SCHEME : K

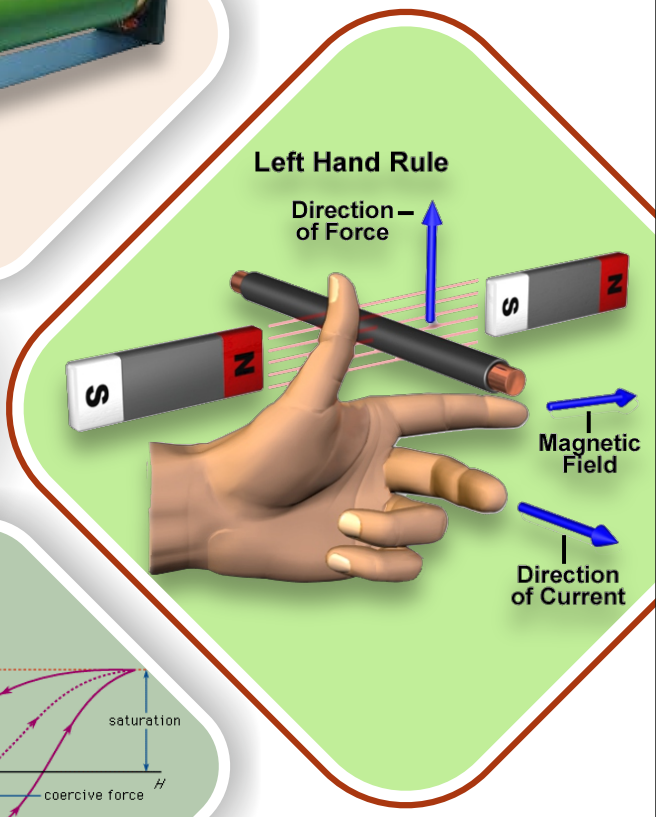
Name : _____

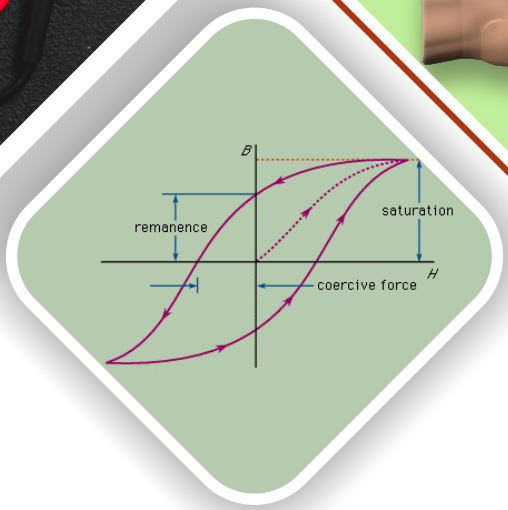
Roll No. : _____ Year : 20___ 20___

Exam Seat No. : _____

LABORATORY MANUAL FOR

FUNDAMENTAL OF ELECTRICAL ENGINEERING (312310)





ELECTRICAL ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the following

- Skill development in line with industry requirements
- Industry readiness and improved employability of Diploma holders
- Synergistic relationship with industry
- Collective and Cooperative development of all stake holders
- Technological interventions in societal development
- Access to uniform quality technical education

A Laboratory manual for

Fundamental of Electrical Engineering

(312310)

Semester – II

(EE/EP/EU)

Maharashtra State

Board of Technical Education, Mumbai

(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education , Mumbai

(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

4th Floor, Government Polytechnic Building, 49, Kherwadi,

Bandra (East), Mumbai- 400051.

MAHARASHTRA STATE
BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr./Ms. …….....

Roll No. ……. of second Semester of Diploma in ….…….....of Institute …….……

(Code : ……) has completed the term work satisfactorily in course **Fundamental of Electrical Engineering (312310)** for the academic year 20…….to 20…….. as prescribed in the curriculum.

Place: …….. **Enrollment No. :…….**

Date: ……. **Exam Seat No.: ……**

Subject Teacher **Head of department** **Principal**

Seal of Institute

Preface

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'T' Scheme curricula for engineering diploma programmes with outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher, instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through "chalk and duster" activity in the classroom situation. Accordingly, the "I scheme laboratory manual development team designed the practical to focus on the outcomes, rather than the traditional age old practice of conducting practical to 'verify the theory" (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected. from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

The basic aim of this course is that, the student must learn the basic concepts, rules and laws of electric and magnetic circuits and practical thereof. The basic concepts of electrical engineering in this course will be very useful for understanding electrical circuits.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Program Outcomes (POs)

- **PO 1. Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, sciences and engineering fundamentals and engineering specialization to solve the engineering problems.
- **PO 2. Problem analysis:** Identify and analyse well-defined engineering problems using codified standard methods.
- **PO 3. Design/ development of solutions:** Design solutions for well-defined technical problems and assist with the design of system components or processes to meet specified needs.
- **PO 4. Engineering tools, Experimentation and Testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.
- **PO 5. Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.
- **PO 6. Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
- **PO 7. Life-long learning:** Ability to analyse individual needs and engage in updating in the context of technological changes.

Program Specific Outcomes (PSOs):

- **PSO 1.** Maintain various types of static and rotating electrical equipment and power system with its control.
- **PSO 2.** Install and maintain all types of illumination and utilization system in residential, commercial and industrial sector considering conservation of electrical energy.

Practical-Course outcome matrix

COURSE LEVEL LEARNING OUTCOMES (COS)

1. CO1 - Determine various parameters used in electric circuit.
2. CO2 - Use basic laws of electrical engineering in D.C. Circuits.
3. CO3 - Use capacitor and battery in electrical circuits.
4. CO4 - Use principles of magnetism in Magnetic Circuits.
5. CO5 - Apply Laws of electromagnetism in electrical circuit and systems.

Sr.No.	Title of the Practical	CO1	CO2	CO3	CO4	CO5
1	Preparation of Layout of Electrical Engineering Laboratory.	✓	-	-	-	-
2	Operation of fire extinguisher and preparation of safety rules charts	✓	-	-	-	-
3	Check lab supply system and make use of relevant electric tools for various applications.	✓	-	-	-	-
4	Verification of Ohm's Law	✓	✓	-	-	-
5	Read analog meters for measurement of various electrical quantities in AC/DC circuits.	✓	-	-	-	-
6	Use of Multimeter and Clip-On meter for the measurement of AC/DC Current, Voltage and Resistance in the given circuit	✓	✓	-	-	-
7	Measurement of frequency, Time period, Peak Value and Average Value of the given A.C. wave on CRO.	✓	✓	-	-	-
8	Verification of Kirchhoff's Voltage Law	✓	-	-	-	-
9	Verification of Kirchhoff's Current Voltage Law	✓	✓	-	-	-
10	Use of rheostat as current regulator and potential divider	✓	✓	-	-	-
11	Determination of PD,EMF and internal resistance of DC source .	✓	✓	-	-	-
12	Verification of parameters of two/three resistances connected in series connection.	✓	✓	-	-	-
13	Verification of parameters of two/three resistances connected in parallel connection.	✓	✓	-	-	-
14	Plot the charging characteristics of capacitor and find the time constant (RC).	✓	-	✓	-	-

15	Plot the discharging characteristics of capacitor and find the time constant (RC).	✓	-	✓	-	-
16	Verification of the equivalent capacitance in series connected circuits	✓	-	✓	-	-
17	Verification of equivalent capacitance of the parallel connected circuits	✓	-	✓	-	-
18	Plot the Rise characteristics of Electric current in a circuit consisting of resistance and inductance in the circuit.	✓	-	-	✓	-
19	Plot the decay characteristics of Electric current in a circuit consisting of resistance and inductance in the circuit.	✓	-	-	✓	-
20	Plot B-H curve for the given magnetic material.	-	-	-	✓	-
21	Plot magnetization curve for magnetic core	-	-	-	✓	-
22	Study of Hysteresis loop for the given transformer coil	-	-	-	✓	-
23	Verification of Faraday's Law of Electromagnetic Induction (Statically Induced EMF)	-	-	-	✓	✓
24	Verification of Faraday's Law of Electromagnetic Induction (Dynamically Induced EMF)	-	-	-	✓	✓
25	Verification of Fleming's Right Hand Rule	-	-	-	✓	✓
26	Verification of Fleming's Left Hand Rule	-	-	-	✓	✓
27	Plot the Charging and discharging Curves of Battery	✓	-	✓	-	-

Content Page

List of Practical's and Progressive Assessment Sheet

Sr. No.	Title of the Practical	Page no.	Date of Performance	Date of Submission	Assessment Marks (25)	Dated sign.of Teacher	Remarks (If any)
1	Preparation of Layout of Electrical Engineering Laboratory.	1					
2	Operation of fire extinguisher and preparation of safety rules charts	7					
3	Check lab supply system and make use of relevant electric tools for various applications.	14					
4	Verification of Ohm's Law	21					
5	Read analog meters for measurement of various electrical quantities in AC/DC circuits.	27					
6	Use of Multimeter and Clip-On meter for the measurement of AC/DC Current, Voltage and Resistance in the given circuit	33					
7	Measurement of frequency, Time period, Peak Value and Average Value of the given A.C. wave on CRO.	42					
8	Verification of Kirchhoff's Voltage Law	47					
9	Verification of Kirchhoff's Current Voltage Law	52					
10	Use of rheostat as current regulator and potential divider	57					
11	Determination of PD,EMF and internal resistance of DC source .	67					
12	Verification of parameters of two/three resistances connected in series connection.	72					

24	Verification of Faraday's Law of Electromagnetic Induction (Dynamically Induced EMF)	145					
25	Verification of Fleming's Right Hand Rule	151					
26	Verification of Fleming's Left Hand Rule	157					
27	Plot the Charging and discharging Curves of Battery	163					
Total							

List of Industry Relevant Skills

The following industry relevant skills of the competency "Use basic principles of electrical engineering in different applications." are expected to be developed in student by undertaking the practicals of this laboratory manual.

1. Determine various parameters used in electric circuit.
2. Use basic laws of electrical engineering in D.C. Circuits.
3. Use capacitor and battery in electrical circuits.
4. Use principles of magnetism in Magnetic Circuits.
5. Apply Laws of electromagnetism in electrical circuit and systems.

Guidelines to Teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each experiment
3. Involve students in performance of each experiment.
4. Teacher should ensure that the respective skills and competencies are developed in. the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.

Instructions for Students

1. Listen carefully the lecture given by teacher about subject, curriculum, learning structure, skills to be developed.
2. Organize the work in the group and make record all programs.
3. Students shall develop maintenance skill as expected by industries.
4. Student shall attempt to develop related hand-on skills and gain confidence.
5. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
6. Student shall refer technical magazines.
7. Student should develop habit to submit the practicals on date and time.
8. Student should well prepare while submitting write-up of exercise.
9. Attach/paste separate papers wherever necessary.

Practical No.1: Preparation of Layout of Electrical Engineering Laboratory

I Practical Significance

To familiarize the students with the lab facilities, equipment, standard operating procedures.

II Industry/Employer Expected Outcome(s)

Well-planned layouts prevent unnecessary expenditures, allowing for better budget allocation for equipment and materials.

III Course Level Learning Outcome(s)

Determine various parameters used in electric circuit.

IV Laboratory Learning Outcome(s)

Draw layout of Electrical Engineering Laboratory.

V Relevant Affective Domain related outcome(s)

Handle tools and equipment carefully.

VI Relevant Theoretical Background

The preparation of layout of an Electrical Engineering Laboratory involves the strategic arrangement of equipment, workstations and utilities to optimize space utilization ,ensure safety compliance and enhance workflow efficiency. This layout is crucial for creating a functional and organized environment that supports educational and research activities in electrical engineering.

Key Aspect of layout preparation:

Space Utilization: Efficient planning ensures that available space is used effectively. Preventing congestion and facilitating easy movement within the laboratory.

Safety Consideration: Logical arrangement based on workflow streamlines processes, reduces bottlenecks, and enhances overall productivity in the laboratory.

Equipment Accessibility: Strategic placement allows easy access for maintenance and repairs, reducing downtime and ensuring the longevity of laboratory assets.

Resource Allocation: Proper allocation of resources, including electrical power and utilities, ensures each workstation has access to necessary requirements for experiments.

Collaboration and Communication: Thoughtful design encourages collaboration, providing spaces for discussions and group work among students, researchers, and faculty. Adaptability to **Technological Changes**: Flexibility in layout accommodates changes in technology, allowing the laboratory to stay current with advancements in electrical engineering.

Compliance with Standards: The layout adheres to industry standards and guidelines, ensuring accreditation and certification criteria are met.

VII Circuit diagram
Layout of Laboratory

VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Drawing tools	--	1

IX Precautions to be followed

1) Verify power ratings.
2) Ensure proper earthing.
3) Use standard Electrical symbols.
4) Don't touch wire with wet hand.

X Procedure

1. Gather Information:
Obtain architectural drawings or floor plans of the space where the electrical layout will be implemented. Identify the location of power sources, distribution panels, and existing electrical infrastructure.

2. Determine Electrical Requirements:
List all electrical equipment and devices that need power in the space. Identify the power rating, voltage, and current requirements for each device.

3. Plan Circuit Distribution:
Determine the locations of electrical panels and distribution boards. Plan the distribution of circuits to various areas based on the power requirements.

4. Define Outlet and Switch Locations:
Identify the placement of electrical outlets, switches, and other control devices. Consider the convenience and safety of users when determining the locations.

5. Sketch Initial Layout:
Begin with a rough sketch of the layout, indicating the placement of major components. Use basic symbols for outlets, switches, lights, and other electrical devices.

6. Incorporate Safety Features:
Include emergency exits, exit signs, and emergency lighting in the layout. Ensure compliance with safety codes and regulations.

7. Conduit and Cable Routes:
Show the routes for conduits and cables, considering aesthetics, accessibility, and safety. Indicate the type and size of conduits or cables for each circuit.

8. Dimension the Layout:
Add dimensions to indicate the distances between components, outlets, and switches. Ensure that spacing complies with building codes and safety standards.

10. Label and Annotate:

Label each component and circuit for clarity. Add annotations, notes, or legends to explain symbols and provide additional information.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Result(s)

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XIV Interpretation of results

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XV Conclusion and recommendation

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XVI Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. Write the name and specification of the software used to draw layout of the laboratory
2. Write the name, specification, cost and manufacturer of the major electrical equipment in the laboratory.

[Space for Answers]

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XVII References/Suggestions for further reading

1. **https://collegedunia.com/exams/types-of-wiring-science-articleid-3865**
2. **https://www.edrawmax.com/article/electrical-plan.html**

XVIII Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		60 %
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.2: Operation of fire extinguisher and preparation of safety rules chart

I Practical Significance

Understanding the operation of fire extinguishers and preparing safety rules charts prevents accidents. It protect lives and create a workplace culture that prioritize safety.

II Industry/Employer Expected Outcome(s)

To use fire extinguisher and follow safety precaution while working in industry.

III Course Level Learning Outcome(s)

Determine various parameters used in electric circuit

IV Laboratory Learning Outcome(s)

Operate the fire extinguishers and prepare charts of the safety rules to be followed in the electrical lab.

V Relevant Affective Domain related outcome(s)

Follow safety rule in the laboratory.

VI Relevant Theoretical Background

A) Fire extinguishers:

A fire extinguisher is an active fire protection device used to extinguish or control small fires, often in emergencies. Typically, a fire extinguisher consists of a hand-held cylindrical pressure vessel containing an agent, which can be discharged to extinguish a fire. There are two main types of fire extinguishers:

1 Stored pressure
2 Cartridge operated

In stored pressure units, the expellant is stored in the same chamber as the firefighting agent itself. Depending on the agent used, different propellants are used. With dry extinguishers, nitrogen is typically used. Stored pressure types are most common type fire extinguishers.

Cartridge operated fire extinguishers contain the expellant gas in a separate cartridge that is punctuated prior to discharge, exposing the propellant to the extinguishing agent.

Fig: Fire Extinguisher

Types of fire:

In order to choose the right type of fire extinguisher, you must now what type of fire you are attempting to control. According to this fires are classified as,

Class A: Wood, paper, textiles, most plastics, and other ordinary combustibles.

Class B: Flammable and combustible liquids (oil, paints, solvent, greases)

Class C: Electrical fire (Live or energized wires or equipment)

Class D: Combustible metals (Magnesium, titanium, potassium, sodium, etc)

Class K: Cooking media (Vegetables or animal oils)

A		Ordinary Combustibles	Wood, Paper, Cloth, Etc.
B		Flammable Liquids	Grease, Oil, Paint, Solvents
C		Live Electrical Equipment	Electrical Panel, Motor, Wiring, Etc.
D		Combustible Metal	Magnesium, Aluminum, Etc.
K		Commercial Cooking Equipment	Cooking Oils, Animal Fats, Vegetable Oils

Sources of fire:

There are three major sources of fire exist in the surroundings.

1. **Heat:** Heat is required to elevate the temperature of a material to its ignition points. Sources of heat include matches ,stoves, sparks, etc
2. **Fuel:** The fuel for a fire may be solid (Coal, wood, paper, cloth), liquid (gasoline, kerosene, alcohol, cooking oil) or gas (propane, natural gas, butane).
3. **Oxygen:** Most fires will burn vigorously in any atmosphere containing at least 20% oxygen.

B) Safety rule

Safety rules charts prominently displayed in a workplace serve as constant reminders of safety protocols. They enhance awareness among employees and visitors, reducing the like hood of accident.

Fig: Safety Chart

VIII Resources required

Sr. No.	Name of Resources	Suggested Broad Specific	Quantity
1	Fire Extinguishers	-	1
2	Safety Charts	-	1

IX Precautions to be followed

1) Access the situation
2) Choose the right extinguisher
3) Know your escape route
4) Follow P.A.S.S .Technique

5) Stand at a safe distance
6) Be mindful of wind direction
7) Us short bursts
8) Watch for Re-Ignition
9) Do not turn your back on the fire
10) Evacuate if necessary
11) Call emergency Services

X Procedure

1. Call for help before attempting to extinguish a serious fire.

The fire may hold much faster than you are capable of dealing with it, so call department as soon as possible .Ask for fire service to come immediately ,giving your address and a brief description of the type of fire.

2. Check for your own safety before starting to extinguish a fire.

There are some key things to check for before you start fighting a fire using fire extinguisher.

a) Are you physically capable of extinguishing a fire?

b) Look for your exit points. Ensure that there is a clear exit for immediate escape.

c) Do not attempt to put out a fire where it is emitting toxic smoke. If you do not know whether the smoke is toxic, leave it to the professionals.

d) Remember that your life is more important than your property, so do not place yourself or others at risk.

3. Assess the fire.

Only a contained fire should be fought using a fire extinguisher, Portable fire extinguishers are valuable for immediate use on small fires. Make a quick commonsense assessment about the utility and safety of using a fire extinguisher for the fire you are experiencing.

4. Select proper type of fire extinguisher.

As explained above there are five types of fires like class- A, B,C,D,K. Each class of fire extinguisher is made for different types of fire, so select proper type of fire extinguisher.

5. Be ready for the fire extinguisher.

Almost all fire extinguishers have a safety pin in the handle. This pin usually looks like a plastic or metal ring. Remember the simple acronym P.A.S.S. to help you use the fire extinguisher effectively. P.A.S.S stands for Pull, Aim, Squeeze, Sweep. The detailed explanation is given below:

Pull: Pull the safety pin from the handle. The pin is located at the top of the fire extinguisher. Once the pin is removed, it unlocks the mechanism, allowing discharge of the extinguisher.

Aim: Aim the extinguisher nozzle at the base of the fire. This removes the sources of fire.

Squeeze: Squeeze the handle or lever slowly to discharge the agent. Letting go of the handle will stop the discharge, so keep it held down.

Sweep: Sweep side to side approximately 15cm over the fire until expended. The sweeping action helps to extinguish the fire.

6. Preparation of Safety Chart

Prepare chart showing Do's and Don'ts on Electrical Safety.

XI Resources used

Sr. No.	Name of Resource	Broad Specification		Quantity	Remarks (If any)

XII Actual Procedure

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XIII Result(s)

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XIV Interpretation of results

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XV Conclusion and recommendation

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XVI Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. Which type of fire extinguisher is used for your electrical engineering laboratory?
2. Write types of fire extinguisher and their uses.

[Space for Answers]

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XVII References/Suggestions for further reading

1. https://dgfscdhg.gov.in/sites/default/files/Electrical%20Fire%20Precautions.pdf
2. https://femalifesafety.org/fire-equipment/portable-fire-extinguishers/

XVIII Suggested Assessment Scheme

Performance Indicators		**Weightage**
Process Related : 15 Marks		60 %
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.3: Check lab supply system and make use of relevant electric tools for various Applications

I Practical Significance

Use of AC/DC supply in the laboratory and elsewhere is very important. Effects and procedure of switching ON and OFF of the supply should be known to the user thoroughly .Importance of toolkit for regular operation of apparatus, equipment, wiring and machines is elaborated in this experiment.

II Industry/Employer Expected Outcome(s)

While performing electrical wiring /maintenance work everybody should be aware of the proper tools required.

III Course Level Learning Outcome(s)

Determine various parameters used in electric circuit.

IV Laboratory Learning Outcome(s)

Use relevant electric tools for various applications

V Relevant Affective Domain related outcome(s)

Follow safety rules in laboratory

VI Minimum Theoretical Background

A) Supply system

The main structural components of Electrical supply system of laboratory are supply system, various panels, machines with foundation which are interlinked.

Supply system comprises of incoming supply, transformer, busbar, main switches, rectifier, panel boards.

For Electrical Engineering laboratory should have Single phase 230V,50 Hz , Three phase 415V,50Hz and DC supply as per laboratory equipment requirement.

Electrical Engineering laboratory consists of measuring equipment, electrical machines, tools, electrical loads.

B) Electric Tools

Electrical technician's kit is very simple and brief. The main tools in the kit ate plier and screwdriver. The electrical technician can do much work only with these two tools, but for electrical wiring purpose, it requires a special kit consists of tools such as cutter, Scratch Awl. Try square, hacksaw, hammer, drilling machines, test lamp, tester, soldering iron, de-soldering gun etc

VII Circuit diagram

Fig: Electric Tool Kit

VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Electrician tool kit	Standard	1 kit
2	Steel rule	150mm	1 No.

IX Precautions to be followed

1. Use ISI marks tools.
2. Use proper tool for proper work (job).
3. Never carry pointed tools in pocket.
4. Never use damaged/broken tools.

X Procedure

1. Identify various electrical tool
2. Observe the given tool(e.g. Screw driver)
3. Draw the free hand sketch of given tool.
4. Label the different parts.
5. Note down the make of tool.
6. Note down the application of given tool.
7. Repeat above instructions for other tools.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			

XII Actual Procedure

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XIII Observations

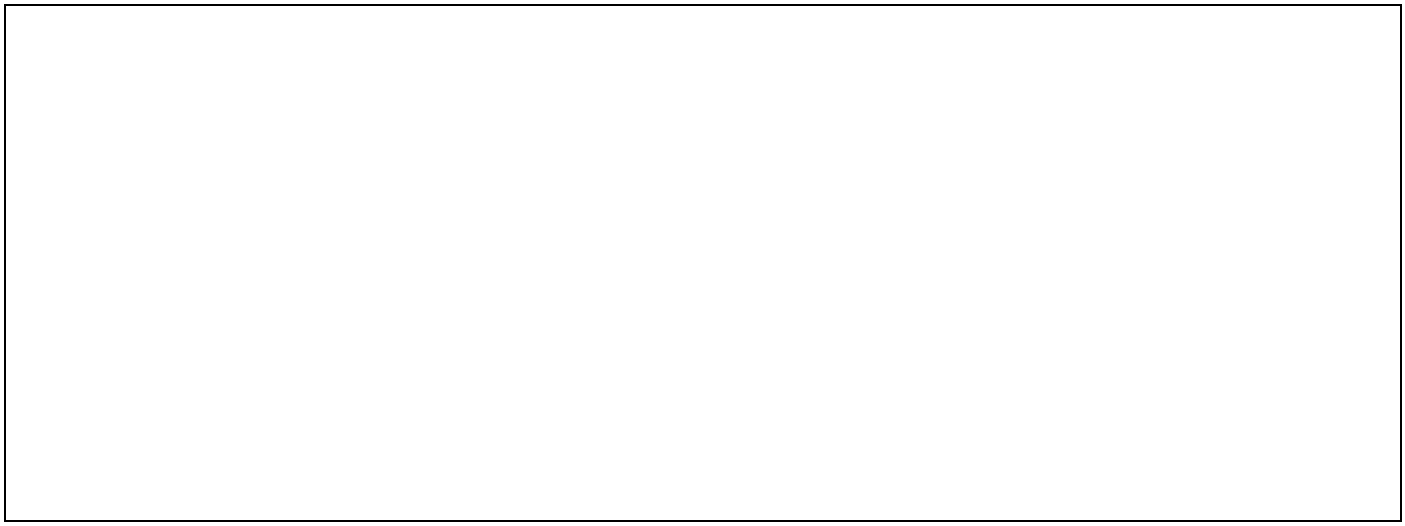
Identify various electrical tools

a) **Name of tool:**
   Sketch:

Application:

b) Name of tool:

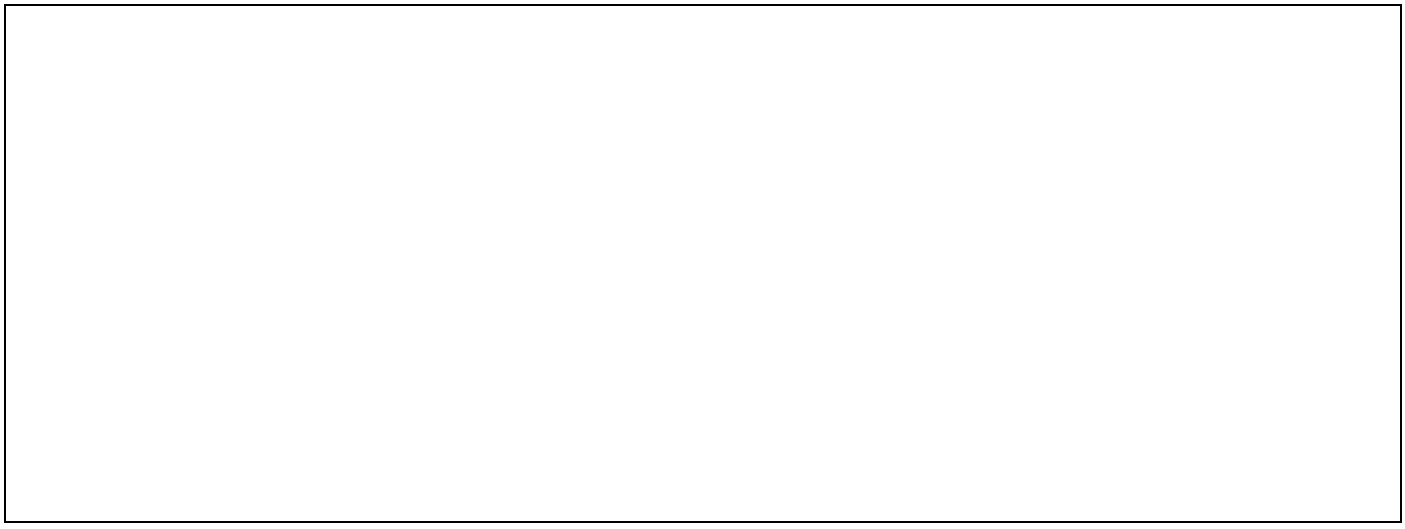
Sketch:



Application:

c) Name of tool:

Sketch:



Application:

d) Name of tool:

Sketch:

Application:

XIV Results

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XV Interpretation of results (Give the meaning of the above results)

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.

1. Prepare a list of tools required for wiring.
2. Name the tools used for following.
   i. Established vertical line on a wall
   ii. Established horizontal line on a wall
   iii. Cut PVC conduit
   iv. Put a hole in wall using hammer
   v. Put a pilot hole for fixing screw on board

3 State any two precautions while working with electricians screw driver.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. http://www.tapaiatools.com/screw_driver.html#second,assessed on 11th April,2018
2. http://homediyelectronics.com/tools/electronicstoolkitessential.php,assessed on 11th April,2018

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		60 %
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.4: Verification of Ohm's Law

I Practical Significance

The precise measurement of electric current, voltage, resistance is required in electrical, mechanical industries. It is imperative to have a method by which we can measure all these electrical parameters. Resistance, current and voltage can all be determined by way of the formula which is needed for designing circuits. Ohm's law is used to find out the desired amount of resistance, voltage and/or current levels to make sure that we are able to design circuits.

II Industry /Employer Expected Outcomes(s)

Solve circuit problems and decide the proper ratings of electrical appliances.

III Course Level Learning Outcome(s)

Determine various parameters used in electric circuit.

Use basic laws of electrical engineering in D.C. circuits

IV Laboratory Learning Outcomes(s)

Verify Ohm's Law

V Relevant Affective Domain related outcomes(s)

Follow safety rules in laboratory

VI Relevant Theoretical Background

Ammeter is used to measure electric current (I) & voltmeter is used to measure potential difference (Voltage) (V).

Ohm's law: It states that "Provided the physical state of the conductor (length, area, temperature) remaining the same in the closed circuit, the current (1) flowing through the conductor is directly proportional to the potential difference (voltage) (V) between the two points of the conductor".

$$I \alpha V$$

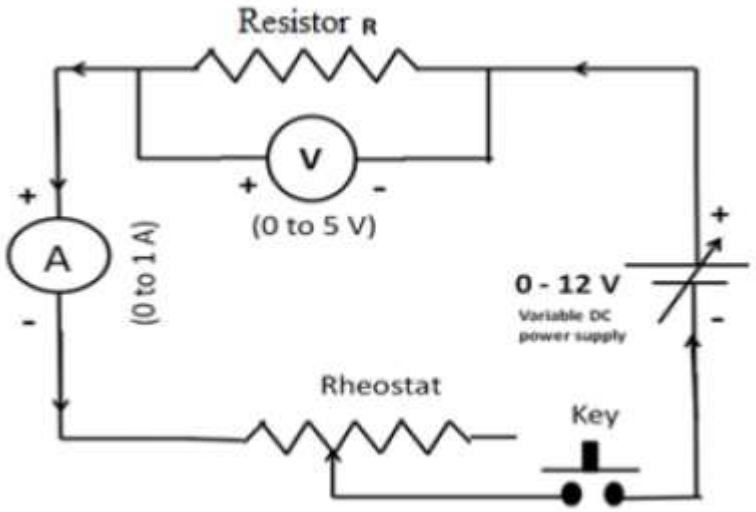
$$V \alpha I$$

$$V=IR$$

$$R = \frac{V}{I}$$

Where, R is the resistance of the conductor.

VII Circuit diagram



VIII Resources Required

Sr. No	Name of Resources	Suggested Broad Specification	Quantity
1	EMF Source	(0-12V)	1
2	DC Voltmeter	(0-5V)	1
3	DC Ammeter	(0-1A)	1
4	Rheostat	(0-500Ω)	1
5	Resistance Wire	Suitable range	1
6	Connecting wires	Suitable wire	As required

IX Precaution to be followed

1 All electrical connections should be neat and tight.
2 The pointer of ammeter/voltmeter should coincide with zero mark.
3 Check the power supply before connection.
4 Connect Ammeter in series.
5 Connect Voltmeter in parallel.
6 Set the DMM at correct AC /DC voltmeter, AC/DC ammeter mode by operating selector switch.

X Procedure

1 Make connection as per circuit diagram.
2 Note the least Count (LC) of ammeter and range.
3 Note the least Count (LC) of ammeter and range.
4 Switch on power supply.
5 Close key in circuit.

6 Keep the position of rheostat at maximum resistance.
7 Ensure that the position of ammeter and voltmeter pointer at minimum.
8 Note the readings of ammeter and voltmeter.
9 Change the position of sliding arm/variable arm of rheostat gradually.
10 Note the corresponding change reading in ammeter and voltmeter.
11 Calculate the resistance of wire using $\mathbf{R = \frac{V}{I}}$
12 Repeat the steps from 9 to 11 to take more readings.
13 Plot the graph with electric current i) along X-axis and voltage ii) along Y- axis
14 Find slope of the graph.
15 Determine the resistance by graph.

XI Resources Used

Sr. No.	Name of Resources	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculation (Use blank sheet provided if space not sufficient)

Sr. No.	Electric current I (Ampere)	Potential difference V (volt)	Resistance $R = \frac{V}{I}$ (Ω)	Mean Resistance R (Ω)

XIV Results

	From Observation	From Graph
Resistance of given wire		

XV Interpretation of Results (Give meaning of the above obtained results)

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XVI Conclusions and recommendation (Action/decisions to be taken based on the interpretation of results)

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XVII Practical Related Question

(Note : Below given are few samples questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO)

1. State the function of rheostat in laboratory.

2. A potential difference of 10V appears across the ends of a resistor when 5A of current flows through it. Find the resistance of the resistor?

[Space for Answer]

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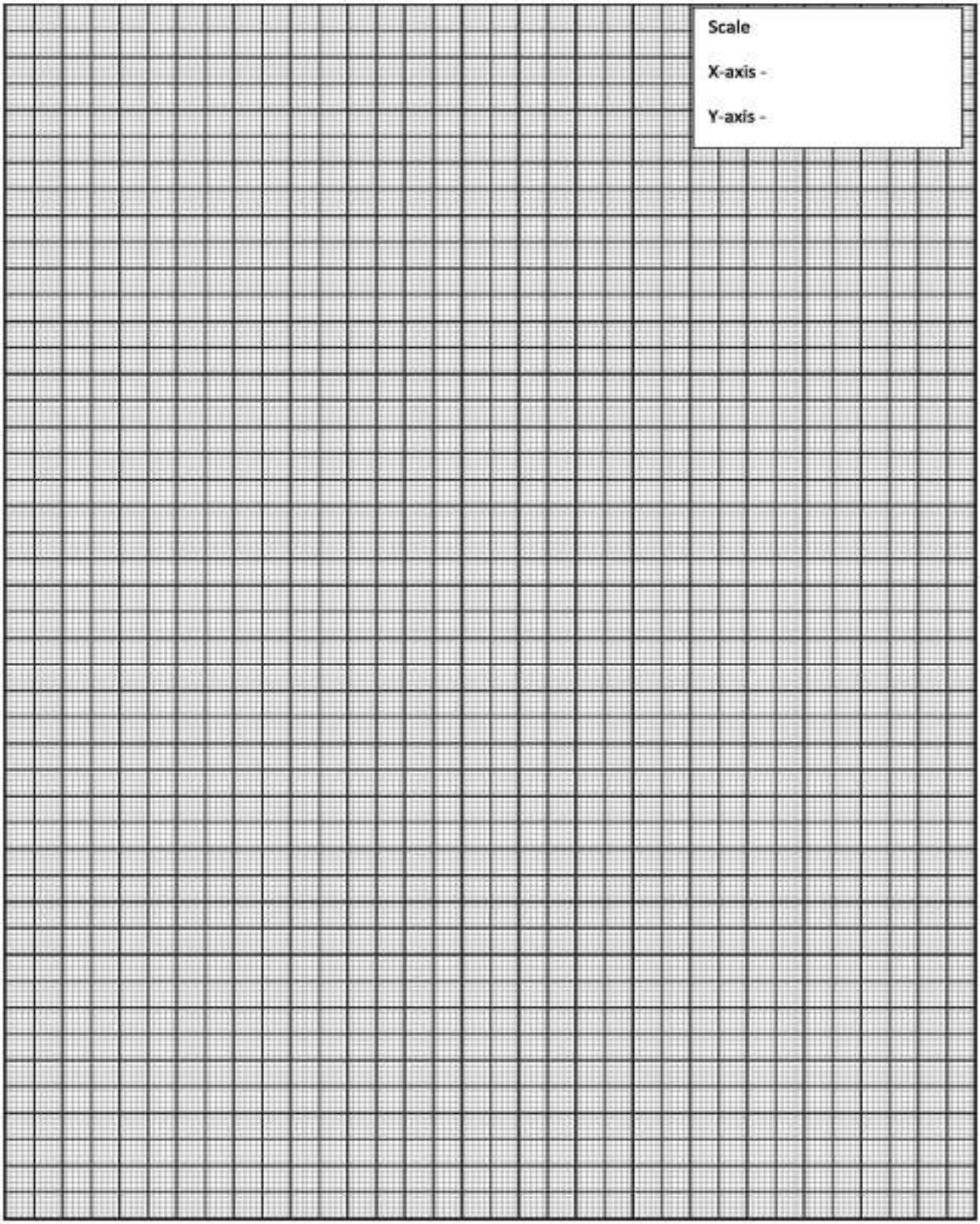
XVIII References / Suggestions for further reading

a. Engineering Physics By Gupta
b. amrita.olabs.edu.in/?=1&brch=6&sim=22&cnt=2
c. cdac.olabs.edu.in/?=74&brch=9&sim=75&cnt=2

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		60 %
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.5: Read Analog meters for measurement of various Electrical Quantities in AC/DC circuits.

I Practical Significance

Understanding the fundamental principles of analog meters and their application in measuring various electrical quantities such as voltage, current, and resistance in both AC and DC circuits.

II Industry /Employer Expected Outcomes(s)

Use relevant measuring instrument in different electrical application.

III Course Level Learning Outcome(s)

Determine various parameters used in electric circuit.

IV Laboratory Learning Outcomes(s)

Able to connect and read multi range analog meter (Voltmeter, Ammeter)

V Relevant Affective Domain related outcomes(s)

Follow safety practices.

VI Relevant Theoretical Background

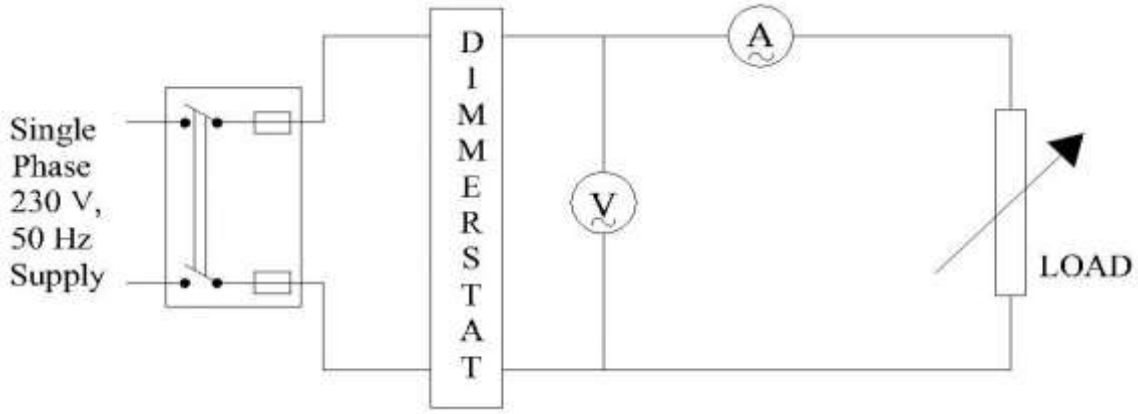
A voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit.

An ammeter (from **Amp**ere **Meter**) is a measuring instrument used to measure the current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the milliampere or microampere.

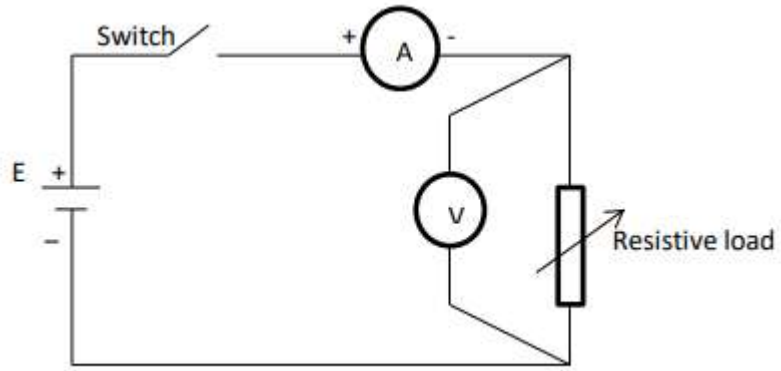
Figure 1: Front View of Ammeter and Voltmeter

VII Circuit diagram

a) Measurement of AC quantities



b) Measurement of DC quantities:



VIII Resources Required

Sr. No.	Name of Resources	Suggested Broad Specification	Quantity
1	Ammeter	Ammeter of suitable range MI/PMMC	1
2	Voltmeter	Voltmeter of suitable range MI/PMMC	1
3	Resistive/Lamp Load	10A,230V,2.5KW	1
4	Single Phase Variac	(0-230V),10A	1
5	Connecting wire	Suitable wires	As required

IX Precaution to be followed

1. Select proper range of meters.
2. Be careful while selecting AC/DC meters
3. Don't increase the current beyond meters capacity.
4. Don't touch the live wire
5. Use autotransformer to vary AC voltage for safety reason.

X Procedure

a. Measurement of AC quantities

1. Make the connections as per the circuit diagram.
2. Check and adjust zero setting of ammeter and voltmeter. (if any)
3. Keep the autotransformer at minimum position.
4. Switch on the supply.
5. Gradually increase the output of autotransformer up to rated voltage.
6. Switch on the load switch/ switches in steps.
7. Note voltmeter and ammeter readings in observation table.
8. Repeat step 6 and 7 four times.
9. Switch off the load and gradually decrease the output of autotransformer to minimum.
10. Switch off the supply.

b. Measurement of DC quantities

1. Make the connection as per circuit diagram.
2. Check and adjust zero setting of ammeter and voltmeter.
3. Rheostat should be on maximum resistance position.
4. Switch ON DC supply.
5. Gradually decrease the resistance by changing the position of sliding contact of rheostat in steps.
6. Note down ammeter and voltmeter reading.
7. Repeat steps 5 to 6 four times and take readings of ammeter and voltmeter.
8. Gradually keep rheostat at maximum resistance position and switch OFF supply.

XI Resources Used

Sr.No.	Name of Resources	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observations and Calculation

a) Measurement of AC quantities

Sr. No.	Voltmeter Reading (Volts)	Ammeter Reading (Amp)
1		
2		
3		
4		
5		

b) Measurement of DC quantities

Sr.No	Voltmeter Reading (Volts)	Ammeter Reading (Amp)
1		
2		
3		
4		
5		

XIV Results

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XV Interpretation of Results (Give meaning of the above obtained results)

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XVI Conclusions and recommendation (Action/decisions to be taken based on the interpretation)

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XVII Practical Related Question

(Note: Below given are few samples questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO)

1. State the difference between AC and DC quantities
2. "An ammeter is always connected in series." Justify this statement.

[Space for Answers]

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XVIII References / Suggestions for further reading

1. Experiments in Basic Electrical Engineering S.K.Bhattacharya K.M.Rastogi ISBN: 978-81- 224-1041-6 New Age International Publications.
2. https://en.wikipedia.org/wiki/Ammeter/voltmeter
3. Electrical Measurements and Measuring Instruments U. A. Bakshi A. V. Bakshl K. A.
4. Bakshi ISBN 9788184314380First Edition 2008 Technical Publications. Pune

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		60 %
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 6: Use of Multimeter and Clip-On meter for the measurement of AC/DC Current, Voltage and Resistance in the given circuit

I Practical Significance

Understanding and demonstrating the application of multimeters and clip-on meters in measuring various electrical quantities such as current, voltage, and resistance in both AC and DC circuits

II Industry/Employer Expected Outcome(s)

To handle Clip –On meter and digital multimeter to measure basic parameters like voltage, current and resistance of the field devices. Therefore this practical will help you to acquire necessary skills**.**

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit.
- Use basic laws of electrical engineering in D.C. Circuit.

IV Laboratory Learning Outcome(s)

Operate Multimeter and Clip-On meter for the measurement of AC/DC Current, Voltage and Resistance in the given circuit.

V Relevant Affective Domain related outcome(s)

- Follow safety practices.

VI Relevant Theoretical Background

Clip meters works on the principle of magnetic induction to make non-contact AC current measurements when electric current flowing through a wire produces a magnetic field. Since alternating current frequently reverses polarity, it causes dynamic fluctuations in the magnetic field which are proportional to the current flow. A current transformer inside the clip meter senses the magnetic fluctuations and converts the value to an AC current reading. This type of measurement is convenient for measuring very high AC currents.

Direct current, however, flows through conductors in a fixed polarity. Consequently, the magnetic field around the conductor does not change and conventional clip meters will register no reading. DC clip meters work on the principle of the Hall Effect. Hall Effect sensors sense the magnetic field caused by current flow which causes a small voltage across the Hall effect sensor. That voltage, which is proportional to current is then amplified and measured.

Clip meter often includes other sensors such as voltmeters, ohmmeters, etc. which increase the versatility of the instrument. These sensors use test leads which plug into the clip meter. As only

current measurement can be made with the clip, other measurements do not benefits from the non-contact nature of the clip.

Fig 1 Front View of Clip on Meter

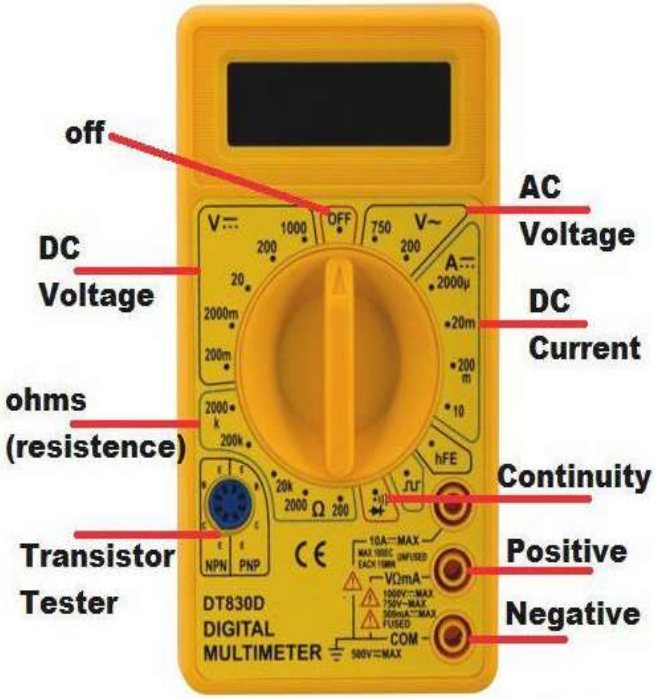
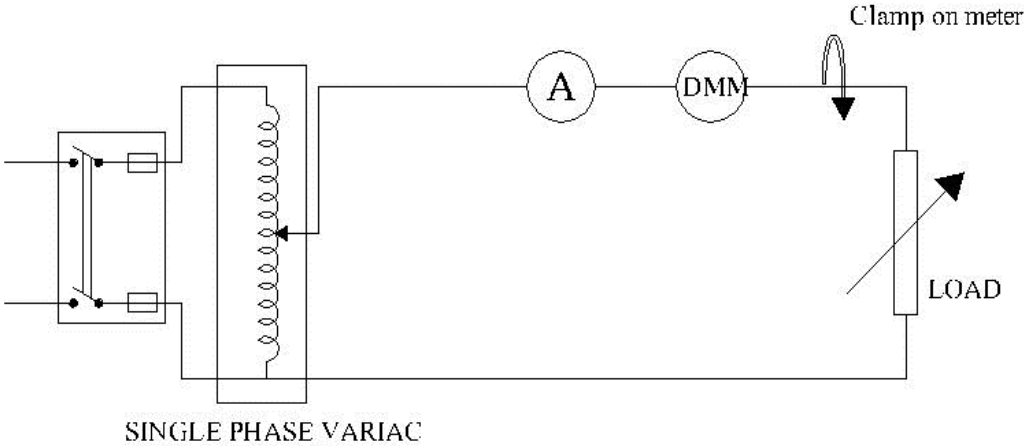


Fig 2 Front View of Digital Multimeter

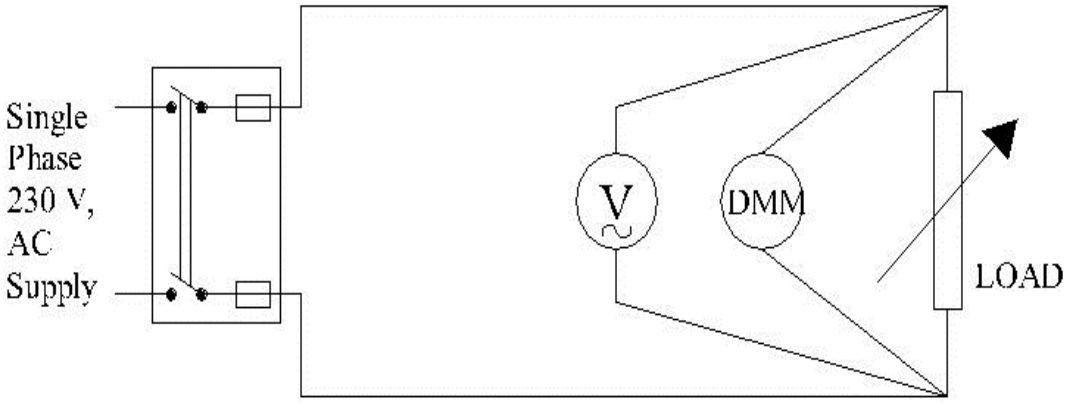
Multimeter is a portable multi range instrument used for measurement of current voltage and resistance .Front panel of digital multimeter consists of Display panel, selector switch, common input connector.

VII Circuit diagram

a) AC Current Measurement



b) AC Voltage Measurement



c) DC Current Measurement (Circuit diagram to be drawn by student under the guidance of teacher)

d) DC Voltage Measurement (Circuit diagram to be drawn by student under the guidance of teacher)

VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
4	Single phase Variac/ Dimmerstat	(0-270V), 4A	1
5	Ammeter	Suitable range PMMC/MI	1
6	Voltmeter	Suitable range PMMC/MI	1
7	Digital Multimeter	Voltage:DC:600Volts;AC:600Volts, Current:DC:20amps;AC:20amps	1
8	Clip on Meter	DCVoltage:600V;AC Voltage:600V, AC Current2A/20A/600A	1
9	EMF source	Suitable range	1
10	Lamp Bank /Lamp Load	5KW	1
11	Rheostat	Suitable range	1

IX Precautions to be followed

1. Select proper range of meters.
2. Be careful while selecting AC/DC meters.
3. Don't increase the current beyond meters capacity.
4. Use dimmerstat for voltage variation in AC.
5. Don't touch the live wires.
6. Set the Clip on meter at correct AC /DC voltmeter ,AC/DC ammeter mode by operating selector switch.
7. Set the DMM at correct AC /DC voltmeter, AC/DC ammeter mode by operating selector switch.

X Procedure

a) AC Current Measurement

1. Connect a circuit as shown in fig for measurement of AC current.
2. Switch ON the supply.
3. Keep dimmerstat at minimum position.
4. Increase the output voltage of dimmerstat up to the rated value.
5. Switch on the load bank switches gradually in steps.
6. Record the current in the observation table after measuring with DMM reading
7. Record the ammeter reading.
8. Record the clip on meter reading by inserting the jaw of the clip on meter in phase wire.
9. Increase the load on by switching on one more switch of the load bank.
10. Repeat steps 6-9 for more readings**.**

b) AC voltage measurement

1. Connect a circuit as shown in fig for measurement of AC Voltage.
2. Switch ON the supply.
3. Keep dimmerstat at minimum position.
4. Increase the output voltage of dimmerstat up to the rated value.
5. Switch on the load bank switches gradually in steps.
6. Record the voltmeter reading.
7. Set the DMM at correct AC voltmeter mode by operating selector switch, record DMM voltage reading.
8. Set the Clip on meter at correct AC voltmeter mode by operating selector switch, record Clip on meter reading.
9. Increase the load on by switching on one more switch of the load bank.
10. Repeat steps 6-9 for more readings.

c) DC Current Measurement

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d) DC Voltage Measurement

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d) Resistance Measurement

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XI Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			
5			
6			
7			
8			

XII Observation table

a) AC Current Measurement

Sr. No.	Clip on meter reading	Ammeter Reading	DMM Reading
1			
2			
3			
4			

b) AC Voltage Measurement

Sr. No.	Clip on meter reading	Voltmeter Reading	DMM Reading
1			
2			
3			
4			

c) DC Current Measurement

Sr. No.	Clip on meter reading	Ammeter Reading	DMM Reading
1			
2			
3			
4			

d) DC Voltage Measurement

Sr. No.	Clip on meter reading	Voltmeter Reading	DMM Reading
1			
2			
3			
4			

e) Resistance Measurement

Sr. No	Resistance measured by Clip on Meter	Resistance measured by DMM
1		
2		
3		
4		

XIII Result(s)

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XIV Interpretation of results

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XV Conclusion and recommendation

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XVI Practical related questions

(Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.)

1. List the minimum and maximum range of current that can be read with clip on meter given to you.
2. State the procedure for continuity test using multi-meter.

[Space for answers]

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XVII References/Suggestions for further reading:

1. Experiments in Basic Electrical Engineering S.K.Bhattacharya K.M.Rastogi ISBN:978-81-224-1041-6 New Age International Publication
2. https://en.wikipedia.org/wiki/current_clip
3. Electrical Measurement and Measuring Instruments U.A.Bakshi A.V.Bakshl K.A.Bakashi ISBN 9788184314380First Edition -2008Technical Publications Pune

XVIII Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		60 %
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 7: Measurement of frequency, Time period, Peak value and average value of given AC waveform using CRO

I Practical Significance

Frequency is an important concept in electrical engineering because it determines the behavior of AC circuits and the performance of electronic devices. An alternating ac waveform is one that varies in both magnitude and direction in more or less an even manner with respect to time. An AC function can mathematically represent either a power source or a single source in the shape of an AC waveform.

II Industry/Employer Expected Outcome(s)

Use single phase AC supply for Electrical and electronic Equipment.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuits.
- Use basic laws of electrical engineering in DC Circuits

IV Laboratory Learning Outcome(s)

Check frequency, Time period, Peak value and average value of given AC waveform using CRO.

V Relevant Affective Domain related outcome(s)

Follow safety rules in the laboratory.

VI Relevant Theoretical Background

Waveform: The shape of the curve obtained by plotting the instantaneous values of voltage or current as ordinate against time is called its waveform.

Time period (T): The time taken in seconds to complete one cycle of an alternating quantity is called its time period. It is generally represented by *T*. Unit of time period is seconds.

$$\boldsymbol{T = \frac{1}{f}}$$

Frequency (F): The number of cycles that occur in one second is called the frequency (*f*) of the alternating quantity.

$$\boldsymbol{F = \frac{1}{T}}$$

Amplitude. The maximum value (positive or negative) attained by an alternating quantity is called its amplitude or peak value. The amplitude of an alternating voltage or current is designated by ***Vm*** or ***Im*** respectively.

Average Value: The average value of a alternating quantity is equal to the average of all its instantaneous values over a period of time.

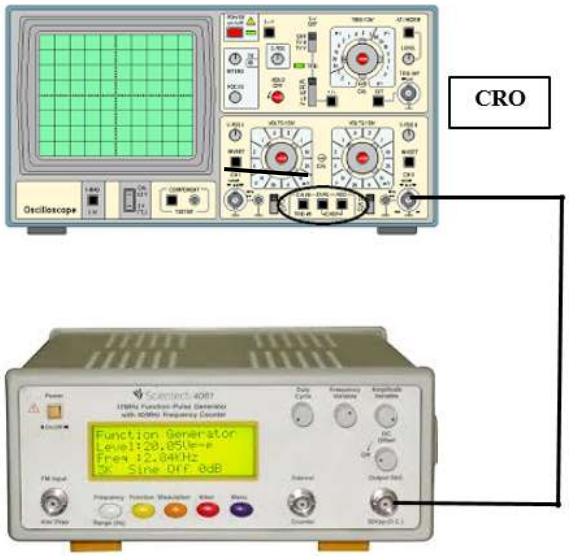
$$Vavg = 0.637Vmax$$

Peak Value: It is the maximum value attained by an alternating quantity. The peak or maximum value of an alternating voltage or current is represented by ***Vm* or *Im*.**

R.M.S Value: The effective or R.M.S. value of an alternating current is that steady current (d.c.) which when flowing through a given resistance for a given time produces the same amount of heat as produced by the alternating current when flowing through the same resistance for the same time.

$$Vrms = 0.707Vmax$$

VII Actual Circuit diagram



VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	CRO with probe	10 Hz- 30 MHz	1
2	Function Generator	0.1 Hz – 11 MHz	1

IX Precautions to be followed:

Connect the function generator output to the CRO's channel using CRO probe properly.

X Procedure

1. Connect the function generator output to the CRO's channel using CRO probe.
2. Adjust the volt per division and time per division of CRO such that the waveform of the current or voltage can be observed properly.
3. Adjust the peak-to-peak value of voltage.
4. Measure and note down the time period and peak value of sine wave.
5. Switch of the supply.

XI Actual Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations

1. **Time** period of AC waveform (T)= …….. division
2. **Time per division=…….**
3. Peak value of ac waveform= ……. Division
4. Volt per division= …….

Calculations

1. Time period of ac waveform (T) = ……..division
   X ……. Time per division = ……. Seconds
2. Peak value of ac waveform= …….. division
   X ……..... volt per division = …… volts
3. Average value of ac waveform = Peak value X 0.637 =…… Volts

XIV Results

1. **Time period:** ……...**seconds**
2. **Peak value:** ……..**volts**
3. **Average value:** ……..... **volts**

XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What is the primary function of a CRO in measuring an AC waveform?
2. State the state condition indicated if vertical line is observed on CRO.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.8: Verification of Kirchhoff's voltage Law

I Practical Significance

Determination of unknown current is possible by setting and solving the equations that represent voltage drops across various elements in the circuit. Kirchhoff's voltage law (KVL) is the base for mesh analysis which is used to analyze circuits with multiple loops.

II Industry/Employer Expected Outcome(s)

Use of Kirchhoff's voltage law to determine current in electric circuits with utmost accuracy and precision is a prime requirement. This practical will help student to interpret complex circuit diagrams and design.

III Course Level Learning Outcome(s)

Use basic laws of electrical engineering in DC Circuits.

IV Laboratory Learning Outcome(s)

Verify Kirchhoff's Voltage Law.

V Relevant Affective Domain related outcome(s)

1. Follow safety rules in the laboratory.

VI Relevant Theoretical Background (With diagrams if required)

It states that **"**The algebraic sum of products of currents and resistances in each of the conductors in any closed path in a network plus the algebraic sum of the e.m.fs in that path is zero".

In other words, $\sum IR + \sum e.m.f. = 0$

Following sign convention is suggested:

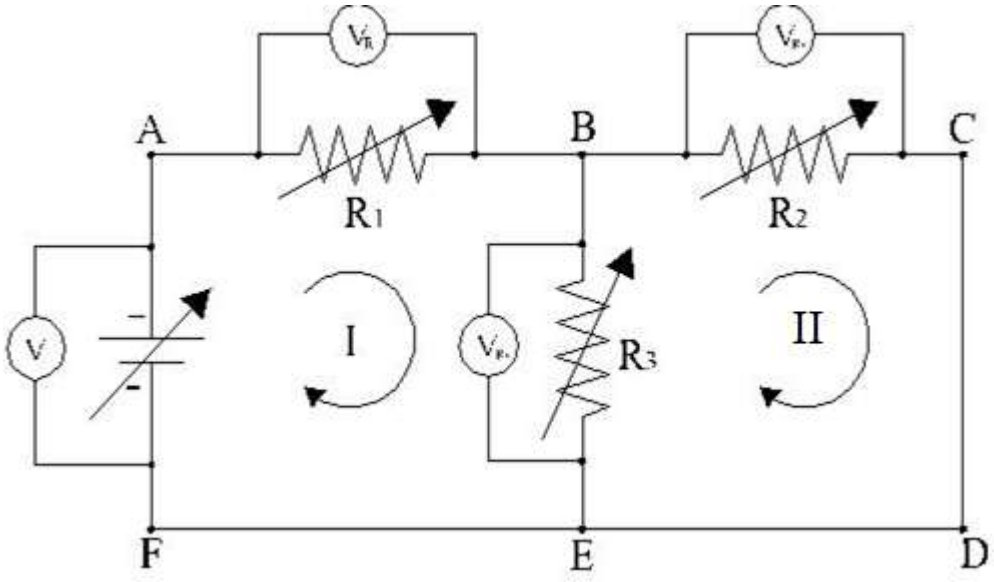
Sign Conventions

a) Battery e.m.f.:

A rise in voltage should be given a + ve sign and a fall in voltage a –ve sign. Keeping this in mind, it is clear that as we move from negative terminal of source to positive terminal, there is a rise in potential, hence this voltage should be given a +ve sign. If, on the other hand, we move from +ve terminal to –ve terminal of voltage source, then there is a fall in potential, hence it is to be considered as –ve.

Sign of IR Drop: Whenever we move in the direction of current there is a drop in voltage, since the current always flows from point at higher potential to the point at lower potential. Hence Voltage drop in the current direction is taken as –ve. However, if we go in a direction opposite to that of the current, then there is a rise in voltage.

VII Circuit diagram



VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF source	Ampere=0-1A Voltage=0-20V	1
2	Voltmeter	Suitable Voltage	4
3	Resistance	Suitable resistor in ohm	3
4	Connecting wires	Suitable Wires	as required

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. First measure the least count of all voltmeters V_1, V_2, and V_3
2. Measure and record the value of each rheostat in circuit diagram.
3. Connect the circuit as shown in the diagram.
4. Switch on the DC Supply & record the readings of voltmeters.
5. Switch OFF the DC Supply.
6. Now, vary any resistance to obtain different readings of voltmeters V_1, V_2 and V_3
7. Repeat the same procedure for different observations.

XI Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations and Calculations

Sr. No.	V1 (I_1R_1) (Volts)	V2 (I_2R_2) (Volts)	V3 (I_3R_3) (Volts)	Supply Voltage (E) (Volts)
1				
2				
3				
4				

Calculations:
For Loop 1:

For Loop 2:

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State Kirchhoff's Voltage Law.
2. Resistance of any material is its bilateral property. True/False

[Space for Answers]

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XVIII References/Suggestions for further reading

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.9: Verification of Kirchhoff's current Law

I Practical Significance

Determination of unknown current is possible by setting and solving the equations that represent currents entering and leaving the node. Kirchhoff's current law (KCL) is base for nodal analysis which is used to analyze circuits with multiple branches.

II Industry/Employer Expected Outcome(s)

Use of Kirchhoff's current law to determine currents in electric circuits with utmost accuracy and precision is a prime requirement. This practical will help student to interpret complex circuit diagrams by applying the principle of conservation of charge at nodes.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit.
- Use basic laws of electrical engineering in DC Circuits.

IV Laboratory Learning Outcome(s)

Verify Kirchhoff's current Law

V Relevant Affective Domain related outcome(s)

Follow safety rules in the laboratory.

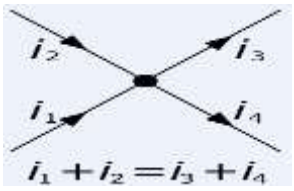
VI Relevant Theoretical Background

It states that **"**In any electrical network, algebraic sum of the currents meeting a point is zero".

OR

The total current leaving a junction is equal to the total current entering that junction. It is obviously true because there is no accumulation or depletion of current at any junction of the network.

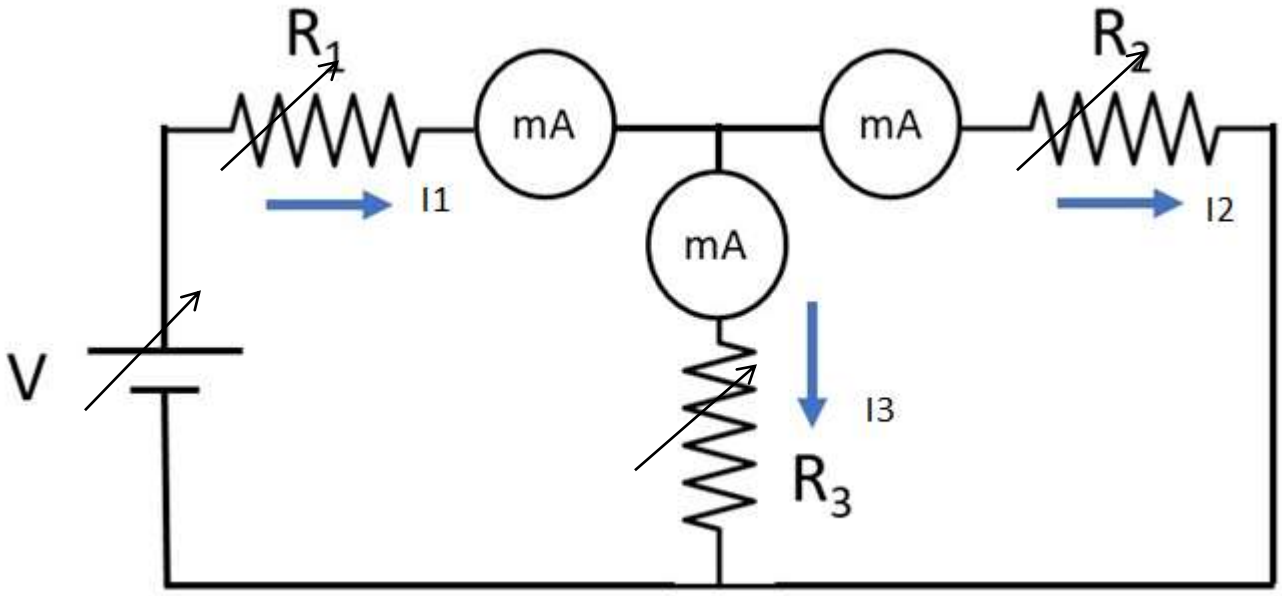
Consider the case of a few current carrying conductors meeting at a node as in fig.



Some conductors have currents leading to node whereas some have currents leading away from node.Assuming the incoming currents to be positive and the outgoing currents negative, applying KCL at node we have,

$$I_1 + I_2 - I_3 - I_4 = 0$$

VII Circuit diagram



VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF source	Ampere=0-1A Voltage=0-20V	1
2	DC milliammeter	Suitable current	3
3	Resistance	Suitable resistor in ohm	2
4	Connecting wires	Suitable wires	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. First measure the least count of all ammeters A_1, A_2, and A_3
2. Measure and record the value of each rheostat in circuit diagram.
3. Connect the circuit as shown in the diagram.
4. Switch on the DC Supply & record the readings of ammeters.
5. Switch OFF the DC Supply.
6. Now, vary any resistance to obtain different readings of ammeters A_1, A_2 and A_3.

7. Repeat the same procedure for different observations.

XI Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations and Calculations

Sr. No.	I_1(mA)	I_2(mA)	I_3(mA)	$I_1 = I_2 + I_3$ (mA)
1				
2				
3				

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State Kirchhoff's Current Law.
2. Resistance of any material is it's a linear property. True/False

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XVIII References/Suggestions for further reading

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 10: Use of rheostat as current regulator and potential divider

I Practical Significance

To understand the use of a rheostat as both a current regulator and a potential divider in electrical circuits, emphasizing its applications in controlling current flow and dividing voltage.

II Industry/Employer Expected Outcome(s)

- Ability to set up electrical circuits incorporating a rheostat.
- Competence in adjusting and calibrating the rheostat for desired current and voltage levels

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit.
- Use basic laws of electrical engineering in D.C. circuits.

IV Laboratory Learning Outcome(s)

Use rheostat as current regulator and potential divider

V Relevant Affective Domain related outcome(s)

Follow safety practices.

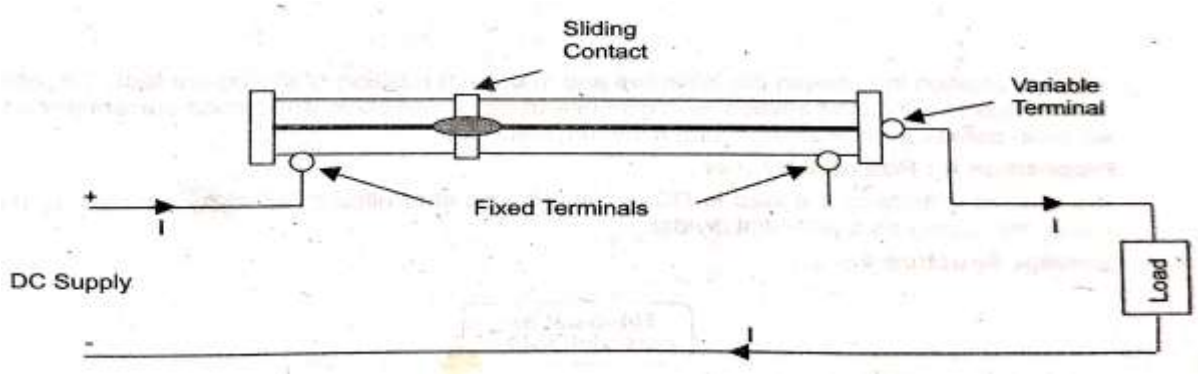
VI Relevant Theoretical Background

A) Current Regulation

Current through the load can be regulated or controlled by varying resistance of the rheostat connected in series with the load.

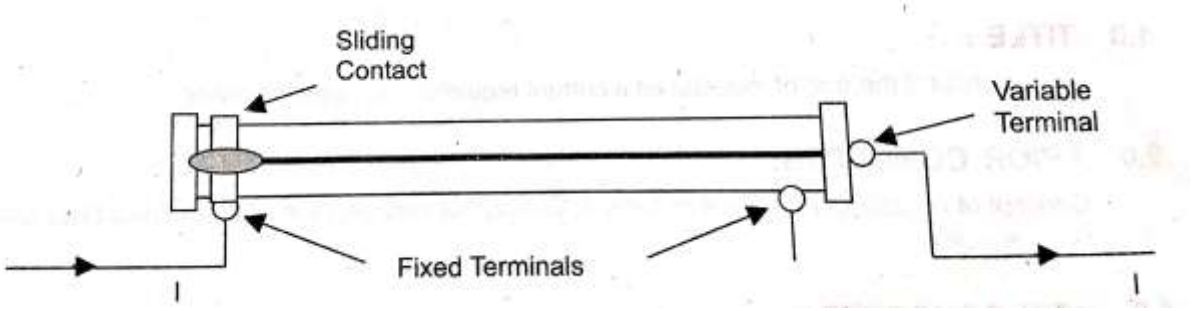
Connection of Rheostat as a Current Regulator

For regulating current through the load, one of the fixed terminal and variable terminal of the rheostat are connected in the circuit.

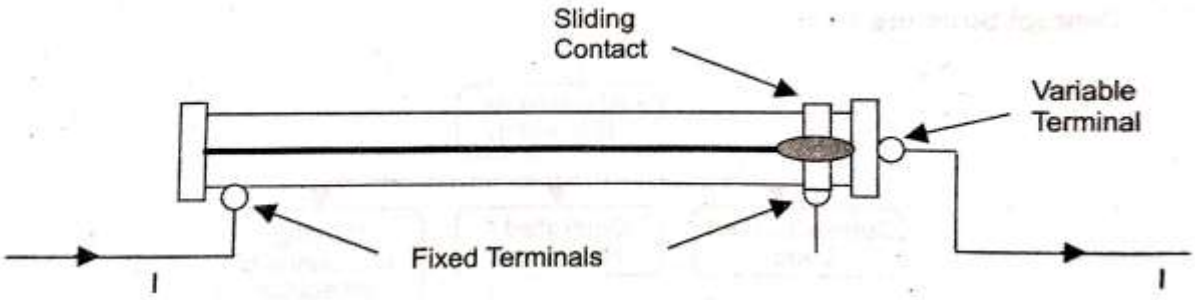


Value of resistance of Rheostat

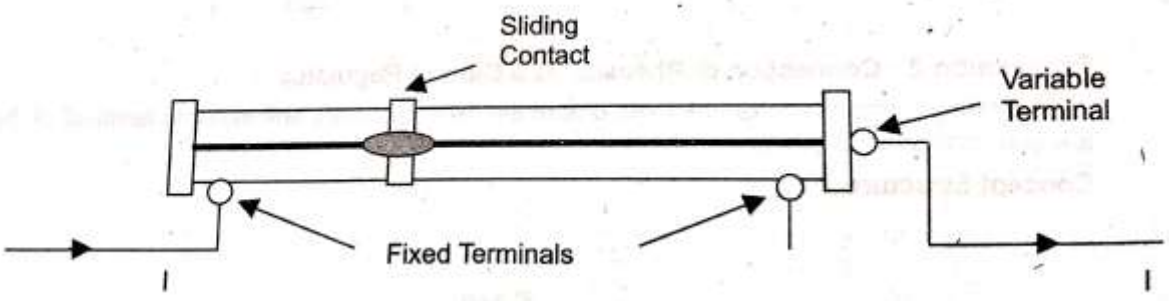
Depending upon the position of sliding contact (i.e. variable terminal) with respect to connected fixed terminal, value of the resistance of the rheostat and hence the current through the load can be regulated or controlled.



(Minimum Resistance position of Rheostat and hence maximum current through load)



(Maximum Resistance position of Rheostat and hence minimum current through load)



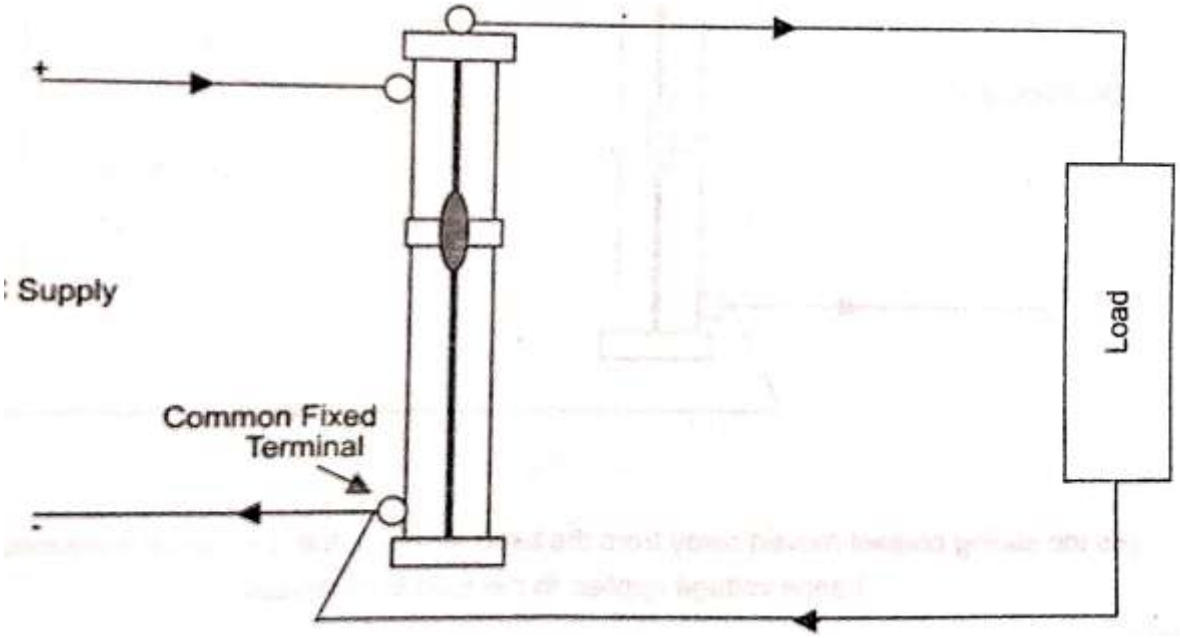
(For any position in between the minimum and maximum position of sliding contact, the resistance of the rheostat will be in between its minimum and maximum value and hence current through load will be in between the maximum and minimum value)

B) Potential divider

The applied voltage to the load in DC circuit can be controlled/varied by connecting rheostat across the supply as a potential divider.

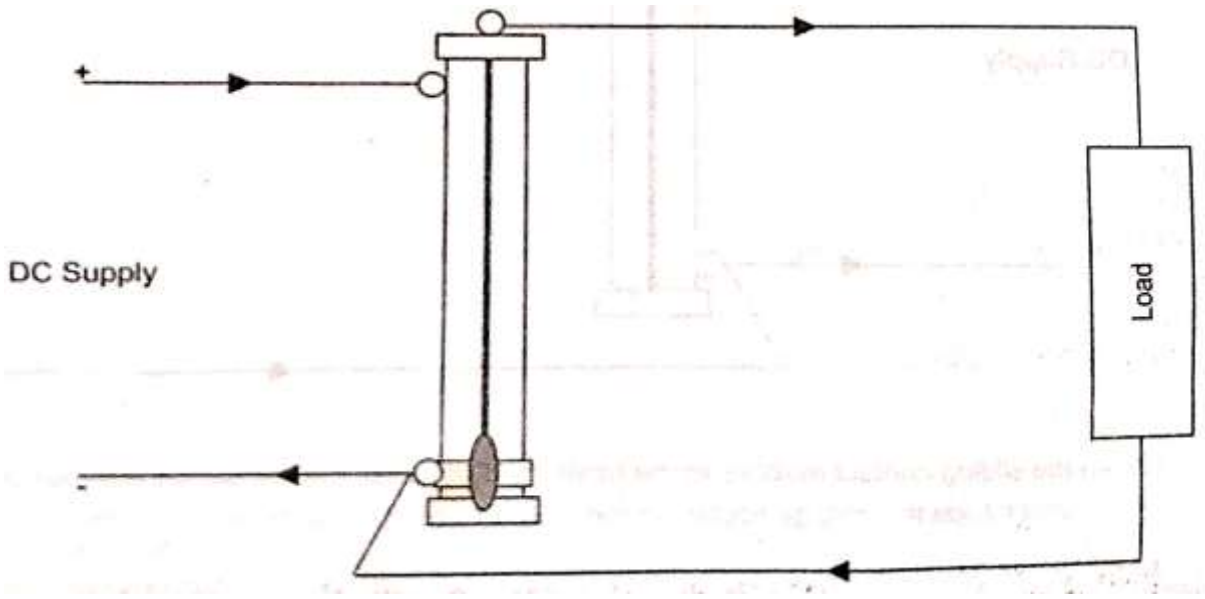
Connecting rheostat as a potential divider

For connecting rheostat as potential divider ,two fixed terminals of rheostat are connected across supply terminals and load is connected between variable terminal and one fixed terminal; which is normally a common negative terminal.

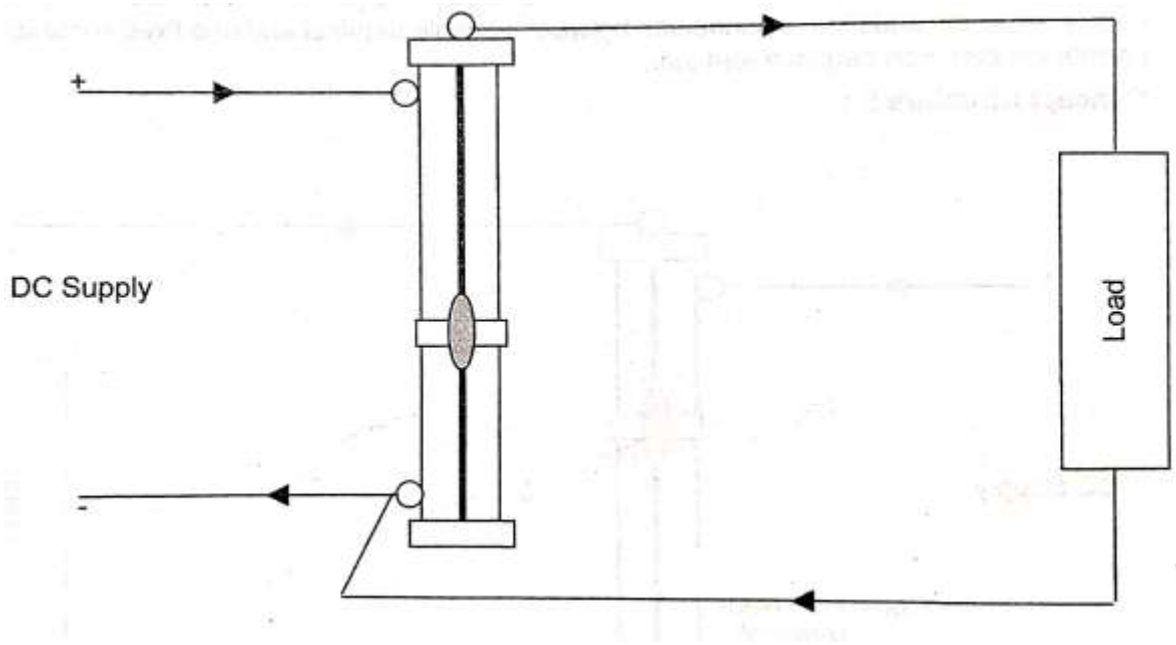


Position of sliding contact for variable voltage

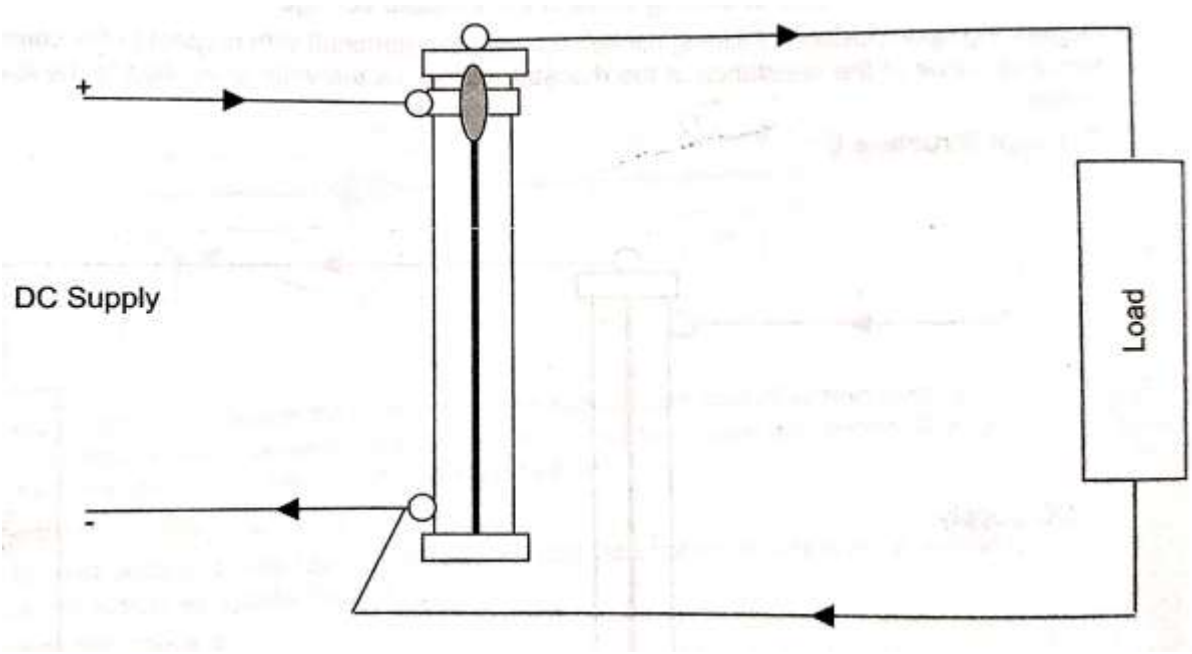
Depending upon position of sliding contact (i.e. variable terminal) with respect to the common fixed terminal, value of the resistance of the rheostat and hence the voltage applied to the load can be varied.



(Minimum Resistance position of Rheostat and
hence voltage applied to the load is minimum i.e. zero)



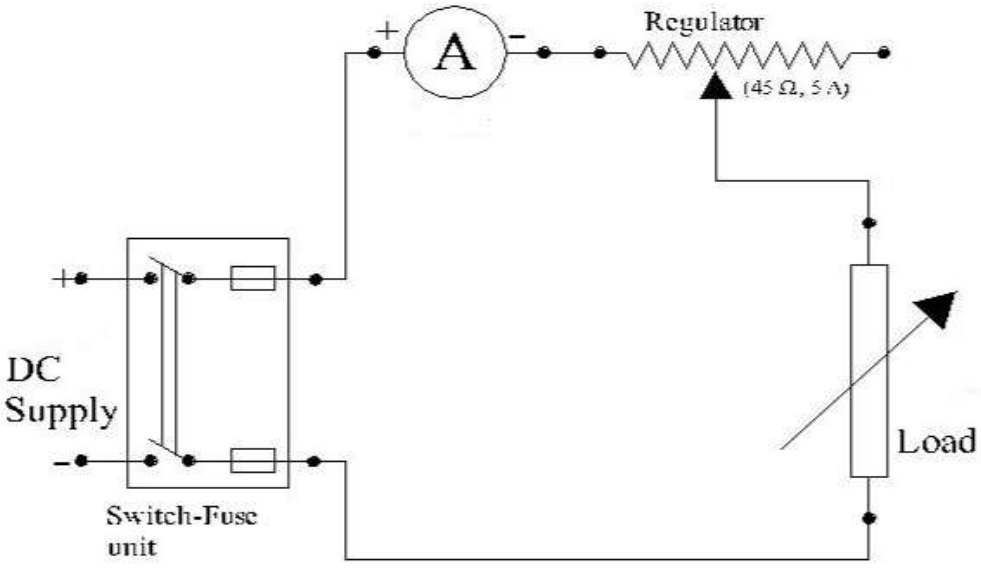
(As the sliding contact moved away from the fixed terminal, hence the resistance increases and hence voltage applied to the load increases)



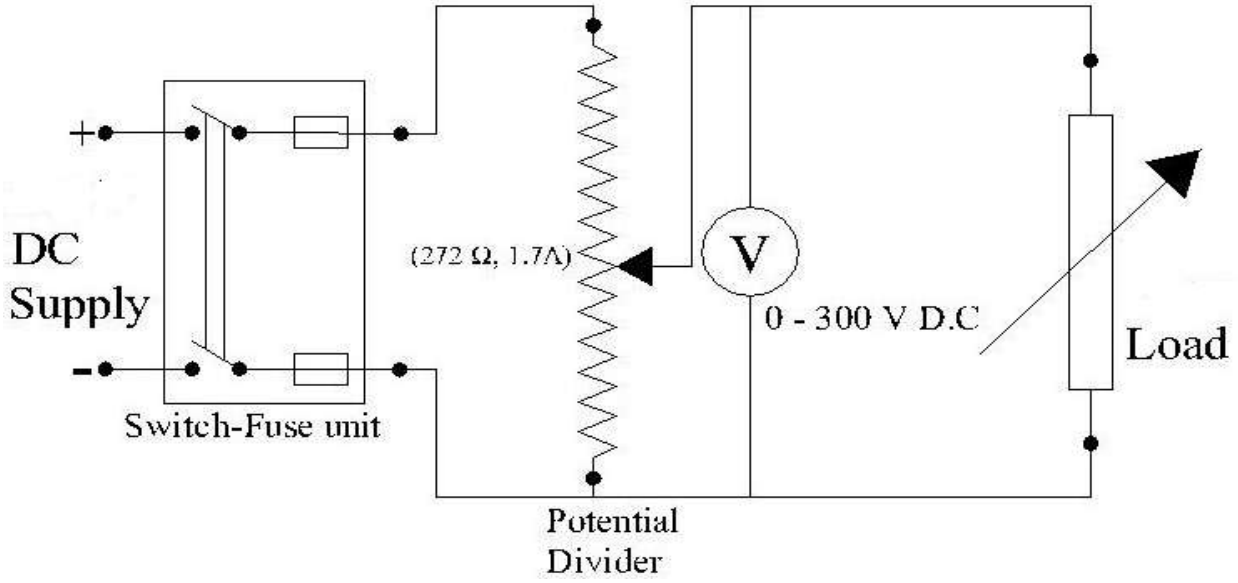
(When the sliding contact reaches at the other fixed terminal, the resistance is maximum and hence the voltage applied to the load is maximum i.e. supply voltage)

VII Circuit diagram

a) Current Regulator



b) Potential divider



VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF source	Suitable range	1
2	DC ammeter	(0-1-2A)	1
3	DC voltmeter	(0-300V)	1
4	Rheostat	Suitable range	2
5	Lamp Load/Rheostat	Suitable range	1
6	Connecting wires	Suitable range	As required

IX Precautions to be followed:

1. Connection should be tight.
2. Appropriate Ohmic and current range should be selected when Rheostat is used as current regulator and as potential divider in order to avoid abnormal heating of rheostats.

X Procedure

a) Rheostat as Current Regulator:

1. Make the connections as shown in circuit diagram-1.
2. Initially keep the sliding contact at maximum resistance position.
3. Switch "ON" the supply and note down the supply voltage and current through load.

4. Move the sliding contact towards the other fixed terminal gradually and note down the respective value of current through load for different positions of sliding contact
5. Finally, take the reading of current through load when the sliding contact is at the minimum resistance position
6. Bring back the sliding contact to maximum resistance position and then Switch "OFF" the supply.

b) Rheostat as Potential Divider

1. Make the connections as shown in circuit diagram-2.
2. Initially keep the sliding contact at minimum resistance position.
3. Switch "ON" the supply and note down the voltage across the load.
4. Move the sliding contact towards the other fixed terminal gradually and note down the respective value of voltage across the load for different positions of sliding contact.
5. Finally, take the reading of voltage across the load when the sliding contact is at the maximum resistance position.
6. Bring back the sliding contact to minimum resistance position and then Switch "OFF" the supply reading.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure

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XIII Observation table

a) Rheostat as Current Regulator:
Supply Voltage= _____V

Sr. No.	Position of Sliding Contact	Current through the Load (Amp)
1	Maximum Resistance	
2		
3		
4	Minimum Resistance	

b) Rheostat as Potential Divider
Supply Voltage= _____V

Sr. No.	Position of Sliding Contact	Voltage across load (Volts)
1	Minimum Resistance	
2		
3		
4	Maximum Resistance	

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

(Note: Below given are few sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO)

1. State the material used for making wire of rheostat. Justify
2. Write the specification of rheostats available in electrical engineering laboratory.

[Space for answers]

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XVIII References/Suggestions for further reading

1) https://www.electrical4u.com/current-divider/

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 11: Determination of PD, EMF and internal resistance of DC source

I Practical Significance

Measurement of Potential Difference (PD), EMF and internal resistance of DC source with utmost accuracy and precision is a prime requirement. Such kinds of measurement are required to get better output voltage from emf source. In this practical we use voltmeter, ammeter to measure internal resistance, EMF and PD.

II Industry/Employer Expected Outcome(s)

Select appropriate sources, designing circuits and ensuring proper operation of electrical system.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit.
- Use basic laws of electrical engineering in D.C. circuits.

IV Laboratory Learning Outcome(s)

Determine PD, EMF and internal resistance of DC source

V Relevant Affective Domain related outcome(s)

Handle tools and equipment carefully**.**

VI Relevant Theoretical Background (With diagrams if required)

a) Nature of Electric Current

An Electric current of which the magnitude and direction remains constant with respect to time is called as Direct Current (DC).

An Electric current of which the magnitude changes at every instant and the direction changes periodically is called as Alternating Current (AC)

b) Concept of EMF, Potential Difference (PD) and Internal Resistance of practical voltage source

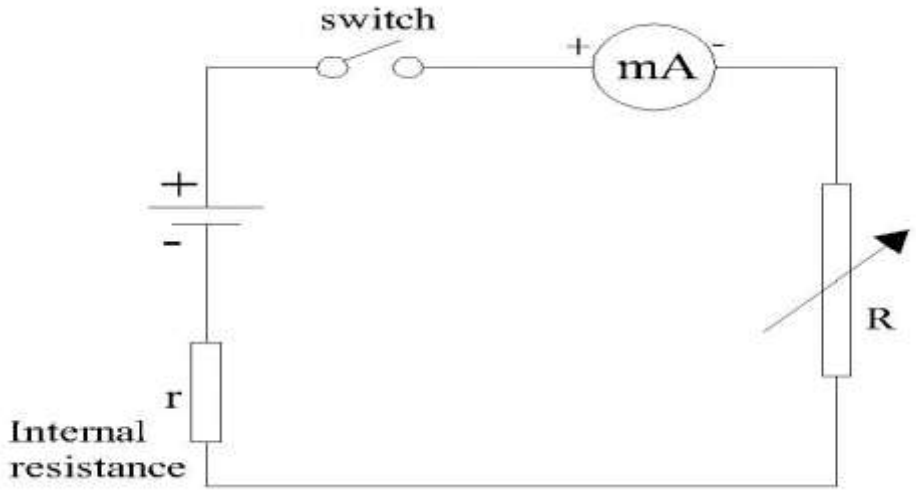
1) **Electro-Motive Force (EMF):** EMF is the force which tends to move electrons i.e. current in an electric circuit.
2) **Potential Difference(PD)**
   Practically, potential difference between the two terminals of the source, when the source is not supplying the load current.
3) **Internal Resistance**
   The internal resistance of DC sources, such as a battery, refers to the inherent resistance within the source itself. When a load is connected to the source and current flows, there is a voltage drop across this internal resistance, which reduces the effective voltage available to the

external circuit. Internal resistance is an important consideration in understanding the behavior of DC sources, especially when connecting it to the external loads.

4) Terminal Voltage

Terminal voltage (V) is the potential difference between the two terminals of the source, when the source is supplying the load current (I).

VII Circuit diagram



VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF source	(0-35V)	1
2	DC ammeter	Suitable range	1
3	DC voltmeter	Suitable range	1
4	Resistive load	Suitable load in ohm	1
5	Switch	Single pole one way switch	1

IX Precautions to be followed

1. Avoid loose connection.
2. Don't touch wire with wet hand.

X Procedure

1) Select the relevant DC source as in circuit diagram.
2) Select the relevant voltmeter, ammeter.
3) Keep the rheostat to its maximum resistance position.

4) Make the connections as per circuit diagram.
5) Switch on the DC supply.
6) Vary the loading rheostat to get suitable value of load current. Note down the reading of ammeter (I).
7) Measure the output voltage of DC source, this give the terminal voltage(V).
8) Repeat the step 6 and 7 to get at least 4 readings.
9) Bring back the loading rheostat to its maximum resistance position.
10) Switch off the supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			
5			

XII Actual Procedure

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XIII Observation and calculation

Sr. No.	E.M.F(E) (Volt)	Load Current(I) (Amp)	Observed Terminal Voltage(V) (Volt)	Voltage Drop across Internal resistance $IR_i = (E-V)$ (Volt)	Internal resistance $R_i = \frac{(E-V)}{I}$ (Ohm)

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

(Note: Below given are w sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.)

1.List the sources of AC current.

2. List the sources of DC current.

3. Give application of storage battery.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.12: Verification of two/three resistances connected in series connection.

I Practical Significance

Behavior of series connected resistances is important in circuit analysis and design as student can calculate total equivalent resistance, determine voltage and current distributions.

II Industry/Employer Expected Outcome(s)

Determination of the equivalent resistance of series connection with utmost accuracy and precision is a prime requirement. Such kind of measurements are possible using measuring instruments like voltmeter, ammeter etc. In this practical we use voltmeter, ammeter to measure the series resistance.

III Course Level Learning Outcome(s)

1. Determine various parameters used in electric circuit.
2. Use basic laws of electrical engineering in D.C. Circuits.

IV Laboratory Learning Outcome(s)

Verify Kirchhoff's Voltage Law.

V Relevant Affective Domain related outcome(s)

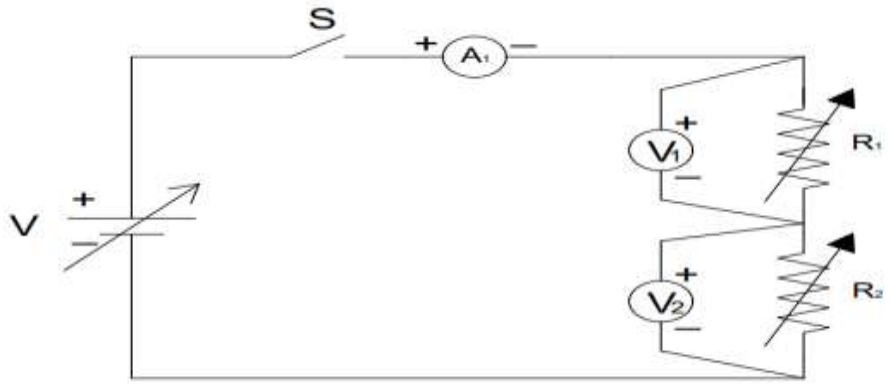
Verify the properties of circuit of series connected resistance.

VI Relevant Theoretical Background (With diagrams if required)

When two or more resistances are in series if they are cascaded or connected sequentially, consequently carry the same current. The equivalent resistances of any number of resistors connected in series is the sum of the individual resistances.

$$R_T = R_1 + R_2 + R_3 + \cdots + R_n$$

VII Circuit diagram



VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF source	ampere=0-1A Voltage=0-20V	1
2	Voltmeter	Suitable voltage	2
3	DC milliammeter	Suitable current	1
4	Resistive load	Suitable load in ohm	1
5	Series resistance	Suitable resistance in ohm	2
6	Connecting wires	Suitable wire	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. Measure the values of resistances to be connected in series by multimeter before connecting them in series.
2. Connect the resistances in series along with ammeters.
3. Switch "ON" the supply .
4. Take readings of ammeters and measure voltage across each resistance and supply voltage.
5. Switch "OFF" the supply

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			
5			
6			

XII Actual Procedure Followed

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XIII Observations and Calculations

R_1 = ______Ω, R_2 =_____ Ω,

V1 (V)	I (Amp)	$R_1 = \frac{V1}{I}$ (Ω)	V2 (V)	$R_2 = \frac{V2}{I}$ (Ω)	$R_T=R_1+R_2$ (Ω)	V (V)

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the values of resistances available in laboratory.
2. Give applications of Series resistance.
3. Whether loads in your house are connected in series or parallel?
4. How many numbers of paths of current are there in series circuit?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		60 %
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.13: Verification of two/three resistances connected in parallel connection.

I Practical Significance

Determination of the equivalent resistance of Parallel connection with utmost accuracy and precision is a prime requirement. Such kind of measurements are possible using measuring instruments like voltmeter, ammeter etc. In this practical we use voltmeter, ammeter to measure the series resistance.

II Industry/Employer Expected Outcome:

The behavior of parallel connected resistances is important in circuit analysis and design. One can calculate total equivalent resistance, determine voltage, and current distributions using the formula directly.

III Course Level Learning Outcome

Use basic laws of electrical engineering in DC Circuits

IV Laboratory Learning Outcome

Verify properties of circuit of parallel connected resistance.

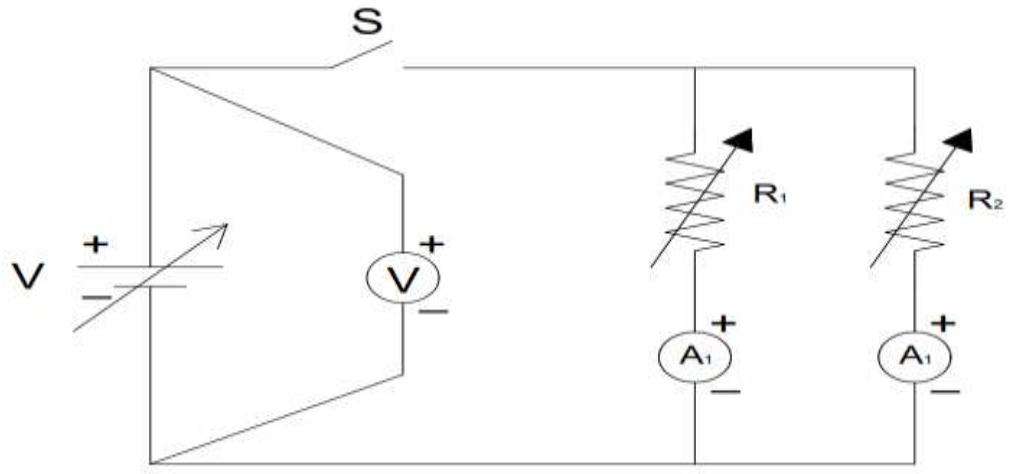
V Relevant Affective Domain related outcome

Follow safety rules in the laboratory.

VI Relevant Theoretical Background

When two or more resistances are in parallel consequently, they have the same voltage across them. The supply current is equal to sum of currents of all branches of parallel circuit. The equivalent resistances of any number of resistors connected in parallel are always less than all individual resistance of each branch.

VII Circuit diagram



VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF source	ampere=0-1A Voltage=0-20V	1
2	Voltmeter	Suitable voltage	1
3	DC milliAmmeter	Suitable current	2
4	Resistance	Suitable resistance in ohm	2
5	Switch	One way Switch	1
6	Connecting Wires	Suitable wires	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. Select the relevant DC source.
2. Select the relevant voltmeter, ammeter.
3. Connect the circuit as shown circuit diagram.
4. Switch on the DC supply.
5. Vary the rheostat to change the current.
6. Record the voltmeter (V) and ammeter (I) readings in the observation table.
7. Determine the voltage across resistance R1 and R2.
8. Repeat steps 5 to 7 for three more sets of readings maintaining supply voltage constant.
9. Switch off the supply.
10. Calculate equivalent resistance.

XI Resources Used

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
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XII Actual Procedure Followed

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XIII Observations and Calculations

Sr. No.	V (Volts)	I_1 (Amps)	$R = \frac{V}{I1}$ (Ohm)	I_2 (Amps)	$R = \frac{V}{I2}$ (Ohm)	$R_T = \frac{(R1 * R2)}{(R1 + R2)}$ (Ohm)

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the types of resistances available in laboratory.
2. Give applications of Parallel resistance.
3. How many paths of current are there in parallel circuit?
4. Comment on voltage across each resistance connected in parallel.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No .14: Plot the charging characteristics of capacitor and find time constant (RC)

I Practical Significance

The time constant of the RC circuit observed from charging curve influences the circuit's response time, filtering performance, signal processing characteristics and overall stability. Controlling the time constant is essential for designing and analyzing the circuit.

II Industry/Employer Expected Outcome(s)

In industries, measurement of time constant of RC circuit with utmost accuracy and precision is a prime requirement. Such kind of measurements are possible using measuring instruments like voltmeter, ammeter etc.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit.
- Use capacitor and battery in electrical circuits.

IV Laboratory Learning Outcome(s)

Determine the time constant (RC) by plotting the charging curves of a capacitor (C) through resistor (R).

V Relevant Affective Domain related outcome(s)

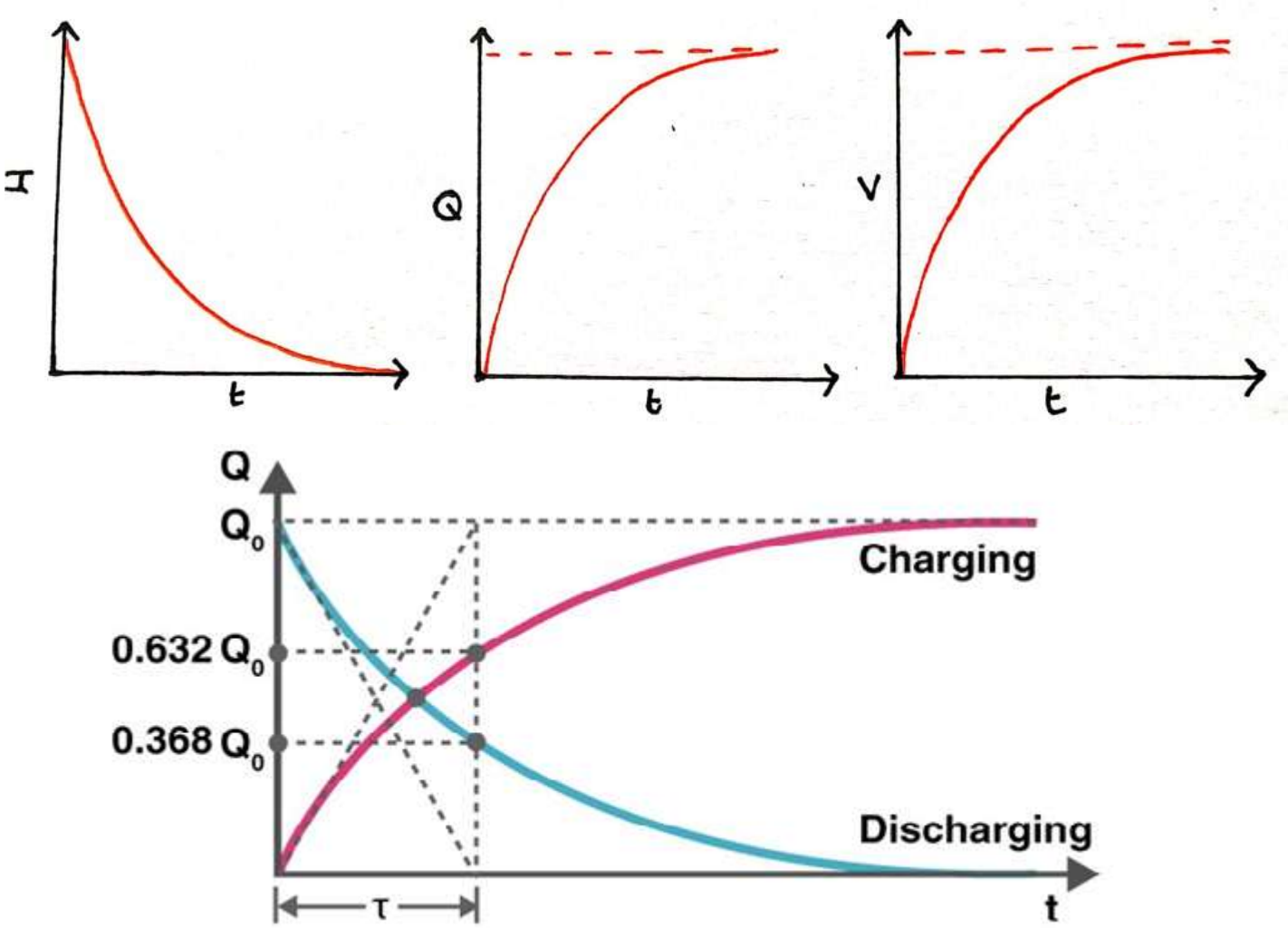
Follow safety rules in the laboratory.

VI Relevant Theoretical Background

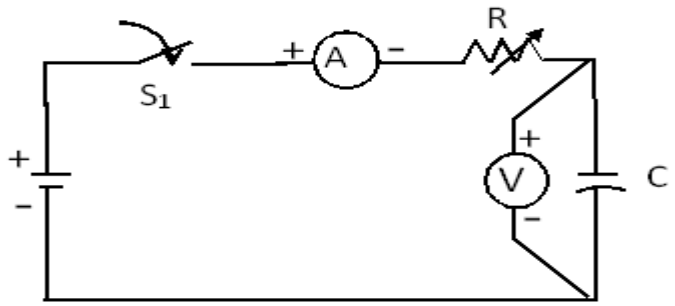
When a DC voltage is applied across a series circuit containing a resistor and the capacitor, electrons flow towards one plate and away from other plate resulting in negative charge on one plate and positive charge on other plate, this process is called as charging of capacitor.

The charging of capacitor in an RC circuit occurs when a voltage is applied across the circuit.(Behavior of Graph is shown in the diagram)

Charging Curves of current, charge and voltage



VII Circuit diagram



VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF source	Ampere=0-1uA Voltage=0-20V	1
2	Voltmeter	Suitable voltage	1
3	Ammeter	Suitable current	1
4	Capacitor	Suitable capacitor	1
5	Resistance	Suitable resistance	1
6	Stopwatch	Suitable stopwatch	1
7	Connecting Wires	Suitable wires	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don’t touch wire with wet hands.
3. Discharge the capacitor completely before connecting the circuit.

X Procedure

1. Select the resistance and capacitor.
2. Select the relevant voltmeter, ammeter.
3. Connect as per circuit diagram.
4. Determine the charging current.
5. Vary the resistance & measure the charging current.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observation table

Sr. No.	Voltage across capacitor (volt)	Time(sec)	Charging current (Amp)

Analytical Treatment for verification

R=_____Ohm, C=_____µF, □=R*C=_____Seconds

Graphical Treatment

i) Mark the point P on charging curve corresponding to 63.2% of final steady state voltage.

ii) Draw a perpendicular PQ on X-axis from point P.

iii) Observe _____Seconds from graph

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define charging time of a capacitor.

2. Write mathematical expression for charging current.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://en.wikipedia.org/wiki/Capacitor
2. www.howstuffworks.com
3. www.electricaltechnology.org
4. www.electrical4u.com

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.15: Plot the Discharging characteristics of capacitor and find time constant (RC)

I Practical Significance

The time constant of the RC circuit observed from charging curve influences the circuit's response time, filtering performance, signal processing characteristics and overall stability. Controlling the time constant is essential for designing and analyzing the circuit.

II Industry/Employer Expected Outcome(s)

In industries, measurement of time constant of RC circuit with utmost accuracy and precision is a prime requirement. Such kind of measurements are possible using measuring instruments like voltmeter, ammeter etc.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuits.
- Use capacitor and battery in electrical circuits.

IV Laboratory Learning Outcome(s)

Determine time constant (RC) by plotting discharging curves of a Capacitor(C) through resister(R)

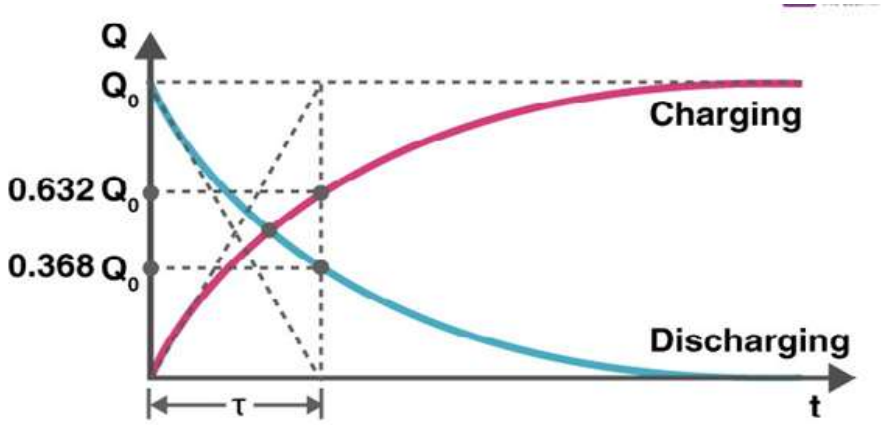
V Relevant Affective Domain related outcome(s)

Follow safety rules in the laboratory.

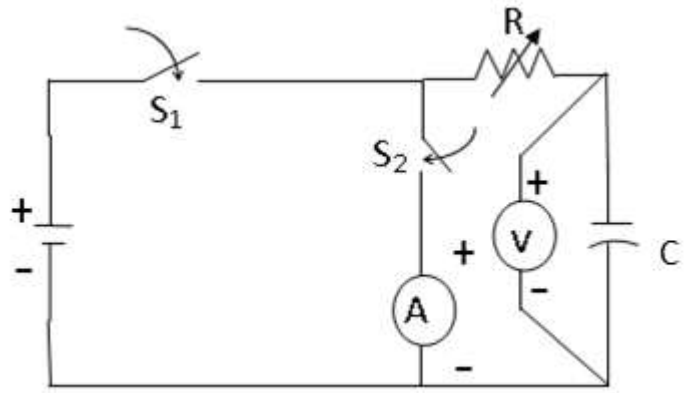
VI Relevant Theoretical Background

When a DC voltage is applied across a series circuit containing a resistor and the capacitor, electrons flow towards one plate and away from other plate resulting in negative charge on one plate and positive charge on other plate, this process is called as charging of capacitor.

The charging of capacitor in an RC circuit occurs when a voltage is applied across the circuit.(Behavior of Graph as shown in the diagram)



VII Circuit diagram



VIII Required Resources

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF source	Voltage=0-20V	1
2	Voltmeter	Suitable voltage	1
3	Ammeter	Suitable current	1
4	Capacitors	Suitable capacitor	1
5	Resistance	Suitable resistance	1
6	Stopwatch	Suitable stopwatch	1
7	Connecting Wires	Suitable wires	As per requirement

IX Precautions

1. Avoid loose connections.
2. Don't touch wire with wet hands.
3. Don't let the capacitor discharge before connecting the circuit.

X Procedure

1. Select the resistance and capacitor.
2. Select the relevant voltmeter, ammeter.
3. Connect as per circuit diagram.
4. Determine the discharging current.
5. Vary the resistance & measure the discharging current.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observation table

Sr. No.	Voltage across capacitor (volt)	Time (sec)	Discharging current (Amps)
1			
2			
3			
4			
5			
6			
7			
8			

Analytical Treatment for verification-

R=_____Ohm, C=_____µF, □=R*C=_____Seconds

Graphical Treatment-

i) Mark the point S on discharging curve corresponding to 36.8% of initial maximum value of voltage.

ii) Draw a perpendicular ST on X-axis from point S.

iii) Point T on X axis indicates time constant.

iv) Observe =_____Seconds from graph.

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define discharging time of a capacitor.
2. Write mathematical expression for discharging current.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. https://en.wikipedia.org/wiki/Capacitor
2. www.electrical4u.com
3. www.howstuffworks.com
4. www.electricaltechnology.org

XIV Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 16 : Verification of equivalent capacitances in series connected circuits.

I Practical Significance

Capacitors I series can be used to filter certain frequencies from signals create a time delay in signal processing circuits, smoothing out voltage fluctuations in power supplies, voltage dividers and sensor circuits. Hence understanding of series connected capacitance in the circuit is essential.

II Industry/Employer Expected Outcome(s)

In industries, measurement of equivalent capacitance with utmost accuracy and precision is a prime requirement. Such kind of measurements are possible using measuring instruments like voltmeter, ammeter etc.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit.
- Use capacitor and battery in electrical circuits.

IV Laboratory Learning Outcome(s)

Find the equivalent capacitance in series connected circuits.

V Relevant Affective Domain related outcome(s)

Follow safety rules in the laboratory

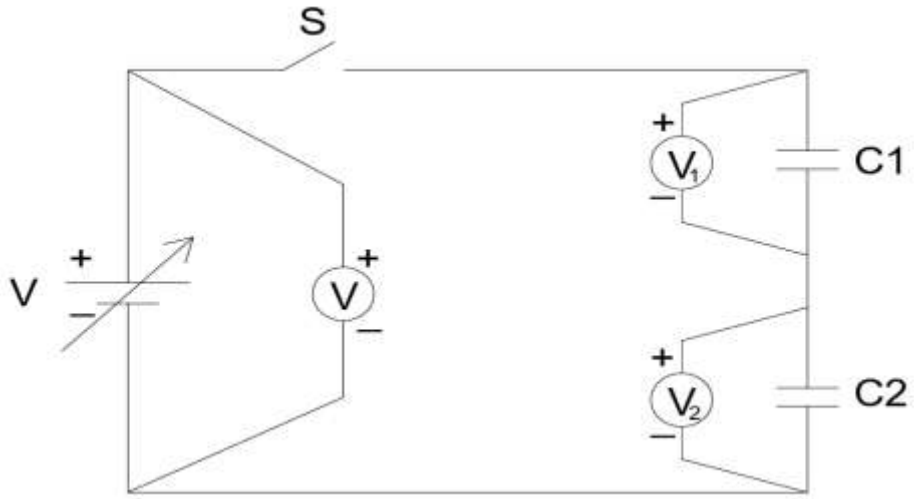
VI Relevant Theoretical Background

A series combination of three capacitors arranged in a row within the circuit. When this series combination is connected to a battery with voltage V, each of the capacitors acquires an identical charge Q. The charge on plate connected to positive terminal of the battery is +Q and the charge on the plate connected to the negative terminal is Q. Charges are then induced on the other plates so that the sum of the charges on all plates, and sum of the charges on any pair of capacitor plates is zero. However, the potential drop $V_1=Q/C_1$ on one capacitor may be different from the potential drop $V_2=Q/C_2$ on another capacitor as capacitors may have different capacitances. Any number of capacitors connected in series is equivalent to one capacitor whose capacitance (Equivalent Capacitor) is smaller than smallest of the capacitances in the series combination. The charge on this equivalent capacitor is same as the charge on any capacitor in series combination. i.e., all capacitors of a series combination have the same charge.

If C_s is equivalent Series Capacitance of the combination:

$$\frac{1}{Cn} = \frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \cdots . + \frac{1}{Cn}$$

VII Circuit diagram



VIII Required Resources

S. No.	Name of Resource	Suggested Broad Specification	Quantity
12	EMF source	Ampere=0-1A Voltage=0-20V	1
13	Voltmeter	Suitable voltage	1
14	Capacitor	Suitable capacitor in farad	2
4	Switch	One way Switch	1
5	Connecting Wires	suitable wires	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.
3. Discharge all the capacitors completely before connecting the circuit.

X Procedure

1. Select the capacitors.
2. Connect as per circuit diagram.
3. Select the relevant voltmeter, ammeter.
4. Determine the Parallel capacitance.
5. Vary the capacitor & measure the equivalent capacitance.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observation table

C_1 = _____µF, C_2 = _____µF

Sr. No.	V (volts)	I (Amp)	V_1 (volts)	V2 (volts)
1				
2				
3				
4				

$V=V_1 + V_2$

$Q=C_T V$

C_T =_____ µF

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Two capacitances of 5 µF and 7 µF are connected in series. Find their equivalent capacitance.
2. Write the formula for equivalent capacitance of series connected capacitances.
3. The equivalent capacitance is _____ than any one of the series capacitors' individual capacitances. (Less/Greater)

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XVIII References/Suggestions for further reading

4. www.electrical4u.com
5. www.howstuffworks.com
6. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.17: Verification of equivalent capacitances in parallel connected circuits.

I Practical Significance

Capacitors in parallel can be used in a wide range of electronic devices and systems, particularly in terms of energy storage, signal processing circuits, power quality improvement. Hence understanding of parallel connected capacitance in the circuit is essential.

II Industry/Employer Expected Outcome(s)

In industries, measurement of equivalent capacitance with utmost accuracy and precision is a prime requirement. Such kind of measurements are possible using measuring instruments like voltmeter, ammeter etc.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit.
- Use capacitor and battery in electrical circuits.

IV Laboratory Learning Outcome(s)

Find the equivalent capacitance of the parallel connected circuits.

V Relevant Affective Domain related outcome(s)

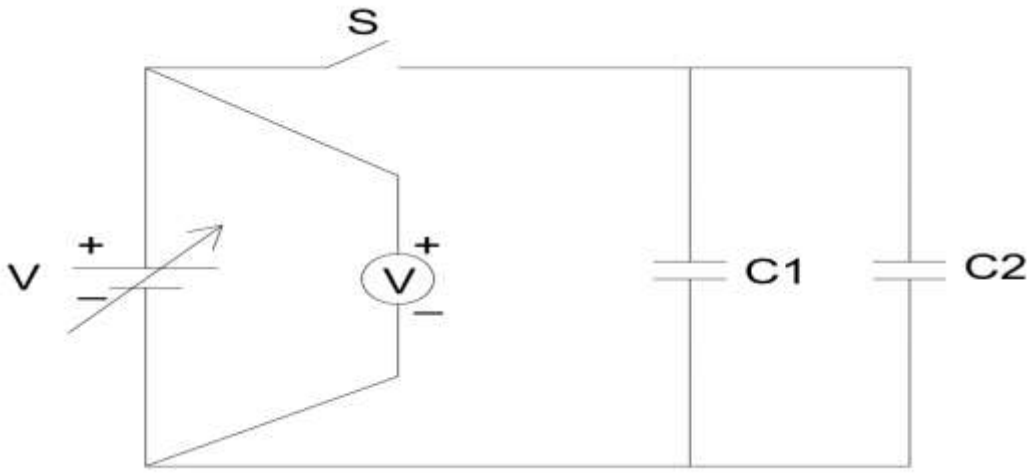
Follow safety rules in the laboratory.

VI Relevant Theoretical Background

When capacitors are connected in parallel, they all have the same voltage across their plates. However, each capacitor in the parallel network may store a different charge. To find the equivalent capacitance Cp of parallel network, we note that the total charge Q stored by the network is the sum of all the individual charges. The equivalent Capacitor of two capacitances connected in parallel is:

$$CT = C1 + C2$$

VII Circuit diagram



VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF source	Ampere=0-1A Voltage=0-20V	1
2	Voltmeter	Suitable voltage	1
3	Capacitor	Suitable capacitor in microfarad	2
4	Switch	One way Switch	1
5	Connecting Wires	Of suitable gauge	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.
3. Discharge all the capacitors completely before connecting the circuit.

X Procedure

1. Select the capacitors and the relevant voltmeter and ammeter. .
2. Connect as per circuit diagram.
3. Switch ON the supply and take the readings of ammeters and voltmeter.
4. Switch OFF the supply.
5. Determine the equivalent Parallel capacitance.
6. Vary the capacitor & measure the equivalent capacitance.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations and calculations

C_1 = ___ µF, C_2 = ___ µF

$V = V_1 = V_2$

$C_T = C_1 + C_2$ µF

$Q = (C_1 + C_2)\ V = C_T V$=

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List out the various capacitors available in the market
2. Write applications of capacitors.
3. Write the formula for equivalent capacitance of parallel connected capacitances.
4. The equivalent capacitance is _____ than any one of the parallel capacitors' individual capacitances. (Less/Greater)

[Space for Answers]

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XVIII References/Suggestions for further reading:

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related: 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.18: Plot the rise characteristics of electric current in a circuit consisting of Resistance and inductance

I Practical Significance

The energy stored in an inductor is a fundamental concept in applications like electrical transformers, high frequency circuits and designing electronic circuits and designing electronic circuits for specific functions.

II Industry/Employer Expected Outcome(s)

Rise and decay characteristics of inductor play vital role in many applications like tuning circuits, Sensors, Store energy in a device, Induction motors, Transformers, filters, chokes, Ferrite beads etc.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit
- Use principles of magnetism in magnetic circuit

IV Laboratory Learning Outcome(s)

Determine the rise characteristics of electric current in a circuit consisting of resistance and inductance

V Relevant Affective Domain related outcome(s)

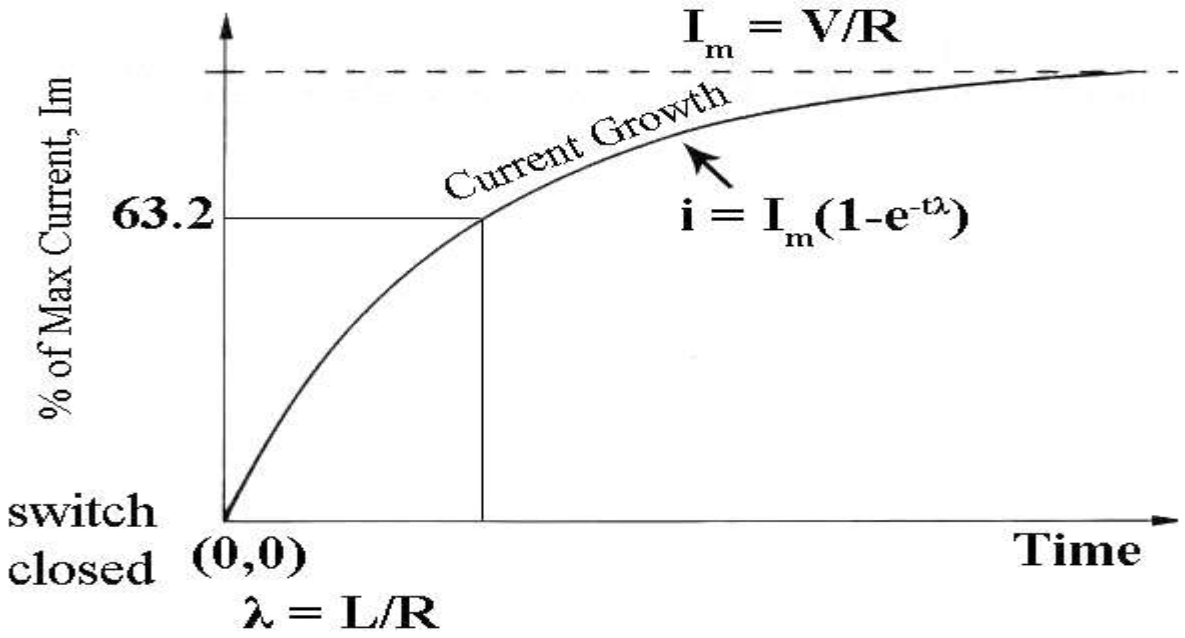
Follow safety rules in the laboratory.

VI Relevant Theoretical Background

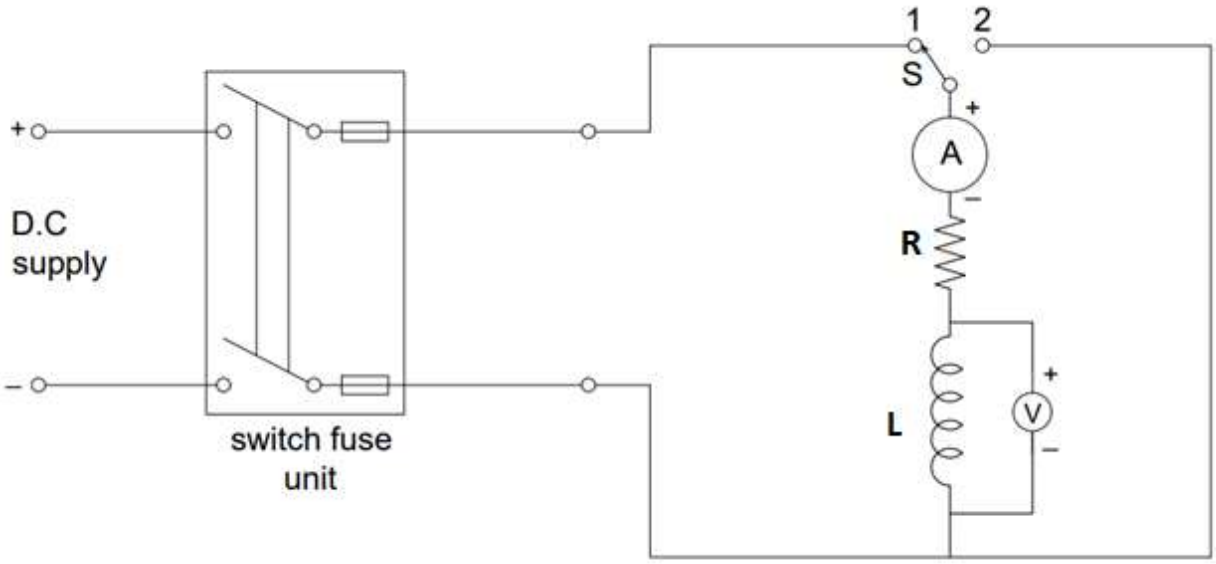
When a circuit consisting of Resistance and inductance in series is connected to DC Supply, the current in the circuit rises gradually and attains its maximum value after certain time period.

The rise of current takes place in an exponential manner and the maximum value of current in the circuit is V/R Ampere. When current rises gradually, energy gets stored in an inductance.

The time required for the current to reach the 63.2% of its maximum value is given by L/R Seconds and called as time constant of inductive circuit.



VII Circuit diagram



VIII Required Resources

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Battery or DC Supply	0-30V	1 No
2	A Choke Coil or a resister in series with inductor	Suitable range	1 No
3	Single Pole Two Way Switch	NA	1 No
4	Digital Multimeter	NA	1 No
5	Stopwatch	NA	1 No

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. Connect the circuit as shown in the diagram
2. Put the switch 'S' on position 1.
3. Switch ON the supply
4. Gradually increase the voltage to initiate the current flow.
5. Take readings on ammeter at every 5 seconds and record till current attains steady or constant value.
6. Switch OFF the supply.
7. Plot the observed current values against time to visualize the rise characteristics.
8. Confirm the prediction and conclude.

XI Resources Used

S. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations

Sr. No.	Time in Seconds	Current in Ampere	Voltage in Volts
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3			
4			
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6			
7			
8			
9			
10			
11			
12			

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define Inductance and State its Unit.
2. Referring the circuit diagram, when switch ‘s” is in position 1, energy is _____ in an inductor.

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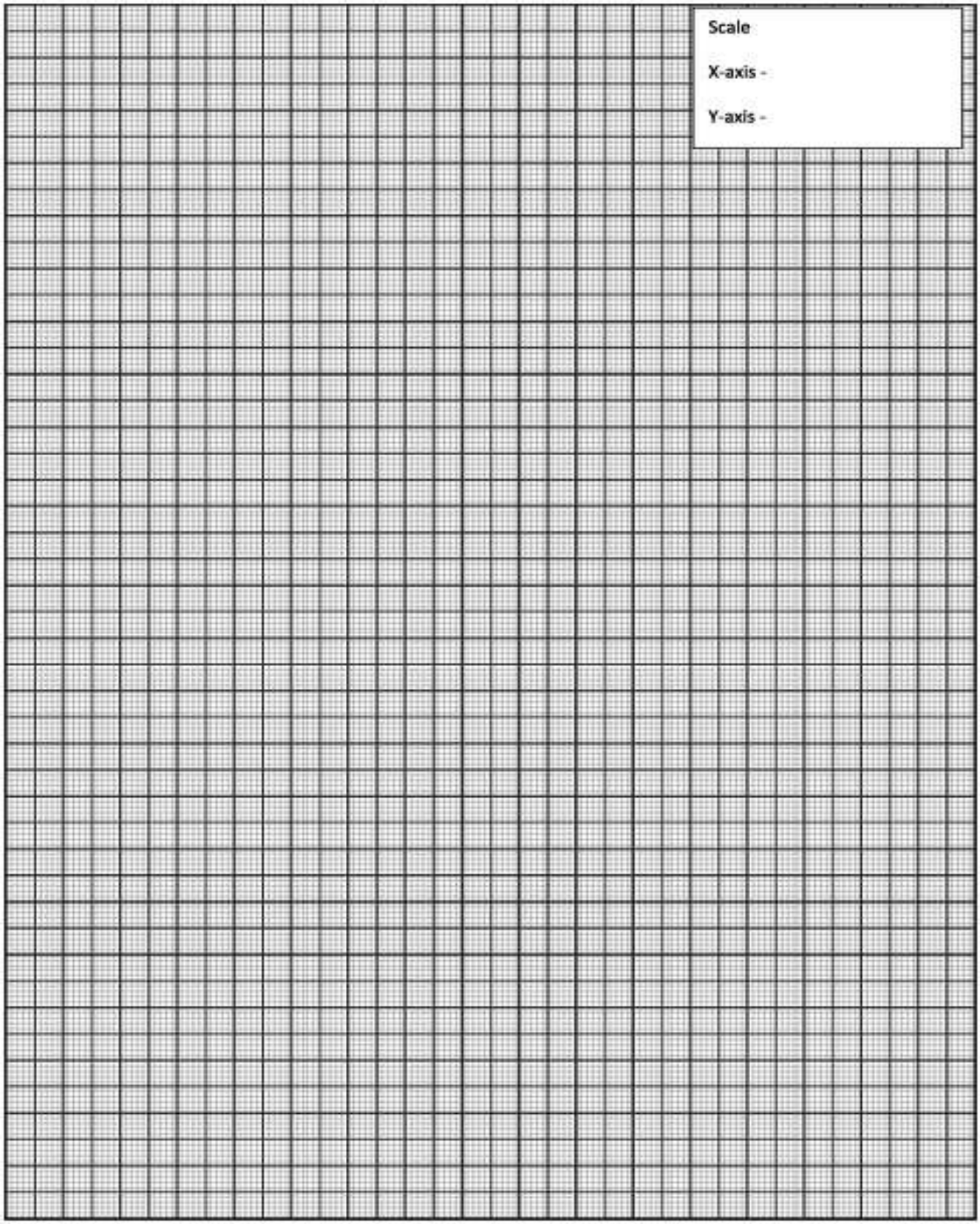
XVIII References/Suggestions for further reading

1. www.britanica.com/science
2. http://Youtu.be/XT-U*mPviH64?si=MLIZBB5BgOA2SWBK
3. www.electrical4u.com
4. www.howstuffworks.com

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.19: Plot the decay characteristics of electric current in a circuit consisting of resistance and inductance

I Practical Significance

The energy stored in an inductor is a fundamental concept in applications like electrical transformers, high frequency circuits and designing electronic circuits and designing electronic circuits for specific functions.

II Industry/Employer Expected Outcome(s)

Rise and decay characteristics of inductor play vital role in many applications like tuning circuits, Sensors, Store energy in a device, Induction motors, Transformers, filters, chokes, Ferrite beads etc.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit
- Use principles of magnetism in magnetic circuit

IV Laboratory Learning Outcome(s)

Determine the decay characteristics of electric current in a circuit consisting of resistance and inductance.

V Relevant Affective Domain related outcome(s)

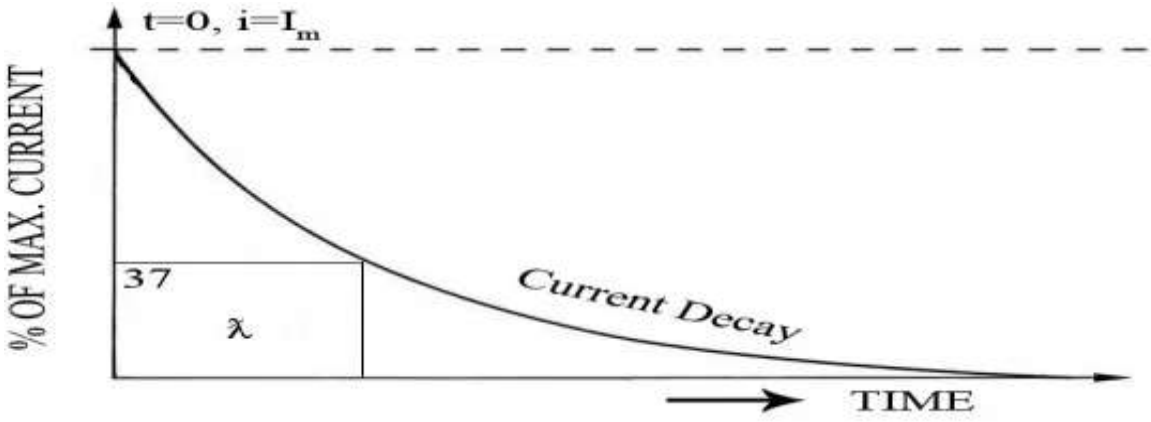
Follow safety rules in the laboratory.

VI Relevant Theoretical Background

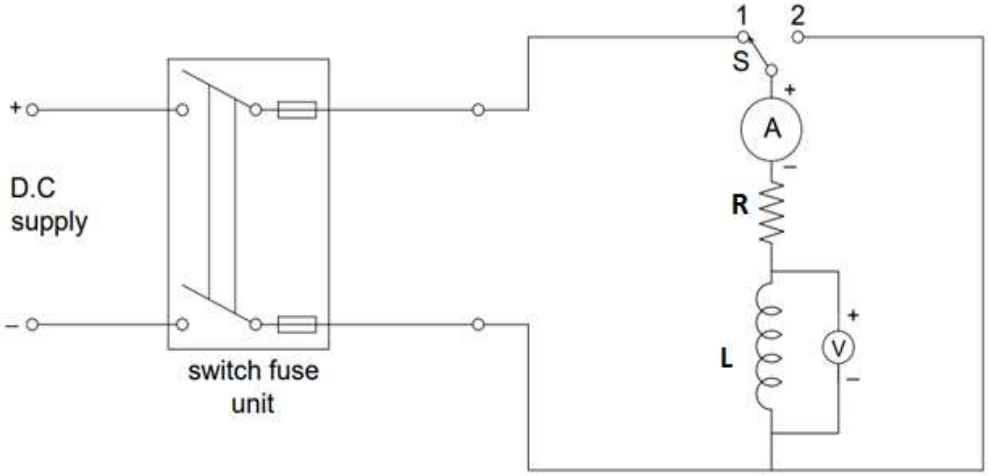
When a circuit consisting of resistance and inductance in series is connected to DC Supply, the current in the circuit rises gradually and attains its maximum value after certain time period.

The rise of current takes place in an exponential manner and the maximum value of current in the circuit is V/R Ampere. When current rises gradually, energy gets stored in an inductance.

The time required for the current to reach the 63.2% of its maximum value is given by L/R Seconds and called as time constant of inductive circuit.



VII Circuit diagram



VIII Required Resources

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Battery or DC Supply	0-30V	1
2	A Choke Coil or a resister in series with inductor	Suitable range	1
3	Single Pole Two Way Switch	NA	1
4	Digital Multimeter	NA	1
5	Stopwatch	NA	1

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. Connect the circuit as shown in the diagram
2. Put the switch 'S' on position 1.
3. Switch ON the supply
4. Wait till the current attains steady or constant value.
5. Switch OFF the supply.
6. Put switch to position 2.
7. Take readings on ammeter at every 5 seconds and record till current becomes zero and record in the observation table.
8. Draw graph of Current v/s time.
9. Confirm the prediction and conclude.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations

Sr. No.	Time in Seconds	Current in Ampere	Voltage in Volts
1			
2			
3			
4			
5			
6			
7			
8			
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10			

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define Inductance and State its Unit.
2. Referring the circuit diagram, when switch ‘s” is in position 1, energy is _____ in an inductor.

[Space for Answers]

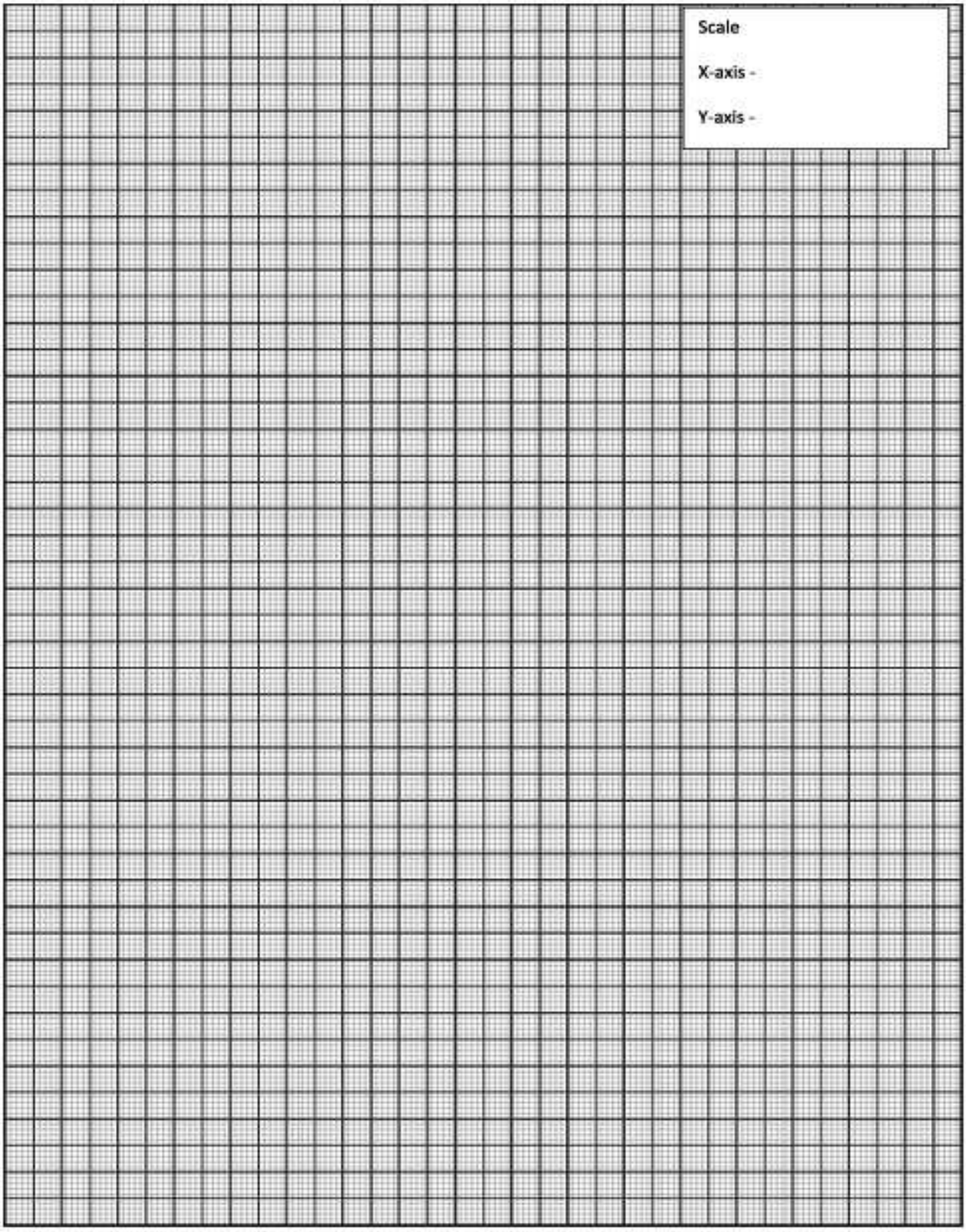
XVIII References/Suggestions for further reading

1. www.britanica.com/science
2. http://Youtu.be/XT-U*mPviH64?si=MLIZBB5BgOA2SWBK
3. www.electrical4u.com
4. www.howstuffworks.com

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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X-axis -
Y-axis -

Practical No.20: Plot B-H Curve for the given magnetic material.

I Practical Significance

B-H curve is essential for understanding the magnetization properties of materials by characterizing permeability. Cores of transformers and rotating machines waste less energy in the form of heat when magnetic material with optimum area under hysteresis loop is used.

II Industry/Employer Expected Outcome(s)

Select the magnetic material for designing core of the electrical machines using BH curve as the magnetic behavior of the magnetic material is instrumental in the design and optimization of various electrical devices and systems across different industries.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit.
- Use principles of magnetism in magnetic circuits

IV Laboratory Learning Outcome(s)

Find B-H Curve for the given magnetic material**.**

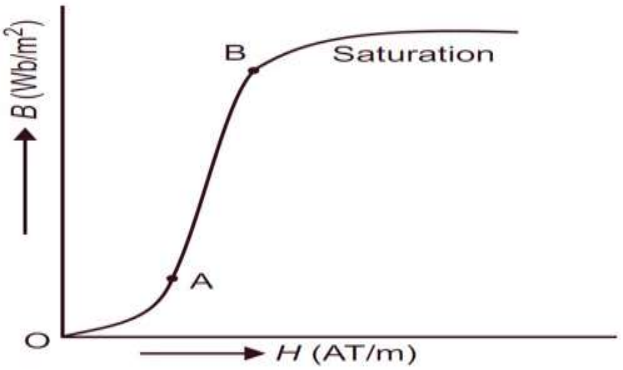
V Relevant Affective Domain related outcome(s)

Follow safety rules in the laboratory.

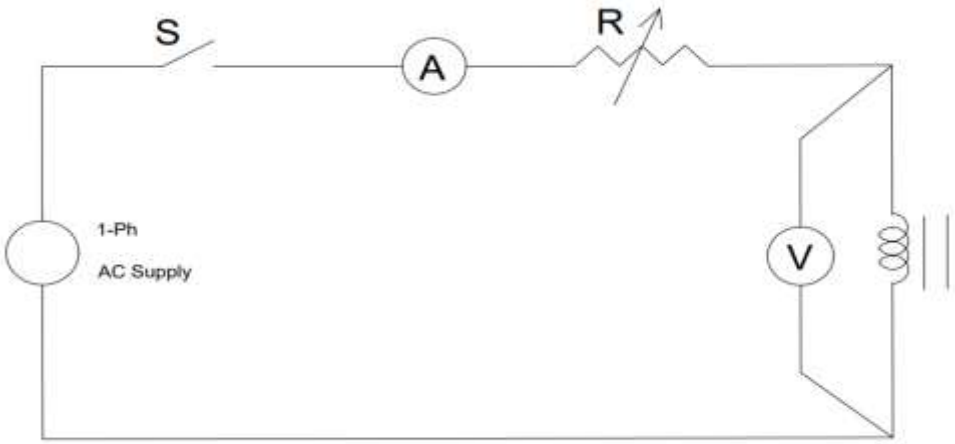
VI Relevant Theoretical Background

The B-H Curve is the graph plotted between magnetic flux density (B) and magnetization force(H). The B-H curve indicates the manner in which the magnetic flux density varies with the change in magnetizing force. The relationship is expresses as $B=\mu H$, where μ is called as absolute permeability of magnetic material.

In the experiment, the curve is drawn between two quantities-voltage and current.
The fig shows the general shape of B-H curve of a magnetic material.



VII Circuit diagram



VIII Resources Used

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Ammeter	Suitable current	1
2	Voltmeter	Suitable voltage	1
3	Rheostat	Suitable resistor in ohm	1
4	Choke Coil	Suitable range	1
5	Connecting wires	Suitable wires	As per requirement

IX Precautions to be followed:

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. Select the inductive coil, relevant voltmeter ,ammeter

2. Connect the circuit as shown in the diagram.
3. Set the rheostat position at maximum resistance.
4. Switch on the Supply.
5. Go on reducing the resistance & record the readings of ammeter and voltmeter.
6. Switch OFF the Supply.
7. Repeat the same procedure for different observations.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations and Calculations

Sr. No.	V (Volts)	I (Ampere)
1		
2		
3		
4		
5		
6		

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8		
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10		

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define i) Magnetic Flux Density(B) ii) Field Intensity(H)
2. Does the curve pass through origin?

[Space for Answers]

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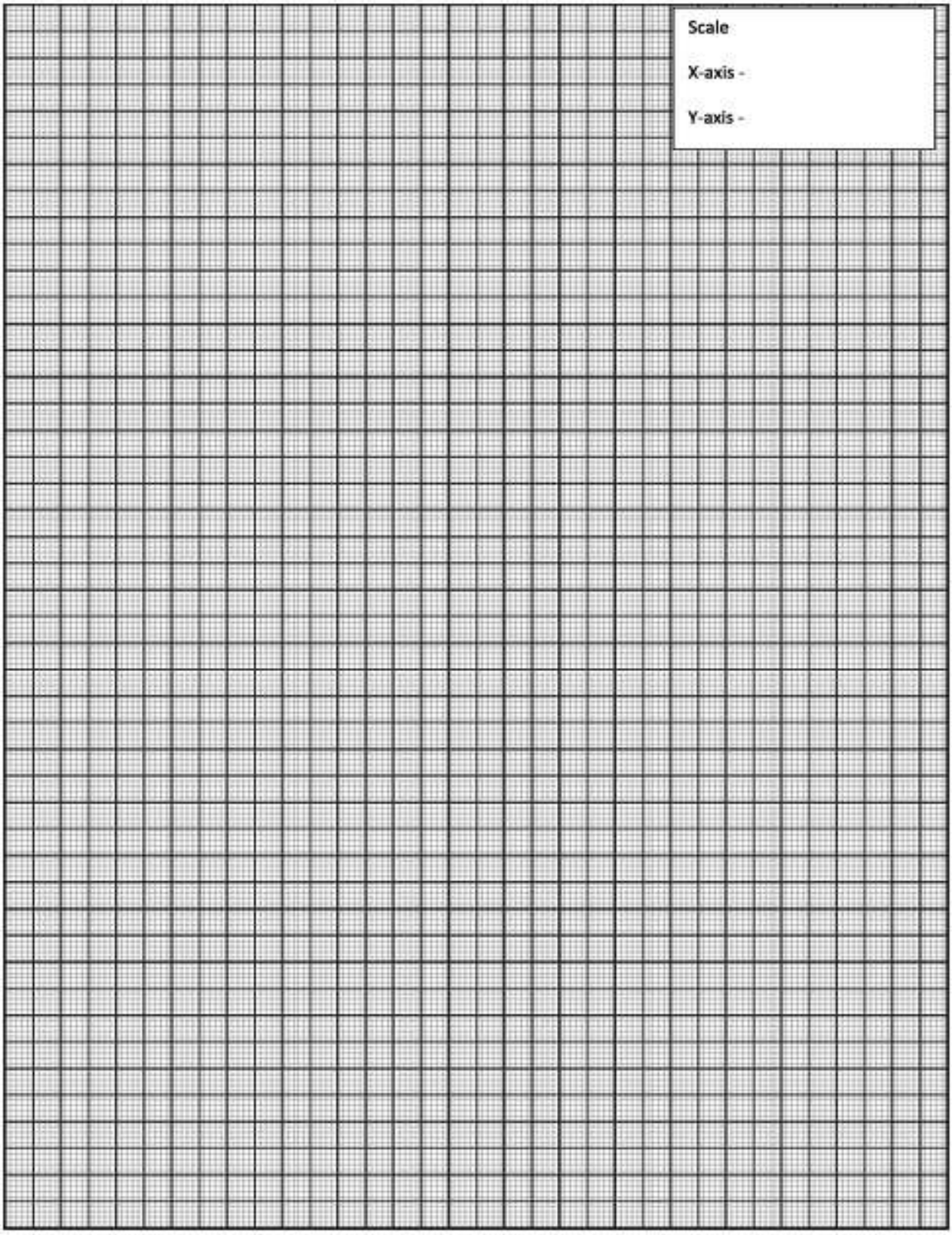
XVIII References/Suggestions for further reading

1. www.britanica.com/science
2. http://Youtu.be/XT-U*mPviH64?si=MLIZBB5BgOA2SWBK
3. www.electrical4u.com
4. www.howstuffworks.com
5. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.21: Plot magnetization Curve for magnetic material.

I Practical Significance

B-H curve for magnetization is essential for understanding the magnetization properties of materials by characterizing permeability.

II Industry/Employer Expected Outcome(s)

Select the magnetic material for designing core of the electrical machines using BH curve as the magnetic behavior of the magnetic material is instrumental in the design and optimization of various electrical devices and systems across different industries.

III Course Level Learning Outcome(s)

Use principles of magnetism in magnetic circuits

IV Laboratory Learning Outcome(s)

Obtain magnetization Curve for magnetic material**.**

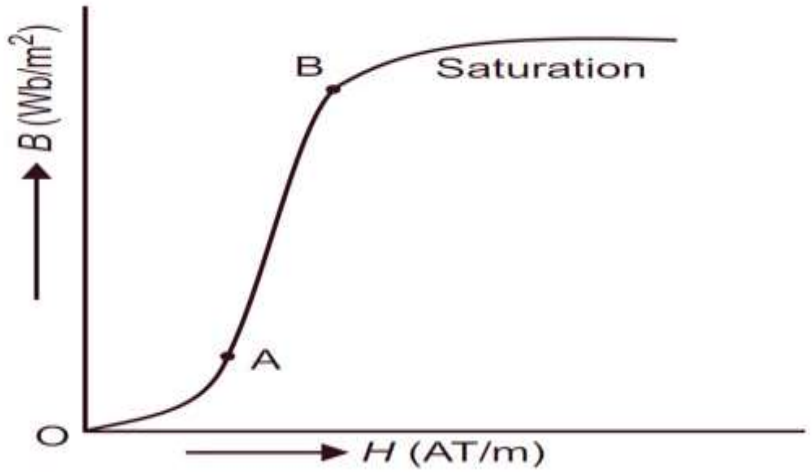
V Relevant Affective Domain related outcome(s)

Follow safety rules in the laboratory.

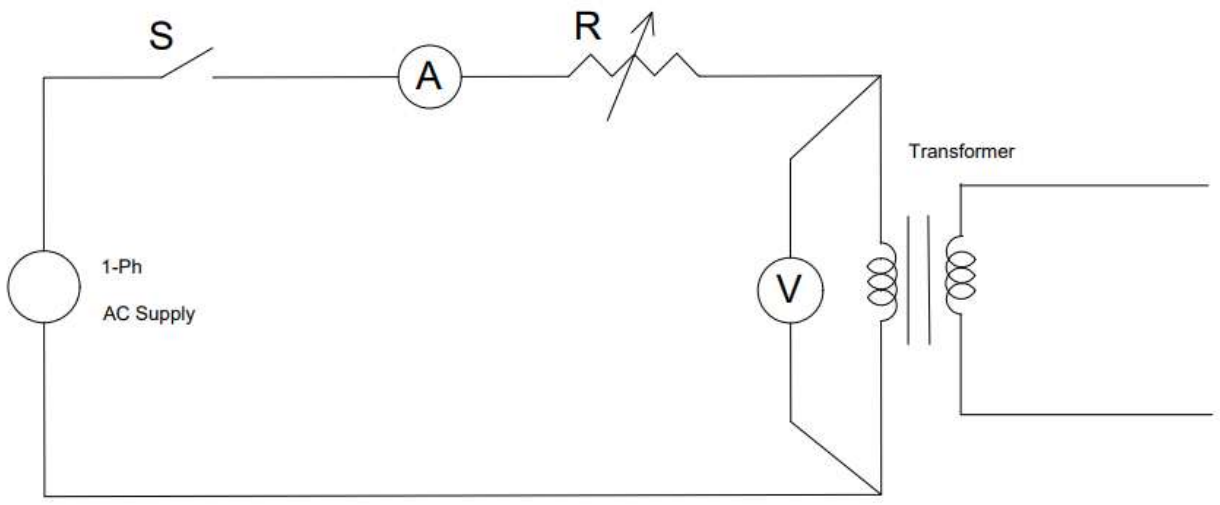
VI Relevant Theoretical Background

The B-H Curve is the graph plotted between magnetic flux density (B) and magnetization force (H). The B-H curve indicates the manner in which the magnetic flux density varies with the change in magnetizing force. The relationship is expresses as B=μH, where μ is called as absolute permeability of magnetic material.

In the experiment, the curve is drawn between two quantities-voltage and current.
The fig shows the general shape of B-H curve of a magnetic material.



VII Circuit diagram



VIII Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Autotransformer	Ampere=5-10A Voltage=0-270V	1
2	Ammeter	Suitable current	1
3	Voltmeter	Suitable Voltage	1
4	Transformer	0.5/1KVA	1
5	Switch	Single Pole Single Throw	1
6	Connecting wires	Suitable Gauge	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.
3. Do not touch the open terminals of transformer.

X Procedure

1. Select the transformer, relevant voltmeter, and ammeter.
2. Connect the circuit as shown in the diagram.
3. Switch on the Supply.
4. Increase the voltage gradually to rated voltage of transformer.
5. Record the readings of ammeter and voltmeter.
6. Reduce the voltage gradually to zero.
7. Switch OFF the Supply.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations

Sr. No.	V (Volts)	I (Amps)
1		
2		
3		
4		
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XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What do you mean by magnetization curve?
2. What is meant by saturation of the magnetic material?

[Space for Answers]

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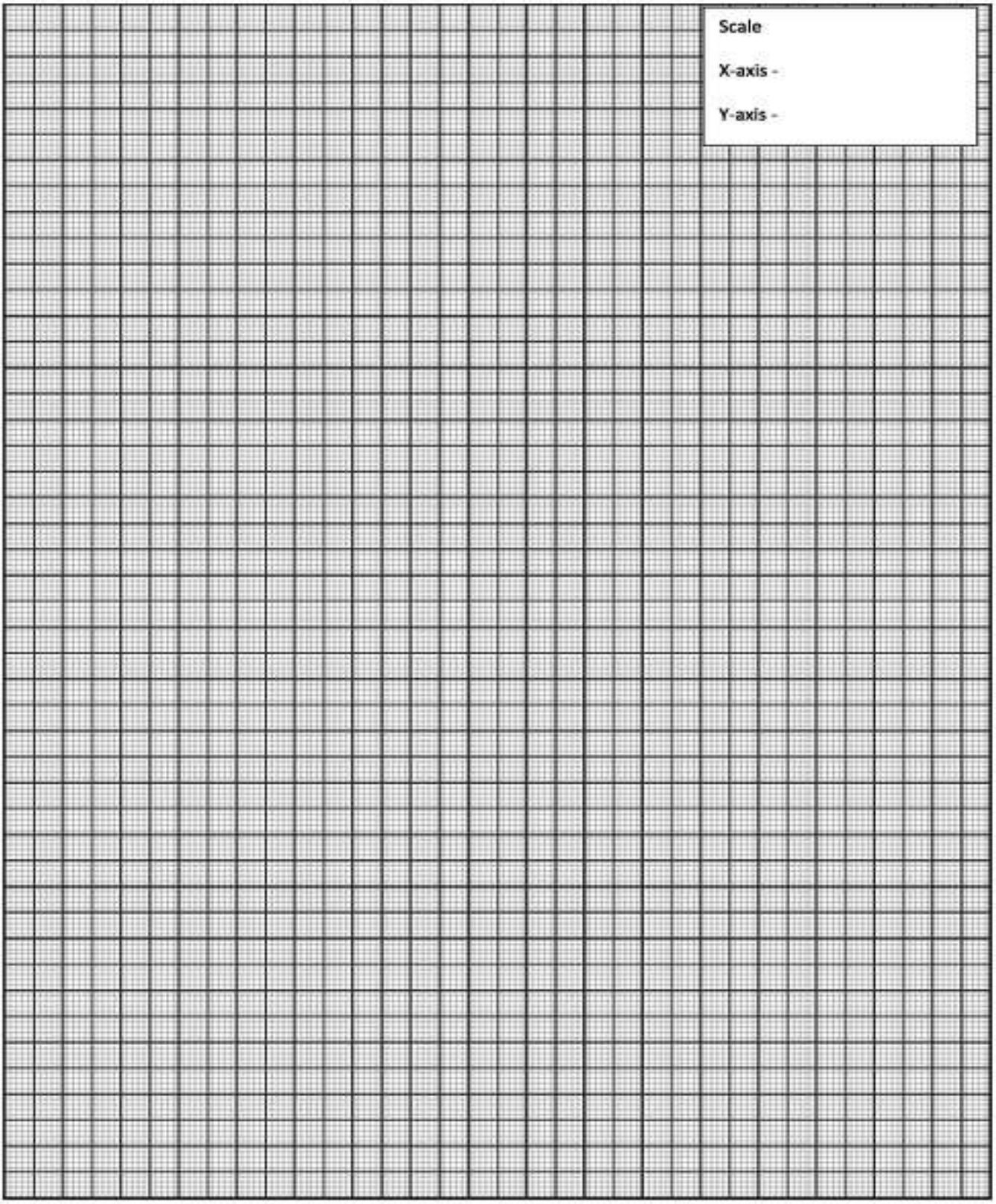
XVIII References/Suggestions for further reading

1. www.britanica.com/science
2. http://Youtu.be/XT-U*mPviH64?si=MLIZBB5BgOA2SWBK
3. www.electrical4u.com
4. www.howstuffworks.com
5. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No 22: Study of Hysteresis loop for the given transformer Coil

I Practical Significance

Right choice of magnetic material for making the core of the machines is possible by studying the area under the hysteresis loop .Various types of ferromagnetic material have different areas under the loop. Area under the loop indicates amount of energy that is lost per cycle of magnetization.

II Industry/Employer Expected Outcome(s)

Area under hysteresis loop of any magnetic material decides the cost of core of any machine. Moreover energy conservation can be achieved by right choice of the magnetic material.

III Course Level Learning Outcome(s)

Use principles of magnetism in Magnetic Circuits.

IV Laboratory Learning Outcome(s)

Plot Hysteresis Loop for the given transformer coil.

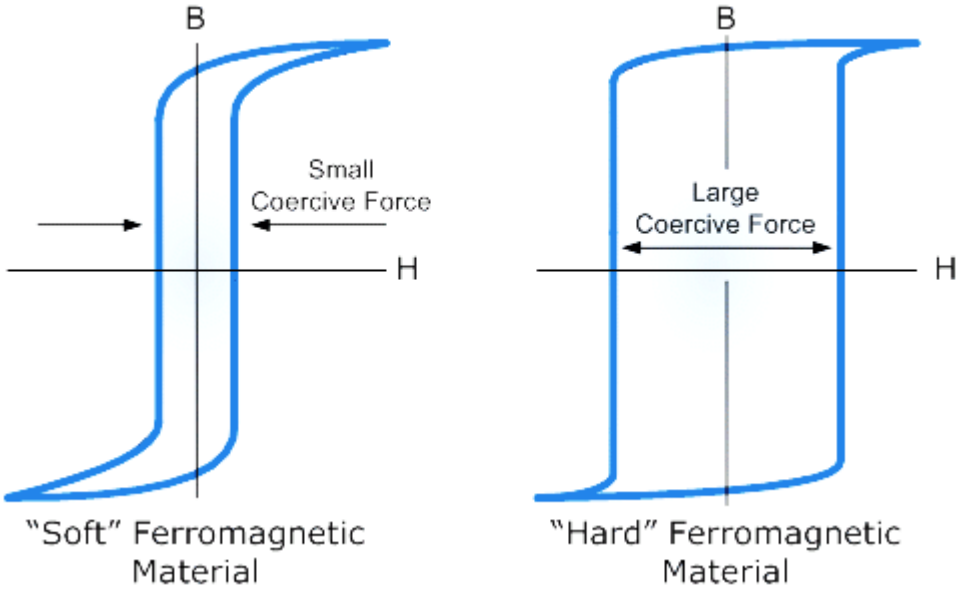
V Relevant Affective Domain related outcome(s)

Follow safety rules in the laboratory

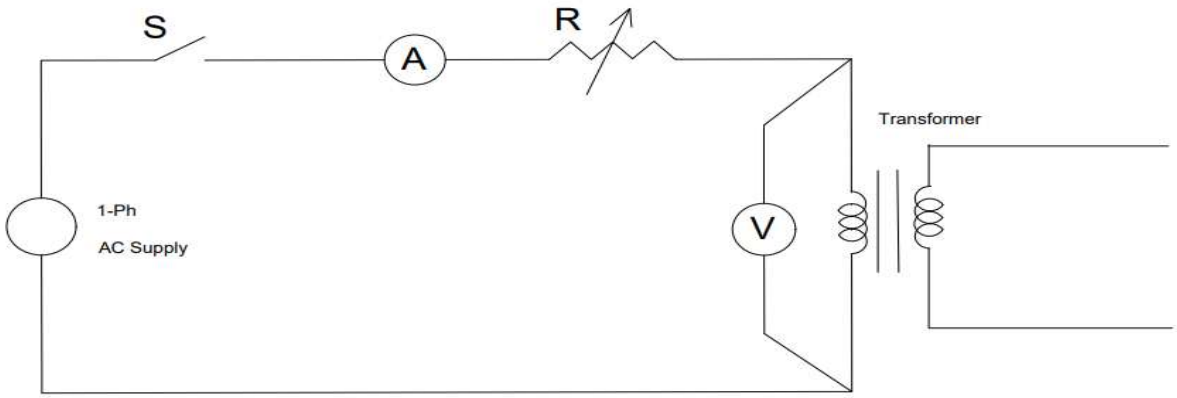
VI Relevant Theoretical Background

Magnetic hysteresis : Lagging of magnetization or magnetic flux density(B) behind the magnetization force(H) is called as magnetic hysteresis.

Due to magnetic hysteresis, a closed loop is obtained when a magnetic material is taken through one complete cycle of magnetization, this loop is known as hysteresis loop.



VII Circuit diagram



VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	EMF Source	ampere=5-10A Voltage=0-300V	1
2	Ammeter	Suitable current	1
3	Voltmeter	Suitable Voltage	1
4	Transformer	0.5/1KVA	1
5	Switch	Single Pole Single Throw	1
6	Resistance	Suitable value	1
7	Connecting wires	Suitable guage	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.
3. Do not touch the open terminals of transformer.

X Procedure

1. Select the transformer, relevant voltmeter, and ammeter.
2. Connect the circuit as shown in the diagram.

3. Set the rheostat to its minimum resistance setting to initiate with a lower current.
4. Activate the DC power source.
5. Record the initial readings of the Current (I) (from the ammeter) and the corresponding Voltage (V) (from the voltmeter).
6. [Current (I) represents Magnetizing Force (H) and the Voltage (V) represents Magnetic Flux Density (B)]
7. Gradually adjust the rheostat to allow more current to flow. At each new setting, record the I and V values.
8. As you increase I by adjusting the rheostat and recording V values, you'll notice an initial magnetization curve forming.
9. After reaching a desired maximum current (saturation), begin reducing the current by adjusting the rheostat in the opposite direction. Record I and V values during this process.
10. Continue this procedure until you return to the initial I value, completing the hysteresis loop on the graph.
11. Based on the collected data, plot a graph with B (flux density) on the y-axis and H (magnetizing force) on the x-axis.
12. Once the hysteresis loop is plotted, analyze its shape, size, and characteristics.
13. Observe how B changes concerning H during both the magnetization and demagnetization phases.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations and Calculations

Sr. No.	Voltage (V) (Volt) Increasing	Current (I) (Amps) Increasing	Voltage (V) (Volt) Decreasing	Current (I) (Amps) Decreasing
1				
2				
3				
4				
5				
6				
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8				

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What do you mean by magnetization curve?
2. What is meant by saturation of the magnetic material?

[Space for Answers]

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XVIII References/Suggestions for further reading

1. www.britanica.com/science
2. http://Youtu.be/XT-U*mPviH64?si=MLIZBB5BgOA2SWBK
3. www.electrical4u.com
4. www.howstuffworks.com
5. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.23: Verification of Faraday's Law of Electromagnetic Induction (Statically Induced EMF).

I Practical Significance

Faraday's law of electromagnetic induction, known as Faraday's law, is the basic law of electromagnetism which helps predict how a magnetic field would interact with an electric circuit to produce an electromotive force (EMF).

Examples of it in action can be seen all around us in everyday life. Generators, motors, transformers, electric instruments, and induction cookers all employ Faraday's Law, allowing us to drive to work, power our homes, cook our food etc.

II Industry/Employer Expected Outcome(s)

In industries, knowledge of existence of static and dynamic an emf with is of prime requirement. Such kind of measurements is possible using measuring instruments like simple Galvanometer.

III Course Level Learning Outcome(s)

- Use principles of magnetism in magnetic circuit
- Apply Laws of Electromagnetism in electrical circuits and systems.

IV Laboratory Learning Outcome(s)

Verify Faraday's Law of Electromagnetic Induction (Statically Induced EMF).

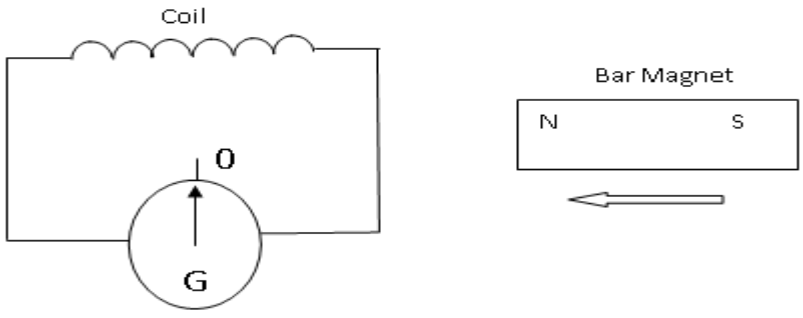
V Relevant Affective Domain related outcome(s)

Follow safety rules in the laboratory.

VI Relevant Theoretical Background

Whenever a conductor cuts magnetic flux an emf is induced in the conductor. Or whenever magnetic flux liking with the conductor/coil changes, an emf is always induced in it.

VII Circuit diagram



VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Bar Magnet	Bar magnet of known polarity	1
2	Galvanometer	Suitable voltage	1
3	Inductive coil	Contactor coil or any suitable coil having large no. of turns	1
4	Connecting Wires	Suitable wires	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. Connect two ends of the coil to the Galvanometer.
2. Take a bar magnet of known polarity.
3. Move the bar magnet in the coil as per the sequence given in observation table.
4. Observe the deflection of Galvanometer.

XI Resources Used

S. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations and Calculations

Sr. No.	Movement of bar magnet	Speed of the magnet(Slow/Fast)	Deflection of Galvanometer connected across coil B	
			Forward/Reverse	Less/More
1	Towards Coil	Slow		
2	Towards Coil	Fast		
3	Away from the Coil	Slow		
4	Away from the Coil	Fast		

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State Fleming's Right Hand Rule.
2. State Lenz's Law.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.24: Verification of Faraday's Law of Electromagnetic Induction (Dynamically Induced EMF).

I Practical Significance

Faraday's law of electromagnetic induction, known as Faraday's law, is the basic law of electromagnetism which helps predict how a magnetic field would interact with an electric circuit to produce an electromotive force (EMF).
Examples of it in action can be seen all around us in everyday life. Generators, motors, transformers, electric instruments, and induction cookers all employ Faraday's Law, allowing us to drive to work, power our homes, cook our food etc.

II Industry/Employer Expected Outcomes

In industries, knowledge of existence of static and dynamic an emf with is of prime requirement. Such kind of measurements are possible using measuring instruments like simple Galvanometer.

III Course Level Learning Outcomes

- Use principles of magnetism in magnetic circuit
- Apply Laws of Electromagnetism in electrical circuits and systems.

IV Laboratory Learning Outcome

Verify Faraday's Law of Electromagnetic Induction (Dynamically Induced EMF).

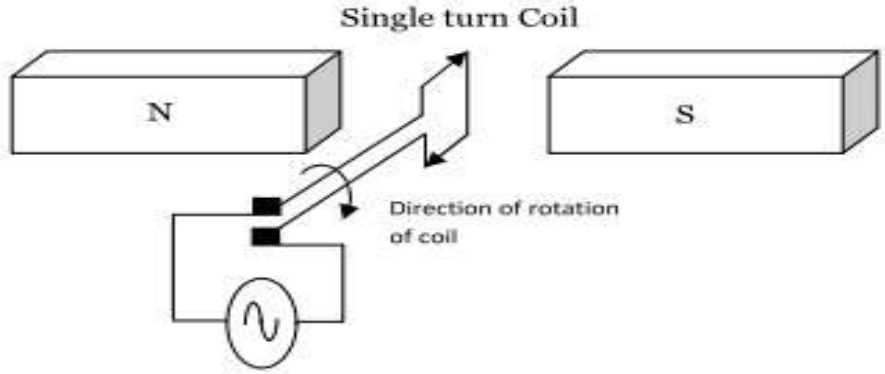
V Relevant Affective Domain related outcome(s)

Follow safety rules in the laboratory.

VI Relevant Theoretical Background

Whenever a conductor cuts magnetic flux an emf is induced in the conductor. Or whenever magnetic flux liking with the conductor/coil changes, an emf is always induced in it.

VII Circuit diagram



Circuit Diagram:

VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Bar Magnet	Bar magnet of known polarity	1
2	Galvanometer	Suitable voltage	1
3	Inductive coil	Contactor coil or any suitable coil having large no. of turns	1
4	Connecting Wires	Suitable wires	As per requirement

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. Connect two ends of the coil to the Galvanometer.
2. Take a bar magnet of known polarity.
3. Move the bar magnet in the coil as per the sequence given in observation table.
4. Observe the deflection of Galvanometer.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations

Sr. No.	Movement of bar magnet	Speed of the magnet(Slow/Fast)	Deflection of Galvanometer connected across coil B	
			Forward/Reverse	Less/More
1	N Pole Towards the Coil	Slow		
2	N-Pole Towards the Coil	Fast		
3	S- Pole Towards the Coil	Slow		
4	S-Pole Towards the Coil	Fast		

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State Fleming's Right Hand Rule.
2. State Lenz's Law.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.25: Verification of Fleming's Right Hand Rule.

I Practical Significance

Fleming's Right Hand Rule holds practical significance in the field of electromagnetism and electrical as it is easier to figure out how the current in a generator's winding is flowing.

II Industry/Employer Expected Outcome(s)

Magnetism plays an important role in electrical and electronic engineering. Fleming's Right Hand Rule is used to predict the direction of the current induced in the generator.

III Course Level Learning Outcome(s)

- Use principles of magnetism in magnetic circuits.
- Apply Laws of Electromagnetism in electrical circuits and systems.

IV Laboratory Learning Outcome(s)

Verify Fleming's Right Hand Rule

V Relevant Affective Domain related outcome(s)

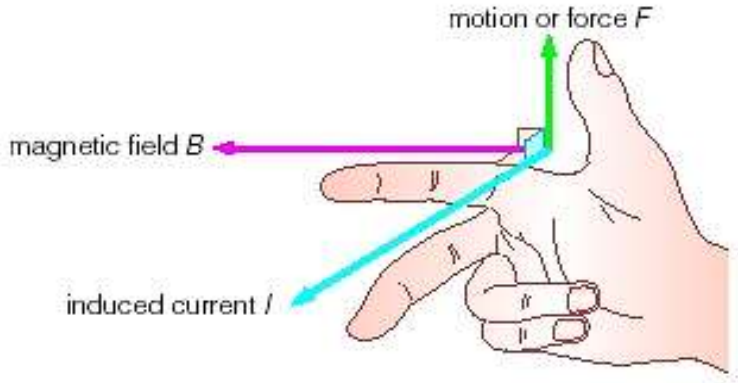
Follow safety electric rule.

VI Relevant Theoretical Background

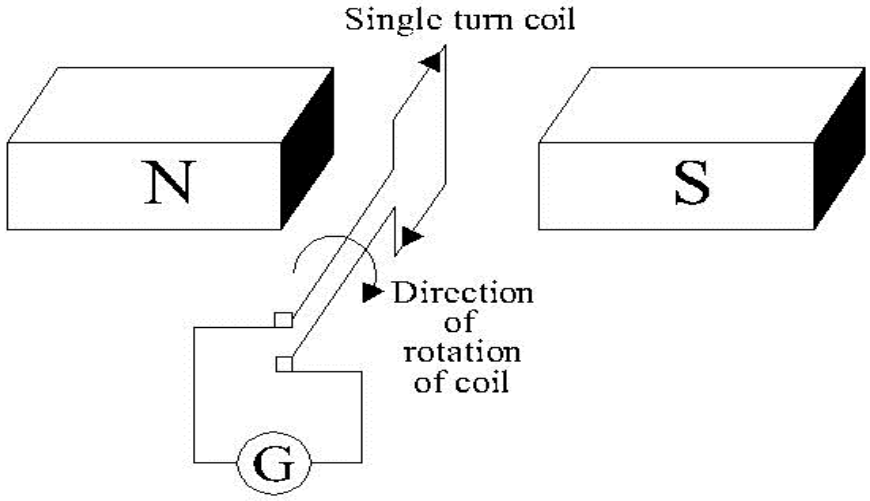
Flemings Right Hand Rule:

The thumb, the forefinger and the middle finger of the right hand are held so that the three fingers are mutually perpendicular to each other. The forefinger is pointed toward the direction of the main field, the thumb toward the direction of movement of the conductor and the middle finger gives the direction of the current set up by the emf induced in the conductor.

Using Fleming's right hand rule, one can predict the direction of the induced current with the knowledge of direction of magnetic field and force.



VII Circuit diagram



VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	A pair of Magnets	Bar magnet of known polarity	1
2	Galvanometer	Suitable rating	1
3	Conductor	Contactor coil or any suitable coil	1

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.
3. Arrange components on a stable surface to prevent the apparatus from tipping over.

X Procedure

1. Connect the ends of the conductor to the galvanometer.
2. Place the conductor in the magnetic field produced by the magnet. Ensure that the conductor can move freely within the magnetic field.
3. When the current is induced in the conductor, observe the direction of motion of the conductor and direction of magnetic field.
4. Compare it to the predicted direction of the force.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations

Sr.No.	Direction of magnetic field(Index Finger)	Direction of Current (Middle Finger)	Direction of Motion (Thumb)	Observation
1	Upwards			
2	Downwards			
3	Towards You (Into the Page)			
4	Away from You (Out of Page)			

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Compare Fleming's Right Hand Rule and Fleming's Left Hand Rule.
2. Give applications of Fleming's Right Hand Rule.

[Space for Answers]

XVIII References/Suggestions for further reading

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org
4. www.britanica.com/science
5. https://en.wikipedia.org/wiki/electromagnetic_induction

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.26: Verification of Fleming's Left Hand Rule.

I Practical Significance

The verification of Fleming's Left Hand Rule holds practical significance in the field of electromagnetism and electrical engineering In absence of it components such as relays, solenoids, inductors, chokes, coils, loudspeakers, motors, generators, transformers and electricity meters etc, would not work.

II Industry/Employer Expected Outcome(s)

Magnetism plays an important role in electrical and electronic engineering. Fleming's Left Hand Rule is used to predict the direction of the force experienced by a current carrying conductor placed in a magnetic field. Hence to predict the direction of rotation of motor, Flemings Left hand rule is used.

III Course Level Learning Outcome(s)

- Use principles of magnetism in magnetic circuits.
- Apply Laws of Electromagnetism in electrical circuits and systems.

IV Laboratory Learning Outcome(s)

Verify Fleming's Right Hand Rule

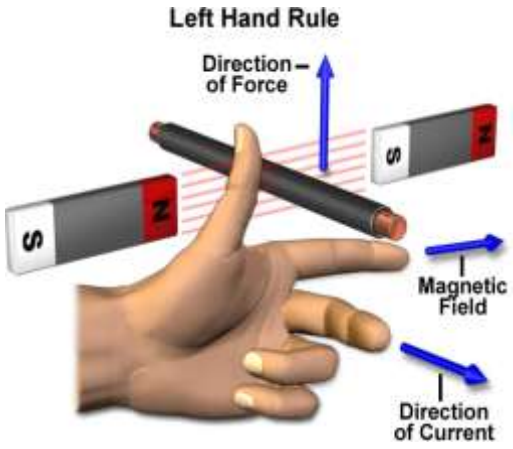
V Relevant Affective Domain related outcome(s)

Follow safety electric rule.

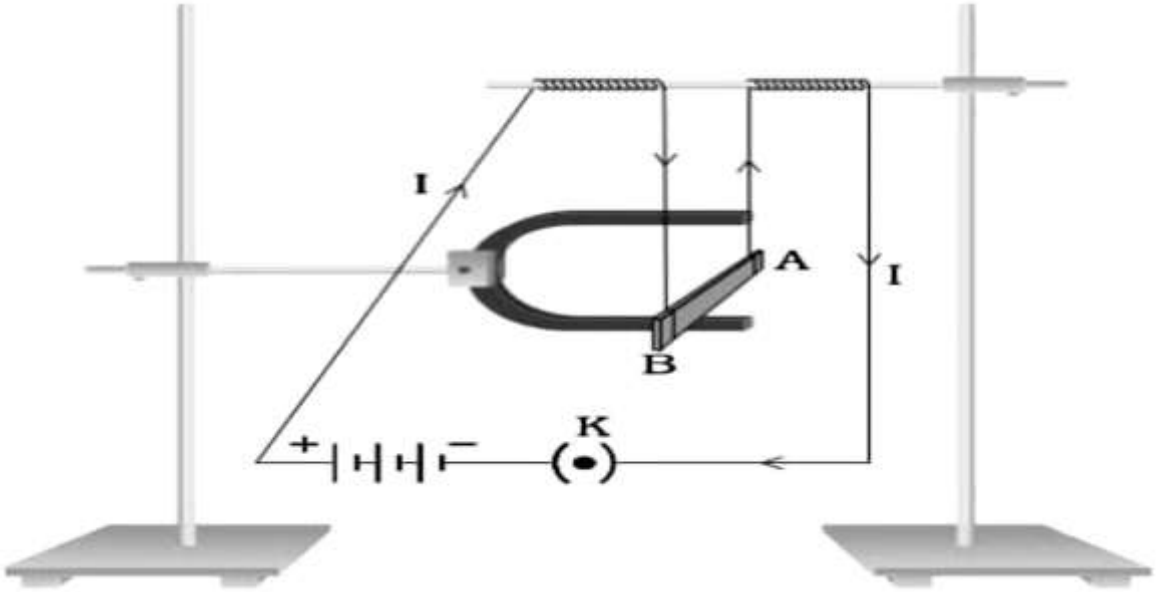
VI Relevant Theoretical Background

Flemings Left Hand Rule: The direction of force developed on a current carrying conductor can be obtained by this rule.

The thumb, the forefinger and the middle finger of the left hand are held at right angle to each other. If the forefinger is pointed toward the direction of the main field and the middle finger along the direction of the current in the conductor, then the thumb gives the direction of force or movement experienced by the conductor.



VII Circuit diagram



VIII Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Pole shoe magnet	Suitable Size	1
2	DC Power Source	Suitable voltage	1
3	Switch	Single Pole Single Throw	1

4	Inductive coil	Contactor coil or any suitable coil having large no. of turns	1
5	Connecting Wires	suitable Gauge	As per requirement
6	Stands/ Holders	suitable Size	2
7			

IX Precautions to be followed

1. Avoid loose connections.
2. Don't touch wire with wet hands.

X Procedure

1. Connect the ends of the conductor to the power source to allow current to flow through it.
2. Place the conductor in the magnetic field produced by the magnet. Ensure that the conductor can move freely within the magnetic field.
3. When the current flows through the conductor, it experiences the force due to interaction between the magnetic fields.
4. Observe the movement of the conductor and compare it to the predicted direction of the force.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity

XII Actual Procedure Followed

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XIII Observations

Sr. No.	Direction of magnetic field (Thumb)	Direction of Current (Index Finger)	Direction of Force (Middle Finger)	Observation
1	Upwards			
2	Downwards			
3	Towards You (Into the Page)			
4	Away from You (Out of Page)			

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

Note: Below given few samples for references. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State Fleming's Left Hand Rule.

2. Give applications of Fleming's Left Hand Rule.

[Space for Answers]

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XVIII References/Suggestions for further reading

1. www.electrical4u.com
2. www.howstuffworks.com
3. www.electricaltechnology.org
4. www.britanica.com/science
5. https://en.wikipedia.org/wiki/electromagnetic_induction

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification Of Components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 27: Plot the Charging and Discharging Curves of Battery.

I Practical Significance

Plotting charging and discharging curves is a powerful tool for assessing and optimizing battery performance, ensuring safety, and extending the overall lifespan of battery systems in various applications.

II Industry/Employer Expected Outcome(s)

Use of batteries in health care instruments like artificial limbs insulin pumps, hearing aids, valves assistance or firefighting or logistic and construction or in vehicles or in military operation forces the operator to know about charging and discharging of battery.

III Course Level Learning Outcome(s)

- Determine various parameters used in electric circuit.
- Use capacitor and battery in electrical circuits.

IV Laboratory Learning Outcome(s)

Determine Charging and Discharging Curves of Battery.

V Relevant Affective Domain related outcome(s)

Handle tools and equipment carefully**.**

VI Relevant Theoretical Background

The charging and discharging curves of a battery can be explained with a basic theoretical understanding. Here's a minimum theory that covers the essential concepts:

Charging Curve

Constant Current (CC) Phase: During the initial stage of charging, the battery is often supplied with a constant current. In this phase, the voltage across the battery gradually increases.

Constant Voltage (CV) Phase: As the battery approaches full capacity, the charging voltage remains constant, and the charging current decreases. This phase ensures that the battery doesn’t get overcharged.

Saturation: The battery is considered fully charged when it reaches a saturation point, and further charging doesn't significantly increase the capacity.

Voltage vs. Time Graph: The charging curve typically shows an initial steep slope during the constant current phase, followed by a more gradual slope in the constant voltage phase.

Discharging Curve

Discharge Phase: When a charged battery is connected to a load, it starts to discharge. The voltage across the battery decreases as the stored energy is released.

Capacity Depletion: The battery discharges until it reaches a minimum voltage, indicating that its stored energy is depleted.

Voltage vs. Time Graph: The discharging curve shows a gradual decline in voltage as the battery provides electrical energy to the connected load.

Key Points:

Open Circuit Voltage (OCV):
The voltage of the battery when it is not connected to any load or charging source. It represents the state of charge.

Peukert's Law:
Describes the non-linear relationship between the discharge current and the capacity of the battery. Higher discharge currents lead to lower effective capacities.

Hysteresis:
The difference in discharge voltage between a battery that has been charged and then immediately discharged compared to a battery that has been at rest for some time before discharging. Temperature Effects: The performance of a battery is influenced by temperature. Higher temperatures generally lead to increased capacity, but excessive heat can degrade the battery.

Cycle Life:
The number of charge-discharge cycles a battery can undergo before its capacity significantly degrades. Each cycle may cause slight changes in the charging and discharging characteristics.

VII Circuit diagram

(To be developed by the students under the guidance of the teacher)

VIII Required Resources

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Ammeter	(0-1-10A)MI/PMMC	1
2	Voltmeter	(0-50-75-150-300V)MI/PMMC	1
3	Resistive/lamp load	230V,5KW	1
4	Single phase Variac	(0-230V),4A	1

IX Precautions :

1. Ensure correct polarity and connections to avoid short circuits or damage to the battery.
2. Use appropriate protective equipment when handling batteries to prevent electrical shocks or chemical exposure.
3. Monitor the battery temperature during the experiment to prevent overheating.
4. Adhere to safety guidelines for working with electrical circuits and components.
5. Avoid overcharging or deep discharging the battery to maintain its lifespan and performance.
6. Follow the electrical laboratory safety guidelines.
7. Use the correct type of battery for the experiment, and make sure it is in good condition.

X Procedure

a) Charging of Battery

1. Connect the battery charger to a power source and ensure it is switched off.
2. Connect the positive terminal of the battery to the positive output of the charger and the negative terminal to the negative output of the charger.
3. Turn on the battery charger and set the desired charging current (if adjustable).
4. Record the initial voltage and current readings.
5. Continue the charging process until the battery reaches its maximum recommended voltage or until the current drops significantly, indicating near-full charge.
6. Record the current (A) and voltage (V) readings across regular time intervals (e.g., every 5 minutes) using the connected instruments.

b) Discharging of Battery

1. Disconnect the battery from the charger.
2. Connect the resistor/incandescent bulb in series with the battery for discharging.
3. Record the initial voltage and current readings.
4. Close the switch to start discharging.
5. Record voltage and current readings at regular intervals during the discharge.
6. Stop discharging when the battery voltage reaches a specified minimum level or as per the experimental plan.

XI Resources Used

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1			
2			
3			
4			
5			

XII Actual Procedure

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XIII Observation table:

a) For Charging Curve

Sr.No.	Time(t)	Voltage(V)	Current(I)

b) For Discharging Curve

Sr.No.	Time(t)	Voltage(V)	Current(I)

XIV Result(s)

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XV Interpretation of results

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XVI Conclusion and recommendation

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XVII Practical related questions

(Note: Below given are w sample questions for reference. Teacher must design more such questions so as to ensure the achievement of identifies CO.)

1. Write types of battery.
2. Write application of battery?

[Space for Answers]

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XVIII References/Suggestions for further reading

2) https://www.electrical4u.com
3) www.howstuffworks.com
4) www.electricaltechnology.org

XIX Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	working in teams	10%
Product Related: 10 Marks		**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusion	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	