

MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY

(SULTAN-UL-ULOOM EDUCATION SOCIETY)

BANJARA HILLS, HYDERABAD-500034

MANUAL OF PHYSICS PRACTICALS for B.E SEM-I&II 2021-2022

Name : _____

Hall Ticket No : _____

Class : _____

Section : _____

LIST OF STAFF MEMBERS

Physics Department

Teaching Staff

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| 2. Mr. Syed Ilyas Mohiuddin | Asst.Professor |
| 3. Mr. Raheem Ahmed | Asst.Professor |
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List of Experiments

- 1. P-N diode**
- 2. Solar Cell**
- 3. Hall Effect**
- 4. Laser**
- 5. Fibre Optics**
- 6. B-H Curve**
- 7. Torsional Pendulum**
- 8. Thermistor**

1. PN-DIODE CHARACTERISTICS

AIM : To study the V-I characteristics of PN junction diode and to find the forward and reverse resistance.

APPARATUS : p-n diode, voltmeters of range 0 – 1.5 V in forward bias and 0 – 15 V in reverse bias milliammeter 0 – 25 mA in FB and microammeter 0-250 micro Amp in RB, and potentiometer.

FORMULA

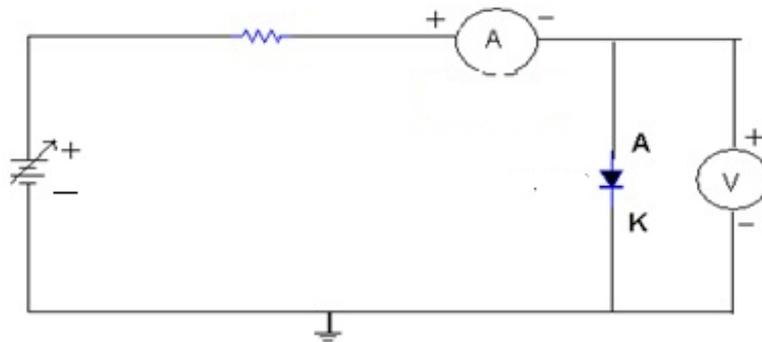
$$\text{Forward or Reverse resistances } (\Delta R) = R = \frac{V}{I} = \frac{\Delta V}{\Delta I} = \frac{x_2 - x_1}{y_2 - y_1}$$

units Ω

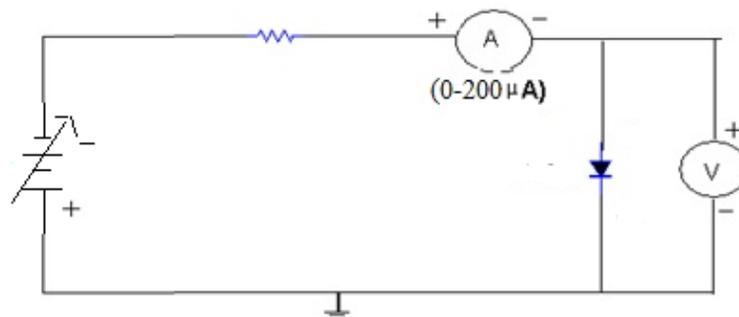
$$\left(\text{From Graph } \frac{x_2 - x_1}{y_2 - y_1} = \frac{1}{\text{Slope}} = \frac{\Delta V}{\Delta I \times 10^{-3}} \right)$$

CIRCUIT DIAGRAMS

Forward Bias Condition:



Reverse Bias Condition:



PROCEDURE :

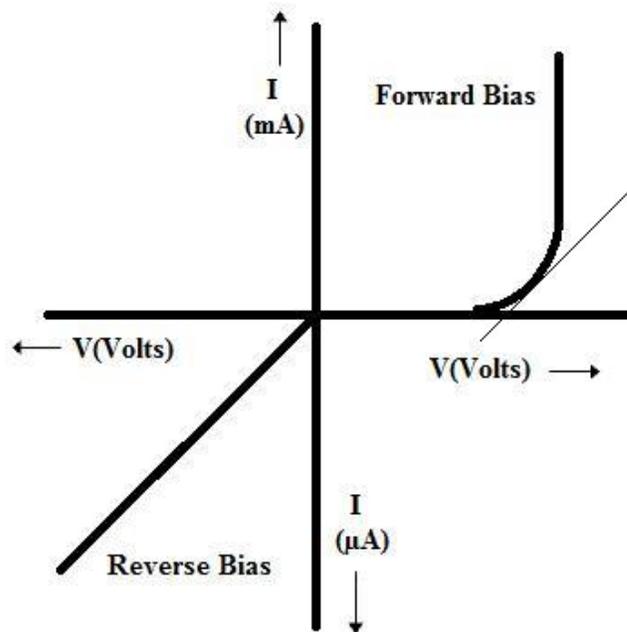
FORWARD BIASING:

Connect 0 – 15 V source in series with 1 KW resistor a milliammeter (0-25mA) and a Silicon diode with its p-side to positive terminal connect a voltmeter (0 – 1.5) across the diode as shown. Close the circuit and increase the voltage gradually in steps and note the corresponding currents. Draw a graph between voltage (on x-axis) and current (on y-axis).

REVERSE BIASING:

Connect a 0 – 15 V source in series with a 1 KW resistor, a microammeter (0 – 250A) and a silicon diode with its n-side connected to positive terminal, connect a voltmeter (0 – 15V) across the diode (as shown). Close the circuit and increase voltage gradually in steps and note the corresponding currents. Draw V – I graph by taking voltage on the negative x-axis and current on the negative y-axis of the same graph sheet containing forward biased characteristics. (as shown). Find the cutin voltage. Also find the forward and reverse bias resistances.

MODEL GRAPH



OBSERVATION TABLE:

FORWARD BIAS	
Voltage (Volts)	Current (mA)

REVERSE BIAS	
Voltage (Volts)	Current (μ A)

RESULTS:

Cut in voltage is V

Forward resistance is Ω

Reverse resistance is Ω

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 obey ohm's law?

Readings

Calculations

2. SOLARCELL

AIM: Plot the I-V characteristics of a solar cell and calculate the Fill factor (FF) and Series resistance (R_S)

APPARATUS: Solar cell, Illuminator, Voltmeter, Milliammeter and Potentiometer, etc.

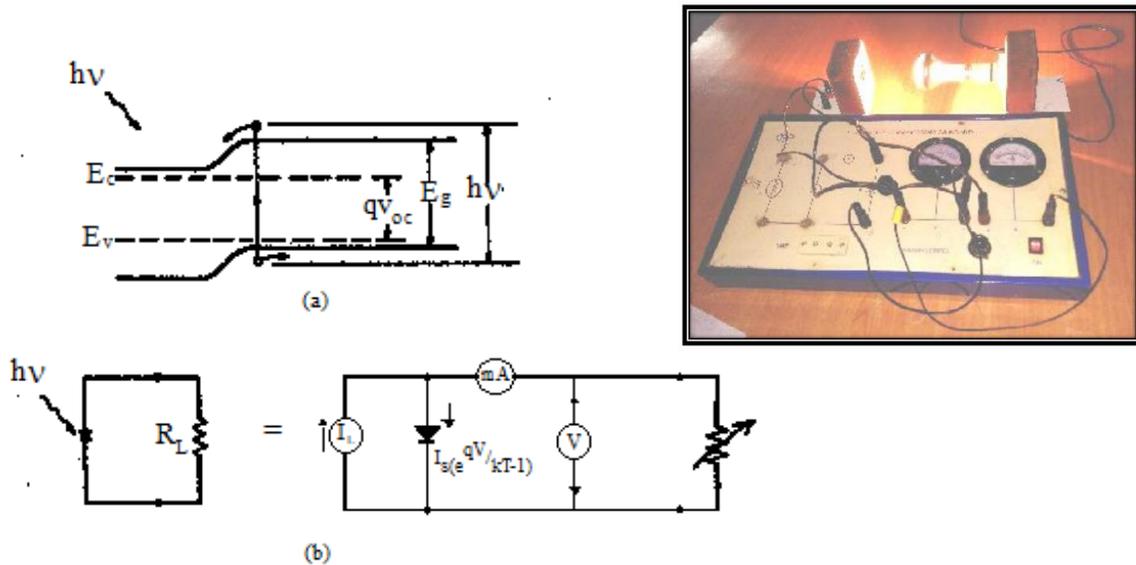
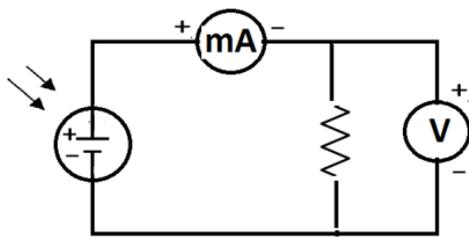


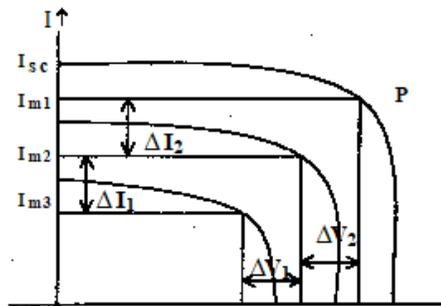
FIGURE - (a) Energy band diagram of a p-n junction solar cell under solar irradiation. (b) Idealized equivalent circuit of a solar cell

CIRCUIT DIAGRAM & Model Graph



Formula: - Fill Factor = $\frac{\text{Rectangle area}}{\text{curve area}}$ OR

And



$$\text{Fillfactor} = \frac{I_m V_m}{I_{sc} V_{oc}} = \frac{\text{Area of Rectangle}}{\text{Maximum curve area}}$$

$$\text{Series resistance} = \frac{1}{2} \times \left[\frac{\Delta V_1}{\Delta I_1} + \frac{\Delta V_2}{\Delta I_2} \right] \Omega \quad (I \text{ in mA})$$

at 20 cm and 25 cm, plot the graphs between V and I. Select a point 'P' on each curve and draw perpendicular lines from P onto both axes, such that the area covered by the rectangle is maximum. Note the V_m and I_m from each curve and calculate the fill factor for each curve, then find out the average fill factor. To find out the series resistance find the differences between two consecutive V_m and I_m .

RESULT:

1. Fill factor (F) =.....
2. Series Resistance (R_S) =

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.

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 V_{oc} and I_{sc} 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?

Readings

Calculations

3. LASER

AIM: To determine the wavelength of the given laser source.

APPARATUS: Laser diode module, grating, Scale and Screen etc.

FORMULA: $\lambda = \frac{\sin\theta}{n.N}$ Units Å or Cm

Where

λ is wavelength of light

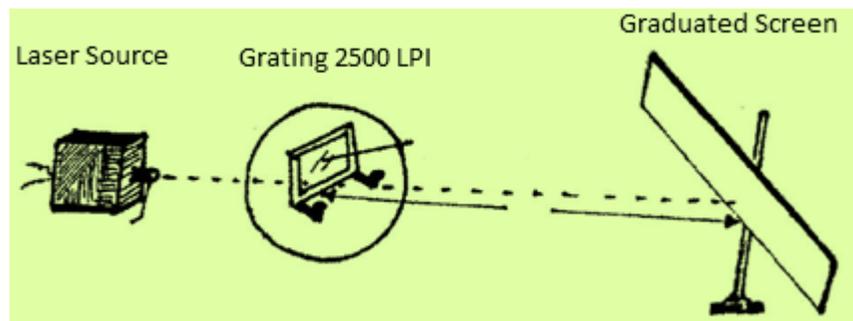
θ is angle of diffraction

n is order of maximum

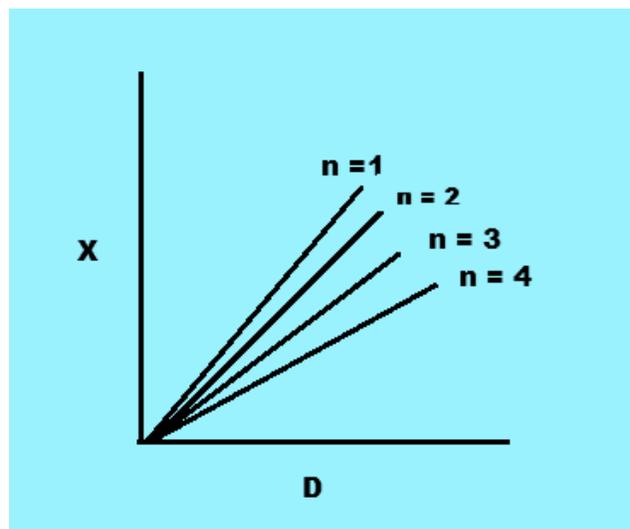
N is number of lines per/cm on grating

$$N = \frac{\text{No.of lines per inch}}{2.54} \quad \text{/cm}$$

DIAGRAM:



MODEL GRAPH:



PROCEDURE:

The laser diode module is mounted horizontally. A diffraction grating (2500LPI) is placed on a stand at the same height and adjusted for normal incidence. When laser is switched on, we get diffraction maxima on a scale placed at about 0.5m distance (D) with respect to grating. The distances between different orders on left and right side (2x) are measured and tabulate. This procedure is repeated for different values of D and the results are tabulated as follows

OBSERVATION TABLE:

S.No.	Distance between grating and screen (D cm)	Order of diffraction (n)	Distance between corresponding order (2x) cm	Distance between centre and maximum (x)cm	$\tan\theta = \left(\frac{X}{D}\right)$ $\theta = \tan^{-1}\left(\frac{X}{D}\right)$	$\sin\theta$	Wavelength $\lambda = \frac{\sin\theta}{n.N}\text{cm}$
1	50cm	1 2 3 4					
2	60cm	1 2 3 4					
3	70cm	1 2 3 4					
4	80cm	1 2 3 4					

Now draw graph between x and D for a given order. A straight line graph is obtained.

The slope of the graph gives $\tan\theta$. i.e., Slope = $\tan \theta$ or $\theta = \tan^{-1}(\text{slope})$

The wavelength λ can be calculated as $\lambda = \frac{\text{Sin}\theta}{n.N}$

Draw graph for other order maxima also.

RESUTLS: The wavelength of the given laser beam is $\lambda = \dots\dots\dots \text{\AA}$

Readings

Calculations

4. B-H CURVE

AIM: To trace the B-H loop (hysteresis) of a ferromagnetic specimen using a cathode ray oscilloscope and to evaluate the energy loss in the specimen.

APPARATUS: B-H curve tracer unit and C R O.

FORMULA & CIRCUIT DIAGRAM:

$$E_L = \frac{N_1}{N_2} \times \frac{R_2}{R_1} \times \frac{C_2}{AL} \times S_V \times S_H \times \text{Area of the loop in } m^2 \quad \text{joules/m}^3/\text{Cycle}$$

Where

Length of the specimen $L = 23 \text{ cm}$

Area of cross-section $A = 2 \times 1.4 \text{ sq. cm}$

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

No. of turns in the secondary $N_2 = 400$

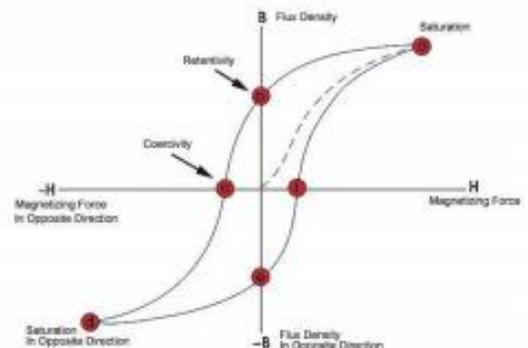
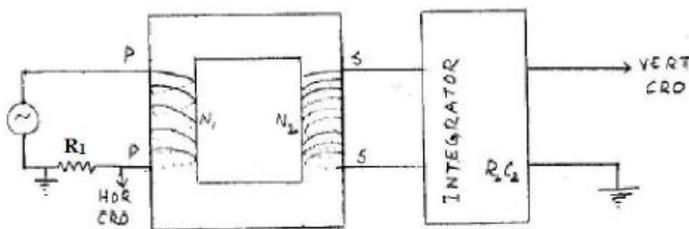
Capacitance $C_2 = 4.7 \text{ micro F}$

Resistance $R_1 = 5, 22, 47 \text{ Ohms}$

Resistance $R_2 = 4.5 \text{ k Ohm}$

Horizontal sensitivity $S_H = \dots\dots\dots \text{volt / m}$ Vertical sensitivity $S_V = \dots\dots\dots \text{volt / m}$

Area of the loop = $\dots\dots\dots \text{ sq.cm} = \dots\dots\dots \text{ sq.m}$



PROCEDURE:

- Connect A to D (A-D = 52 ohm; B-D = 18 ohm; C-D = 6 ohm). Connect the primary terminals of the specimen to P.P. and secondary to S.S terminals.
- Adjust the CRO to work on external mode (the time base is switched off). Adjust the horizontal and vertical position controls such that the spot is at the centre-of the CRO screen.
- Connect terminal marked GND to the ground of the CRO. Connect terminal H to the horizontal input of the CRO. Connect terminal V to the vertical input of the CRO. Switch on the powersupply of the unit. The Hysteresis loop is formed.
- Adjust the horizontal and vertical gains such that the loop occupies maximum area on the screen of the CRO. Once this adjustment is made do not disturb the gain controls.
- Trace the loop on a translucent graph paper. Estimate the area of the loop.
- Remove the connection from CRO without disturbing the horizontal and vertical gain controls.
- Determine the vertical sensitivity of the CRO by applying a known AC voltage say 1 volt (peak to peak). If the spot deflects by X cms for 1 volt, the vertical sensitivity is $10^2 / X$ (volt/m). Let it be S_v .
- Determine the horizontal sensitivity of CRO by applying AC voltage say 1 volt (peak to peak).
- Let the horizontal sensitivity be S (volt/m)

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)
5				
22				
47				

RESULT: The energy loss per unit volume per cycle is..... joule/m³/cycle.



Readings

Calculations

5. OPTICAL FIBER

AIM: To determine the Numerical Aperture of an Optical Fiber.

APPARATUS: Optical Fiber Kit, D.C. Power supply, 1 & 3 meter FO cable, N.A. Jig, adapter (9V) and connectors.

PRINCIPLE: Total Internal reflection

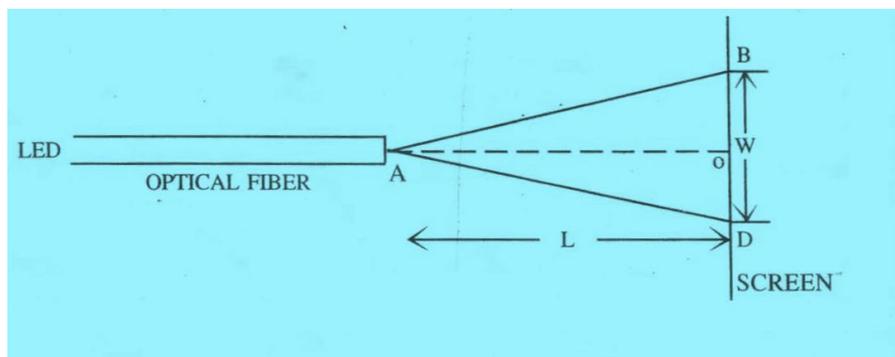
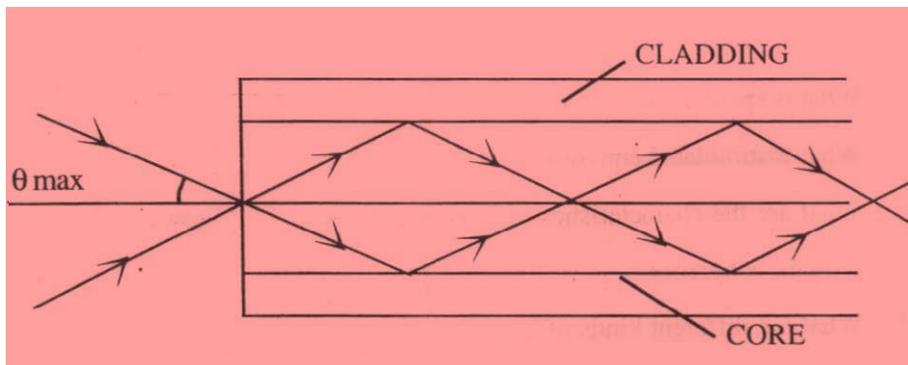
FORMULA: Numerical aperture N. A. = $\frac{W}{\sqrt{4L^2+W^2}}$

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

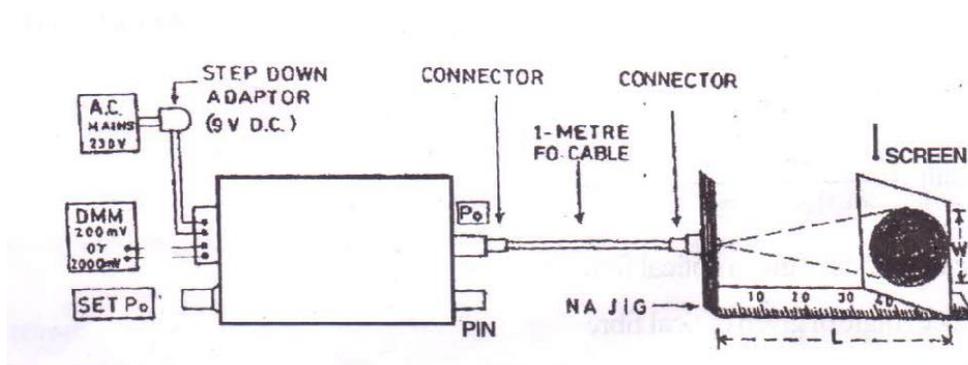
Where

W is diameter of the Light Spot

L is distance between Jig and Screen



PROCEDURE: The experiment arrangement is shown below.



The step by step procedure is as follows:

Step1: Insert one end of either one meter length plastic Optical Fiber cable in the allotted knob until you feel that the fiber is touching micro lens of kit. Do not push by applying undue force that may damage micro-lens. Gently tight the nut that holds the inserted fiber firmly. Similarly connect another end to N.A. Jig nut.

Step2: Connect power adapter pin into the Socket 'Vin' and plug to 230V AC Line. Switch on ON/OFF switch. Red light will appear at the end of the fiber in the NA kit. To set maximum output power turn 'SET Po / I_F' knob in clockwise direction. The red light intensity will increase to it is the maximum FO LED O/P Power.

Step3: Hold the provided Scaled screen at a distance of 10mm (L) on N.A. kit. A red spot appears on the Screen, measure the diameter (W) of the spot.

(DARK ROOM WILL FACILITATE BETTER VIEWING).

Substitute the measured values (L) and (W) in the N.A. formula.

Repeat the experiment for the distance of 15mm, 20mm, and 25mm etc., and note the readings in observation table.

OBSERVATION:

S. No.	L(mm)	W(mm)	N.A.	θ_{\max} (Degree)
1.				
2.				
3.				
4.				
5.				

RESUTL: Numerical Aperture NA -----

Acceptance angle is -----

Readings

Calculations

6. HALL EFFECT EXPERIMENT

Aim: To determine 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:

$$(i) \quad R_H = \frac{V_H \times t}{I \times B} \quad \text{Units: cm}^3/\text{Coulombs}$$

Where

R_H = Hall Coefficient

V_H = Hall Voltage

I = Current Through Specimen

B = Applied Magnetic field

$$(ii) \quad n = \frac{1}{R_H \times e} \quad \text{Units: cm}^{-3}$$

Where

n = Carrier Concentration

e = electric charge (1.6×10^{-19} coulomb)

R_H = Hall Coefficient

$$(iii) \quad \mu = \sigma \times R_H \quad \text{Units: cm}^2 \cdot \text{V}^{-1} \cdot \text{Sec}^{-1}$$

Where

μ = Mobility of Charge Carrier

σ = Conductivity

R_H = Hall Coefficient

Note: ($\sigma = 0.1$ coulomb/volt.sec.cm. for Ge Crystal)

Procedure:

Introduce the Hall probe in between the electromagnet's pole pieces (whose separation is kept constant) and slowly increases the current through the solenoids which increases the magnetic field strength and note down the corresponding magnetic field from Gauss meter.

Connect the widthwise connections of the Hall probe to the terminals marked as 'voltage' and lengthwise connections to the terminals marked as 'current' and switch 'ON' the Hall effect setup. Turn the knob towards current side and slowly adjust the current to few mA say 2 or 3mA (which is constant, flows through the sample). Then turn the knob towards the voltage side. This voltmeter measures the Hall voltage (V_H) appears in the voltmeter only when magnetic field is applied. But sometimes voltmeter may show some value (V_0) even in the absence of applied magnetic field. This voltage is due to the misalignment of widthwise connections in the sample. V_1 is the total voltage in the voltmeter which includes V_H & V_0 . Then Hall voltage for particular magnetic field is ($V_1 - V_0$). Through the specimen and note down the corresponding Hall voltage. Repeat the experiment for different values of magnetic field.

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:

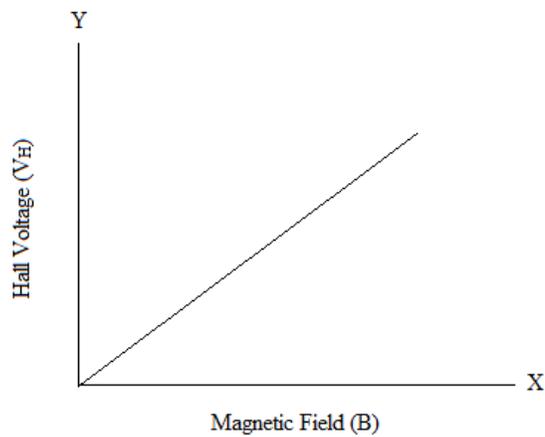
Thickness of the sample (t) = 0.5mm = $0.5 \times 10^{-3} \text{m} = 5 \times 10^{-4} \text{m}$

Current passing through the specimen _____ mA.

Tabular Coulumn:

S. No.	Current Passing Through Electromagnet (Amp)	Corresponding Magnetic field (Gauss)	Hall Voltage V_H (mV)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Graph:



Result:

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

Readings

Calculations

7. Torsional Pendulum

Aim :

To determine the rigidity modulus of the material of the wire.

Apparatus :

A circular disc provided with chuck nut (torsional pendulum), steel wire, stop watch, screw gauge, vernier calipers.

Introduction :

A torsional pendulum, or torsional oscillator, consists of a disk-like mass suspended from a thin rod or wire. When the mass is twisted about the axis of the wire, the wire exerts a torque on the mass, tending to rotate it back to its original position. If twisted and released, the mass will oscillate back and forth, executing simple harmonic motion. This is the angular version of the bouncing mass hanging from a spring. This gives us an idea of moment of inertia. We try to calculate the moment of inertia of a ring given the moment of a disc. We can also verify the perpendicular axis theorem and compare it with theoretically calculated values.

Procedure :

The circular metal disc is suspended to a wire of convenient length as shown in the figure-2.

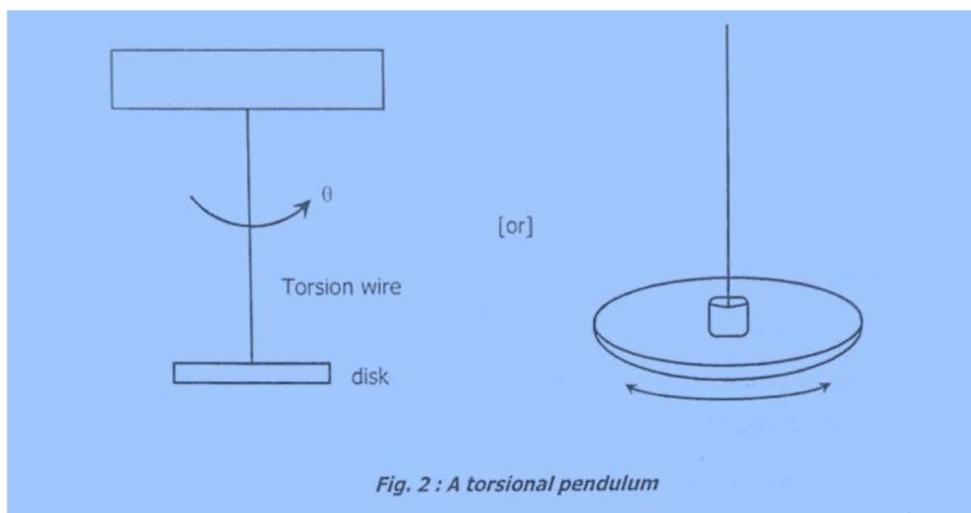


Fig. 2 : A torsional pendulum

A vertical pin (a small mark on the disk when it is in equilibrium) is placed in front of the disc. This will help to note the number of oscillations made by the disc. The disc is set to oscillate through small angles.

Care is to be taken to see that there is no lateral movement of the disc. When the disc is rotating, the time taken for 20 oscillations is noted with help of a stop watch. This is repeated twice and the mean of the two trials is taken. The time period (T) for one oscillation is calculated.

The experiment is repeated for different lengths of the pendulum. The radius of the wire [a] is to be found accurately with screw gauge because it occurs the fourth power in the equation [15]. The radius [R] of the disc is found with vernier calipers.

The mass [M] of the disc is obtained by balance. The mean value of the (ℓ / T^2) is substituted in the equation [15] and η is calculated.

$$\eta = \frac{4\pi MR^2}{a^4} \left[\frac{\ell}{T^2} \right] \dots\dots [15]$$

Table -1

S.No	Length of the wire (ℓ)	Time taken for 10 Oscillations (t)			Time Period (T=t/10)	ℓ/T^2
		Trial-1	Trial-2	Mean		

Readings

Calculations

8 TEMPERATURE CHARACTERISTICS OF A THERMISTOR

AIM: To draw the temperature versus resistance characteristics of a Thermistor and to evaluate the constants.

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

PRINCIPLE: A thermistor is a device sensitive to temperature variation. It consists of a mixture of oxides of cobalt, magnesium, 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 $R = Ae^{B/T}$ (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.

FORMULA :

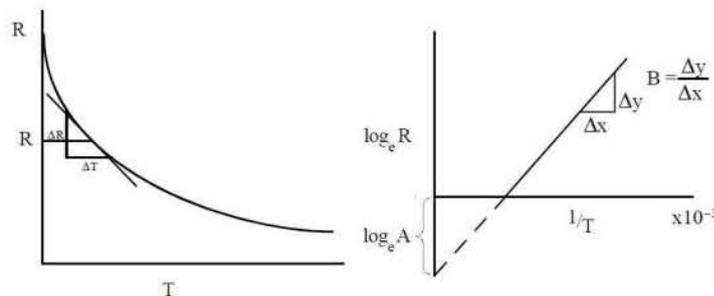
$$\text{Temperature coefficient of thermistor } \alpha = \frac{1}{R} \left(\frac{\Delta R}{\Delta T} \right) / K$$

Thermistor constants A (ohms) and B (K)

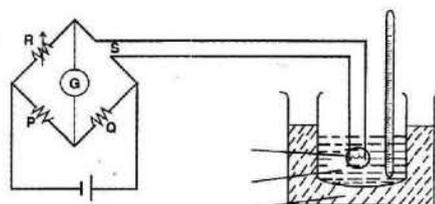
$A = e^{-x}$ where x is the value of negative y intercept and $B = dy / dx$

(B is the slope of line drawn between $1/T$ vs $\log_e R$)

MODEL GRAPH & CIRCUIT DIAGRAM



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 form the other three arms. P and Q represent the ratio arms. Both of them have equal resistance. The resistance 'R' is a variable resistance. The thermistor is placed in a tube containing transformer oil or groundnut oil. The test tube is placed in a water 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 resistance of thermistor. The water bath is heated until the water boils. Now the water is allowed to cool down. The resistance of the thermistor is measured at different temperatures at regular intervals of 10^0 C. The resistance and corresponding temperatures are noted in the table No.1. Plot a graph between resistance and absolute temperature as shown in model graph. From the graph it can be seen that 'R' decreases exponentially with increase in temperature. To evaluate the temperature coefficient of resistance a tangent is drawn to the curve at a suitable value of R as shown.

OBSERVATIONS:

Sl. No.	Temperature of thermistor		$1/T$	Resistance of the thermistor R	$\text{Log}_e R$
	t °C	T K			

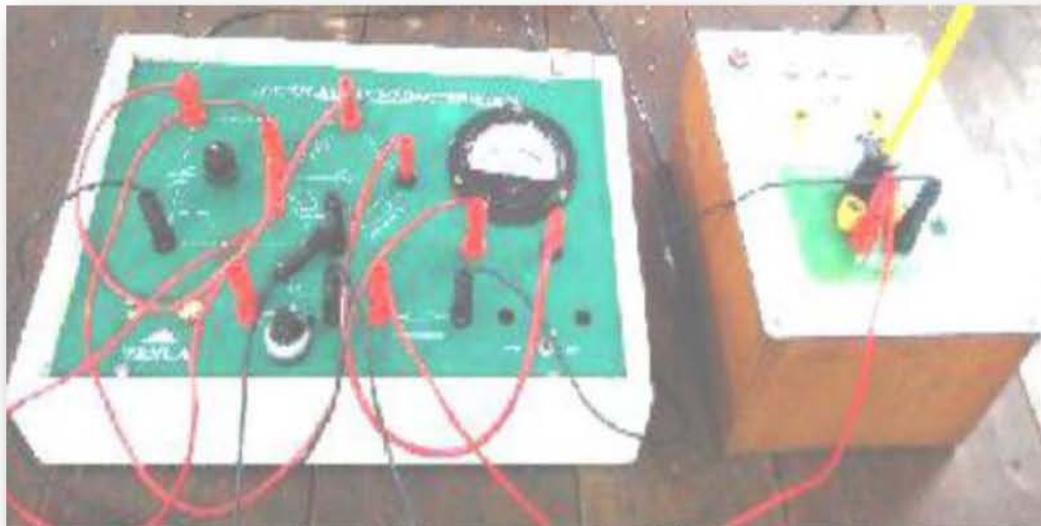
Table - I

RESULTS:

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

SAMPLE VIVA QUESTIONS:

1. What is thermistor?
2. What are applications of thermistor?
3. How thermistors are fabricated.
4. Why the resistance of a thermistor decreases with increase in temperature.
5. What is the principle of Wheatstone's bridge?
6. What is temperature coefficient of resistance? What is its unit?



Reading

Calculations