calculations :

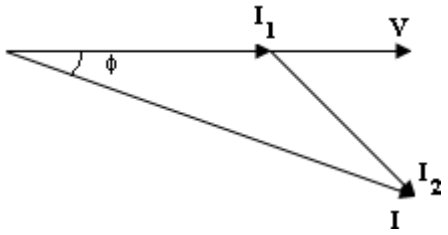
Power consumed by the Inductor (P_L) = $(I^2 - (I_1^2 + I_2^2)) / (2R)$

Power Factor ($\cos \phi$) = $(I^2 - (I_1^2 + I_2^2)) / (2I_1I_2)$

11. Measurement of Power in Single Phase Circuit by 3 – Ammeter method

Model Graphs :





Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

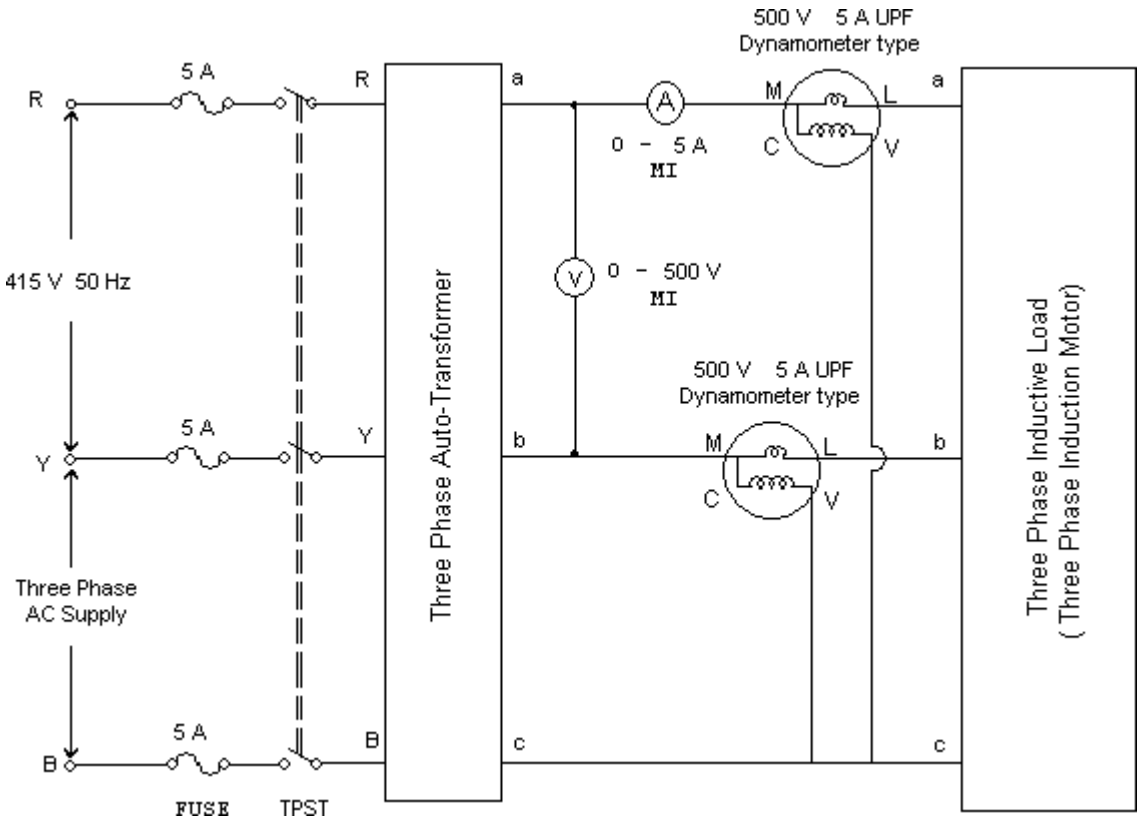
EXPERIMENTAL METHODOLOGY

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Objective of the experiment : To measure the active power, reactive power and power factor of a three phase balanced load by using Two Wattmeter method.

Sno	Apparatus Name	Specifications	Quantity
1	Dynamometer type Wattmeter	1-Phase 500V 5A UPF	2
2	Moving Iron Voltmeter	1-Phase 0-500V	1
3	Moving Iron Ammeter	1-Phase 0-5A	1
4	Three Phase Induction Motor	415V 5A	1
5	Three Phase Auto-Transformer	0-500V 10A	1
6	Connecting Wires	500V 10A	Required Number

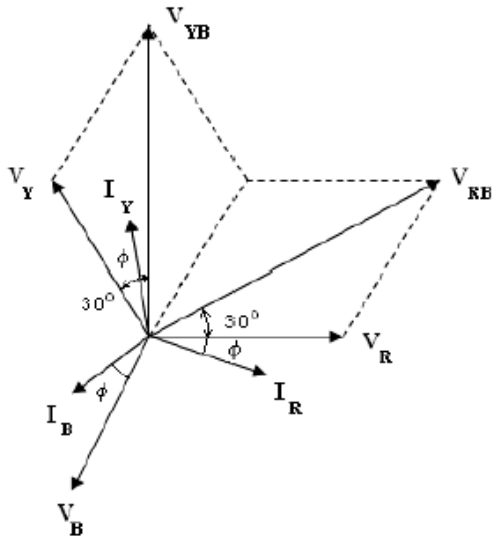
Circuit Diagram :



12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Theory :

Two-Wattmeter method is used to measure the power in a 3-ϕ balanced or unbalanced A.C. circuit.



V_R, V_Y & V_B and I_R, I_Y & I_B are phase voltages and phase currents.

$W_1 = V_{RB}\, I_R \cos(30^O + \phi)$

$W_2 = V_{YB}\, I_Y \cos(30^O - \phi)$

Active Power $= W_1 + W_2 = \sqrt{3}\, V_L I_L \cos\phi$

Reactive Power $= \sqrt{3}\,(W_1 \sim W_2) = \sqrt{3}\, V_L I_L \sin\phi$

Procedure :

- Constructs the circuit as per Circuit Diagram.
- Initially keeps the Moving contact of the auto-transformer to zero position.
- Connects the Single Phase AC supply to the circuit.
- Applies voltage across the three phase inductive load in steps by rotating the moving contact of the auto-transformer, without exceeding the rated current of it.
- Notes down the corresponding Voltmeter, Ammeter and Wattmeters readings at every step.
- Turns OFF the power supply to the circuit.
- Disconnects the circuit.
- Calculates the power and power factor of the circuit at every step the applied voltage.

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Observations :

Sno	Voltmeter Reading (volts)	Ammeter Reading (amps)	Wattmeter-1 Reading (watts)	Wattmeter-2 Reading (watts)	Active Power of the load (watts)	Power factor of the load	Reactive Power of the load (var)
1							
2							
3							
4							

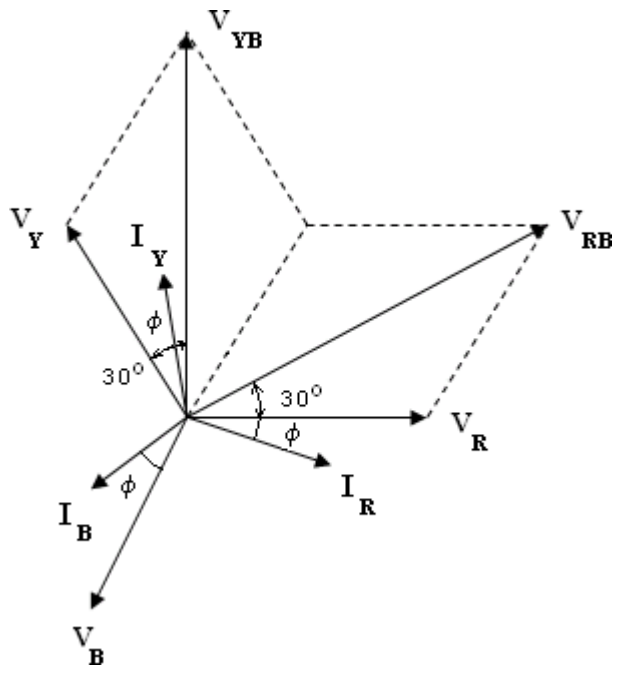
Specimen Calculations :

Power $(P) = W_1 + W_2$

Power factor $(\text{Cos } \phi) = \text{Cos}\left(\text{Tan}^{-1}\left(\sqrt{3}(W_1 \sim W_2) / (W_1 + W_2)\right)\right)$

12. Measurement of Power in 3 – Phase Balanced Circuit by 2 – Wattmeter method

Model Graphs :



Precautions :

1. Disconnecting the Power Supply from the mains before making the circuit.
2. Ensuring the correct range of meters.
3. Checking the circuit by the concerned staff member.
4. Avoiding loose contacts.
5. Observing the readings without error.
6. Avoiding the overheating of the elements due to over load.

C20 – EE310

ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB

Model Question Papers

SBTET, AP

STATE BOARD OF TECHNICAL EDUCATION & TRAINING, ANDHRA PRADESH.

DIPLOMA EXAMINATIONS - PRACTICALS

C20 – EE-310 – ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB

Duration : 03 hours **Formative Assessment – 1** Maximum Marks : 60

Instructions:

I. Any one question is allotted by the lottery system.

II. Each question carries three sub questions: a, b and c of total 54 marks.

III. Viva carries 06 marks.

IV. Perform the test with standard safety procedures by the use of right tools.

1	.	(a)	Draw the circuit diagram to verify the Ohm's law and its limitations.	08 M	CO1
		(b)	Conduct the test to verify the Maximum Power Transfer Theorem.	20 M	CO2
		(c)	Find out what happens when the terminals of one voltage source are reversed while working with Super Position Theorem.	26 M	CO2
2	.	(a)	Draw the circuit diagram to verify the Kirchhoff's Voltage law and Kirchhoff's Current law.	10 M	CO1
		(b)	Conduct the test to verify the Thevenin's Theorem.	20 M	CO2
		(c)	Find out what happens when the connections to the current coil of the Dynamometer type Wattmeter are reversed.	24 M	CO3
3	.	(a)	Draw the circuit diagram to verify the Super Position Theorem.	12 M	CO2
		(b)	Conduct the test to verify the Ohm's law and its limitations.	16 M	CO1
		(c)	Find out the amount of power transferred when the value of load resistance becomes the half of Thevenin's Resistance of the remaining circuit.	26 M	CO2
4	.	(a)	Draw the circuit diagram to verify the Thevenin's Theorem.	10 M	CO2
		(b)	Conduct the test to calibrate the given Dynamometer type Wattmeter.	24 M	CO3
		(c)	Find out what happens when the terminals of the voltage source are reversed while using Kirchhoff's laws.	20 M	CO1
5	.	(a)	Draw the circuit diagram to verify the Maximum Power Transfer Theorem.	14 M	CO2
		(b)	Conduct the test to verify the Super Position Theorem.	20 M	CO2
		(c)	Find out what happens when the temperature around a resistor is decreased and the voltage across the resistor is increased.	20 M	CO1

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DIPLOMA EXAMINATIONS - PRACTICALS

C20 – EE-310 – ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB

Duration : 03 hours **Formative Assessment – 1** Maximum Marks : 60

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6 .	(a)	Draw the circuit diagram to calibrate the given Dynamometer type Wattmeter.	14 M	CO3
	(b)	Conduct the test to verify the Kirchhoff's Voltage law and Kirchhoff's Current law.	16 M	CO1
	(c)	Find out what happens when the voltage source is replaced with the open circuit while using Thevenin's Theorem.	24 M	CO2

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DIPLOMA EXAMINATIONS - PRACTICALS

C20 – EE-310 – ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB

Duration : 03 hours **Formative Assessment – 2** Maximum Marks : 60

Instructions:

I. Any one question is allotted by the lottery system.

II. Each question carries three sub questions: a, b and c of total 54 marks.

III. Viva carries 06 marks.

IV. Perform the test with standard safety procedures by the use of right tools.

1 .	(a)	Draw the circuit diagram to calibrate the given Single Phase Induction type Energymeter.	14 M	CO3
	(b)	Conduct the test to determine the Idle and Energy components of current passing through the Single Phase Inductive Circuit.	20 M	C04
	(c)	Find out what happens when the DC Power Supply is given to the Single Phase Inductive Circuit while measuring the power using Three Ammeter method.	20 M	CO5
2 .	(a)	Draw the circuit diagram to determine the Quality factor and Power factor of a Single Phase Inductive Circuit.	12 M	C04
	(b)	Conduct the test to measure the power in a Three Phase Inductive Circuit by using Two Wattmeter method.	20 M	CO5
	(c)	Find out what happens when the UDC Power Supply is given to the Single Phase Inductive Circuit while measuring the power using Three Voltmeter method.	22 M	CO5
3 .	(a)	Draw the circuit diagram to determine the Idle and Energy components of current passing through the Single Phase Inductive Circuit.	10 M	C04
	(b)	Conduct the test to measure the power in a Single Phase Inductive Circuit by using Three Ammeter method.	20 M	CO5
	(c)	Find out what happens when the connections to the current coil of the Single Phase Induction type Energymeter are reversed.	24 M	CO3

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DIPLOMA EXAMINATIONS - PRACTICALS

C20 – EE-310 – ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB

Duration : 03 hours **Formative Assessment – 2** Maximum Marks : 60

4 .	(a)	Draw the circuit diagram to measure the power in a Single Phase Inductive Circuit by using Three Voltmeter method.	12 M	CO5
	(b)	Conduct the test to determine the Quality factor and Power factor of a Single Phase Inductive Circuit.	22 M	C04
	(c)	Find out what happens when the pointer of a Wattmeter moves in anticlockwise direction while measuring the power in a Three Phase Inductive Circuit by using Two Wattmeter method.	20 M	CO5
5 .	(a)	Draw the circuit diagram to measure the power in a Single Phase Inductive Circuit by using Three Ammeter method.	12 M	CO5
	(b)	Conduct the test to calibrate the given Single Phase Induction type Energymeter.	20 M	CO3
	(c)	Explain the significance of Idle and Energy components of current passing through the Single Phase Inductive Circuit, on its performance.	22 M	C04
6 .	(a)	Draw the circuit diagram to measure the power in a Three Phase Inductive Circuit by using Two Wattmeter method.	14 M	CO5
	(b)	Conduct the test to measure the power in a Single Phase Inductive Circuit by using Three Voltmeter method.	20 M	CO5
	(c)	Explain the significance of Quality factor and Power factor on the performance of an Inductive Circuit.	20 M	C04

STATE BOARD OF TECHNICAL EDUCATION & TRAINING, ANDHRA PRADESH.

DIPLOMA EXAMINATIONS - PRACTICALS

C20 – EE-310 – ELECTRICAL CIRCUITS AND MEASURING INSTRUMENTS LAB

Duration : 03 hours | **Summative Assessment** | Maximum Marks : 60

Instructions:

I. Any one question is allotted by the lottery system.
II. Each question carries three sub questions: a, b and c of total 54 marks.
III. Viva carries 06 marks.
IV. Perform the test with standard safety procedures by the use of right tools.

1	.	(a)	Draw the circuit diagram to verify the Ohm's law and its limitations.	08 M	CO1
		(b)	Conduct the test to verify the Maximum Power Transfer Theorem.	20 M	CO2
		(c)	Find out what happens when the terminals of one voltage source are reversed while working with Super Position Theorem.	26 M	CO2
2	.	(a)	Draw the circuit diagram to verify the Kirchhoff's Voltage law and Kirchhoff's Current law.	10 M	CO1
		(b)	Conduct the test to verify the Thevenin's Theorem.	20 M	CO2
		(c)	Find out what happens when the connections to the current coil of the Dynamometer type Wattmeter are reversed.	24 M	CO3
3	.	(a)	Draw the circuit diagram to verify the Super Position Theorem.	12 M	CO2
		(b)	Conduct the test to verify the Ohm's law and its limitations.	16 M	CO1
		(c)	Find out the amount of power transferred when the value of load resistance becomes the half of Thevenin's Resistance of the remaining circuit.	26 M	CO2
4	.	(a)	Draw the circuit diagram to verify the Thevenin's Theorem.	10 M	CO2
		(b)	Conduct the test to calibrate the given Dynamometer type Wattmeter.	24 M	CO3
		(c)	Find out what happens when the terminals of the voltage source are reversed while using Kirchhoff's laws.	20 M	CO1

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5	.	(a)	Draw the circuit diagram to verify the Maximum Power Transfer Theorem.	14 M	CO2
		(b)	Conduct the test to verify the Super Position Theorem.	20 M	CO2
		(c)	Find out what happens when the temperature around a resistor is decreased and the voltage across the resistor is increased.	20 M	CO1
6	.	(a)	Draw the circuit diagram to calibrate the given Dynamometer type Wattmeter.	14 M	CO3
		(b)	Conduct the test to verify the Kirchhoff's Voltage law and Kirchhoff's Current law.	16 M	CO1
		(c)	Find out what happens when the voltage source is replaced with the open circuit while using Thevenin's Theorem.	24 M	CO2
7	.	(a)	Draw the circuit diagram to calibrate the given Single Phase Induction type Energymeter.	14 M	CO3
		(b)	Conduct the test to determine the Idle and Energy components of current passing through the Single Phase Inductive Circuit.	20 M	C04
		(c)	Find out what happens when the DC Power Supply is given to the Single Phase Inductive Circuit while measuring the power using Three Ammeter method.	20 M	CO5
8	.	(a)	Draw the circuit diagram to determine the Quality factor and Power factor of a Single Phase Inductive Circuit.	12 M	C04
		(b)	Conduct the test to measure the power in a Three Phase Inductive Circuit by using Two Wattmeter method.	20 M	CO5
		(c)	Find out what happens when the UDC Power Supply is given to the Single Phase Inductive Circuit while measuring the power using Three Voltmeter method.	22 M	CO5

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9	.	(a)	Draw the circuit diagram to determine the Idle and Energy components of current passing through the Single Phase Inductive Circuit.	10 M	C04
		(b)	Conduct the test to measure the power in a Single Phase Inductive Circuit by using Three Ammeter method.	20 M	CO5
		(c)	Find out what happens when the connections to the current coil of the Single Phase Induction type Energymeter are reversed.	24 M	CO3
10	.	(a)	Draw the circuit diagram to measure the power in a Single Phase Inductive Circuit by using Three Voltmeter method.	12 M	CO5
		(b)	Conduct the test to determine the Quality factor and Power factor of a Single Phase Inductive Circuit.	22 M	C04
		(c)	Find out what happens when the pointer of a Wattmeter moves in anticlockwise direction while measuring the power in a Three Phase Inductive Circuit by using Two Wattmeter method.	20 M	CO5
11	.	(a)	Draw the circuit diagram to measure the power in a Single Phase Inductive Circuit by using Three Ammeter method.	12 M	CO5
		(b)	Conduct the test to calibrate the given Single Phase Induction type Energymeter.	20 M	CO3
		(c)	Explain the significance of Idle and Energy components of current passing through the Single Phase Inductive Circuit, on its performance.	22 M	C04
12	.	(a)	Draw the circuit diagram to measure the power in a Three Phase Inductive Circuit by using Two Wattmeter method.	14 M	CO5
		(b)	Conduct the test to measure the power in a Single Phase Inductive Circuit by using Three Voltmeter method.	20 M	CO5
		(c)	Explain the significance of Quality factor and Power factor on the performance of an Inductive Circuit.	20 M	C04