Muffakham Jah College of Engineering & Technology

Engineering Physics

Lab Manual

MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY

(SULTAN-UL-ULOOM EDUCATION SOCIETY)

BANJARA HILLS, HYDERABAD-500034

PHYSICS LAB MANUAL B.E. I/IV
2025-26

Name : ______________________________

Hall Ticket No : ______________________________

Class : ______________________________

Section : ______________________________

LIST OF STAFF MEMBERS

Physics Department

Teaching Staff

1.	Dr. Shaik Kareem Ahmmad	Professor
2.	Mr. Syed Ilyas Mohiuddin	Asst.Professor
3.	Dr. Md. Raheem Ahmed	Asst. Professor
4.	Dr. Nazima Siddiqui	Asst.Professor
5.	Ms. Samera Saniya	Asst.Professor

Non-Teaching Staff

1.	Mr. Atique-ur-Rehman	Lab Assistant
2.	Mr. Shaik Shakeel	Lab Assistant

List of Experiments

1. P-N DIODE CHARACTERISTICS

AIM : To study the current voltage characteristics of P-N junction diode and to evaluate the resistance.

APPARATUS: p-n diode, voltmeter (0-1.5V), milliammeter (0-25 mA), connecting wires and potentiometer.

FORMULA

$$\textit{Forward Resistanc } R_f = \frac{\Delta V_f}{\Delta I_f} = \frac{V_2 - V_1}{I_2 - I_1}$$

Where

ΔV_f change in forward voltage

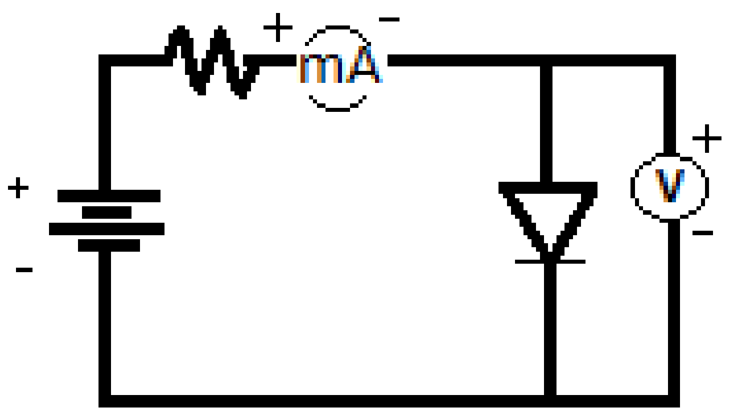
ΔI_f change in forward current

UNITS: Ohms (Ω)

PROCEDURE:

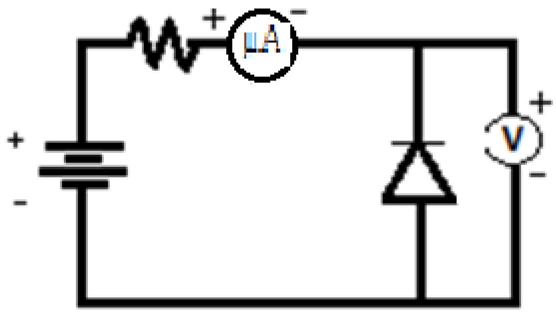
FORWARD BIASING:

Connect the positive terminal of the variable DC power supply to one end of the resistor, and the other end of the resistor is connected to the positive terminal of the milli-ammeter, and the negative terminal of the milli- ammeter is connected to the anode of the p-n junction diode. The power supply's negative terminal is directly connected to the cathode. Now connect the voltmeter across the diode such that the positive terminal is connected to the anode and the negative terminal is connected to the cathode. Now start the experiment by varying the power supply, note the voltage drop across the diode and the current passing through it. After taking the readings, plot the I-V characteristics to determine the forward resistance by drawing a tangent to the curve.

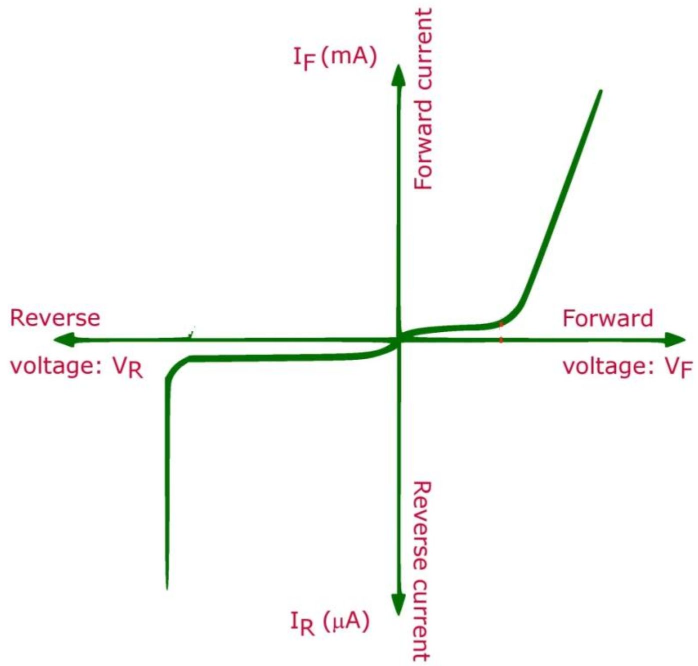


REVERSE BIASING:

Connect the positive terminal of the variable DC power supply to one end of the resistor, and the other end of the resistor is connected to the positive terminal of the miroammeter. The negative terminal of the miroammeter is connected to the cathode of the p–n junction diode. The negative terminal of the power supply is directly connected to the anode of the diode. Now connect the voltmeter across the diode such that the positive terminal is connected to the cathode and the negative terminal is connected to the anode . Start the experiment by varying the power supply, note the voltage drop across the diode and the current passing through it. After taking the readings, plot the I–V characteristics to determine the reverse saturation current.



MODEL GRAPH



OBSERVATION TABLE:

Forward bias	
Voltage (Volts)	Current (mA)

Reverse bias	
Voltage (Volts)	Current (μA)

Results:

Forward resistance = ……………………………Ω

Cut-in Voltage = …………………………………V

Teacher's Signature

SAMPLE VIVA QUESTIONS:

1. What is p-n junction?
2. What is depletion layer?
3. What is potential barrier?
4. What is forward biasing.
5. What is reverse biasing?
6. What is cut in voltage?
7. What is breakdown voltage?
8. What are majority charge carriers?
9. What are minority charge carriers?
10. Why the diode has low resistance in forward biasing
11. Why the diode has high resistance in reverse biasing.
12. Does diode

Calculations

2. ENERGY BAND GAP OF SEMICONDUCTOR

AIM: To find the energy band gap semiconductor using a diode in reverse bias.

APPARATUS: P-N diode, Variable DC power supply, voltmeter, micro ammeter, thermometer and heating arrangement for the diode.

FORMULA: Energy band gap of semiconductor (E_g) = slope x 2 x 1.38 x 10^{-23} Joule

OR

(E_g) = slope x 1.725 x 10^{-4} eV

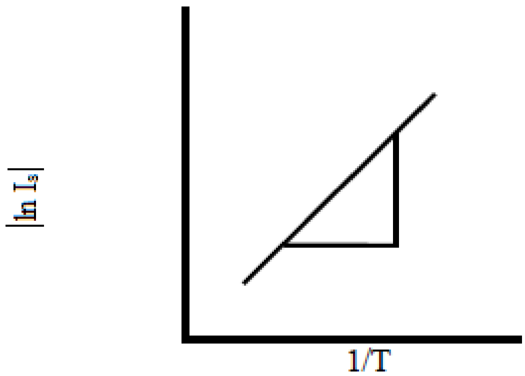
$$Slope = \frac{y_2 - y_1}{x_2 - x_1} = \frac{lnIs}{\frac{1}{T}}$$

Where

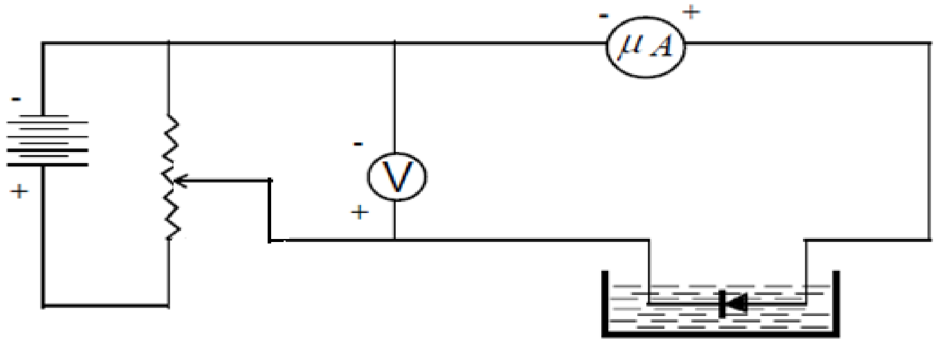
I_s is reverse saturation current

T is absolute temperature

MODEL GRAPH:



CIRCUIT DIAGRAM:



PROCEDURE:

The diode is placed in an oil bath. Now the diode is reverse biased by applying some potential difference. Note the current reading at room temperature before switching on the heater. Now switch on the heater and keep heating until the desired temperature is reached. Switch off the heater and note the current reading while the temperature of the diode decreases. Now plot the graph between the logarithm of I_s and 1/T a straight line is obtained in the graph. Now calculate the slope and substitute it into the formula to calculate the energy band gap in electron volts.

OBSERVATION TABLE:

Temperature		$\frac{1}{T}(K^{-1})$	Reverse bias current Is (μA)	lnIs
t^0 (C)	T(K)			
80				
75				
70				
65				
60				
55				
50				
45				
40				

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

Teacher's Signature

SAMPLE VIVA QUESTIONS:

1. **What do you mean by energy band in solids?**
2. **Define energy band gap.**
3. **What is the difference between a conductor, semiconductor, and insulator in terms of band gap?**
4. **What is the typical value of band gap for a semiconductor?**
5. **Give two examples of semiconductor materials and their band gap values.**
6. **What is the difference between valence band and conduction band?**
7. **Why does a semiconductor not conduct electricity at absolute zero temperature?**
8. **How does temperature affect the band gap of a semiconductor?**
9. **What is the difference between intrinsic and extrinsic semiconductor?**
10. **Why is silicon widely used in electronic devices?**

Calculations

3. B-H CURVE

AIM: To trace the hysteresis loop for ferromagnetic material using cathode ray oscilloscope and to evaluate the energy loss.

APPARATUS: Transformer, CRO, trace paper, resistors and connecting wire.

FORMULA:

$$\textbf{Energy loss} = \frac{N_1}{N_2} \, X \, \frac{R_2}{R_1} \, X \, \frac{C_2}{AL} \, X \, S_V \, X \, S_H \text{ X Area of the loop in } m^2$$

Where

Length of the specimen L = 0.28m

Area of cross-section A = 2 x 1.4 x 10^{-4} sq.m

No. of turns in the primary N_1 = 200 No. of

turns in the secondary N_2 = 400 Capacitance C

= 5.5x10^{-6} F

Resistance R_1 = 5, 22, 47Ω

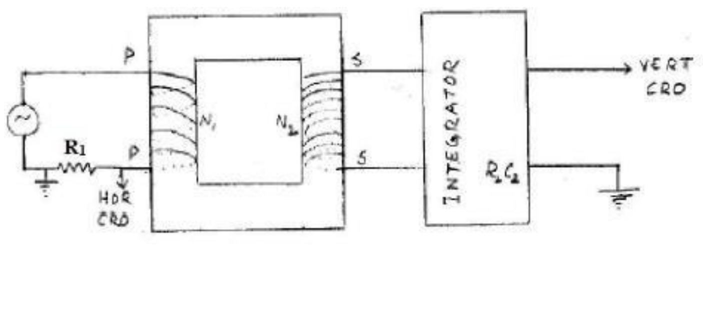
Resistance R_2 = 2.2x10^3Ω

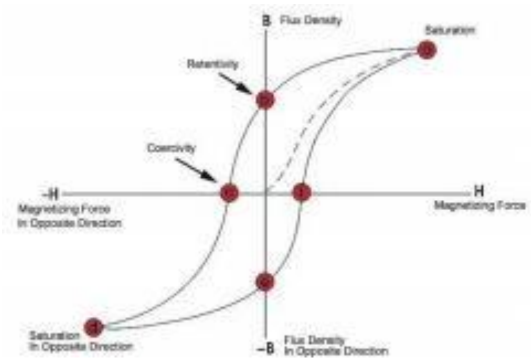
Horizontal sensitivity S_H in volt /m

Vertical sensitivity S_V in volt /m

UNITS: Joules/m^3/cycle

DIAGRAM:





PROCEDURE:

Connect R_1 in series to the primary coil of the transformer. Connect the horizontal input of cathode ray oscilloscope (CRO) across R_1 using coaxial cable, and connect the vertical input of CRO across C_2 in the secondary of the transformer using coaxial cable. Now adjust the vertical and horizontal channels volt/div knob for producing a loop with maximum area on the CRO screen. Now trace the loop on translucent graph paper for different values of R_1. Note the values of horizontal and vertical sensitivity using the volt/div. knob for different loops. Multiply the values of horizontal and vertical sensitivity each by 100 to convert it to volts/meter.

OBSERVATION TABLE:

Resistance R_1 (Ω)	Horizontal Sensitivity S_H (V/m)	Vertical Sensitivity S_V (V/m)	Area of the loop (m^2)	Energy loss (joule/m^3/cycle)

RESULT: The energy loss per unit volume per cycle is..........................Joule/m^3/cycle.

Teacher's Signature

SAMPLE VIVA QUESTIONS:

1. **What do B and H represent in the B–H curve?**
2. **What is magnetic hysteresis?**
3. **Why does the B–H curve form a loop instead of a straight line?**
4. **What is retentivity (residual magnetism)?**
5. **What is coercivity?**
6. **What information do we get from the area of the B–H loop?**
7. **Differentiate between soft magnetic and hard magnetic materials using the B–H curve.**
8. **Why is soft iron preferred in transformer cores?**
9. **Why are permanent magnets made from materials having a wide B–H loop?**
10. **What happens to the shape of the B–H curve if the material is heated above the**
11. **Curie temperature?**

4. SOLAR CELL

AIM: To study voltage current characteristics of the given solar cell and calculate the fill factor and series resistance.

APPARATUS: Solar cell, incandescent bulb, voltmeter, milliammeter, potentiometer and connecting wires.

FORMULA:

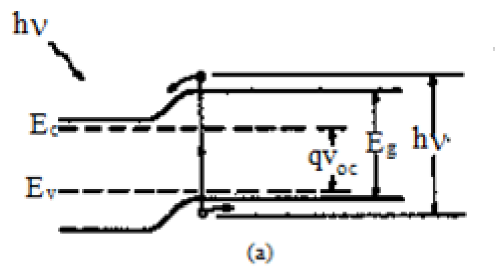
$$\textbf{FILL FACTOR} = \frac{I_m V_m}{I_{sc} V_{oc}} = \frac{\text{Maximum Area Rectangle}}{\text{Area of curve}}$$

Where

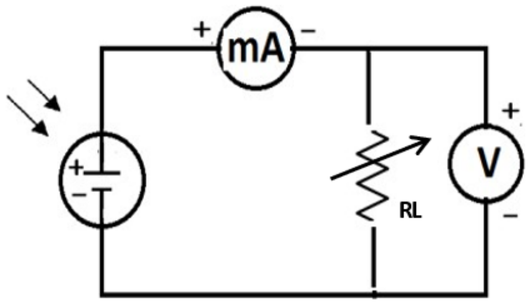
I_m is maximum current
V_m is maximum voltage
I_{sc} is short circuit current
V_{oc} is open circuit voltage

$$\textit{Series Resistance } R_S = \frac{1}{2} X \left[\frac{\Delta V_1}{\Delta I_1} + \frac{\Delta V_2}{\Delta I_2}\right]\Omega$$

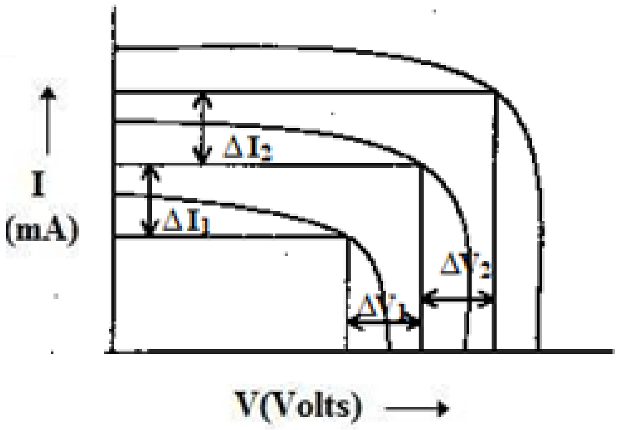
Energy band diagram of solar cell:



Circuit diagram:



Model graph:



PROCEDURE:

Connect the anode of the solar cell to the positive terminal of the ammeter and connect the negative terminal of the ammeter to one end of the load resistor, and the other end of the load resistor to the cathode of the solar cell. Then, connect the positive terminal of the voltmeter to the negative terminal of the ammeter, and the negative terminal of the voltmeter to the cathode of the solar cell.

Place the light source near the solar cell. Disconnect the load (R_L) from the solar cell and note the open circuit voltage (Voc) from the voltmeter, then short-circuit the load by shorting the two terminals of the load and note the short-circuit current (Isc). Now vary the load resistance and note down the readings of the voltmeter and ammeter. Repeat this process for another two sets of readings with different intensities of light by adjusting the distance of the bulb from the solar cell.

PRECAUTIONS:

1. See that the light from the source falls normally on the solar cell.
2. Make sure that connections are made properly and ensure good contact.

Observation Table

:

Voc = *Isc =*			*Voc =* *Isc =*			*Voc =* *Isc =*		
S. No.	*Voltage (V)*	*Current (mA)*	*S. No.*	*Voltage (V)*	*Current (mA)*	*S. No.*	*Voltage (V)*	*Current (mA)*

RESULT:

1. Fill Factor (FF) =……………

2. Series Resistance (R_s) = …………Ω

Teacher's Signature

SAMPLE VIVA QUESTIONS:

1. What is meant by solar cell?
2. What is the difference between Light Emitting Diode P-N junction and solar cell P-N junction?
3. What do you mean by Voc and Isc and explain them.
4. How does the power output of the solar cell depend on the wavelength of light falling on it?
5. On which parameter of the semiconductor, the solar efficiency mainly depends?
6. To improve the efficiency of the solar cell what are the necessary steps one has to take?
7. Explain the forward and reverse bias characteristics of the P-N junction?
8. What is the difference between photo conducting diode and photovoltaic diode?
9. How to select the semiconducting material for solar cell?
10. What is photocell?

Calculations

5. TEMPERATURE CHARACTERISTICS OF A THERMISTOR

Aim. To study the characteristics of Thermistor and to evaluate the constants.

APPARATUS: Thermistor, Wheatstone bridge, test tube containing oil, water bath and heater.

PRINCIPLE/THEORY:

A thermistor is a device sensitive to temperature variation. It consists of a mixture of oxides of cobalt, manganese; nickel with finely divided copper, The mixture is embedded in a ceramic base. It is provided with two platinum leads. Thermistors are available in many shapes such as discs, beads and rods etc. The fundamental property of a thermistor is its temperature dependence of resistance. The resistance of a thermistor has a non-linear variation with temperature. With the increase in temperature the resistance of a thermistor decreases exponentially as given by the relation $R = Ae^{\frac{B}{T}}$ ………………..(1)

Where A and B are constants and T the absolute temperature. The present experiment is to determine 'R' as a function of 'T' and to evaluate the constants A and B.

<u>FORMULA:</u>

Temperature coefficient of thermistor $\boldsymbol{\alpha = \frac{1}{R}\left(\frac{\Delta R}{\Delta T}\right) / K}$

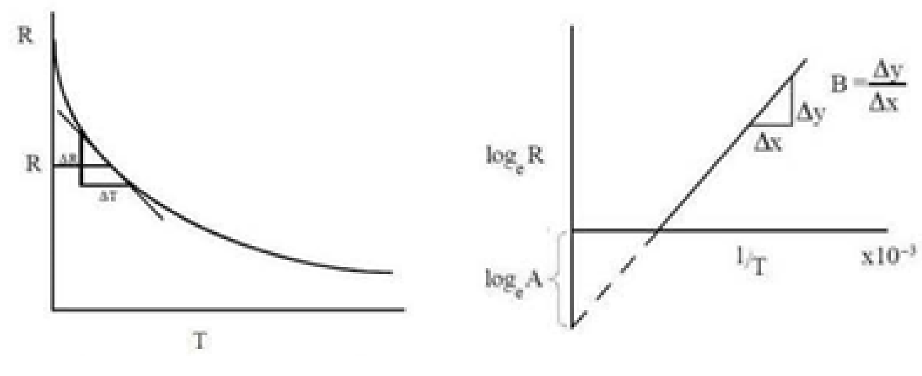
Thermistor constants A (ohms) and B (K)

A = e-x

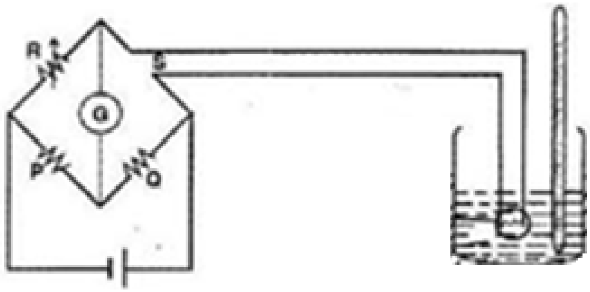
Where x is the value of negative Y intercept and B = dy / dx

(B is the slope of line drawn between $\frac{1}{T}\ V_s\ log_e$R)

<u>MODEL GRAPH:</u>



EXPERIMENTAL ARRANGEMENT:



PROCEDURE:

A Wheatstone bridge is set up as shown in the figure. The thermistor is connected in the fourth arm of the bridge, while P, Q, and R are from the other three arms. P and Q represent the ratio of arms. Both of them have equal resistance. The resistance 'R' is a variable resistance. The thermistor is placed in a oil bath. The temperature is noted. The variable resistance 'R' is adjusted such that the galvanometer shows no deflection. The resistance of 'R' is equal to the resistance of the thermistor. The resistance of the thermistor is measured at different temperatures at regular intervals. The resistance and corresponding temperatures are noted. Plot a graph between resistance and absolute temperature. To evaluate the resistance's temperature coefficient, a tangent is drawn to the curve at a suitable value of R.

OBSERVATION TABLE:

S.No.	Temperature of thermistor		$\frac{1}{T}$ (K^{-1})	Resistance of the thermistor R	$Log_e\, R$
	t^0 (C)	T(K)			

RESULTS:

1. Temperature coefficient of resistance…………………./K
2. The Value of constant A = ……………………………..Ω
3. The value of constant B = ………………………………K

Teacher's Signature

SAMPLE VIVA QUESTIONS:

1. What is thermistor?
2. What are the application of thermistor?
3. How thermistor are fabricated?
4. Why the resistance of thermistor decreases with increase in temperature?
5. What is the principle of wheastone bridge.
6. What is temperature coefficient of resistance? What is its units?

Calculations

6. TORSIONAL PENDULUM

Aim: To find the rigidity modulus wire using Torsional Pendulum.

Apparatus: A circular disc provided with chuck nut, steel wire, stop watch, screw gauge.

Formula:

$$\eta = \frac{4\Pi M R^2}{a^4} \frac{l}{T^2}$$

Where
M - mass of the disc

R - radius of the disc

a - radius of the wire

l- length of the wire

T - time period (time taken for one oscillation

Units: dynes/Cm^2

PROCEDURE:

A circular metal disc is suspended from a wire of the given length, as shown in the figure. Place your index finger in front of the mark on the disc. Now twist the notch slightly such that there is no lateral movement of the disc. When the disc is rotating, the time taken for given oscillations is noted with the help of a stopwatch. This is repeated twice, and the mean of the two trials is taken, and the time period is calculated. The experiment is repeated for different oscillations of the pendulum. The radius of the wire is measured using a screw gauge. The radius of the disc is measured with the scale, and the mass of the disc is taken to be 1000 grams. The mean value is substituted in the formula.

Radius of wire:

P.S.R	H.S.R.	(H.S.R × L.C)	T.R= P.S.R+(H.S. R×L.C)

S.No.	Number of Oscillations 'n'	Time taken for given oscillations			Time Period (T)	$\frac{l}{T^2}$
		Trial-1	Trial-2	Mean (t)		

Result: The rigidity modulus of the given wire is …...................... dynes/cm^2

Teacher's Signature

SAMPLE VIVA QUESTIONS:

1. What is a torsional pendulum?
2. What is the restoring force (or torque) acting in a torsional pendulum?
3. Define torsional rigidity (or modulus of rigidity).
4. What factors determine the time period of a torsional pendulum?
5. Give the formula for the time period of a torsional pendulum.
6. Why is a torsional pendulum used to measure the rigidity modulus of a wire?
7. How does the length and radius of the wire affect the oscillations of a torsional pendulum?
8. Why is damping usually small in a torsional pendulum experiment?
9. What is the advantage of using a torsional pendulum over an ordinary simple pendulum for experiments?
10. Name some practical applications of torsional pendulums.

7.LASER

AIM: To find the wavelength of laser source using diffraction grating.

APPARATUS: Laser Source, grating, Scale and Screen.

FORMULA: $\boldsymbol{\lambda = \frac{Sin\theta}{n.N}}$

Where

λ is wavelength of light

θ is angle of diffraction

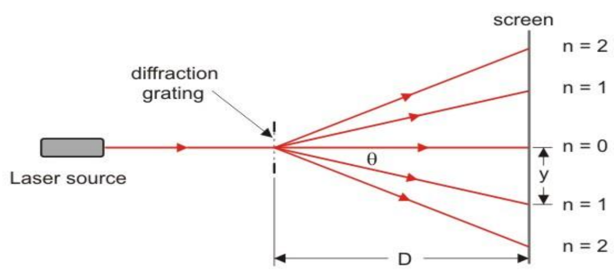
n is order of maximum

N is number of lines per centimeter on grating

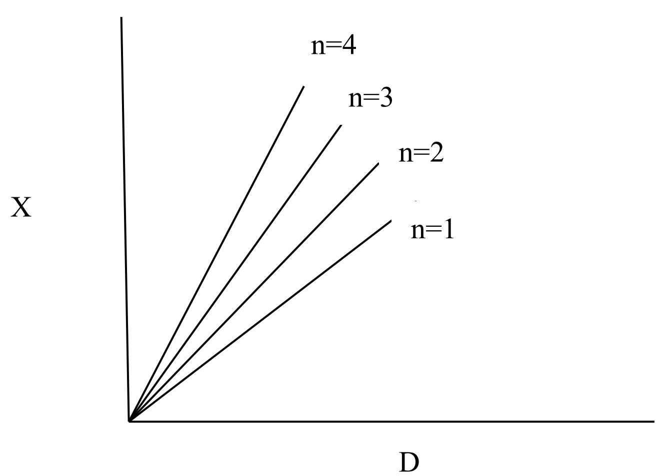
$N = \frac{No.\ of\ lines}{inch} = \frac{No.of\ lines}{2.54cm}$ Or $\frac{2500}{2.54} = 984.25$ lines/cm

Units: Å or Cm

DIAGRAM:



MODEL GRAPH:



PROCEDURE:

The laser diode module is mounted horizontally. A diffraction grating is placed on a stand at the same height and carefully aligned for normal incidence. When the laser is switched on, a diffraction pattern appears on the screen. This pattern is traced onto a sheet of plain paper. The distances between the central maximum and the corresponding order maxima on both sides are measured and recorded. This procedure is then repeated for different values of **D** (distance between the grating and the screen).

Now plot the graph between x and D for different order of maxima. A straight line graph is obtained.The slope of the graph gives tanθ. i.e., Slope = tan θ or θ = $\tan^{-1}$(slope) the wavelength λ can be calculated as $\lambda = \frac{Sin\theta}{n.N}$

OBSERVATION TABLE:

S.No.	Distance between grating and screen D(cm)	Order of diffraction n	Distance between central maximum and corresponding maxima (x)cm		$\theta = \tan^{-1}\left(\frac{X}{D}\right)$	Wavelength $\lambda = \frac{Sin\theta}{n.N}\ cm$
			Left	Right		
1		1 2 3				
2		1 2 3				
3		1 2 3				

RESUTLS: The wavelength of the given laser beam is λ =............................ **cm**

λ =………………….. **Å**

Teacher's Signature

SAMPLE VIVA QUESTIONS:

i. **What does LASER stand for?**
2. **What is the principle of laser action?**
3. **What is the difference between spontaneous emission and stimulated emission?**
4. **What is population inversion? Why is it necessary in lasers?**
5. **What is the role of the optical resonator (mirrors) in a laser?**
6. **Give two important characteristics of laser light.**
7. **What is the difference between ordinary light and laser light?**
8. **Name two types of lasers and their active medium.**
9. **Mention two applications of lasers in daily life or technology.**
10. **Why is laser light highly monochromatic and coherent?**

Calculations

8. OPTICAL FIBER

AIM: To calculate the numerical aperture and acceptance angle of an Optical Fiber.

APPARATUS: Optical Fiber Kit, few meters of Fiber Optical cable, N.A. Jig and screen.

PRINCIPLE: Total Internal reflection

FORMULA:

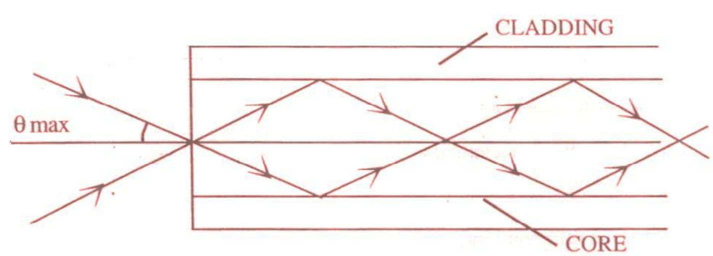
$$\text{Numerical Aperture} = \frac{W}{\sqrt{4L^2 + W^2}}$$

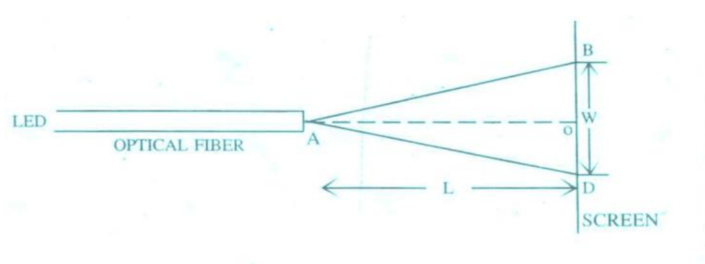
$$\text{Acceptance angle} = \alpha_m = \sin^{-1}(N.A.)$$

Where
W is diameter of the Light Spot
L is distance between Jig and Screen

UNITS:

Numerical Aperture = No unit
Acceptance angle = degrees





PROCEDURE:

Insert one end of the optical fibre cable in the allotted slot of the kit until you feel that the fibre is touching the micro lens of the kit. Do not push by applying undue force that may damage the micro-lens. Gently tighten the nut that holds the insert fibre firmly. Similarly, connect the other end to the N.A. jig nut. Set the variable intensity knob for the maximum position; a red spot appears on the screen. Measure the diameter of the spot. Measure the diameter (W) of the light spot by varying the distance between the screen and jig (L) and calculate the numerical aperture and acceptance angle for the corresponding values of W and L.

OBSERVATION:

S. No.	L(mm)	W(mm)	N.A.	$\theta_i(max)$
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

RESUTL:

Numerical Aperture (N.A) = --------------

Acceptance angle $\theta_i(max) =$ --------------

Teacher's Signature

SAMPLE VIVA QUESTIONS:

1. What is an optical fiber?
2. What principle does an optical fiber work on?
3. What is total internal reflection (TIR)?
4. What are the main parts of an optical fiber?
5. Differentiate between step-index and graded-index optical fibers.
6. What is numerical aperture (NA) in optical fiber?
7. What is acceptance angle in optical fibers?
8. What are the main advantages of optical fiber communication?
9. What is attenuation (loss) in optical fibers?
10. Mention two applications of optical fibers.

9.HALL EFFECT EXPERIMENT

Aim: To find the Hall Coefficient, Carrier concentration and Mobility of charge carrier of a given semiconducting material.

Apparatus: Semiconducting sample (Specimen), Hall Effect Setup, Hall Probe, Electromagnet, Constant current power supply and Digital Gauss meter.

Formula:

(i) $R_H = \frac{V_H \, X \, t}{I \, X \, B}$ Units: cm^3/Coulomb

Where

R_H = Hall Coefficient

V_H = Hall Voltage

I = Current through Specimen

B = Applied Magnetic field

(ii) $n = \frac{1}{R_H \; X \; e}$ Units: cm^{-3}

Where

n = Carrier Concentration

e = electric charge (4.803 x 10^{-10} statcoulomb)

R_H = Hall Coefficient

(iii) $\mu = \sigma \, X \, R_H$ Units: $cm^2.V^{-1}. Sec^{-1}$

Where

μ = Mobility of Charge Carrier

σ = Conductivity

R_H = Hall Coefficient

Note: (σ = 0.1coulomb/volt.sec.cm. for Ge Crystal)

PROCEDURE:

Place the Hall probe and specimen with the electrodes between the poles of electromagnet. Now set the current passing through the specimen. Now slowly increase the current through the solenoid which increases the magnetic field strength. Now note the Hall voltage for corresponding values of magnetic fields from Gauss meter. And plot the graph between magnetic field and Hall voltage as shown in the model graph.

PRECAUTIONS:

1. Keep the sample perpendicular to magnetic field.
2. Before switching on the Hall Effect setup see that all knobs are set to read zero.
3. Hall probe must be handling carefully.
4. Do not send the high current through the Electromagnetic for longer time.

OBSERVATION:

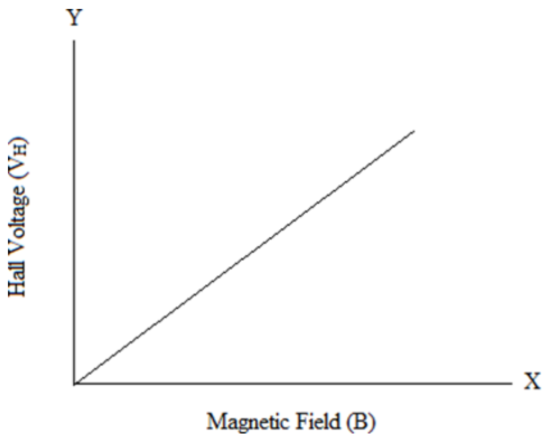
Thickness of the sample (t) = 0.2cm

Current passing through the specimen _____________mA.

Observation table

Corresponding Magnetic field (Gauss)	Hall Voltage V_H (mV)

Graph



Result:

1. Hall Coefficient (R_H) = ____ cm^3/Coulombs
2. Carrier Concentration (n) = ____________________________________ cm^{-3}
3. Mobility (μ) = ____ $cm^2.V^{-1}.Sec^{-1}$

Teacher's Signature.

SAMPLE VIVA QUESTIONS:

1. **What is the Hall effect?**
2. **Who discovered the Hall effect and when?**
3. **What is the principle of the Hall effect?**
4. **Define Hall voltage.**
5. **What factors does the Hall voltage depend on?**
6. **What is the Hall coefficient?**
7. **How can the Hall effect be used to determine the type of semiconductor (n-type or p-type)?**
8. **Name two applications of the Hall effect.**
9. **Why does Hall voltage change sign for n-type and p-type semiconductors?**
10. **What is the importance of Hall effect in magnetic field measurement?**

Calculations