I

Name _____

Roll No. _____ Year 20____ 20____

Exam Seat No. _____

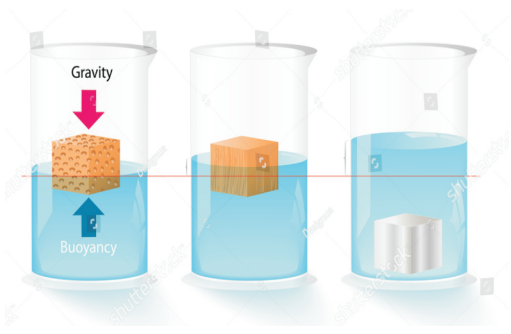
CIVIL & MECHANICAL GROUPS | SEMESTER - II | DIPLOMA IN ENGINEERING AND TECHNOLOGY

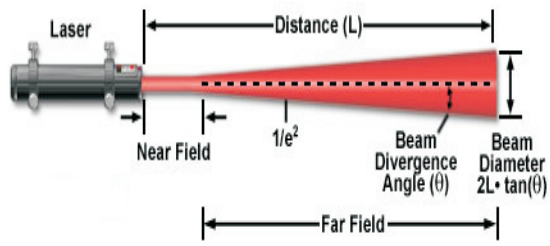
A LABORATORY MANUAL

FOR

APPLIED SCIENCE (PHYSICS)

(22202)





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

(22202)

Semester-II

(CE/CR/CS/ME/AE/PG/PT/FG)

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 (22202)** 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 have to deal with various materials and machines. The study of concepts and principles of science like elasticity, viscosity, surface tension, motion, thermo couples, photo-sensors, LASERs, X-Rays will help the student to select and use relevant materials and methods which will be economical and eco-friendly.

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 societal 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.** Select relevant material in industry by analyzing its physical properties.
- **b.** Apply laws of motion in various applications.
- **c.** Use LASERs, X-Rays and photo electric sensors.
- **d.** Select the relevant metallurgical process related to industrial applications.
- **e.** Use relevant water treatment process to solve industrial problems.
- **f.** Use relevant fuel in relevant applications.

Sr. No.	Title of the Practical	CO a.	CO b.	CO c.	CO d.	CO e.
1.	Use Searle's method to determine the Young's modulus of given wire	√	-	-	-	-
2.	Apply Archimedes' principle to determine the buoyancy force on a solid immersed in liquid.	-	√	-	-	-
3.	Determine the coefficient of viscosity of given liquid by Stoke's method.	√	-	-	-	-
4.	Find the downward force, along an inclined plane, acting on a roller due to gravity and its relationship with the angle of inclination.	-	√	-	-	-
5.	Predict the range of the projectile from the initial launch speed and angle.	-	√	-	--	-
6.	i) Find the dependence of the stopping potential on the frequency of light source in photo electric effect experiment. ii) Find the dependence of the stopping potential on the intensity of light source in photo electric effect experiment.	-	-	√	-	-
7.	Determine the I-V characteristics of photoelectric cell and LDR.	-	-	√	-	-
8.	Determine the divergence of laser beam.	-	-	√	-	-

Guidelines to Teachers

Hints regarding strategies to be used

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

* To be transferred to Proforma of CIAAN-2017.

Practical No. 1: Young's modulus by Searle's method

I Practical Significance

- In industries mechanical properties like strength, stiffness (Rigidity), ductility, malleability and brittleness have to be carefully studied to select a material for a particular job. The metallic parts of machines should not be subjected to stress beyond the elastic limit otherwise they will be deformed. In civil engineering, beams are the simplest and most common parts of large structures. In an arched stone bridge, the stone is compressed and this makes the stone weak. Hence, steel arch is used as it is stronger than the stone arched bridge. The thickness of the metallic rope needed to lift a given load is decided using the knowledge of elastic limit of the material of the rope and the factor of safety.
- Young's modulus (Y) is a measure of the ability of a material to withstand changes in length when force is applied on it .Material either elongates or gets compressed depending on a type of force applied on it. Young's modulus of elasticity predicts how much a material sample extends under tension or shortens under compression.
- In this experiment, we use Searle's apparatus to determine Young's modulus of elasticity of given steel wire.

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

Select relevant material in industry by analyzing its physical properties.

IV Practical Outcome

Use Searle's method to:
Determine the Young's modulus of wire.

V Competency & Practical Skills

a. Measurement skills
b. Analysis of physical properties.
c. Error estimation skills

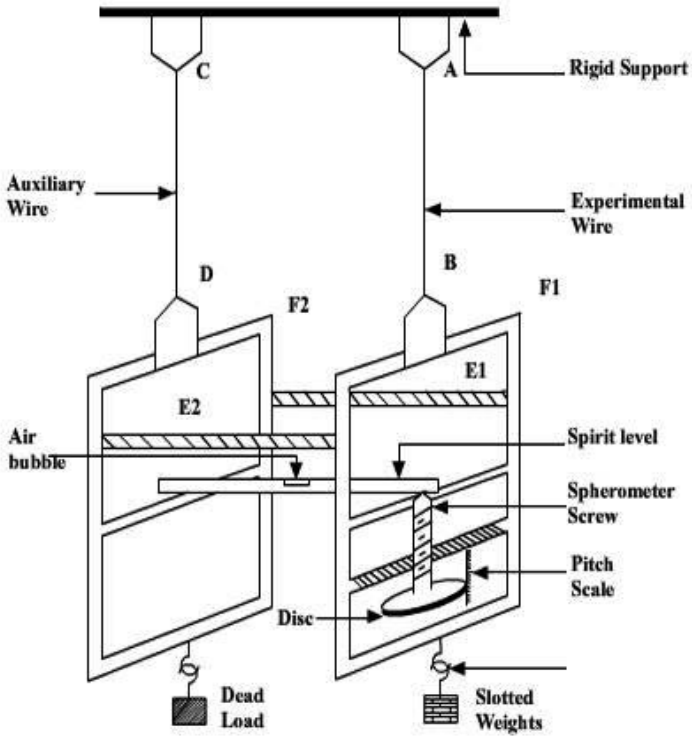
VI Relevant Affective domain related Outcomes

a. Follow safe practices.
b. Practice good housekeeping.
c. Function as a team member.

VII Minimum Theoretical Background

1. Searle's apparatus: Searle's apparatus consists of two metal frames F1 and F2. Each frame has a torsion head at the upper side and a hook at the lower side. These frames are suspended from two wires AB and CD of same material, length and cross-section. The upper ends of the wires are screwed tightly in two torsion heads fixed in the same rigid support. A spirit level rests horizontally with one end hinged in the frame F2. The

other end of the spirit level rests on the tip of a spherometer screw, fitted in the frame F1. The spherometer screw can be rotated up and down along a vertical pitch scale marked in millimeters. The two frames are kept together by cross bars E1 and E2.



2. Hooke's law: Hooke's Law states that within the limit of elasticity, stress applied is directly proportional to strain produced. That is, the extension produced in a wire is directly proportional to the load attached to it.

   If a wire of length **L** and radius **r** be loaded by a weight **Mg** and if ***l*** is the extension produced,

   Longitudinal stress $= \frac{Mg}{\pi r^2}$ ----------(1)

   Longitudinal strain= $\frac{l}{L}$ ---------- (2)

3. Young's modulus (Y): It is defined as the ratio of Tensile (Longitudinal) stress to Tensile (longitudinal)Strain.

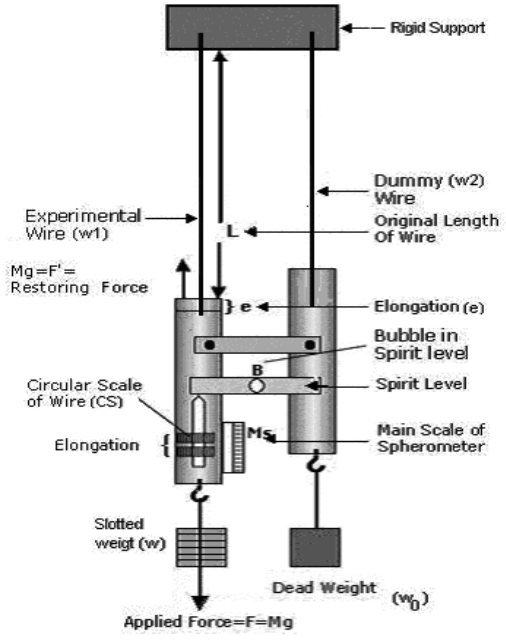
   $$Y = \frac{Tensile\ stress}{Tensile\ strain}$$

$$Y=\frac{Mg/\pi r^2}{l/L}$$

$$Y=\frac{MgL}{\pi r^2 l}$$

L **:** Length of the wire
l : Extension for a load M
r : Radius of the wire
g : Acceleration due to gravity
M : Mass added in the hanger

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



IX Resources required

Sr. No	Instrument /Object	Specification	Quantity	Remarks
1	Searle's apparatus	Conventional	1 No.	whichever is available
2	Two long steel wires of same length and diameter	Length: 2 meter Diameter: 0.1-0.15 mm	1 No.	Available dimensions
3	A set of slotted weights	1/2 Kg each	1 No.	Available dimensions
4	weight hanger	1 Kg	1 No.	whichever is available
5	Dead load	1 Kg	1 No.	whichever is available
6	Meter scale	1meter	1 No.	whichever is available

X Procedure

Part I: To find area of cross section of experimental wire

1. Find out Least count of micrometer screw gauge.
2. Determine zero error correction (z) of the micrometer screw gauge.
3. Take observations for diameter of wire at three different places.
4. Calculate radius "r" of wire.
5. Calculate area of cross section of wire, using A= πr^2
6. Record the observations in Table No. 1

Part II: Find elongation of wire after application of weight.

1. Find L.C. of spherometer.
2. Load both the wires with same loads of about 1 Kg.(Dead load Wo)
3. Adjust the bubble in the spirit level at center with the help of spherometer screw.
4. Record the reading of spherometer in loading column against Wo in the observation table no2.
5. Increase load on experimental wire by 0.5 Kg.
6. Observe the movement of bubble for 2,3 minutes so that wire elongates.
7. Take the reading when bubble is stationary.
8. Bring the bubble of spirit level in the center with the help spherometer screw
9. Record the spherometer reading against weight 0.5 Kg.
10. Repeat the procedure from step 5 to 8 up till the load becomes (Wo + 2.5) Kg.
11. Record the last spherometer reading for (Wo + 2.5) Kg in both the columns of loading and unloading.
12. Decrease the load gradually in steps of 0.5 Kg.
13. Observe the movement of bubble for 2,3 minutes so that wire contracts.
14. Take the reading when bubble is stationary.
15. Bring the bubble of spirit level in the center with the help spherometer screw.
16. Record the spherometer reading against weight (Wo + 2.0) Kg.
17. Repeat the procedure from step 12 to 15 till the load becomes (Wo) Kg.
18. Calculate mean spherometer reading for each load attached to the experimental wire.
19. Calculate elongation (e) in given wire (refer observation table 2)
20. Calculate Tensile(longitudinal) stress using formula $\sigma = \frac{M g}{A}$
21. Calculate Tensile(longitudinal) strain using formula $E = \frac{e}{L}$
22. Calculate Young's modulus of elasticity using formula $Y = \frac{\sigma}{E}$
23. Determine mean value of Young's modulus of elasticity "Y"
24. Plot a graph of stress (σ) against stain (E), calculate Slope.

XI Precautions

1. Micrometer screw should be rotated in same direction while taking reading.
2. The load added should be within elastic limit.
3. The experiment should be carried out using a common support, as any sagging will have no effect the measurement of the extension.
4. The wire under test should be uniform and free from kinks.

5. The area is measured by taking repeated readings of the diameter of the wire from different sections.
6. Repeated readings for extensions should be taken as this reduces margin of error.
7. After every instance that a load is added and removed the proper amount of waiting time should be given to avoid personal error.
8. After every instance that a load is added and removed the original length of the wire should always be obtained as this ensures that the elastic limit would not have been exceeded

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:

Part I: To find area of cross section (A) of experimental wire

a) To find Zero Correction (Z)

Least count of Micrometer	cm
Zero error correction (z)	cm

b) To find area of cross section of experimental wire

Sr. No	MSR cm.	CSR cm.	T.R.= (MSR+ CSR) cm	Corrected diameter TR $\pm$ Z (cm)	Average Corrected Diameter (m)	Radius of wire r (m)	Area of wire $A = \pi r^2$ (m^2)
1							
2							
3							

Part II: Find elongation of wire after application of weight.

Original length of wire (L) = ……. m. (Given)
Gravitational acceleration g = 9.81 m/s^2

Sr. No	Load M Kg.	Weight Mg Kg.	Spherometer Reading			Elongation (e) m	Stress $\sigma = Mg/A$ N/m^2	Strain E=e/ L	Y = σ/E N/m^2
			Load cm.	Unload cm.	Mean cm.				
1	Wo=				X_0	-	-	-	-
2	Wo+0.5=				X_1	$X_1 - X_0$			
3	Wo+1.0=				X_2	$X_2 - X_0$			
4	Wo+1.5=				X_3	$X_3 - X_0$			
5	Wo+2.0=				X_4	$X_4 - X_0$			
6	Wo+2.5=				X_5	$X_5 - X_0$			
"Y"								Mean	

XVI. Results:

Standard value of Young's modulus of given metallic wire	Young's modulus by Experiment	Young's modulus by Graph

XVII. Interpretation of results:

Error in the measurement = [Known (standard) value- Experimental value]

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. "It is necessary to wait for some time after each loading or unloading" Give reason.
2. Explain the role of dummy wire in Searle's apparatus.
3. "Dead load is attached to wires initially" Give reason
4. Explain the graph developed using readings from Searle's apparatus.
5. A & B are wires of different materials having equal length and equal cross sectional area. If they extend by amounts e & e^{I} due to same force F applied to them, Identify the wire of material having larger value of Y. Give reason.
6. A cable that can support a load W is cut into two equal parts .Find maximum load that can be supported by either part of wire ?
7. From the values of Young's modulus "Y" for some materials shown below, Predict material that will be more elastic when equal force are applied.

Material	Y
A	3×10^{11} N/m^2
B	2×10^{11}N/m^2
C	1×10^{11} N/m^2

Space to write answers

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XX. References / Suggestions for further Reading

a. amrita.olabs.edu.in/?sub=1&brch=5&sim=16&cnt=1
b. https://www.youtube.com/watch?v=zqCkb80o_wY
c. mptbc.nic.in/experiments-py-11.pdf
d. https://en.wikipedia.org/wiki/Young%27s_modulus
e. physicsnet.co.uk/a-level-physics-as-a2/materials/young-modulus/
f. https://www.youtube.com/watch?v=U5SOFeZJelY
g. vlab.amrita.edu/?sub=1&brch=280&sim=550&cnt=2

XXI. Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the instrument	5
2	Determination of Least Count(L.C.) of instrument	5
3	Determination of Area of cross section of wire	10
4	Determination of Young's modulus of wire	20
5	Plotting graph	10
6	Calculation of parameters concerned	10
Product Related : 10 Marks		**40 %**
1	Error estimation	10
2	Interpretation of result	10
3	Conclusions & Recommendations	10
4	Practical related questions	10
Total (25 Marks)		**100 %**

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: Determination of the buoyancy force on a solid immersed in a liquid by using Archimedes' principle.

I Practical Significance

Archimede's principle is used in designing ships and submarines fish float based on Archimede's Principles. Most of fish have organ swim bladder; when they want to rise, fish release gas into the swim bladder and increase their volume. As a result they displace more water. The force of buoyancy acting on them increase e.g. A hot air ballon rises and floats due to buoyancy force.

In industry a hydrometer uses Archimedes Principle to determine the density of any liquid.

II Relevant program outcomes (POs) and PSOs

PO 2 – Discipline Knowledge

PO 3 – Experiment and Practice

III Relevant Course outcomes

Select relevant material in industry by analyzing its physical properties.

IV Practical Outcome

Determine the the buoyancy force by using Archimende;s principle

V Competency & Practical Skills

a. Measurement Skill.
b. Analysis of physical properties

VI Relevant Affective domain related Outcomes

a. Follow safety practices.
b. Practice good housekeeping.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

When a metallic block is immersed in water (or any other liquid), four vertical forces act Upon the block below the surface of water. These forces can be grouped into two types of forces.

1. Downward forces
    a. The weight of the block.
    b. The downward thrust due to pressure of the liquid on the upper surface of the block.
2. Upward forces
    a. The tension of the spring, which measures the apparent weight.
    b. The upward thrust due to liquid present below the lower surface of the block. This upward thrust is known as *Buoyancy*.

The more a body is immersed in water, the more the weight of the body decreases. The weight of the body is least when it is completely immersed in water. This means that *loss* in weight of the body increases as it is completely immersed in water.
When a body is partly or completely immersed in water (or any other liquid), then:
Loss in weight of body = Weight of water (liquid) displaced by the body = Buoyant force or upthrust exerted by water (any liquid) on the body.
It was Archimedes who first observed that bodies lose their weight when immersed in water. He proposed a principle based on his observation that is now known as the Archimedes' Principle.
The Principle states that: “A body immersed in a liquid loses weight by an amount equal to the weight of the liquid displaced.”

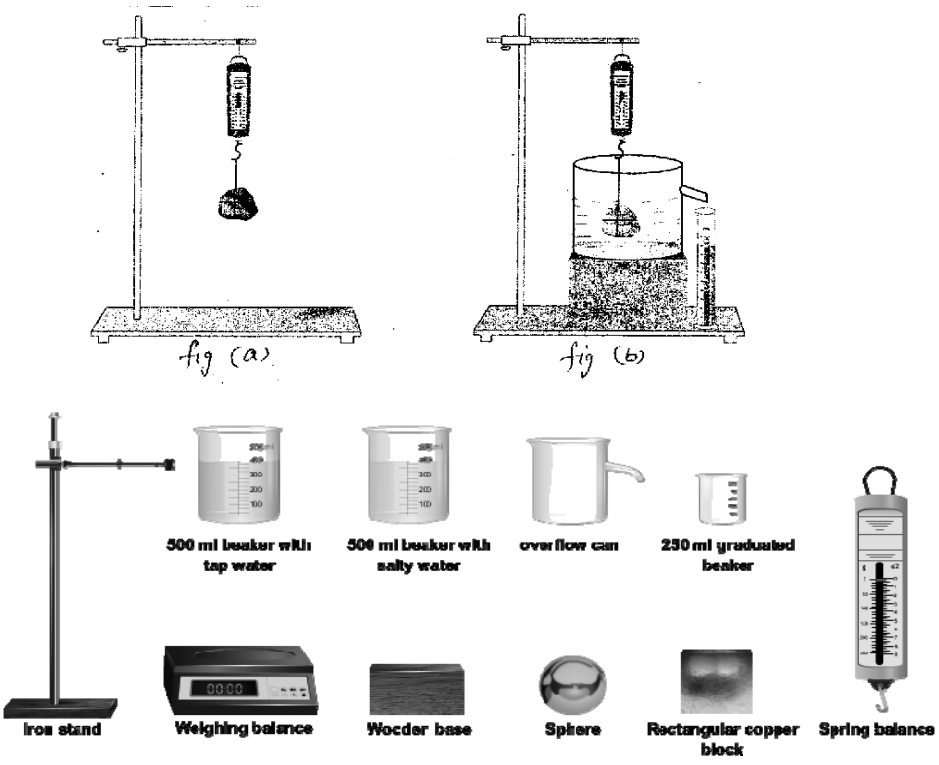
Archimedes principle also states that: “When a body is immersed in a liquid, an upward thrust, equal to the weight of the liquid displaced, acts on it.”

Thus, when a solid is fully immersed in a liquid, it loses weight which is equal to the weight of the liquid it displaces.

Weight of the solid in air – Weight of solid when immersed in Liquid
= Loss in weight of the solid = weight of the liquid displaced

The more the density of liquid in which the solid is immersed, the less is the weight of the liquid displaced on immersing the solid.
Some bodies, if dropped in water, sink, such as a stone or a metallic needle. On the other hand, some bodies, even of the same weight as that of those that sink, float on water. This can be proved through the Laws of Flotation.
A body will float if the weight of the body is equal to the weight of the liquid displaced.
If the weight of the immersed body is more than the weight of the water displaced, the body will sink.

Diagram :



VIII Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Overflow-can	Plastic/glass	01 No	As per availability
2	Wooden block		01 No	
3	Measuring cylinder	100 ml	01 No	
4	Spring balance		01 No	
5	Two small solid non porous objects		01 No	
6	Tap water	Known density		
7	Strongly salted water	Known density		
8	Thread,	1 meter	01 No	
9	Laboratory stand	steel	01 No	

IX Procedure

1. Find the range and least count of spring balance and measuring cylinder.
2. Ensure that pointer of spring balance is at zero mark, when no mass is attached to it. If not, then note the zero error.
3. Place an overflow-can on a wooden block and full it with tap water until the water begins to flow from its spout means the level of water in the over flow-can is up to its brim.

4. Tie one of the two given solid object with a thread and suspend it from the hook of spring balance, already clamped in the laboratory stand as shown in fig (a) of solid object in air.
5. Note the reading.
6. Keep a empty measuring cylinder under the spout of the overflow-can to collect water.
7. Immerse the solid fully into the tap water in overflow can as shown in fig (b)
8. Collect the water displaced by the solid in the overflow can that flows out in the measuring cylinder.
9. Wait till the last drop of excess water flows out.
10. Note the volume of tap water collected in the measuring cylinder.
11. Note the reading to get mass of solid object in tap water.
12. Record the observation.
13. Repeat the whole procedure for second objects and for both object taking strongly salted water.

X Precautions

1. Ensure that the pointer is at zero mark in the spring balance, before using it.
2. Hang the spring balance vertically with the laboratory stand.
3. The density of solid should be larger than that of liquid, so that it sinks in it.
4. The solid objects used should be non porous otherwise they will absorb some water.
5. While recording the volume of displaced water, the line of sight should be at the same level as that of the lower meniscus of water.
6. The readings of the spring balance should be taken only after its pointer comes to rest.

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

1. Range of spring balance = _____g
2. Least count of the spring balance =_____g
3. Acceleration due to gravity (g) =_____m/s^2.

Table A : For tap water							
Sr No	**Solid object**	**Reading of spring balance, when solid object is in air**	**Reading of the spring balance, when solid object is full immersed in tap water**	**Loss in weight of the solid when fully immersed in water W_S Tap**	**Volume of tap water collected in measuring cylinder V Tap**	**Weight of tap water collected in measuring cylinder Ww tap = V Tap x ρ tap x g**	**Difference in loss in weight of solid and weight of displaced tap water Ws Tap - Ww Tap**
1	First						
2	Second						

Table B : For strongly salted water							
Sr No	**Solid object**	**Reading of spring balance, when solid object is in air**	**Reading of the spring balance, when solid object is full immersed in tap water**	**Loss in weight of the solid when fully immersed in water W_S Tap**	**Volume fo tap water collected in measuring cylinder V Tap**	**Weight of tap water collected in measuring cylinder Ww tap = V Tap x ρ tap x g**	**Difference in loss in weight of solid and weight of displaced tap water Ws Tap - Ww Tap**
1	First						
2	Second						

XV Calculations:

XVI Results

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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. If the density of a body is greater than the density of the liquid, what will the weight of body be?
2. State Archimede's Principle.
3. State applications of Archimede's Principle.

Space to write answers

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XX References / Suggestions for further Reading

a. youtube.com: Videos of Practical demonstration of Ohm's law.
b. vimeo.com: Videos of Practical demonstration of Ohm's law.
c. www.authorstream.com/.../aSGuest60357-468668-**ohm**-s-**law**/*OHM'S LAW Ppt* Presentation.
d. http://amrita.olabs.edu.in/?sub=1&brch=4&sim=99&cnt=199

XXI Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Selection of the instrument	10
2	Arrangement of instrument	10
3	Handling of instruments	10
4	Proper measurement	15
5	Calculation of parameters concerned	15
Product Related : 10 Marks		**40 %**
1	Accuracy of Measurement	10
2	Interpretation of result	10
3	Conclusions& Recommendations	10
4	Practical related questions	10
Total (25 Marks)		**100 %**

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: Coefficient of Viscosity by Stokes method

I Practical Significance

In mechanical industry, viscosity is useful in bearing operation to reduce friction by using lubricant of optimum viscosity. Concept of viscosity is useful to control flow in turbo machines. In hydraulics, viscosity is most frequently used in the calculation of Reynolds number to determine whether laminar, transitional, or completely turbulent flow exists. In light machinery, thin oils (e.g., clock oil) with low viscosity are used. In heavy and fast moving machinery solids or thick highly viscous oils (e.g., grease) are used. Viscosity plays an important role in the quality control and various research and development stages in lab, process and research environments as well as a wide range of industries and applications including Food, Chemical, Pharmaceutical, Petrochemical, Cosmetics, Paint, Ink, Coatings, Oil and Automotives. In refineries and petrochemical processes, on-site control is of primary importance in regards to product quality. Viscosity is one of the key parameter of many petroleum products. It influences storage, handling, and operational conditions.

Drug companies manufacture medicines, such as cough syrup, that have a high viscosity. Still cough syrups are drinkable, in order to coat and soothe the throat. People in many occupations need to know how to adjust the viscosity of a substance to suit specific applications. For example, chefs need to know how to make gravies thinner than sauces and frostings thicker than icings. Mechanics must choose an engine oil that is the right viscosity for the season. Artists need to know how to thin or thicken oil paints or acrylics. Technicians must control the viscosity of various chemicals in chemical processing plants. The coating on candy bars must be at precisely the right consistency and temperature in order to cover the bar completely with the same amount of chocolate each time. In this experiment Stoke's method is used to determine the coefficient of viscosity of given fluid.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge.

PO2- Discipline knowledge.

PO3- Experiments and practice.

PO8- Individual and team work

PO10-Lifelong learning

III Relevant Course Outcomes

Select relevant material in industry by analyzing its physical properties.

IV Practical Outcome

Determine the coefficient of viscosity of given liquid by Stoke's method.

V Competency & Practical Skills

a. Measurement skills
b. Error Analysis

VI Relevant Affective domain related Outcomes

a. Handling the instrument carefully.
b. Demonstrate working as a leader/a team member.

VII Minimum Theoretical Background

1) Viscosity: It is the property of a fluid by virtue of which an internal resistance comes into play when the liquid is in motion, and opposes the relative motion between its different layers. Thus, it is the resistance of a fluid to flow.
When liquid flows over flat surface, a backward viscous force acts tangentially to every layer. This force depends upon the area of the layer, velocity of the layer, and the distance of the layer from the surface.

$$F \propto A\frac{dv}{dx} \qquad F=\eta\ A\frac{dv}{dx}$$

Where η is the *coefficient of viscosity* of the liquid.

2) Terminal velocity: When a spherical body freely falls in a liquid, It falls down in the liquid with accelerated velocity for about one-third of the height. Then it travels with uniform velocity called terminal velocity.

3) Stoke's Law: Stoke's law was established by an English scientist Sir George G Stokes (1819-1903).
When a spherical body moves down through an infinite column of highly viscous liquid, it drags the layer of the liquid in contact with it. As a result, the body experiences a retarding force.
Then according to Stokes law, the viscous drag force,

$$F = 6\pi\eta rv \quad ,$$

Where, r - Radius of the spherical body
v - Velocity of the spherical body
It gives the relationship between retarding force and velocity. When viscous force plus buoyant force becomes equal to force due to gravity, the net force becomes zero. The sphere then descends with a constant terminal velocity (v_t).

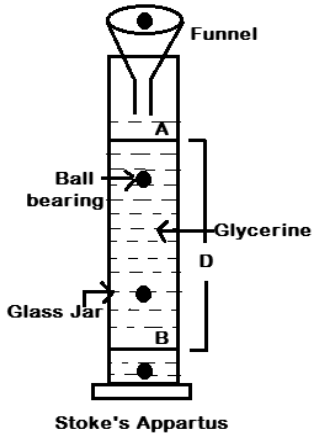
Now, $$6\pi\eta rv = \frac{4}{3}\pi r^3(\sigma-\rho)g$$

where, ρ - Density of the liquid
σ - Density of the spherical body

Now, the coefficient of viscosity of the liquid can be calculated by using the formula,

$$\eta = \frac{2}{9}\frac{r^2(\sigma-\rho)g}{v}$$

VIII Circuit diagram / Experimental set-up / Work Situation



IX Resources required:

Sr. No	Name of Instrument	Specifications	Quantity	Remarks
1	A long cylindrical glass jar	Borocil	01 No	Available dimensions
2	Transparent viscous fluid	Glycerin, AR grade	5 lit	Available dimensions
3	Metre scale	Wooden/metal, 1 meter	01 No	Available dimensions
4	Spherical ball	Steel bob Φ 5mm,6mm,7mm	01 Packet each	Available dimensions
5	Micrometer Screw gauge	L.C=0.001cm, Range=0 to 2.5cm	01 No	Available dimensions
6	Stop clock	Seconds timer	01 No	Available dimensions
7	Vernier caliper	L.C.=0.002cm Range=0-15cm	01 No	Available dimensions

X Procedure

Part 1: Find the diameter (d) of the ball using the micrometer screw gauge.

1. Find the least count and zero error correction (z) of the given micrometer screw guage.
2. Find the diameter (d) of the ball using the micrometer screw gauge.
3. Record the observations in table 1
4. Calculate the radius(r) of ball r = d/2.

Part 2: Calculate the terminal velocity of the ball

1. Mark two reference points A and B on the jar using two threads/rubber bands well below the free surface of liquid. The marking A is made well below the free surface of liquid, so that by the time when the ball reaches A, it would have acquired terminal velocity v.
2. Adjust the position the thread B so that the distance between A and B is 60cm.
3. Place the funnel near the mouth of the tube.
4. Drop the ball of known diameter gently in the liquid. When the ball crosses the point A, start the stop watch.
5. When the ball reaches the point B, stop the stop watch and note the time taken by the ball to reach the point B.
6. If the distance moved by the ball is d and the time taken to travel is t, then velocity,

$$v = \frac{s}{t}$$ v = terminal velocity

7. Calculate the coefficient of viscosity of glycerin using formula,

$$\eta = \frac{2}{9}\frac{r^2(\sigma - \rho)g}{v}$$

XI Precautions (if any)

1. Avoid contaminating the balls, use tweezers or tissue paper to hold the balls.
2. Drop the balls centrally into the sample liquid using funnel.

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

Part 1: To find the diameter of the sphere using screw gauge:

Pitch of the screw gauge = ... cm

Number of divisions on the circular scale =.....

Least count of the screw gauge (L.C.) =..... cm

Zero error correction of the micrometer screw gauge (z) = ……..... cm

Table 1

Metal sphere No.	MSR. (cm)	CSD (div.)	CSR=CSD×L.C. (cm)	Total reading = MSR.+CSR (cm)	Corrected Reading = T.R ± Z	Mean Diameter of the Metal sphere, 'd' m	Radius of metal sphere r = d/2 m
1							
2							
3							
4							

Part 2: To find the terminal velocity of the sphere:

Given data: Density of the liquid, ρ = ……..kg/m^3

Volume of Metal Sphere V= 4/3π r^3 ……..m^3

Mass of Metal Sphere M =…….. kg

Density of the sphere, σ = V/M =…….kg/m^3

Distance between points A and B on the tube, s = 60 cm= 0.6 m

Liquid taken = ----------

Table 2

Metal sphere No.	**Time taken to travel the distance s, t (s)**	**Velocity, v = s/t (m/s)**	**Mean terminal velocity v (m/s)**
1			
2			
3			

XVI Calculations:

Coefficient of viscosity of glycerin using formula,

$$\eta = \frac{2}{9}\frac{r^2(\sigma-\rho)g}{v}$$

$$\eta = \frac{2}{9}\times \text{——————————}$$

$$\eta = \text{……..}\text{N.S/m}^2$$

XVII Results:

Standard value of coefficient of viscosity of given liquid	coefficient of viscosity of given liquid by Experiment

XVIII Interpretation of results

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XIX Conclusions and Recommendations

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XX Sample 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. What will happen if density of ball bearing is less than density of glycerine oil?
2. Why funnel is used for dropping the ball bearing?
3. State the relation between radius of the ball bearing and terminal velocity.
4. A spherical ball of radius 0.3 mm falls vertically through water. Find the coefficient of viscosity of water given that terminal velocity acquired by the ball=9.8×10^{-2} m/s, density of water =10^3 Kg/m^3, density of ball = 1.5×10^3 Kg/m^3.
5. Cooking oil appears to move more fluidly upon a frying pan after being heated on a stove. Why?

Space to write answers:

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XX References / Suggestions for further Reading

a. amrita.olabs.edu.in/?sub=1&brch=5&sim=168&cnt=2
b. www.learncbse.in
c. http://www.youtube.com/watch?v=SCNZHSgzRYs
d. http://www.youtube.com/watch?v=950xl3MEKM8&feature=related

XXI Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the instrument	20
2	Determination of radius of metal sphere using micrometer screw gauge	20
3	Determination of terminal velocity using Stoke's tube.	20
Product Related : 10 Marks		**40 %**
1	Timely submission of reports	5
2	Neatness	5
3	Calculation of coefficient of viscosity using Stoke's formula	10
4	Interpretation of result	5
5	Conclusions & Recommendations	5
6	Practical related questions	10
Total (25 Marks)		**100 %**

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: Force on the roller on an inclined plane

I. Practical Significance

The force laws, together with the laws of motion, are the foundations of classical mechanics. They are based on experimental observations and were formulated more than three centuries ago by Isaac Newton (1642-1727).

An inclined plane, also known as a ramp, is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. The inclined plane is one of the six classical simple machines defined by Renaissance scientists. Inclined planes are widely used to move heavy loads over vertical obstacles; examples vary from a ramp used to load goods into a truck, to a person walking up a pedestrian ramp, to an automobile or railroad train climbing a grade.

Moving an object up an inclined plane requires less force than lifting it straight up, at a cost of an increase in the distance moved. The mechanical advantage of an inclined plane, the factor by which the force is reduced, is equal to the ratio of the length of the sloped surface to the height it spans. Due to conservation of energy, the same amount of mechanical energy (work) is required to lift a given object by a given vertical distance, disregarding losses from friction, but the inclined plane allows the same work to be done with a smaller force exerted over a greater distance.

II. Relevant Program Outcomes (POs)

PO1 – Basic knowledge
PO3 – Experiments and practice
PO8 – Individual and teamwork
PO10 – Life-long learning

III. Relevant Course Outcomes

Apply laws of motion in various applications.

IV. Practical Outcome

To Find: The downward force, along an inclined plane, acting on a roller due to gravity and its relationship with the angle of inclination.

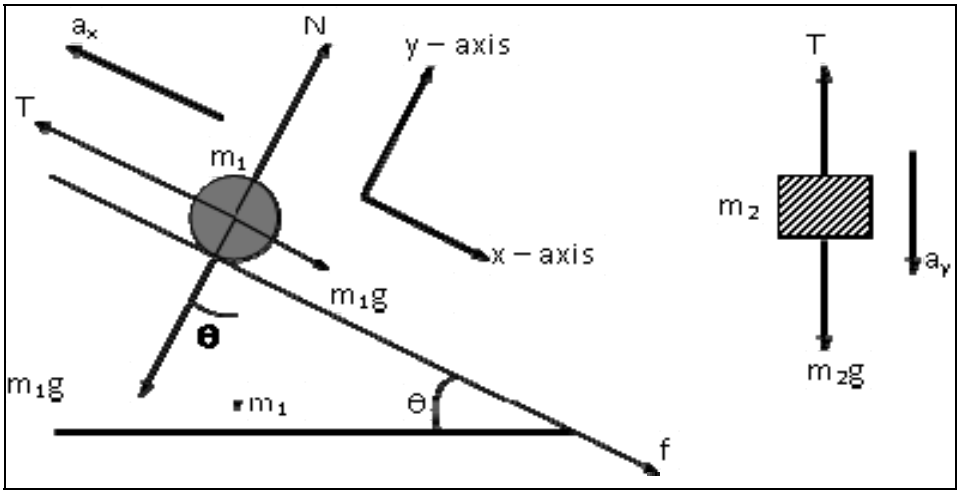
V. Competency and Practical Skills

a. Measurement skills
b. Error estimation skills

VI. Relevant Affective Domain Related Outcomes

a. Follow safe practices
b. Demonstrate working as a leader/ a team member
c. Follow ethical practices

VII. Minimum Theoretical Background



If total weight $W_1 = m_1g$ moves the body up and total weight $W_2 = m_2g$ makes the body move down, then downwards force acting on the body along the inclined plane is

$$W = \frac{W_1+W_2}{2} = \frac{(M_1+M_2)}{2} g$$

This force must be equal to mg sin□

i.e W = mg sin□

For the same body m is a constant.

So W α sin□

If a graph is plotted between W (along Y axis) and sin□ (along X axis).then it is a straight line.

VIII. Circuit diagram/experimental setup/work situation:

IX. Resources required

An inclined plane, A trolley or roller, pan, weight box, spring balance spirit level, strong thread, half meter scale.

X. Procedure

1. Test the pulley of the inclined plane and see that is free from friction. Oil it, if necessary.
2. Keep the apparatus on the table with the slot portion of the base beyond the edge of the table.
3. Make the base of inclined plane horizontal (test by spirit level) and make it stable (by putting paper pieces if necessary).
4. Bring the inclined plane to horizontal position (touching the base). The angle of inclination is now zero (as indicated by protractor).
5. Find the weight of the roller by a spring balance and place it on the inclined plane in the middle.
6. Tie one end of a thread to the roller placed on the inclined plane and pass it over the pulley.
7. Pass the thread through the slot in base.
8. Find the weight of the pan by the spring balance and tie it to free end of thread, keeping the thread free from board.
9. Raise the inclined plane and fix it at an angle of $30^{0.}$ The roller may start rolling down with acceleration.
10. Put weights on pan and increase them till the roller just starts moving upward with uniform velocity only on tapping. Note the total weights in pan.
11. Remove some small weights from weights in the pan till the roller just starts moving downward with uniform speed only on tapping. Note the total weights in pan.
12. Increase the angle of inclination in steps of 5^0 each, making it 35^0, 40^0, 45^0, 50^0, 55^0 and 60^0 and repeat steps 10 and 11.
13. Record your observation in table as given below.

XI. Precautions

1. Pulley should be friction less.
2. Base should be stable and horizontal.
3. Thread should not touch the board or table.
4. Inclined surface should be clean, dry and smooth (use glass top).
5. Weights in pan should be increased or decreased in small steps.
6. Weights should be noted only when the roller just starts moving up or moving down.

XII. Actual Procedure Followed:

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XIII. Resources Used (with proper specifications)

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XIV. Precautions followed

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XV. Observations and Calculations:

a. Least count of spring balance =.....g wt.
b. Zero error of spring balance (e) =.....g wt.
c. Zero correction of spring balance (c) = ($\pm$e) =.....g wt.
d. Observed weight of the roller (w_0) =.....g wt.
e. Corrected weight of the roller (w=mg) = (w_0 + c) =.....g wt.
f. Observed weight of the pan (p_0) =.....g wt.
g. Corrected weight of the pan (p)= (p_0 + c) =.....g wt.

Tables for angle of inclination and weights in pan

Sr. No	Angle of inclination (θ) (degree)	sinθ	w sinθ = mg sinθ	Weight in pan when roller moves		Total weight when roller moves		Force acting on roller downward	Error W - mg sinθ
				Upward w_1 (gwt)	Downward w_2 (g wt)	Upward $W_1 = w_1+p$ (gwt)	Downward $W_2 = w_2+p$ (gwt)	$W=\frac{W_1+W_2}{2}$	
1	30								
2	35								
3	40								

4	**45**								
5	**50**								
6	**55**								
7	**60**								

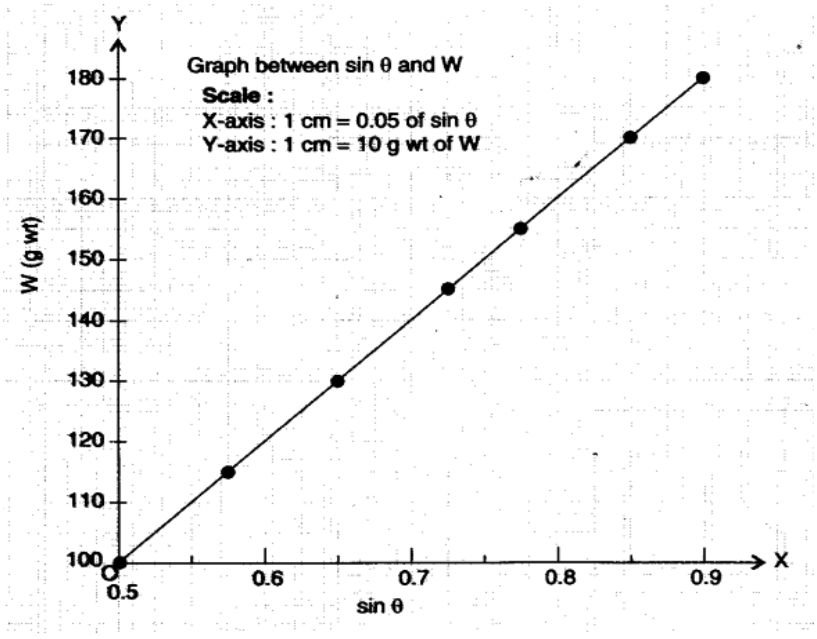

Fig. Graph between sin θ and *W*. It is a straight line.

XVI. Results

1. Downwards force on the body of weight W = mg on an inclined plane is mg sin□
2. The graph between W and sin θ is a straight line, i.e. W α sin□

XVII. Interpretation of Results

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XVIII. Conclusions and Recommendations:

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XIX. Practical Related Questions

1. What is inclined plane?
2. What is the relation between downward force and angle of inclination of the plane?
3. What is the normal reaction on the inclined plane?
4. Why is the glass plate fixed on an inclined plane?

Space to write answers

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XX **References/suggestions for further reading**

https://www.youtube.com/watch?v=WZTbz-fL6bM

XXI Suggested Assessment scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1.	Arrangement of inclined plane in horizontal position	10
2.	Least count and zero error of spring balance and measurement of weights	10
3.	Accuracy in measurement of W_1 and W_2	10
4.	Measurement of □ and calculation of sin□	10
5.	Team spirit	20
Product Related : 10 Marks		**40 %**
1.	Timely submission and neatness	10
2.	Interpretation of result	10
3.	Conclusions and Recommendations	10
4.	Practical related questions	10
Total (25 Marks)		**100 %**

Name of Students 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: Study of Projectile motion

I. Practical significance

A particle moving under the combined effect of vertical and horizontal forces is called a projectile. A projectile is any object that is given an initial velocity and then follows a path determined entirely by gravitational acceleration. Regardless of whether you're launching a balloon, a baseball, or an arrow, all projectiles follow a very predictable path, making them a great tool for studying kinematics.

II. Relevant program outcomes (POs)

PO1 – Basic knowledge
PO3 – Experiments and practice
PO8 – Individual and teamwork
PO10 – Life-long learning

III. Relevant Course Outcome(s)

Apply laws of motion in various applications.

IV. Practical outcome

Predict the range of the projectile from the initial launch speed and angle.

V. Competency and Practical Skills

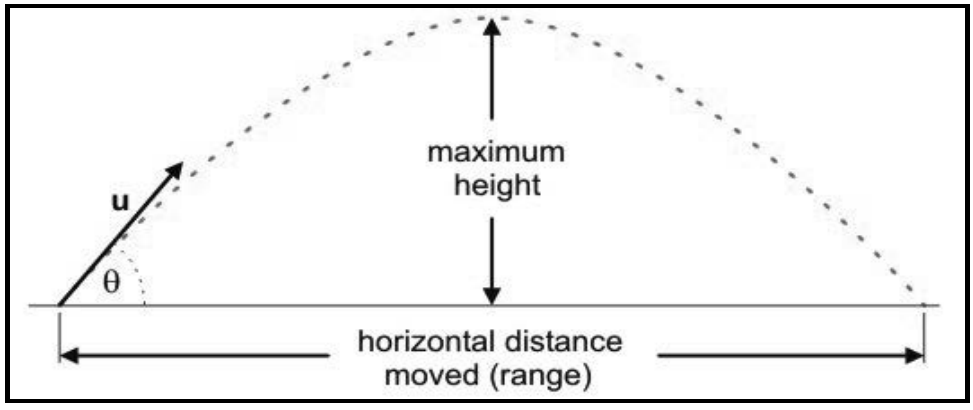
a. Measurement skills
b. Error estimation skills

VI. Relevant Affective Domain Related Outcomes

a. Follow safe practices
b. Demonstrate working as a leader/ a team member
c. Follow ethical practices

VII. Minimum Theoretical Background

Projectile motion is a predictable path travelled by an object that is influenced only by the initial launch speed, launch angle, and the acceleration due to gravity.



The following terms are commonly used in projectiles:

1. Trajectory. It is the path traced by a projectile in the space.
2. Velocity of projection. It is the velocity with which a projectile is projected.
3. Angle of projection. It is the angle with the horizontal at which the projectile is Projects.
4. Time of flight. It is the total time taken by a projectile, to reach maximum height and to return back to the ground.
5. Range. It is the distance between the point of projection and the point where the projectile strikes the ground.

Equations associated to the trajectory motion (projectile motion) are articulated as,

Time of Flight, $T = \frac{2\,v \sin\theta}{g}$

Maximum height reached, $H = \frac{v^2 . \sin^2\theta}{2g}$

Horizontal Range, $R = \frac{v^2 \sin 2\theta}{g}$

Where
the initial velocity is v
the component of v along the y-axis is v sin θ
the component of v along the x-axis is v cos θ

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

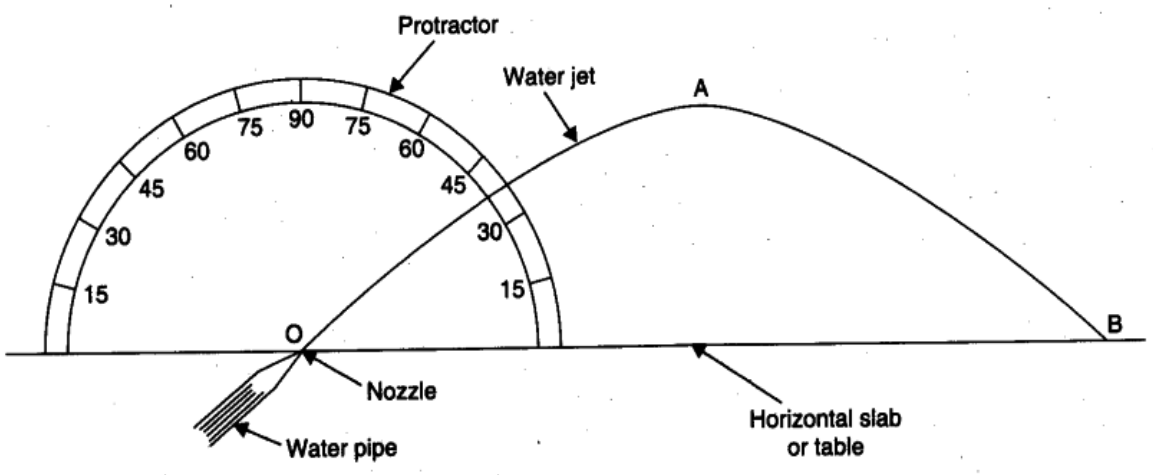


Fig. Range of a water jet.

IX. Resources Required

A ply board, protractor with radius of about 30cm and mark $0^0 - 90^0$ with an interval of 15^0 each, a 10 m long measuring tape. A constant level reservoir under pressure (a tap connected to a tank or water supply line), a water pipe with a metallic nozzle (narrow opening).

X. Procedure

1. Arrange a constant level of water reservoir at one end of a horizontal slab of the laboratory.
2. Connect a water pipe with the outlet of the reservoir and insert a metallic nozzle in the other end of the pipe held in hand.
3. Open the water tap and check that there is no leakage of water (remove if it is there).
4. Fix the protractor in a slot in a horizontal base to make its plane vertical and graduated surface vertical towards yourself.
5. Place the nozzle at the center O of the protractor and falls back on the slab at some distance.
6. The jet moves along a parabola and falls back on the slab at some distance.
7. Set the water tap such that the distance is few meters.
8. Ask your laboratory bearer to make a mark B1 on the slab where the jet falls.
9. Change the angle to 15^0, 30^0 , 45^0, 60^0 and 75^0 and repeat Step 8 to get marks B_2, B_3, B_4 and B_5 (Do not change the setting of water tap otherwise it will change the velocity of jet).
10. Measure distances OB_1, OB_2, OB_3, OB_4 and OB_5 by the measuring tape. These distances give range R for different angles (and same velocity).
11. Record your observations in the table as given below.

XI. Precautions Followed

1. Throughout the experimental procedure don't change the setting of the water jet.
2. Jet should be thin in order to give fine point of fall.

XII. Actual procedure followed

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XIII. Resources used (with proper specifications)

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XIV. Precautions followed

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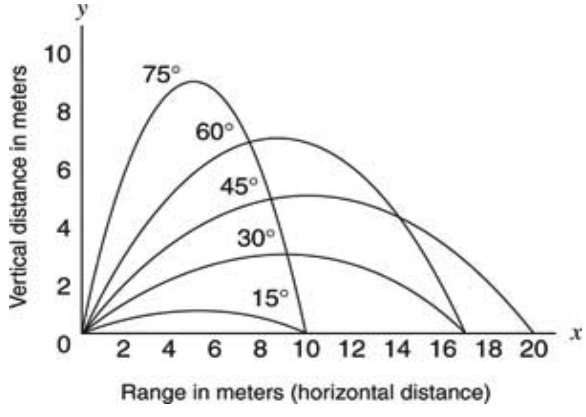
XV. Observations and Calculations:

1. Table for Range and Angle of Projection:

Sr. No.	Angle of Projection of water jet (in degree)	Range of water jet (m)
1	15^0	OB_1 =
2	30^0	OB_2 =
3	45^0	OB_3 =
4	60^0	OB_4 =
5	75^0	OB_5 =



XVI. Results:

From graph we find the following two results:

a. Range is same for two complementary angles (i.e. 15^0 & 75^0 or 30^0 & 60^0)
b. Range is maximum for the angle of projection of 45^0

XVII. Interpretation of Results

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XVIII. Conclusions and Recommendations

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XIX. Practical related questions

1. What is Projectile motion?
2. What is the velocity of projection?
3. What is range of projection and how it changes with the angle of projection?
4. A body is projected with a velocity of 40 m/s at an angle of 45^0 with horizontal surface, what will be the range of projection.

Space to write answers

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XX. References/suggestions for further reading

1. learncbse.in/to-study-the-variation-in-range-of-a-projectile-with-angle-of-projection
2. http://study.com/academy/lesson/projectile-motion
3. https://www.youtube.com/watch?v=rkvdp5snPpk

XXI. Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Arrangement of Water reservoir with jet pipe	20
2	Water reservoir Velocity adjustment	20
3	Team spirit	20
Product Related : 10 Marks		**40 %**
1	Timely submission and neatness	10
2	Interpretation of result	10
3	Conclusions and Recommendations	10
4	Practical related questions	10
Total (25 Marks)		**100 %**

Name of Students Team Members

1. ……
2. ……..
3. ……
4. ……

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

Practical No. 6: Study 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

a. Find the dependence of the stopping potential on the frequency of light source in photo electric effect experiment.
b. Find the dependence of the stopping potential on the intensity of light source in photo electric effect experiment.

V Practical Skills

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

VI Relevant Affective Domain Related Outcomes

a. Handle tools and equipment carefully.
b. Practice energy conservation.
c. Function as a team leader / a team member.

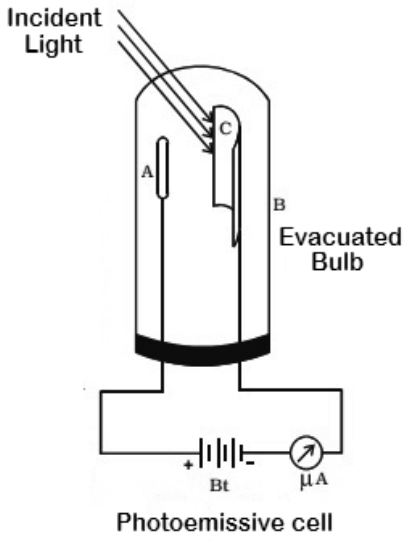
VII Minimum Theoretical Background

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 etc.

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 above.

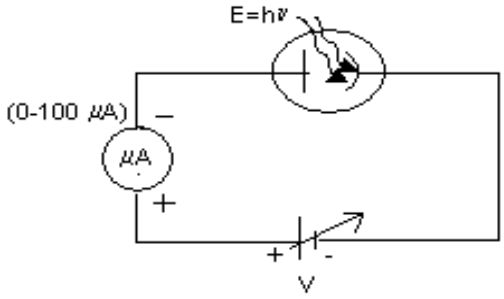


Photoemissive cell

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.

Stopping Potential: When we apply a positive potential on the plate placed directly opposite to this metal plate, the plate attracts the negative electrons. A force acts on these electrons and thus they get accelerated towards this plate. So, the more positive potential we apply on this (collector) plate, more rapidly will the electrons flow through the circuit. But if we apply a negative potential on this (collector) plate, the electrons will not approach so easily. Only the electrons with sufficient energy and hence, velocity, will be able to surpass this opposing potential called retarding potential of the (collector) plate. If we keep on increasing this negative (retarding) potential, there will be one point when no more electrons reach this plate and thus, no electron flows through the circuit. Thus, current flow through the circuit stops. This potential applied on the (collector) plate is called as the stopping potential.

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



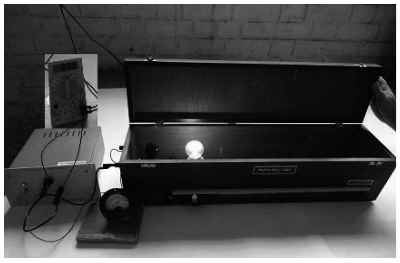


Fig. To determine characteristics of photoelectric cell

IX Resources required

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

Specification of Filters

Color	Blue	Green	Yellow	Orange	Red
Wavelength (A^0)	4600	5000	5400	5700	6350
Frequency (Hz) (calculate using the formula $\gamma = c / \lambda$ $c = 3 \times 10^8$ m/s					

X. Procedure

Part I: Effect of Frequency on Stopping Potential

1. Make circuit connections as shown in diagram.
2. Keep applied voltage constant say 2V.
3. Keep light source close to photocell (at constant distance).
4. Calculate the frequency of each color using the formula $C = \gamma\lambda$. (Value of λ is given)

5. To find the stopping potential, give the negative potential and measure the voltage using multi-meter where the current decreases to zero.
6. Now for various frequencies find the stopping potential (Table 1)
7. Plot a Graph of stopping potential on (Y-axis) Versus photoelectric frequency on (X-axis)

Part II: Effect of Intensity of light on Stopping Potential

1. Keep intensity of incident light constant. This is done by keeping distance between photocell and light source constant, say d_1 = 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. Repeat the same procedure for two more different distances (i.e. d_2 and d_3)
5. 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

XV. Observations and Calculations

Table 1: Effect of Frequency on Stopping Potential

Color	Blue	Green	Yellow	Orange	Red
Wavelength (A^0)	4600	5000	5400	5700	6350
Frequency (Hz)					
Stopping Potential (Vs)					

Table 2: Effect of Intensity of light on Stopping Potential

Obs. No.	Distance between Source and Photoelectric cell d_1 = ……. cm		Distance between Source and Photoelectric cell d_2 = ……. cm		Distance between Source and Photoelectric cell d_3 = ……. cm	
	Applied Voltage 'V' (Volt)	Photoelectric current 'I' (µA)	Applied Voltage 'V' (Volt)	Photoelectric current 'I' (µA)	Applied Voltage 'V' (Volt)	Photoelectric current 'I' (µA)
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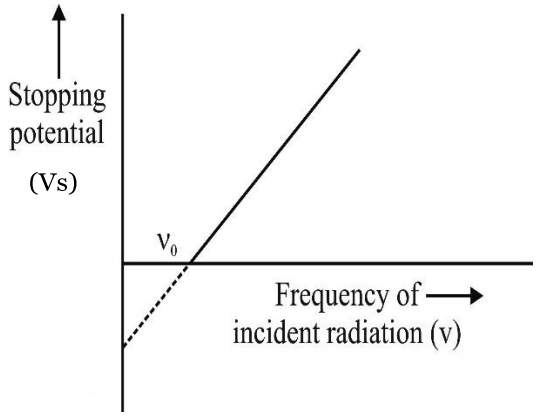

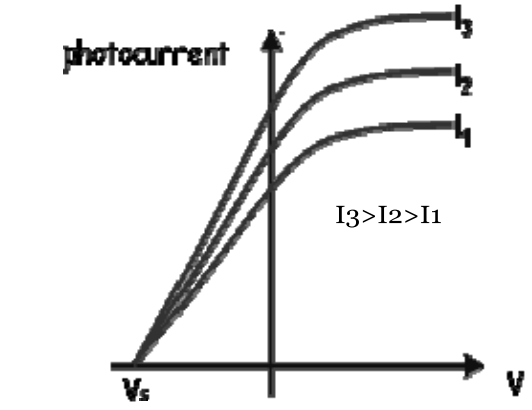

XVI. Results

a. The stopping potential …… (Increases / decreases) when the frequency of light source increases.
b. In case of photoelectric cell, the stopping potential at all intensities of light……. (remains constant / varies)

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 the applications of photoelectric effect?
2. What is the use of optical bench in this experiment?
3. What happens if the photocell is moved away from the source (bulb)?
4. Define Stopping Potential.
5. What is the use of light source in this experiment?

Space to write answers

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XX. References / Suggestions for further Reading

a. Engineering Physics By Gaur & 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

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

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 %**
1	Timely submission of reports	5
2	Neatness	5
3	Interpretation of result from graphs	15
4	Practical related questions	15
Total (25 Marks)		**100 %**

Name of Student Team Members

1. ……..
2. ……
3. …….
4. ……..

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


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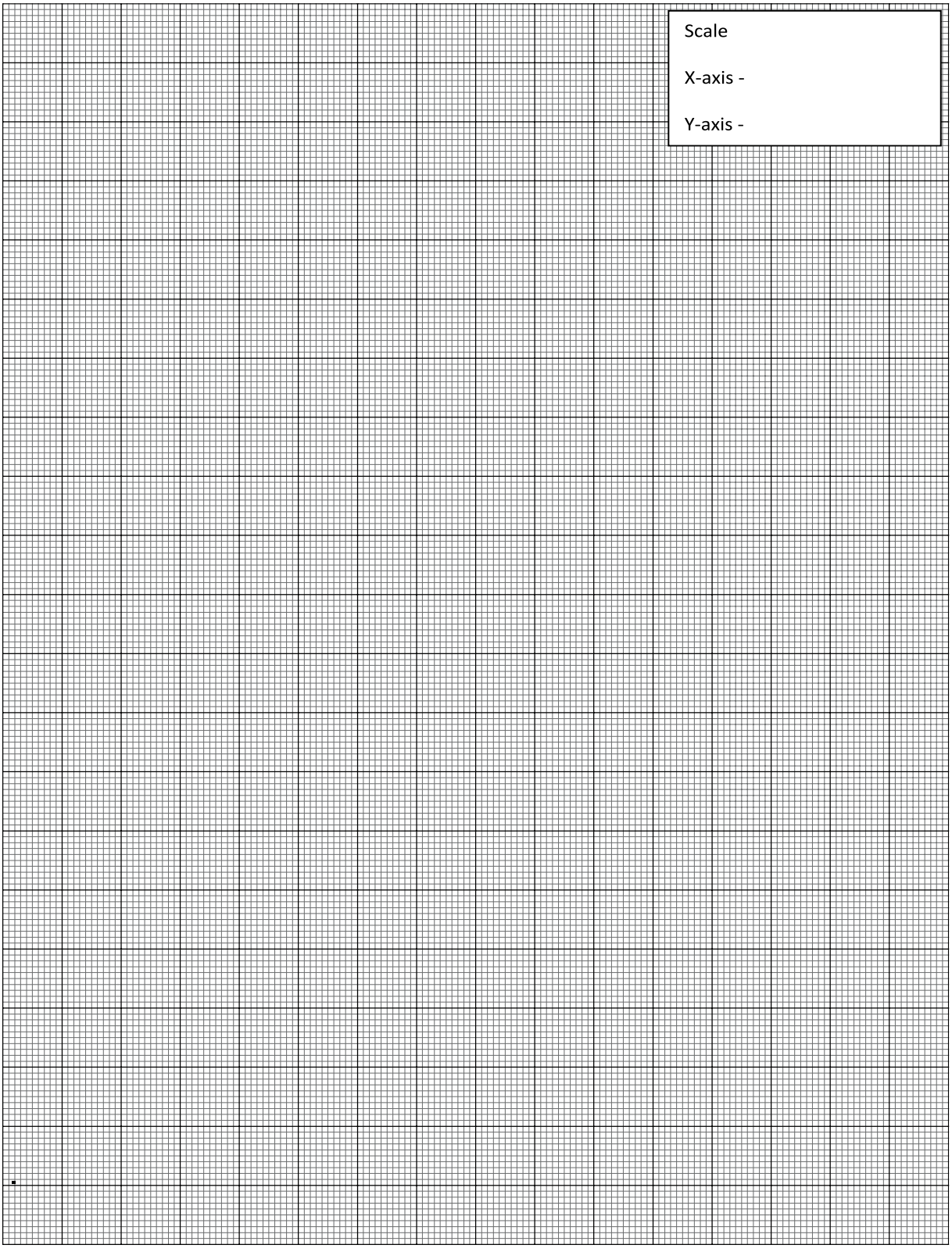
Y-axis -


Scale
X-axis -
Y-axis -

Practical No. 7: I -V characteristics of photoelectric cell and LDR

I Practical Significance

In industry different types of light sensors such as photocell/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. There are 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. Photocell/LDR are widely used in space and robotics for controlled and guided motions of vehicles and robots. The light sensor enables a robot to detect light. Robots can be programmed to have a specific reaction if a certain amount of light is detected. Photocell/LDR are 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 measure the temperature of stars, to study the spectrum of heavy bodies, to operate street light, to compare the illuminating powers of two sources, in photometers, for locating minor flaws in metallic sheets, to determine the opacity of solids and liquids, 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 and LDR

V Competency & Practical Skills

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

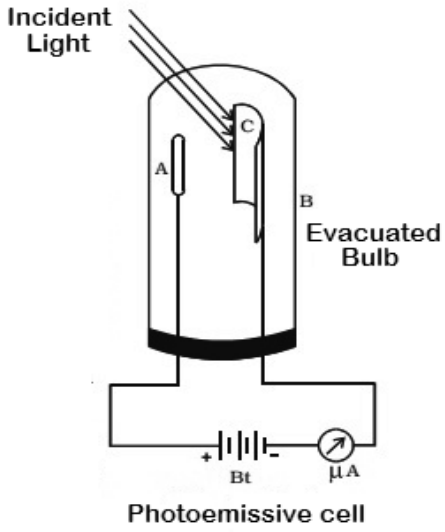
VI Relevant Affective domain related Outcomes

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

VII Minimum Theoretical Background

1. **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

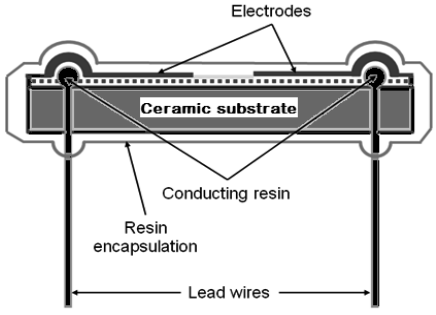


Photoemissive cell

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 caesium 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 above.

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.

2. **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

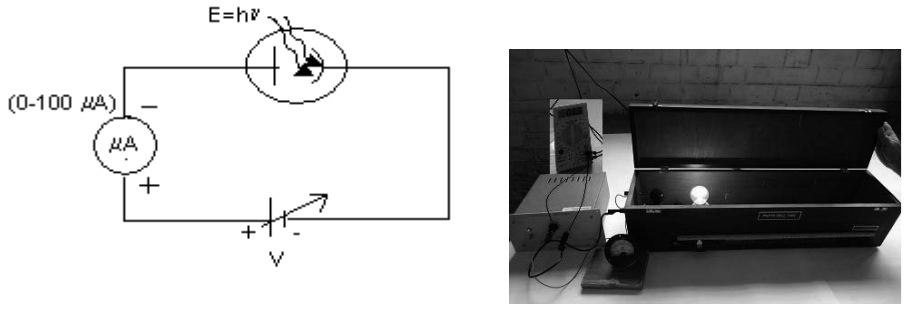


Fig (1) To determine characteristics of photoelectric cell

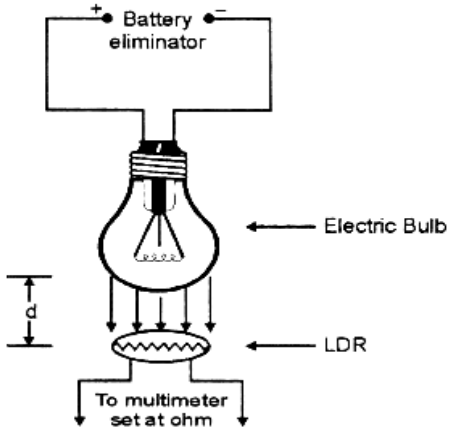


Fig (2) To determine characteristics of LDR

IX Resources required

S. 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
5	Phoresistor cell setup	Photo resistor 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 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).

Part III: Effect of intensity on a 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 3)
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. 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 V = ……. volt	
	Distance 'd' in cm	Photoelectric current 'I' (μA)
1		
2		
3		
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6		
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9		
10		

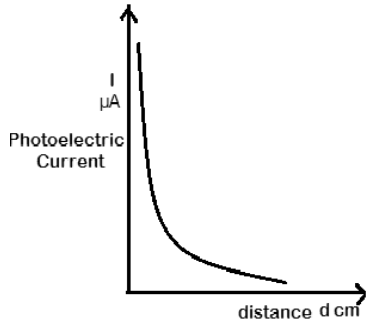

Table 2: Effect of applied voltage on photoelectric current.
(When Intensity of light is kept constant)

Obs. No.	Distance 'd' =……. Cm	
	Applied Voltage 'V' (Volt)	Photoelectric current 'I' (μA)
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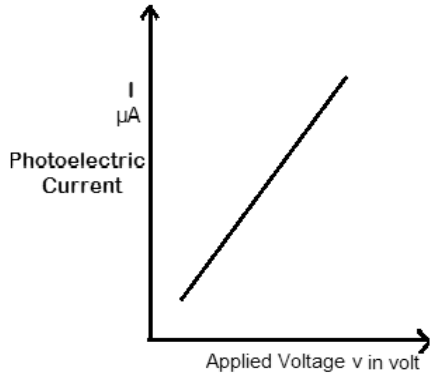

Table 3: Effect of Intensity of light on resistance of LDR.

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
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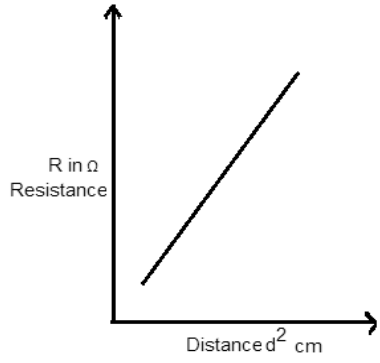

XVI Results:

Observation table No	Nature of graph
1	
2	
3	

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.

c. 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 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. Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks

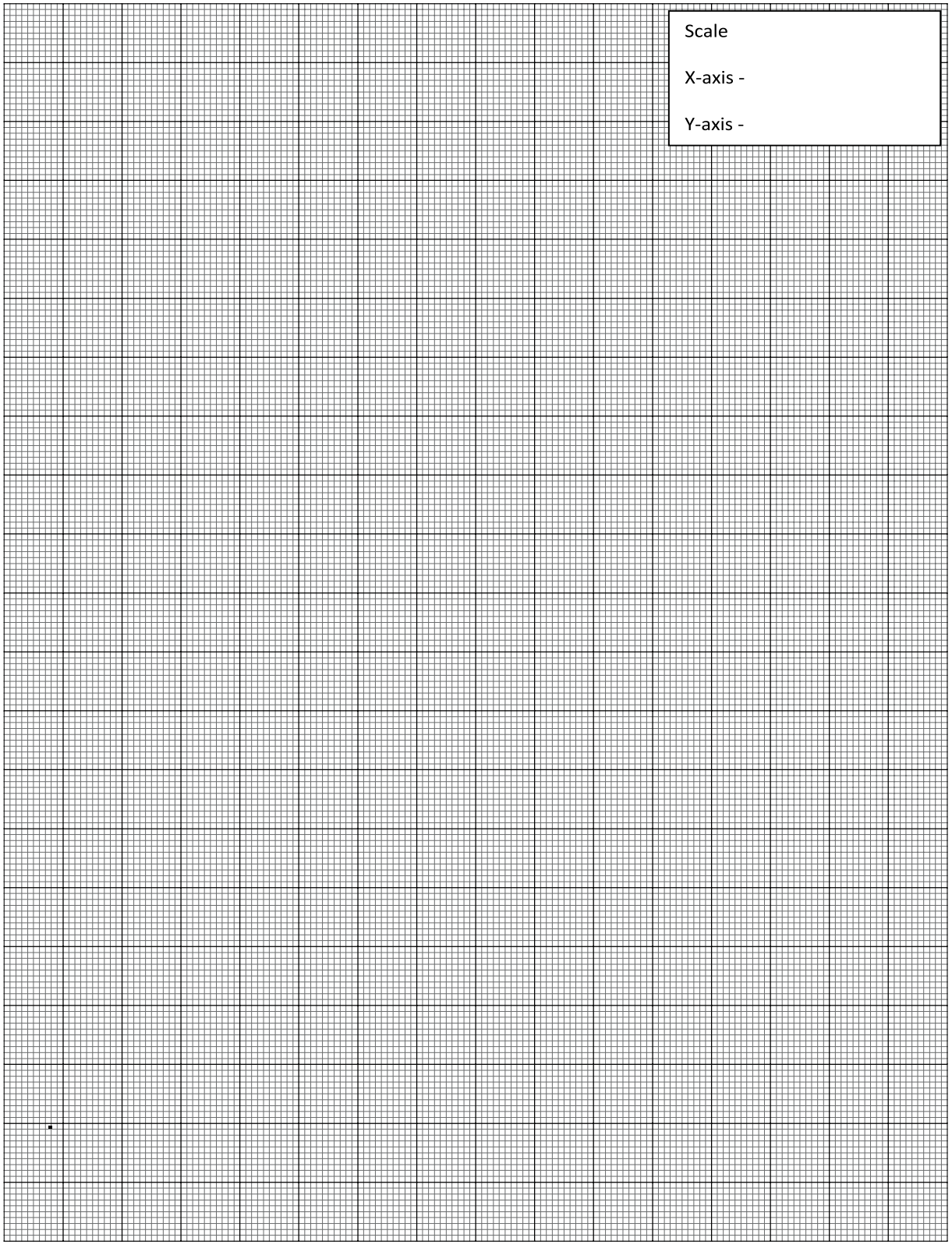
Performance Indicators		Weightage
Process Related : 15 Marks		**60 %**
1	Handling of the instrument	5
2	Performing Part I	15
3	Performing Part II	15
4	Performing Part III	15
5	Plotting graphs	10
Product Related : 10 Marks		**40 %**
1	Timely submission of reports	5
2	Neatness	5
3	Interpretation of result from graphs	15
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100 %**

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 -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Practical No. 8: Divergence of LASER Beam

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

II. Relevant Program Outcomes (POs)

PO1 – Basic Knowledge
PO3 – Experiments and Practice
PO8 - Individual and team work
PO10 - Life-long learning

III. Relevant Course Outcomes

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

IV. Practical Outcomes

Determine the divergence of LASER beam.

V. Competency & Practical Skills

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

VI. Relevant Affective Domain Related Outcomes

a. Handle tools and equipment's carefully.
b. Function as a team member.
c. Follow safe practices

VII. Minimum Theoretical Background

Laser is an extremely coherent, monochromatic, directional, focusable, polarized and powerful 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 6328^{o}). 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

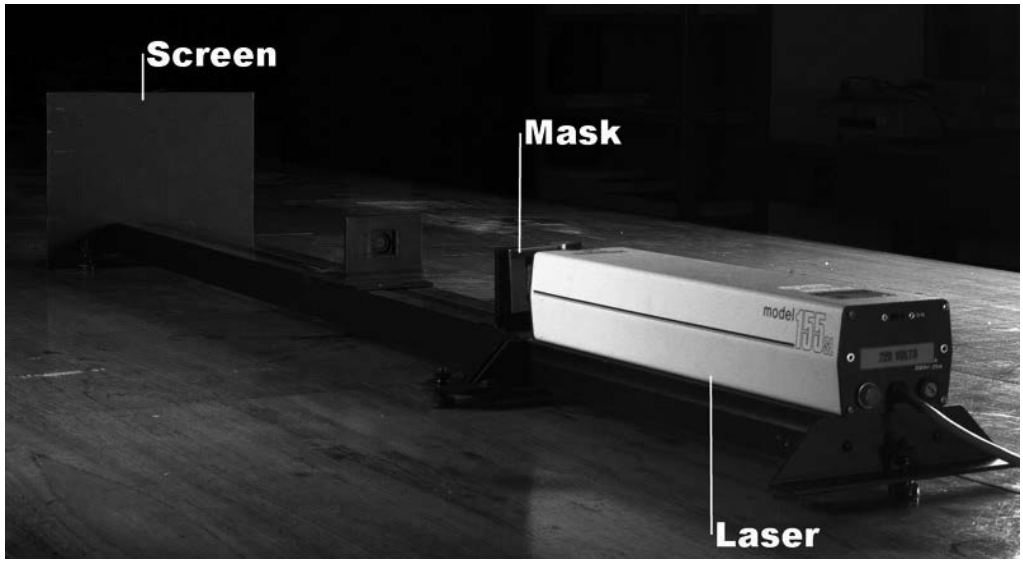


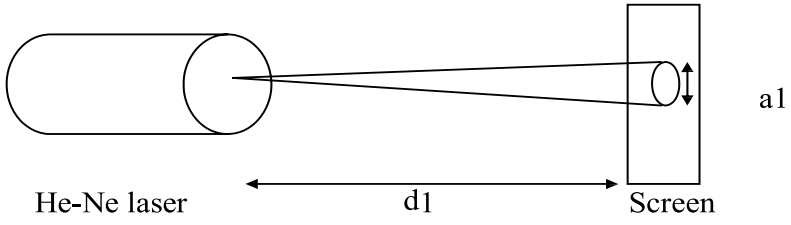
Fig.1. Measurement of Divergence of Laser beam

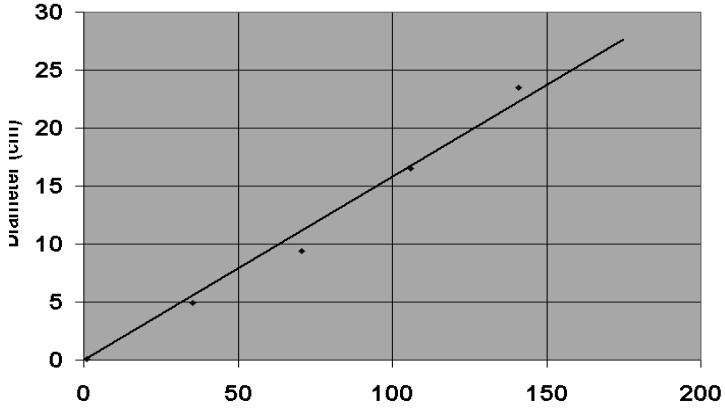
IX. Resources Required

Sr. No.	Instrument/Object	Specifications	Quantity	Remark
1	He-Ne laser kit (IFHN 05)	CLASS II (0.4 to 1.0 mW)	1	
2	Card board (screen) with white paper.	10cm x 10cm	1	
3	Meter scale	1m	1	

X. Procedure

a. The laser beam from He-Ne is made to fall on the screen which is kept at a distance of d1 from the source.
b. The spot size of the beam is noted by taking horizontal and vertical diameter and their mean is taken as a1.
c. Now the position of the screen is altered to a new position d2 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 a2.
d. The same procedure is repeated by changing the position of the screen at equal intervals at least 5 times.
e. The readings corresponding to the position of the screen and spot size of the beam is tabulated.
f. From this, the angle of divergence of the laser beam is calculated using the formula $\Phi = (a2-a1) / (d2-d1)$ radian.
g. 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

Sr. 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	$\Phi = (a_n - a_{n-1})/(d_n - d_{n-1})$ radians
1					————
2					
3					
4					
5					

Calculations

1. Distance between laser source and the screen (d_1) = …….. cm
2. Spot size of the laser beam on the screen for distance d_1 (a_1) = ……. cm
3. Distance between laser source and the screen (d_2) = ……cm
4. Spot size of the laser beam on the screen for distance d_2 (a_2) =……. cm
5. Angle of divergence of the laser beam, $\Phi = (a_2-a_1)/(d_2-d_1)$ radian

XVI. Result

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

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. 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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XX. 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

XXI. Suggested Assessment Scheme

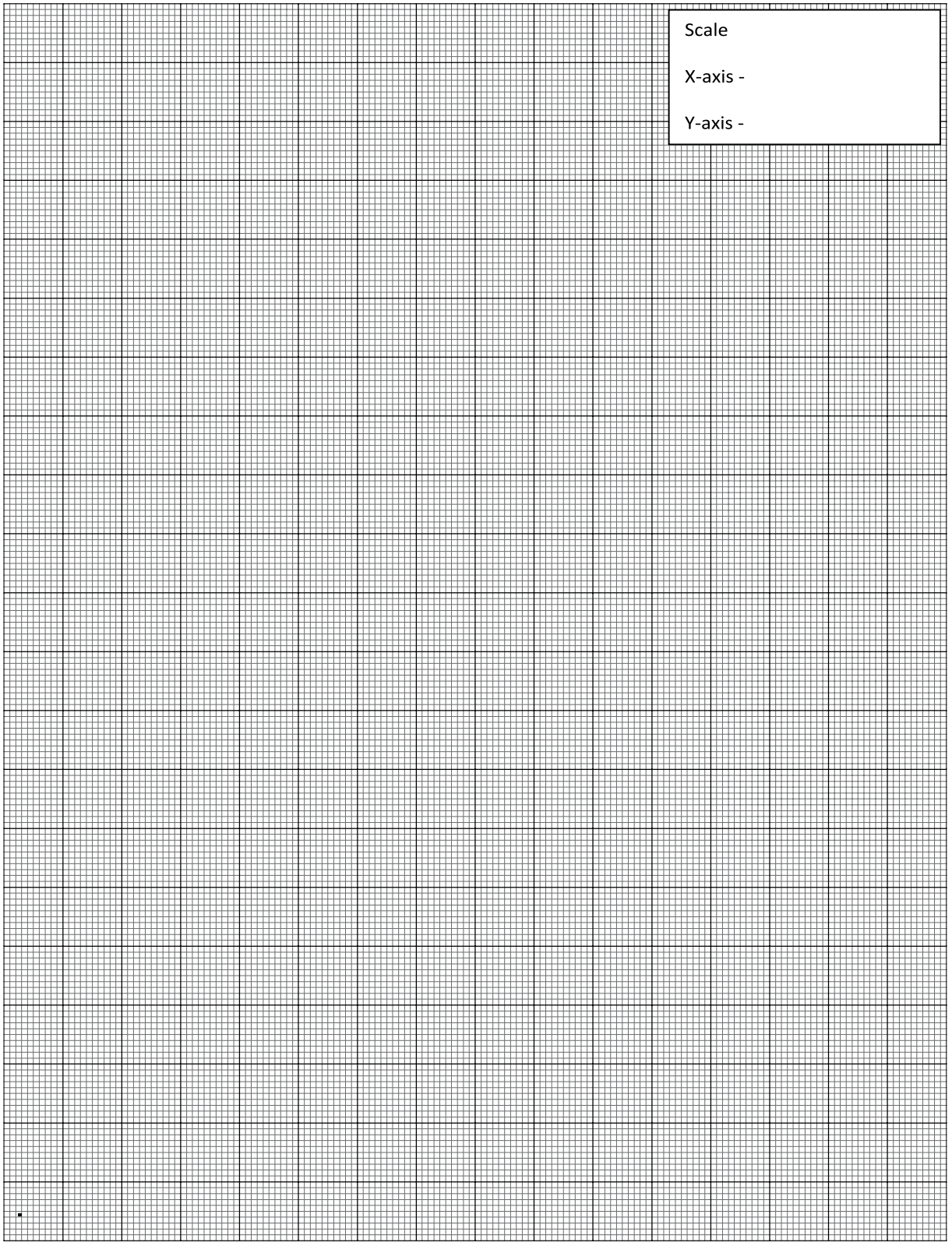
The given performance indicators should serve as a guideline for assessment regarding process and product related marks

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 %**
1	Timely submission of reports	10
2	Neatness	5
3	Interpretation of result from graphs	10
4	Conclusions & Recommendations	5
5	Practical related questions	10
Total (25 Marks)		**100 %**

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 -

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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