INSTRUCTIONS TO STUDENTS

The students must follow the instructions very strictly to perform an experiment systematically and neatly. It is also to be noted that they should prepare in advance sufficiently about the experiment that they are going to do before coming to the class. Questions relevant to the experiment will be asked and marks will be allotted depending on the performance of the student.

1. All the students are supposed to bring the following items.
   a. Lab manual
   b. Calculator
   c. Pencil, scale & eraser
   d. Graph sheets

2. Do not borrow calculator, scale, pencil, eraser or any such items from others. Do not move from your allotted working table. Call the attender to your working place to receive any required material, apparatus, graph paper or logarithm tables.

3. Do not consult with others. If you have any doubt, report to the teachers for clarification.

4. Before you begin to do the experiments read the following particulars in your lab manual.
   - Aim
   - Apparatus
   - Formula: with the name of the parameters in it and their units.
   - Schematic /circuit diagram of the apparatus
   - Tabular form
   - Use pen to enter readings.

5. a) At the end of your experiment do the calculations neatly on a separate page.
    b) Result: Discuss your result with respect to the probable errors you come across while performing the experiment.

7. The allocation of marks for physics practical (sessional) is shown below:
   a. Performance in the practical class
   b. Practical examination
   c. Viva – voce at the end of the year.
## Index Sheet

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Page No.</th>
<th>Name of the experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>Lattice constant by powder XRD</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>Particle size by LASER diffraction</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>Refractive Index of a liquid by minimum deviation</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>Young's modulus by uniform bending method</td>
</tr>
<tr>
<td>5</td>
<td>18</td>
<td>Determination of Hall coefficient of a semiconductor</td>
</tr>
<tr>
<td>6</td>
<td>23</td>
<td>Energy loss of a magnetic material</td>
</tr>
<tr>
<td>7</td>
<td>26</td>
<td>Energy band gap of a semiconducting diode</td>
</tr>
<tr>
<td>8</td>
<td>29</td>
<td>Creep behaviour of a metal wire</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Average</strong></td>
</tr>
</tbody>
</table>
1. LATTICE CONSTANT BY POWDER XRD

Experiment No: .................   Date: .................

AIM: To determine the lattice constant ‘a’ of the given cubic crystal using powder X-ray diffraction film patterns.

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

DIAGRAM:

Figure 1. (a) Debye-Scherrer cylindrical camera; (b) Film mounted in camera; (c) Film on stretchout
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 centers of entrance hole and exit hole on the stretched film strip = \(\pi R\)).

Then the diffraction angle \(\theta\) for that particular crystal plane can be calculated from the equation

\[
\theta = \frac{S}{4R} \times \frac{180}{\pi}
\]

(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 \(\lambda\) is the wavelength of incident monochromatic X-rays; then according to Bragg’s law,

\[
n\lambda = 2d \sin \theta
\]

or

\[
d = \frac{n\lambda}{2\sin \theta}, \text{ (in Å)}
\]

(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

\[
a = \frac{n\lambda}{2\sin \theta} \sqrt{h^2 + k^2 + l^2}, \text{ (in Å)}
\]

(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 \(\theta\) for different sets of Bragg’s planes using eq. (1).
3. Substitute the \( \theta \) 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.

**OBSERVATIONS:**

Radius of the Debye-Scherrer Camera, \( R = \) \( \text{cm} \)

Wavelength of incident X-rays, \( \lambda = 1.542 \text{ Å} \) (for Cu-K\( \alpha \) Radiation)

Diffraction Order \( n = 1 \)

Table 1. **Copper (Cu) [FCC]**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Distance between the two symmetric arcs ( S ) (cm)</th>
<th>Bragg’s angle ( \theta = \frac{S}{4R} \times \frac{180}{\pi} ) (degrees)</th>
<th>Inter-planar separation ( d = \frac{n\lambda}{2\sin\theta} ) (Å)</th>
<th>Miller Indices ((hkl))</th>
<th>Lattice Constant ( a = d\sqrt{h^2+k^2+l^2} ) (Å)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average lattice parameter = \( \text{Å} \).
Table 2. Tungsten (W) [BCC]

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

Average lattice parameter $= \text{Å}$.

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 $a = \text{Å}$ for Cu [$a_{\text{standard}} = 3.61 \text{ Å}$] and $\text{Å}$ for W [$a_{\text{standard}} = 3.16 \text{ Å}$].
Supplementary Procedure to obtain the (hkl) Values from the Hull-Debye Chart: (for information / demonstration purpose only, and not for presenting in the examination).

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

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.
2. PARTICLE SIZE BY LASER DIFFRACTION

Experiment No: …………..  Date: ………….  

AIM: To determine particle size of lycopodium powder by LASER diffraction. 

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

DIAGRAM: 

FORMULA: 

\[
\text{Particle size (d)} = \frac{nAD}{r} \mu m
\]

Where, 

‘\(\lambda\)’ 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:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Distance between the glass plate and the screen (D) (cm)</th>
<th>Order (n)</th>
<th>Distance between central maximum and n\textsuperscript{th} order bright fringe (r) (cm)</th>
<th>Particle size (d) = \frac{n\lambda D}{r} (\AA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average size of the particle (d) = \text{Å}

RESULT:
The average particle size of the lycopodium powder (d) is determined to be \mu m.
3. REFRACTIVE INDEX OF A LIQUID BY MINIMUM DEVIATION

Experiment No: ………………  Date: ……………

AIM: To determine the refractive index of a liquid by minimum deviation method using hollow prism

APPARATUS: Spectrometer, Monochromatic source (Sodium vapor lamp), Power supply for source, Hollow prism filled with a liquid, Magnifying lens, Table lamp

DIAGRAM:

Refraction by a prism, showing the prism angle of prism (A) and the deviation angle (D)

FORMULA:

The refractive index of a liquid is determined by the following formula

\[ \mu = \frac{\sin \left( \frac{A + D_m}{2} \right)}{\sin \left( \frac{A}{2} \right)} \]

Where, \( A \) is the angle of prism = 60°

\( D_m \) is the angle of minimum deviation

Least Count of Spectrometer:

Least count = \( \frac{\text{Value of one Main Scale Division}}{\text{Number of vernier divisions}} \) = 0.5°/30 = (1/60)°

(1° = 60’)

Page | 11
Major parts of spectrometer:

1. Collimator
2. Prism table
3. Telescope

PROCEDURE TO DETERMINE THE ANGLE OF MINIMUM DEVIATION ($D_m$):

- Initially, the direct image is viewed through the telescope. The telescope is adjusted and fixed at the position when the vertical cross wires coincide with the direct image. The direct readings on both the Verniers (left and right) are noted (let them be $R1$ and $R2$).
- To measure the minimum deviation ($D_m$), the prism is placed at the center of the prism table such that base is parallel to the collimator and the refracted image is observed.
- The prism table is rotated slowly increasing the angle of incidence. The refracted image moves towards the direct ray position and the angle of deviation decreases. The telescope is also moved to follow the image.
- At one stage the image stops, turns back and moves in the opposite direction. The position of the image where it turns back is the minimum deviation position.
- When the image turns, the telescope is adjusted so that the vertical cross wire coincides with the image at this position.
- The reading on both the Verniers (left and right) are noted (let them be $R3$ and $R4$).
- The differences $R1$–$R3$ (say $a$) and $R2$–$R4$ (say $b$) are calculated.
- The average of ‘$a$’ and ‘$b$’ gives the angle of minimum deviation $D_m$.

DETERMINATION OF REFRACTIVE INDEX ($\mu$):

By substituting the angle of minimum deviation ($D_m$) in the above formula, we will get the refractive index of a particular liquid taken in the hollow prism.
OBSERVATION TABLE:

Direct Readings: $R1 = 180^\circ$ and $R2 = 0^\circ$ or $360^\circ$

<table>
<thead>
<tr>
<th>Name of liquid</th>
<th>Spectrometer Readings</th>
<th>Average $D_m = (a+b)/2$</th>
<th>$\mu$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vernier 1/Left Vernier</td>
<td>Vernier 2/Right Vernier</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MSR</td>
<td>VC</td>
<td>VCX LC</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salt water</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PRECAUTIONS:

1. Always the hallow prism should be placed carefully on the prism table.
2. Light from the collimator should incident normally on the hallow prism.

RESULT: Refractive index of various liquids were calculated and the values are

Liquid 1 (Pure water) =

Liquid 2 (Salt water) =
4. YOUNG'S MODULUS BY UNIFORM BENDING METHOD

Experiment No: ………………… Date: ……..

AIM: To determine the Young’s Modulus of a given material by uniform bending method.

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:

![Diagram of Young's Modulus by Uniform Bending Method]

FORMULA:

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

\[ Y = \frac{3gad^2}{2b^3} \left( \frac{M}{e} \right) \text{ Dynes/cm}^2 \]

\( g = \) 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 up to 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 = \textbf{0.001 cm}
# OBSERVATION TABLE:

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

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**

$$Y = \frac{3ga^2}{2bd^3} \left( \frac{M}{e} \right) \text{ Dyne/cm}^2$$
GRAPH:

![Graph Image]

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

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  =  \text{ Dyne/cm}^2 (From observations)

=  \text{ Dyne/cm}^2 (From graph)
5. DETERMINATION OF HALL COEFFICIENT OF A SEMICONDUCTOR

Experiment No: ............... Date: ............... 

AIM: To study the Hall Effect and to calculate: 
1) The Hall Coefficient \( R_H \) 
2) The carrier concentration \( n \) of a given semiconducting sample.

EQUIPMENT/APPARATUS

- Power Supply for the electromagnet (0 – 16 Volts, 5 Amps) 
- Constant Current Power Supply (0 – 50 mA, Ideally 0 – 20 mA) 
- Gauss meter with Hall Probe 
- Semiconducting sample (Ge single crystal) mounted on PCB. (p-type/n-type Ge crystal)

THEORY:

The Hall Effect is due to the nature of the current in a conductor. Current consists of the movement of many small charge carriers, typically electrons, holes, ions or all three. When a magnetic field is present, these charges experience a force, called the Lorentz force. When such a magnetic field is absent, the charges follow approximately straight, 'line of sight' paths between collisions with impurities, phonons, etc. However, when a magnetic field with a perpendicular component is applied, their paths between collisions are curved so that moving charges accumulate on one face of the material. This leaves equal and opposite charges exposed on the other face, where there is a scarcity of mobile charges. The result is an asymmetric distribution of charge density across the Hall element, arising from a force that is perpendicular to both the 'line of sight' path and the applied magnetic field. The separation of charge establishes an electric field that opposes the migration of further charge, so a steady electrical potential is established for as long as the charge is flowing.
If an electric current flows through a conductor in a magnetic field, the magnetic field exerts a transverse force on the moving charge carriers which tends to push them to one side of the conductor. This is most evident in a thin flat conductor as illustrated.

A buildup of charge at the sides of the conductors will balance this magnetic influence, producing a measurable voltage between the two sides of the conductor. The presence of this measurable transverse voltage is called the Hall Effect after E. H. Hall who discovered it in 1879. Note that the direction of the current I in the diagram is that of conventional current, so that the motion of electrons is in the opposite direction.

This effect is very useful in determining-

1) The nature of charge carries e.g. whether semiconductor is on n-type or p-type
2) Carrier concentration or the number density of charge carries
3) Mobility of charge carriers

BLACK DIAGRAM OF EXPERIMENTAL SETUP:
FORMULAE:

Power Supply for Electromagnet: **1.5 Amp**

i) **Hall Coefficient:** \( R_H = \frac{V_H}{I} \times \frac{t}{B} \) **Ω-m/Tesla**

Where \( V_H \) = Hall Voltage (mV)

\( I \) = Current through the specimen (mA)

\( t \) = thickness of specimen in meters (\( t = 0.5 \times 10^{-3} m \))

\( B \) = Magnetic flux density (Tesla)

ii) **Carrier Concentration:** \( n = \frac{1}{qR_H} \) \( /m^3 \)

Where \( q \) = Charge of electrons/holes

\( R_H \) = Hall Coefficient (Ω-m/Tesla)

**SOURCE OF ERROR:**

1. Before starting the experiment, check if the gauss meter is showing zero value or not. For this place the probe at somewhere and adjust offset zero knob until you see zero on display.

2. Ensure that the specimen is located at the center of the pole faces and is exactly perpendicular to the magnetic field.

3. To measure the magnetic flux density, the hall probe should be placed at the center the pole faces.

4. Check the direction of electromagnet coils so that it generates the maximum magnetic field, this can be check by placing the soft iron near the generated magnetic field, and observing if it strongly or weakly attracted to the magnetic poles.
OBSERVATION TABLE:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Current I (mA)</th>
<th>Hall Voltage $V_H$ (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MODEL VOLTAGE-CURRENT GRAPH:

![Model Voltage-Current Graph]

Slope = $V_H/I$
PROCEDURE:

1. Switch on the power supply of electromagnet and measure the magnetic flux density in between the pole faces using Gauss probe.
2. Place the specimen in between the pole faces such that the magnetic field is perpendicular to the strip.
3. Connect one pair of contacts of specimen on the opposite faces to the current source and other pair to the multi-meter of Hall Effect setup.
4. Using current source, Pass the current (mA) through the specimen and measure the resulting Hall voltage in the multi-meter.
5. Increase the current through the specimen gradually and measure the corresponding Hall voltages.

RESULT:

Hall Coefficient \((R_H)\) = \(\Omega\text{-m/Tesla}\)

Carrier Concentration \((n)\) = \(\text{/m}^3\)
6. 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 energy loss.

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

DIAGRAM:

FORMULA:

The energy loss is given by

\[ E = \left( \frac{N_1}{N_2} \right) \times \left( \frac{R_2}{R_1} \right) \times \left( \frac{C_2}{A \times L} \right) \times S_V \times S_H \times \text{area of the loop} \]

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:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Transformer Core</th>
<th>Ferrite Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>N$_1$</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>N$_2$</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>R$_1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R$_2$</td>
<td>4.7 KΩ</td>
<td>4.7 KΩ</td>
</tr>
<tr>
<td>C$_2$</td>
<td>4.7 μF</td>
<td>4.7 μF</td>
</tr>
<tr>
<td>A</td>
<td>2.6*10$^{-4}$ m$^2$</td>
<td>0.90*10$^{-4}$ m$^2$</td>
</tr>
<tr>
<td>L</td>
<td>25.4*10$^{-2}$ m</td>
<td>11.22*10$^{-2}$ m</td>
</tr>
<tr>
<td>$S_V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_H$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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
7. ENERGY BAND GAP OF A SEMICONDUCTING DIODE

Experiment No: .......... Date: ............

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

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

FORMULA:
\[ \ln I_s = \text{constant} - 5.036 \Delta E \left(10^3/T\right) \]

Where, \( I_s \) is reverse saturation current through diode (µA)
\( \Delta E \) 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.

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

THEORY:
There exists a small energy gap between valence 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 valence band to conduction band. The energy needed is the measure of energy band gap, \( \Delta E \), 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

\[ \ln I_s = \text{constant} - 5.036 \Delta E \left(10^3/T\right) \]

Where \( T \) is absolute temperature in kelvin and \( \Delta E \) 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.

**CIRCUIT DIAGRAM:**

![Circuit Diagram](image)

**PROCEDURE:**
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 I_s 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.
OBSERVATION TABLE:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Temperature (°C)</th>
<th>Temperature (K)</th>
<th>$10^3/T$ (K$^{-1}$)</th>
<th>Reverse Current $I_s$ (µA)</th>
<th>ln $I_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MODEL GRAPH:

\[
\text{Slope}(m) = \frac{AB}{BC}
\]

RESULT:

Band gap of given semiconductor is: \( eV \)
8. CREEP BEHAVIOUR OF A METAL WIRE

Experiment No: ………… Date: …………..

AIM: To determine creep constant of a given material.

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.
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:**

![Successive stages of Creep](image)

**Fig. 1 Successive stages of Creep**
FORMULA:

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

Viscous Creep Constant \( (k) \) = \( \frac{\Delta l}{l_t} / t \)

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 200 gm 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 \( \Delta l/l_0 \) vs \( t^{1/3} \) in order to obtain transient creep \( (\beta) \), slope of the plot is calculated.
- A graph is drawn between \( \Delta l/l_t \) vs \( t \) in order to obtain viscous creep \( (k) \), slope of the plot is calculated.
OBSERVATION TABLE:

Initial length of the wire \( (l_o) = \) \( \text{cm} \)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Time</th>
<th>( t ) (min)</th>
<th>( t ) (sec)</th>
<th>( t^{1/3} ) (sec(^{1/3}))</th>
<th>Instantaneous Length ( (l) ) (cm)</th>
<th>( \Delta l = l - l_o ) (cm)</th>
<th>( \Delta l/l_o )</th>
<th>( \Delta l/l_t )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GRAPH-1:

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

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 ($\beta$) $= (\sec)^{-1/3}$
2. Viscous creep constant ($k$) $= (\sec)^{-1}$
GUIDELINES FOR PREPARATION OF LAB BASED PROJECT REPORT

➢ For soft copy of the report
  • Font type: Times new roman
  • Font size: 12 point
  • Line spacing: 1.5

➢ Hand written projects are also allowed.

➢ Use A4 size papers.

➢ Use stick file for holding the stapled report and submit.

Report should have the following sections:

1. **Introduction**: Write importance of the work.

2. **Methodology**: Write procedure used for implementation of the project.

3. **Results and Discussion**: Analysis the results.

4. **Conclusion**: Highlight the important points of the work.

5. **Future Scope**

6. **References**
List of Projects Proposed for I/IV B. Tech

Students who registered for the course, Engineering Materials are directed to select and implement any one project from the list shown below or do a project of their interest for partial fulfillment of credits of the course structure, 2-2-2.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of the Faculty</th>
<th>Title of the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dr. N.S.M.P. Latha Devi</td>
<td>Electricity generation using piezoelectric material through footfall pressure.</td>
</tr>
<tr>
<td>2</td>
<td>Dr. G. Sunita Sundari</td>
<td>Construction of an electric transformer.</td>
</tr>
<tr>
<td>3</td>
<td>Dr. M. Venkateswarlu</td>
<td>Spectroscopic studies of lanthanide ions doped glasses.</td>
</tr>
<tr>
<td>4</td>
<td>Mr. M.V.V.K.S. Prasad</td>
<td>Verification of working of constant DC power supply using various semiconducting devices</td>
</tr>
<tr>
<td>5</td>
<td>Dr. Sk. Mahamuda</td>
<td>Optical properties of rare earth doped glasses.</td>
</tr>
<tr>
<td>6</td>
<td>Dr. K. Swapna</td>
<td>Optical properties of rare earth doped Telluride glasses.</td>
</tr>
<tr>
<td>7</td>
<td>Dr. A. Venkateswara Rao</td>
<td>Fabrication of Dye - Sensitized solar cell.</td>
</tr>
<tr>
<td>8</td>
<td>Dr. Ch. Rajesh.</td>
<td>Synthesis of silver (Ag) nanoparticles (NPs) using bamboo leaves.</td>
</tr>
<tr>
<td>9</td>
<td>Dr. G. Kiran Kumar</td>
<td>Energy loss of fast charged particles in materials using SRIM/TRIM calculations.</td>
</tr>
<tr>
<td>10</td>
<td>Dr Sk. Babu</td>
<td>Study of molecular interactions in liquid mixtures</td>
</tr>
<tr>
<td>11</td>
<td>Mr. M. V. V. K. S. Prasad</td>
<td>Energy Band Gap Studies of Semiconductor Diodes.</td>
</tr>
<tr>
<td>12</td>
<td>Mr. M. Gnana Kiran</td>
<td>Construction of solar hot dog cooker.</td>
</tr>
<tr>
<td>13</td>
<td>Dr. N. Krishna Jyothi</td>
<td>Dielectric properties of solid polymer electrolytes.</td>
</tr>
<tr>
<td>14</td>
<td>Dr. A. V. Ravindra</td>
<td>Thickness determination of a thin film using low-angle x-ray diffraction.</td>
</tr>
<tr>
<td>15</td>
<td>Dr. S. Siva Kumar</td>
<td>Construction of Power Generator</td>
</tr>
<tr>
<td>16</td>
<td>Dr. D. Thanga Raju</td>
<td>Construction of Mini Hydrogen Generator: Water to Fuel Converter</td>
</tr>
</tbody>
</table>
TITLE OF THE PROJECT

submitted

for

partial fulfillment of requirements for I year B.Tech program

by

NAME OF THE STUDENT
ID NO.

Department of Physics
K L University
2017-18
Department of Physics
K L University

Certificate

I................................................................., ID No. .............................., branch ......................,
lab section............ hereby submit a report on project titled ..................................................
as a part of fulfilling the requirements of I/IV B.Tech .......... semester examination of academic
year 2017-2018.

Signature of Student                                    Signature of faculty
                                                     (Guide)

Date:                                               Signature of Head of the Department
# Index

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of the content</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Methodology</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Results and Discussion</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Conclusion</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Future Scope</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>References</td>
<td></td>
</tr>
</tbody>
</table>