MRCET CAMPUS

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS INSTITUTION - UGC, GOVT. OF INDIA)

Affiliated to JNTUH; Approved by AICTE, NBA-Tier 1 & NAAC with A-GRADE | ISO 9001:2015

Maisammaguda, Dhulapally, Komaplly, Secunderabad - 500100, Telangana State, India

LABORATORY MANUAL & RECORD

Name:..

Roll No:................Branch:...

Year:..................Sem:..

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Certificate

Certified that this is the Bonafide Record of the Work Done by

Mr./Ms...Roll.No.................of

B.Tech I year .... Semester for Academic year 2021 - 2022

in...Laboratory.

Date: Faculty Incharge HOD

Internal Examiner External Examiner

INDEX

S.No	Date	Name of the Activity/Experiment	Grade/ Marks	Faculty Signature

PREFACE

Laboratory work is an important part of the process of learning physics where students apply their knowledge practically. It allows students to deepen their understanding and improve their problem-solving techniques, and enables them to take an active part in the enquiry into the natural world. Experiments performed in the physics laboratory play a significant role in understanding the concepts taught in the theory. In all aspects of laboratory sessions, you will be investigating the nature of science. We believe that the best way to do this through hands on experience and laboratory activities. The lab is a place for you to actively engage in the process of science. Along with this goes the importance of writing a lab report. The lab report is not only a write-up for you to share the results discovered during experimentation, but it is also an opportunity for you to analyze your procedure on scientific basis, and correct any mistakes you may have made. Remember that science is imperfect, when we learn new information by trying new things and continuing to ask questions outside of class.

Applied Physics lab plays a prominent role in developing different Engineering courses. Applied physics lab is primarily related to Mechanical, sound, light, magnetism, and Electrical & Electronic based experiments.

The present Applied Physics lab is currently divided into 10 different lab experiments. Students must able to perform a minimum of 8 experiments in lab out of given list of experiments in physics lab. The list of experiments which are cited below labeled as follows;

In Torsional Pendulum experiment students try to find the rigidity modulus of the given wire & know the importance of various elastic constants by comparing them practically.

Melde's experiment is related to waves & harmonic oscillations. Students determine the frequency of electrical tuning fork or bar equivalent to A.C. frequency cycle.

Stewart and Gee's method experiment is related to magnetism. They were able to find magnetic induction along the axis of current carrying circular coil. Students gain knowledge of how magnetic induction varies with current carrying coil along the axis.

Dispersive power of the material of a prism experiment is related to light or optics. Students justify that how refractive index varies with each colour of wave-length of light with the help of solid glass prism & calculate the D.P.of prism & also compare their D.P. of various materials of prisms. Also, students know the various spectrums study & learn practice of measurements by using a spectrometer in lab.

Diffraction grating using laser experiment is based on laser source & diffraction grating A diffraction grating is an optical device that splits and diffracts light into several beams travelling in different directions. Laser light is sent through grating which forms a diffraction pattern or order of grating spectrum by forming laser spots on the screen of various diffraction orders. Students determine wavelength of given laser light by appropriate formula & know the applications of lasers in various scientific & industrial fields.

Newton's Rings experiment is based on concept of interference of light. Students able to find radius of curvature of Plano convex lens or wave-length of monochromatic light by formation of circular rings known as Newton's rings. Students on further analysis can also able to know that they can find refractive index of liquid by changing the medium i.e. air with liquid. Students study the applications of interference of light in thin-films, Michelson-Interferometer, complementary colors in soap bubbles & oil layers act as thin films in reflected & transmitted light etc.

LED experiment is related to semiconductor devices. LED (Light emitting diode) is a forward biased PN-junction diode works on the principle of Electro-luminescence which converts electrical energy into light energy. Students will calculate the cut-in voltages and forward resistance of various LED's (different manufacturing materials) by plotting the graph between voltage & current which is an exponential curve or graph & compare their results and on upon further investigation students justify that how LED are useful when compared to ordinary lamp or bulb in terms of electrical rating and power savers. Students know clearly the applications of LED bulbs or lamps in household supply, industries & commercial fields.

Solar cell experiment is also related to semiconductor devices. Solar cell is a forward biased PN-junction diode which is quiet opposite to LED works on the principle of Photo-voltaic effect which converts light energy into electrical energy. The main purpose of solar-panels is nothing but to absorb the sun's rays or light and convert them into heat or electricity. From this Students find the fill-factor by appropriate formula by plotting I-V exponential graph and also they find percentage efficiency of solar cell, Students can able to do mini-project on solar panels or usage of solar cell & can explain its applications in domestic, industry & scientific fields.

NA of optical fiberrefers to numerical aperture which is related to fiber-optics experiment. Students calculate acceptance angle and NA of various optical communication cables with trainer-kit and compare them. Students able to differentiate the merits of using optical fibers over co-axial cables (electrical cables) & know its applications in telecommunication companies to transmit telephone signals, Internet communication and cable television signals.

Hall-Effect experiment is related to generation of Hall-voltage or Potential difference across an electrical conductor (metal) or semiconductor material. Students were able to determine hall-coefficient at constant current and constant magnetic field of metals or semiconductor materials & compare the results of various materials. Students learn the importance or applications of Hall Effect measurements in lab.

In conclusion we can say that the present hand-out/ workbook of Applied physics lab manual presents itself in a very simple style that even a below average students can understand the concepts & procedures of the experiments without much strain & learn the practical's in physics lab with more zeal & interest. We look forward for your suggestions for further improvement of the book.

The authors express their happiness on the encouraging welcome given in preparation of lab-manual for under-graduate students by the Physics faculty all over of the department.

Faculty of Physics

MRCET

PROGRAM OUTCOMES

A B.Tech –graduate should possess the following program outcomes.

1 **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2 **Problem analysis**: Identify ,formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5 **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6 **The engineer and society** : Apply reasoning informed by the contextual knowledge to assess societal ,health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7 **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9 **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams ,and in multi disciplinary settings.

10 **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large ,such as, being able to comprehend and write effective reports and design documentation ,make effective presentations ,and give and receive clear instructions.

11 **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi disciplinary environments.

12 **Life long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

CODE OF CONDUCT

1. Students should bring lab Manual/Record for every laboratory session and should enter the readings /observations in the manual while performing the experiment.
2. The group- wise division made in the beginning should be adhered to, and no mix up of students among different groups will be permitted later.
3. The components required pertaining to the experiment should be collected from stores in –charge after duly filling in the requisition form.
4. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.
5. Any damage to the apparatus that occurs during the experiment should be brought to the notice of lab in-charge, consequently, the cost of repair or new apparatus should be brought by the students.
6. After completion of the experiment, certification of the concerned staff in –charge in the observation book is necessary.
7. Students should be present in the labs for the total scheduled duration.
8. Students should not carry ant food items inside the laboratory.
9. Use of cell phones and IPODs is forbidden.
10. Students should not write on or deface any lab desks, computers, or any equipment provided to them during the experiment.
11. Every student should keep his/her work area properly before leaving the laboratory.

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

B. TECH- I- YEAR- I & II-SEM

L	T	P	C
-	-	3	1.5

(R20A0082) APPLIED PHYSICS LAB

(Any 8 experiments compulsory)

COURSE OBJECTIVES: Students can be able to

1. Identify the specific types of elastic and electrical nature of materials in physics lab.
2. Observe concepts of magnetism in physics lab.
3. Analyze propagation of light in various optical devices practically.
4. Examine various opto electronic devices practically
5. Well-equipped with the properties of semiconductor devices in physics lab.

LIST OF EXPERIMENTS:

1. Torsional pendulum-Rigidity modulus of given wire.
2. Melde's experiment –Transverse and Longitudinal modes.
3. Stewart and Gee's method- Magnetic field along the axis of current carrying coil.
4. Spectrometer-Dispersive power of the material of a prism
5. Diffraction grating-using laser -Wave length of light.
6. Newton's Rings –Radius of curvature of Plano convex lens.
7. LED -Characteristics of LED.
8. Solar cell -Characteristics of a Solar cell.
9. Optical fiber- Evaluation of numerical aperture of optical fiber.
10. Hall effect –To study Hall effect in semiconducting samples.

REFERENCE BOOKS:

1. Practical physics by Dr. Aparna, Dr K.V Rao, V.G.S.Publications.
2. Engineering physics practical lab manual – MRCET.

COURSE OUTCOMES:

1 Students are able to measure the elastic constants of the given material of the wire and also determine the ac frequency of vibrating bar.

2 Students are able to determine the magnetic induction of a circular coil carrying current by applying the principles of terrestrial magnetism.

3 Students are able to frame relativistic ideas of light phenomenon

4 Students are able to achieve the analysis of V-I characteristics of opto electronic devices

5 Students are able to determine the carrier concentration and identify the given semiconductor material with the help of Hall Effect.

CONTENTS

1.TORSIONAL PENDULUM

Aim: To determine the rigidity modulus (η) of the material of the wire using a Torsional Pendulum.

Apparatus: A circular disc provided with a chuck nut at its center, copper wire, another chuck nut fixed to a wall bracket or a rigid clamp, stop watch, meter scale, screw gauge, vernier calipers.

Description: The Torsional pendulum consists of a uniform circular metallic disc of about 10 to 12 cm diameter with 1 or 2 cm thickness, suspended by a wire at the center of the disc. The lower end of the wire is gripped into the chuck nut at the center of the disc and the upper end is gripped into another chuck nut, which is fixed to the wall bracket.

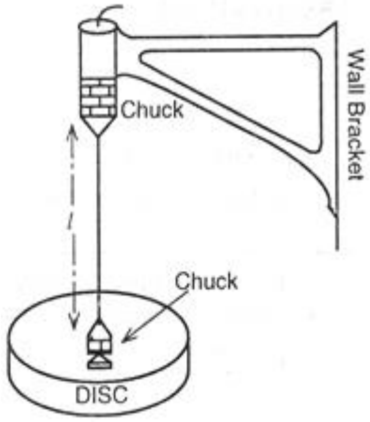
Formula:

$$\eta = \frac{4\pi M R^2}{a^4} \times \frac{L}{T^2} \qquad dynes/cm^2$$

Where , M= Mass of the disc (gm) R = Radius of the disc (cm)
L = Length of the wire (cm) a = Radius of the wire (cm) $T = Time\ period$ (sec)

Theory:

The Wire fixed in between the chuck nuts is twisted using the circular brass disc. When the disc is rotated, the external couple acts on the wire. Due to this an internal couple develops in the wire. Because of these couples similar to action and reaction, the disc starts oscillating about the wire as axis. The oscillations are known as torsional oscillations.



Torsional Pendulum

To determine Rigidity modulus the measurable parameters are M, R, a, L and T. Since the same disc is used M and R can be determined. Here M can be weighed using a balance while R can be measured using vernier calipers as per the table II. The radius of the wire "a" can be determined using screw guage and can be tabulated in table III. For different length(L), the time periods (T) and T^2 are determined and tabulated in the table I. Using the formula substituting all the values, The rigidity modulus can be calculated.

If "a" is the radius of the wire "L" is the length of the wire between the chuck nuts and the Rigidity modulus ("η") of the material of the wire is related to the couple "C" per unit twist of the wire as,

$$C = \frac{a^4 \eta \pi}{2L} \ldots\ldots\ldots..(1)$$

Time period and Torsional Oscillation is related to couple "C" as,

$$T^2 = 4\pi^2 \frac{I}{C} \ldots\ldots\ldots(2)$$

$$C = 4\pi^2 \frac{I}{T^2} \ldots\ldots\ldots(3)$$

From equation (3) and (1) we have

$$\eta = 8\,\pi I/a^4 \ \text{x}\ \frac{L}{T^2} \ldots\ldots\ldots(4)$$

The moment of inertia(I) of a circular disc whose geometric axis coincides with the axis of rotation is given by

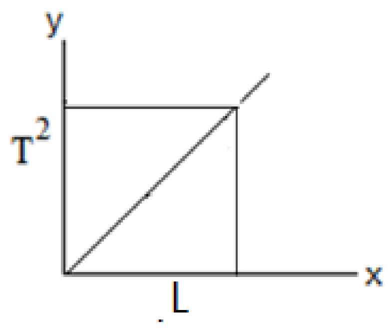
$$I = \frac{MR^2}{2} \dots\dots\dots\dots (5)$$

where
M = Mass of the disc
R = Radius of the disc
Substituting the value of "I" from (5) in (4) we get

$$\eta = \frac{4\pi MR^2}{a^4} \times \frac{L}{T^2} \dots\dots\dots\dots (6)$$

Procedure:

1. The circular metal disc is suspended as shown in figure. Length of the wire between the chuck nuts is adjusted to 90 cm.
2. When the disc is in equilibrium position, a small mark is made on the curved edge of the disc. This marking will help to note the number of oscillations made by the disc when the disc oscillates.
3. The disc is set to oscillate by slowly turning the disc through a small angle. Care is to be taken to see that there is no lateral movement of the disc.
4. When the disc is oscillating, the time (t) taken for 10 oscillations is noted with the help of a stopwatch and recorded in the observation table in trial 1.
5. The procedure is repeated for the same length of the wire and again the time taken for 10 oscillations is noted and recorded in the observations table in trial 2 .From trial 1 & 2 the mean for 10 oscillations is obtained. The time period (T) i.e. the time taken for one oscillation is calculated.
6. The experiment is repeated, by decreasing the length of the wire in steps of 10 cm and the results are tabulated in table 1.
7. The radius of the wire 'a' is to be found accurately using a screw gauge since it occurs in the fourth power in equation (6).
8. The Radius (r) and the Mass (m) of the disc are found with the vernier calipers and a rough balance respectively. The mean value of $\left(\frac{L}{T^2}\right)$ is substituted in equation (6) and η can be calculated.
9. A graph is drawn by taking 'L' on the X- axis and T^2 on Y-axis which represent a linear graph. From the linear graph, the slope $\frac{L}{T^2}$ is determined. Using $\frac{L}{T^2}$ the rigidity modulus 'η' of the wire can be calculated.



Observations:

1. Mass of the disc (M) = ------------- gm
2. Radius of the disc (R) = ------------- cm
3. Average radius of the wire (a) = -------------- cm

Table I:

S.No.	Length of the wire 'L' between the chuck nuts (cm)	Time taken for 10 Oscillations (t sec)			Time Period (T sec) $T = \frac{t}{10}$	T^2	$\frac{L}{T^2}$ cm/sec^2
		Trial - I	Trial – II	Average(t)			
1							
2							
3							
4							
5							
						Average value of $L/_{T^2}$ =	

Table II:

Determination of diameter and radius of the disc using Vernier calipers:

$$Least\ count\ of\ Vernier\ Calipers\ = \frac{Value\ of\ one\ main\ scale\ division}{No.of\ divisions\ on\ vernier\ scale} = \ldots\ldots\ldots\ cm$$

Zero error = ... Zero correction = ...

S.No.	Main Scale Reading (MSR)	Vernier Coincidence (n)	(n) x L.C	Total Reading MSR + (n x L.C) cm
			Avg	

Diameter of the disc = cm

Radius of the disc = cm

Table III:

Determination of diameter of the wire using SCREW GUAGE:

$$Least\ count\ = \frac{Pitch\ of\ the\ screw}{No.of\ Head\ scale\ divisions} = \dots\dots\dots\dots\dots\dots\dots.mm$$

Error = Correction =

S.No	Pitch Scale Reading (PSR)	Head Scale Reading		H.S.R x. L.C	Total reading PSR + (HSR x L.C) mm
		Observed	Corrected		
1					
2					
3					
				Average diameter	

Average diameter = ___________________mm

Radius of the wire (a) = _____________mm…………………cm

Precautions:

1. Ensure the wire is free from kinks.
2. The vibration of the disc must be in the horizontal plane.
3. The amplitude of motion of the disc must be small.
4. Avoid wobbling of the disc.

Result:

The rigidity modulus of (η) of the given metallic wire

Experimental =___________________ dynes/cm^2

Graphical =___________________ dynes/cm^2

Applications:

1. The torsional oscillations will help in determining rigidity moduli or rigidity nature of the material.
2. With help of thee rigidity modulus the other elastic moduli (Y, Poison ration ,σ ,K) can be estimated.
3. Anybody which can have the torsional oscillations they can be damped. In ballistic galvanometer these oscillations are used in determining charge on the conductor.
4. New researches, promising the determination of frictional forces between solid surfaces and flowing liquid environments using forced torsion pendulums.
5. Use of a torsional pendulum as a high-pressure gage and determination of viscosity of helium gas at high pressures.

VIVA VOICE QUESTION AND ANSWERS

1 **Define Rigidity modulus? Give the formula & explain ?**
It is the ratio of tangential stress to tangential strain. It can also be stated as shearing stress or angular stress to shearing strain or angular strain. It is generally denoted as "**η**".

2 **On what factors the rigidity modulus (η) depends** ?
It depends on nature of solid material, It depends on mass of the material, It depends on radius of disc & depends on length, and inversely on fourth power of radius & finally on square of time period

3 **What is Torsional pendulum? Explain in brief ?**
A heavy circular metallic disc suspended by means of a wire in between chuck nuts from a rigid support is known as torsional pendulum. The disc is made to oscillate about the wire as the axis.

4 **Explain need and meaning of the graph.**
As per the formula $\frac{L}{T^2}$ is an important term. In this L & T^2 are proptional to one another. Hence the graph represents a straight line passing through the origin.

5 **How do you show that (η) is constant for a given material ?**

$$\eta = \frac{4\pi MR^2}{a^4} \times \frac{L}{T^2}$$

In the formula $\frac{4\pi MR^2}{a^4}$ is constant. In the second term since L is proportional to T^2 , second term is also constant. Finally rigidity modulus η must be definitely a constant

6 **If L vs. T^2 is a straight line, what is the nature of the graph between L & T.**
L & T is not a straight line but it represents a curve.

7 **Write the L.C's of Vernier and screw gauge.**
Least count of Vernier Calipers = 0.01 cm
Least count of Screw Gauge = 0.001 cm

8 **What is Zero Error and its correction while using screw gauge ?**
Zero of Head scale and zero of the Pitch scale if they are not coinciding then there is zero error. If zero is above pitch scale error is negative, must give positive correction by adding & vice-versa.

9 **What are the units of η ?**
$dynes/cm^2$

10 **What are three Elastic Moduli ?**
Young's modulus, rigidity modulus, & bulk modulus.

GRAPH

NAME OF THE EXPERIMENT: ....

on x-axis 1 unit =

on y- axis 1 unit =

2.MELDE'S EXPERIMENT–TRANSVERSE AND LONGITUDINAL MODES

Aim: To determine the Frequency of a vibrating tuning fork using Melde's Arrangement.
Apparatus: Connecting wires, Meter scale, thread, scale pan, weight box, smooth pulley fixed to a stand, electrically maintained vibrator or a tuning fork.
Formulae:

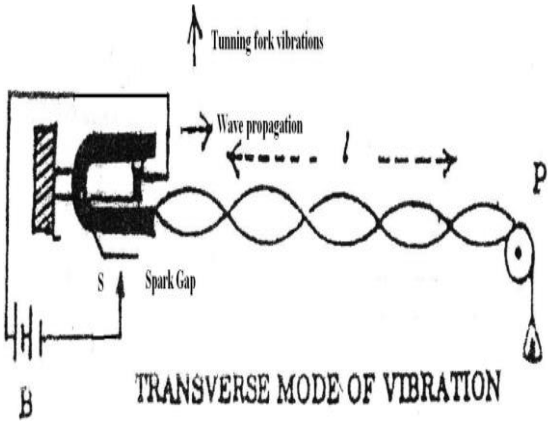
1. **Longitudinal arrangement**: $n = \frac{1}{L}\sqrt{\frac{T}{m}}$ Hz.
2. **Transverse arrangement**: $n = \frac{1}{2L}\sqrt{\frac{T}{m}}$ Hz.

Where, m = mass per unit length of the string or Linear density of the thread (gm/cm)
L = Length of the single loop (cm)
T = Tension in thread.

Note: We know from the formulae, that in the case of longitudinal arrangement it is $\frac{1}{L}$ while in the case of transverse arrangement it is $\frac{1}{2L}$

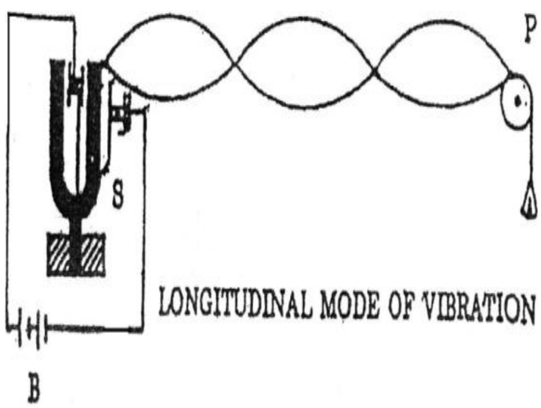
Description:

One end of the thin thread is connected to a small screw provided on one of the prongs of the tuning fork, the other end of the thread is connected to a light cardboard pan and the thread is passed over a pulley fixed on to a stand kept at a distance of 1 – 2 meters from the fork. Small weights are placed in the pan so that the sufficient tension is created to the string. The tension in the string can be altered by changing the weights in the pan.



Longitudinal and Transverse vibrations

The tuning fork is arranged for longitudinal vibrations as shown in figure i.e., the vibrations of the prong are *parallel* to the length of the thread. After noting the observations in this position, the tuning fork is arranged for Transverse vibrations i.e., the vibrations of the prong are perpendicular to the length of the thread. In other words, In transverse wave the prong should vibrate ***perpendicular*** to the thread.



Procedure:

1. The apparatus (tuning fork) is first arranged longitudinal vibrations with the length of the string 1-2 meters and passing over the pulley. The electric circuit is closed and adjusted till the fork vibrates steadily.
2. The load in the pan is adjusted slowly, till a convenient number of loops (say between (3–10) with well – defined nodes and maximum amplitude at the antinodes are formed, the vibrations of the string being in the vertical plane.
3. The No. of Loops (x) formed in the string between the pulley and the fork is noted. The length of the string between the pulley and the fork (d) is noted.
4. The length (L) of a single loop is calculated by: $L = \frac{d}{x}\ cm$.
5. The experiment is repeated by changing the load M. So that the number of loops increased or decreased by one. The readings are tabulated in Table I.
6. Next, the fork or vibrator is arranged for the transverse vibrations as in fig(b). The experiment is repeated as was done for the longitudinal vibrations and the readings are tabulated in table II.
7. At the end of the experiment, the mass m of the pan, the mass of the string ‘w’ and the length ‘y’ of the string are noted.

Observations:

Mass of the string (w) = --------------- gm

Length of the string (y) = ------------- cm

Mass of the pan (m') = ------------------ gm

Mass per unit length (or) Linear density ‘m’ = -----------------------gm/cm

Table I: Longitudinal Arrangement:

S.No	Load Applied in the pan (M) gm	Tension T=$(M + m')$ g	No. of Loops (x)	Length of (x) Loops (d)	Length of each Loop $L = \frac{d}{x}$	$\sqrt{T}$	$\frac{\sqrt{T}}{L}$
						Average value of $\frac{\sqrt{T}}{L}$	

Table II: Transverse Arrangement:

.

S. No	Load Applied in the pan M gm	Tension T = $(M+m^1)$ g	No. of Loops (x)	Length of x loops (d)	Length of each loop $L = \frac{d}{x}$	$\sqrt{T}$	$\frac{\sqrt{T}}{L}$
						$Avg\ of\ \frac{\sqrt{T}}{L}$	

Precautions:

1. The loops must be well-defined.
2. The plane of vibration of the thread must be vertical.
3. In counting the loop lengths, the two extreme ends must be taken into account.

Result:

1. Frequency of a tuning fork in longitudinal arrangement is ___________ Hz
2. Frequency of a tuning fork in Transverse arrangement is _____________ Hz.

Applications:

1. Melde's experiment helps us understanding the formation of standing waves with nodes and anti nodes.
2. By measuring the distance between nodes and anti nodes are in between nodes and anti nodes the wavelengths can be calculated.
3. With the help of this wavelength and knowing the frequencies the velocity of propagation of the waves can be also determined.
4. In melde's experiment the vibrations of the electrically excited tuning fork can be transmitted as mechanical waves along the thread.
5. We can determine the frequency of electrically driven Tuning fork in transverse longitudinal arrangement.
6. By calculating the sound frequency through this experiment it can serve multiple benefits to medical science.

VIVA VOICE QUESTION AND ANSWERS

1 **Define the term frequency. What are the units and dimensional formula of frequency?**
Frequency is defined as the number of cycles passing through a fixed point (i.e., oscillations or vibrations or revolutions) per unit time. Frequency is also defined as the number of waves that passes a fixed point in the given time.Its unit is sec-1 or Hertz. Dimensional formula is$[M^0 L^0 T^{-1}]$

2 **What are the laws of stretched strings in terms of frequency?**
Frequency is inversely proportional to length of string
Frequency is proportional to the root of the tension
Frequency is inversely proportional to the root of the linear density of the string.

3 **Define Resonance?**
When natural frequency of a body is equal to applied frequency due to external periodic force then the body executes sympathetic vibrations and the phenomenon is known as resonance.

4 **What are longitudinal and transverse waves? Give example for each.**
Longitudinal and transverse waves are Mechanical Waves i.e., the waves which propagate through a material medium (mostly gases) at a wave speed which depends on the elastic and inertial properties of that medium. Longitudinal waves are the waves in which the medium particles vibrate parallel or along the direction of propagation of the wave.
Example: Sound waves in air are longitudinal waves.
Transverse waves are the waves in which the medium particles vibrate perpendicular to the direction of propagation of the wave.
Example: Electromagnetic wave; ripple in water and a waves generated on a musical instruments.

5 **What are nodes and antinodes?**
Region of zero or minimum displacement of wave is called nodes and the region of maximum displacement of wave is called antinodes.

6 **What is a Stationary wave?**
A stationary wave superposition of incident waves and reflected transverse waves in opposite direction between any two fixed points is known as stationary wave.

7 **What is the distance between two consecutive nodes?**
The distance between successive nodes (or successive antinodes) is half a wavelength (λ/2).

8 **What is the distance between a node and next immediate antinode?**
The distance between node and next immediate antinode is quarter of a wavelength (λ/4).

9 **What is linear density?**
It is defined as the mass per unit length of the thread. Its unit is gm/cm in CGS and kg/m in MKS (or SI).

3. STEWART'S AND GEE'S GALVANOMETER

Aim: To study the variation of magnetic field along the axis of a circular coil carrying current.

Apparatus: Stewart and Gees, Rheostat, Ammeter, Battery eliminator, plug key,commutator.

Formula: $B = B_e \tan\theta$ Oersted

$$B = \frac{2\pi n i a^2}{10(a^2+x^2)^{3/2}} \text{ Oersted}$$

(**Since we are measuring in CGS system we can use the formula)**

Where, B = magnetic field due to circular coil carrying current.

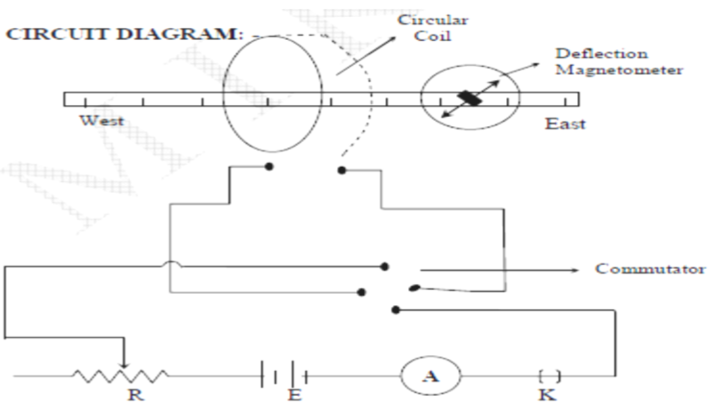
B_e = Earth's horizontal magnetic field (B_e= 0.38 Oersted)

n is the number of turns in the coil

a is the mean radius of the coil and

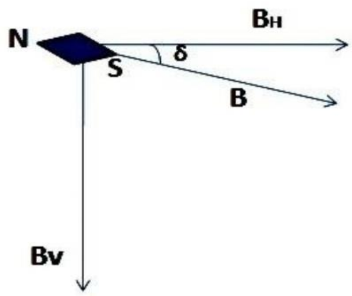
x is the distance of the point from the center of the coil along the axis.

Circuit diagram:



Theory: -

The apparatus consists of a circular frame "c" in figure made up of non-magnetic substance. An insulated Copper wire is wounded on the frame. The ends of the wire are connected to the other two terminals. By selecting a pair of terminals the number of turns used can be changed. The frame is fixed to a long base B at the middle in a vertical plane along the breadth side. The base has leveling screws. A non-magnetic metal frame is supported on the uprights. The plane of the frame contains the axis of the coil and this frame passes through the circular coil. A magnetic compass like that one used in deflection magnetometer is supported on a movable wooden platform. This platform can be moved on the frame along the axis of the coil.



B can be resolved into cosine and sine components as shown below

$B_H = B\cos\delta \quad B_V = B\sin\delta$

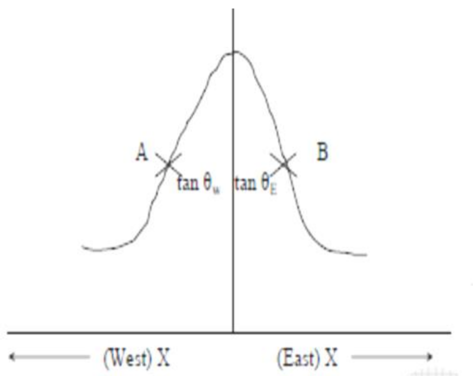
The compass is so arranged that the center of the magnetic needle always lie on the axis of the coil. The apparatus is arranged so that the plane of coil is in the magnetic meridian. The frame with compass is kept at the center of the coil and the base is rotated so that the plane of the coil is parallel to the magnetic needle in the compass. The compass is rotated so that the aluminum pointer reads zero zero. Now the wooden frame is along East-West directions. When a current "i" flows through the coil the magnetic field produced is in the perpendicular direction to the plane of the coil. The magnetic needle in the compass is under the influence of two magnetic fields. "B" due to coil carrying current and the earth's magnetic field "Be" which are mutually perpendicular. The needle deflects through an angle 'θ'satisfying the tangent law.

$$\frac{B}{B_e} = \tan\theta \quad \text{(Tangent law)}$$

$$\text{and } B = \frac{2\pi n i a^2}{10(a^2+x^2)^{3/2}} \text{Oersted}$$

Procedure:

1. With the help of magnetic compass and a chalk, a long line of about one meter is drawn on the working table, to represent the magnetic meridian.
2. Another line perpendicular to the line is also drawn to represent **East** and **West** directions.
3. The Stewart and Gees galvanometer is set with its coil in the magnetic meridian as shown in the fig.
4. The external circuit is connected as shown in the circuit diagram, keeping the ammeter, rheostat away from the deflection magnetometer.
5. The magnetometer is set at the center of the coil and rotated to make the aluminum pointer reads, (0,0) deflection in the magnetometer.
6. The key K, is closed and the rheostat is adjusted so as the deflection in the magnetometer is about 60°.
7. The current in the commutator is reversed and the deflections in the magnetometer are observed.
8. The deflections in the magnetometer before and after reversal of current should not differ much. In case of sufficient difference say above 2° to 5°, necessary adjustments are to be made.
9. The deflections before and after reversal of current are noted when x = 0 and the experiment is repeated by moving the deflection magneto meter in steps of 2cm, **east** as well as **west** directions. The readings are noted in the Table .
10. The mean deflections are denoted as θ_E and θ_w .
11. A graph is drawn between distance X along x-axis and the corresponding Tan θ_E and Tan θ_W along y -axis. The shape of the curve is shown in the fig below.
12. The point A and B marked on the curve lie at distance equal to half of radius of the coil (a/2) on either side of the coil.



OBSERVATIONS

Current carrying in the ammeter(i) = Amp

Radius of a coil = cm.

DISTANCE FROM THE COIL(x) cm.	DEFLECTION IN ***EAST*** DIRECTION				Mean (θ_E)	$\tan\theta_E$	DEFELCTIONS IN ***WEST*** DIRECTION				Mean (θ_W)	$\tan\theta_W$
	θ_1	θ_2	θ_3	θ_4			θ_1	θ_2	θ_3	θ_4		

Precautions:

1. The coil should be carefully adjusted in the magnetic meridian.
2. All the magnetic and current carrying conductors should be at a considerable distances from the apparatus.
3. The current passed in the coil should be of such a value as to produce a deflection of nearly 75^0.
4. Current should be checked from time to time and for this purpose an ammeter should be connected in series with the battery.
5. Parallax should be removed while reading the position of the pointer. Both ends of the pointer should be read.
6. The curve should be drawn smoothly.

Result:

From the graph it is clear that intensity of magnetic field decreases symmetrically on either side of the coil on Y-axis in the graph.

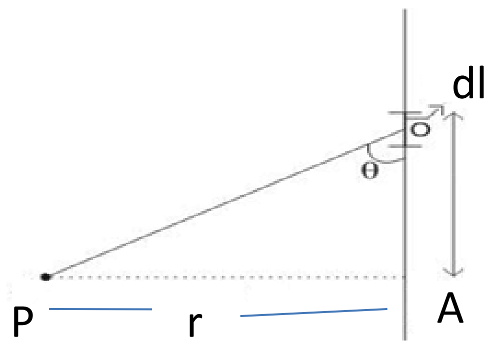
Applications:

1. The magnetic field due to circular coil is mainly used in designing galvanometers, electric motors.
2. Property of magnet is used by navigators to find their way in steering the ships.
3. It is used to verify Biot Sawart's law.

VIVA VOICE QUESTION AND ANSWERS

1 **What is Faraday's law ?**
The induced electromotive force in any closed circuit is equal to the negative of the time rate of change of the magnetic flux through the circuit. It is a basic law of electromagnetism predicting how a magnetic field will interact with an electric circuit to produce an electromotive force (EMF).

2 **What is Biot Savart's Law ?**
According to this law, the magnetic induction field strength (the magnetic field) at a point P, which is at a distance of R unit away from a current carrying conductor, varies as follows,
dB is directly proportional to current (I);
dB is directly proportional to the sine of angle of θ
dB is directly proportional to dl; and
dB is inversely proportional to R^2
i.e.,



3 **What is magnetic permeability ?**
It is the degree of magnetization that a material obtains in response to an applied magnetic field.

4 **What is the purpose of a plane mirror in the deflection magnetometer ?**
It is used to avoid the parallax error while taking readings.

5 **What is the unit of 'B' ?**
Tesla or Weber/m^2 or Gauss. 1Gauss= 10^{-4} Tesla

6 **What is a null point ?**
A null point is a point at which the resultant or total magnetic field induction B is zero.

7 **What happens to the value of 'B' if the current value is doubled?**
The value of B also gets doubled.

8 **What is the purpose of using a rheostat in this experiment ?**
Rheostat is a variable resistor device, which helps to increase or decrease the current across the magnetic galvanometer.

9 **What is a commutator ?**
It is a device used to reverse the direction of current.

10 **What is the importance of Stewart gee's galvanometer?**
To verify the variation of magnetic field due to a circular current carrying coil.

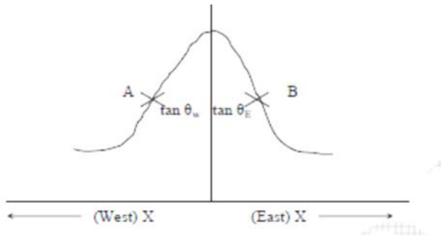
11 **What is Tangent law ?**
$B = B_H \tan\theta$

12 **How do you arrange the instrument to satisfy the law?**
The arms of the Stewart gee's galvanometer must be kept in East west direction so that the circular coil is North south magnetic meridian direction. Without passing the current the aluminum pointer should read 0-0 in the compass box

13 **Formula for magnetic field due to circular coil?**

$$dB = \frac{\mu_0 I dl sin\theta}{4\pi r^2}$$

14 **What is the nature of variation of magnetic field due to circular coil?**



15 **Why the curve is parabolic?**

As per the formula the field decreases about the y-axis since the denominator value 'x' increases

$B = B_e \tan\theta$ (by Tangent law)

and $B = \frac{2\pi n i a^2}{(a^2+x^2)^{3/2}}$ $erg.$

16 **Explain the curve** ?

The curve is parabolic in nature and symmetric about Y-axis.in other words the magnetic field decreases symmetrically on either side of the coil w.r.t the distance ($\frac{1}{x^3}$) on either side of the coil.

17 **What is the importance of magnetic component of earth's field ?**

For all practical purposes horizontal component (B_H=0.38 oersted) is taken in to account, as the resultant magnetic field of earth B = 0.4 oersted. The suspended magnet or magnetic needle aligns in the direction of B_H practically.

18 **What is the Application of magnetic field due to circular coil ?**

The magnetic field due to circular coil is mainly used in designing galvanometers, electric motors, e.t.c.

GRAPH

NAME OF THE EXPERIMENT: ....

on x-axis 1 unit =

on y- axis 1 unit =

—

4.DISPERSIVE POWER OF THE MATERIAL OF A PRISM – SPECTROMETER

Aim: To determine the dispersive power of the material of the given prism.

Apparatus: Spectrometer, Mercury vapor lamp, prism, reading lens and spirit level.

Theory:

The refractive index of the material of the prism is given by

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)} \quad (1)$$

A is the angle of the equilateral prism and D is the angle of minimum deviation.

When the angle of incidence is small, the angle of deviation is large. As the angle of incidence is slowly increased, the angle of deviation begins to diminish [progressively, till for one particular value of the angle of incidence, the angle of deviation decreases to a least value. The refracted rays takes reverse path. The angle of deviation starts increasing. This angle is known as angle of minimum of deviation D.

The dispersive power (ω) of the material of the given prism can be written as

$$\omega = \frac{(\mu_B - \mu_R)}{(\mu - 1)} \quad (2)$$

μ_B = The refractive index of the blue ray.

μ_R = The refractive index of the red ray

And $\mu = \frac{(\mu_B + \mu_R)}{2}$

Noting the angles of minimum deviation D, for any two colors (say) μ_B & μ_R are calculated using the formula.

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Procedure:

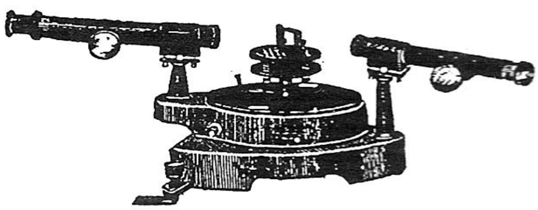


Figure 1 : *Spectrometer*

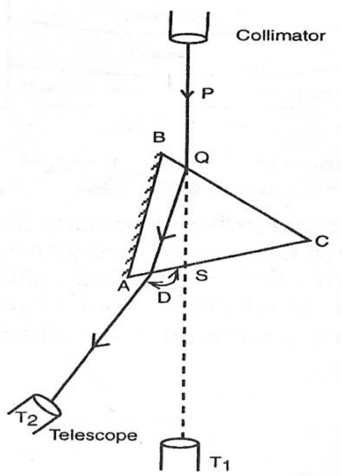


Figure 2 : *Arrangement of Prism for dispersive power*

The telescope is focused on to the direct ray (white light) and the readings in Vernier I and II are noted.

The prism is placed on the prism table with the ground surface of the prism table side parallel to the collimator as in fig (2). The ray of light passing through the collimator strikes the polished surface BC of the prism at Q in fig (2) and undergoes deviation along OR if emerges out of the prism form the face AC as in fig (2). The deviated ray (continuous spectrum) is seen through the telescope in position T_2.

Looking at the spectrum the prism table is slowly moved on to one side, so that the spectrum moves towards undedicated path of the beam. The deviated ray (spectrum) also moves on the same side for some time and the ray starts turning back even though the prism table is moved in the same direction. The point at which the ray starts turning back is called the minimum deviation position. In the spectrum, it is sufficient if (green) one color is adjusted for the minimum deviation position. In this limiting position of the spectrum, deviation of the beam is minimum. The telescope is fixed on the colour and the tangent screw is slowly operated until the point of intersection of the crosswire is exactly on the image. The reading of the blue co lour is noted in Vernier (I) and Vernier (II) and tabulated in table I. Similar procedure is repeated for other colours & Vernier (I) and Vernier (II) readings are noted and tabulated in the Table 1.

The difference of readings between the deviated reading for the blue colour and the direct reading gives the angle of minimum deviation reading for that colour (D_B).The refractive indices for different (at least four colours) rays are calculated using equation 1, (assuming the angle of equilateral prism, $A = 60^0$), the values of refractive indices are substituted in equation (2) and the dispersive power of the material of the prism is calculated.

Observations :

If MSR is 1° or 60^{I} or and no of VSRs are $60. Then\ L.C = \frac{60^{I}}{60} = 1^{I}$

Angle of the prism (A) = 60^0 if

Table-I:

Direct ray reading: Vernier I (V_{1d}) = ---------------

Vernier II (V_{2d}) = ---------------

Colour	Reading corresponding to minimum deviation position		Angle of Minimum Deviation (D)		Mean value of D	Refractive index μ
	V_1	V_2	$V_1 \sim V_{1d}$	$V_2 \sim V_{2d}$		
Violet						
Indigo						
Blue						
Green						
Yellow						
Orange						
Red						

Precautions:

1. The prism & other arrangement should not be disturbed while doing the experiment.
2. Spectrometer is to be arranged using the levelling screws given at the bottom of the spectrometer.

Result: Dispersive power of the material of the prism is --------------

Applications:

1. In this experiment the light energy is resolved into it's components namely seven colours.
2. By measuring refractive indices of these colours one can calculate the energies of seven colours separately.
3. The refractive indices of different transparent chemical liquid can also be determined.
4. The study of dispersive power experiment helped the chemical engineers to design different types of refract meters.

VIVA VOICE QUESTION AND ANSWERS

1 **What is the principle of Spectrometer?**
The principle of Spectrometer is principle of the double convex lens to converge the light rays and diverge the light rays from the parallel rays.

2 **Define Prism? What are the different types of prisms ?**
Prism is made up of transparent material bounded by geometrical surfaces (triangular & rectangular).Prisms can be equilateral triangle based, right angle triangle based, and liquid prisms etc.

3 **How do you define the dispersive power of a prism?**
The ability or capacity of the prism to resolve or disperse the spectral lines in terms of refractive indices.

4 **What is "i-d "curve?**
The plot of angle of incidence on X-axis and angle of deviation (d) on Y-axis is parabolic curve having angle of lowest peak (minimum deviation)

5 **What is angle of prism? What is Angle of minimum deviation?**
Angle of prism is angle made at the vertex by the two refracting surfaces of the prism. Angle of minimum deviation is the lowest angle in I-D curve. At the angle of minimum deviation angle of incidence and angle of emergence are equal

6 **Why is the spectrometer telescope fixed with a Ramsden's eye- piece and not with Huygens's eye- piece?**
Ramsden's eye- piece is having cross wire to locate position of image; Huygens's eye-piece is not having cross wire to locate the image. Hence Ramsden's eye- piece is used.

7 **What are verniers in spectrometer?**
Verniers are circular scales .either one degree or a half a degree divided in to 60 divisions or 30 divisions. The least count will be one minute.
(1/60 of a degree).

8 **How do you calculate L.C of the spectrometer**?
It can be 1/60 of a degree or 1/30 of a half a degree

9 **Define Refractive index?**
It is the ratio of velocity of light in air or vacuum to the ratio of velocity of light in medium. ($\mu = c/v$)

10 **Give formula for Dispersive power of the prism?**

$$\omega = \frac{(\mu_B - \mu_R)}{(\mu - 1)}$$

5. WAVE LENGTH OF LASER BEAM

Aim: To determine the wavelength of laser beam.

Apparatus: Laser source, Diffraction Grating, Screen and Meter Scale.

Principle: The wavelength of the laser can be determined by using diffraction due to N Slits. When light rays are incident on a grating a diffraction pattern with intensity maxima will be observed on the screen with diminishing intensity in various orders.

Formula:

$$\lambda = \frac{\sin\theta}{Nn} (A^{\circ})$$

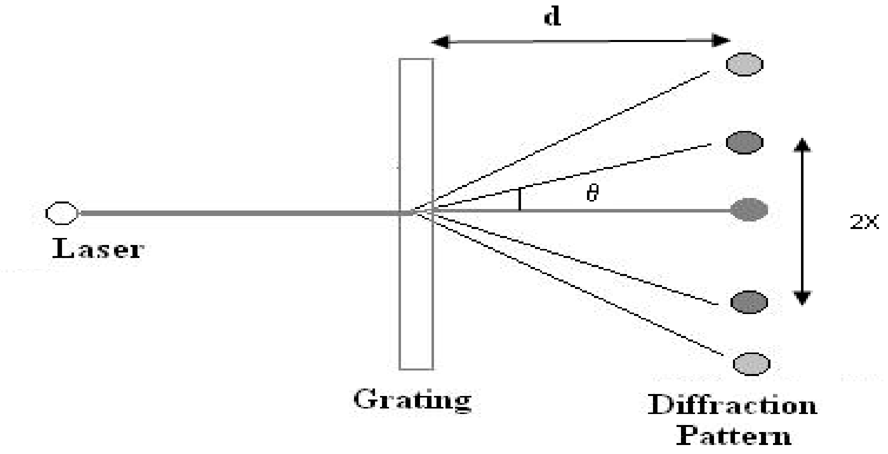
Where, 'θ' is the angle of diffraction

'λ' is the wavelength of the laser beam (1A° =10^{-8}cm)

'N' is the number of lines per cm of the grating. (**1 Inch= 2.54 cm**)

[For 15000 LPI 'N' is 5905.5 /cm and For 2500 LPI 'N' is 984.25/cm.]

'n' is the order of diffraction.



Procedure:

1. Arrange the laser source and grating on the table at the same height.
2. Focus the laser beam on the grating and observe the diffraction pattern formed on the screen.
3. It will be observed that central maxima will be of maximum intensity and the other maxima's are of decreasing intensities. Measure the distance between the screen and grating.
4. Measure the distance between the corresponding maxima of the same order (2x cm).
5. The experiment is repeated for different values of 'd' and the readings are noted.
6. The value of wavelength is calculated for each value obtained using the formula $\sin\theta = \frac{x}{\sqrt{x^2+d^2}}$ and the average value of wavelength is determined.

Tabular form:

S No.	Distance between screen and grating (d) cm	Order (n)	The distance between corresponding maxima (2x) (cm)	x cm	$\sin\theta = \frac{x}{\sqrt{x^2+d^2}}$	$\lambda = \frac{\sin\theta}{Nn}\ cm$
					Average	

Precautions :

1. Do not view the laser beam through naked eye.
2. The measurements are to be done accurately.

Result :

The wavelength of the laser beam is ______________A^0

VIVA VOICE QUESTION AND ANSWERS

1 **What is LASER?**
The term LASER stands for Light Amplification by Stimulated Emission of Radiation. It is a device which produces a powerful, monochromatic collimated beam of light in which the waves are coherent.

2 **What are the characteristic of laser ?**
Laser have high intensity, high coherence, high monochoromation and high directionality with less divergence.

3 **What is the principle of LASER?**
The principle of a laser is based on three separate features: a) stimulated emission b) population inversion and c) an optical pumping.

4 **What is diffraction?**
Diffraction is the bending or spreading of light through narrow apertures or corners of obstacles and enter into the geometric shadow.

5 **What is grating element?**
(e+d) is known as grating element where e is the slit width and d is the separation between the two ruled lines or slits.

6 **What is wavelength?**
The distance between any two successive points in the wave train which have the same phase is called the wavelength.

7 **What is monochromatic light?**
Light source having single colour or single wavelength or single frequency is called monochromatic light.

8 **What is the function of optical resonator?**
To amplify or increase the intensity of active medium.

9 **What is meta stable state?**
Meta stable state is intermediate state and it has a longer lifetime.

10 **What is population inversion?**
The number of atoms in exited state is more than that of ground state.

6. NEWTON'S RINGS

Aim:

To determine the radius of curvature of Plano convex lens by using Newton's rings arrangement.

Apparatus:

Traveling microscope, sodium vapour lamp, Plano convex lens, a thick glass plate (P_1), a thin glass plate (P_2), a black paper and reading lens.

Formula:

The radius of curvature of the Plano convex lens can be related to diameters of the Newton's rings as

$$R = \frac{{D_n}^2 - {D_m}^2}{4\lambda(n-m)}$$

R = Radius of curvature of the Plano convex lens

D_n= Diameter of the n^{th} ring.

D_m= Diameter of the m^{th} ring.

λ = Wavelength of the light source

Description:

A black paper is laid on the base of the traveling microscope over which the thick glass plate p_1 is placed. Over this thick glass plate, a Plano convex lens F of large focal length is placed. A parallel beam of light from the sodium lamp is made to fall on the glass plate P_2, inclined at 45^0 with the horizontal as shown in the figure 1. A beam of light is reflected on to the large focus lens by the glass plate P_2. As a result of interference between the light reflected from the lower surface of the lens and the top surface of the thick glass plate, concentric rings called the Newton's rings are formed. The observed rings are with alternate bright and dark rings, having a central black spot as seen through the microscope.

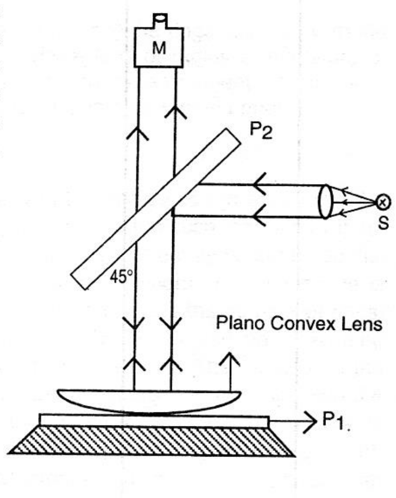
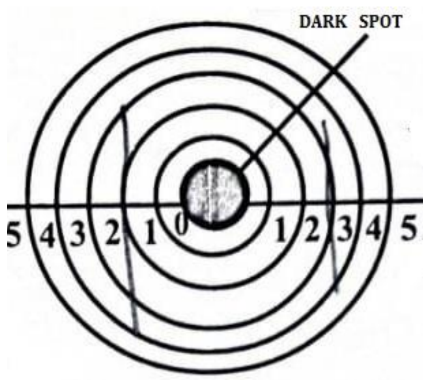


Figure 1 : *Arrangement of Newton's Rings*



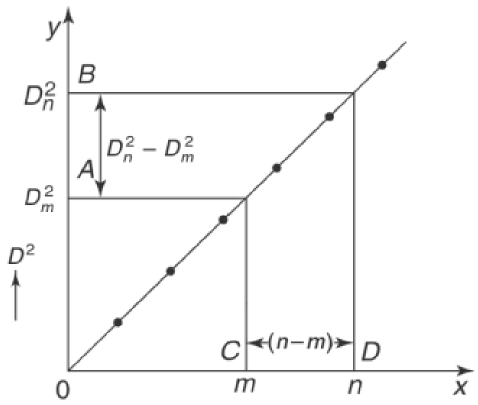
NEWTON RINGS

Procedure:

1. The point of intersection of the cross-wires in the microscope is brought to the center of the ring system, The wire may be set tangential to any one of the ring; and starting from the centre of the ring system.
2. The microscope is moved on to one side (say) left across the field of view counting the number of rings.
3. After passing beyond 10^{th} or 15^{th} ring, the direction of motion of the microscope is reversed and the cross-wires is set at the 10^{th} or 15^{th} dark ring, tangential to it.
4. The reading on the microscope scale is noted, using a magnifying glass.
5. Similarly, the readings with the cross-wires is set on 10^{th}, 8^{th}, 6^{th} --- --- --- 2^{nd} dark ring the readings are noted.
6. The microscope is moved in the same direction and the readings corresponding to the 2^{nd}, 4^{th}, 6^{th} --- --- --- $10^{th,}$ dark ring on right side are noted.
7. Readings are to be noted with the microscope moving in one and the same direction to avoid errors due to backlash.
8. The observations are tabulated in table .

Graph:

A graph is drawn with number of rings as abscissa (x-axis) and the square of diameter of the ring as the ordinate (y-axis). The graph will be a straight line. From graph, the value of $({D_n}^2\ amd\ {D_m}^2)$ corresponding to two numbers $\boldsymbol{n}$ *and* $\boldsymbol{m}$ are noted. Using these values in equation (2) the radius of curvature is calculated



Observations

Wavelength of the source $= 5896 \times 10^{-8}$ cm.

Value of 1 MSD= 0.1 cm.

Total no. of divisions on the vernier = 100

Least count of travelling microscope= $\frac{\text{Value of 1 MSD}}{\text{Total no.of divisions on the vernier}} =$

MICROSCOPE READINGS

S.No	No. of rings	LEFT			Right			Diameter	
		M.S.R cm	V.C × L.C	T_L	M.S.R cm	V.C ×L.C	T_R	$D = T_L \sim T_R$	D^2
1									
2									
3									
4									

Precautions:

1. While taking observations, the microscope should be moved only in one direction to avoid the error due to back-lash.
2. The lens and glass plate must be perfectly clean.
3. The slow motion screw of the microscope must be used while taking readings.
4. The central spot must be dark.

RESULT:

The radius of the curvature of the given Plano convex lens is $R_{experimental}$ = ……….. cm.

$R_{graphical}$ = ……………cm.

Applications:

1. The wavelength of unknown source can be determined.
2. Standardisation of a meter can be done.
3. Optical flatness of surface can be determined.
4. Refractive index of a liquid can be estimated.

VIVA VOICE QUESTION AND ANSWERS

1 **What is the basic principle of Newton's rings experiment ?**
The basic principle illustration of the interference of light waves reflected from the opposite surfaces of a thin film of variable of Newton's rings experiment is Interference phenomenon in thin films. The phenomenon of Newton's rings is an thickness.

2 **Define Interference ?**
It is superposition of two or more coherent waves giving rise for bright and dark fringes of equal width.

3 **Why the rings are circular ?**
The air film formed below the Plano convex lens where the rings are observed, is plano concave. The path difference along the circle is constant that's why the rings are circular in this experiment

4 **What are Newton's Rings ?**Alternate dark and bright rings with central dark spot are called Newton's rings.

5 **Why it is necessary for the light to fall normally on Plano convex lens ?**
In the path difference 2μt Cos r of thin films ,angle of refraction r should be zero(Cos r=1).This is possible only when light rays are made to incident vertically on the air film enclosed, by means of the glass plate kept at $45^0$with respect to the incident beam from the source.

6 **What is constructive interference and destructive interference?**
When two light waves interfere at each other such that the resultant intensity at a point increases due to crest falling on crest or trough falling on the trough. This interference is called constructive interference.

If crest falls on the trough or trough falls on the crest, there is annihilation or cancellation of the wave. Hence the resultant intensity is zero and it is called destructive interference.

7 **What is the purpose of glass plate incline at 45° in this experiment ?**
For normal incidence of light wave.

8 **Why the centre of the rings is dark ?**
Because the Plano convex lens and the plane glass plate are in contact and corresponding to that particular point of contact the centre ring appears dark.

9 **Which light do we use in this experiment ?**
Monochromatic light. Example: Sodium light, refractive index, radius of curvature of the lens, in designing interferometer.

10 **If we replace yellow light with green light, is there any difference in the formation of rings ?**
No, because both are monochromatic lights only.

11 **What will happen if we use white light in this experiment ?**
Colored fringes will form.

GRAPH

NAME OF THE EXPERIMENT: ....

on x-axis 1 unit =

on y- axis 1 unit =

7. LED CHARACTERISTICS

Aim: To study the V-I characteristics of Light Emitting Diode.
Apparatus: LED characteristic board, Power supply, Digital voltmeter, DC Digital Ammeter, LED & connectors.
Theory:

LED is an Opto-electronic device which works on the principle of electroluminescence, the process that converts electrical input into a light output. This device basically consists of a direct band gap Semiconductor material doped with impurities to create a structure called p-n junction.

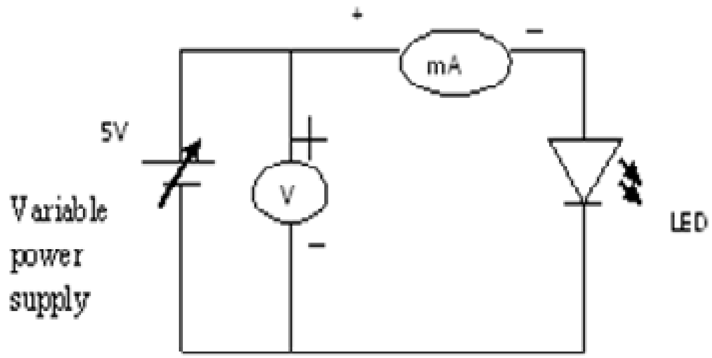
Under forward bias, the positive voltage is applied to the p-region and negative to the n-region. The holes and electrons are pushed towards the junction. The charge carriers that diffuse through p-n junction recombine with the majority carriers on the other side and emit photons whose energy is equal to the difference of conduction and valence band of the semiconductor (band gap of semiconductor).

$$E_g = E_c - E_V = h\upsilon$$

Where, υ = frequency of emitted photons
h = plank's constant.

LED:
At low injection process these electrons and holes recombine radiatively and through spontaneous emission process emit photons. Depending on the band gap, different wavelengths of light may be produced. The spectra of the available LEDs cover the entire range from infrared to ultraviolet region.

Circuit diagram:



Procedure:

1. Connect the LED circuit as shown in fig.
2. Slowly increase the forward bias voltage with the help of voltage controller.
3. Note down the corresponding voltage and current readings in the table.
4. Plot a graph between Voltage v/s Current and find forward resistance of diode.

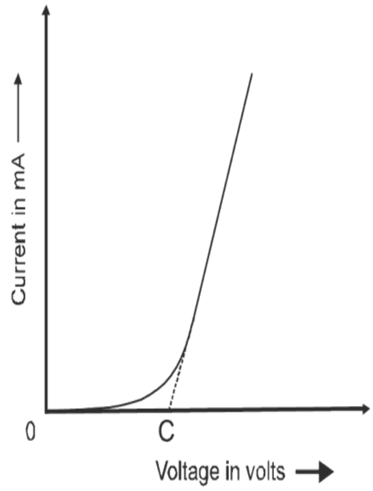


Table :

Sl. No.	VOLTAGE (V)	CURRENT I (m A)

Precautions:

1. Do not Exceed current limit of 30mA else the laser diode may get damaged.
2. Do not look at the laser directly with the laser turned on.
3. It is extremely damaging to apply a large reverse bias to a laser diode.

Result:

V-I Characteristics of laser diode and LED are studied. From graph,

The threshold voltage for given LED is ……….. V.

Applications:

1. **Sign Applications with LEDs:** The low energy consumption, low maintenance, and small size of LEDs have led to uses as status indicators and displays on a variety of equipment and installations.
2. **Lighting:** The mechanical robustness and long lifetime LEDs are used in automotive lighting on cars, motorcycles, and bicycle lights.
3. **Data communication and other signaling:** Light can be used to transmit data and analog signals. For example, lighting white LEDs can be used in systems assisting people in navigating in closed spaces while searching necessary rooms or objects.
4. **Machine vision systems:** Barcode scanners are the most common example of machine vision applications, and many of those scanners use red LEDs instead of lasers. Optical computer mice use LEDs as a light source for the miniature camera within the mouse.
5. **Biological detection:** UV induced fluorescence is one of the most robust techniques used for rapid real-time detection of biological aerosols.

VIVA VOICE QUESTION AND ANSWERS

1 **What are the applications of LED ?**
LEDs, indicator lamps in electronic devices , traffic signals, digital display, burger alarams etc.

2 **What is a LED ?**
LED is a Light Emitting Diode which works on the principle of electroluminescence.

3 **What is the principle involved behind the emission of light from LEDs ?**
Electroluminescence

4 **If we increase the LED voltage what happened to LED current ?**
LED current increases non-linearly.

5 **How is a LED different from other light sources ?**
LED consumes less energy and is in toxic compared to incandescent fluorescent light bulbs. It has much longer life time. For example, a 60-watt incandescent light bulb draws more than $300 worth of electricity per year and provides about 800 lumens of light; an equivalent compact fluorescent uses less than 15 watts and costs only about $75 of electricity per year. LED bulbs are even better, drawing less than 8 watts of power, costing about $30 per year, and lasting 50,000 hours or longer.

6 **What is dynamic resistance ?**
Due to the non-linear nature of Current-Voltage curve, there exists a unique value of resistance at every point of the curve which is called dynamic resistance.

7 **What are the materials used in LED ?**
GaAs, GaAsP, GaP

GRAPH

NAME OF THE EXPERIMENT: ....

on x-axis 1 unit =

on y- axis 1 unit =

9. SOLAR CELL CHARACTERISTICS

Aim: To determine the characteristics of solar cell and calculate fill factor.
Apparatus required: Solar cell trainer kit, Solar cell, Variable light source
Formula:

Fill factor= $\frac{I_m \times V_m}{I_{sc} \times V_{oc}}$

Where, I_m is maximum current, I_{sc} is short circuit current, V_m is maximum voltage, V_{oc} is open circuit voltage

CIRCUIT DIAGRAM:

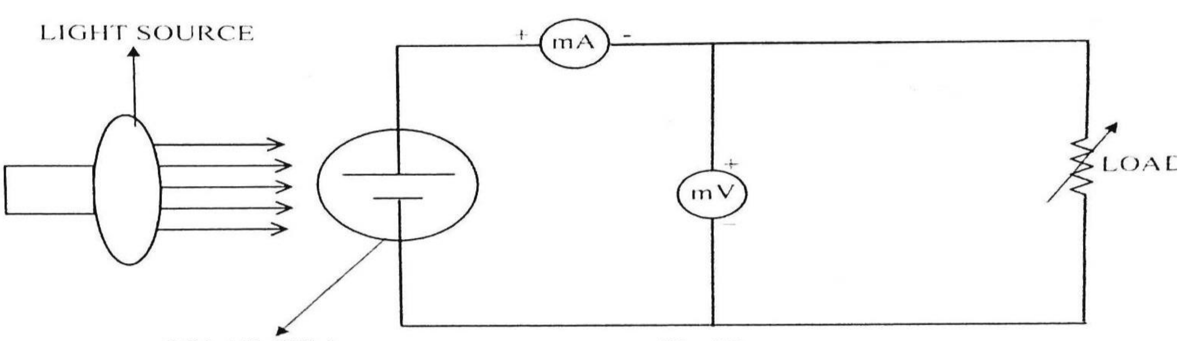


Fig (1)

Theory:

If the depletion of unbiased junction is illuminated, charge separation takes place, resulting in forward bias on the junction. Such device having large area junction very close to the surface is capable of delivering power and is known as SOLAR CELL. The cell converts directly solar energy into electricity.

The Solar Cell radiation is proportional to the delivered power of cell. The efficiency of a cell is expressed in terms of the electrical power output compared with the power in the incident Photon Flux. The efficiency of Solar Cell depends on the fraction of light reflected from the surface and the fraction absorbed before reaching the junction. Silicon is widely used for Solar Cells.

Procedure:

1. Place solar cell directly in front of variable intensity light source, and connect solar cell to trainer kit.
2. Keep constant intensity of variable light source and distance from solar cell to the source.
3. Connect the circuit as shown above.
4. Now measure short circuit current(I_{sc}) for zero load and open circuit voltage(V_{oc}) for maximum load.
5. Vary the load and note down voltage and current readings respectively.
6. Plot a graph by taking voltage and current along x and y axis with the given scale. An exponential power decay curve is obtained.
7. Calculate fill factor.

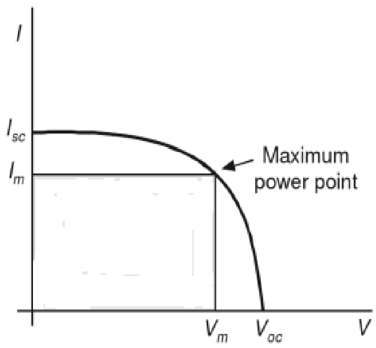


Table:

S.No	Voltage (V)	Current (mA) (I)	Power $P = V \times I$

Precautions:

1. Handle apparatus gently.
2. Give connections correctly.
3. The voltage and corresponding current should be noted simultaneously.

Result: V-I characteristics of solar cell were studied.

Fill factor $=$

Applications:

1. **Solar cell for transportation:** Solar energy is used in cars. This solar power is created by photovoltaic cells. This electricity is transferred to the storage battery or powers the motor.
2. **Solar cell panels:** On the rooftop, solar panels are kept. It is used as a solar heater that heats the water. This water can be used for bathing. Also, another use it helps in generating power.
3. **Solar thermal power production:** Solar thermal power production means the conversion of solar energy into electricity through thermal energy. In this procedure, solar energy is first utilized to heat up a working fluid, gas, water or any other volatile liquid. This heat energy is then converted into mechanical energy m a turbine. Finally, a conventional generator coupled to a turbine converts this mechanical energy into electrical energy.
4. **Solar charging batteries:** Solar charger is a device that uses sunlight to generate electricity. This electricity is then used to charge electrical devices.
5. **Solar cells in calculators:** Solar-powered calculators use photovoltaic cells. These calculators work with solar energy. The light from the sun gives power for the operation of calculators. Solar calculators work very well in outdoor light.

VIVA VOICE QUESTION AND ANSWERS

1 **What is solar cell?**
A solar cell or photovoltaic cell is a device that converts light energy into electrical energy.

2 **What is the phenomenon involved in solar cell?**
Phenomena involved in solar cell is photo-voltaic effect.

3 **Is solar cell prepared from a semiconducting material?**
YES, solar cell is Prepared from high semiconductor elements such as gallium, indium, arsenide etc.

4 **Write the maximum power output equation ?**
Assuming the current/voltage relationship is linear (it's not, but this gives you crude lower bound), you could measure the short-circuit current and the open-cell voltage and do $\frac{1}{4}$ **IV** to obtain the maximum theoretical power given a worst-case 0.25 fill factor. However a more reasonable value might be obtained by using a different factor

5 **Write the equation for the efficiency of solar cell?**
The efficiency is the most commonly used parameter to compare the performance of one solar cell to another. Efficiency is defined as the ratio of energy output from the solar cell to input energy from the sun.

6 **What is fill factor?**
Fill-factor: The Fill Factor (FF) is essentially a measure of quality of the solar cell. It is calculated by comparing the maximum power to the theoretical power (PT) that would be output at both the open circuit voltage and short circuit current together

7 **What are the applications of solar cell** ?
Electrical Grid Power: Solar cell produces electrical power for the commercial grid, solar cells widely used as, many traffic, emergency and construction road signs use solar cells for power, reducing the need for gasoline-powered generators for remote and mobile uses.
Rooftop Solar Panels: Many commercial and residential buildings have solar panels that produce electricity; in most cases, the building gets its power primarily from a conventional utility connection, but the solar cells generate enough power to reduce the owner's conventional electric use and the associated electric bill. The solar panel connects to a power management system that automatically switches to the utility when solar power isn't available.

GRAPH

NAME OF THE EXPERIMENT: ....

on x-axis 1 unit =

on y- axis 1 unit =

9. NUMERICAL APERTURE OF AN OPTICAL FIBRE

Aim: To determine the numerical aperture of an optical fiber.

Apparatus: Optical fiber trainer module, Numerical Aperture (NA) Jig (screen with concentric circles).

Formula:

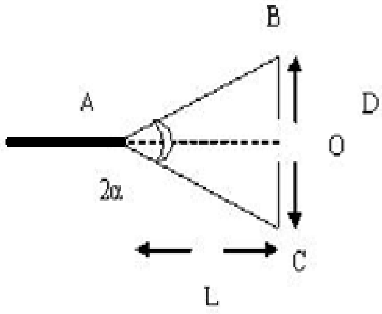
The NA of the optical is $NA = \sin\alpha = \frac{\sqrt{{n_1}^2 - {n_2}^2}}{n_0}$ (1)

Therefore, $\alpha = \sin^{-1}(NA)$ (2)

Where n_1 -- refractive index of the core,

n_2 -- refractive index of cladding, and

n_0 -- is the refractive index of medium outside the core(air).



From the above diagram the acceptance angle can be calculated by measuring the diameter of the circular region over which the far-field intensity is distributed at the other end of the fibre. Light from the fibre end A fall on the screen. Let the diameter of the light falling on the screen BC= D.

From triangle ABO sin α = OB/AB $= \frac{D/2}{\sqrt{D^2/4 + 4L^2}}$

$$NA = \sin\alpha = \frac{D}{\sqrt{D^2 + 4L^2}}$$

Circuit diagram:

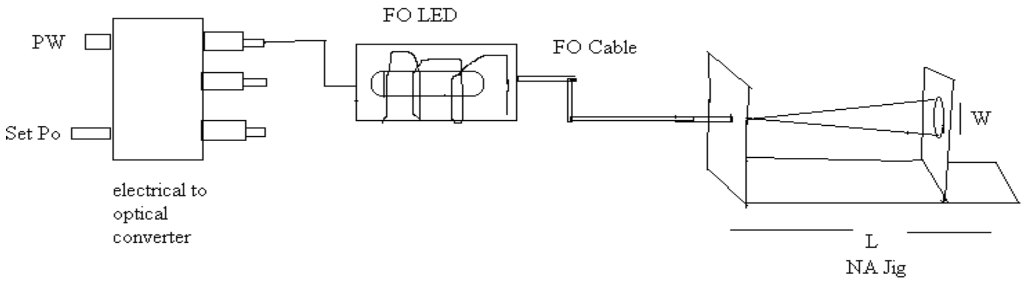


Fig: Focusing of light on the circles of given screen (NA jig)

Theory:

Optical fiber is a very thin and flexible medium having a cylindrical shape consists of core, cladding and protective shield. The light launched inside the core through its one end propagates to the other end due to total internal reflection at the core-clad interface. This is the principle of optical fiber. The angle at which the light ray is incident on the fiber such that it is transmitted through the fiber in guided mode is called the "acceptance angle" (maximum launching angle "α"). The cone defined by twice the acceptance angle is called acceptance cone. The light collecting capacity of the fibre is expressed in terms of acceptance angle using parameter called Numerical Aperture (NA). The Sin of the acceptance angle is called NA of the fibre. Thereby the NA of an optical system/device is a measure of how much light is collected by system/device.

Procedure:

1. One end of the optical fibre is connected to the power output of LED. And the other end of the fibre is connected to NA Jig through the connector.
2. The AC main is switched on. The light emitted by LED passes through the optical fibre cable to the other end. The set Po knob is adjusted such that, maximum intensity is observed on the screen and it should not be further disturbed.
3. A screen with concentric circles of known diameter is moved along the length of the NA Jig to observe the circular spreading of the light intensity on the screen.
4. The screen is adjusted such that, the first circle from the centre of the screen is completely filled with the light. At this position, the distance (L) from this fibre end to the screen is noted on the NA Jig.
5. The experiment is repeated for the subsequent circles by adjusting the length L along NA jig and the readings are noted in table.

Table:

S. No	Diameter of the circle (D) mm	Distance from screen (L) mm	$NA = \frac{D}{\sqrt{D^2 + 4L^2}}$	Acceptance angle $\alpha = \sin^{-1}(NA)$
Avg values of NA and α				

Precautions:

1. Adjust the distance from the screen properly and measure the diameter of the rings.
2. Handle the optical fibre cable carefully.
3. Use maximum intensity of the light while doing the experiment.
4. Tabulate the readings without parallax

Result:

The numerical aperture of the given optical fiber is found to be ___________.

The acceptance angle of the given optical fiber is found to be ____________.

Applications:

1. NA is generally used in microscopy for describing the acceptance cone.
2. In fiber optics, it describes the angles range where light is occurring on the fiber optic will be broadcasted along with it.
3. Used in microscope objective.
4. Used in lens, photographic objective.

VIVA VOICE QUESTION AND ANSWERS

1 **What is numerical aperture?**
Numerical aperture is thus considered as a light gathering capacity of an optical fibre. Numerical Aperture is defined as the Sine of half of the angle of fibre's light acceptance cone. i.e.$\boldsymbol{NA} = \mathbf{sin}\,\boldsymbol{\alpha}$ where, α is called acceptance cone angle.

2 **What is acceptance angle ?**
The acceptance angle of an optical fiber is defined: It is the maximum angle of a ray (against the fiber axis) hitting the fiber core which allows the incident light to be guided by the core.

3 **How do you explain total internal reflection ?**
When light goes from a denser medium to a less dense medium, as the angle of incidence exceeds the critical angle, the ray reflects back to the denser medium. This phenomenon is called Total Internal Reflection. Total Internal Reflection is a very efficient reflection, as the loss of light energy is almost negligible. Example: such as glass to air or water to air.

4 **Give some lively examples which use total internal reflection ?**
Total internal reflection is the operating principle of optical fibers, which are used in endoscopes and telecommunications.

5 **What is optical fibre ?**
An optical fiber is a very thin strand of plastic or glass that is used to transmit messages via light.

6 **Mention the types of optical fiber.**
Single mode fiber is optical fiber that is designed for the transmission of a single ray or mode of light as a carrier and is used for long-distance signal transmission. Multimode fiber is optical fiber that is designed to carry multiple light rays or modes concurrently, each at a slightly different reflection angle within the optical fiber core. Multimode fiber transmission is used for relatively short distances because the modes tend to disperse over longer lengths.

7 **What is attenuation?**
Attenuation or loss in optical fibers basically refers to the loss of power. During transit, light pulse loses some of their photons, thus reducing their amplitude. Attenuation for a fiber is usually specified in decibels per kilo meter. The degree of attenuation depends on the wavelength of light transmitted.
Attenuation measures the reduction in signal strength by comparing the output power with input power. Measurements are made in decibels (dB). The basic measurement for loss is done by taking the logarithmic ratio of input power (Pi) to the output power (Po).

8 **What is bending loss and types of bending loss in optical fibers ?**

Transmission loss in the fiber during its propagation through the optical fiber cable.

Types of bending losses in optical fiber are

1. Addition of impurity to fiber.
2. Material composition loss.
3. Absorption & scattering loss.
4. Radiation loss

9 **What are the advantages of optical fiber ?**

1. Greater bandwidth.2. Low attenuation and greater distance 3. Security

10 **What is step index and graded index fiber of an optical fiber?**

A step-index profile is a refractive index profile characterized by a uniform refractive index within the core and a sharp decrease in refractive index at the core-cladding interface so that the cladding is of a lower refractive index.

In fiber optics, a graded index is an optical fiber whose core has a refractive index that decreases with increasing radial distance from the optical axis of the fiber.

10. HALL EFFECT

Aim: To determine the hall coefficient of the given p type semiconducting material.

Apparatus: IC regulated power supply, Electromagnets, Constant current power supply, Hall sensor & semiconductor crystal.

Formula:

Hall coefficient $\boldsymbol{R_H} = \left(\frac{V_H}{I}\right)\frac{t}{B} m^3/C$

Where, $\boldsymbol{R_H}$ = hall coefficient of semiconductor materials

t = thickness of the sample

B = applied magnetic field in the y − direction.

V_H = Hall voltage in volts.

$I = current\ through\ the\ specimann\ in\ mA$

Block diagram of Experimental set up:

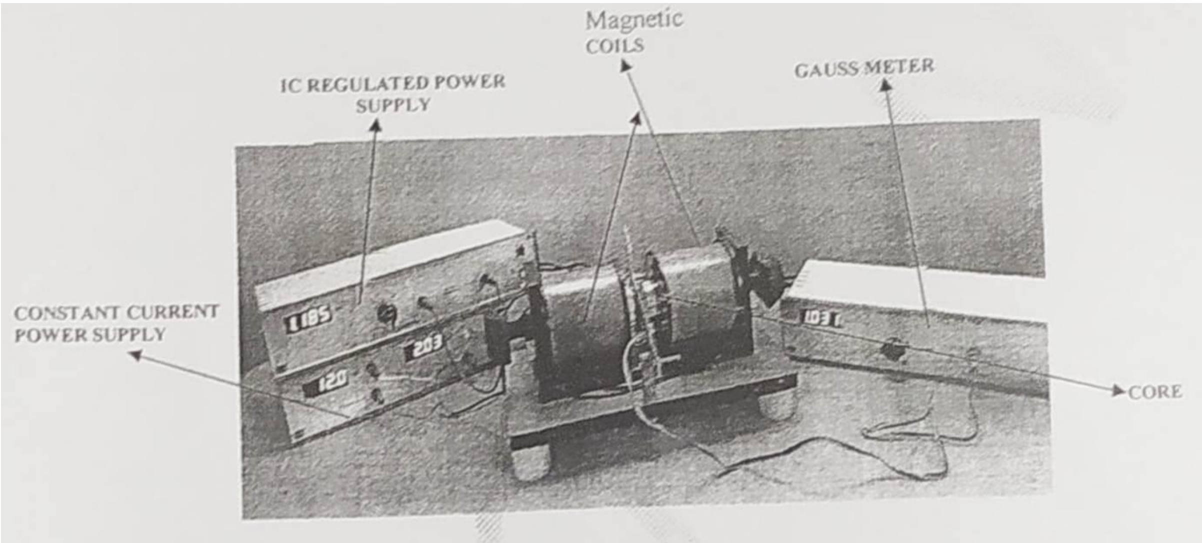
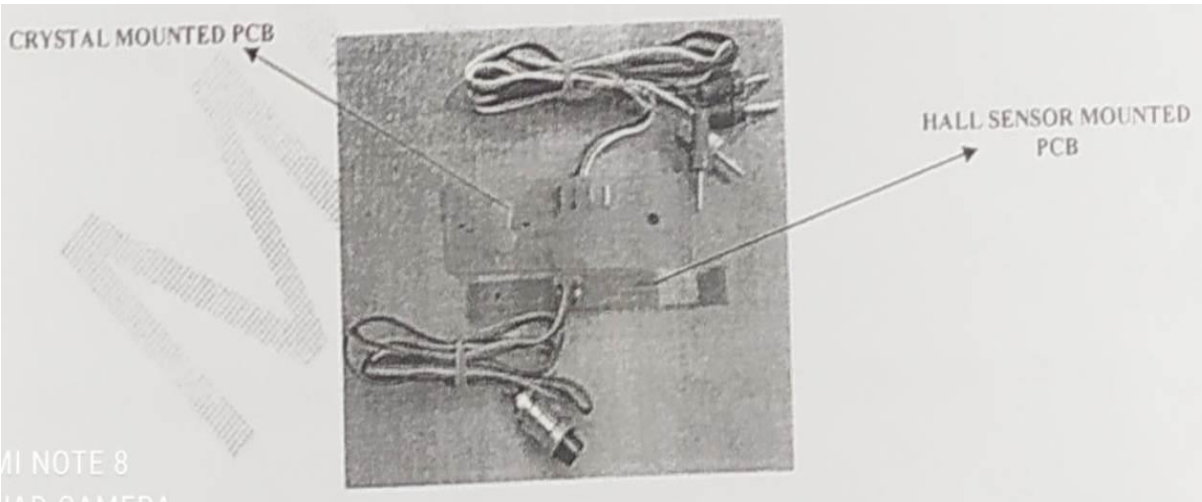
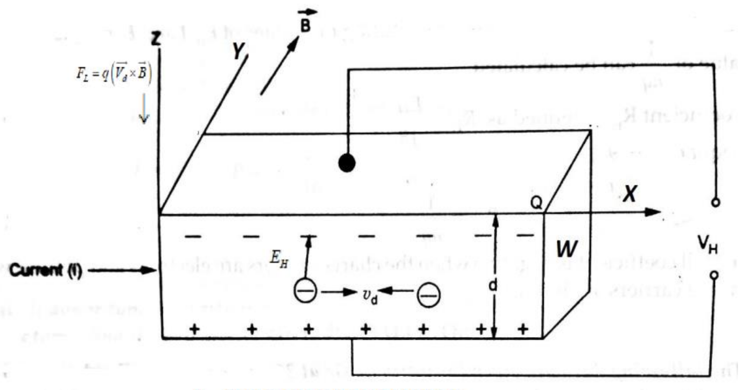


Fig (1)



Circuit diagram:

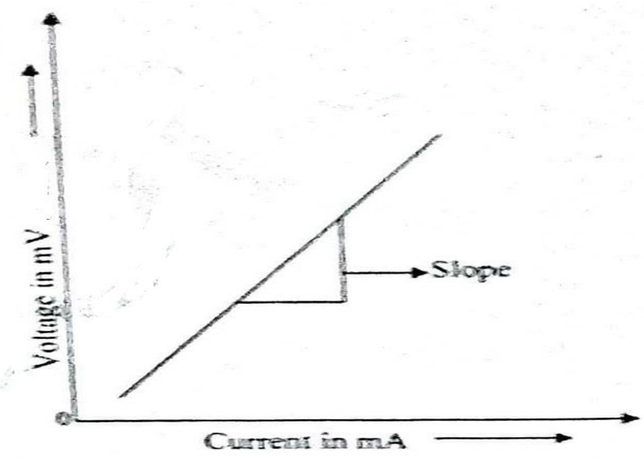


P - TYPE SEMICONDUCTOR

Principle: If semiconductor is placed in a uniform magnetic field and a constant current is sent as show in the figure , then a voltage is developed in the sample along z-direction. This voltage is known as hall voltage and the phenomenon is known as Hall effect. The hall voltage is depend on magnetic field and the probe current through the sample.

Procedure:

1. Connect the IC regulated power supply terminals to electromagnetic coils in their respective sockets.
2. Connect Hall probe to Gauss meter .Switch " ON" the Gauss meter, set the Gauss meter reading to "0.00" by adjusting the knobs.
3. Now place the Hall probe in the magnetic field exactly at the centre of the electromagnetic cores. Set the Gauss meter reading to 2KG magnetic field. This is achieved by applying suitable current to electromagnets & by simultaneously positioning the electromagnetic cores by turning the knobs.
4. Connect the crystal mounted PCB to constant current power supply to their respective sockets.
5. Remove Hall probe from the magnetic field and place crystal in the same position without disturbing the position of the magnetic cores.
6. Switch "ON" the constant current power supply & apply current in steps of 0.1 Ma, rotate the crystal till it becomes perpendicular to magnetic field. Hall voltage will be maximum in this adjustment, note the corresponding Hall voltage at constant magnetic field.
7. Plot the graph between current and Hall voltage which is a straight line & find the slope.



Observations:

Thickness of the sample = $\mathbf{7 \times 10^{-2}}\ cm$

Magnetic flux density B = ... KG

Tables:

At constant magnetic field		
S.No	***Current I*** (mA)	***Hall Voltage*** V_H (mV)

Calculations:

From the variation of current vs voltage graph – slope $of\ \frac{V_H}{I} =$

Hall coefficient $R_{H_1} = \left(\text{slope } \frac{V_H}{I}\right)\frac{t}{B} \times 10^8 cm^3 col^{-1}$

Precautions:

1. Keep the sample perpendicular to the magnetic field.
2. Hall probe must be handled carefully.
3. Do not send the high currents through the electromagnets for longer times.
4. Keep the pole gap of 2.5 cm.
5. When the sample is not placed between the poles, set the initial reading to zero by adjusting the zero control.

Result:

Hall coefficient $\boldsymbol{R_H} =$..............................

Applications:

1. It is used to find out whether the given semiconductor is N − type or P − type .
2. It is used to measure carrier concentration, mobility and conductivity of a semiconducting material.
3. Hall voltage is produced of two input quantities namely the current and the magnetic field. Using this principle, the Hall effect device is used as a multiplier.
4. It is used as a magnetic field sensor. Using the Hall effect devices, the magnetic field ranging from $\boldsymbol{1\mu T} to \boldsymbol{1T}$ is sensed.

VIVA VOICE QUESTION AND ANSWERS

1 **Define Hall Effect?**
When a current carrying specimen is placed in a transverse magneticfield then a voltage is developed which is perpendicular to both, direction of current and magnetic field. This phenomenon is known Hall Effect.

2 **What causes Hall Effect?**
Whenever a charge moves in a mutually perpendicular electric andmagnetic field it experiences Lorentz force due to which it deflects from its path and Hall voltage is developed.

3 **what is unit Hall coefficient?**
Ohm-meter/Tesla.

4 **Which type of magnet is used in the experiment, temporary or permanent?**
Temporary.

5 **What is Hall Coefficient?**
It is the electric field developed per unit current density per unit magnetic field.

6 **What is Lorentz force?**
If charge 'q' moves in a magnetic and electric field 'B' &'E' respectively
with velocity v then force on it is given by
F= qE+ Bqv.sinɵ

7 **What is hall probe ?**
A semiconductor sandwiched between two Perspex plates.

8 **Under which condition, an electron moving through a magnetic field experiences maximum force ?**
An electron moving through a magnetic field experiences maximum force, when it moves perpendicular to the direction of the magnetic field.

GRAPH

NAME OF THE EXPERIMENT: ....

on x-axis 1 unit =

on y- axis 1 unit =