I

Name _____

Roll No. _____ Year 20____20____

Exam Seat No. _____

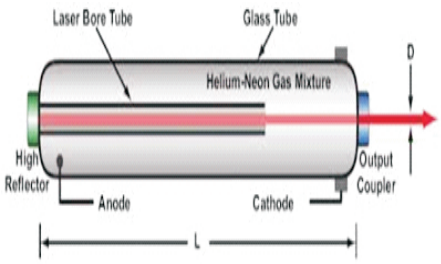
ELECTRICAL & ELECTRONICS GROUPS | SEMESTER - II | DIPLOMA IN ENGINEERING AND TECHNOLOGY

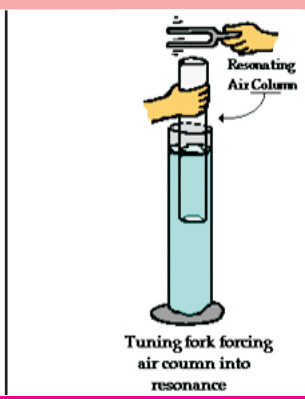
# A LABORATORY MANUAL

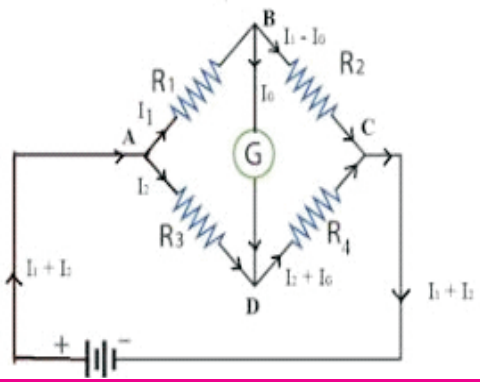
# FOR

# APPLIED SCIENCE (PHYSICS)

# (22211)




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 changing technological and 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 followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual for

# Applied Science – Physics

# (22211)

## Semester-II

**(EE/EP/EU/IE/IS/IC)**

**Maharashtra State**
**Board of Technical Education, Mumbai**
**(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)**

Maharashtra State Board of Technical Education,
(Autonomous) (ISO 9001 : 2015 ) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra ( East ), Mumbai - 400051.
(Printed on December, 2017)

# MAHARASHTRA STATE

# BOARD OF TECHNICAL EDUCATION

## Certificate

This is to certify that Mr. / Ms. …… Roll No. ……., of First Semester of Diploma in…….. …… of Institute,……. …….(Code: ……...) has completed the term work satisfactorily in Subject **Applied Science-Physics (22211)** for the academic year 20…….. to 20…….. as prescribed in the curriculum.

Place: ……  Enrollment No:……

Date: ……  Exam. Seat No: ……

**Subject Teacher**  **Head of the Department**  **Principal**

Seal of Institution

# 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 'I' Scheme curricula for engineering diploma programmes with outcome-base 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 practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals 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 as a 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.

Diploma engineers (also called technologists) have to deal with various materials and machines. The study of concepts and principles of science like capacitance and current electricity, electromagnetic induction and alternating current, photo-sensors and LASER, water treatment and analysis, electrochemistry and batteries, metals, alloys, insulators and others will help them in understanding the engineering courses where emphasis is laid on the applications. This course is developed in the way by which fundamental information will help the diploma engineers to apply the concepts and principles of advanced science in various engineering applications to solve broad based problems.

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.

## Programme Outcomes (POs) to be achieved through Practicals

PO1. **Basic knowledge**: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Discipline specific engineering problems.

PO2. **Discipline knowledge**: Apply Discipline specific engineering knowledge to solve broad-based engineering related problems.

PO3. **Experiments and practice**: Plan to perform experiments and practices to use the results to solve broad-based engineering problems.

PO4. **Engineering tools**: Apply relevant technologies and tools with an understanding of the limitations

PO5. **The engineer and society**: Assess social, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of engineering.

PO6. **Environment and sustainability**: Apply engineering solutions also for sustainable development practices in social and environmental contexts.

PO7. **Ethics**: Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of engineering.

PO8. **Individual and team work**: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PO9. **Communication**: Communicate effectively in oral and written form.

PO10. **Life-long learning**: Engage in independent and life-long learning activities in the context of technological changes also in the engineering and allied industry.

# Practical- Course Outcome matrix

**Course Outcomes (COs)**

- **a.** Use relevant capacitors in electrical circuits.
- **b.** Use equipment/instruments based on radioactive and ultrasonic principles.
- **c.** Use equipment/instruments based on photoelectric effect, X-Ray and LASER.
- **d.** Select relevant water treatment process for various applications.
- **e.** Use relevant electrolyte in batteries for different applications.
- **f.** Use relevant metals, alloys and insulating materials in various applications.

| S. No. | Title of the Practical | CO a. | CO b. | CO c. | CO d. | CO e. |
|---|---|---|---|---|---|---|
| 1. | i) Use condensers to increase and decrease the equivalent capacity of the circuit.<br>ii) Determine the characteristics of condenser using RC circuit. | √ | - | - | - | - |
| 2. | i) Use meter bridge to determine the equivalent resistance of the conductors in series and parallel.<br>ii) Use meter bridge to estimate specific resistance of a given wire. | - | √ | - | - | - |
| 3. | i) Use potentiometer to compare emf of two cells.<br>ii) Use potentiometer to find internal resistance of a cell. | - | √ | - | - | - |
| 4. | Use resonance tube to determine velocity of sound. | - | √ | - | - | - |
| 5. | Use ultrasonic distance - meter to measure distance. | - | √ | - | - | - |
| 6. | i) Use photoelectric cell to see the dependence of photoelectric current on intensity of light.<br>ii) Use photoelectric cell to see the dependence of photoelectric current on plate potential. | - | - | √ | - | - |
| 7. | Use LDR to see the dependence of resistance of LDR on intensity of light. | - | - | √ | - | - |
| 8. | Use He Ne LASER to find the divergence of LASER beam with distance. | - | - | √ | - | - |

## Brief Guidelines to Teachers

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.

## Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a **dated log book** for the whole semester, apart from this laboratory manual which s/he has to **submit for assessment to the teacher** in the next practical session.
2. Students should read the precaution carefully before start of experiment.

# Content Page

## List of Practicals and Progressive Assessment Sheet

| Sr. No. | Practical outcomes | Page No. | Date of perfor-mance | Date of submission | Assessment marks(25) | Dated sign. of teacher | Remarks (if any) |
|---|---|---|---|---|---|---|---|
| 1. | i) Use condensers to increase and decrease the equivalent capacity of the circuit.<br>ii) Determine the characteristics of condenser using RC circuit. | 1 | | | | | |
| 2. | i) Use meter bridge to determine the equivalent resistance of the conductors in series and parallel.<br>ii) Use meter bridge to estimate specific resistance of a given wire. | 12 | | | | | |
| 3. | i) Use potentiometer to compare emf of two cells.<br>ii) Use potentiometer to find internal resistance of a cell. | 22 | | | | | |
| 4. | Use resonance tube to determine velocity of sound. | 31 | | | | | |
| 5. | Use ultrasonic distance – meter to measure distance. | 40 | | | | | |
| 6. | i) Use photoelectric cell to see the dependence of photoelectric current on intensity of light.<br>ii) Use photoelectric cell to see the dependence of photoelectric current on plate potential. | 46 | | | | | |
| 7. | Use LDR to see the dependence of resistance of LDR on intensity of light. | 55 | | | | | |
| 8. | Use He Ne LASER to find the divergence of LASER beam with distance. | 62 | | | | | |
| **Total Marks** | | | | | | | |

* To be transferred to Proforma of CIAAN-2017

# Practical No. 1: Capacitors

## I Practical Significance:

A capacitor can store electric energy when disconnected from its charging circuit, so it can be used like a temporary battery, or like other types of rechargeable energy storage system. Capacitors are commonly used in electronic devices to maintain power supply while batteries are being changed. A resistor–capacitor circuit (RC circuit), or RC filter or RC network, is an electric circuit composed of resistors and capacitors driven by a voltage or current source. A first order RC circuit is composed of one resistor and one capacitor and is the simplest type of RC circuit. RC circuits can be used to filter a signal by blocking certain frequencies and passing others. The two most common RC filters are the high-pass filters and low-pass filters; band-pass filters and band-stop filters usually require RLC filters, though crude ones can be made with RC filters.

## II Relevant Program Outcomes (POs):

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

## III Relevant Course Outcomes:

Use relevant capacitors in electrical circuits.

## IV Practical Outcome:

1. Use condenser to increase and decrease the equivalent capacitance of the circuit.
2. Determine the characteristics of condenser using RC circuit.

## V Competency & Practical Skills:-

a. Circuit connections Skills.
b. Measurement Skills.
c. Graph plotting skills.

## VI Relevant Affective domain related Outcomes

a. Handle tools and equipment's carefully.
b. Function as a team member.
c. Practice good housekeeping.

## VII. Minimum Theoretical Background:

### Capacitors in Series and in Parallel

Capacitors are one of the standard components in electronic circuits. Moreover, complicated combinations of capacitors often occur in practical circuits. It is, therefore, useful to have a set of rules for finding the equivalent capacitance of some general arrangement of capacitors. It turns out that we can always find the equivalent capacitance by repeated application of *two* simple rules. These rules related to capacitors connected in series and in parallel.

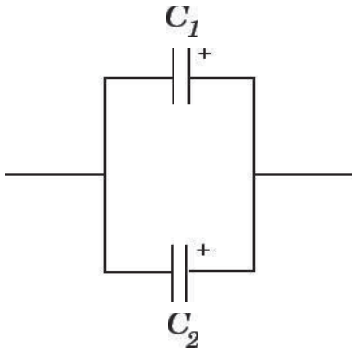



**Figure 1:** *Two capacitors connected in parallel.*

Consider two capacitors connected in *parallel*: *i.e.*, with the positively charged plates connected to a common ``input'' wire, and the negatively charged plates attached to a common ``output'' wire--see Fig. 1. What is the equivalent capacitance between the input and output wires? In this case, the potential difference $V$ across the two capacitors is the same, and is equal to the potential difference between the input and output wires. The total charge Q, however, stored in the two capacitors is divided between the capacitors, since it must distribute itself such that the voltage across the two is the same. Since the capacitors may have different capacitances, $C_1$ and $C_2$, the charges $Q_1$ and $Q_2$ may also be different. The equivalent capacitance $C_{eq}$ of the pair of capacitors is simply the ratio Q/V, where $Q= Q_{1+} Q_2$ is the total stored charge.

$$C_{eq=} C_{1+} C_2$$

Here, we have made use of the fact that the voltage $V$ is common to two capacitors.

The equivalent capacitance of N capacitors connected in parallel is the sum of the

$$C_{eq} = \sum_{i=1}^{N} C_i$$

individual capacitances.

For $N$ capacitors connected in parallel, Eq. (114) generalizes to .

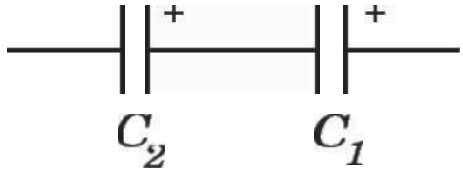



**Figure 2 :** *Two capacitors connected in series.*

Consider two capacitors connected in *series*: *i.e.*, in a line such that the positive plate of one is attached to the negative plate of the other--see Fig. 2. In fact, let us suppose that the positive plate of capacitor 1 is connected to the ``input'' wire, the negative plate of capacitor 1 is connected to the positive plate of capacitor 2, and the negative plate of capacitor 2 is connected to the ``output'' wire. What is the equivalent capacitance between the input and output wires? In this case, it is important to realize that the charge Q stored in the two capacitors is the same. This is most easily seen by considering the ``internal'' plates: *i.e.*, the negative plate of capacitor 1, and the positive plate of capacitor 2. These plates are physically disconnected from the rest of the circuit,

so the total charge on them must remain constant. Assuming, as seems reasonable, that these plates carry zero charge when zero potential difference is applied across the two capacitors, it follows that in the presence of a non-zero potential difference the charge +Q on the positive plate of capacitor 2 must be balanced by an equal and opposite charge -Q on the negative plate of capacitor 1. Since the negative plate of capacitor 1 carries a charge -Q, the positive plate must carry a charge +Q. Likewise, since the positive plate of capacitor 2 carries a charge +Q, the negative plate must carry a charge-Q. The net result is that both capacitors possess the same stored charge Q. The potential drops, $V_1$ and $V_2$, across the two capacitors are, in general, different. However, the sum of these drops equals the total potential drop V applied across the input and output wires: *i.e.*, $V= V_{1+} V_2$. The equivalent capacitance of the pair of capacitors is again $C_{eq} = Q/V$.

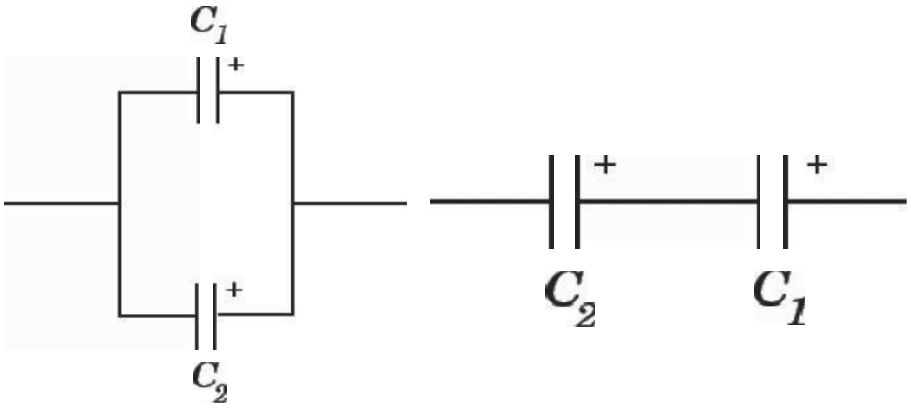
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}.$$

Here, we have made use of the fact that the charge Q is common to two capacitors. Hence, the rule is:

The reciprocal of the equivalent capacitance of N capacitors connected in series is the sum of the reciprocals of the individual capacitances. $1/C_{eq} = \sum_{i=1}^{N}(1/C_i)$.

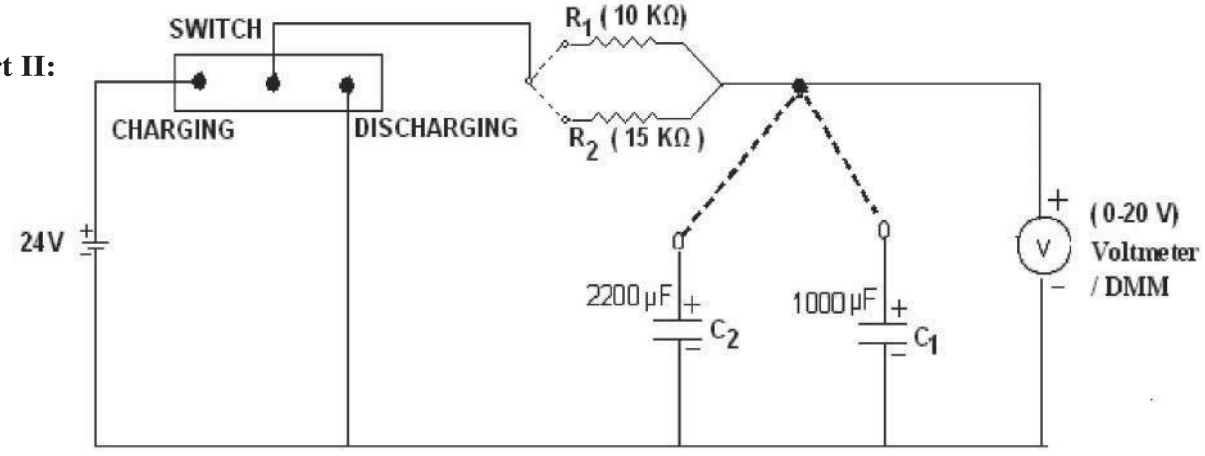
## VIII. Practical set-up / Circuit diagram / Work Situation

**Part I:**




**a. parallel combination** **b. series combination**

**Part II:**




## IX. Resources required:

| Sr. No. | Instrument/Object | Specifications | Quantity |
|---|---|---|---|
| 1 | Circuit board | With minimum two capacitors and two resistors | 01 |
| 2 | Multimeter | | 01 |
| 3 | Stop watch | 0-1 hr | 01 |
| 4 | Connecting wires | | |

## X. Procedure

**Part I: Use condenser to increase and decrease the equivalent capacitance of the circuit.**

1. Using multimeter, measure directly the capacitance of each of the two capacitors in the circuit board.
2. Connect the two capacitors on the circuit board in a series arrangement and measure the total capacitance.
3. Connect the two capacitors in a parallel arrangement and measure the total capacitance.
4. Calculate the expected capacitances of the two configurations using formula of equivalent capacitance of series and parallel combination.

**Part II: Determine the characteristics of condenser using RC circuit.**

1. Connect the circuit as shown in the diagram.
2. Consider any one pair of resistor and capacitor say R1C1/R1C2/R2C1/R2C2
3. Make sure that the voltage across the capacitor is zero.
4. Keep the switch on 'ON mode' (Charging).
5. Select 20 V range on a multimeter.
6. Start the stop watch, note the charging voltage across the capacitor at different intervals of time i.e. 5, 10, 15, 20--- sec.
7. Note the maximum voltage across capacitor.
8. Now keep the switch on 'OFF mode' (Discharging)
9. Start the stop watch, note the discharging voltage across the capacitor at different interval of time i.e. 5, 10, 15, 20--- sec.
10. Determine time constant from component value using formula.
11. Plot the graph of charging voltage 'V' (Y-axis) against time 't'(X-axis)
12. Plot the graph of discharging voltage 'V' (Y-axis) against time 't'(X-axis)

## XI. Precautions to be followed

1. Make connection according to circuit diagram
2. Check connection with the help of teacher.
3. Take readings accurately

## XII. Actual procedure followed

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## XIII. Resources used

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## XIV. Precautions followed

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## XV. Observations and Calculations

**Table 1: Equivalent capacitance of the circuit.**

| Sr. No. | Theoretical value μF | Measured value μF |
|---|---|---|
| $C_1$ | | |
| $C_2$ | | |
| $C_s$ | | |
| $C_p$ | | |

Determine the characteristics of condenser using RC circuit.
R=……..
C=…….

**Table 2: Charging of Condenser**

| Obs. No. | Time required (t) sec | Voltage (V) volt |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

**Table 3: Discharging of Condenser**

| Obs. No. | Time required (t) sec | Voltage (V) volt |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

## XVI. Calculation

1) $C_p = C_1 + C_2$

2) $C_s = C_1 x C_2 / ( C_1 + C_2)$

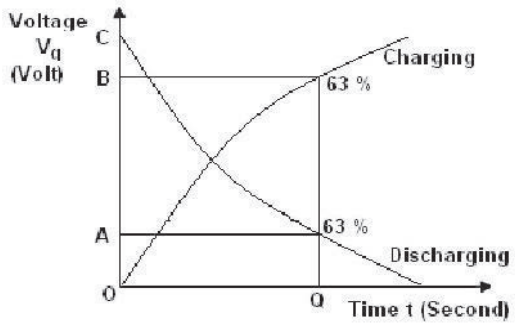
3) Time constant

$t = RxC$

= ……..... x ……..

= ……...sec

**Graph**




## XVII. Results

1. Equivalent capacitance of parallel combination $C_p$=…….
2. Equivalent capacitance of series combination $C_s$=…….
3. Time constant t =…….

## XVIII. Interpretation of results

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……
……

## XIX. Conclusions and Recommendations

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……..
……..
……..
……..
……..
……..
……..

## XX. Practical Related Questions

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

1. Define capacitance.
2. What will happen if two terminals of capacitor are shorted? How capacity of capacitor varies with dielectric media?
3. Name the three household instruments or appliances where capacitors are used.
4. State law of capacitors in parallel.
5. Define 1 farad.

**Space to write answers**

……
……
……
……
……

## XXI. References / Suggestions for further Reading

a. Engineering Physics by Gaur and Gupta
b. vimeo.com/7509789

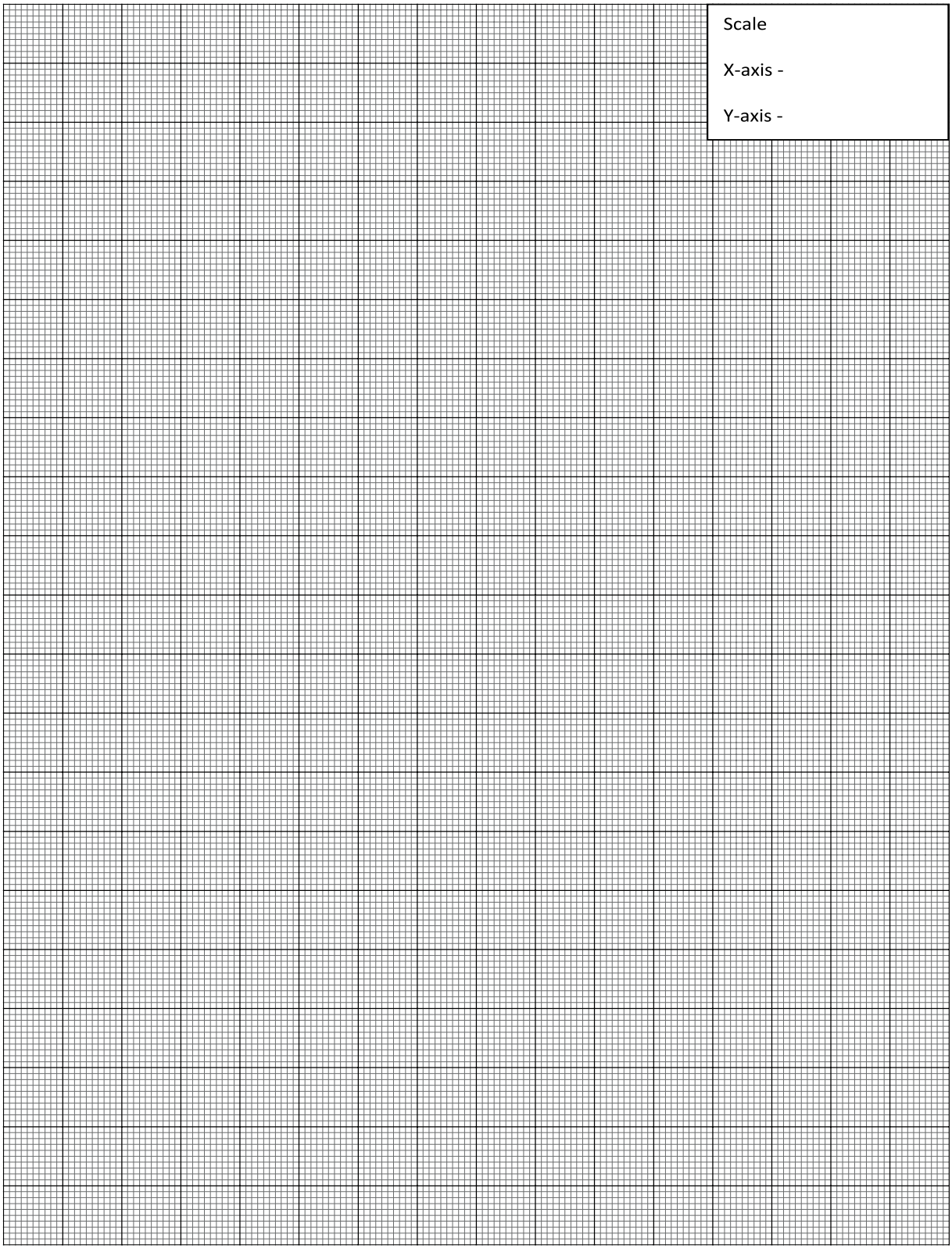
## XXII. Assessment Scheme

| Performance indicators | | Weightage |
|---|---|---|
| **Process related: 15 Marks** | | 60% |
| 1 | Proper connection of electrical circuit | 10 |
| 2 | Taking proper reading | 20 |
| 3 | Calculation | 20 |
| 4 | Plotting Graphs | 10 |
| **Product related: 10 Marks** | | **40%** |
| 4 | Timely submission and Neatness | 20 |
| 5 | Conclusions & Recommendations | 10 |
| 6 | Practical related questions | 10 |
| | **Total (25 Marks)** | |

***Name of Student Team Members***

1. ……..
2. ……
3. ……
4. ……...

| **Marks Obtained** | | | **Dated Signature of Teacher** |
|---|---|---|---|
| **Process Related (15)** | **Product Related (10)** | **Total (25)** | |
| | | | |


Scale
X-axis -
Y-axis -

# Practical No. 2: Meter Bridge

## I Practical Significance

The Wheatstone bridge illustrates the concept of a difference measurement, which can be extremely accurate. Variations on the Wheatstone bridge can be used to measure capacitance, inductance, impedance and other quantities, such as the amount of combustible gases in a sample, with an explosimeter. The Kelvin bridge was specially adapted from the Wheatstone bridge for measuring very low resistances. In many cases, the significance of measuring the unknown resistance is related to measuring the impact of some physical phenomenon (such as force, temperature, pressure, etc.) which thereby allows the use of Wheatstone bridge in measuring those elements indirectly.

## II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

## III Competency & Practical Skills

a. Measurement Skills.
b. Electrical circuit connection skill

## IV Relevant Course Outcomes

Use relevant resistors in electrical circuits.

## V Practical Outcomes

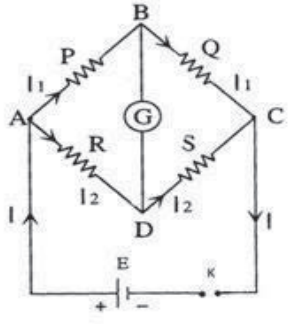
1. Use Meter Bridge to determine the equivalent resistance of the resistors in series and parallel.
2. Use Meter Bridge to estimate specific resistance of a given wire.

## VI Relevant Affective domain related Outcomes:

a. Handle tools and equipments carefully.
b. Practice good housekeeping.
c. Function as a team member

## VII Minimum Theoretical Background

**Wheatstone's principle:-**

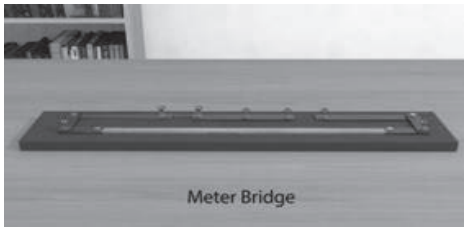


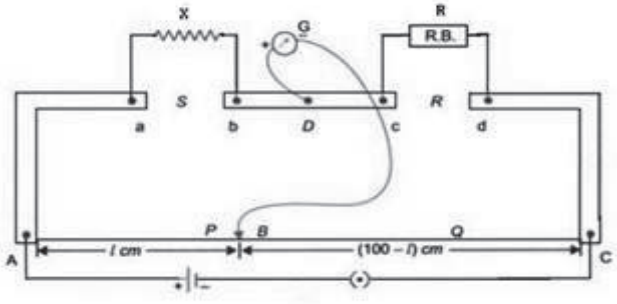
The meter bridge is operates under Wheatstone's principle. Here, four resistors P, Q, R, and S are connected to form the network ABCD. The terminals A and C are connected to a battery, and the terminals C and D are connected to a galvanometer through keys K1 and K2 respectively. In the balancing condition, there is no deflection on the galvanometer. Then,

$$\frac{P}{Q} = \frac{R}{S}$$

**Meter Bridge apparatus**:-

The meter bridge, also known as the slide wire bridge consists of a one meter long wire of uniform cross sectional area, fixed on a wooden block. A scale is attached to the block. Two gaps are formed on it by using thick metal strips in order to make the Wheat stone's bridge. The terminal B between the gaps is used to connect galvanometer and jockey.




A resistance wire is introduced in gap S and the resistance box is in gap R. One end of the galvanometer is connected to terminal D and its other end is connected to a jockey. As the jockey slides over the wire AC, it shows zero deflection at the balancing point (null point).

If the length AB is $l$, then the length BC is ( 100-$l$ ).
Then, according to Wheatstone's principle;

$$\frac{X}{R} = \frac{l}{(100 - l)}$$

Now, the unknown resistance can be calculated as,

$$X = R\frac{l}{(100 - l)}$$

The specific resistance or resistivity of the material of the wire can be then calculated by using the relation,

$$\rho = \frac{\pi r^2 X}{L} ;$$

Where L be the length of the wire and r be its radius.

## VIII. Practical set-up / Circuit diagram / Work Situation

Fig 1:

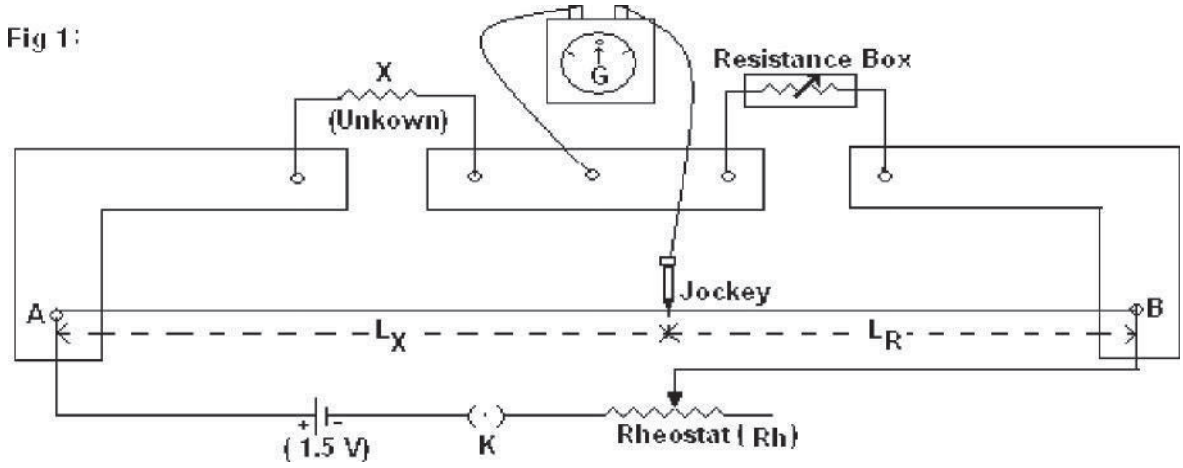



Fig 2:

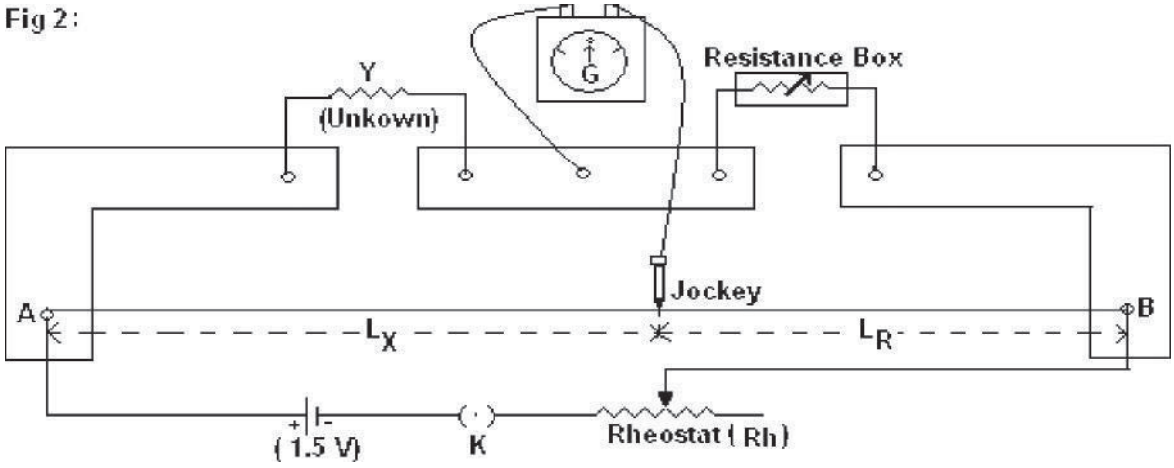
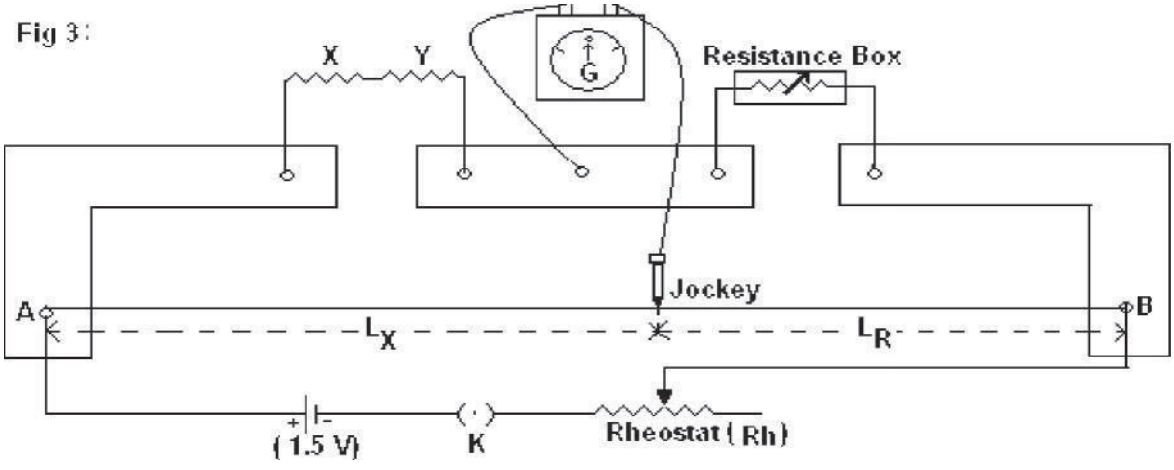
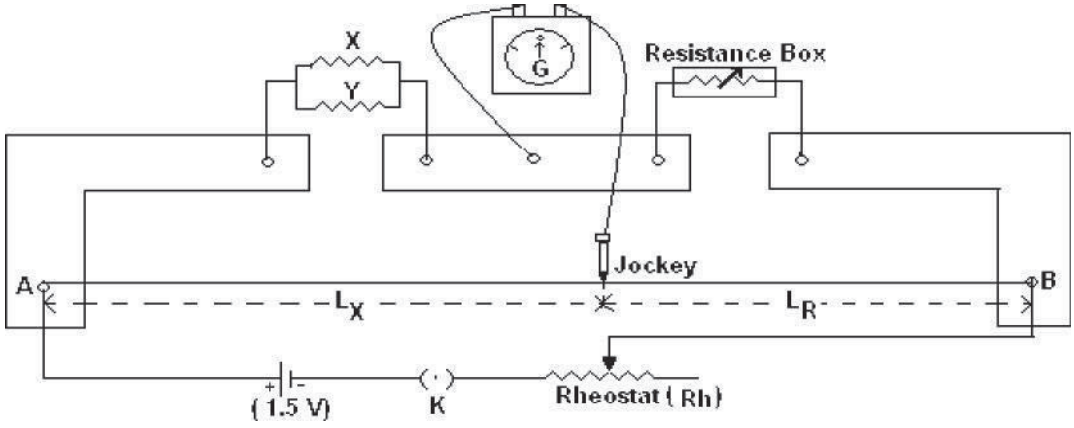



Fig 3:






## IX. Resources required :

| Sr. No. | Instrument/Object | Specifications | Quantity |
|---|---|---|---|
| 1 | Meter bridge | - | 1 |
| 2 | Unknown resistors | 5,10,15-ohm | 1 each |
| 3 | Resistance box | 4 decade ranges from 1 ohm to 1 Kilo ohm | 1 |
| 4 | Battery eliminator | 0-12,2 A | 1 |
| 5 | Rheostat | 0-500 ohm | 1 |
| 6 | Resistance wire | Nichrome/Eureka | 1 |
| 7 | Galvanometer | | 1 |
| 8 | Connecting wires | | |
| 9 | Pencil jockey | | 1 |
| 10 | Plug key | | 1 |

## X. Precautions to be followed

1. All electrical Connections should be neat and tight.
2. Check the power supply before connection.
3. Check connections with the help of teacher.

## XI. Procedure

**Part I:**

1. Make the connection as shown in the circuit diagram (Refer Fig: 1)
2. Connect the unknown resistance X in one gap of meter Bridge and known resistance in second gap of meter bridge.
3. Take out some plug from the resistance box and thus introduce a suitable value of resistance.
4. Check the connections by touching the jockey at the two ends A and B of the bridge wire.
5. If the deflections are in opposite directions at A and B then proceed. If the deflections are in the same direction, it means that the connection is faulty. Check

the connections and ensure that you get the deflections in opposite direction at the two end of meter bridge.

6. Adjust the value of R so as to obtain null point somewhere near the middle of bridge wire.
7. Measure $L_x$ and $L_R$ (where $L_R = 100-L_x$)
8. Adjust value of R such that null point is obtained between 30 cm and 70 cm on the bridge wire.
9. Measure $L_x$ and $L_R$ for at least 2 different values of R.
10. Interchange the positions of X and R and repeat steps 3-8.
11. Calculate Unknown resistance "X' using formula.
12. Replace the unknown resistance X by unknown resistance Y and repeat steps 3-10.
13. Calculate Unknown resistance "Y' using formula
14. Now connect the resistance X and Y in series combination such that this combination can be treated as a single resistance Rs and repeat steps 3-10.
15. Calculate Unknown resistance "X series Y' using formula
16. Now connect the resistance X and Y in parallel combination such that this combination can be treated as a single resistance $R_P$
17. Repeat steps 3-10 from stepwise procedure of experiment
18. Calculate Unknown resistance "X parallel Y' using formula

**Part II:**

1. Connect the wire of unknown resistance in one gap of Meter Bridge and known resistance in second gap of Meter Bridge.
2. Repeat steps 3-11.
3. Calculate specific resistance of wire by using formula.

## XII. Resources used

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## XIII. Actual procedure followed (use blank sheet provided if space not sufficient)

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## XIV. Observations and Calculations

### Observation table 1: To Determine Series and Parallel combination of resistance

| Unknown Resistance | Obs No. | Resistance from resistance Box | Null Point | | | | Mean | | Unknown Resistance = R. Lx / $L_R$ | Mean Unknown Resistance |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Before Interchanging | | After Interchanging | | $L_X$ cm | $L_R$ cm | | |
| | | | $L_X$ cm | $L_R$ cm | $L_X$ cm | $L_R$ cm | | | | |
| X | 1 | | | | | | | | | X = |
| | 2 | | | | | | | | | |
| Y | 1 | | | | | | | | | Y= |
| | 2 | | | | | | | | | |
| X and Y in series $R_S$ | 1 | | | | | | | | | Rs= |
| | 2 | | | | | | | | | |
| X and Y in Parallel $R_P$ | 1 | | | | | | | | | Rp= |
| | 2 | | | | | | | | | |

### Table No. II: To Determine Specific resistance of a given wire Observations

1. Length of given wire L=……. cm.
2. Radius of the wire r=……cm (given).
3. Cross sectional area of wire (A) =$\pi r^2$=……$cm^2$.

| Unknown Resistance | Obs No. | Resistance from resistance Box | Null Point | | | | Mean | | Unknown Resistance = R. Lx / $L_R$ | Mean Unknown Resistance |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Before Interchanging | | After Interchanging | | $L_X$ cm | $L_R$ cm | | |
| | | | $L_X$ cm | $L_R$ cm | $L_X$ cm | $L_R$ cm | | | | |
| R | 1 | | | | | | | | | R= |
| | 2 | | | | | | | | | |

## XV. Calculations

1) $R_s = X+Y$

2) $$R_P = \frac{X \times Y}{X + Y}$$

$$R_P = \frac{\langle \ldots\ldots \times \ldots\ldots \rangle}{\langle \ldots\ldots + \ldots\ldots \rangle}$$

$$R_P = \ldots\ldots\ldots\ldots \Omega$$

3) Specific resistance $\rho = RA/L$

=……..Ωcm

## XVI. Result

1. Unknown resistance (X)=…… Ω.
2. Unknown resistance (Y)=…… Ω.
3. Equivalent resistance of series combination by theory ($R_s$) =……..Ω.
4. Equivalent resistance of series combination by experiment ($R_s$) =……..Ω.
5. Equivalent resistance of parallel combination by theory ($R_p$) =……..Ω.
6. Equivalent resistance of parallel combination by experiment ($R_p$) =……..Ω.
7. Specific resistance if material of wire=…….Ωcm

## XVII. Interpretation of results

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## XVIII. Conclusions and Recommendations

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## XIX. Practical Related Questions

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

1. State principle of Wheatstone's network.
2. State law of resistances in series.
3. State law of resistances in parallel.
4. Define specific resistance.

## Space to write answers

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## XX. References / Suggestions for further Reading

Engineering Physics By Gupta

## XXI. Suggested Assessment Scheme

| Performance indicators | | Weightage |
|---|---|---|
| **Process related: 15 Marks** | | 60% |
| 1 | Proper connection of electrical circuit | 20 |
| 2 | Taking proper reading | 20 |
| 3 | calculation | 20 |
| **Product related: 10 Marks** | | 40% |
| 4 | Timely submission and Neatness | 20 |
| 5 | Conclusions & Recommendations | 10 |
| 6 | Practical related questions | 10 |
| | **Total (25 Marks)** | |

***Name of Student Team Members***

1. ……..
2. ……
3. ……
4. ……..

| **Marks Obtained** | | | **Dated Signature of Teacher** |
|---|---|---|---|
| **Process Related (15)** | **Product Related (10)** | **Total (25)** | |
| | | | |

# Practical No. 3: Potentiometer

## I Practical Significance

A potentiometer is an instrument for measuring voltage by comparison of an unknown voltage with a known reference voltage. If a sensitive indicating instrument is used, very little current is drawn from the source of the unknown voltage. Since the reference voltage can be produced from an accurately calibrated voltage divider, a potentiometer can provide high precision in measurement. The method was described by Johann Christian Poggendorff around 1841 and became a standard laboratory measuring technique.This null balance measuring method is still important in electrical metrology and standards work and is also used in other areas of electronics.

## II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

## III Relevant Course Outcomes

Use relevant Voltage divider in electrical circuits.

## IV Practical Outcome

1. Use potentiometer to compare emf of two cells.
2. Use potentiometer to find internal resistance of a cell.

## V Competency & Practical Skills

a. Measurement Skills
b. Electrical circuit connection skill

## VI Relevant Affective domain related Outcomes

a. Handle tools and equipments carefully.
b. Practice good housekeeping.
c. Function as a team member

## VII Minimum Theoretical Background

**Potentiometer**

Potentiometer is a device used to measure the internal resistance of a cell, to compare the e.m.f. of two cells and potential difference across a resistor. It consists of a long wire of uniform cross sectional area and of 04 m in length. The material of wire should have a high resistivity and low temperature coefficient. The wires are stretched parallel to each other on a wooden board. The wires are joined in series by using thick copper strips. A metre scale is also attached on the wooden board. It works on the principle that when a constant current flows through a wire of uniform cross sectional area, potential difference between its two points is directly proportional to the length of the wire between the two points.

**Electromotive force (e.m.f) of a cell**

Electromotive force (emf) is a measurement of the energy that causes current to flow through a circuit. It is the energy provided by a cell or battery per coulomb of charge passing through it. It can also be defined as the potential difference across the terminals of a cell, when no current flows through it. Electromotive force is also known as

voltage, and it is measured in volts. Electromotive force is not truly a force; rather, it is a measurement of energy per unit charge.

$$\epsilon = \frac{E}{Q} \quad ,$$

where E is the energy and Q is the charge.

Using a potentiometer, we can determine the emf of a cell by obtaining the balancing length l. Here, the fall of potential along the length l of the potentiometer wire is equal to the emf of the cell, as no current is being drawn from the cell.

Then,

$$E \propto l \quad \text{or,} \quad E = kl \; ;$$

where k is the potential gradient along the wire.

Thus it is possible to compare the emf's of two given cells by measuring the respective balancing lengths $l_1$ and $l_2$.

i.e; $E_1 = kl_1$ and $E_2 = kl_2$

or $$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

**Relation between e.m.f., potential difference, and internal resistance of a cell**

If a cell of emf E and internal resistance r, connected to an external resistance R, then the circuit has the total resistance (R+r). The current I in the circuit is given by,

$$I = \frac{E}{R+r} \quad \text{or} \quad E = I(R+r)$$

Hence, $V = IR = E - Ir$

This means, V is less than E by an amount equal to the fall of potential inside the cell due to its internal resistance.

From the above equation,

$$\frac{r}{R} = \frac{E = V}{V}$$

Or; The internal resistance of the cell,

$$r = R\frac{E - V}{V}$$

Using a potentiometer, we can adjust the rheostat to obtain the balancing lengths $l_1$ and $l_2$ of the potentiometer for open and closed circuits respectively.

## VIII Circuit diagram / Experimental set-up / Work Situation

**Part I: To Compare e.m.f. of two cells.**

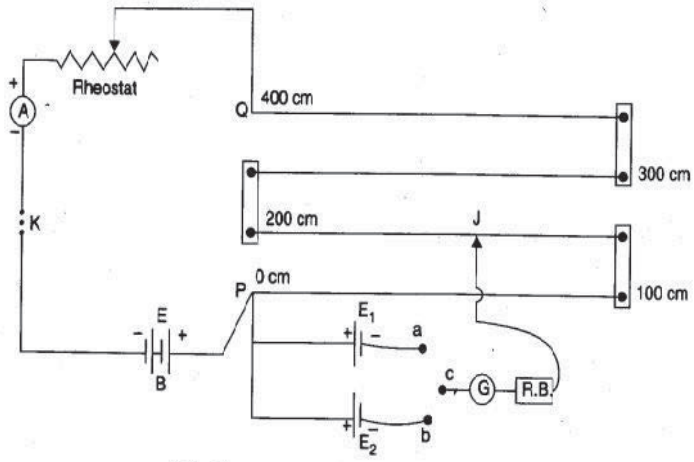


**Fig.** Comparison of the e.m.f. of two cells.

**Part II:** To find Internal resistance of a cell

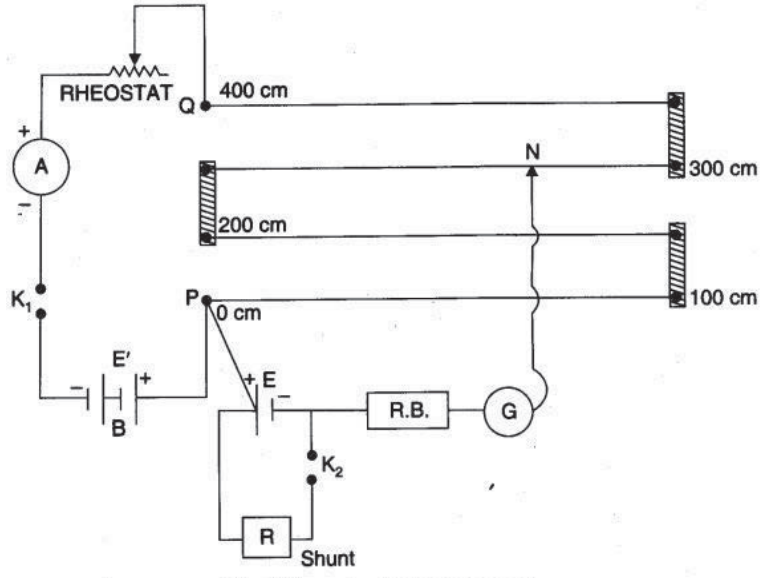


**Fig.** Internal resistance of a cell.

## IX Resources required

| Sr. No. | Instrument/Object | Specifications | Quantity |
|---|---|---|---|
| 1 | Potentiometer | - | 1 |
| 2 | Battery eliminator | 0-12 V,2A | 1 |
| 3 | Resistance box | 4decade ranges from 1 ohm to 1Kilo ohm | 2 |
| 4 | Ammeter | 0-5 A | 1 |
| 5 | Rheostat | 0-500 ohm | 1 |
| 6 | Daniel cell | | 1 |
| 7 | Leclanche cell | | 1 |
| 8 | Galvanometer | | 1 |
| 9 | Connecting wires | | |
| 10 | Pencil jockey | | 1 |
| 11 | One way key | | 2 |
| 12 | Two way key | | 1 |

## X Procedure

**Part I: To Compare e.m.f. of two cells.**

1. Arrange the required apparatus on a table and make the connections as per the circuit diagram.
2. Tight the plugs of the resistance box.
3. Note the reading on the ammeter.
4. To test the connection, insert plug in the one way key $k_1$ and also in between the terminals a and c of the two way key. Introduce a sufficiently high resistance on the resistance box (R.B). Place the jockey at the two end points of the wire. Press the jockey at both end of the potentiometer wire and note the deflection in galvanometer. If the galvanometer shows opposite deflection, the connections are correct.
5. Now, gently slide the jockey along the potentiometer wire and stop when null point is obtained.
6. Measure the length $l_1$ between this point and the end P of the potentiometer. It is the balancing length for the cell $E_1$.
7. Disconnect the cell $E_1$ by removing the plug from the gap ac of the two way key and connect the cell $E_2$ by inserting plug into the gap bc of the two way key.
8. Again slide the jockey along the potentiometer wire to obtain the null point. Measure the new balancing length $l_2$ for the cell $E_2$ based on this point.
9. Make sure that the reading on the ammeter is constant throughout the observation.
10. Repeat the experiment by increasing the current by adjusting the rheostat and record the observations.
11. Each time, the ratio between the emf's of the given cells can be calculated using the relation, $\frac{E_1}{E_2} = \frac{l_1}{l_2}$

**Part II: To find Internal resistance of a cell**

1. Arrange the required apparatus on a table and make the connections as per the circuit diagram.
2. Tight the plugs of the resistance box.
3. To test the connection, insert the key $k_1$ and note the ammeter reading. Introduce a sufficiently high resistance on the resistance box (R.B). Place the jockey at the two end points of the wire. If the galvanometer shows opposite deflection, then the connections are correct.
4. Without inserting the key $k_2$, slide the jockey along the potentiometer wire and stops when null point is obtained.
5. Measure the balancing length $l_1$ between this point and the end P of the potentiometer.
6. Now, introduce plugs in keys $k_1$ and $k_2$. Take out a small resistance from the resistance box R connected in parallel with the cell.
7. Again slide the jockey along the potentiometer wire to obtain the null point. Measure the new balancing length $l_2$ based on this point.
8. Reduce the value of R successively and in each time, measure the balancing length.
9. Keep the reading on the ammeter constant throughout the observation.

## XI. Actual procedure followed

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## XII. Resources used (with major specifications)

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## XIII. Precautions followed

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## XIV. Observations and Calculations

### Observation table 1

| Sr. No. | Ammeter reading (A) | Balancing length when | | $\frac{E_1}{E_2} = \frac{l_1}{l_2}$ |
|---|---|---|---|---|
| | | $E_1$ in the circuit, $l_1$ (cm) | $E_2$ in the circuit, $l_2$ (cm) | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |

**Calculations:**

Calculate the ratio of $E_1$ and $E_2$ for each set of $l_1$ and $l_2$. The mean of the calculated values gives the ratio of emf's of the two given primary cells.

### Observation Table 2:

Ammeter reading = ……..A

| Sr. No. | Resistance, R ($\Omega$) | Position of null point (cm) | | Internal resistance $r = R\frac{(l_1 - l_2)}{l_2}$ () ($\Omega$) |
|---|---|---|---|---|
| | | Without shunt R, $l_1$(cm) | With shunt R, $l_2$(cm) | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

**Calculations:**

Calculate the value of r for each set of $l_1$ and $l_2$. The mean of the calculated values gives the internal resistance (r) of the given cell.

## XV. Result

The emf's of the two given primary cells are compared.

The ratio of emf's of the two given primary cells, $E_1/E_2$ =.....

The internal resistance of the given primary cell, r = ...…….. ohm

## XVI. Interpretation of results

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## XVII. Conclusions and Recommendations

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## XVIII. Practical Related Questions

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

1. State principle of potentiometer
2. State uses of potentiometer
3. Define Internal Resistance of a cell

**Space to write answers**

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## XIX. References / Suggestions for further Reading

a. Engineering Physics By Gaur,Gupta
b. http://amrita.olabs.edu.in/?sub=1&brch=6&sim=231&cnt=2

## XX. Suggested Assessment Scheme

| Performance indicators | | Weightage |
|---|---|---|
| **Process related: 15 Marks** | | **60%** |
| 1 | Proper connection of electrical circuit | 20 |
| 2 | Taking proper reading | 20 |
| 3 | calculation | 20 |
| **Product related: 10 Marks** | | **40%** |
| 4 | Timely submission and Neatness | 20 |
| 5 | Conclusions & Recommendations | 10 |
| 6 | Practical related questions | 10 |
| | **Total (25 Marks)** | |

***Name of Student Team Members***

1. ……..
2. ……
3. ……
4. ……

| Marks Obtained | | | Dated Signature of Teacher |
|---|---|---|---|
| **Process Related (15)** | **Product Related (10)** | **Total (25)** | |
| | | | |

# Practical No. 4: Resonance Tube to Determine Velocity of Sound

## I. Practical Significance

In industry, phenomenon of resonance is used in variety of applications such as manufacturing musical instruments, Constructing big halls or auditorium, in ultra sonography in silencer of a vehicle in automobile industry, Resonating circuits, filters, loud speakers etc. in electronic industry .Resonance phenomena occur with all types of vibrations or waves such as mechanical resonance, acoustic resonance, electromagnetic resonance, nuclear magnetic resonance (NMR), electron spin resonance (ESR) Resonant systems can be used to generate vibrations of a specific frequency (e.g., musical instruments), or pick out specific frequencies from a complex vibration containing many frequencies (e.g., filters). Resonance occurs widely in nature in many manmade devices. Sound waves are produced by the compression of a substance by vibrations caused by objects such as vocal cords, guitar strings, organ pipe, loud speaker etc. A resonance frequency exists when a system is driven by its natural frequency. Pendulums and swings demonstrate only one natural frequency. In this experiment the principle of resonance is utilized to determine the velocity of a sound wave in air using resonance tube method.

## II. Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

## III. Relevant Course Outcomes

Use equipment/instruments based on radioactive and ultrasonic principles.

## IV. Practical Outcome

Use resonance tube to determine velocity of sound

## V. Practical Skills

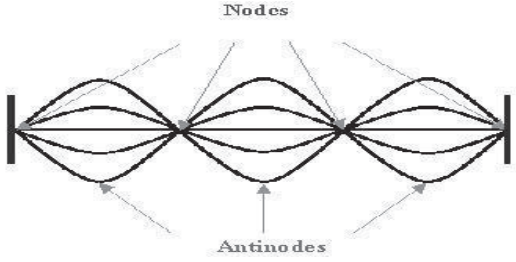
Measurement Skills.

## VI. Relevant Affective domain related Outcomes

a. Handle tools and equipments carefully.
b. Practice energy conservation.
c. Function as a team member.

## VII. Minimum Theoretical Background

1. Stationary waves

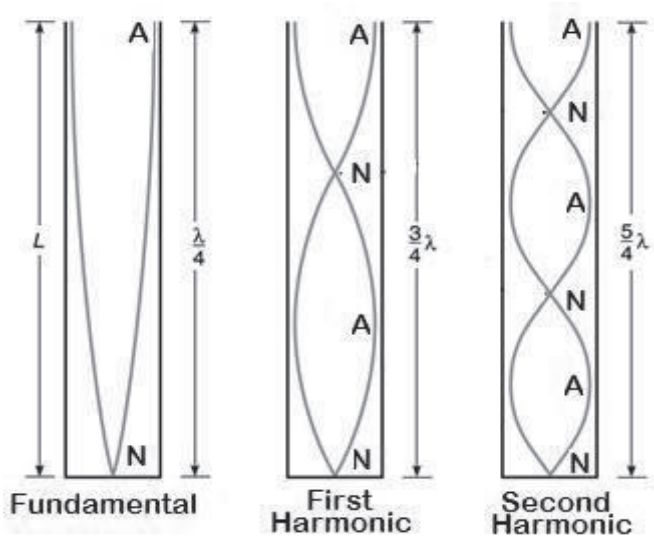



Stationary waves are produced by the superposition of two waves of same frequency and amplitude travelling with same velocity in opposite directions. Due to the constructive interference, these waves produce certain fixed points along the medium

which undergo zero displacement. These points of no displacement are known as **nodes**. Midway between every nodes are regions of maximum displacement. These points are called **antinodes**.

**2. Reflection of sound at the end of closed tube**

When a tube enclosing a column of air is excited by resonant vibrations produced by a tunning fork placed over the mouth of the tube, a stationary wave system is set up formed due to the superposition of direct waves and the reflected waves at the end of the tube. The node is formed at the lower fixed end and the antinode is just above the open end of the tube. This distance is considered as end correction (e) in the resonating length of air column.




Production of longitudinal stationary waves in air column

Standing waves can be formed in a tube of air due to the interference of longitudinal sound waves travelling in opposite directions. In a pipe closed at one end, the closed end is a displacement node and the open end is a displacement antinode.

**3. Resonance**

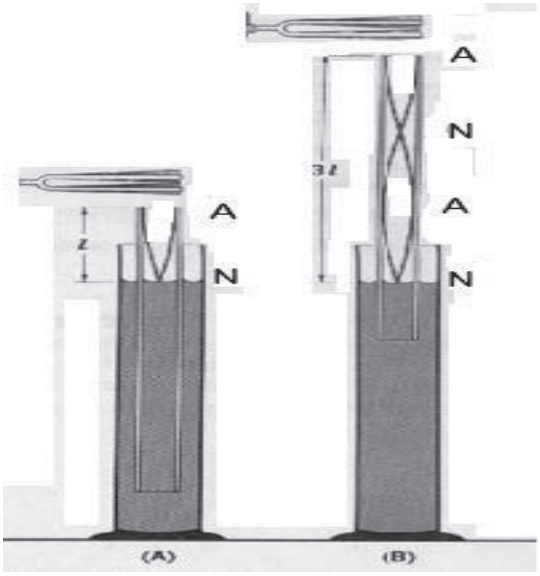
It is a phenomenon in which the natural frequency of a body becomes equal to the frequency of externally applied force (force frequency) and the body starts vibrating with maximum amplitude

**4. About Resonance column apparatus**

Vibration of air column can be set up in a resonance column apparatus. It consists of along metal tube held vertically in a tall jar containing the water. The tube can be fixed in vertical position. The length of the air column can be varied by raising or lowering the tube.

Here, the surface of water will act as the closed end. When a vibrated tuning fork is held above the open end, longitudinal waves are sent down the air column. These waves are reflected at the water surface and thus produce standing waves. Nodes are produced at the water surface and antinodes are produced at the open end.

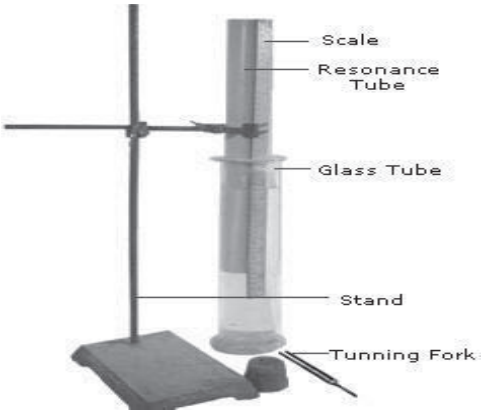
When the frequency of waves in the air column becomes equal to the natural frequency of tuning fork, a loud sound is produced in the air column. It is the condition for resonance. It occurs only when the length of air column is proportional to one-fourth of the wavelength of sound waves having frequency equal to frequency of tuning fork.




Learning Outcomes

- Students understand the concept of standing waves and the various terms related to them.
- Students learn the relation between frequency, wavelength and velocity of a wave.
- Students understand transverse and longitudinal waves.

## VIII. Circuit diagram / Experimental set-up / Work Situation



## IX. Resources required

| Sr. No. | Instrument/Object | Specifications | Quantity |
|---|---|---|---|
| 1 | Resonance column apparatus | | 1 |
| 2 | Tuning forks of known frequency | | 5 |
| 3 | Rubber hammer | | 1 |

## X. Procedure

1. Measure the inner diameter of the resonance tube using a Vernier caliper.
2. Calculate the end correction 'e'.
3. Take the tuning fork of a particular frequency; note the frequency in the observation table.
4. Hit the tuning fork on the rubber pad so that it produces forced frequency.
5. Place the vibrating tuning fork on top of the resonance tube, so that the air molecules vibrate and produce the natural frequency.
6. Move the resonance tube up and down and find the position of the resonance, the position where the natural frequency is equal to forced frequency.
7. Resonance is the position where we hear a loud sound.
8. Note the vibrating length from the surface of the water till the end of the tube as 'l'.
9. Calculate the corrected length as L = l + e
10. Repeat the same procedure for three times so as to reduce the error.
11. Now repeat the same procedure for five different frequencies of tuning fork
12. Complete the observation table and calculate the Velocity of sound using the formula.
13. Plot the graph of n Vs 1/L and find the velocity of sound by graph.
14. Compare the result from observation and graph.

## XI. Precautions

Sources of error for this experiment may consist of mistaking overtones as resonance and therefore including overtones in the data. Another source of error could include missing points of resonance and therefore not including resonance points into the data. Furthermore, the length of the air column could have been incorrectly interpreted when holding the tuning fork above the air column and adjusting the length of the air column.

## XII. Actual procedure followed

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## XIII. Resources used (with major specifications)

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## XIV. Precautions followed

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## XV. Observations and Calculations

i. Least count of Vernier caliper L.C. = ---------- cm

ii. Calculate Diameter (d) of resonance tube:

| Obs. No. | MSR cm | VSD | VSR=VSD x L.C cm | TR = MSR + VSR cm | Diameter cm | Average diameter of resonance tube cm |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |

iii. End Correction e= 0.3d = ----------cm

iv. Calculate velocity of sound:

| Obs. No. | Frequency of tuning fork (n) Hz | Length of air column | | | Mean l cm | Resonating Length L=l+e (cm) | 1/L ($cm^{-1}$) | Velocity v= 4nL (cm/s) |
|---|---|---|---|---|---|---|---|---|
| | | $l_1$ cm | $l_2$ cm | $l_3$ cm | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |

Calculations
Velocity of sound in air at room temperature;
V= ----------cm/s= ----------m/s
**Graph: plot graph of frequency (n) against 1/L**

## XVI. Results

1) Velocity of sound in air at room temperature = ----------m/s by experiment.
2) Velocity of sound in air at room temperature = ----------m/s by graph.

## XVII. Interpretation of results

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## XVIII. Conclusions and Recommendations

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## XIX. Practical Related Questions

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

1. Name the type of vibrations produced in the air column in resonance tube.
2. State the purpose of obtaining resonating length in the experiment.
3. State the effect of increase in frequency on resonating length of air column.
4. Explain the effect on resonating position if water is replaced by kerosene oil in this experiment.
5. The velocity of sound in air at 30$^{o}$C is 351.45 m/s. Calculate the velocity of sound in air at 0 degree Celsius.

**Space to write answers**

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## XX. References / Suggestions for further Reading

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

## XXI. Suggested Assessment Scheme

| Performance indicators | | Weightage |
|---|---|---|
| **Process related: 15 Marks** | | **60%** |
| 1 | Handling of the instrument | 10 |
| 2 | Performing Part I | 20 |
| 3 | Performing Part I | 20 |
| 4 | Plotting Graphs | 10 |
| **Product related: 10 Marks** | | **40%** |
| 5 | Timely submission and Neatness | 20 |
| 6 | Conclusions & Recommendations | 10 |
| 7 | Practical related questions | 10 |
| | **Total (25 Marks)** | |

***Name of Student Team Members***

1. ……..
2. …….
3. …….
4. …….

| Marks Obtained | | | Dated Signature of Teacher |
|---|---|---|---|
| **Process Related (15)** | **Product Related (10)** | **Total (25)** | |
| | | | |


Scale
X-axis -
Y-axis -

# Practical No. 5: Ultrasonic Distance-Meter

## I Practical Significance:

Ultrasound devices operate with frequencies from 20 kHz up to several gigahertz. Ultrasound is used in many different fields. Ultrasonic devices are used to detect objects and measure distances. Ultrasound imaging or sonography is often used in medicine. In the nondestructive testing of products and structures, ultrasound is used to detect invisible flaws. Industrially, ultrasound is used for cleaning, mixing, and to accelerate chemical processes. Scientists are also studying ultrasound using graphene diaphragms as a method of communication.

## II Relevant Program Outcomes (POs):-

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

## III Relevant Course Outcomes

Use equipment/instruments based on radioactive and ultrasonic principles.

## IV Practical Outcome

Use Ultrasonic distance-meter to measure distance.

## V Competency & Practical Skills

Measurement Skills.

## VI Relevant Affective domain related Outcomes

a. Handle tools and equipment's carefully.
b. Function as a team member.

## VII Minimum Theoretical Background:

Ultrasonic sound refers to sound with a frequency greater than the human audible range (20Hz to 20 KHz).

Ultrasonic can be produced by different methods. The most common methods include:

**Mechanical method** In this, ultrasonic frequencies up to 100 KHz are produced. But this method is rarely used due to its limited frequency range.

**Piezoelectric generator** this is the most common method used for the production of ultrasound. When mechanical pressure is applied to opposite faces of certain crystals which are cut suitably, electric fields are produced. Similarly, when subjected to an electric field, these crystals contract or expand, depending on the direction of the field. Thus a properly oriented rapid alternating electric field causes a piezoelectric crystal to vibrate mechanically. This vibration, largest when the crystal is at resonance, is used to produce a longitudinal wave, *i.e.*, a sound wave.

**Magnetostriction generator**: In this method, the magnetostriction method is used for the production of ultrasonic. Frequencies ranging from 8000 Hz to 20,000Hz can be produced by this method.

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed

time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

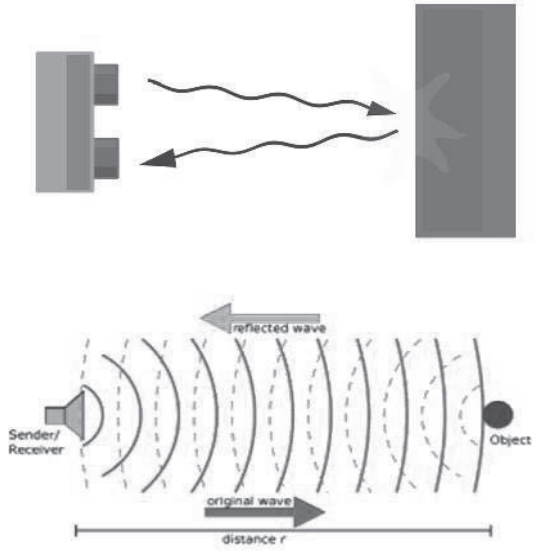
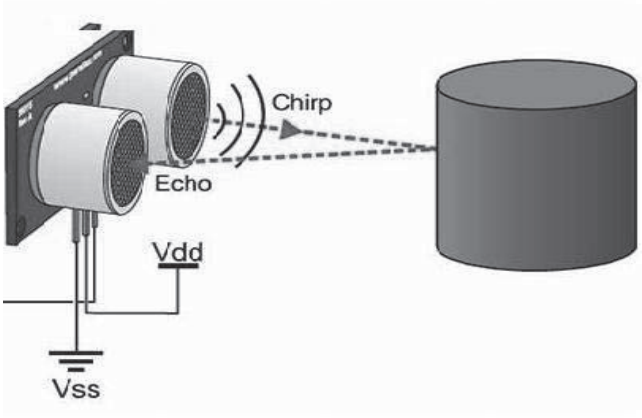



*Diagram of the basic ultrasonic sensor operation*

Since it is known that sound travels through air at about 340 m/s, you can take the time for the sound wave to return and multiply it by 340 meters to find the total round-trip distance of the sound wave. Round-trip means that the sound wave traveled 2 times the distance to the object before it was detected by the sensor; it includes the 'trip' from the sonar sensor to the object AND the 'trip' from the object to the Ultrasonic sensor (after the sound wave bounced off the object). To find the distance to the object, simply divide the round-trip distance in half.

$$distance = \frac{speed\ of\ sound\ \times time\ taken}{2}$$

**VIII Circuit diagram / Experimental set-up / Work Situation**



## IX Resources required

| S. No. | Instrument/Object | Specifications | Quantity | Remark |
|---|---|---|---|---|
| 1 | Ultrasonic distance meter | | 1 | |
| 2 | Meter scale | | 1 | |

## X Procedure:

1. Connect the mains cord to the Trainer.
2. Switch 'On' the power supply.
3. Now select Clock Generator for frequency of 40 kHz at mode '2'.
4. Select second switch at "Distance Measurement" mode.
5. Adjust the Threshold Voltage such that the display shows exact reading of distance.
6. Take the reflector plate from the accessories box and hold it with the hands in the Ultrasonic range.
7. Move the reflector plat up and down parallel to the ultrasonic sensors (Transmitter and Receiver).
8. Observe the display as it shows the distance (in cm) between the ultrasonic sensors and the object.
9. Note the reading of distance and compare it by taking a meter scale.
10. Change the distance of the object from ultrasonic distance meter and note down readings.

**Note** : Object should be placed more than 28cm. far from the Ultrasonic sensors.

## XI Precautions:-

1. Handle the equipment carefully.
2. Do not obstruct the path of the ultrasonic waves.

## XII Actual procedure followed:

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## XIII Resources used (with major specifications)

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**XIV Precautions followed:**

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**XV Observations and Calculations:**

| Sr. No. | Distance measured on ultrasonic distance meter($d_1$) | Distance measured by meter scale($d_2$) | Error ($d_2$-$d_1$) |
|---|---|---|---|
| **1** | | | |
| **2** | | | |
| **3** | | | |
| **4** | | | |
| **5** | | | |

**XVI Result:**

Distance of the object is measured by Ultrasonic distance meter.

**XVII Interpretation of result**

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**XVIII Conclusions and Recommendations**

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**XIX Practical Related Questions**

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

1. Define ultrasonic waves.
2. State properties of ultrasonic waves.
3. State four application of ultrasonic waves.
4. What is piezoelectric effect?

**Space to write answers**

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## XX References / Suggestions for further Reading

a. Engineering Physics by Gaur and Gupta**.**

## XXI Suggested Assessment Scheme

| **Performance indicators** | | **Weightage** |
|---|---|---|
| **Process related: 15 Marks** | | **60%** |
| 1 | Handling of the instrument | 30 |
| 2 | Proper measurement | 30 |
| **Product related: 10 Marks** | | **40%** |
| 3 | Timely submission of reports | 10 |
| 4 | Neatness | 10 |
| 5 | Conclusions & Recommendations | 10 |
| 6 | Practical related questions | 10 |
| | **Total (25 Marks)** | |

***List of Student Team Members***

1. ……..
2. ……
3. …….
4. ……..

| **Marks Obtained** | | | **Dated Signature of Teacher** |
|---|---|---|---|
| **Process Related (15)** | **Product Related (10)** | **Total (25)** | |
| | | | |

# Practical No. 6: I –V Characteristics of Photoelectric Cell

**I Practical Significance**

In industry different types of light sensors such as photocell and photo diodes are used in manufacturing and other industrial applications. A light sensor is a device that is used to detect light. Computers, wireless phones, and televisions, use ambient light sensors to automatically control the brightness of a screen. Barcode scanners used in retailer locations work on light sensor technology. The light sensor enables a robot to detect light. Photocell is used in auto Flash for camera, in industrial process control and headlight dimmer. Photocells are used in television camera to reproduce sound recorded on films, in counting devices, in burglar and fire alarms, to control the temperature in chemical reactions and to determine the Planck's constant.

**II Relevant Program Outcomes (POs)**

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

**III Relevant Course Outcomes**

Use LASERs, X-Rays, LDR and photoelectric cell based equipment.

**IV Practical Outcome**

Determine I -V characteristics of photoelectric cell

**V Practical Skills**

a. Circuit connections Skills.
b. Measurement Skills.
c. Drawing skills.

**VI. Relevant Affective domain related Outcomes**

a. Handle tools and equipments carefully.
b. Practice energy conservation.
c. Function as a team member.

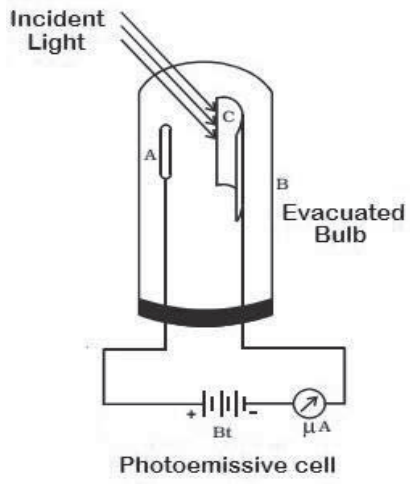
**VII. Minimum Theoretical Background**

**Photocell:** The photoelectric cell is a device which converts light energy into electrical energy.

The photo electric cells are of three types:

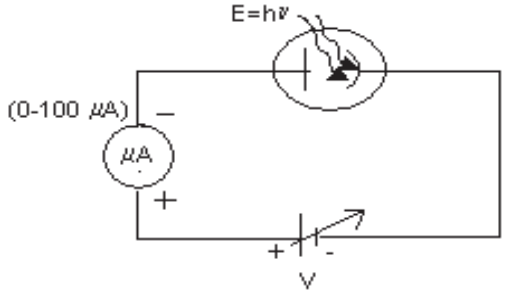
1. Photo emissive cell
2. Photo voltaic cell and
3. Photo conductive cell

It consists of a highly evacuated bulb B made of glass or quartz. A semi cylindrical metal plate C connected to the negative terminal of a battery, acts as cathode. This plate is coated with a low work function material such as cesium oxide, in order to get large number of photo electrons. A thin platinum wire A is connected to the positive terminal of the battery and kept along the axis of the metal plate C and this serves as the anode as shown in Figure below.




When a light of suitable wave length falls on the cathode, photo electrons are emitted, which are attracted by the anode A. The resulting current is measured by a micro ammeter. The current produced by this type of cell is proportional to the intensity of the incident light for a given frequency.

## VIII. Circuit diagram / Experimental set-up / Work Situation



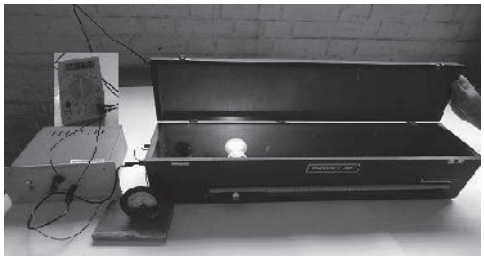



**Fig (1) To determine characteristics of photoelectric cell**

## IX. Resources required

| Sr. No. | Instrument/Object | Specifications | Quantity | Remark |
|---|---|---|---|---|
| 1 | Variable Power supply | Range- 0 to 12V Range-500 mA | 01 | Whichever is available |
| 2 | Microammeter | Range- 0 to 100 μA | 01 | Whichever is available |
| 3 | Voltmeter/multimeter | Range- 0 to 10V | 01 | Whichever is available |
| 4 | Phoelectric cell setup | Photo electric cell and variable light source enclosed in a wooden box | 01 | Whichever is available |

## X. Procedure

**Part I:** Effect of Intensity of light on photoelectric current.

1. Make circuit connections as shown in diagram.
2. Keep applied voltage constant say 2V.
3. Keep light source close to photocell.
4. Note value of photoelectric current from micro ammeter in the observation table.
5. Decrease intensity of incident light by moving light source away from the photocell. This is done by increasing the distance of light source from the photocell.
6. Record the change in photoelectric current from micro ammeter for equal intervals of the distance.
7. Take at least 10 readings.(Table 1)
8. Plot a Graph of photoelectric current 'I 'on (Y-axis) Versus distance' d' on (X-axis)

**Part II:** Effect of applied voltage (plate potential) on photoelectric current.

1. Keep intensity of incident light constant. This is done by keeping distance between photocell and light source constant, say 10 cm
2. Increase the potential difference across photocell using variable power supply and measure the photoelectric current.
3. Take at least 10 readings.(Table 2)
4. Plot a Graph of photoelectric current 'I' on (Y-axis) Versus applied voltage 'V' on (X-axis).

## XI. Precautions

1. Stray light should be avoided.
2. The effect of the reflected light from the bench surface should be minimized.
3. Very sensitive micro ammeter should be used.
4. All electrical Connections should be neat and tight.
5. The pointer of micro ammeter should coincide with zero mark.
6. Check the power supply before connection.
7. Check connection with the help of teacher.

## XII. Actual procedure followed

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## XIII. Resources used (with major specifications)

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## XIV. Precautions followed

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## XV. Observations and Calculations

**Table 1:** Effect of Intensity of light on photoelectric current.
(When voltage is kept constant)

| Obs. No. | Applied voltage (plate potential) V = ……. volt | |
|---|---|---|
| | Distance 'd' in cm (cm) | Photoelectric current 'I' (μA) |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

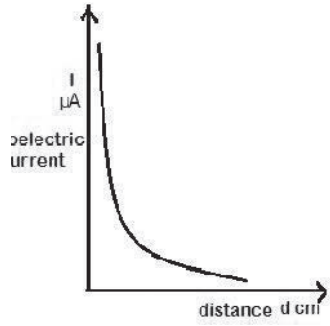


**Table 2:** Effect of applied voltage (Plate potential) on photoelectric current.
(When Intensity of light is kept constant)

| Obs. No. | Distance'd' =……. Cm | |
|---|---|---|
| | Applied Voltage 'V' (Volt) | Photoelectric current 'I' (μA) |
| 1 | | |
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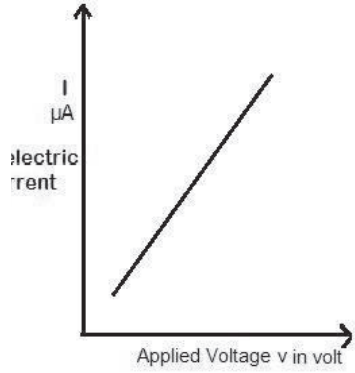
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |



## XVI. Results

| Observation table No | Nature of graph |
|---|---|
| 1 | |
| 2 | |

## XVII. Interpretation of results

a. In case of photoelectric cell, photoelectric current increases with…… (increase/decrease) in intensity of light.

b. In case of photoelectric cell, Photoelectric current …… (increase / decrease) with increase in applied voltage.

## XVIII. Conclusions and Recommendations

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## XIX. Practical Related Questions

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

1. Which of the following instrument makes use of photoelectric effect?
   Television receiver, television camera, cathode ray oscilloscope, radar.
2. What is the use of optical bench?
3. What happens if the photocell is moved away from the source (bulb)?

**Space to write answers**

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## XX. References / Suggestions for further Reading

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

## XXI. Suggested Assessment Scheme

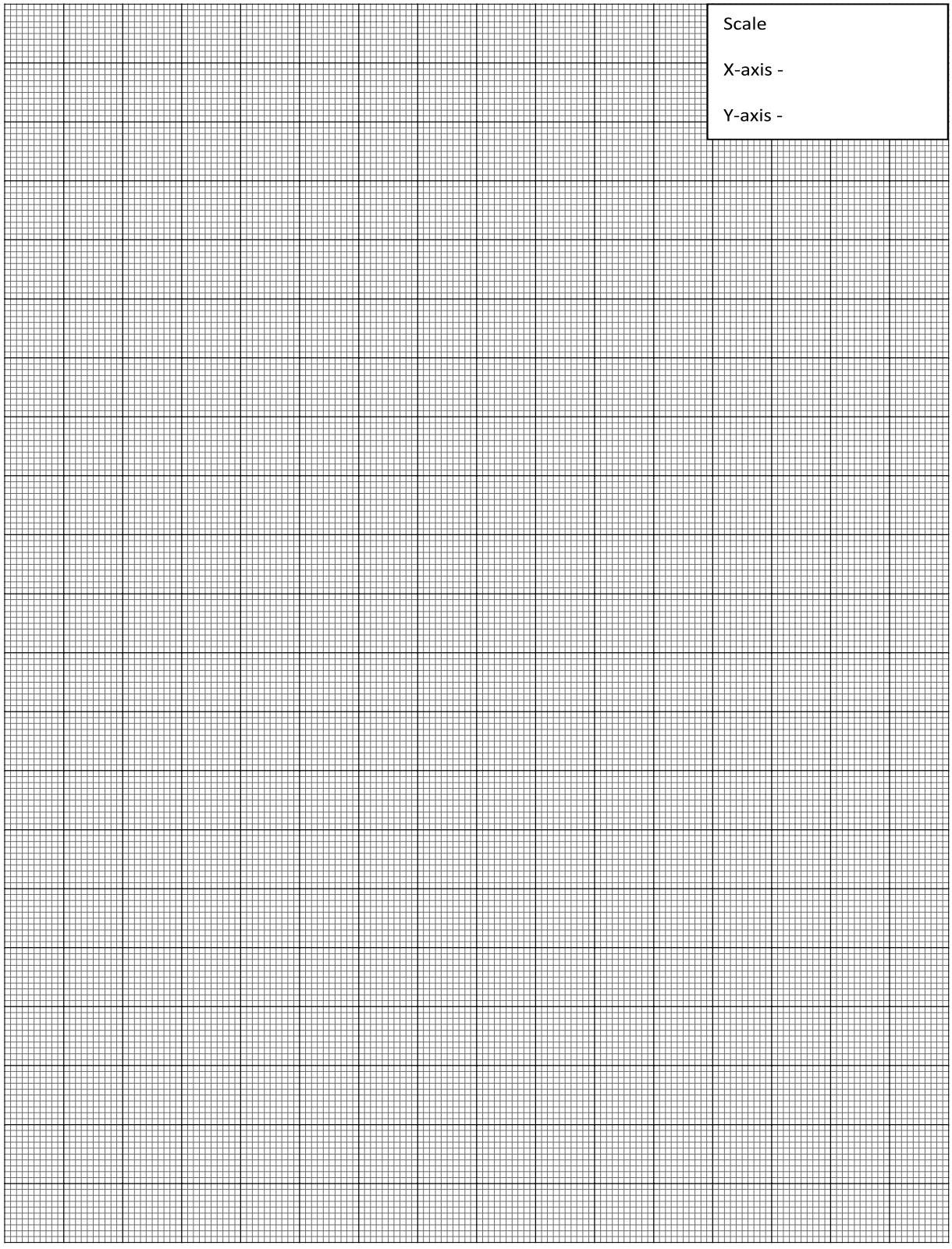
| Performance indicators | | Weightage |
|---|---|---|
| **Process related: 15 Marks** | | **60%** |
| 1 | Handling of the instrument | 10 |
| 2 | Performing Part I | 20 |
| 3 | Performing Part II | 20 |
| 4 | Plotting graphs | 10 |
| **Product related: 10 Marks** | | **40%** |
| 5 | Timely submission of reports | 5 |
| 6 | Neatness | 5 |
| 7 | Interpretation of result from graphs | 15 |
| 8 | Conclusions & Recommendations | 5 |
| 9 | Practical related questions | 10 |
| | **Total (25 Marks)** | |

***List of Student Team Members***

1. ……..
2. ……
3. ……
4. ……

| Marks Obtained | | | Dated Signature of Teacher |
|---|---|---|---|
| **Process Related (15)** | **Product Related (10)** | **Total (25)** | |
| | | | |


Scale
X-axis -
Y-axis -


Scale
X-axis -
Y-axis -

# Practical No. 7: Characteristics of LDR

## I Practical Significance

In industry different types of light sensors such as photo resistor and photo diodes are used in manufacturing and other industrial applications. A light sensor is a device that is used to detect light. Photo resistor also called as light dependent resistor (LDR). It has a resistor whose resistance decreases with increasing incident light intensity. Computers, wireless phones, and televisions, use ambient light sensors to automatically control the brightness of a screen. Barcode scanners used in retailer locations work on light sensor technology. LDR are widely used in space and robotics for controlled and guided motions of vehicles and robots. LDR are used in auto Flash for camera, in industrial process control and headlight dimmer.

## II Relevant Program Outcomes (POs)

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

## III Relevant Course Outcomes

Use LASERs, X-Rays, LDR and photoelectric cell based equipment.

## IV Practical Outcome

Determine I -V characteristics of LDR

## V Competency & Practical Skills

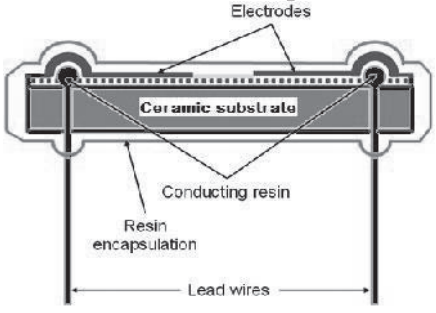
a. Circuit connections Skills.
b. Measurement Skills.
c. Drawing skill

## VI Relevant Affective domain related Outcomes

1. Handle tools and equipments carefully.
2. Practice energy conservation.
3. Function as a team member.

## VII Minimum Theoretical Background

**Photoresistor/ LDR:** Photo resistor is also called as light dependent resistor (LDR). It has a resistor whose resistance decreases with increasing incident light intensity. It is made of a high resistance semiconductor material, cadmium sulfide (CdS). The resistance of a CdS photo resistor varies inversely to the amount of light incident upon it. Photo resistor follows the principle of photoconductivity which results from the generation of mobile carriers when photons are absorbed by the semiconductor material.



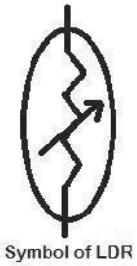


Symbol of LDR

Figure above shows the construction of a photo resistor. The CdS resistor coil is mounted on a ceramic substrate. This assembly is encapsulated by a resin material. The sensitive coil electrodes are connected to the control system though lead wires. On incidence of high intensity light on the electrodes, the resistance of resistor coil decreases which will be used further to generate the appropriate signal by the microprocessor via lead wires. Photo resistors are used in science and in almost any branch of industry for control, safety, amusement, sound reproduction, inspection and measurement.

## VIII. Circuit diagram / Experimental set-up / Work Situation

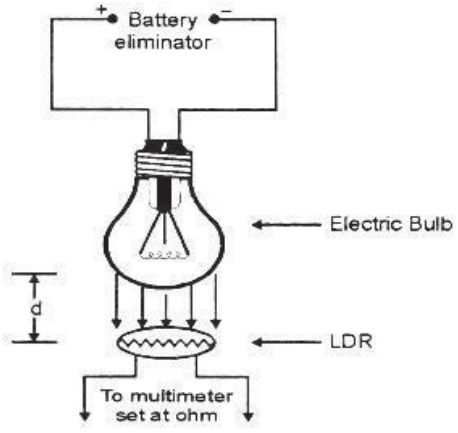



**Fig (1) To determine characteristics of LDR**

## IX. Resources required

| Sr. No | Instrument/Object | Specifications | Quantity | Remark |
|---|---|---|---|---|
| 1 | Voltmeter/multimeter | Range- 0 to 10V | 01 | Whichever is available |
| 2 | Photo resistor setup | Photo resistor and variable light source enclosed in a wooden box | 01 | Whichever is available |

## X. Procedure

**Effect of intensity on resistance of Photoresistor/LDR (Light Dependent Resistor)**

1. Select the appropriate range of multimeter to measure resistance.
2. Plug the metallic ends of probe at suitable places in multimeter. Adjust zero ohm in multimeter.
3. Keep LDR at distance of 5 or 10 cm from electric bulb.
4. Connect the metallic probes to two metal ends on LDR.
5. Allow light to fall on LDR and read the value of resistance from multimeter.
6. Decrease intensity of incident light by moving light source away from the LDR. This is done by increasing the distance of light source from the LDR.
7. Take 10-12 readings.(Table)
8. Plot a graph of R against $d^2$

## XI. Precautions

1. Stray light should be avoided.
2. The effect of the reflected light from the bench surface should be minimized.
3. All electrical Connections should be neat and tight.
4. Check the power supply before connection.
5. Check connection with the help of teacher.

## XII. Actual procedure followed

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## XIII. Resources used (with major specifications)

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## XIV. Precautions followed

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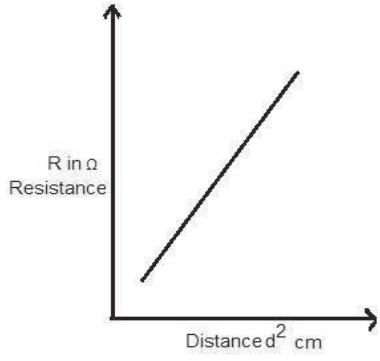
## XV. Observations and Calculations

**Table:** Effect of Intensity of light on resistance of LDR.

| Sr. No. | Distance of LDR from source of light 'd' in cm | Resistance of LDR 'R' in Ω | Square of distance $d^2$ in cm |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |



## XVI. Results

| Observation table No | Nature of graph |
|---|---|
| 1 | |

## XVII. Interpretation of results

Resistance of LDR is (directly/Inversely)……. proportional to square of the distance of LDR from the source of light.

## XVIII. Conclusions and Recommendations

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## XIX. Practical Related Questions

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

1. Which of the following instrument makes use of LDR?
   Television receiver, television camera, cathode ray oscilloscope, radar.
2. What is the use of optical bench?

**Space to write answers:**

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## XX. References / Suggestions for further Reading

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

## XXI. Suggested Assessment Scheme

| **Performance indicators** | | **Weightage** |
|---|---|---|
| **Process related: 15 Marks** | | **60%** |
| 1 | Handling of the instrument | 20 |
| 2 | Performing Part I | 20 |
| 3 | Plotting graphs | 20 |
| **Product related: 10 Marks** | | **40%** |
| 4 | Timely submission of reports | 5 |
| 5 | Neatness | 5 |
| 6 | Interpretation of result from graphs | 15 |
| 7 | Conclusions & Recommendations | 5 |
| 8 | Practical related questions | 10 |
| | **Total (25 Marks)** | |

***List of Student Team Members***

1. ……..
2. ……
3. ……
4. ……

| **Marks Obtained** | | | **Dated Signature of Teacher** |
|---|---|---|---|
| **Process Related (15)** | **Product Related (10)** | **Total (25)** | |
| | | | |


Scale
X-axis -
Y-axis -

# Practical No. 8: Divergence of LASER with distance

**I. Practical Significance:** lasers are key tools in manipulating and communicating information (in CD and DVD players, supermarket barcode readers and broadband telecommunications), in measurement (surveying and environmental studies), chemical analysis (of foods, medical specimens and materials) and, increasingly, in transforming materials (welding, cutting and etching, printing, and surgery).

**II. Relevant Program Outcomes (POs):**

PO1- Basic knowledge
PO3- Experiments and practice
PO8- Individual and teamwork
PO9- Communication
PO10- Lifelong learning

**III. Relevant Course Outcomes :**

Use LASERs, X-Rays, LDR and photoelectric cell based equipment.

**IV. Practical Outcome:**

Use He-Ne LASER to find divergence of LASER beam with distance.

**V. Competency & Practical Skills:**

Measurement Skills.

**VI. Relevant Affective domain related Outcomes:**

a. Handle tools and equipment's carefully.
b. Function as a team member.

**VII. Minimum Theoretical Background:**

Laser is an extremely coherent, monochromatic, uni-directional, and highly intense light. These extraordinary features make it greatly applicable in day-to-day life, science and technology. A few notable applications of laser include medical diagnosis and treatments, fibre optic communications, CD-ROMS, CD players, laser printers, defence, cutting, welding, drilling, surveying, aligning etc. Laser is produced due to stimulated radiation; a process where a resonating photon stimulates the de-excitation of an excited atom. This results in to emission of two coherent photons, which are identical in all respects. These photons further stimulate the de-excitation of other excited atoms and this continues to generate an avalanche of coherent photons. For stimulated emission to take over spontaneous emission and stimulated absorption, a few conditions are necessary. These are availability of metastable state (life time $\approx$ 10-3 sec), population inversion (greater number of atoms in metastable state than in lower energy state) and enough number of photons in the cavity (mirrors).

**He-Ne laser:**He-Ne laser is a low power, continuous gas laser, which is used in supermarket scanners, student laboratories and holography. The active system is neon, which is pumped electronically via helium in a resonant cavity made of discharge tube. The main lasing occurs in neon between the levels E6 (metastable) and E3 which produces an intense coherent beam of red colour (wavelength $6328A^0$). The population

of photons necessary for stimulated emission is maintained by mirrors (one is semi-transparent) on both sides. Brewster windows are used to polarize the laser light.

## VIII. Circuit diagram / Experimental set-up / Work Situation

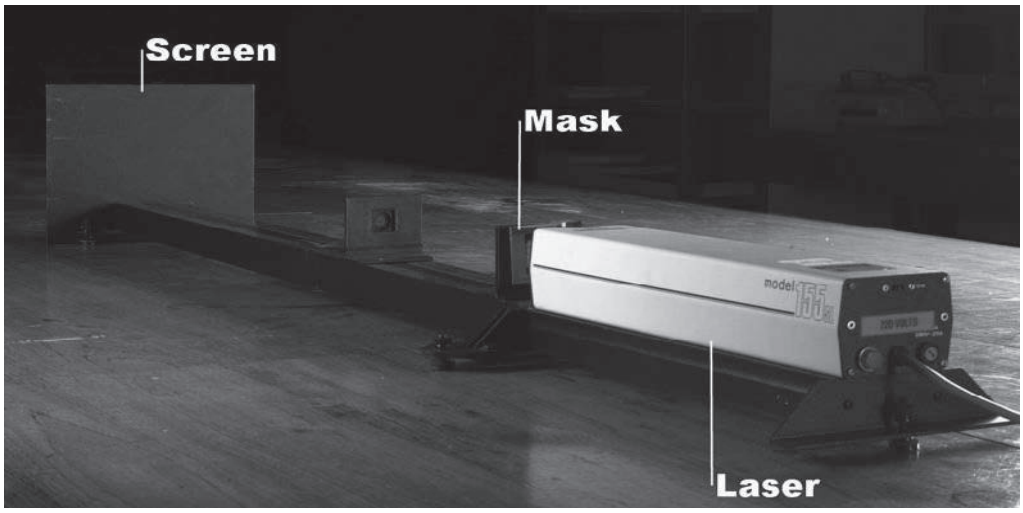


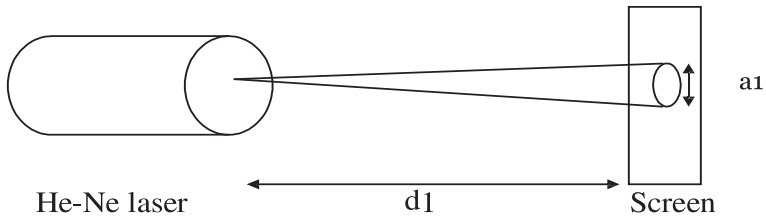

**Fig.1. Measurement of Divergence of Laser beam**

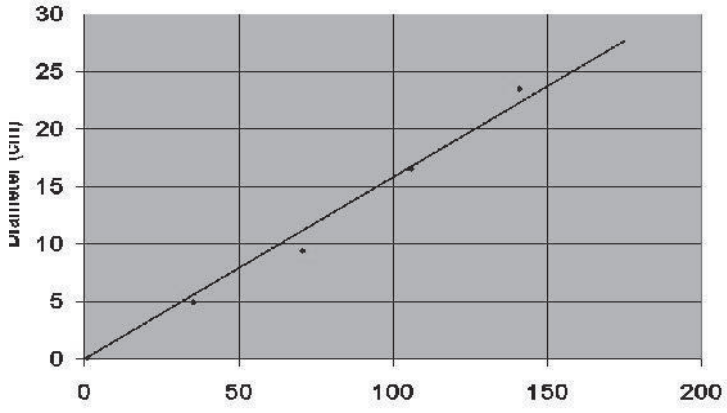
## IX. Resources required :

| S. No. | Instrument/Object | Specifications | Quantity | Remark |
|---|---|---|---|---|
| 1 | He-Ne laser kit | CLASS II (0.4 to 1.0 mW) | 1 | |
| 2 | Card board (screen) with white paper. | 10cmX10cm | 1 | |
| 3 | Meter scale | 1m | 1 | |

## X. Procedure:

1. The laser beam from He-Ne is made to fall on the screen which is kept at a distance of $d_1$ from the source.
2. The spot size of the beam is noted by taking horizontal and vertical diameter and their mean is taken as $a_1$.
3. Now the position of the screen is altered to a new position $d_2$ from the laser source and again the spot size of the beam is noted by taking horizontal and vertical diameter and their mean is taken as $a_2$.
4. The same procedure is repeated by changing the position of the screen at equal intervals at least 5 times.
5. The readings corresponding to the position of the screen and spot size of the beam is tabulated.
   From this, the angle of divergence of the laser beam is calculated using the formula $\Phi = (a_2-a_1)/(d_2-d_1)$ radian.
6. Plot graph of spot size ($a_n$) vs distance between source and screen ($d_n$).Find slope of the graph.




## XI. Precautions

1. Handle the equipment carefully.
2. Do not obstruct the path of the LASER beam.

## XII. Actual procedure followed

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## XIII. Resources used (with major specifications)

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## XIV. Precautions followed

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## XV. Observations and Calculations

| S. No. | Distance between laser beam and screen ($d_n$) cm | Diameter of the spot (Horizontal) cm | Diameter of the spot (Vertical) cm | Mean Diameter of the spot ($a_n$) cm | $\Phi = (a_n - a_{n-1})/(d_n - d_{n-1})$ radian |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

## XVI. Calculations:

Distance between laser source and the screen ($d_1$) = …….. cm
Spot size of the laser beam on the screen for distance $d_1$ ($a_1$) = ……. cm
Distance between laser source and the screen ($d_2$) = ……cm
Spot size of the laser beam on the screen for distance $d_2$ ($a_2$) =……. cm
Angle of divergence of the laser beam,
$\Phi$ = (a2-a1)/(d2-d1) radian **=**

## XVII. Result:

1. Angle of divergence of the beam using He-Ne laser by experiment $\Phi$ = …… rad.
2. Angle of divergence of the beam using He-Ne laser by graph(slope) $\Phi$ = …… rad.

## XVIII. Interpretation of result

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## XIX. Conclusions and Recommendations

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## XX. Practical Related Questions

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

1. State long form of LASER.
2. State properties of LASER.
3. State four applications LASER.
4. State four types of LASER.

## Space to write answers

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## XXI. References / Suggestions for further Reading

a. Engineering Physics By Gaur and Gupta.

b. http://vlab.amrita.edu/?sub=1&brch=189&sim=342&cnt=2

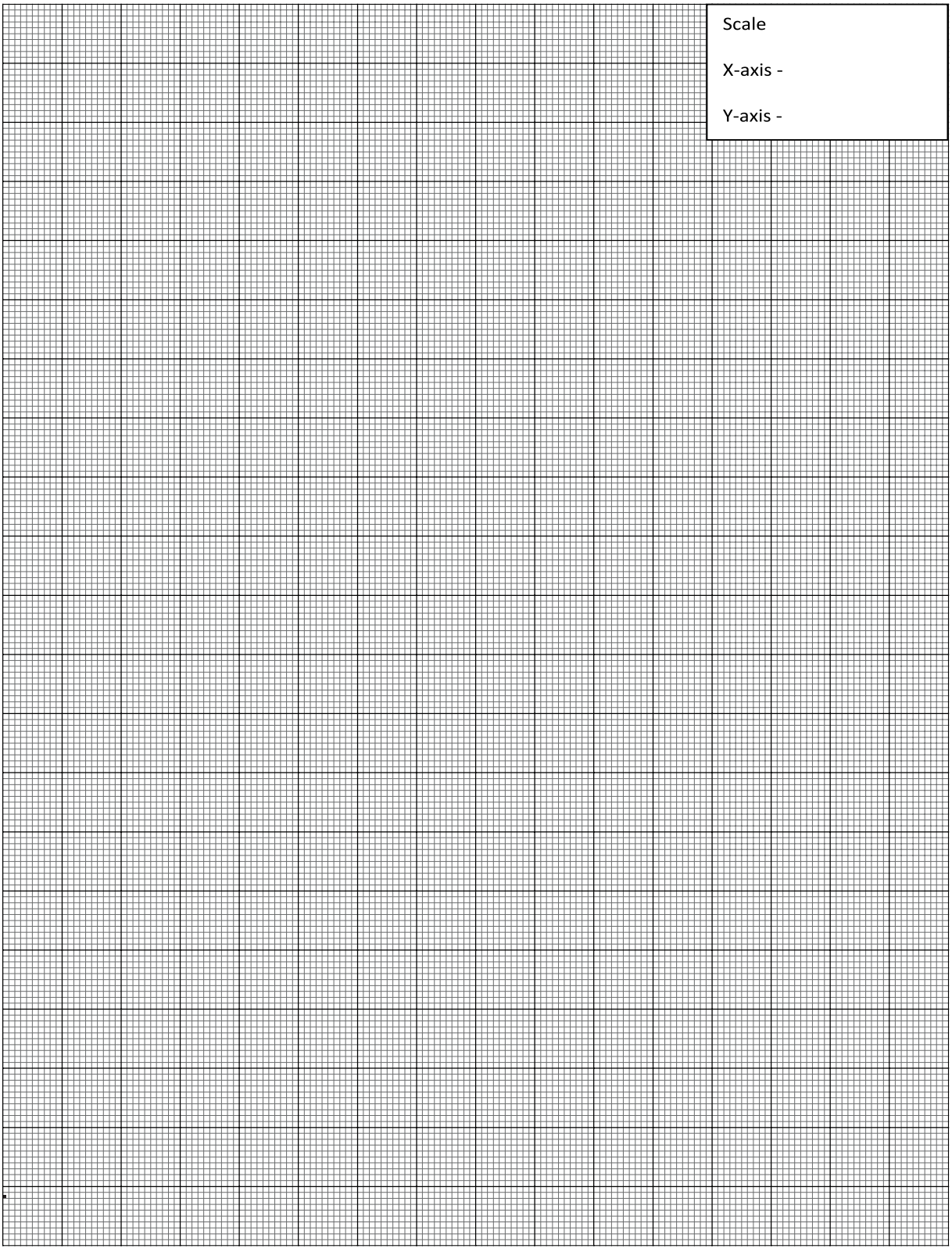
## XXII. Suggested Assessment Scheme:

| Performance indicators | | Weightage |
|---|---|---|
| **Process related: 15 Marks** | | **60%** |
| 1 | Handling of the instrument | 20 |
| 2 | Proper measurement | 20 |
| 3 | Calculation of parameter concerned | 10 |
| 4 | Plotting graphs | 10 |
| **Product related: 10 Marks** | | **40%** |
| 5 | Timely submission of reports | 10 |
| 6 | Neatness | 5 |
| 7 | Interpretation of result from graphs | 10 |
| 8 | Conclusions & Recommendations | 5 |
| 9 | Practical related questions | 10 |
| | **Total (25 Marks)** | |

***List of Student Team Members***

1. …….
2. ……
3. …….
4. …….

| Marks Obtained | | | Dated Signature of Teacher |
|---|---|---|---|
| **Process Related (15)** | **Product Related (10)** | **Total (25)** | |
| | | | |


Scale
X-axis -
Y-axis -

# List Of Laboratory Manuals Developed by MSBTE

**First Semester:**

| | | |
|---|---|---|
| 1 | Fundamentals of ICT | 22001 |
| 2 | English | 22101 |
| 3 | English Work Book | 22101W |
| 4 | Basic Science (Chemistry) | 22102 |
| 5 | Basic Science (Physics) | 22102 |

**Second Semester:**

| | | |
|---|---|---|
| 1 | Bussiness Communication Using Computers | 22009 |
| 2 | Computer Peripherals & Hardware Maintenace | 22013 |
| 3 | Web Page Design with HTML | 22014 |
| 4 | Applied Science (Chemistry) | 22202 |
| 5 | Applied Science (Physics) | 22202 |
| 6 | Applied Machines | 22203 |
| 7 | Basic Surveying | 22205 |
| 8 | Applied Science (Chemistry) | 22211 |
| 9 | Applied Science (Physics) | 22211 |
| 10 | Fundamental of Electrical Engineering | 22212 |
| 11 | Elements of Electronics | 22213 |
| 12 | Elements of Electrical Engineering | 22215 |
| 13 | Basic Electronics | 22216 |
| 14 | 'C' programming Language | 22218 |
| 15 | Basic Electronics | 22225 |
| 16 | Programming in "C" | 22226 |
| 17 | Fundamentals of Chemical Engineering | 22231 |

**Third Semester:**

| | | |
|---|---|---|
| 1 | Applied Multimedia Techniques | 22024 |
| 2 | Advanced Serveying | 22301 |
| 3 | Highway Engineering | 22302 |
| 4 | Mechanics of Structures | 22303 |
| 5 | Building Construction | 22304 |
| 6 | Concrete Technology | 22305 |
| 7 | Strength Of Materials | 22306 |
| 8 | Automobile Engines | 22308 |
| 9 | Automobile Transmission System | 22309 |
| 10 | Mechanical Operations | 22313 |
| 11 | Technology Of Inorganic Chemicals | 22314 |
| 12 | Object Oriented Programming Using C++ | 22316 |
| 13 | Data Structure Using 'C' | 22317 |
| 14 | Computer Graphics | 22318 |
| 15 | Database Management System | 22319 |
| 16 | Digital Techniques | 22320 |
| 17 | Principles Of Database | 22321 |
| 18 | Digital Techniques & Microprocessor | 22323 |
| 19 | Electrical Circuits | 22324 |
| 20 | Electrical & Electronic Measurment | 22325 |
| 21 | Fundamental Of Power Electronics | 22326 |
| 22 | Electrical Materials & Wiring Practice | 22328 |
| 23 | Applied Electronics | 22329 |
| 24 | Electrical Circuits & Networks | 22330 |
| 25 | Electronic Measurments & Instrumentation | 22333 |
| 26 | Principles Of Electronics Communication | 22334 |
| 27 | Thermal Engineering | 22337 |
| 28 | Engineering Matrology | 22342 |
| 29 | Mechanical Engineering Materials | 22343 |
| 30 | Theory Of Machines | 22344 |

**Fourth Semester:**

| | | |
|---|---|---|
| 1 | Hydraulics | 22401 |
| 2 | Geo Technical Engineering | 22404 |
| 3 | Chemical Process Instrumentation & Control | 22407 |
| 4 | Fluid Flow Operation | 22409 |
| 5 | Technology Of Organic Chemicals | 22410 |
| 6 | Java Programming | 22412 |
| 7 | GUI Application Development Using VB.net | 22034 |
| 8 | Microprocessor | 22415 |
| 9 | Database Managment | 22416 |
| 10 | Electric Motors And Transformers | 22418 |
| 11 | Industrial Measurements | 22420 |
| 12 | Digital Electronics And Microcontroller Applications | 22421 |
| 13 | Linear Integrated Circuits | 22423 |
| 14 | Microcontroller & Applications | 22426 |
| 15 | Basic Power Electronics | 22427 |
| 16 | Digital Communication Systems | 22428 |
| 17 | Mechanical Engineering Measurments | 22443 |
| 18 | Fluid Mechanics and Machinery | 22445 |
| 19 | Fundamentals Of Mechatronics | 22048 |
| 20 | Guidelines & Assessment Manual for Micro Projects & Industrial Training | 22049 |

**Fifth Semester:**

| | | |
|---|---|---|
| 1 | Network Management & Administration | 17061 |
| 2 | Solid Modeling | 17063 |
| 3 | CNC Machines | 17064 |
| 4 | Behavioral Science(Hand Book) | 17075 |
| 5 | Behavioral Science (Assignment Book) | 17075 |
| 6 | Windows Programming using VC++ | 17076 |
| 7 | Estimation and Costing | 17501 |
| 8 | Public Health Engineering | 17503 |
| 9 | Concrete Technology | 17504 |
| 10 | Design of Steel Structures | 17505 |
| 11 | Switchgear and Protection | 17508 |
| 12 | Microprocessor & Application | 17509 |
| 13 | A.C. Machines | 17511 |
| 14 | Operating System | 17512 |
| 15 | Java Programming | 17515 |
| 16 | System Programming | 17517 |
| 17 | Communication Technology | 17519 |
| 18 | Hydraulic & Pneumatics | 17522 |
| 19 | Advanced Automobile Engines | 17523 |
| 20 | Basic Electrical & Electronics | 17524 |
| 21 | Measurement and Control | 17528 |
| 22 | Power Engineering | 17529 |
| 23 | Metrology & Quality Control | 17530 |
| 24 | Computer Hardware & Networking | 17533 |
| 25 | Microcontroller | 17534 |
| 26 | Digital Communication | 17535 |
| 27 | Control System & PLC | 17536 |
| 28 | Audio Video Engineering | 17537 |
| 29 | Control System | 17538 |
| 30 | Industrial Electronics and applications | 17541 |
| 31 | Heat Transfer Operations | 17560 |
| 32 | Chemical Process Instrumentation & control | 17561 |

**Sixth Semester:**

| | | |
|---|---|---|
| 1 | Solid Modeling | 17063 |
| 2 | Highway Engineering | 17602 |
| 3 | Contracts & Accounts | 17603 |
| 4 | Design of R.C.C. Structures | 17604 |
| 5 | Industrial Fluid Power | 17608 |
| 6 | Design of Machine Elements | 17610 |
| 7 | Automotive Electrical and Electronic Systems | 17617 |
| 8 | Vehicle Systems Maintenance | 17618 |
| 9 | Software Testing | 17624 |
| 10 | Advanced Java Programming | 17625 |
| 11 | Mobile Computing | 17632 |
| 12 | System Programing | 17634 |
| 13 | Testing & Maintenance of Electrical Equipments | 17637 |
| 14 | Power Electronics | 17638 |
| 15 | Illumination Engineering | 17639 |
| 16 | Power System Operation & Control | 17643 |
| 17 | Environmental Technology | 17646 |
| 18 | Mass Transfer Operation | 17648 |
| 19 | Advanced Communication System | 17656 |
| 20 | Mobile Communication | 17657 |
| 21 | Embedded System | 17658 |
| 22 | Process Control System | 17663 |
| 23 | Industrial Automation | 17664 |
| 24 | Industrial Drives | 17667 |
| 25 | Video Engineering | 17668 |
| 26 | Optical Fiber & Mobile Communication | 17669 |
| 27 | Therapeutic Equipment | 17671 |
| 28 | Intensive Care Equipment | 17672 |
| 29 | Medical Imaging Equipment | 17673 |

## Pharmacy Lab Manual

**First Year:**

| | | |
|---|---|---|
| 1 | Pharmaceutics - I | 0805 |
| 2 | Pharmaceutical Chemistry - I | 0806 |
| 3 | Pharmacognosy | 0807 |
| 4 | Biochemistry and Clinical Pathology | 0808 |
| 5 | Human Anatomy and Physiology | 0809 |

**Second Year:**

| | | |
|---|---|---|
| 1 | Pharmaceutics - II | 0811 |
| 2 | Pharmaceutical Chemistry - II | 0812 |
| 3 | Pharmacology & Toxicology | 0813 |
| 4 | Hospital and Clinical Pharmacy | 0816 |

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