

ENGINEERING PHYSICS LABORATORY

LAB MANUAL

Course Code : AHSB10
Regulations : IARE - R18
Class : I B.Tech II Semester
Branch : CSE / IT / EEE / CE

Prepared by

Mr. K Saibaba
Assistant Professor



Freshman Engineering

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal – 500 043, Hyderabad



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Certificate

*This is to certify that it is a bonafied record of practical work done by
Mr/Kum. _____ bearing
the Roll No. _____ of _____ class
_____ branch in the
Engineering Physics laboratory during the academic year
_____ under our supervision.*

Head of the Department

Lecture In-Charge

External Examiner

Internal Examiner

ENGINEERING PHYSICS LAB SYLLABUS

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ENGINEERING PHYSICS LABORATORY

OBJECTIVE:

The objective of this lab is to teach students, the importance of physics through involvement in experiments. This lab helps to have knowledge of the world due to constant interplay between observations and hypothesis, experiment and theory in physics. Students will gain knowledge in various areas of physics so as to have real time applications in all engineering streams.

OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. **Understand** the world around us.
2. **Understand** the concept of error and its analysis.
3. **Develop** experimental skills
4. **Design** new experiments in Engineering.
5. **Compare** the theory and correlate with experiment.
6. **Identify** the appropriate application of particular experiment.
7. **Understand** and apply fundamental electronic circuits.
8. **Analyze** the experimental result.
9. **Understand** the applications of physics experiments in day to day life.
10. **Examine** ideas about the real world.



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PROGRAM OUTCOMES

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	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.
PO3	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.
PO4	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.
PO5	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.
PO6	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.
PO7	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.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	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.
PO11	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 multidisciplinary environments.
PO12	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.

PROGRAM SPECIFIC OUTCOMES

AERONAUTICAL ENGINEERING	
PSO1	Professional skills: Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products.
PSO2	Practical implementation and testing skills: Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies.
PSO3	Successful career and entrepreneurship: To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats.
PSO4	Successful career and entrepreneurship to prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats.
CIVIL ENGINEERING	
PSO1	ENGINEERING KNOWLEDGE: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication
PSO2	BROADNESS AND DIVERSITY: Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage
PSO3	SELF-LEARNING AND SERVICE: Graduates will be motivated for continuous self-learning in engineering practice and/ or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.
MECHANICAL ENGINEERING	
PSO1	To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.
PSO2	An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.
PSO3	To build the nation, by imparting technological inputs and managerial skills to become Technocrats.
ELCTRICAL AND ELECTRONICS ENGINEERING	
PSO1	Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.
PSO2	To explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.
PSO3	To be able to utilize of technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test , maintain power systems and industrial applications.

COMPUTER SCIENCE ENGINEERING

PSO1	Professional Skills: The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexity.
PSO2	Problem-Solving Skills: The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.
PSO3	Successful Career and Entrepreneurship: The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.

INFORMATION TECHNOLOGY

PSO1	Professional Skills: The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer - based systems of varying complexity.
PSO2	Software Engineering Practices: The ability to apply standard practices and strategies in software service management using open-ended programming environments with agility to deliver a quality service for business success.
PSO3	Successful Career and Entrepreneurship: The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.

ELECTRONICS AND COMMUNICATION ENGINEERING

PSO1	Professional Skills: An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.
PSO2	Problem-Solving Skills: An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.
PSO3	Successful Career and Entrepreneurship: An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

Expt. No.	Program Outcomes Attained	Program Specific Outcomes Attained						
		AERO	CIVIL	MECH	ECE	EEE	CSE	IT
1	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
2	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
3	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
4	PO1, PO2, PO4, PO9, PO11, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
5	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
6	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
7	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
8	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
9	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
10	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
11	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3
12	PO1, PO9, PO12	PSO3	PSO2	PSO3	PSO3	PSO2	PSO3	PSO3



ENGINEERING PHYSICS LABORATORY

DO's

1. Conduct in a responsible manner at all times in the laboratory.
2. Keep the work area clean, neat and free of any unnecessary objects.
3. Read the description, procedure and precautions of the experiment in the lab manual.
4. Place all sensitive electronic equipment safely on experimental table.
5. Before using the equipment one must read the labels and instructions carefully.
6. Set up and use the equipment as directed by the lab instructor.
7. Circuit connections are to be done only in power off mode.
8. Check out the circuit connections before switching on the power.
9. Increase the power readings from minimum to maximum.
10. All procedures and experimental data should be recorded in the lab observation notebook.
11. Switch off the power in the circuit after completion of the experiment.
12. Any failure / break-down of equipment must be reported to the instructor.
13. Return the material properly after completing the experiment.
14. Replace the materials in proper place after work.
15. Be careful when handling optical items like prisms, gratings etc.

DON'Ts

1. Do not wear loose clothing and do not hold any conducting materials in contact with skin when the power is on.
2. Do not touch any equipment or other materials in the laboratory area until instructed by instructor.
3. Do not modify or damage the laboratory equipment in any way unless the modification is directed by the instructor.
4. Do not handle electrical equipment and connections with wet hands.
5. Do not try to connect power in to the circuit without proper understanding of the circuit diagram.
6. Do not look directly into laser source.
7. Do not short any battery box or power supply, it may damage retina in your eye.
8. Never switch on the power button of the circuit until it has been approved by instructor.

SAFETY NORMS

1. The lab must be equipped with fire extinguisher.
2. Never rewire or adjust any element of a closed circuit.
3. Avoid dangling electrical cords as they can cause electrical shocks and injuries.
4. Make sure all heating devices and gas valves are turned off before leaving the laboratory.
5. Exercise caution when handling liquids in the vicinity of electrical equipment.
6. Use gloves to pick broken pieces of glass or ceramics.
7. Handle hot equipment with tongs, safety gloves and other appropriate aids.
8. Follow all other safety measures provided on the instrument.

EXPERIMENT- I HALL EFFECT

Aim:

Determination of charge carrier density.

Apparatus: Hall effect panel, Hall probe, Electromagnet, Constant current power supply, Digital gauss meter with hall probe, Hall probe stand (wooden).

Theory:

Hall Effect consist basically of a thin piece of rectangular p-type semiconductor material such as gallium arsenide (GaAs), indium antimonide (InSb) or indium arsenide (InAs) passing a continuous current through itself. When the device is placed within a magnetic field, the magnetic flux lines exert a force on the semiconductor material which deflects the charge carriers, electrons and holes, to either side of the semiconductor slab. This movement of charge carriers is a result of the magnetic force they experience passing through the semiconductor material.

As these electrons and holes move side wards a potential difference is produced between the two sides of the semiconductor material by the build-up of these charge carriers. Then the movement of electrons through the semiconductor material is affected by the presence of an external magnetic field which is at right angles to it and this effect is greater in a flat rectangular shaped material.

The effect of generating a measurable voltage by using a magnetic field is called the Hall Effect after Edwin Hall who discovered it back in the 1870's with the basic physical principle underlying the Hall effect being Lorentz force. To generate a potential difference across the device the magnetic flux lines must be perpendicular, (90°) to the flow of current and be of the correct polarity, generally a south pole.

The Hall effect provides information regarding the type of magnetic pole and magnitude of the magnetic field. For example, a south pole would cause the device to produce a voltage output while a north pole would have no effect. Generally, Hall Effect sensors and switches are designed to be in the "OFF", (open circuit condition) when there is no magnetic field present. They only turn "ON", (closed circuit condition) when subjected to a magnetic field of sufficient strength and polarity.

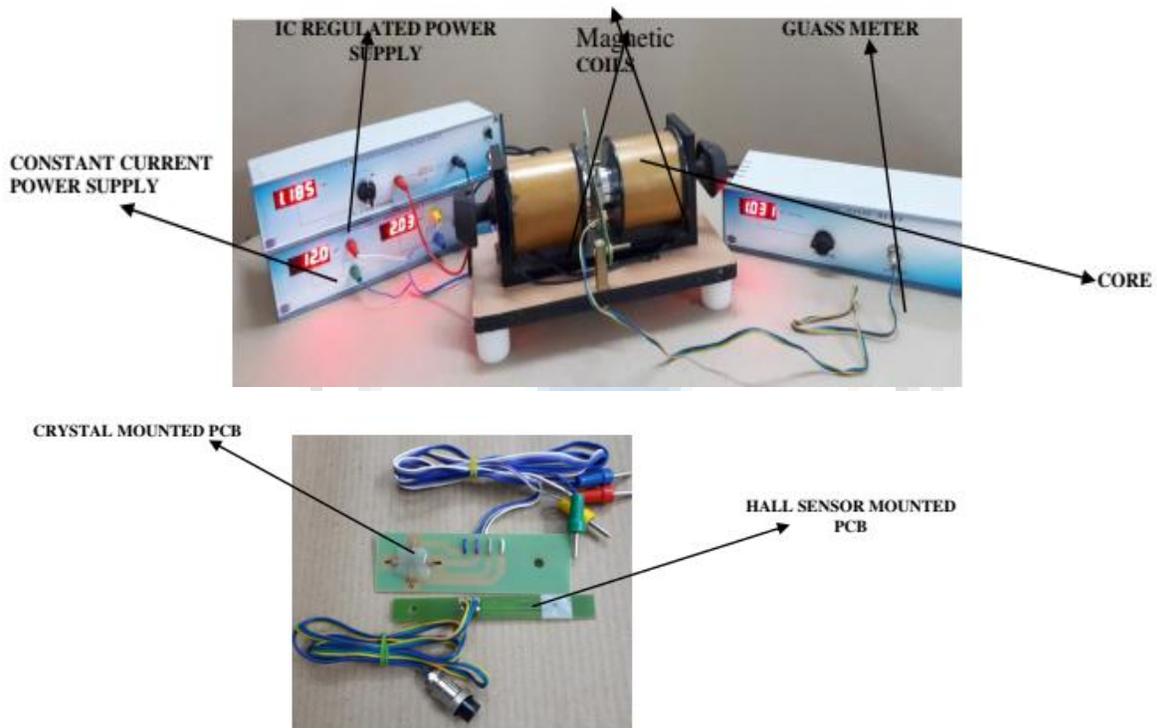
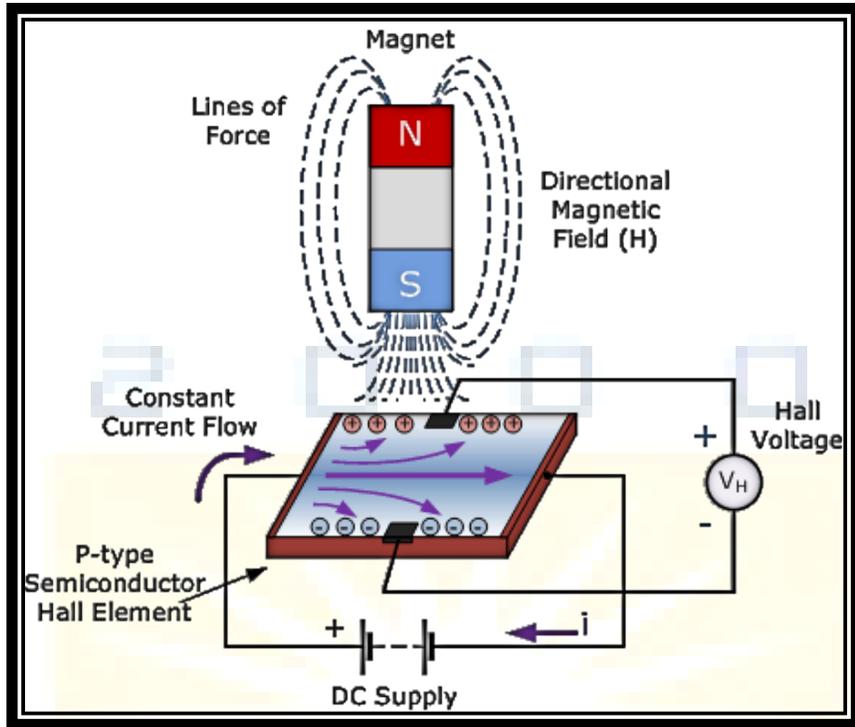
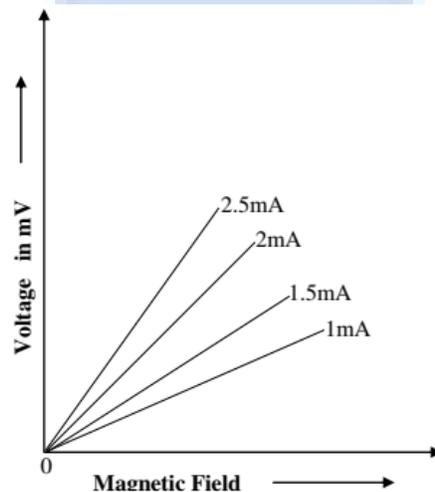


Fig. 1. Hall effect Setup

Procedure:

1. To demagnetise the coils, place the sensor mounted PCB exactly at the center of the core. Apply reverse current through the coils till the Gauss meter reads '0.00'.
2. Switch "OFF" all the sources, set the IC regulated power supply (to the magnetic coils) knob to minimum.
3. Increase the gap between magnetic cores to maximum by turning the core knobs.
4. Place crystal & sensor mounted PCB together in the magnetic field exactly at the center of the magnetic cores gap.
5. Connect the crystal mounted PCB to constant current power supply to their respective sockets.
6. Connect Hall probe to Gauss meter. Switch "ON" the Gauss meter, set the Gaussmeter reading to "0.00" by adjusting the knob.
7. Switch "ON" IC regulated power supply to the magnetic coils & constant current power supply.
8. Set the current across the crystal to 1mA, vary magnetic field (starting from 0.00KG) in steps of 0.25KG. This can be achieved by applying current to electromagnetic coils & simultaneously changing the position of electromagnetic cores.
9. Note the corresponding Hall voltage at constant current through semiconductor sample.
10. Plot the graph between magnetic field (B) and hall voltage (V_H), which is a straightline & find the slope of the line.
11. Repeat the above steps from 2 to 6 for different values of current applied to semiconductor crystal say 1mA, 1.5mA, 2mA & 2.5mA.

Ideal Graph:



Observation:

Trail No	Magnetic field B (Tesla)	Thickness (t) m	Hall current I (mA)	Hall Volage V_H (mV)	$R_H = \frac{V_H t}{I * B}$	$n = \frac{1}{e R_H}$

Result:

Charge carrier concentration $n =$ -----

Viva Voce

1. What is Hall Coefficient?
2. What are the applications of Hall Effect?
3. Define Hall Effect?
4. Write the Hall Coefficient equation?
5. What is the difference between Electric field and Magnetic field?

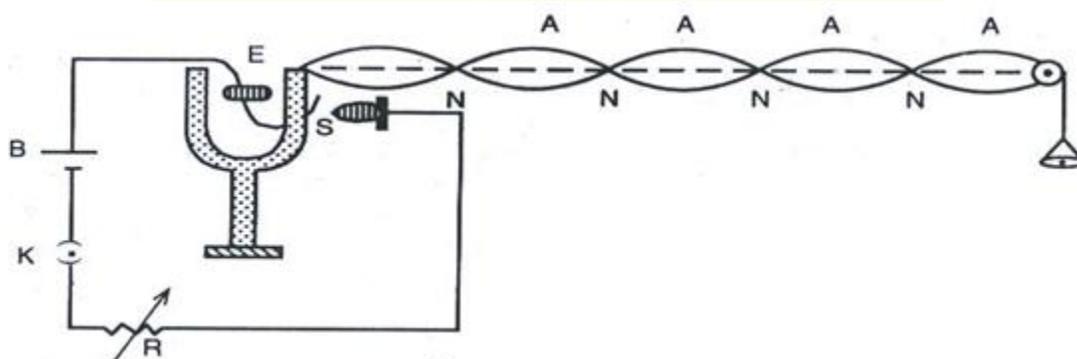
EXPERIMENT-II DETERMINING FREQUENCY OF LONGITUDINAL WAVES

Aim:

To determine the frequency of a tuning fork in longitudinal mode using Melde's arrangement.

Apparatus:

Melde's arrangement, rheostat, plug keys, connecting wires, meter scale, thread, weight box, power supply.



Principle:

Frequency of tuning fork $n = \frac{1}{l} \sqrt{\frac{T}{m}}$ Hz

m - Mass per unit length (or) linear density.

T - Tension = $(M+m) \times g$.

l - Length of a single loop.

Procedure:

In longitudinal mode, the tuning fork is parallel to the vibrating thread. Set the Melde's experiment in the longitudinal mode of vibrations and note the observations in observation table for different lengths. Calculate the frequency of the tuning fork by using the formula.

Observations:

Mass of the thread (w) = _____ gm,

Length of the thread (y) = _____ cm,

Mass of the pan (p) = _____ gm,

Linear density (m) = _____ gm/cm .

S.No	Load applied in the pan (M) gm	Tension $T=(M+p)g$	No. of loops (x)	Length of the x loops (d)	Length of the each loop $l = \frac{d}{x}$	\sqrt{T}	$\frac{\sqrt{T}}{l}$	$n_l = \frac{1}{l} \sqrt{\frac{T}{m}}$

Average of $n =$

Precautions:

1. The thread should be uniform and inextensible.
2. Well defined loops should be obtained by adjusting the tension with milligram weights.
3. Frictions in the pulley should be least possible.

Result:

Frequency of the tuning fork in longitudinal mode _____ Hz.

Viva Voce

1. What is frequency?
2. What are standing waves?
3. Explain the difference between longitudinal and transverse waves.
4. What is Resonance?

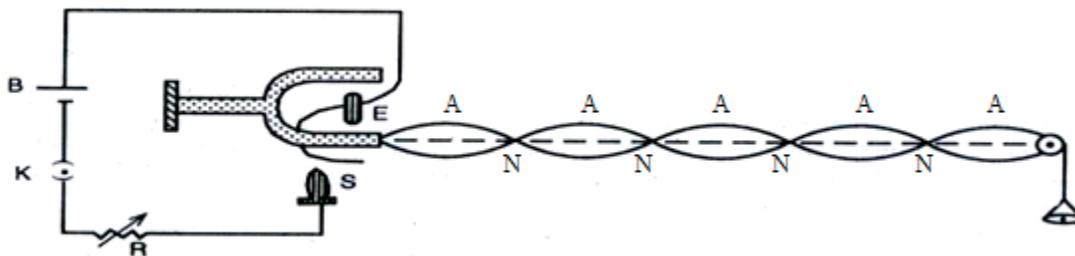
CALCULATING FREQUENCY OF TRANSVERSE WAVES

Aim:

To determine the frequency of a tuning fork in transverse mode using Melde's arrangement.

Apparatus:

Melde's arrangement, rheostat, plug keys, connecting wires, meter scale, thread, weight box, power supply.



Principle:

$$\text{Frequency of tuning fork } n = \frac{1}{2l} \sqrt{\frac{T}{m}} \text{ Hz}$$

m - Mass per unit length (or) linear density.

T - Tension = $(M+m) \times g$.

l - Length of a single loop.

Procedure:

In transverse mode, the tuning fork is made to vibrate perpendicular to vibrating thread. The vibrating thread forms many well defined loops. These loops are due to the stationary vibrations set up as a result of the superposition of the progressive wave from the prong and the reflected wave from the pulley. The frequency of each segment coincides with the frequency of the fork.

Set the Melde's experiment in transverse mode vibrations with 2-3 meters length of thread and note the number of loops and length of the thread are recorded in observations table. Repeated the same procedure for different length and recorded is in the observation table and calculated the frequency of the tuning fork.

Observations:

Mass of the thread (w) = _____ gm, Length of the thread (y) = _____ cm,

Mass of the pan (p) = _____ gm, Linear density (m) = _____ gm/cm .

Table:

S. No	Load applied in the pan(M)gm	Tension $T=(M+p)g$	No. of loops (x)	Length of the x loops (d)	Length of the each loop $l = \frac{d}{x}$	\sqrt{T}	$\frac{\sqrt{T}}{l}$	$n_t = \frac{1}{2l} \sqrt{\frac{T}{m}}$

Average of $n =$

Precautions:

- 1.The thread should be uniform and inextensible.
- 2.Well defined loops should be obtained by adjusting the tension with milligram weights.
- 3.Frictions in the pulley should be least possible.

Result:

Frequency of the tuning fork in Transverse mode _____ Hz.

Viva Voce

1. Define nodes and anti-nodes.
2. Define resonance condition.
3. Explain the importance of Melde's experiment.
4. Give some important application of Melde's experiment.

EXPERIMENT - III
MAGNETIC FIELD ALONG THE AXIS OF CURRENT CARRYING COIL –
STEWART AND GEE'S METHOD

Aim:

To determine the field of induction at several points on the axis of a circular coil carrying current using Stewart and Gee's type of tangent galvanometer.

Apparatus:

Stewart and Gee's galvanometer, battery eliminator, ammeter, commutator, rheostat, plug keys, connecting wires.

Principle:

When a current of i -amperes exists through a circular coil of n -turns, each of radius a , the magnetic induction B at any point(P) on the axis of the coil is given by

$$B = \frac{\mu_0 n i a^2}{2(x^2 + a^2)^{3/2}} \text{-----(1)}$$

where B is the magnetic induction on the axial line of the coil

$\mu_0 = 4\pi \times 10^{-7}$ H/m (permeability of free space)

' n ' is number of turns in the coil

' i ' is the current through the coil

' a ' is the radius of the coil (in cm)

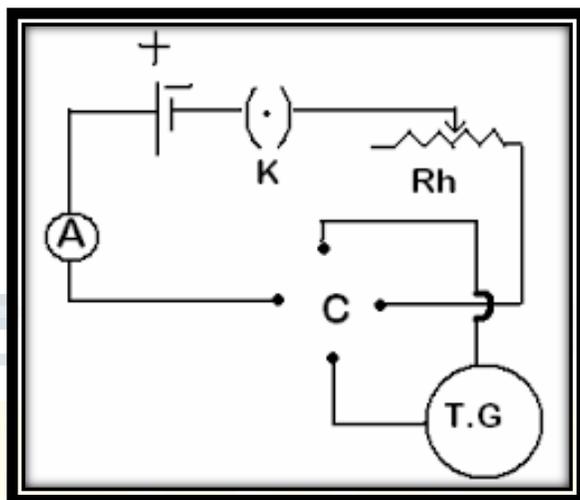
' x ' is the distance from the centre of the coil to the centre of the magnet (in cm)

When the coil is placed in the magnetic meridian, the direction of the magnetic field will be perpendicular to the magnetic meridian; i.e., perpendicular to the direction of the horizontal component of the earth's field; say B_e . When the deflection magnetometer is placed at any point on the axis of the coil such that the centre of the magnetic needle lies exactly on the axis of the coil, then the needle is acted upon by two fields B and B_e , which are at right angles to one another. Therefore, the needle deflects obeying the tangent law,

$$B = B_e \tan \theta \text{-----(2)}$$

B_e the horizontal component of the earth's field is taken from standard tables. The intensity of the field at any point calculated from equation (2) and verified using equation(1).

Figure:



Procedure :

With the help of the deflection magnetometer and a chalk, a long line of about one meter is drawn on the working table, to represent the magnetic meridian. Another line perpendicular to this line is also drawn. The Stewart and Gee's galvanometer is set with its coil in the magnetic meridian, as shown in the figure. The external circuit is connected, keeping the ammeter, rheostat away from the deflection magnetometer. This precaution is very much required because, the magnetic field produced by the current passing through the rheostat and the permanent magnetic field due to the magnet inside the ammeter affect the magnetometer reading, if they are close to it.

The magnetometer is set at the centre of the coil and rotated to make the aluminum pointer read (0,0) in the magnetometer. The key, K, is closed and the rheostat is adjusted so as the deflection in the magnetometer is about 60° . The current in the commutator is reversed and the deflection in the magnetometer is observed. The deflection in the magnetometer before and after reversal of current should not differ much. In case of sufficient difference say above 2° or 3° , necessary adjustments are to be made.

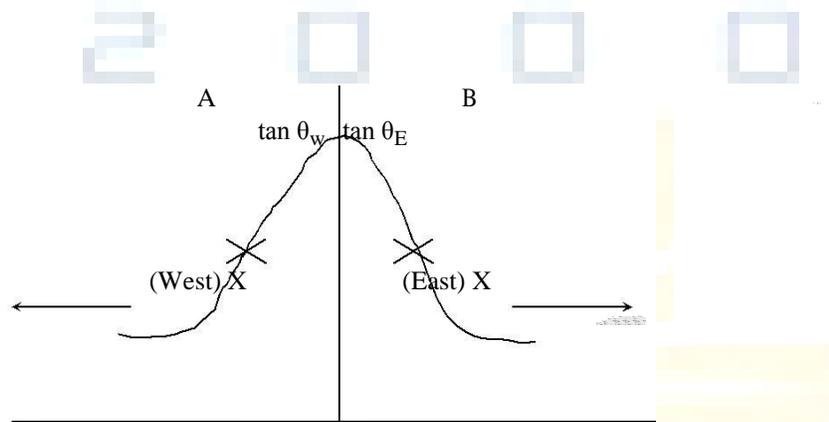
The deflections before and after reversal of current are noted when $d = 0$. The readings are noted in Table 1. The magnetometer is moved towards East along the axis of the coil in steps of 5 cm at a time. At each position, the key is closed and the deflections before and after reversal of current is noted. The mean deflection be denoted as $\text{Tan}\theta_E$. The magnetometer is further moved towards east in steps of 5cm each time and the deflections before and after reversal of current are noted, until the deflection falls to 30° .

The experiment is repeated by shifting the magnetometer towards west from the centre of the coil in steps of 5cm, each time and deflections are noted before and after reversal of current. The mean deflection is denoted as $\text{Tan}\theta_W$.

It will be found that for each distance (X) the values in the last two columns are found to be equal verifying equation (1) and (2).

A graph is drawn between X on x-axis and the corresponding $\tan \theta_E$ and $\tan \theta_W$ along y-axis. The shape of the curve is shown in the figure. The points A and B marked on the curve lie at distance equal to half the radius of the coil ($a/2$) on either side of the coil.

Graph:



Precautions:

1. The ammeter, voltmeter should keep away from the deflection magnetometer because these meters will affect the deflection in magnetometer.
2. The current passing through rheostat will produce magnetic field and magnetic field produced by the permanent magnet inside the ammeter will affect the deflection reading.

S.No	Distance of deflection magnetometer from centre of the coil(X) in meters	Deflection in the magnetometer East side					Deflection in the magnetometer West side					$\theta = \frac{\theta_e + \theta_w}{2}$	Tan θ	$B = B_e \tan \theta$	$B = \frac{\mu_0 n i a^2}{2(x^2 + a^2)^{3/2}}$		
		θ_1	θ_2	θ_3	θ_4	Mean θ_e	Tan θ_e	θ_1	θ_2	θ_3	θ_4					Mean θ_w	Tan θ_w

Result :

The theoretical and calculated values are approximately same.

Viva Voce

1. Define magnetic field induction.
2. Write units of magnetic field induction.
3. What is the principle behind the experiment?

EXPERIMENT – IV B-H CURVE

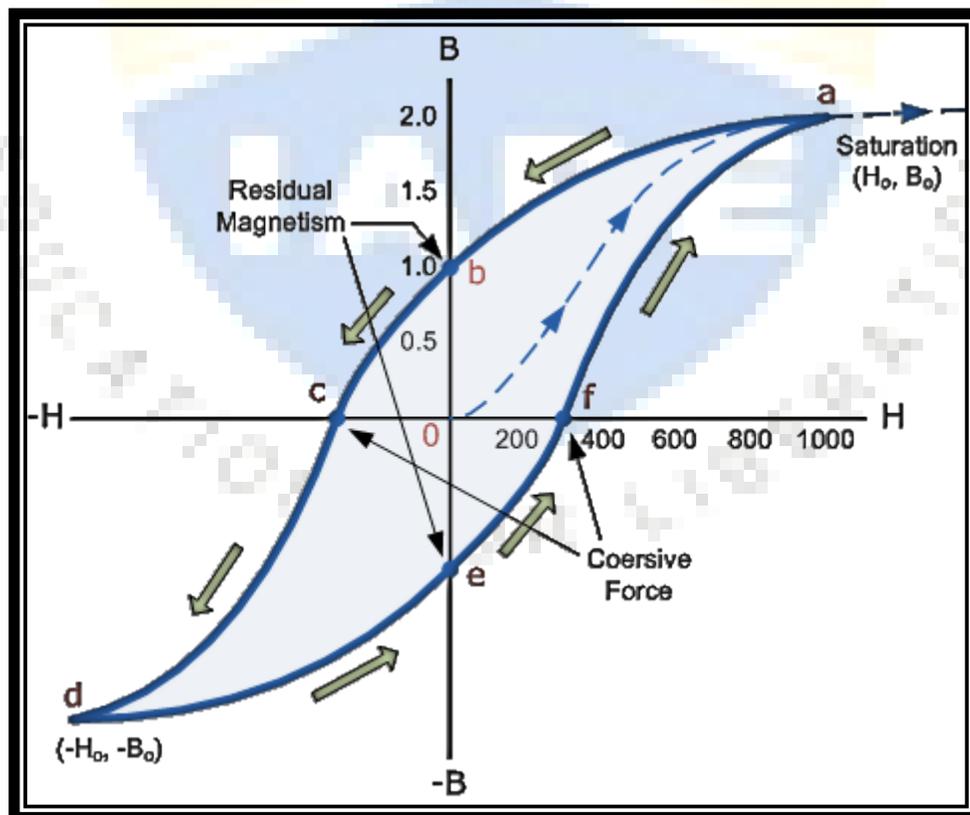
Aim: To determine the value of retentivity and coercivity of a given magnetic material.

Apparatus:

The Hysteresis Loop tracer used in this experiment is HLT-111. Diameter of the pick-up coil – 3.21 mm, $G_x = 100$, $G_y = 1$ Sample Used: Thin cylindrical rod made of Commercial Nickel.

Theory:

Consider a magnetic material being subjected to a cycle of magnetization. The graph intensity of magnetization (B) vs. magnetizing field (H) gives a closed curve called B-H loop. The intensity of magnetization B does not become zero when the magnetizing field H is reduced to zero. Thus the intensity of magnetization M at every stage lags behind the applied field H. This property is called magnetic hysteresis. The B-H loop is called hysteresis loop. The shape and area of the loop are different for different materials.



Lets assume that we have an electromagnetic coil with a high field strength due to the current flowing through it, and that the ferromagnetic core material has reached its saturation point, maximum flux density. If we now open a switch and remove the magnetising current flowing through the coil we would expect the magnetic field around the coil to disappear as the magnetic flux reduced to zero.

However, the magnetic flux does not completely disappear as the electromagnetic core material still retains some of its magnetism even when the current has stopped flowing in the coil. This ability for a coil to retain some of its magnetism within the core after the magnetisation process has stopped is called Retentivity or remanence, while the amount of flux density still remaining in the core is called Residual Magnetism, B_R .

The reason for this that some of the tiny molecular magnets do not return to a completely random pattern and still point in the direction of the original magnetising field giving them a sort of “memory”. Some ferromagnetic materials have a high retentivity (magnetically hard) making them excellent for producing permanent magnets.

While other ferromagnetic materials have low retentivity (magnetically soft) making them ideal for use in electromagnets, solenoids or relays. One way to reduce this residual flux density to zero is by reversing the direction of the current flowing through the coil, thereby making the value of H , the magnetic field strength negative. This effect is called a Coercive Force, H_C .

If this reverse current is increased further the flux density will also increase in the reverse direction until the ferromagnetic core reaches saturation again but in the reverse direction from before. Reducing the magnetising current, i once again to zero will produce a similar amount of residual magnetism but in the reverse direction.

Then by constantly changing the direction of the magnetising current through the coil from a positive direction to a negative direction, as would be the case in an AC supply, a Magnetic Hysteresis loop of the ferromagnetic core can be produced.

Procedure:

- Power on the device.
- Slowly vary the applied magnetic field using magnetic field slider. M-H graph corresponding to the field will be plotted, whenever the slider is stopped.
- Tabulate the loop width, the tip-to-tip height and positive intercept to negative intercept distance for each magnetic field as shown in the table below.

S. No	Magnetic Field (Gauss)	Loop Width (mm)	Tip-To-Tip Height(V)	Positive Intercept to Negative intercept Distance (V)

Calculation of coercivity:

Plot the loop width of hysteresis loop against magnetic field.

The intercept of the straight line fit on the J-axis gives loop width. Coercivity,

$$H_c = \frac{G_o * (0.5 * (loop - width))}{\left(\frac{A_s}{A_n} - N\right)}$$

Calculation of saturation magnetisation:

Plot the positive intercept to negative intercept distance against magnetic field. Find the asymptote and use the equation below:

Saturation magnetisation,

$$M_s = \frac{G_o \times \mu_r \times G_x \times (0.5 \times \text{tip to tip length})}{4\pi \times G_y \times \left(\frac{A_s}{A_c} - N\right)} \text{ gauss}$$

Calculation of retentivity:

Plot the tip-to-tip separation against the magnetic field. Draw asymptote

Retentivity,

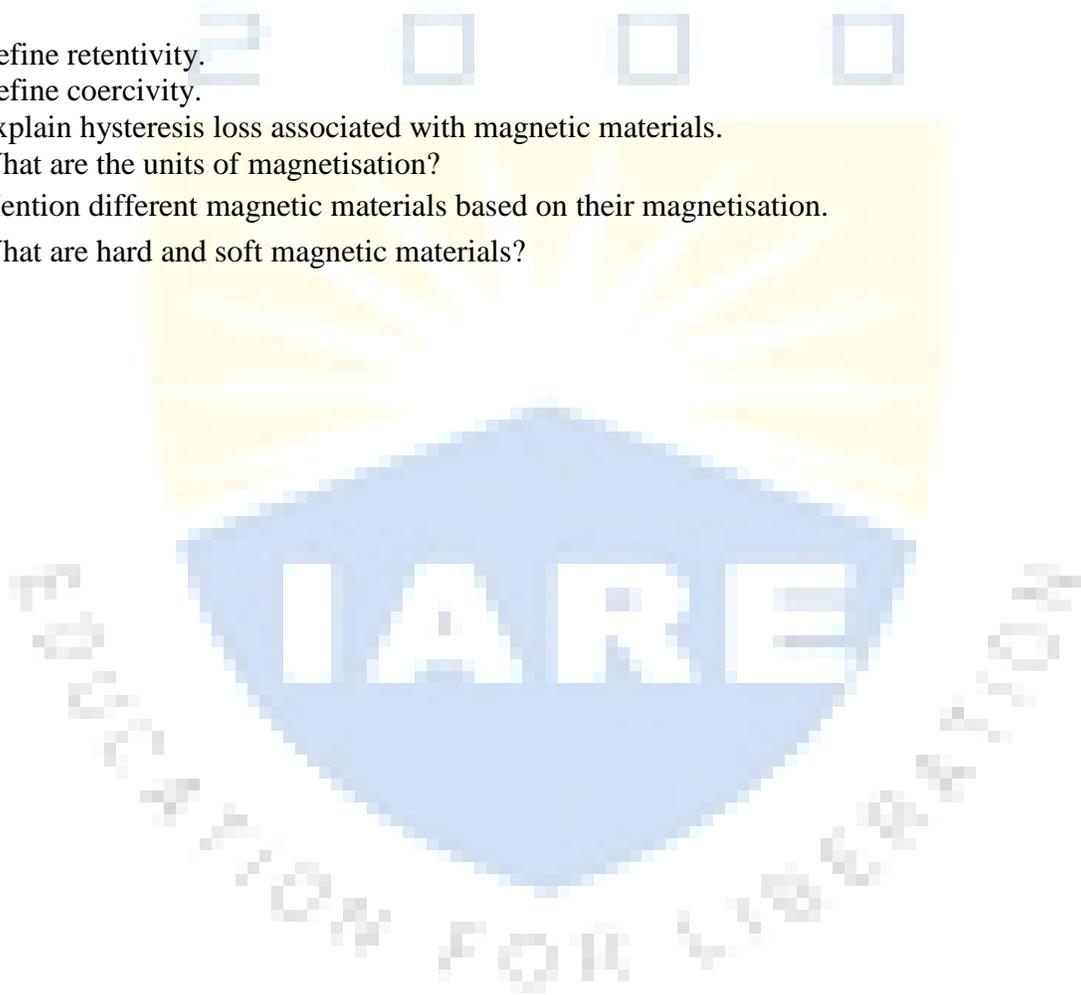
$$M_r = \frac{G_o \times \mu_r \times G_x \times (0.5 \times \text{intercept distance})}{4\pi \times G_y \times \left(\frac{A_s}{A_c} - N\right)} \text{ gauss}$$

Result:

1. The obtained value of the coercivity for the given sample is ----- oersted.
2. The obtained value of the saturation magnetisation for the given sample is ----- gauss.
3. The obtained value of the retentivity for the given sample is ----- gauss.

Viva Voce

1. Define retentivity.
2. Define coercivity.
3. Explain hysteresis loss associated with magnetic materials.
4. What are the units of magnetisation?
5. Mention different magnetic materials based on their magnetisation.
6. What are hard and soft magnetic materials?



EXPERIMENT- V ENERGY BAND GAP OF SEMICONDUCTOR

Aim: To determine the energy band gap of a given semiconductor using a diode in reverse bias.

Apparatus: P-N diode, power supply, voltmeter, microammeter, thermometer and heating arrangement for the diode.

Formula: Energy band gap of semiconductor (E_g) = slope $\times 2 \times 1.38 \times 10^{-23}$ Joule

OR

$$(E_g) = \text{slope} \times 1.725 \times 10^{-4} \text{ eV}$$

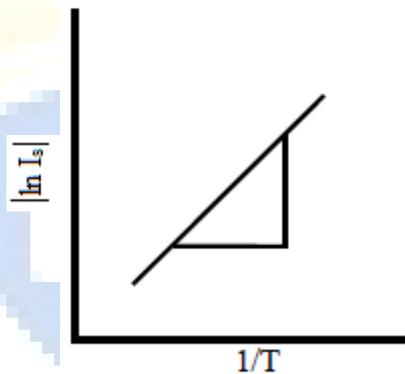
Where

$$\left[\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\ln I_s}{1/T} \right]$$

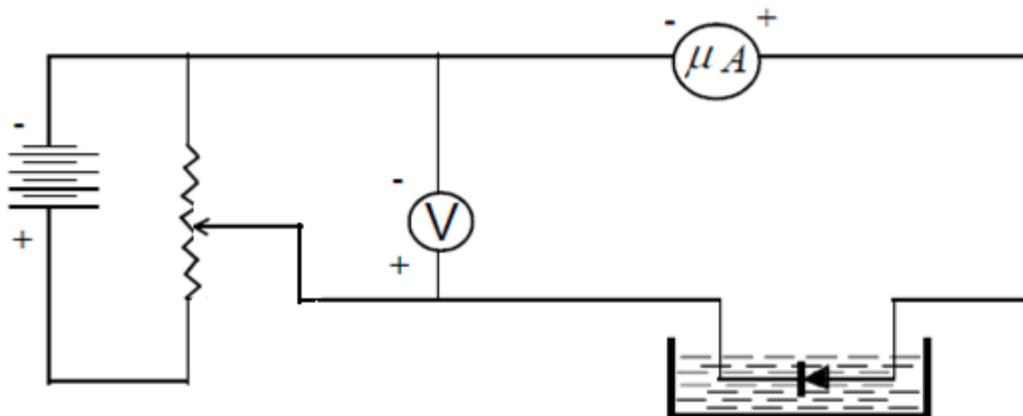
I_s is reverse saturation current

T is absolute temperature

Model Graph:



Circuit diagram:



Procedure:

The diode is connected in reverse bias as shown in the circuit diagram. The diode is placed in an oil bath. The temperature of the oil is noted. A constant potential difference (say 10 V) is applied and the current I_s is noted. The temperature is raised to 80°C and the corresponding current is noted. The experiment is repeated by decreasing temperature in steps of 10°C (upto 40°C). A graph is plotted between ($\ln I_s$) and $1/T$ and a straight line graph is obtained with negative slope. We can also plot a graph by taking the numerical values of $\ln I_s$ on Y-axis and on $1/T$ the x-axis. Then we get a straight line graph with positive slope. The slope of the graph is found out. The band gap energy is calculated using formula.

Observation table:

Temperature		$1/T$ ($\times 10^{-3}$)	Reverse bias current (I_s)	$\ln I_s$
$t^{\circ}\text{C}$	TK			
90	363	2.75		
85	358	2.79		
80	353	2.83		
75	348	2.87		
70	343	2.92		
65	338	2.96		
60	333	3.00		
55	328	3.05		
50	323	3.10		
45	318	3.14		
40	313	3.19		

Result: The energy band gap of a given semiconductor is eV.

Viva Voce:

1. Define energy gap.
2. How pn junction is formed?
3. What are intrinsic and extrinsic semiconductors.
4. Discuss forward and reverse biasing of diode.
5. Explain depletion layer in pn junction.



EXPERIMENT - VI EVALUATION OF NUMERICAL APERTURE OF A GIVEN FIBRE

Aim:

To determine the numerical aperture of a given optical fiber.

Apparatus:

Step index fiber optic cable 1 or 2m length, light source, N.A. measurement jig.

Description:

The schematic diagram of the fiber optic trainer module is shown in figure.

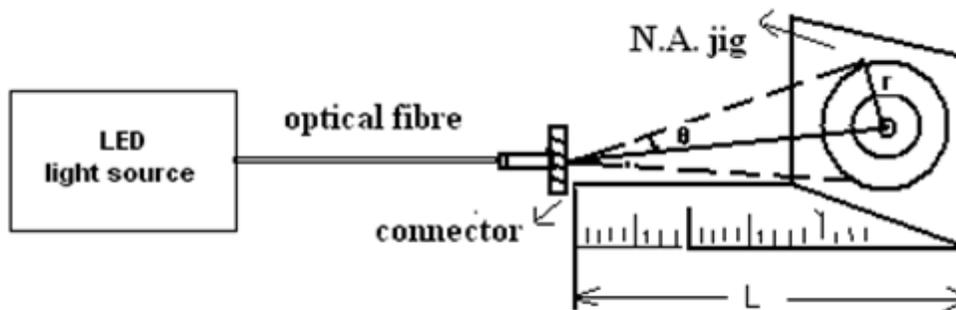


Figure Arrangement for N.A. measurement

Theory:

The numerical aperture of an optical system is a measure of the light collected by an optical system. It is the product of the refractive index of the incident medium and the sine of the maximum angle.

$$\text{Numerical Aperture (NA)} = n_i \sin \theta_{\max} \dots \dots \dots (1)$$

For air $n_i = 1$

For a step index fibre, the N.A. is given by:

$$\text{NA} = (n_{\text{core}}^2 - n_{\text{cladding}}^2)^{1/2} \dots \dots \dots (2)$$

For small differences in refractive indices between the core and cladding, equation (2) reduces to

$$\text{NA} = n_{\text{core}}(2\Delta)^{1/2} \dots \dots \dots (3)$$

Where Δ is the fractional difference in the refractive indices of the core and the cladding i.e.

$$\Delta = [n_{\text{core}} - n_{\text{cladding}}] / n_{\text{core}}$$

Light from the fibre end 'A' falls on the screen BD.

Let the distance between the fibre end and the screen = AO = L

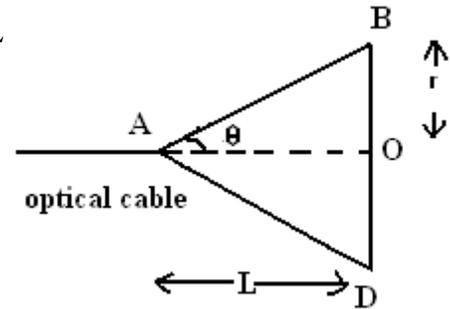
From the ΔAOB $\sin\theta = \frac{OB}{AB}$

$OB = r$ and $AB = [r^2 + L^2]^{1/2}$

$NA = \sin\theta = \frac{r}{[r^2 + L^2]^{1/2}}$

Knowing r and L, the N.A. can be calculated.

Substituting this value of N.A. in equation (1), the acceptance angle θ can be calculated.



Procedure:

1. LED is made to glow by applying about 1.5 V DC power supply.
2. Light is allowed to propagate through an optical fiber cable whose NA is to be determined.
3. The output is screened on a concentric circles of known diameter is placed at a distance of 1, 2, 3, 4 and 5 cm and corresponding radius of the concentric circles is noted.
4. The experiment is repeated for different lights.

Observations:

S.No.	L (mm)	r (mm)	N.A. = $\frac{r}{[r^2 + L^2]^{1/2}}$	θ (degrees)

Applications:

1. Optical fibers may be used for accurate sensing of physical parameters and fields like pressure, temperature and liquid level.
2. For military applications like fiber optic hydrophones for submarine and underwater sea application and gyroscopes for applications in ships, missiles and air craft's.

Result:

The NA of the optical fiber is

The Acceptance angle θ is

Viva Voce

1. Define Acceptance angle.
2. Define Numerical aperture.
3. Explain construction of optical fiber
4. Discuss principle of optical fiber.
5. What are advantages of using fiber optic communication.

EXPERIMENT - VII
WAVELENGTH OF LASER SOURCE – DIFFRACTION GRATING

Aim:

To determine the wavelength of a given source of laser using a plane transmission grating.

Apparatus:

Plane diffraction grating, laser source, a scale and prism table.

Theory:

An arrangement consisting of large number of parallel slits of the same width and separated by equal opaque space is known as the “diffraction grating”. A grating is constructed by rubbing equidistant parallel lines ‘N’ ruled on the grating per inch are written over it.

$$\lambda = \frac{2.54 \sin\theta}{n.N}$$

Where

λ is the wavelength of light.

N Lines per inch on the plane diffraction grating

n is the order of diffraction light.

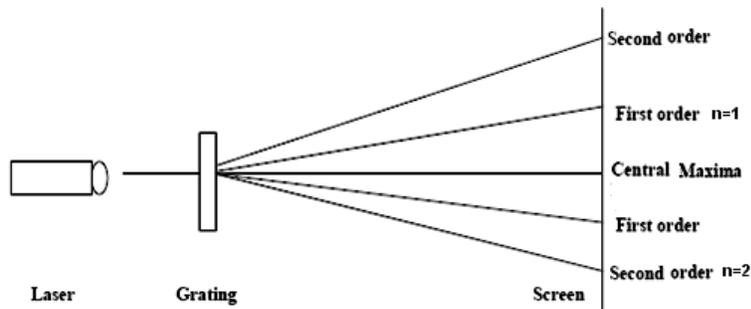
Procedure:

A plane diffraction grating consists of parallel sides glass plates with equidistant fine parallel lines drawn very closely upon it by means of a diamond point. The number of lines drawn per inch is written on the diffraction grating by the manufacturers like 15000 LPI or 25000 LPI. The laser system used in this experiment is semiconductor laser.

Place the grating in front of the laser beam such that light incident normally on the grating. When a semiconductor laser light incidents on the grating, the diffraction pattern is produced on the other side of the it. This diffraction pattern can be observed by arranging a screen at certain distance from the grating. The diffraction pattern consists of central maxima and secondary maxima. The secondary maxima in the diffraction pattern observed is on either side of central maxima due to first order, second order and so on.

Now measure the distance between the grating and the screen and tabulate it as 'D' and the distance between central maxima to first order on left side of central maxima as 'd₁' and then central maxima and first order on right side of central maxima as 'd₂' and it is tabulated. Similarly, note down the readings for second order on both sides of central maxima.

Diagram:



Tabular form:

S. No.	Distance (D)	Order (n)	Left side (d ₁)	Right side (d ₂)	$d = \frac{d_1 + d_2}{2}$	$\sin \theta = \frac{d}{\sqrt{d^2 + D^2}}$	$\lambda = \frac{\sin \theta}{n} \text{ A}^\circ$
1							
2							

Average wavelength = _____ A⁰

Result:

Wavelength of the given Laser light = _____ A⁰

Viva Voce

1. Define spontaneous emission.
2. Define stimulated emission.
3. What is diffraction?
4. What are the characteristics of LASER?

EXPERIMENT - VIII PLANK'S CONSTANT

Aim:

Determination of Planck's constant.

Apparatus:

0-10 V power supply, a one way key, a rheostat, a digital milliammeter, a digital voltmeter, a 1 K resistor and different known wavelength LED's (Light-Emitting Diodes).

Theory:

Planck's constant (h), a physical constant was introduced by German physicist named Max Planck in 1900. The significance of Planck's constant is that 'quanta' (small packets of energy) can be determined by frequency of radiation and Planck's constant. It describes the behavior of particle and waves at atomic level as well as the particle nature of light. An LED is a two terminal semiconductor light source. In the unbiased condition a potential barrier is developed across the p-n junction of the LED. When we connect the LED to an external voltage in the forward biased direction, the height of potential barrier across the p-n junction is reduced. At a particular voltage the height of potential barrier becomes very low and the LED starts glowing, i.e., in the forward biased condition electrons crossing the junction are excited, and when they return to their normal state, energy is emitted. This particular voltage is called the knee voltage or the threshold voltage. Once the knee voltage is reached, the current may increase but the voltage does not change.

The light energy emitted during forward biasing is given as ,

$$E = \frac{hc}{\lambda} \text{-----(1)}$$

$$E = eV \text{-----(2)}$$

$$eV = \frac{hc}{\lambda}$$

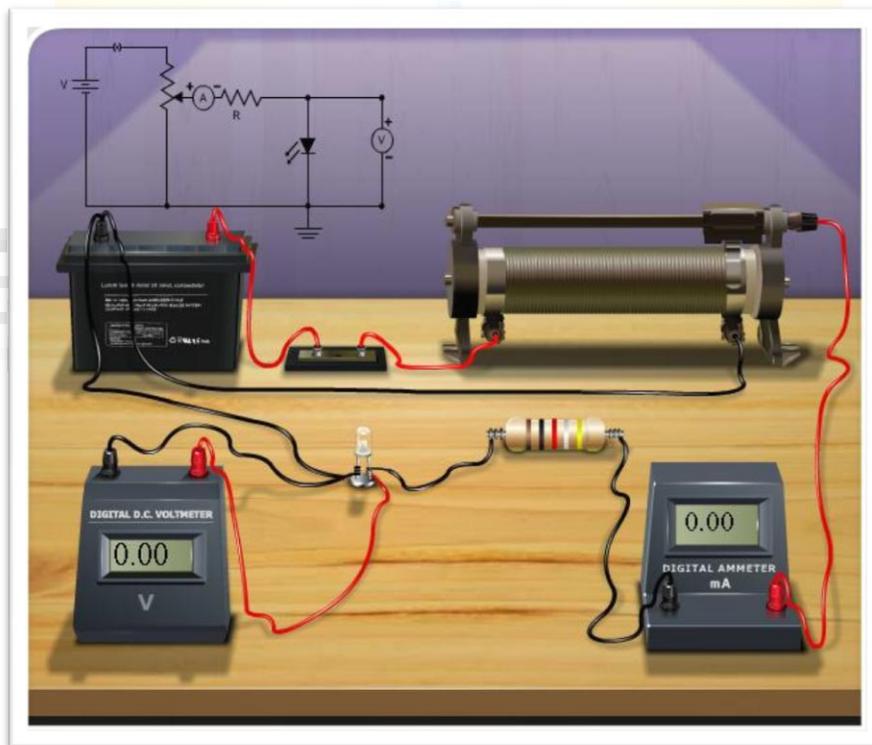
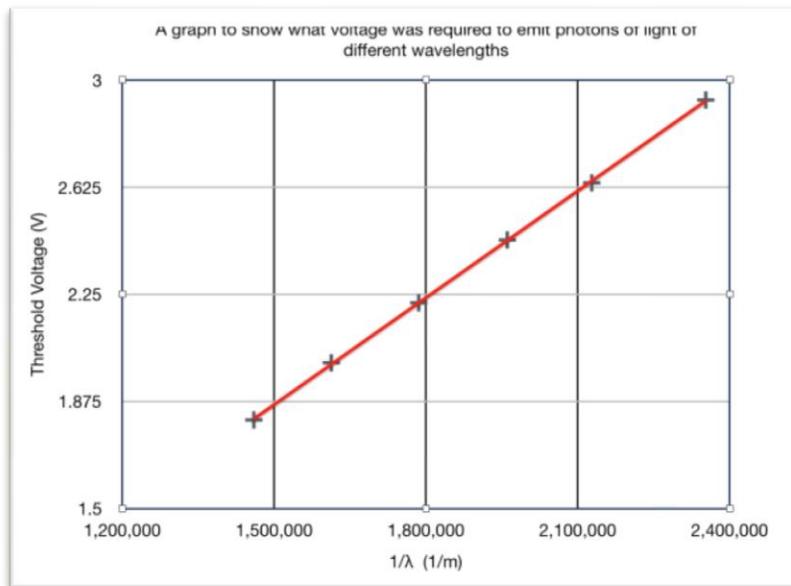
$$V = \frac{hc}{e} \left(\frac{1}{\lambda} \right)$$

$$s = \frac{hc}{e}$$

$$h = \frac{e}{c} s \text{-----(3)}$$

Where h Planck constant, λ wavelength, s slope of the curve of $1/\lambda$ vs V , V voltage, E electric field.

Circuit and Tabular form:



Colour of LED	Wavelength (λ) nm	Knee voltage (V) volt	$\lambda \times V$	$h = e\lambda V/c$

Procedure

1. After the connections are completed, click on 'Insert Key' button.
2. Click on the combo box under 'Select LED' button.
3. Click on the 'Rheostat Value' to adjust the value of rheostat.
4. Corresponding voltage across the LED is measured using a voltmeter, which is the knee voltage.
5. Repeat, by changing the LED and note down the corresponding knee voltage.
6. Calculate 'h' using equation
7. The wave length of infrared LED is calculated by using equation.

Result:

Plank constant $h = \text{----- j-s.}$

Viva Voce

1. What is LED.
2. What are direct bandgap semiconductors.
3. What is the value of h?
4. Explain forward biasing.
5. What are the units of Planck's constant?

EXPERIMENT - IX V-I CHARACTERISTICS OF LED

Aim:

To study the V-I characteristics of light emitting diode and find the Threshold voltage and forward resistance of LED.

Apparatus:

Light emitting diode, 0-5V variable Supply, 0-10v Voltmeter, 0-50mA DC Ammeter.

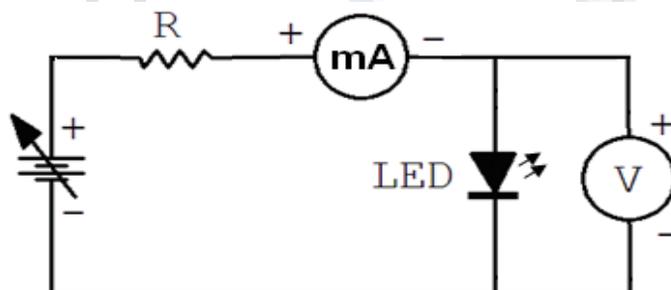
Theory:

In a PN junction charge carrier recombination takes place when the electrons cross from the N-layer to the P-layer. The electrons are in the conduction band on the P-side while holes are in the valence band on the N-side. The conduction band has a higher energy level compared to the valence band and so when the electrons recombine with a hole the difference in energy is given out in the form of heat or light. In case of silicon or germanium, the energy dissipation is in the form of heat, whereas in case of gallium-arsenide and gallium phosphide, it is in the form of light. This light is in the visible region. Germanium and silicon, which have E_g about 1eV cannot be used in the manufacture of LED. Hence Gallium arsenide, Gallium phosphide which emits light in the visible region are used to manufacture LED.

Procedure for V-I Characteristics:

1. Connect the Light emitting diode as shown in figure.
2. Slowly increase forward bias voltage in steps of 0.1 volt.
3. Note the current passing through the LED.
4. Do not exceed 30mA current.
5. Plot a graph of light emitting diode
6. Voltage vs light emitting diode current.

Circuit diagram:



Result :

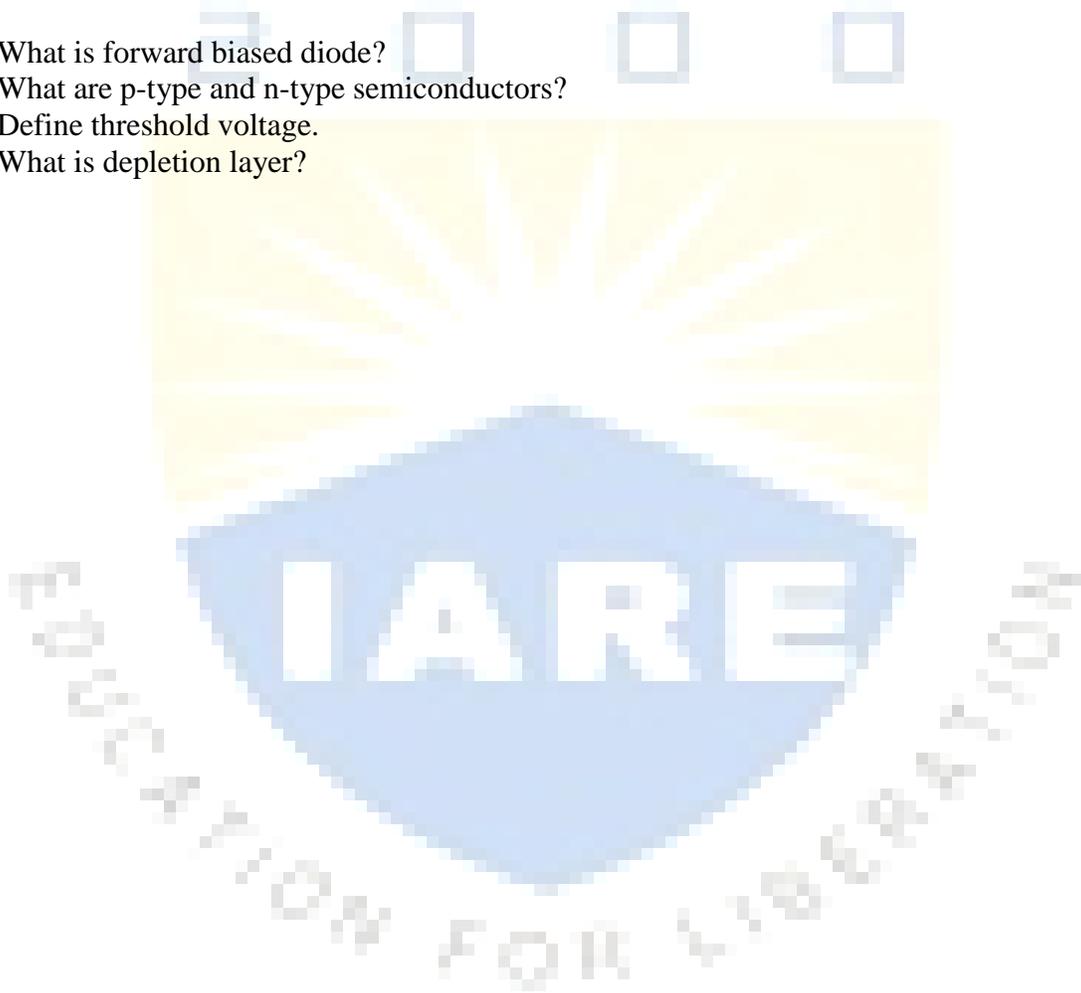
V-I characteristics of given LED are studied.

Calculated Threshold Voltage $V_{th} = \underline{\hspace{2cm}}$ V.

Forward Resistance $R_f = \underline{\hspace{2cm}}$ Ω .

Viva Voce

1. What is forward biased diode?
2. What are p-type and n-type semiconductors?
3. Define threshold voltage.
4. What is depletion layer?



EXPERIMENT – X

NEWTON'S RINGS - RADIUS OF CURVATURE OF PLANO-CONVEX LENS

Aim:

To determine radius of curvature of plano convex lens using sodium light by forming Newton's rings.

Apparatus:

Travelling microscope, sodium vapour lamp, plane convex lens, plano convex lens, a thin glass plate and a magnifying glass.

Principle:

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

λ - Wave length of sodium light

R - Radius of curvature of the of Plano convex lens.

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

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

Description:

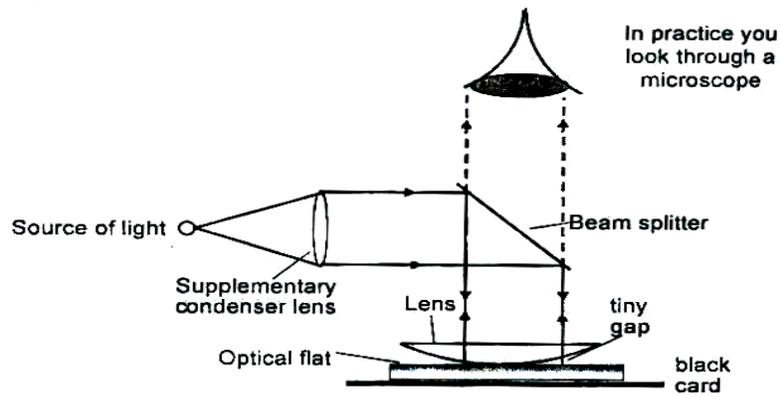
A black paper is laid on the base of the travelling microscope over which the thick glass plate is placed. Over this thick glass plate, a plano convex lens is placed. A parallel beam of light from the sodium lamp is made to fall on the glass plate which is inclined at 45° with the horizontal, as shown in the figure 1. The beam of light is reflected on to the setup made by means of a glass plate. 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 Newton's rings, with alternate bright and dark rings, having a central black spot are seen through the microscope shown in figure2. The microscope is focused properly so that the rings are in sharp focus. The rings so formed are not to be disturbed till the experiment is completed.

Procedure:

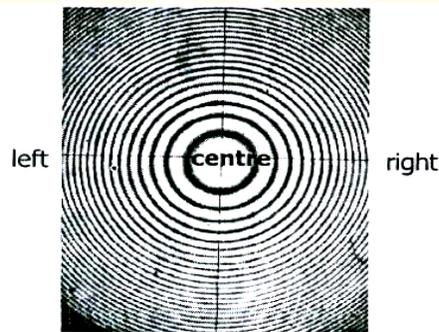
The point of intersection of the cross wires in the microscope is brought to the centre of the ring system. The wire is set tangential to any one ring, and starting from the centre of the ring system, the microscope is moved on to one side; say left, across the field of view counting the number of rings. Now the cross wires are set at 30^{th} ring and the reading on the microscope scale is noted, using a magnifying glass. Similarly, the readings with the cross wires set on 25^{th} , 20^{th} , 15^{th} , 10^{th} dark rings are noted. The microscope is moved in the same direction and the readings corresponding to 10^{th} , 15^{th} , 20^{th} , 25^{th} , 30^{th} dark rings on the right side are noted. The readings are tabulated in the observation table.

A graph is drawn with the number of rings on X-axis and the square of diameter of the rings on Y-axis. The nature of the graph is a straight line as shown in figure3. From the graph, the values of D_m^2 and D_n^2 corresponding to m and n values are noted. The slope of the graph is calculated from the formula, using these values the wave length of sodium light is calculated.

Experimental set-up:

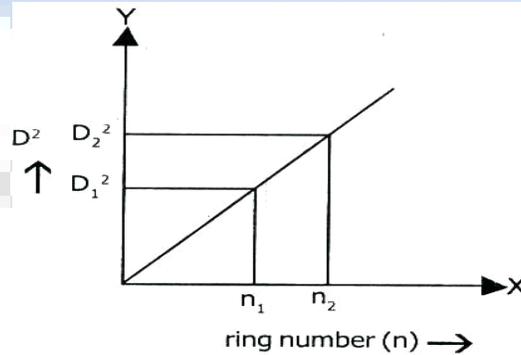


Schematic diagram of Newton's rings setup



Photograph of Newton's rings formed

Graph:



Precautions:

1. Wipe the lens and the glass plates with cloth before starting the experiment.
2. The centre of the rings must be dark.
3. Use reading lens with light while observing the readings.
4. Before starting the experiment make sure that the movement of microscope in both sides of the rings.

Observations:

S.no	Ring number (n)	Microscope reading			D ²
		On the left side (a)	On the right side (b)	Diameter of the ring D = (a - b)	

$$\text{Slope of the straight line} = \frac{D_2^2 - D_1^2}{n_2 - n_1}$$

$$\text{Radius of curvature, } R = \frac{\text{Slope}}{4\lambda}$$

λ = Wavelength of sodium light = 5890 Å°.

Result:

The radius of curvature of plano convex lens is _____ cm.

Viva questions:

1. What is Interference?
2. How Newton's rings are formed?
3. What is the least count of travelling microscope?
4. Why the central spot is dark?
5. Define radius of curvature of lens.

EXPERIMENT – XI LASER SINGLE SLIT EXPERIMENT

Aim:

To determine the width of a given single slit using laser diffraction.

Apparatus:

Laser source with stand, Single slit with stand and a screen with stand.

Procedure:

1. Fix the single slit to the stand at an appropriate height.
2. Set the given laser horizontally on table with a distance (say 15 cms) from the slit.
3. Adjust the position of the slit such that it is in the path of the laser beam.
4. Switch on the laser and observe the pattern on the screen.
5. Select a distance ($L = 100$ cms) between the slit and screen using meter scale.
6. Now measure the distances of 1st & 2nd order from the center point (brightest point) of the pattern . Let the average of these distances be denoted as l_1 & l_2 respectively

$$l_1 = (l_1' + l_1'') / 2 , \text{ and } l_2 = (l_2' + l_2'') / 2 .$$

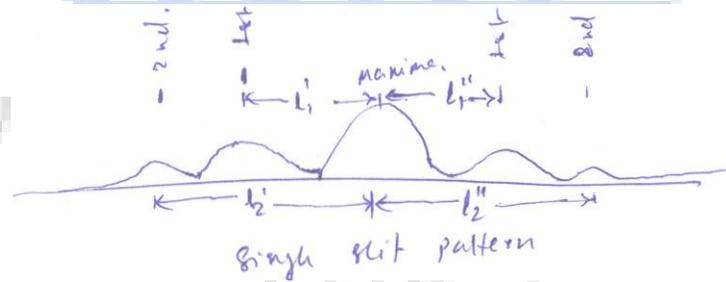
7. Repeat the above steps for different L values i.e. 150 cms, 200 cms.....
8. Plot a graph between l (y-axis) and L (x-axis) for each order ($m=1,2,\dots$). You will get a straight line corresponding to each m value. Calculate the l/L for each m value.
9. Now draw another graph between l/L (y-axis) & m (x-axis). You will get a straight line. Determine the slope of this line.
10. Width of the slit can be calculated : $d = \lambda / (l/L \cdot 1/m)$ nm.

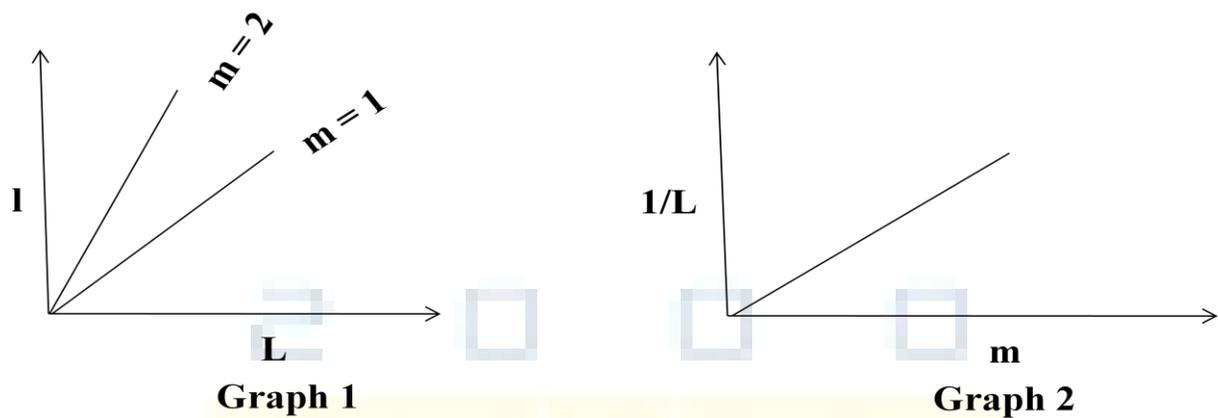
Observations:

L	1 st order m=1			2 nd order m=2		
	l_1'	l_1''	$(l_1' + l_1'')/2$	l_2'	l_2''	$l_2 = (l_2' + l_2'')/2$
100 cm						
150 cm						
200 cm						



Pattern produced from a single slit.





Result:

Width of a single slit is found to be _____.

Viva Voce

1. Define diffraction.
2. What is the difference between single slit and double slit diffraction.
3. What is the condition for diffraction to occur.
4. Discuss differences between interference and diffraction.

EXPERIMENT – XII

V-I CHARACTERISTICS OF PIN AND AVALANCHE DIODE

Aim: To draw V - I characteristics of Photo Diode For different Light Intensities.

Introduction & Theory:

A Photo Diode is a two terminal PN Junction Device, which operates in a reverse mode. It has a small transparent window, which allows light to strike on the PN junction. Fig 1 (a) and (b) shows the structure and schematic symbol of Photo Diode.

It may be recalled that a rectifier diode has a very small reverse current when it is reverse biased. The reverse biased current is produced by thermally generated electron hole pairs in the depletion layer, which are swept across the junction by the electric field created by the reverse voltage. In a rectifier diode, the reverse current increases with the temperature due to an increase in the number of electron hole pairs.

A Photo Diode differs from a rectifier diode in a sense that its reverse current increases with the light intensity at the PN junction. When there is no incident light, the reverse current is almost negligible and it is called the dark current. An increase in the amount of light energy produces an increase in the reverse current.

Applications of Photo diodes

- 1) Photo Detection.
- 2) Demodulation.
- 3) Logic Circuits.
- 4) Switching.
- 5) Optional Communication system.
- 6) Character Recognition.

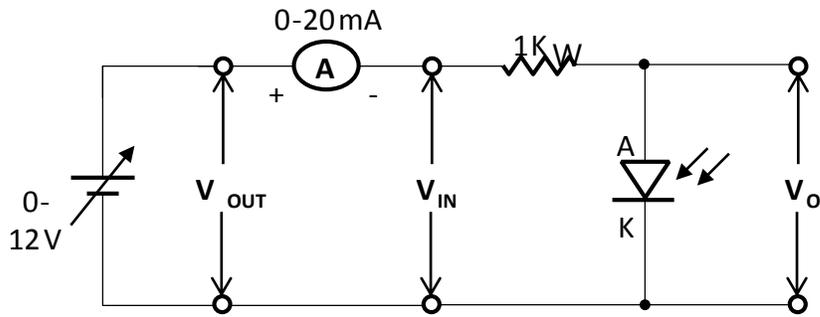


Fig.2a. Forward characteristics

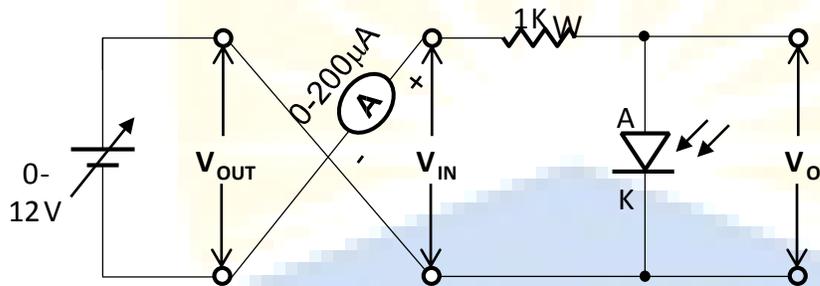


Fig.2b. Reverse characteristics

Experimental procedure

Forward characteristics

- 1) Switch on the trainer kit.
- 2) Set the voltage potentiometer in the minimum position and connect the built in DC source to the input terminals of first circuit (fig -2a) to conduct forward characteristics.
- 3) Connect Ammeter and voltmeter as shown in Fig 2a.

- 4) Connect the lamp, Increase the input voltage gradually and measure the Forward voltage drop V_O across the diode in incremental steps as shown in Table -1 and note the current I_O at each incremental step of the voltage.
- 5) Draw a graph between V_O and I_O as shown in Fig -2c.
- 6) Note The Forward Characteristics of Photo Diode.

Reverse characteristics

- 1) Switch on the trainer kit.
- 2) Set the voltage Potentiometer in the minimum position and connect the built in DC source to the input terminals of second circuit (fig -2b) to conduct Reverse Characteristics and swith on the bulb.
- 3) Connect the Micro Ammeter and voltmeter as shown in Fig -2(b).
- 4) Adjust the Voltage V_o in incremental steps and measure the V_o and I_o from the meters for each incremental steps as shown in Table -2.
- 5) Draw a graph between V_R and I_R .
- 6) Repeat step 1 to step 6 at different intensities of light. Draw V_R Vs I_R on the same graph as shown Fig 2(c).

Observations:

Table -1

V_o volts	I_o (mA)

Table -2

V_o volts	I_o (mA)

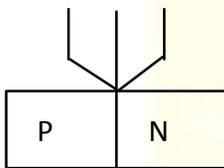


Fig 1(a)
Structure of a Photo diode

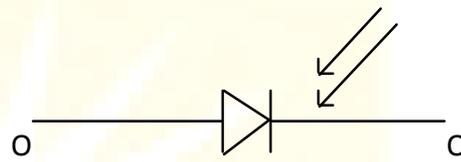


Fig 1(b)

Symbolic representation of a Photo Diode.

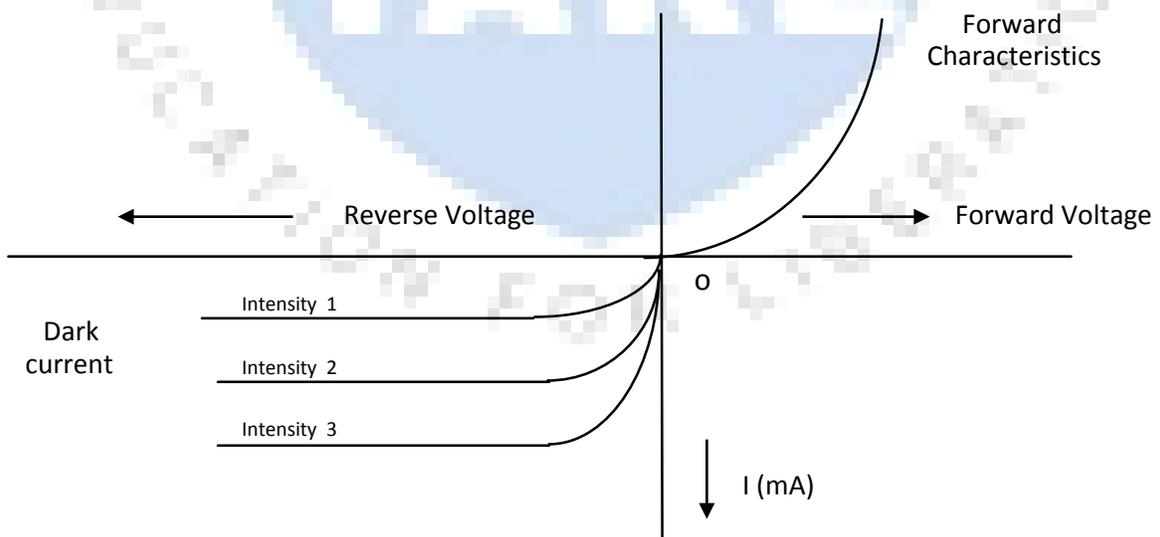


Fig 2(c) Characteristics curves of a photo diode

Result:

V-I characteristics of PIN and Avalanche photodiodes are studied.

Viva Voce

1. What is photodiode?
2. How photo diode is different from LED.
3. What do you mean by biasing of diode.
4. Explain the principle of PIN and Avalanche photo diode.

