APPLIED PHYSICS

SEPH0009

STUDENT ID:

ACADEMIC YEAR: 2023-24

STUDENT NAME:

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A.Y. 2023-24 LAB/SKILL CONTINUOUS EVALUATION

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				Program/ Procedure (5M)	Data and Results (10M)	Analysis & Inference (10M)				
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S.No	Date	Experiment Name	Pre-Lab (10M)	In-Lab (25M)			Post-Lab (10M)	Viva Voce (5M)	Total (50M)	Faculty Signature
				Program/ Procedure (5M)	Data and Results (10M)	Analysis & Inference (10M)				
9.		**Determination of wavelength of Laser by Grating.**								
10.		**Determination of Acceptance angle and Numerical Aperture using fiber optic cable.**								
11.		**Determination of energy band gap of a given material**								

Experiment Title: Determination of Lattice Constant

Aim/Objective: To determine the lattice constant '**a**' of the given cubic crystal using powder X-ray diffraction film patterns.

Description:

This Section must contain detailed information pertaining to the Aim/Objective of the Laboratory Session

Pre-Requisites:

Crystal Structure, Bragg's Law, Miller Indices, XRD,

Pre-Lab:

1. State crystal structure?
2. List out various types of lattice parameters for identifying crystal structure?
3. Discuss significance of Miller Indices?
4. List out the factors effecting crystal structure?
5. Discuss the importance of lattice parameters in identifying the crystal structure.
6. Explain the types of unit cells
7. State lattice and basis.
8. Sketch the structures of SC,BCC and FCC
9. List out the examples of SC, BCC and FCC
10. Explain the significance of Crystal Grating.

In-Lab:

APPARATUS: Powder XRD film strip, Hull-Debye chart, scale

Figure 1. (a) Debye-Scherrer cylindrical camera; (b) Film mounted in camera; (c) Film on stretchout

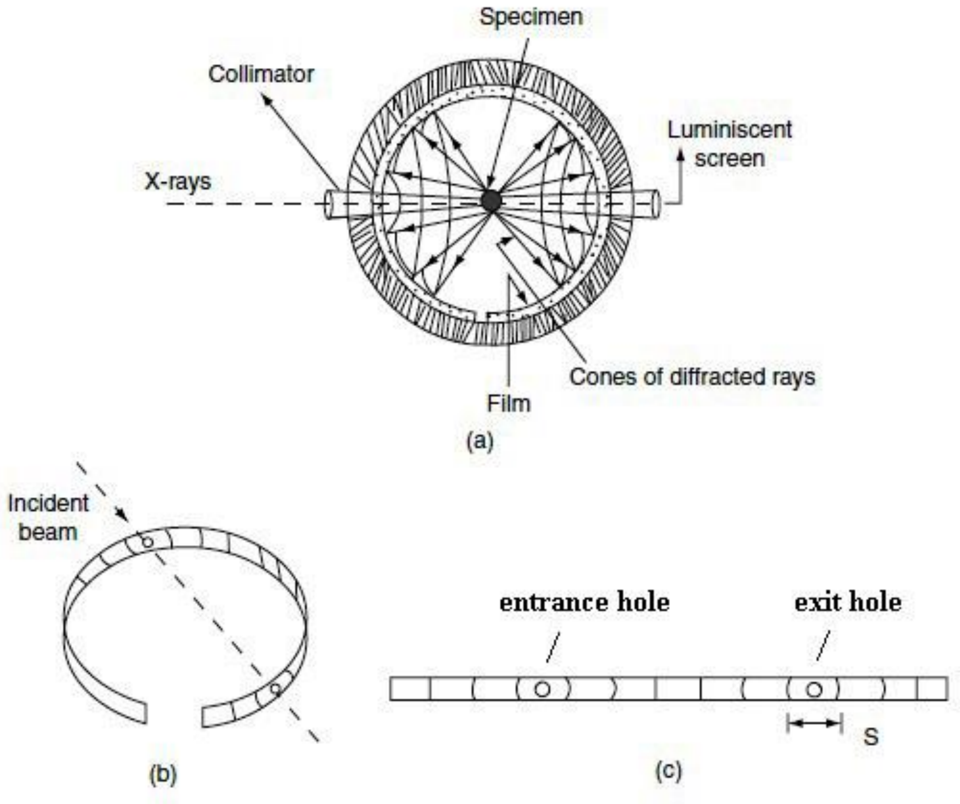


DIAGRAM:

FORMULA:

Let the distance between the two symmetric arcs around the exit hole corresponding to any particular crystal plane having miller indices **(hkl)** as measured from the stretched **powder XRD film strip** pattern be **S** and **R** be the inner radius of the Debye-Scherrer camera (See Fig. 1 (a-c). **R** value can either be collected from the data sheet provided by the manufacturer of the camera or be calculated from the distance between the centres of entrance hole and exit hole on the stretched film strip = πR).

- Then the Bragg angle θ for that particular crystal plane can be calculated from the equation

$$\theta = \frac{S}{4R} * \frac{180}{\pi} \qquad (1)$$

If **n** is the order of diffraction, **d** is the inter-planar distance for the particular set of Bragg's planes represented by the Miller Indices **(hkl),** and **λ** is the wavelength of incident monochromatic X-rays; then according to Bragg's law,

$$n\lambda = 2d\sin\theta$$

or

$$d = \frac{n\lambda}{2\sin\theta}, \text{ (in Å)} \qquad (2).$$

Using these inter-planar spacing **d**, and Miller Indices **(hkl)** values for different sets of Bragg's planes, the lattice constant **a**of the given cubic structured material can be calculated using the formula

$$a = d\sqrt{h^2 + k^2 + l^2}$$

or

$$a = \frac{n\lambda}{2\sin\theta}\sqrt{h^2 + k^2 + l^2}, \text{ (in Å)} \qquad (3).$$

PROCEDURE:

1. Place the Powder XRD film strip on the flat surface of the Comparator or Travelling Microscope and measure the distances **S** between different sets of symmetric arcs corresponding to different sets of Bragg's planes as shown in Fig. 1 (c).
2. Tabulate the values and calculate the diffraction angles **θ** for different sets of Bragg's planes using eq. (1).
3. Substitute the **θ** values in eq. (2) and calculate the inter-planar spacing **d** for different sets of Bragg's Planes.
4. Obtain the Miller Indices **(hkl)** of the Bragg's planes either from the Hull-Debye chart or from the standard XRD patterns of the specified samples or from any other standard calculation methods.
5. Substitute these **d** and **(hkl)** values in eq. (3) and calculate the lattice constant **a.**
6. Calculate the average value of lattice constant '**a**' of the given cubic structured crystalline solid material.

Data and Results:

OBSERVATIONS:

Radius of the Debye-Scherrer Camera, **R** = cm

Wavelength of incident X-rays, **λ** = **<u>1.542 Å</u>**(for Cu-K_α Radiation)

Diffraction Order **n** = 1

Table 1. <u>Copper (Cu) [FCC]</u>

S. No.	**Distance between the two symmetric arcs S (cm)**	**Bragg's angle** $\theta = \frac{S}{4R} \times \frac{180}{\pi}$ **(degrees)**	**Inter-planar separation** $d = \frac{n\lambda}{2\sin\theta}$ **(Å)**	**Miller Indices (hkl)**	**Lattice Constant** $a = d\sqrt{h^2+k^2+l^2}$ **(Å)**
1					
2					
3					

Average **lattice parameter** = Å.

Table 2. <u>Tungsten (W)[BCC]</u>

S. No.	**Distance between the two symmetric arcs S (cm)**	**Bragg's angle** $\theta = \frac{S}{4R} \times \frac{180}{\pi}$ **(degrees)**	**Inter-planar separation** $d = \frac{n\lambda}{2\sin\theta}$ **(Å)**	**Miller Indices (hkl)**	**Lattice Constant** $a = d\sqrt{h^2+k^2+l^2}$ **(Å)**
1					
2					
3					

Average **lattice parameter** = Å.

Supplementary Procedure to obtain the (hkl) Values from the Hull-Debye Chart: (for information / demonstration purpose only, and not for presenting in the examination).

1. Standard Hull-Debye chart for a particular crystal system represents Lattice Constant **a** versus inter-planar spacing **d** graphs for several possible orientations of Bragg's planes represented by different Miller indices (hkl).
2. Take a rectangular strip of graph sheet and mark your inter-planar spacing **d** values as vertical lines on the graph strip along the one-dimensional X-axis by taking the scale as same as the scale on the X-axis of the Standard Hull-Debye Chart provided to you.
3. Move the graph strip along the Y-axis direction until as maximum number of your obtained **d-** values as possible exactly coincide with different graphs on the chart simultaneously at a particular value of **a** on Y-axis as shown in Fig. 2.
4. Identify the related **(hkl)** values and tabulate them for the corresponding **d**-values.

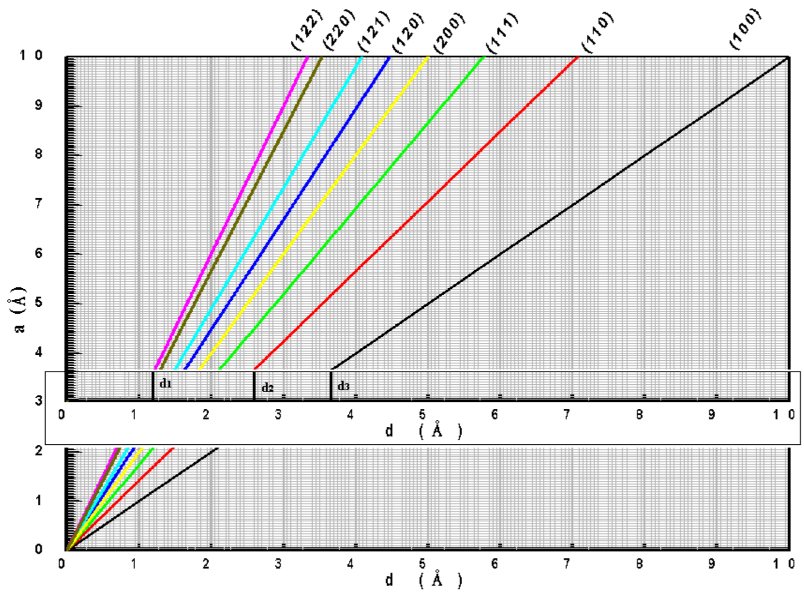


Fig.2. Determination of **(hkl)** values from the known **d** values from the Hull-Debye chart

Analysis and Inferences:

PRECAUTIONS:

1. While taking reading, move the comparator or travelling microscope in only one direction (either towards right side or towards left side).

2. Take readings without parallax error.

RESULT: Using the Powder XRD Film pattern, the Lattice Constant of the given cubic crystalline material is determined as **a** = Å for Cu [$a_{standard}$ = 3.61 Å] and

= Å for W [$a_{standard}$ = 3.16 Å].

VIVA QUESTIONS:

1. State the principle behind the X-Ray Crystallography?
2. List out the uses of XRD?
3. Explain significance of Bragg's Law?
4. How are X-rays produced?
5. State interplanar spacing.
6. Mention some of the crystal planes
7. Discuss the role of crystal planes in diffraction pattern.
8. State interplanar Spacing.
9. Explain the millerr indices significance
10. State the difference between Bragg's angle and Diffraction Angle.

Post-Lab:

The determination of crystalline planes for given cubic materials.

- **Procedure/Program:**

  This Section is meant for the student to Write the program/Procedure for Experiment

  (Leave at least 2-3 Pages for each Procedure/ Program/ Solution)

- **Data and Results:**

This Section is meant for the students to collect, record the results generated during the Program/Experiment execution. Include instructions on how to present the results, such as creating tables, graphs, or visualizations.

(Leave at least 1 Page for recording the results)

Evaluator Remark (if Any):	**Marks Secured: _____out of 50**
	Signature of the Evaluator with Date

Evaluator MUST ask Viva-voce prior to signing and posting marks for each experiment.

Experiment Title: PARTICLE SIZE BY LASER DIFFRACTION

Aim/Objective: To determine particle size of lycopodium powder by LASER diffraction.

Description:

This Section must contain detailed information pertaining to the Aim/Objective of the Laboratory Session

Pre-Requisites:

Understanding of Particle size analysis methods, Sample characteristics, Particle description, Sample Size

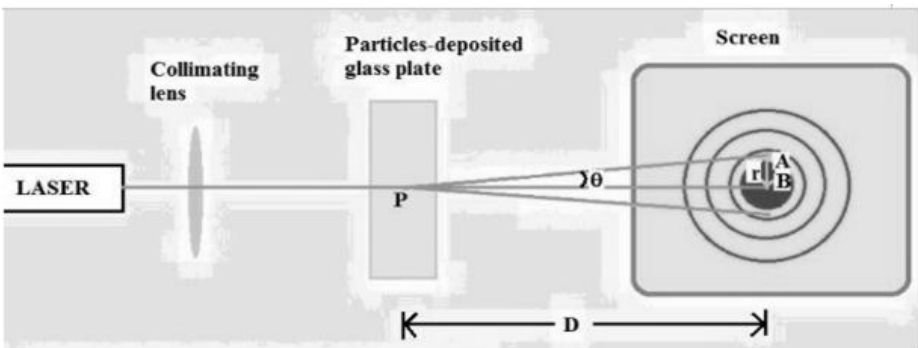
Pre-Lab:

1. State the principle behind particle size analysis using laser diffraction?
2. Write the meaning of LASER
3. Discuss the advantages of using laser diffraction over particle size analysis techniques?
4. Can laser diffraction be used for both dry and wet samples.
5. State diffraction.
6. Discuss the types of diffraction.
7. List out the types of LASER
8. Mention the units for Wavelength

In-Lab:

APPARATUS: Diode LASER, Glass plate containing fine lycopodium powder, Screen, Scale

DIAGRAM:



FORMULA:

Particle size (d) = $\frac{n\lambda D}{r}$ **μm**

Where,

'**λ**' is the wavelength of laser light (**6900 Å**)

'**D**' is the distance between glass plate and screen (cm)
'**r**' is the distance between central maximum and n^{th} order bright fringe (cm)

'**n**' is the order of the fringe.

PROCEDURE:

- A plane glass plate with the lycopodium powder of particle size in the range of micrometer sprayed over it is taken.
- The powder sprayed glass plate is kept in between the LASER source and the screen (wall in our case).
- The LASER beam is allowed to fall on the glass plate, then the LASER beam gets diffracted by the particles present on the glass plate.
- A good diffraction pattern (rings) on the screen should be obtained by adjusting the distance between the glass plate and the screen.
- Measure the distance between the glass plate and the screen (**D**) only after obtaining good diffraction pattern on the screen.
- Then, measure the distance between the central maximum and several ordered (**n = 1, 2, 3**) bright fringes (**r**).
- Substitute the values in the given formula and find the size of the particle of the given powder using the given formula.
- Then, change the distance between the glass plate and the screen (**D**) and repeat the aforementioned procedure to tabulate the values.
- Find the average particle size in '**cm**' and convert it into micrometer (**μm**).
- Finally, write the result.

PRECAUTIONS:

1. LASER source, lens, glass plate and screen should be rectilinear at the same height.
2. The LASER light should not be seen directly.
3. Diffraction fringes should be clear.
4. Measurements should be taken without parallax error.

OBSERVATION TABLE:

S.No.	**Distance between the glass plate and the screen (D) (cm)**	**Order (n)**	**Distance between central maximum and n^{th} order bright fringe (r) (cm)**	**Particle size (d) = $\frac{n\lambda D}{r}$ (Å)**
1		1		
		2		
		3		
2		1		
		2		
		3		
3		1		
		2		
		3		
4		1		
		2		
		3		

Average size of the particle (d) = **Å**

RESULT:

The average particle size of the lycopodium powder (**d**) is determined to be µm

VIVA QUESTIONS:

1. Discuss the principle behind particle size analysis by laser diffraction?
2. Mention the safety precautions should be taken when conducting a laser diffraction experiment?
3. Discuss the role of lycopodium powder in getting diffraction?
4. Mention the effect in diffraction pattern observed if the distance between screen and glass plate increased.
5. For higher distances, the diffraction rings diameter increases or decreases.
6. Mention the number of orders of diffraction pattern observed during the experiment.
7. Mention the color of the LASER used in the experiment and its wavelength.
8. Do diffracted waves interfere with each other?
9. List out the characteristics of LASER.
10. State the interference phenomenon.

Post-Lab:

Determine the Particle Size of a given powder using various colours of Laser.

- **Procedure/Program:**

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- **Analysis and Inferences:**

This Section is meant for the students to analyse their data, perform calculations Include questions or prompts to encourage critical thinking and interpretation of the data.

(Leave at least 1 Page for recording the analysis and inferences)

Evaluator Remark (if Any):	**Marks Secured: _____out of 50**
	Signature of the Evaluator with Date

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Experiment Title: YOUNG'S MODULUS BY UNIFORM BENDING METHOD

Aim/Objective: To determine the Young's Modulus of a given material by uniform bending method.

Description:

This Section must contain detailed information pertaining to the Aim/Objective of the Laboratory Session

Pre-Requisites:

Young's Modulus, Specimen dimensions, Moment of Inertia Calculations.

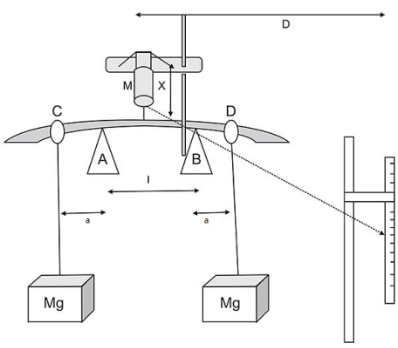
Pre-Lab:

1. State Young's Modulus?
2. Discuss the differences between stress and strain.
3. List out the various types of Modulii of Elasticity
4. List out the some of the mechanical properties of material.
5. Discuss the significance of Young's modulus of a material.
6. Discuss the use of Travelling Microscope.
7. Mention the least count of travelling microscope.
8. Discuss the significance of least count of a material.

In-Lab:

APPARATUS: A metal beam of iron/steel/wood strip having a uniform rectangular cross section, two knife edge supporters, pin, two weight hangers, meter scale, travelling microscope, vernier calipers and screw gauge.

DIAGRAM:



FORMULA:

Young's Modulus of a beam of rectangular cross section is given by

$$Y = \frac{3gal^2}{2bd^3}\left(\frac{M}{e}\right) \text{Dynes/cm}^2$$

g = acceleration due to gravity in cm/s^2

l = length of the beam between two knife edge supports in cm

a = distance on each side between the knife edge support and place from where weight hanger is hung in cm

b = breadth of the beam in cm

d = thickness of the beam in cm

M = Mass hung from each weight hanger in gm

e = elevation of the midpoint due to a mass M in cm

PROCEDURE:

- The arrangements are made as shown in the diagram.
- The length *l* of the beam between C and D is adjusted to 50 cm.
- The weight hangers are suspended at E and F at a distance of 15 cm from C and D.
- The pin is fixed vertically with wax at the midpoint N of AB=l m of the beam.
- The travelling microscope is brought before N and is focused such that the horizontal cross wire coincides tangentially with the tip of the pin.
- The reading on the vertical scale is noted as Z_0. Let each weight hanger has a mass M_0.
- Now a mass M of 50 gm is added on either weight hanger and the reading of travelling microscope is noted as Z.
- Now e = Z-Z_0 is the elevation of the midpoint for a mass M (on either side).
- Next the masses are increased each time by 50 gm and the corresponding reading Z is noted and e is calculated.
- This process is continued upto a mass of 200 gm.
- Now, the weights are gradually decreased, each time by 50 gm and the readings (with mass decreased) are taken once again and entered into the Table 1.
- Average value of $\left(\frac{M}{e}\right)$ is found from Table 1.

- The value of $\left(\frac{M}{e}\right)$ can also be found from graph between M and e. Substituting these values in the equation, we can calculate Y.

OBSERVATION:

1 MSD on travelling microscope = 0.05 cm,

Total no. of Vernier divisions = 50,

LC of travelling microscope = 1MSD/ total no. of Vernier divisions = 0.05/50 = **0.001 cm**

OBSERVATION TABLE:

Mass (M) gm	**Increasing load**			**Decreasing Load**			**Mean Z** $= \frac{a+b}{2}$	$e = z \sim z_0$ **cm**	$\frac{M}{e}$
	MSR	**VC**	**MSR+(V.C *L.C) (a)**	**MSR**	**VC**	**MSR+(V.C *L.C)(b)**			**gm/cm**
Only weight hanger (50)									---
100									
150									
200									
250									

Average value of $\frac{M}{e}$ = gm/cm

Calculations:

Average value of $\left(\frac{M}{e}\right)$ = gm/cm

Distance between knife edge bridges l= 50 cm

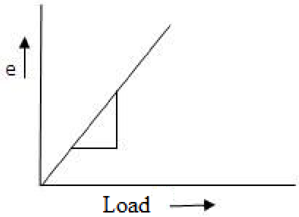
Distance from knife edge to weight hanger a = 15 cm

Breadth of beam b =2.54 cm

Thickness of beam d = 0.6 cm

Young's Modulus of material of given beam $Y = \frac{3gal^2}{2bd^3}\left(\frac{M}{e}\right)$ **Dyne/cm^2**

GRAPH:



$\left(\frac{M}{e}\right)$ **from graph is to be substituted in the formula for** $Y = \frac{3gal^2}{2bd^3}\left(\frac{M}{e}\right)$ **Dyne/cm^2**

PRECAUTIONS:

1. The beam should be placed symmetrically on the knife edges.
2. Weights should be suspended symmetrically.
3. The adjustment screw of travelling microscope should always be rotated in the same direction once the reading is started taking.

RESULT:

Young's modulus of given material = **Dyne/cm^2**(From observations)

= **Dyne/cm^2**(From graph)

VIVA QUESTIONS:

1. Mention the SI units of Young’s Modulus?
2. How can you verify the accuracy of the obtained young’s modulus value in the experiment?
3. How the Young’s modulus relate with the stress and strain?
4. State Hook’s law.
5. Mention the procedure to find the Young’s modulus of a material from the stress-strain curve.
6. Discuss the role of knife edges in the determination of Young’s Modulus.
7. Is the spectrometer is used for this experiment.
8. Mention the measurement of Least count of Travelling microscope.
9. If the thickness and length of the material changes, young’s modulus will change or not.
10. List out the various types of stress and strain of a material.

Post-Lab:

To determine the Young's Modulus of a given material (Wood and Plastic) by uniform bending method.

- **Procedure/Program:**

  This Section is meant for the student to Write the program/Procedure for Experiment

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Experiment Title: CREEP BEHAVIOUR OF A METAL WIRE

Description:

Aim/Objective: To determine creep constant of a given material.

Pre-Requisites:

Creep Behaviour, Creep Mechanisms, Temperature and Stress effect, Creep behaviour of materials, Applications

Pre-Lab:

1. Discuss the purpose of the conducting the creep behaviour experiment on material wire?
2. State the property creep.
3. Discuss different stages of creep.
4. State Viscous Creep
5. State Transient Creep.
6. Is the property depends upon the time or not.
7. Mention the applications of studying the property creep.
8. How do you prepare the material wire specimen before conducting the creep testing?
9. Explain its significance in engineering materials?

In-Lab:

APPARATUS: Lead wire of 30 cm length, retort stand, weight carriers, stop clock, check nut.

THEORY:

Most of the materials obey Hooke's law within the elastic limit and hence linear behavior in the stress – strain diagram is observed. However, conventional stress – strain diagram does not fully represent the behavior of certain engineering materials under tension. The deformation under load take place continuously at a decreasing rate over long periods. This time dependent elongation phenomenon is called creep.

At elevated temperatures and constant stress or load, many materials continue to deform at a slow rate. This behavior is called creep. At a constant stress and temperature, the rate of creep is approximately constant for a long period of time. After this period of time and after a certain amount of deformation, the rate of creep increases, and fracture soon follows. This is illustrated in Figure 1.

Initially, primary or transient creep occurs in Stage I. The creep rate, (the slope of the curve) is high at first, but it soon decreases. This is followed by secondary (or steady-state) creep in Stage II, when the creep rate is small and the strain increases very slowly with time. Eventually, in Stage III (tertiary or accelerating creep), the creep rate increases more rapidly and the strain may become so large that it results in failure.

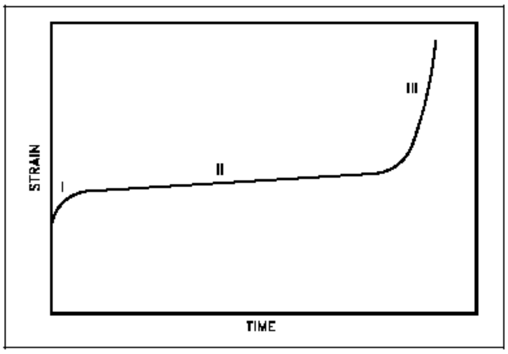
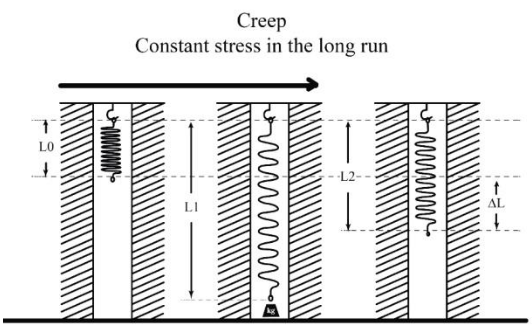


Fig.1 Successive stages of Creep

Hence, creep is the slow progressive deformation of the material under constant stress. Creep is thermally activated process due to its dependence on temperature and time. Some of the mechanisms of creep which are more significant are

i) Movement of delay dislocations
ii) Diffusion of vacancies
iii) Sliding of neighbouring grains

DIAGRAM:



FORMULA:

Transient Creep Constant $(\beta) = \frac{\left(\frac{\Delta l}{l_0}\right)}{t^{1/3}}$

Viscous Creep Constant $(k) = \frac{\left(\frac{\Delta l}{l_t}\right)}{t}$

Where,

l_0 is the initial length of the wire (cm)

l_t is the instantaneous length of the wire (cm)

t is time (sec)

Procedure:

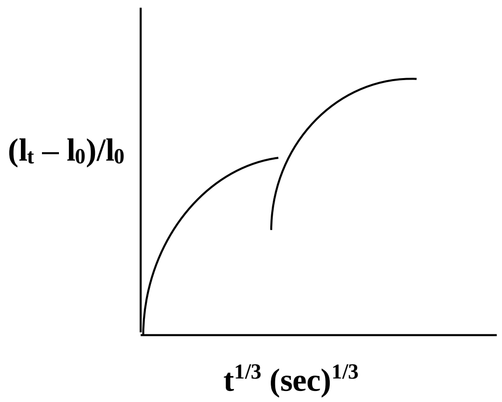
- In the experiment, in order to explain the concept of creep, the material chosen is the soldering lead wire used for winding the electronic circuiting.
- A convenient length of this wire 15 cm approximately was taken and one end of this wire is clamped to the retort stand with the help of check nut.
- The other end of this wire is tied to the weight carrier, where load can be added as shown in the figure.
- A known constant weight of approximately 200gm is placed on the weight carrier.
- Because of the tension applied to the wire, there will be elongation, which is to be noted for every 3 or 5 minutes.
- The data is tabulated.
- A graph is drawn between $\mathbf{\Delta l/l_0}$ vs $\mathbf{t^{1/3}}$ in order to obtain transient creep (β), slope of the plot is calculated.
- A graph is drawn between $\mathbf{\Delta l/l_t}$ vs $\mathbf{t}$ in order to obtain viscous creep (k), slope of the plot is calculated.

OBSERVATION TABLE:

Initial length of the wire (l_o) = cm

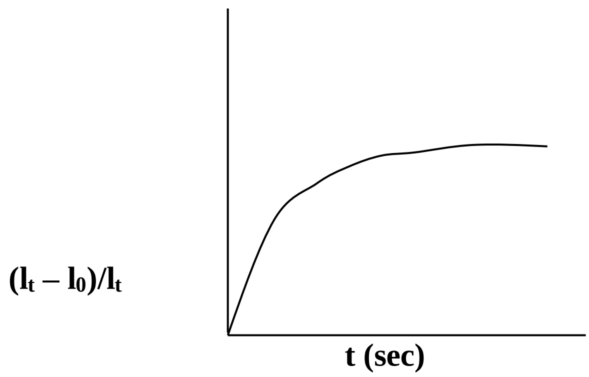
S. No.	Time			Instantaneous Length			
	t (min)	t (sec)	$t^{1/3}$ $(sec)^{1/3}$	(l_t) (cm)	$\Delta l = l_t - l_o$ (cm)	$\Delta l / l_o$	$\Delta l / l_t$

GRAPH-1:



The slope of the Graph plotted between $\Delta l/l_0$ vs. $t^{1/3}$ will give transient creep constant (β)

GRAPH-2:



The slope of the graph plotted between $\Delta l/l_t$ vs. t will give viscous creep constant (k)

PRECAUTIONS:

1. Take the readings without any parallax error.
2. Temperature should be maintained as constant.

RESULT:

1. Transient creep constant (β) = **(sec)$^{-1/3}$**
2. Viscous creep constant (k) = **(sec)$^{-1}$**

VIVA QUESTIONS:

1. Discuss the creep behaviour in materials?
2. List out factors influence the creep behaviour of the wire during the experiment?
3. Mention the temperature affect on the creep behaviour of the wire?
4. Discuss the significance of applying a constant load or stress during the creep testing of the material wire?
5. Explain how grain boundaries and microstructure affect the creep behaviour of a material wire?
6. Discuss about Creep Fracture
7. Explain the various factors affecting creep.
8. Discuss different stages of creep.
9. State Viscous Creep
10. State Transient Creep.

Post-Lab:

Aim: To determine creep constant of a given material for example tin/lead based material

- **Procedure/Program:**

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Experiment Title: Hall Effect

Aim/Objective: To study the dependence of Hall voltage with current and magnetic field and to find the Hall coefficient

Description:

This Section must contain detailed information pertaining to the Aim/Objective of the Laboratory Session

Pre-Requisites:

Hall Effect, Hall voltage, Hall coefficient, Semiconductors and types of semiconductors

Pre-Lab:

1. State Hall Effect
2. Discuss the principle of Hall effect.
3. Whether Hall effect occur in a conductor subjected to a magnetic field and carrying a current?
4. Mention the different types of semiconductors
5. Discuss Electric and Magnetic Fields
6. State Hall Coefficient? How its related to carrier density and carrier mobility of the material?
7. State the hall voltage in the experiment.

In-Lab:

FORMULA:

Hall effect apparatus – semi conductor sample (probe) a tiny D.C. electromagnet, digital millivoltmeter & milliammeter, constant current source, and power supply.

$$V_H = (R_H)(1/ne)(1/t)Bi_c$$

$$= K \times Bi_c \times 10^{-8} \text{ volts}$$

Where

i_c = constant d.c. current (X-axis) (amp)

B = d.c. magnetic field (Y-axis) (tesla)

n = carriers concentration

e = charge electron (coulombs)

t = thickness of sample crystal (m)

R_H= Hall coefficient of the crystal.

DIAGRAM:

A schematic diagram of the working principle and the apparatus is shown below.

PRINCIPLE:

If a sample-conductor or semi conductor, material is placed in a uniform d.c. magnetic field (along axis) and a constant current (along Y-axis)is sent, then a voltage along (Z-axis) is developed across the sample. This voltage is known as Hall voltage which depends on the magnetic field strength i.e. indirectly on the magnet current and the probe current through the sample.

Hall effect is useful to establish the polarities of the current carriers and also to measure magnetic field (gauss meter).

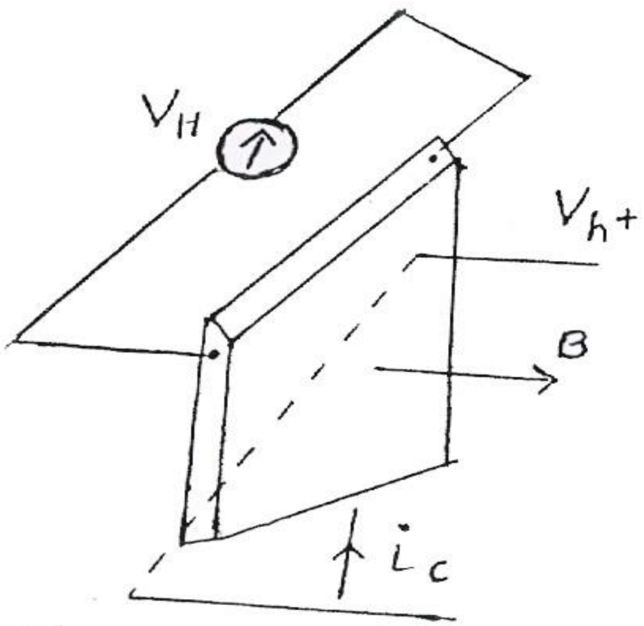


fig: HALL EFFECT

PROCEDURE:

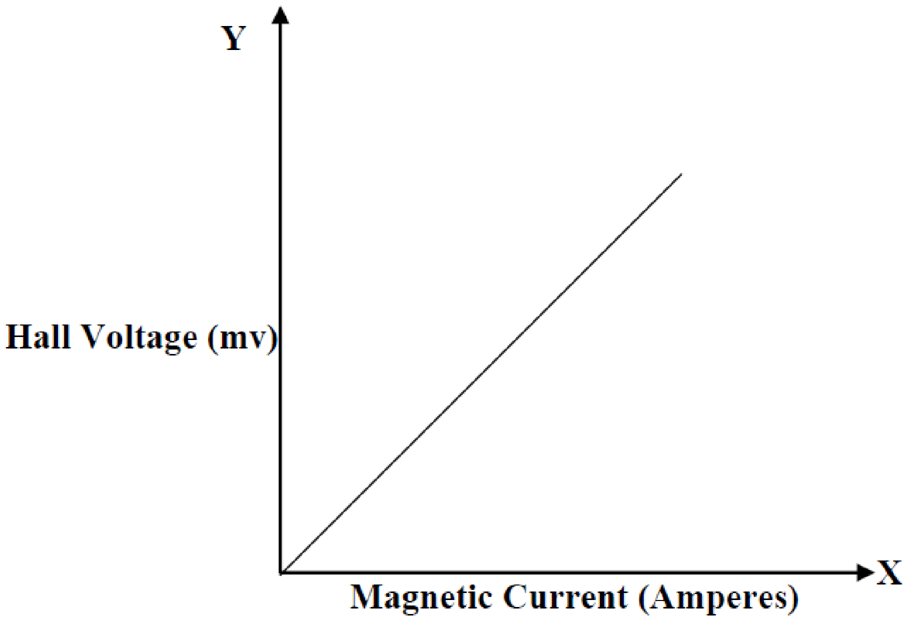
1. Arrange the Hall effect apparatus and do the circuit connections as per the diagram.
2. Remove the sample (or probe) from the stand in the magnet.
3. Set the selector switch at the position marked ‘probe’ on the front panel. Adjust the current control and set the current, i_c to a desired value (say 70 ma).
4. The probe current must remain constant in the remaining part of the experiment.
5. Now set the selector, switch at the position marked magnet.
6. Adjust the magnet current control and set the magnet current to convenient value, say 500 mA.
7. The probe out put may show some value. By adjusting the zero control make the initial reading (without the sample) become zero.
8. Fix the sample or probe to stand and place above the magnet. Arrange it symmetrically between the polls of the magnet. The width of the sample must be parallel to the surface of the poles.
9. Note down the Hall voltage as shown by the probe out put digital display.
10. Measure the Hall voltage for different values of magnet current-400, 300, 200, 100 mA.
11. Enter the readings in a tabular form.
12. Draw the graph with magnet current along X-axis and Hall voltage along Y-axis. The nature of the graph is linear type.
13. In the second part of experiment, adjust the magnet current control until the current is 500 mA. Keep this current constant in the remaining part of the experiment.
14. Set the selector switch at the position probe.
15. Adjust the current control until the probe current reads 70 mA.
16. Note the Hall voltage.
17. Measure the Hall voltage for different values of probe current-60, 50, 40, 30 mA.
18. Tabulate the readings as follows. Draw a graph with probe current along X-axis and Hall voltage along Y-axis. Mark the value of magnet current.

Tabular column

Probe current - (mA)

S.No.	Magnetic Current (A)	Hall Voltage (mv)

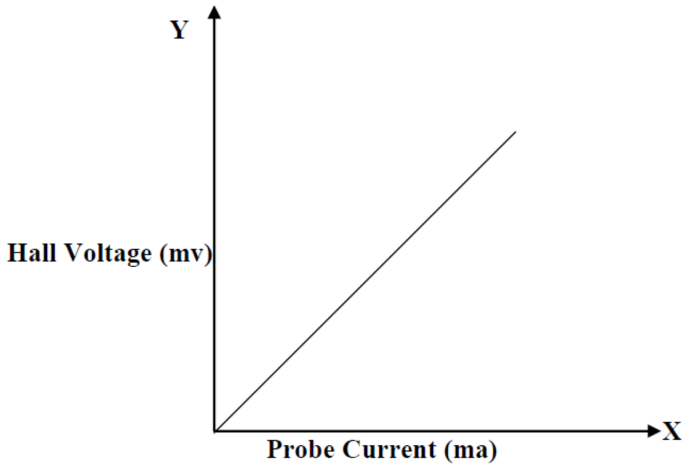
Graph 1
Probe Current = Constant



Magnetic current - (A)

S.No.	Probe Current (mA)	Hall Voltage (mv)

Graph 2
Magnetic Current = Constant



PRECAUTIONS:

1. Handle the probe gently and carefully.
2. Strictly follow the operating instructions.
3. When a sample is not placed in the magnet, set the initial reading to zero by adjusting the zero control.
4. Do not set the probe current greater than 80 mA.
5. Keep the pole gap of about 2.5 cms.

RESULT:

The dependence of Hall voltage with current and magnetic field is studied.

VIVA QUESTIONS:

1. State Hall effect.
2. Mention the principle behind the Hall Effect.
3. Is the Hall effect occur in conductor.
4. Mention the applications of Hall effect.
5. State Hall Coefficient.
6. Discuss the significance of Hall Coefficient
7. State carrier concentration.
8. Outline the majority charge carriers in p-type semiconductor.
9. Outline the majority charge carriers in n-type semiconductor.
10. Mention the units of carrier concentration.

Post-Lab:

Determine the Hall Coefficient for Si/Ge material doped with trivalent or Penta valent impurities

- **Procedure/Program:**

  This Section is meant for the student to Write the program/Procedure for Experiment

  (Leave at least 2-3 Pages for each Procedure/ Program/ Solution)

- **Data and Results:**

This Section is meant for the students to collect, record the results generated during the Program/Experiment execution. Include instructions on how to present the results, such as creating tables, graphs, or visualizations.

(Leave at least 1 Page for recording the results)

- **Analysis and Inferences:**

This Section is meant for the students to analyse their data, perform calculations Include questions or prompts to encourage critical thinking and interpretation of the data.

(Leave at least 1 Page for recording the analysis and inferences)

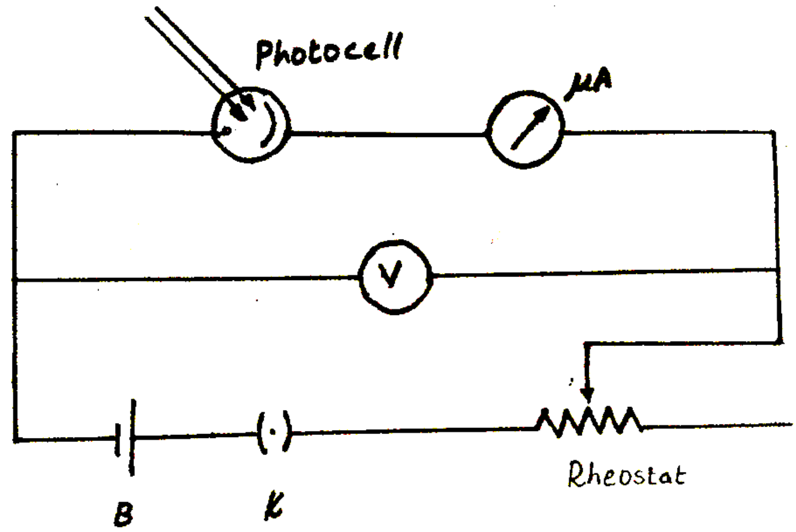
Evaluator Remark (if Any):	**Marks Secured: _____out of 50**
	Signature of the Evaluator with Date

Evaluator MUST ask Viva-voce prior to signing and posting marks for each experiment.

Experiment Title: Determination of Planck's constant.

Aim: To determine the value of Planks constant "h".

Diagram:



Theory: From Einstein theory of Photo-electric effect

$$h\nu = {}^{1}\!/_{2}\, mv^2 + w_0$$

where, $h\nu$ is the energy of incident light photon.

½ mv2 is kinetic energy gained by electrons.

w_0 is the work function

If ν_0 is the threshold frequency, then work function $w_o = h\nu_0$. If V_0 is stopping potential, then ½ $mv^2 = eV_0$

Where 'e' is the charge of electron

$h\nu = h\nu_0 + eV_0$

$eV_0 = h\nu - h\nu_0$

$V_o = (h/e)\nu - (h/e)\nu_0$

The above equation can be compared with a straight line Y = mx + c

Pre-Requisites:

Plank's constant, photoelectric effect, Monochromatic light source

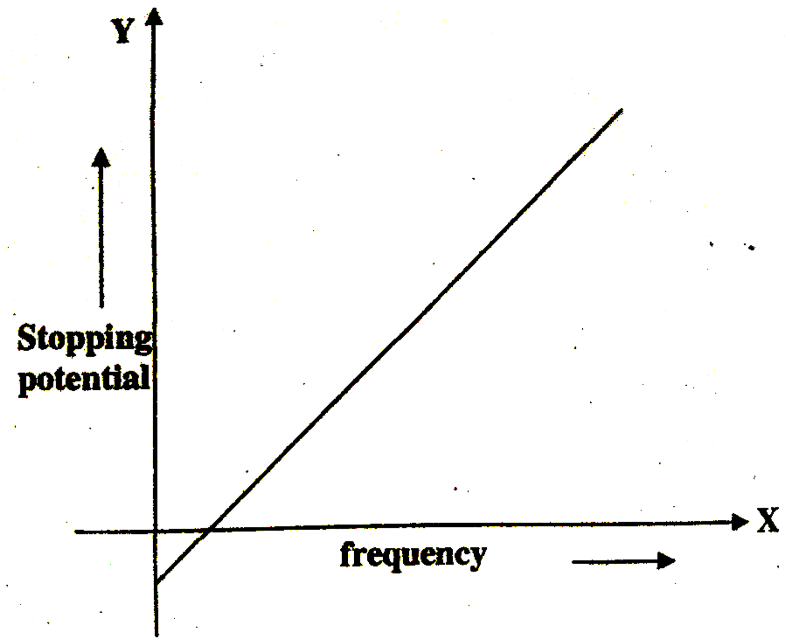
Pre-Lab:

1. Explain the Planck's constant and its importance
2. Describe the photoelectric effect
3. List out the essential components of experimental setup required for the determining Planck's constant.
4. How do you measure the stopping potential in the photoelectric effect setup?
5. Can you explain how the frequency of incident light affects the kinetic energy of emitted photoelectrons?
6. Discuss the role of photo metal in getting current.
7. Mention the nature of light
8. Mention the properties of light which will be explained on the basis of particle nature of light
9. List out the laws of photoelectric effect laws.
10. Mention the units of Planck's constant.

(Leave Space between each question for the writeup)

In-Lab:

Model Graph:



A graph is drawn by taking frequency values on x axis and stopping potential value on y axis. A shown in the graph, a straight line not passing through origin will come. We can equate the slope of the above straight line with (h/e) value of the equation 1.

V0 = (h/e)V – (h/e)V0

h/e = Tanθ,……….> h = e Tanθ

- **Procedure/Program:**

  Procedure: The connections are made as per the circuit diagram. Light of fixed wavelength (red light) is made to fall photocell by placing the red filter in the path of light. The potentiometer is varied until the photo current becomes zero and the value of stopping potential is noted.

  Following the same procedure, for different filters (orange and yellow) the stopping potential values are noted. ***(Leave at least 2-3 Pages to record the Procedure/Program)***

- **Data and Results:**

  The observations are noted in the following table.

  FOR HIGH INTENSITY:

S. No	Filter	Wavelength (Å)	Frequency (Hzs)	Stopping potential V_0
1	R	6907	4.35×10^{14}	
2	O	6234	4.81×10^{14}	
3	Y	5790	5.18×10^{14}	
4	G	5500	5.89×10^{14}	
5	B	4602	6.52×10^{14}	

FOR MEDIUM INTENSITY:

S. No	Filter	Wavelength (Å)	Frequency (Hzs)	Stopping potential V_0
1	R	6907	4.35×10^{14}	
2	O	6234	4.81×10^{14}	
3	Y	5790	5.18×10^{14}	
4	G	5500	5.89×10^{14}	
5	B	4602	6.52×10^{14}	

FOR LOW INTENSITY:

S. No	Filter	Wavelength (Å)	Frequency (Hzs)	Stopping potential V_0
1	R	6907	4.35×10^{14}	
2	O	6234	4.81×10^{14}	
3	Y	5790	5.18×10^{14}	
4	G	5500	5.89×10^{14}	
5	B	4602	6.52×10^{14}	

(Leave at least 1 Page to record the results)

- **Analysis and Inferences:**

  Result: The value of planks constant, h = …………………j-sec.

  (Leave at least 1 Page for each Program)

Sample VIVA-VOCE Questions (In-Lab):

1. Mention Planck’s constant, and explain its significance?
2. Explain the photoelectric effect in simple terms.
3. How the photoelectric effect does is used to determine Planck’s constant.
4. Why it is important to repeat the experiment with different light intensities?
5. State the objective of the experiment, which is to determine Planck’s constant using the photoelectric effect.
6. Briefly outline the step-step procedure followed during the experiment.
7. Discuss the conditions for conducting photoelectric effect experiment.
8. State photo electrons
9. List out the characteristics of phtoelectrons
10. Describe the experimental apparatus and setup used in the experiment, including the light source.

Post-Lab: Verify the phtoto-electric effect laws

- **Procedure/Program:**

(Leave at least 2-3 Pages for each Procedure/ Program/ Solution)

- **Data and Results:**
    1. Detail any equations or formulas used in the analysis.
    2. Explain any graphs or plots used to represent the experimental results.

(Leave at least 1 Page for recording the results)

- **Analysis and Inferences:**
    1. Explain how the data was analyzed to determine Planck's constant.
    2. Discuss any variations in the data and potential sources of error.

(Leave at least 1 Page for recording the analysis and inferences)

Evaluator Remark (if Any):	**Marks Secured: _____out of 50**
	Signature of the Evaluator with Date

Evaluator MUST ask Viva-voce prior to signing and posting marks for each experiment.

Experiment Title: Solar Cell Fill factor - Characteristics

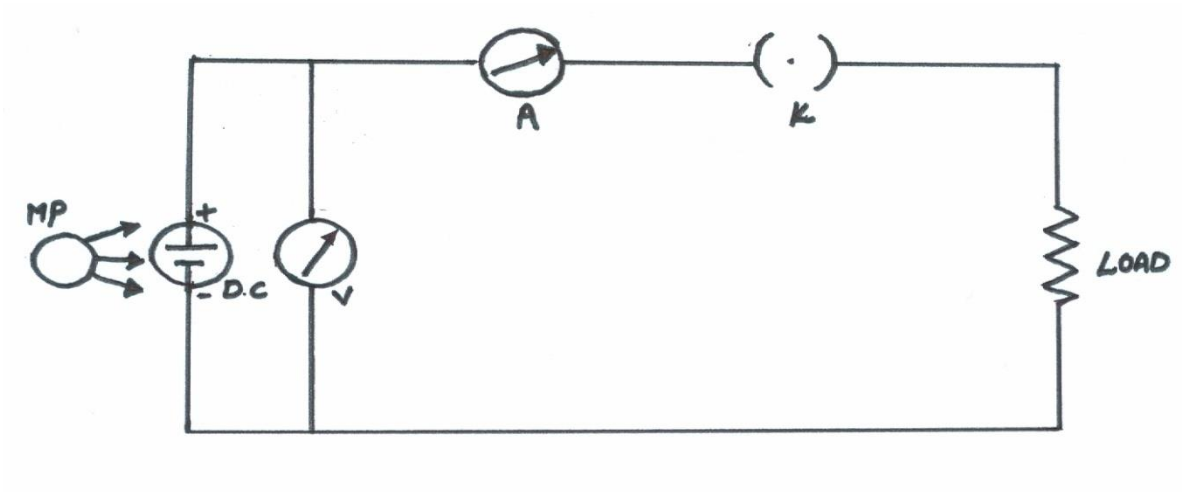
Aim/Objective:

To determine the fill factor of the solar cell.

Description:

APPARATUS: Solar cell, milli ammeter, voltmeter, variable load, key, lamp.

CIRCUIT DIAGRAM:



Formula: The fill factor (N) of the solar cell is given by.

$$N = \frac{I_{mp}}{I_{sc}} x \frac{V_{mp}}{V_{oc}} = \frac{\max .usefulpower}{idealpower}$$

Where,

I_{mp} : Current at max. power amp

V_{mp} : Volatage at max. power Volts

I_{sc} : Short circuit current amp

V_{oc} : Open circuit voltage Volts

Pre-Requisites: Solar cell, Light source, Characterization setup, I-V measurement Equipment

Pre-Lab:

1. Mention the main objective of the Solar cell characteristics experiment?
2. Explain the working principle of a solar cell and how it converts sunlight into electrical energy?
3. Discuss the role of semiconductor in the construction of solar cell
4. State P-N Junction diode.
5. Explain the significance of Junction in getting current.

(Leave Space between each question for the writeup)

In-Lab:

- **Procedure/Program:**

1. Connect the circuit as showed in the diagram
2. Switch on the lamp. Keep the lamp close to the solar cell and set it so that the incident light falls normally on the cell.
3. Set the load resistance max (say 10,000) measure the open circuit voltage V_{oc}.
4. Close the key. Keep zero resistance in the load. Note down the short circuit current I_{sc}.
5. Vary the load in equal steps. For each load R note down the output current I and voltage V.
6. Enter the readings in a tabular form.

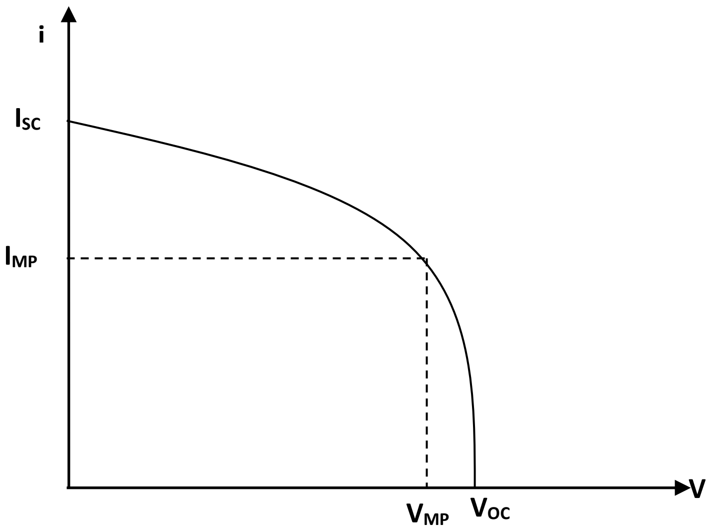
(Leave at least 2-3 Pages to record the Procedure/Program)

- **Data and Results:**

1. Open circuit voltage, V_{oc} = Volts.
2. Short circuit current, I_{sc} = amps.
3. Voltage at Max.power, V_{mp} = Volts.
4. Current at max.power,I_{mp} = amps.

S.No	Load, R (ohms)	Voltage V, (volts)	Current I,(amps)	Power P=VI (watts)

MODEL GRAPH



PRECAUTIONS:

1. Do not set the lamp very close to the cell. Let it get heated up and the characteristics may change.
2. Keep the intensity of the light constant throughout the experiment.
3. Change the load at equal steps slowly.

(Leave at least 1 Page to record the results)

- **Analysis and Inferences:**
- **RESULT:** The fill factor of the cell, n is ………………..

(Leave at least 1 Page for each Program)

VIVA-VOCE Questions (In-Lab):

1. What is the main objective of the solar cell characteristics experiment?
2. Describe the I-V curve of a solar cell ?
3. How do you calculate the efficiency of a solar cell based on the experimental data obtained from the I-V curve?
4. What kind of light source is used in the experiment and why it is necessary to have a stable and controlled light source?
5. Mention the essential parameters that characterize a solar cells performance?
6. State Photovoltaic cell
7. Mention the differences between photo diode and photo detector.
8. State fill factor
9. How do you determine the efficiency of solar cell
10. Discuss the role of semiconductor in solar cell.

Post-Lab: To Study the solar cell characteristics

- **Procedure/Program:**
  1. Describe the experimental setup used in the solar cell characteristics experiment.
  2. Provide a step-by-step description of the experimental produce you followed.
  3. Mention any adjustments or precautions taken during the data collection.

(Leave at least 2-3 Pages for each Procedure/ Program/ Solution)

- **Data and Results:**
    1. Analysis of the impact of light intensity on solar cell performance.
    2. Observation of how I_{Sc} , V_{OC} , V_{MP} change with varying light intensity/temperatute.
    3. Calculate the fill factor and efficiency for solar cell sample based on experimental data.

(Leave at least 1 Page for recording the results)

- **Analysis and Inferences:**
    1. Explain how you analysed the data to extract the desired solar cell characteristics.
    2. Explain any calculations of formulas used to obtain the parameters

(Leave at least 1 Page for recording the analysis and inferences)

Evaluator Remark (if Any):	**Marks Secured: _____out of 50**
	Signature of the Evaluator with Date

Evaluator MUST ask Viva-voce prior to signing and posting marks for each experiment.

Experiment Title: Determination of wavelength of Laser by Grating

Aim/Objective:

To determine the wavelength of laser beam using diffraction

Description:

FORMULA:

$$\text{Wavelength } (\lambda) = \frac{Sin\,\theta}{nN}$$

Where ' θ ' is the angle of diffraction.

$$\theta = \frac{l}{r} x \frac{180}{\Pi}$$

'n'is the order of the spectrum

'N' is the number of lines per cm of the grating.

'l' is the distance of n^{th} principal maxima from the central maxima. r is the distance of the screen from the grating.

Pre-Requisites: Diode laser, transmission grating, screen, meter scale.

Pre-Lab:

1. mention the main objective of the experiment to determine the wavelength of a laser using a grating?
2. Explain the principle of diffraction and how diffraction grating disperses light into its component wavelengths?
3. Describe the experimental setup to measure the diffraction pattern produced by the grating.
4. Mention the type of laser source is required for the experiment and why is it important for the laser to emit the single wavelength?
5. Explain the why it is necessary to conduct the experiment in a dark room or an environment with minimal ambient light?

In-Lab:

- **Procedure/Program:**

Mount the grating on the stand. Illuminate the grating with laser beam. The beam on the grating produces several spots due to diffraction. The bright spot is central maximum. The other spots on both sides of central maximum are principal maxima. Measure the distance (l) of the n^{th} principal maxima from the central maxima. And also measure the distance (r) of screen from the grating. Note the number of lines per cm given on the grating plate. Calculate wavelength using the formula given below.

$$\text{Wavelength } (\lambda) = \frac{Sin\theta}{nN}$$

(Leave at least 2-3 Pages to record the Procedure/Program)

- **Data and Results:**
- **Tabular column:**

S.No:	Order of the spectrum (n)	Distance of spot from central max. (l)	Distance of screen from grating (r)	$\theta = \frac{l}{r} x \frac{180}{\Pi}$	$\lambda = \frac{Sin\theta}{nN}$

(Leave at least 1 Page to record the results)

- **Analysis and Inferences:**

The wavelength of the laser is obtained as ……………….. Å.

(Leave at least 1 Page for each Program)

Sample VIVA-VOCE Questions (In-Lab):

1. Mention the Abbreviation of LASER
2. State grating and how it is giving the diffraction pattern?
3. Mention the condition to get the diffraction phenomenon.
4. Explain the diffraction pattern formed on the screen and what information can be obtained from the pattern?
5. List the practical applications of this experiment?
6. Mention the material with which the number of lines drawn on grating plate.
7. State wavelength.
8. Mention the units of wavelength of light.
9. Discuss how the diffraction play an important role in the determination of structure of materials.
10. Discuss the effect if the distance between the screen and grating changes.

Post-Lab: Determine the wavelength of various colors of Laser using diffraction grating.

- **Procedure/Program:**

1. Briefly overview of the experiment objective which is to determine the wavelength of a laser using a grating.
2. Provide a step-by-step description of the experimental procedure followed during the experiment.

(Leave at least 2-3 Pages for each Procedure/ Program/ Solution)

- **Data and Results:**

1. Present the raw data obtained during the experiment such as measurements taken from the diffraction pattern.
2. Include the measurements of the grating spacing and any calibration data, if applicable.

(Leave at least 1 Page for recording the results)

- **Analysis and Inferences:**

1. Explain how you analyzed the data to determine the wavelength of the laser.
2. Discuss the uncertainty associated with the measured wavelength, including any sources of error.

(Leave at least 1 Page for recording the analysis and inferences)

Evaluator Remark (if Any):	**Marks Secured: _____out of 50**
	Signature of the Evaluator with Date

Evaluator MUST ask Viva-voce prior to signing and posting marks for each experiment.

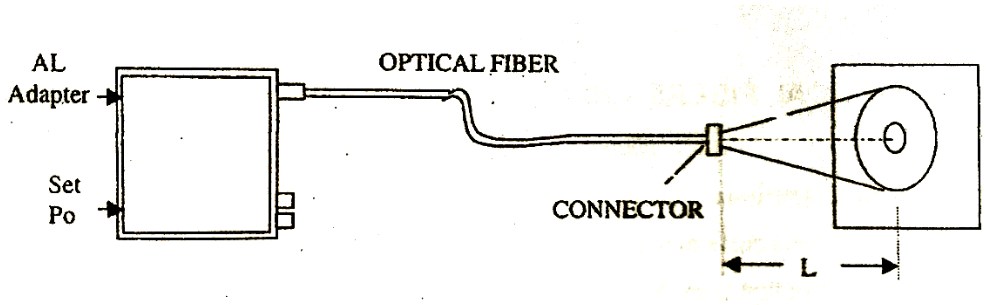
Experiment Title: Determination of Numerical Aperture using fiber optic cable.

Aim/Objective:

To determine the numerical aperture of the given (PMMA) plastic optical fiber.

Description:

Diagram:



NUMERICAL APERTURE

Formula:

$$N.A = \frac{W}{(4L^2 + W^2)^{1/2}}$$

Where W is the diameter of the light patch on the screen and L distance of the screen from the fiber end.

Theory:

The numerical aperture of an optical system is a measure of the light collected by an optical system. It is product of the refractive index 'n_1' of the incident medium and the sine of the maximum ray angle 'θ_{max}'.

Numerical aperture (N.A) = $n_1 \text{Sin}\theta_{max}$ ……………. (1)

For air n1 = 1

So, N.A. = $\text{Sin}\theta_{max}$ ………………. (2)

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

$$N.A = (n^2_{core} - n^2_{clad})^{1/2} \text{ .... } (3)$$

Suppose light from the fiber end 'A' falls on the screen XY. Let the diameter of the light falling on the screen BD = W and let the distance between the fiber end and the screen A0 = L.

Therefore $N.A = \frac{W}{(4L^2 + W^2)^{1/2}}$

Knowing W and L, the N.A can be calculated and substituted this N.A value in equation (2), the acceptance angle 'θ_{max}' can be calculated.

Pre-Requisites: Optical fiber cable, stand, scale

Pre-Lab:

1. Explain the structure of optical fiber
2. Outline the principle of total internal reflection
3. Mention the main objective of the experiment to determine the acceptance angle and numerical aperture of a fiber optic cable?
4. Explain the concept of numerical aperture?
5. Describe the experimental setup used in the experiment, including the fiber optic cable, light source and measurement apparatus.
6. Listout the key parameters to measure in the experiment and how are they related to the numerical aperture?

In-Lab:

This Section must contain at least 2 Programs/Experiments that links the lecture to be performed during the laboratory Session.

- **Procedure/Program:**
- Numerical Aperture measurement schematic diagram is as shown. The measurement of Numerical Aperture step by step procedure is as follows:
- **Step 1:**
  Connect one end of the cable of to PO and another end to the N.A (i.e. launching O/P of LED into OF cable).
- **Step 2:**
  Connect power adapter into socket V_{in} plug the A.C mains. Red light should be appearing at the end of the fiber on the N.A. To set maximum output turn the SET PO/ it knob clockwise. The red light intensity should increase.
- **Step 3:**
  Hold the acrylic white screen printed scale at a distance of 10mm 9L from the emitting fiber and you will view the red spot on the screen to measure the diameter W of the spot.
  Substitute the measured values (L) and (W) in N.A formula

$$N.A = \text{Sin max} = \frac{W}{(4L^2 + W^2)^{1/2}}$$

Repeat the experiment for the distance of 15 mm, 20 mm, 25 mm and 30 mm and note the readings in the below table

- **Data and Results:**

Sr. No	L(mm)	W (mm)	N.A	Max (degrees)

(Leave at least 1 Page to record the results)

- **Analysis and Inferences:**

The numerical aperture of given optical fiber is

(Leave at least 1 Page for each Program)

Sample VIVA-VOCE Questions (In-Lab):

1. Define the numerical aperture?
2. Outline the critical angle.
3. Mention the role of critical angle.
4. Discuss the importance of critical angle in guiding the light.
5. List the applications of optical fiber
6. Mention why we need to find the Numerical Aperture of an optical fiber.
7. List the types of optical fiber
8. State optical sensors.
9. Mention the type of light used in optical fibers.
10. Discuss the role of rarer and denser media in obtaining the internal reflection phenomenon.

Post-Lab: Determination of Acceptance angle of an optical fiber.

- **Procedure/Program:**

1. Explain an brief overview of the experiment objective which is to determine the acceptance angle and numerical aperture of a fiber optic cable.
2. Explain the importance of measuring these parameters in understanding the fiber optic cable's light-coupling efficiency.
3. Explain how the light source emits stable and monochromatic light for accurate measurements.

(Leave at least 2-3 Pages for each Procedure/ Program/ Solution)

- **Data and Results:**

(Leave at least 1 Page for recording the results)

- **Analysis and Inferences:**

1. Explain how you analyzed the data to determine the acceptance angle and calculate the numerical aperture of the fiber optic cable.
2. Explain the calculations or formulas used to extract the parameters from the experimental measurements.

(Leave at least 1 Page for recording the analysis and inferences)

Evaluator Remark (if Any):	**Marks Secured: _____out of 50**
	Signature of the Evaluator with Date

Evaluator MUST ask Viva-voce prior to signing and posting marks for each experiment.

Experiment Title: Determination of energy band gap of a given material

Aim/Objective:

To determine the band gap of a semiconductor using p-n junction diode.

Description:

THEORY:

There exists a small energy gap between valance band and conduction band of a semiconductor. For conduction of electricity, certain amount of energy is given to the valence electron so that it excites from valance band to conduction band. The energy needed is the measure of energy band gap, ΔE, between two bands. When a p-n junction is reverse biased then current is due to minority carriers whose concentration is dependent on the energy gap. The reverse current I_s (saturated value) is a function of the temperature of the junction diode.

For small range of temperature, the relation is expressed as

$$\ln I_s = \text{constant} - 5.036\ \Delta E\ (10^3/T)$$

Where T is absolute temperature in kelvin and ΔE is energy gap in electron volt.

A graph is plotted between ln I_s and $10^3/T$, which comes out to be a straight line. The slope of this line will be 5.036 ΔE, giving the value of band gap for the semiconductor.

FORMULA:

$$\ln I_s = \text{constant} - 5.036\ \Delta E\ (10^3/T)$$

Where, $I_s$is reverse saturation current through diode (µA)

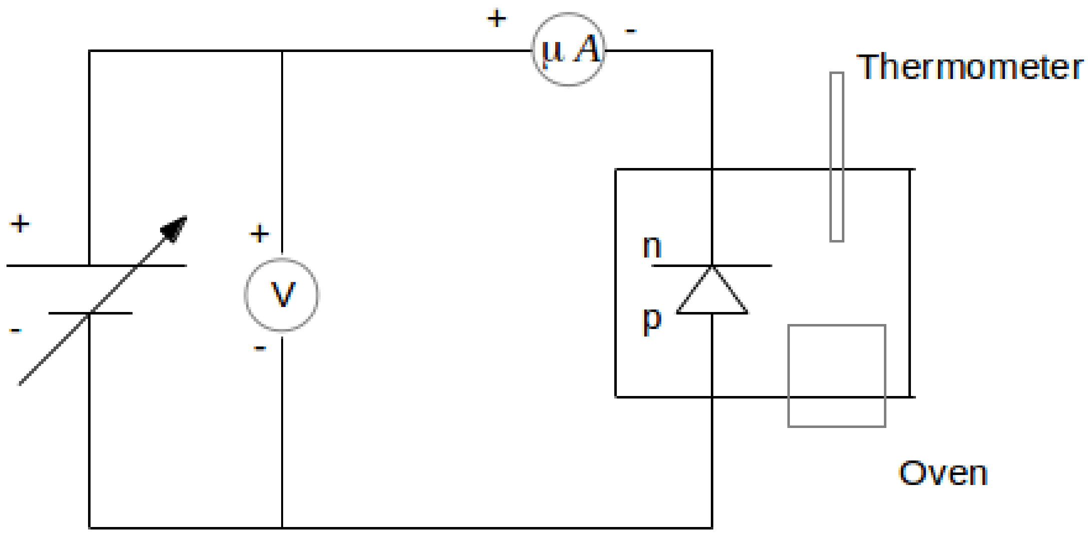
ΔE is energy band gap of semiconductor (eV)

T is absolute temperature (K)

A graph is plotted between log I_s and $10^3/T$ that comes out to be a straight line. Band gap can be found from the slope of the plot.

$$\Delta E = \text{Slope of the line} / 5.036\ (\text{eV})$$

CIRCUIT DIAGRAM:



Pre-Requisites: Semiconductor diode (Ge), oven, power supply, thermometer, voltmeter and micro-ammeter**.**

Pre-Lab:

1. Mention the main objective of the experiment to determine the energy band gap of given material?
2. Explain the concept of the energy band gap and its significance in determining a material's electronic properties?
3. How does the energy band gap influence the absorption of light by the material?
4. Mention the type of light source is required for the experiment, and why is it important to have to known and controlled wavelength of the light?
5. Explain the process of measuring the material's absorbance as a function of light wavelength or energy?

In-Lab:

- **Procedure/Program:**

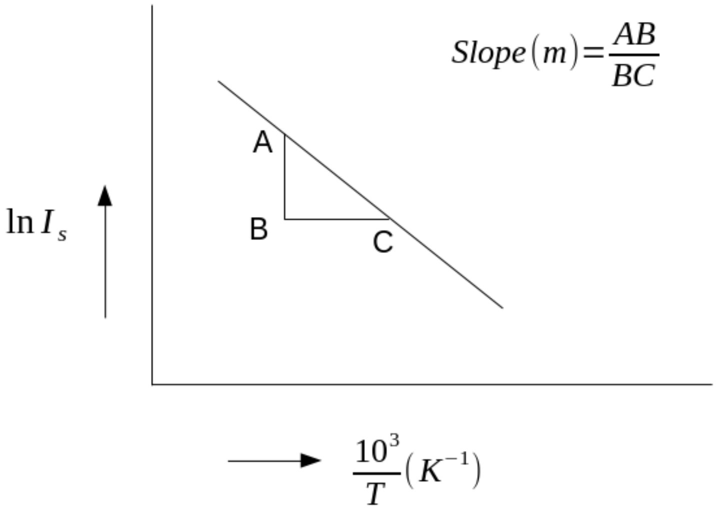
1. Connect the diode in the circuit, containing micro-ammeter and voltmeter.
2. Fix a thermometer to measure the temperature.
3. Switch the heater and move the control knob to allow the oven temperature to increase up to 60 °C.
4. Tabulate the readings of reverse current Is in micro-ammeter for every 5 °C rise in temperature.
5. As the temperature reaches about 65 °C, switch off the oven. The temperature will rise further, say about 70-80 °C and will become stable.
6. Now temperature will begin to fall and tabulate the readings of I_s for every 5 °C fall in temperature.

(Leave at least 2-3 Pages to record the Procedure/Program)

- **Data and Results:**
- **OBSERVATION TABLE:**

S.No	**Temperature (°C)**	**Temperature (K)**	**$10^3/T$ (K^{-1})**	**Reverse Current I_s (μA)**	**ln I_s**

- **MODEL GRAPH:**



(Leave at least 1 Page to record the results)

- **Analysis and Inferences:**

Band gap of given semiconductor is: eV

(Leave at least 1 Page for each Program)

Sample VIVA-VOCE Questions (In-Lab):

1. State energy band gap.
2. Mention the values of band gap for various materials.
3. If the temperature increases, is it effect the band gap.
4. State reverse current.
5. Why the circuit is connected in reverse bias mode
6. State resistance
7. Is the resistance affected with temperature?
8. State conductivity
9. Is the conductivity affected with the temperature?
10. Outline the relation between resistivity and conductivity.

Post-Lab: Determine the energy band gap of silicon/germanium

- **Procedure/Program:**

  This Section is meant for the student to Write the program/Procedure for Experiment

  (Leave at least 2-3 Pages for each Procedure/ Program/ Solution)

- **Data and Results:**

This Section is meant for the students to collect, record the results generated during the Program/Experiment execution. Include instructions on how to present the results, such as creating tables, graphs, or visualizations.

(Leave at least 1 Page for recording the results)

- **Analysis and Inferences:**

This Section is meant for the students to analyse their data, perform calculations Include questions or prompts to encourage critical thinking and interpretation of the data.

(Leave at least 1 Page for recording the analysis and inferences)

Evaluator Remark (if Any):	**Marks Secured: _____out of 50**
	Signature of the Evaluator with Date

Evaluator MUST ask Viva-voce prior to signing and posting marks for each experiment.

12. ENERGY LOSS OF A MAGNETIC MATERIAL

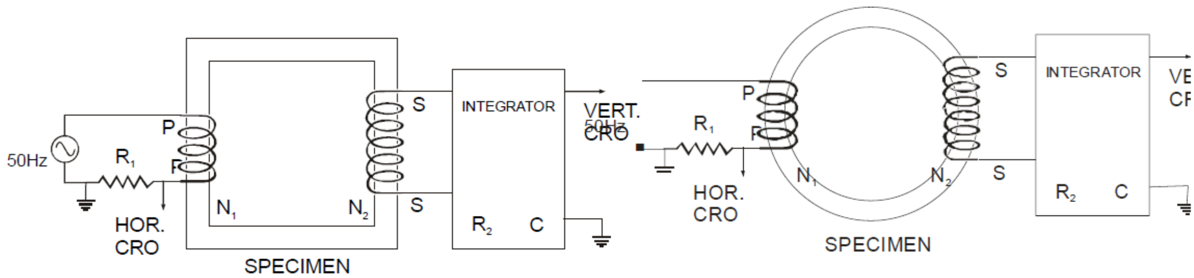
Experiment No: **Date:**

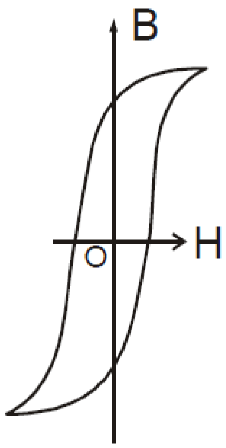
AIM: To trace the B-H curve of a transformer core and ferrite core and to calculate energyloss.

APPARATUS: CRO, capacitors, resistors, multimeter and core of the transformer.

DIAGRAM:

The experimental arrangement is shown in below figure





B H Curve

Pre LAB:

1.Define Coercivity.

2. Define Retentivity.

3. State Hysteresis.

4. Explain difference between B-H curve in hard and soft magnetic materials.

5. Distinguish between hard and soft magnetic materials.

FORMULA:

The energy loss is given by

$$E = \left(\frac{N_1}{N_2}\right) * \left(\frac{R_2}{R_1}\right) * \left(\frac{C_2}{A * L}\right) * S_V * S_H * area\ of\ the\ loop$$

Where N_1 and N_2 are number of turns in the primary and secondary of the transformer, R_1 and R_2 are resistances in the circuit, C_2 is the capacitor, L is length of the specimen, A is the area of cross section of the specimen, S_V and S_H are sensitivity of vertical and horizontal of CRO.

PROCEDURE:

1. Arrange the circuit as shown in the circuit diagram. The input of the primary of the core is supplied by step down transformer (T). The voltage across R_1 is given to horizontal input of CRO while the voltage across the C_2 feeds the vertical input of CRO.
2. The horizontal and vertical gain controls of the CRO are adjusted to get a loop of convenient size.
3. Trace the BH curve on a graph paper.
4. Determine the vertical sensitivity S_V and horizontal sensitivity S_H without disturbing the gain controls. The sensitivity is expressed in volt per cm.

OBSERVATION TABLE:

Parameter	Transformer Core	Ferrite Core
N_1	200	100
N_2	400	200
R_1		
R_2	4.7 KΩ	4.7 KΩ
C_2	4.7 μF	4.7 μF
A	$2.6*10^{-4}m^2$	$0.90*10^{-4}m^2$
L	$25.4*10^{-2}$ m	$11.22*10^{-2}$ m

S_V		
S_H		

PRECAUTIONS:

1. The specimen should be at the center of the magnetizing coil very close to the probe.
2. If the area of the loop is expressed in cm^2, the sensitivity should be expressed in volt/ cm in either case the length of the coil should be in meters.

RESULTS:

The energy loss of transformer core = J/cycle/ V

The energy loss of ferrite core = J/cycle/ V

13.DIELECTRIC CONSTANT OF A SOLID

Experiment No: **Date:**

AIM: To determine the dielectric constant of a given solid material.

APPARATUS: Dielectric constant kit containing an audio oscillator (1 KHz), digital voltmeter (0 – 9.99 V dc), standard capacitance and electronic circuitry, Dielectric cells 75 mm and 25 mm Gold plated brass discs, Glass, Baklite, PZT disc.

Powder XRD film strip, Hull-Debye chart, scale

DIAGRAM:

Pre Lab:

1.Define Dielectric constant.

2.Explain difference between insulator and dielectric.

3. Give few examples of dielectric materials.

4. Justify the statement all dielectric materials are insulators but all insulators may not be dielectric materials.

5. How dielectric materials are useful in Capacitors.

Theory:

In this experiment an LC circuit is used to determine the capacitance of the dielectric cell and hence the dielectric constant. The audio oscillator is incorporated inside the instrument. If C_{sc} and C_{dc} represents the capacitances of the standard capacitor and dielectric cell respectively and if V_{sc} and V_{dc} are the voltages across SC and DC then

$$\frac{V_{sc}}{I} = \frac{1}{\omega C_{sc}}$$

$$I = V_{sc}\omega C_{sc}$$

The same current I pass through the dielectric cell

$$\frac{V_{dc}}{I} = \frac{1}{\omega C_{dc}}$$

$$C_{dc} = \frac{I}{\omega V_{dc}} = C_{sc}\frac{V_{sc}}{V_{dc}}$$

By measuring V_{sc} and V_{dc} and using the value of the C_{sc} we can determine the capacitance of the dielectric cell containing the sample. If C_o represents the capacitance of the dielectric cell without the sample and the plates separated by air gap whose thickness is the same as the thickness if the sample, the C_o is given by

$$C_o = \frac{\varepsilon_o A}{d}$$

$$C_o = \frac{r^2}{36d}$$

Where ‘r’ represents the radius of the gold plated plates and‘d’ represents thickness of the sample in meters.

The dielectric constant of the sample is given by the equation

$$\varepsilon_r = \frac{C}{C_o}$$

PROCEDURE:

1) Connect CRO to the terminals provided on the front panel of the main unit. If no sinusoidal wave form appears on CRO, then adjust “CAL” such that waveform appears.

2) Connect the dielectric cell assembly to the main unit and insert the sample in between the SS plate.

3) Switch ON the unit.

4) Choose the standard capacitor (with the help of switch S_2) SC_1 for materials having low dielectric constants (like Bakelite, Glass Plywood) or SC_2 for material having high dielectric constant (PZT).

5) Throw S_1 towards DC to measure the voltage across dielectric cell, say V_{dc} and towards SC to measure voltage across standard capacitor, say V_{sc}. Calculate the capacitance C using the relation

$$C = \left(\frac{V_{sc}}{V_{dc}}\right) x C_{sc}$$

6) Measure thickness of the sample using cell holder and calculate the value of the C_o (air) using the relation

$$C_o = \frac{\varepsilon_o A}{d} = \frac{r^2}{36d} nf$$

7) Determine the dielectric constant of the sample using the relation

$$\varepsilon_r = \frac{C}{C_{o(air)}}$$

PRECAUTIONS:

1. Do not put extra pressure as PZT and glass samples are brittle and may be damaged.

RESULT: The dielectric constant of the given sample =