



# POTTI SRIRAMULU CHALAVADI MALLIKARJUNA RAO COLLEGE OF ENGINEERING & TECHNOLOGY

SPONSORED BY SKPVV HINDU HIGH SCHOOLS COMMITTEE, Estd : 1906

APPROVED BY AICTE, NEW DELHI, AFFILIATED TO JNTU KAKINADA  
ACCREDITED BY NAAC, NBA for B.TECH PROGRAMS in CSE, ECE & EEE, ISO 9001:2015 CERTIFIED

# 7-3-6/1, RAGHAVA REDDY STREET, ONE TOWN, VIJAYAWADA - 520001

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COLLEGE CODE : **PSCV** [ EAMCET, ECET, ICET, POLYCET]



## FRESHMEN ENGINEERING DEPARTMENT



### APPLIED PHYSICS LABORATORY RECORD

Course: B.Tech. (R20)

Branch: \_\_\_\_\_

Academic Year: \_\_\_\_\_

Year & Sem: \_\_\_\_\_

REGISTER NUMBER : \_\_\_\_\_



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## CERTIFICATE



*This is to certify that this is a bonafide work done by  
Mr./Ms.....bearing  
Roll.No: ..... of I B.Tech ..... Semester in  
..... branch for the Applied Physics laboratory during  
the academic year .....*

*Number of Experiments Recorded :*

*Marks Awarded :*

*Signature of the Faculty with Date*

*Signature of the H.O.D with Date*

*Signature of Internal Examiner*

*Date :*

*Signature of External Examiner*

*Date :*

# INDEX

S.N.	EXPT. NO.	NAME OF THE EXPERIMENT	DATE	PAGE NO.	MARKS	FACULTY SIGNATURE

## INSTRUCTIONS TO THE STUDENTS

- *Main objective of the laboratory is learning by doing.*
- *The experiments are designed to illustrate phenomena in different areas of Physics and to expose you to measuring instruments.*

**All the students should follow the following rules while coming into the laboratory**

- 1) Before entering into the Laboratory, every student need to sign in students Log-Book.
- 2) Come to laboratory equipped with Record, Pen, Pencil, Scale, Calculator to perform the experiment with interest and an attitude of learning.
- 3) You need to come well prepared to do the experiment, Work quietly and carefully.
- 4) Handle the instruments with care. If any breakage, report to the faculty/Instructor.
- 5) Do not perform unauthorized experiments and Do not fiddle idly with apparatus.
- 6) All the presentations of data, tables and graphs calculations should be done neatly and carefully.
- 7) Be honest and careful while recording and representing the data, never make up readings/graph. If any particular reading appears wrong, repeat the measurement carefully.
- 8) Graphs should be drawn neatly with pencil, mention the labels and units carefully.
- 9) Complete the calculations, drawing graphs within the stipulated time and submit to the faculty before leaving the laboratory.
- 10) Return all the equipment you have signed out for the purpose of your experiment.
- 11) Laboratory attendance and performance will be treated as internal assessment/marks.

## COURSE OBJECTIVES

Physics Laboratory curriculum is reoriented to the needs of circuitual & non circuitual branches of graduate engineering courses offered by JNTUK that serves as a transit to understand the branch specific advanced topics.

The course is designed to: Impart the practical Knowledge in different areas of Physics and to expose to measuring the physical quantities and the instruments.

## COURSE OUTCOMES

*Student will be able to*

CO. 1	Demonstrate the concepts of physics experimentally with physical equipment.
CO. 2	Summarize the required data to perform experiments related to engineering physics.
CO. 3	Calculate the physical values with targeted accuracy by explaining the basic knowledge, principles, and concepts of physics using required instruments.

**Prepared by: 1) Dr. P. Naresh**

**2) Dr. A. Bindu Madhavi**

**3) S. Sri Devi**

# AIR WEDGE METHOD

**Experiment. No:**

**Date:**

**Aim:** To determine the thickness of a given thin object by forming wedge shaped air film.

**Apparatus:** Traveling Microscope, two plane glass plates of the same size, thin object (paper/wire), and another glass plate fixed to a frame & sodium vapour lamp.

**Scope of the experiment:**

Light is an electromagnetic radiation which can be seen. In case of light waves, when two light waves superimpose, then the resultant amplitude in the region of super position is different than the amplitude of individual waves. This modification in the distribution of intensity in the region of super position is called interference.

**Formula:** Thickness of the thin object,  $t = \frac{\lambda l}{2\beta}$  cm

where  $\lambda$  is the wavelength of the light,  $\beta$  is the fringe width

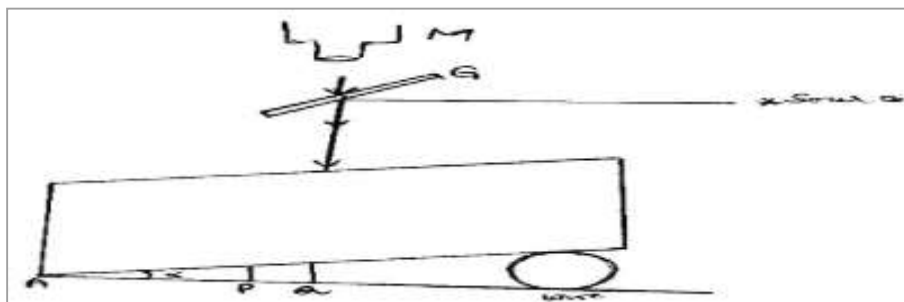
' $l$ ' is the distance between the point of contact of the two glass plates and wire

Least count of traveling microscope =  $\frac{\text{Value of 1 main scale division}}{\text{Number of Vernier divisions}} = \frac{0.05}{50}$  cm

L.C = 0.001 cm

**Procedure:**

1. The two optically plane glass plates are cleaned well and fixed a small diameter of given wire in between them at one end.
2. At the other end the two glass plates are contacted.
3. The separated space between the glasses is formed a wedge shape.
4. Another glass plate is fixed to a stand at about  $45^\circ$  to the horizontal so that the light falling on it will be reflected down to fall on the wedge.
5. The interference fringes are observed through the Microscope.
6. The readings of the microscope for the different fringes are noted and tabulated.



7. The average width of each 5 fringes is calculated and determined each fringe width  $\beta$ .
8. The distance of the wire from the point of contact of the two plates ' $l$ ' is measured.
9. Finally, the thickness of the given thin object is calculated by using the formula.

thickness of the thin object,  $t = \frac{\lambda l}{2\beta}$  cm where  $\lambda$  is wavelength of the light,

' $l$ ' is distance between the point of contact of the two glass plates and thin object,  $\beta$  is the fringe width.

**Observations:**      **Table:** Determination of fringe width ( $\beta$ ).

S.No	No. of the fringe	Travelling Microscope Reading				Width of 5 fringes ( $x$ ) cm
		M.S.R (a) cm	VC	VC x LC (b) cm	Total Reading (a+b) cm	

Average width of 5 fringes ( $x$ ) = \_\_\_\_\_

Width of each fringe,  $\beta = \frac{x}{5} = \text{_____ cm}$

**Calculations:**

Thickness of thin object,  $t = \frac{\lambda l}{2\beta}$  cm

Here,  $\lambda = 5893 \times 10^{-8}$  cm,  $\beta =$  \_\_\_\_\_  $l =$  \_\_\_\_\_

$$\therefore t = \frac{\lambda l}{2\beta} \text{ cm}$$

**Precautions:**

1. The glass plate should be very clean and thin.
2. The object used should be thin.
3. Readings should be taken without parallax error.

**Result:**

Thickness of given paper is calculated by air-wedge method.

Thickness of the given paper ( $t$ ) = \_\_\_\_\_ cm.

# NEWTON'S RINGS EXPERIMENT

**Experiment. No:**

**Date:**

**Aim:** To determine the radius of curvature of Plano-convex lens by forming Newton's Rings.

**Apparatus:** Plano Convex lens, two plane glass plates, traveling microscope, magnifying lens and Sodium vapor lamp.

**Scope of the experiment:**

Light is an electromagnetic radiation which can be seen. In case of light waves, when two light waves superimpose, then the resultant amplitude in the region of super position is different than the amplitude of individual waves. This modification in the distribution of intensity in the region of super position is called interference.

**Description:**

A Plano – convex lens with its convex surface is placed on a plane glass plate. The thickness of the air film at the point of contact is zero. If monochromatic light is allowed to fall normally on the Plano- convex lens, the alternate dark and bright rings are concentric around the point of contact between the lens and glass plate.

**Formula:** Radius of curvature of Plano- convex lens,  $R = \frac{D_m^2 - D_n^2}{4\lambda(m - n)}$  cm

Where,  $D_m^2, D_n^2$  are the diameters of the  $m^{\text{th}}$  and  $n^{\text{th}}$  rings,

$\lambda$  is the wavelength of light ( $5893 \times 10^{-8}$  cm),

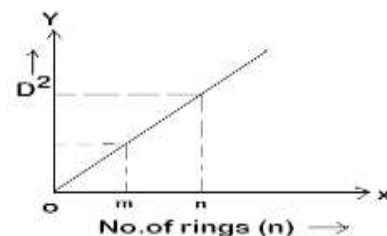
$m, n$  are the numbers of the rings.

$$\text{Least count of traveling microscope} = \frac{\text{Value of 1 main scale division}}{\text{Number of Vernier divisions}} = \frac{0.05}{50} \text{ cm}$$

$$\text{L.C} = 0.001 \text{ cm}$$

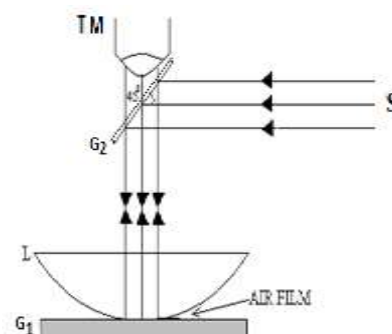
**Graph:**

A graph is drawn to Number of the newton rings and diameter of the ring.



**Experimental arrangement:**

1. The experimental arrangement is shown in the figure.
2. "L" is a Plano convex lens of large radius of curvature (R) is placed on a plane glass plate "G<sub>1</sub>" with its curved surface.
3. "S" is a monochromatic light source.
4. "G<sub>2</sub>" is another glass plate, which is at an angle 45° with the vertical.



**Observations:**

**Table:** Determination of the diameter of Newton's rings

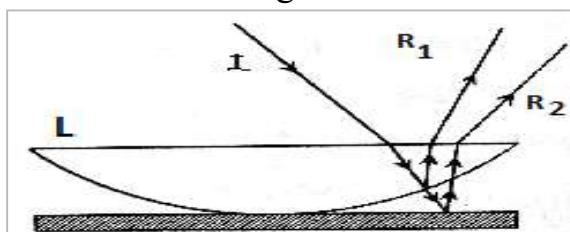
S.No	No. of the ring	Travelling Microscope readings								Diameter (D=L~R) cm	D <sup>2</sup> cm <sup>2</sup>
		Left side				Right side					
		M.S.R cm (a)	V.C	VCxLC cm (b)	Total Reading (L=a+b) cm	M.S.R cm (a)	V.C	VCxLC cm (b)	Total Reading (R=a+b) cm		

**Calculations:** Radius of curvature of Plano-convex lens,  $R = \frac{D_m^2 - D_n^2}{4\lambda(m - n)} \text{ cm}$



### Procedure:

1. When a monochromatic light is incident on glass plate 'G<sub>2</sub>,
2. The glass plate G<sub>2</sub> reflects the light normally into thin (air) film.
3. Some part of light is reflected from the upper layer of thin film (curved surface of lens) as R<sub>1</sub>
4. And some part of light is transmitted through the thin film and it gets reflected from the glass plate 'G<sub>1</sub>' as R<sub>2</sub>.
5. These two reflected rays R<sub>1</sub> & R<sub>2</sub> produce interference pattern. This interference pattern is in circular fringes. These are called Newton's rings.



6. The microscope is moved inside so that the cross wires pass over 16 dark rings. Record the main scale and the Vernier coincidence readings and tabulated.
7. Now the microscope is moved so that the vertical cross wire is set at the end of the 12<sup>th</sup>, 8<sup>th</sup>, 4<sup>th</sup> bright rings then record MSR and VC.
8. Similarly, the readings of the microscope can be noted on the other side 4<sup>th</sup>, 8<sup>th</sup>, 12<sup>th</sup> and 16<sup>th</sup> bright rings and tabulated.
9. A graph is drawn to the number of bright rings on X-axis and the square of the diameter of the ring (D<sup>2</sup>) on Y-axis.
10. The graph gives straight line passing from origin. From the graph, the values of D<sub>n</sub><sup>2</sup> and D<sub>m</sub><sup>2</sup> corresponding to n<sup>th</sup> and m<sup>th</sup> rings are found.
11. The radius of curvature (R) of the Plano convex lens can be calculated using the formula.

$$R = \frac{D_m^2 - D_n^2}{4\lambda(m - n)} \text{ cm} \quad (\text{or}) \quad \lambda = \frac{D_m^2 - D_n^2}{4R(m - n)} \text{ A}^0$$

### Precautions:

1. Readings should be taken without any parallax error.
2. The lens and the glass plate should be perfectly clean.
3. While taking the observations the microscope should be moved only in one direction to avoid the error.
4. The slow motion tangent screw alone should be moved in taking observations.

### Result:

Radius of curvature of given Plano-convex lens is calculated by Newton's rings experiment.

Radius of curvature of Plano-convex lens = \_\_\_\_\_ cm.

# DIFFRACTION GRATING

**Experiment. No:**

**Date:**

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**Aim:** To determine wavelength of a given source of light by using Diffraction Grating in the normal incidence position.

**Apparatus:** Plane diffraction grating, Spectrometer, Spirit level, Reading Lens & Mercury vapour lamp.

**Scope of the experiment:**

Light is an electromagnetic radiation which can be seen. Diffraction is one of the properties of light and is closely related to interference. The diffraction phenomenon is due to mutual interference of secondary wavelets originating from various points of the wave front which are not blocked off by the obstacle.

**Description:** A plane diffraction grating consists of a parallel sided glass plate with equidistant fine parallel lines drawn very closely upon it by means of a diamond point. (the gratings used in the laboratory are exact replicas of the original gratings on celluloid film).

Diffraction grating is a plane transparent material contains large number of equidistant, sharp, parallel lines. The student grating is about 15,000 LPI.

**Formula:** The wavelength of given light source,  $\lambda = \frac{\sin \theta}{Nn} A$  or cm

Where  $\lambda$  is wavelength of the light used ( $5500 \times 10^{-8}$  am),

$\theta$  is the angle of diffraction,

N is number of lines per cm in grating ( $N = 5905.5$ ),

n is order of the spectrum (=1),

$$\text{Least count of spectrometer} = \frac{\text{Value of one main scale division}}{\text{No. of vernier divisions}} = \frac{0.5^0}{30} = \frac{30^1}{30} = 1^1$$

**Procedure:**

The usual initial adjustments of the Spectrometer are done. The least count of the Vernier of the spectrometer is found.

**A. Normal incidence Position:**

1. The slit of the spectrometer is illuminated with sodium vapour lamp.
2. The telescope is placed in line with the axis of the Collimator and the direct image of the slit is observed and adjusted the spectrometer reading as  $0^0 - 0^0$  and  $0^0 - 180^0$ .
3. The prism table is clamped and the telescope turned through exactly  $90^0$  and fixed.
4. The grating mounted on its holder on the prism table such the prism table is released and rotated until the image of the slit is seen in the telescope by reflection.
5. After fixed the prism table, the Vernier table is released and rotated through exactly  $45^0$  from this position.

**Observations:****Table:** Wavelength of Spectral lines

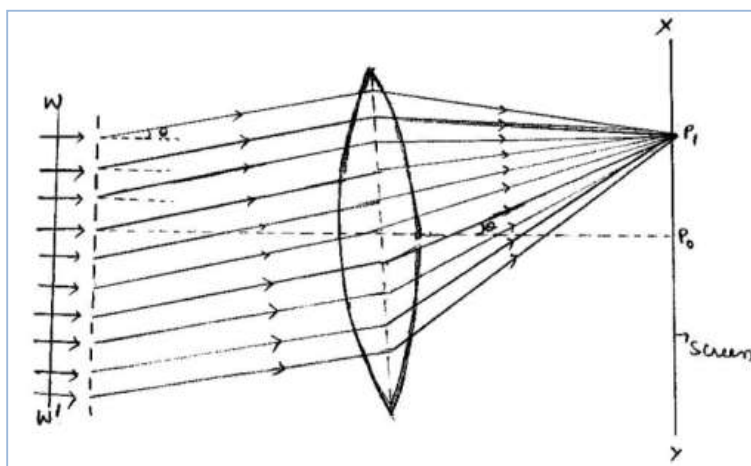
S.N.	Color of spectral line	Spectrometer Reading					Angle of diffraction ( $\theta = \theta_1 \sim \theta_2$ ) in degree	$\lambda = \frac{\sin \theta}{Nn} \text{ \AA}^0$
		M.S.R (a) in degree	VC	VC x LC (b) in degree	Total Reading ( $\theta_1 = a + b$ ) in degree	Direct reading ( $\theta_2$ ) in degree		

Average value of  $\lambda =$  \_\_\_\_\_**Calculations:**wavelength of spectral line  $\lambda = \frac{\sin \theta}{Nn}$

- Vernier table is fixed in this position and the telescope is brought back to the direct reading position.
- Now the light from Collimator strikes the grating normally and taken direct reading  $\theta_1$ .

### **B. Measurement of Wavelength ( $\lambda$ ):**

- Telescope is moved to catch the first order direct image on one side, say on the left.
- With mercury vapour lamp, the spectrum of colours is seen.
- Now the point of intersection of the cross wires is set on the violet line and its reading is noted on vernier as  $\theta_1$ .



- Similarly, the readings corresponding to the other colors are also noted as  $\theta_2$  and tabulated.
- The diffracted angle ( $\theta = \theta_2 - \theta_1$ ) of the spectral line calculated.
- Finally, the wavelength of given light source can be calculated by using the following formula.

$$\lambda = \frac{\sin \theta}{Nn} A$$

### **Precautions:**

- Readings should be taken without parallax error.
- Always the grating should be held by the edges. The ruled surface should not be touched.
- Light from the Collimator should be uniformly incident on the surface of the grating.

### **Result:**

Wavelength of given light source is determined using Diffraction Grating in normal incidence position.

Wavelength of light source = \_\_\_\_\_ cm

# DISPERSIVE POWER OF PRISM

Experiment. No:

Date:

**Aim:** To determine the dispersive power of the material of a prism by spectrometer.

**Apparatus:** Spectrometer, prism, spirit level, reading lens and mercury lamp.

**Formula:** The dispersive power of the material of a prism is given by

$$\omega = \frac{\mu_v - \mu_R}{\left(\frac{\mu_v + \mu_R}{2} - 1\right)}$$

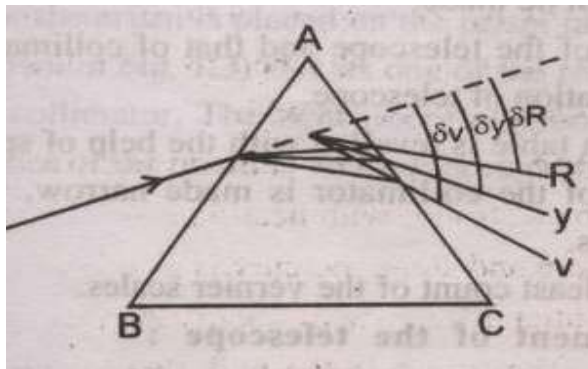
$\mu_v$  is Refractive index of the material of a prism for violet color,

$\mu_R$  is Refractive index of the material of a prism for red color.

Refractive index is given by, 
$$\mu = \frac{\sin\left(\frac{A + D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Where  $A$  = Angle of prism ( $60^\circ$ )  
 $D_m$  = Angle of minimum deviation

**Model Diagram:**



**Procedure:**

To obtain pure spectrum by spectrometer the following adjustments must be made:

- The axis of the telescope and that of collimator must intersect the central axis of rotation of telescope.
- The prism table is leveled with the help of spirit level.
- The slit of the collimator is made narrow, vertical and symmetrical on both sides.
- Note the least count of Vernier scales.

## (A) Telescope Adjustment

**Schuster's method:** There is another method of adjusting the telescope and the collimator for parallel rays. This method is called Schuster's method. The method is as follows:

- i) First of all, prism table is adjusted at the same height of the collimator and telescope.
- ii) Now the prism is placed on the prism table in such a position that it's one of the refracting surface faces the collimator. The light emerging from the other refracting

surface of the prism is viewed through the telescope.

- iii) The prism table and the telescope both are then rotated slowly and simultaneously so that the spectral lines always remain the cross-wire. A state is reached when on rotating the prism table further, the direction of rotation of the spectral lines reversed. This position is the position of minimum deviation.
- iv) Now, keeping the telescope fixed, the prism table is rotated through a small angle. The spectral lines are seen to be blurred. The telescope is adjusted with the help of rack and pinion arrangement so that spectral lines become distinct and clear.
- v) In this position the spectrometer will be set for parallel rays coming out of the collimator, focusing parallel rays by telescope at its cross wire and the prism in the position of angle of minimum deviation.

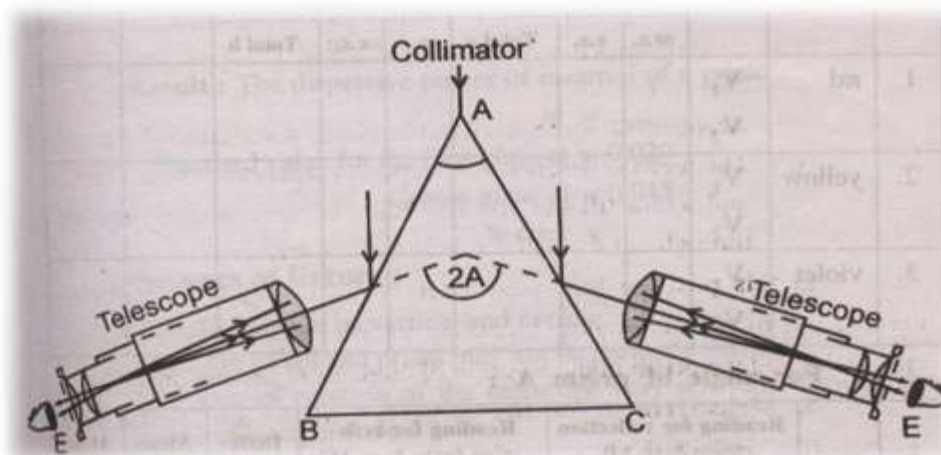
### **(B) Measurement of the angle of minimum deviation**

Follow the procedure as given in steps (i), (ii), and (iii) of the Schuster's method.

- i) Now fix the vertical cross-wire on one of the extreme spectral line of the spectrum with the help of tangent screw of the telescope. Note the reading of both the Vernier's on the main scale.
- ii) Similarly fix the vertical cross wire on the mean line and extreme spectral line on the other end of the spectrum and in each position note the MSR and Vernier readings.
- iii) The position of the prism table is kept fixed and the prism is removed. The telescope is rotated till the direct image of the slit is viewed at its vertical cross-wire. The position of the telescope is noted by the reading of MSR and Vernier.
- iv) The difference of readings in steps (ii), (iii) is the angle of minimum deviation.

### **(C) Measurement of the angle of Prism (A)**

- i) Place the prism on the prism table with its angle of prism  $A$  towards the collimator and with its refracting edge  $A$  at its center. In this position some of the light falling on each refracting surface  $AB$  and  $AC$  will be reflected and can be received by the telescope.



**Observations:**    **Table :** Refractive Index of spectral lines

S.N.	Color of spectral line	Spectrometer Reading					Angle of minimum deviation ( $D_m = \theta_1 - \theta_2$ ) in degree	$\mu = \frac{\sin\left(\frac{A + D_m}{2}\right)}{\sin(A/2)}$ $A^\circ$
		M.S.R (a) in degree	VC	VC x LC (b) in degree	Total Reading ( $\theta_1 = a + b$ ) in degree	Direct reading ( $\theta_2$ ) in degree		

**Calculations**

- ii) The telescope is moved to one side to receive the light reflected from the refracting surface AB and the image of the slit is focused at the vertical cross-wire. The reading of two Vernier's is noted on the main scale.
- iii) Now the telescope is moved to another side to receive the light reflected from the refracting surface AD and the image of slit is focused again at the vertical cross-wire. The reading of two Vernier's is noted again on the main scale.
- iv) The difference of readings in steps (ii) and (iii) is calculated for both the Vernier's. The mean of these two differences will be twice the angle of prism. Therefore, half of this angle gives the angle of prism.

**Precautions:**

1. The slit should be as narrow as possible but the knife edge of the slit should not touch each other.
2. The telescope and the collimator should be separately set for parallel rays.
3. The height of the prism table should be so adjusted that the maximum light must fall on the entire surface of the prism.
4. While taking observations the telescope and the prism table must be clamped.
5. The reading lens should be used for taking readings on both the Vernier.

**Result:**

The dispersive power of material of a prism is calculated.

The Dispersive power of given prism ( $\omega$ ) = \_\_\_\_\_



# PLANCK'S CONSTANT

Experiment. No: \_\_\_\_\_

Date: \_\_\_\_\_

**Aim:** Estimate the value of Planck's constant using photoelectric effect.

**Apparatus:** Tungsten-halogen light source (Lamp), different colour filters, a built-in power supply with an ammeter and voltmeter, phototube (detector) and connectingwires.

**Description:**

Planck's constant ( $h$ ), a physical constant was introduced by German physicist named Max Planck in 1900. Planck's constant is essential for understanding the motions of atoms and subatomic particles, as well as how quantum mechanics and modern electronics operate. At the time, existing formulas did not describe accurately the observed results for all temperatures. It describes the behavior of particle and waves at atomic level as well as the particle nature of light.

**Formula:**

1. Theoretically, Planck's constant  $h = \frac{e\lambda V_0}{C} \text{ Js}$

Here,  $e$  is charge of an electron ( $1.60217663 \times 10^{-19}$  coulombs),

$\lambda$  is wavelength of light from the filter in nm,

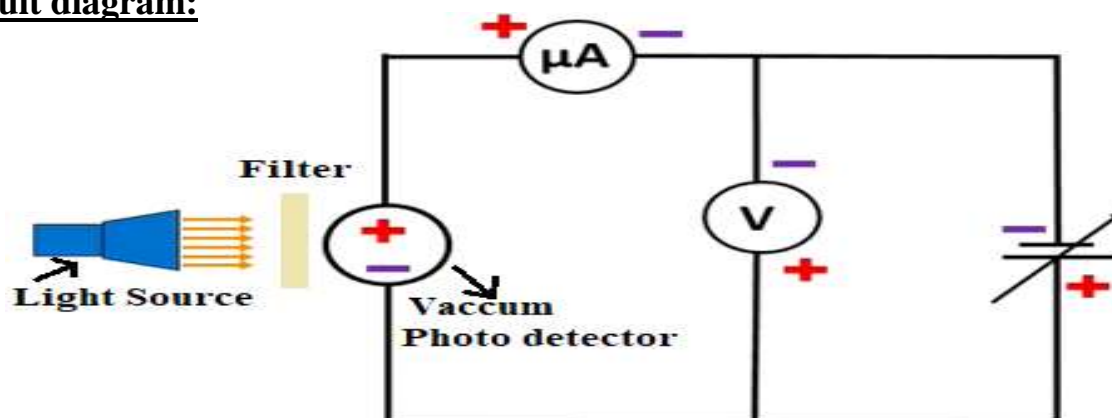
$V_0$  is the stopping potential in volts,

$C$  is the velocity of light ( $3 \times 10^8$  m/s)

2. Graphically, Planck's constant,  $h = \text{slope} \times e$

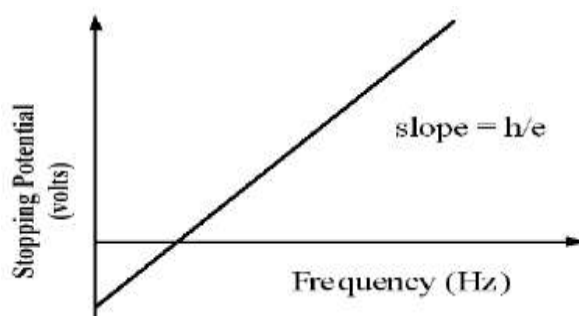
Here,  $e$  is charge of an electron ( $1.60217663 \times 10^{-19}$  coulombs).

**Circuit diagram:**



### Model graph:

A graph is drawn between frequency( $\nu$ ) of light and stopping potential ( $V_0$ )



### Procedure:

1. The experimental set-up is shown in the above circuit.
2. It comprises of a tungsten-halogen light source with five different colored filters, a Cesium-type vacuum phototube (photo detector), a built-in power supply and a current multiplier.
3. After Plug in the connections first turn on the lamp (it may take nearly 5 minutes to warm up) and then switch on the power supply for Planck's constant kit.
4. The phototube with receptor must be in front of lamp source as near as possible.
5. Adjust the voltage knob for zero voltage and the current knob for zero value.
6. Mount any of a colored filter in front of the phototube at the receptor space.
7. Adjust the current value to zero and record corresponding voltage ( $V_0$ ) reading, it is called as stopping potential.
8. Repeat the above steps 6 and 7 for different colour filters and record their stopping potentials.
9. By the observations, using wavelength and stopping potential values determine the values of Planck's constant for different filters theoretically.
10. Draw a graph between frequency of light along X-axis and stopping potential along Y-axis.
11. By measuring the slope value from the graph, the value of Planck's constant can be calculated using the following formula.

$$\text{Planck's constant (h)} = \text{Slope} \times e \quad \text{Js}$$

here, 'e' is charge of an electron ( $=1.60217663 \times 10^{-19}$  coulombs).

**Observations:**

S.No.	Filters	Frequency ( $\nu$ ) in Hz	Wavelength ( $\lambda$ ) in nm	Stopping Potential ( $V_0$ ) in Volts
1	Red	$4.25 \times 10^{14}$	665	
2	Yellow	$5.15 \times 10^{14}$	578	
3	Green	$5.55 \times 10^{14}$	546	
4	Blue	$6.06 \times 10^{14}$	436	

Average,  $h =$  \_\_\_\_\_

**Calculations:**

**Precautions:**

1. Should not change intensity of light while taking data.
2. Readings should be taken without parallax error.
3. Place the filters properly in front of photo detector at specified space.

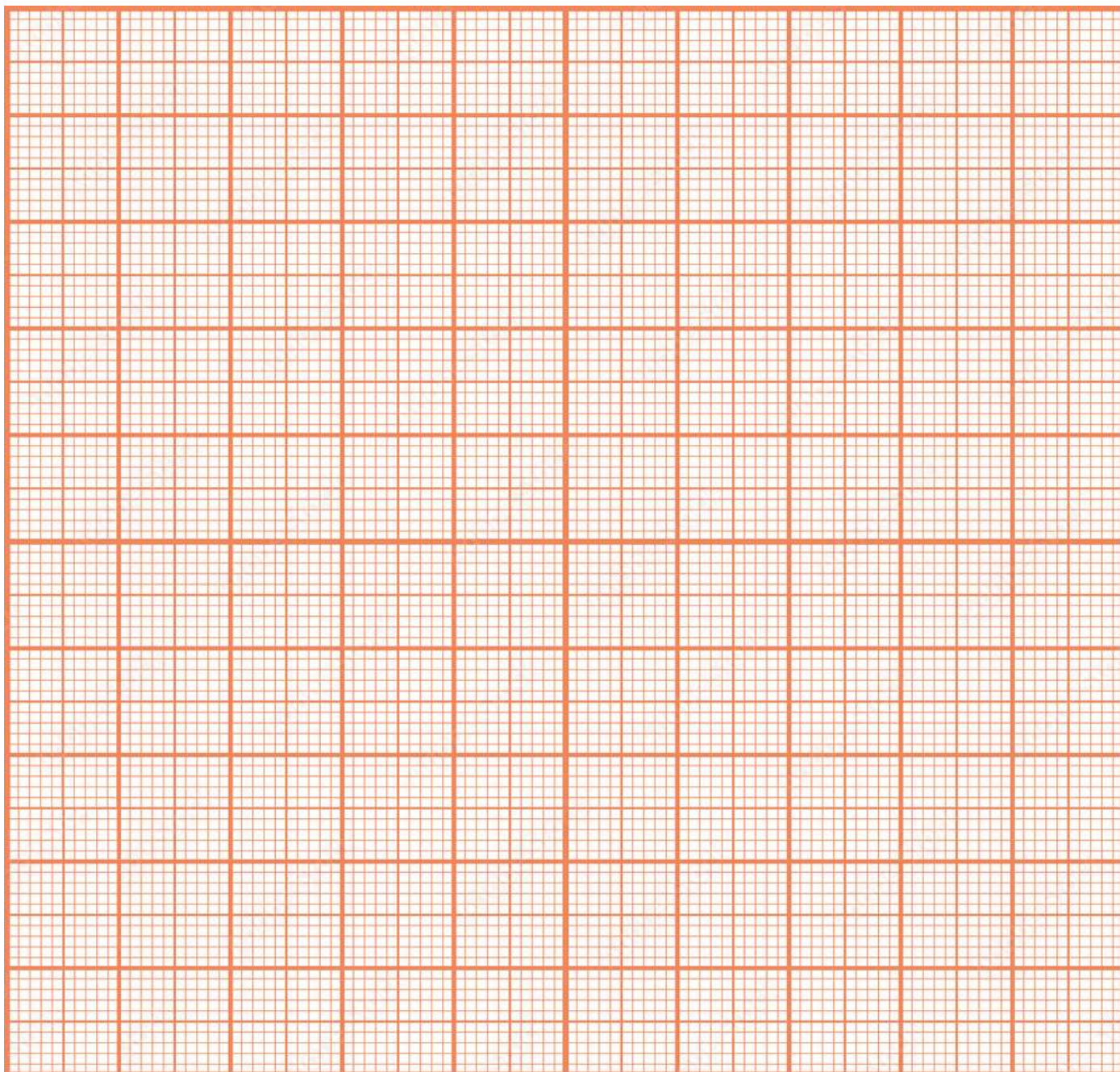
**Graph:**

The graph is drawn between frequency(  $\nu$ ) of light along X-axis and stopping potential ( $V_0$ ) along Y-axis.

**Scale:**

On X - axis 1Unit =

On Y - axis 1Unit =



**Result:**

Estimated the value of Planck's constant by photoelectric effect using different filters.

Planck's constant ( $h$ ) = \_\_\_\_\_ Js.

# WAVELENGTH OF LASER

**Experiment. No:**

**Date:**

**Aim:** To Determine the wavelength of laser source using diffraction grating.

**Apparatus:** Laser source, diffraction grating, grating holder stand, grating holder, screen, meter scale.

**Formula:** The wavelength of given Laser source,  $\lambda = \frac{\sin \theta}{Nn} A$  or cm

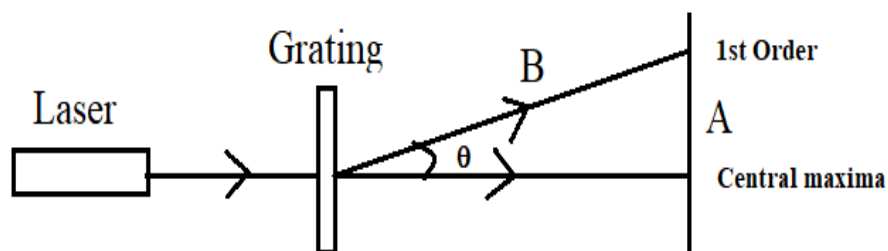
Where  $\lambda$  is wavelength of the laser used,

$\theta$  is the angle of diffraction,

N is number of lines per cm in grating (N=5905.5),

n is order of the spectrum.

**Model figure:**



**Procedure:**

1. Mount the diffraction grating on a grating stand a few centimeters from the laser source.
2. Adjust the diffraction grating in between laser and screen.
3. Turn off the lights in the room and turn on the laser source.
4. Measure the angle of diffraction of first laser spot from the central maxima using meter scale and tabulate the readings.
5. By changing the distance between laser source and diffraction grating, measure the angle of diffraction of first laser spot from the central maxima and tabulate the readings.
6. Finally, calculated the wavelength of given laser source using diffraction grating by using the following formula.
7. The wavelength of given Laser source is calculated by the following equation.

$$\lambda = \frac{\sin \theta}{Nn} A^0 \text{ or cm}$$

**Observations:** Table: Wavelength of given Laser source

S.No.	Distance from central maxima to 1 <sup>st</sup> order (A in cm)	Distance from grating to 1 <sup>st</sup> order (B in cm)	$\sin \theta = \frac{A}{B}$	$\lambda = \frac{\sin \theta}{Nn} A^0$

**Calculation:**

**Precautions:**

1. Readings should be taken without parallax error.
2. Always the grating should be perpendicular to the laser light.

**Result:**

Wavelength of laser source is determined using diffraction grating.

Wavelength of laser source = \_\_\_\_\_ A<sup>0</sup>



# OPTICAL FIBER

## NUMERICAL APERTURE & ACCEPTANCE ANGLE

Experiment. No:

Date:

**Aim:** To determine the Numerical Aperture and Acceptance angle of Optical Fiber.

**Apparatus:** Optical fiber kit, Optical fiber with connector & Numerical Aperture jig.

**Description:**

The optical fibers used for optical communication called wave guides made of transparent dielectrics.

Light waves cannot travel far in open atmosphere as the energy gets very rapidly dissipated. Hence some kind of guiding channel is needed just like for guiding electric current a conducting path, like a metal wire, is needed. Optical fiber provides the necessary wave guide for light.

**Acceptance angle ( $\phi_{max}$ ):**

The maximum value of incident angle of incident light at which enter into the optical fiber is called acceptance angle ( $\phi_{max}$ ).

$$\phi_{max} = \sin^{-1} \left[ \sqrt{n_1^2 - n_2^2} \right]$$

**Numerical Aperture(NA):**

Numerical aperture is directly proportional to the acceptance angle.

$$NA = \sin \phi_{max} \quad \text{or} \quad NA = \sqrt{n_1^2 - n_2^2}$$

**Formula:**

1) The numerical aperture of the fiber,  $NA = \sin(\phi_{max}) = \frac{W}{\sqrt{4L^2 + W^2}}$

Where  $\theta$  is the acceptance angle of the fiber in degrees.

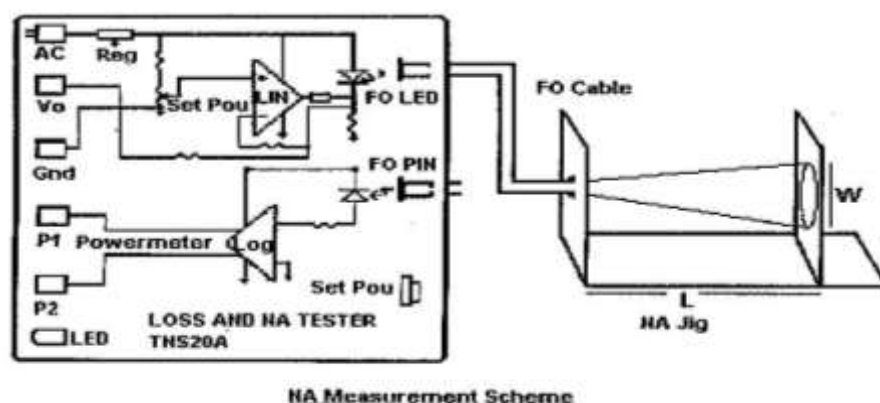
W is width of the beam spread (diameter of the light filled circle in mm)

L is the distance of the screen from the fiber end in mm.

2) Numerical aperture is directly proportional to the acceptance angle.

$$NA = \sin \phi_{max}$$

**Diagram:**



**Procedure:**

- 1) Connect the one end of the cable one to the 660nm L.E.D. FO connector of Tx unit and other end to the NA jig as shown in the figure.
- 2) Plug the AC main turn the P<sub>o</sub> Knob to clockwise direction to set maximum P<sub>o</sub>.  
The light intensity should increase at the end of the fiber on the NA jig.
- 3) Hold the white scale-screen, provided in the Kit vertically at a distance (L) from the emitting fiber end and view the Red spot on the screen for firstly 10mm (W) .
- 4) Calculate the numerical aperture of given optical fiber from the following formula

$$NA = \frac{W}{\sqrt{4L^2 + W^2}}$$

- 5) Repeated the experiment for 20mm and 30mm of spot sizes and tabulated the readings in the table.

**Observations:**      **Table:** Numerical aperture and Acceptance angle of fiber

S.No.	W (mm)	L (mm)	$NA = \frac{W}{\sqrt{4L^2 + W^2}}$	Acceptance angle ( $\theta = \sin^{-1}(NA)$ ) in degrees

**Calculations:**

**Precautions:**

1. Optical fiber must be in straight and with tension.
2. Readings must be taken carefully.
3. Check the connections before switched on the power.

**Result:**

Numerical Aperture and Acceptance angle of given optical fiber is calculated.

The Numerical Aperture of given optical fiber is \_\_\_\_\_

The Acceptance angle of given optical fiber is \_\_\_\_\_



# ENERGY BAND GAP OF A SEMICONDUCTOR

Experiment. No:

Date:

**Aim:** To Determine the energy band gap of a semiconductor of p-n diode.

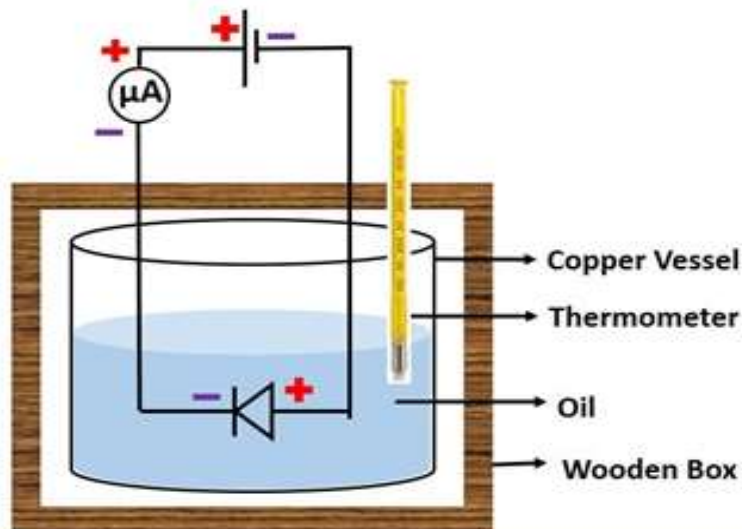
**Apparatus:** Semiconductor diode, thermometer, copper vessel for heating, power supply, Volt meter, Ammeter and connecting wires.

**Description:**

In isolated atoms, the energies of the electrons will be in discrete values. When the atoms combine to form a solid, these discrete energy levels will form into the corresponding energy bands. These energy bands are called allowed energy levels. The energy gap between two allowed bands is called forbidden band or Energy band gap. For example, in case of germanium,  $E_g = 0.72 \text{ eV}$  and in case of silicon,  $E_g = 1.1 \text{ eV}$ .

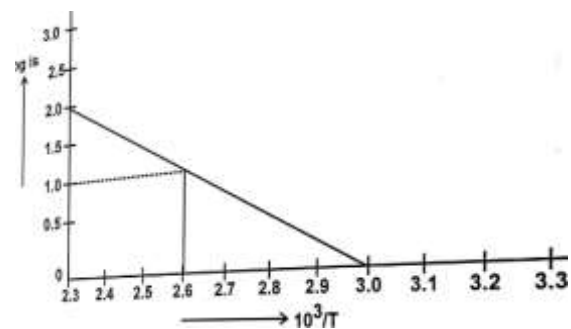
**Formula:** *Band gap  $\Delta E = \text{Slope} / 5.036 \text{ electron volts}$*

**Circuit diagram:**



**Graph:**

A graph is drawn between  $10^3/T$  to  $\log I_s$ .



**Procedure:**

1. Pour coconut oil in copper vessel and Plug the mains to the power supply.
2. Insert the thermometer in the copper vessel along with reverse biased p-n diode.

3. Plug the two leads to the diode in the socket, red plug in +ve socket and black plug in -ve socket.
4. Make the connections properly.
5. Now put the power switched ON position and see that the light is glowing.
6. Put the oven switch to ON position and allow the oven temperature to increase up to 90°C. As soon as the temperature reaches 90°C switch off the oven enabling the temperature to rise further and stable around 90°C.
7. When the temperature becomes stable, start taking the readings of current (I) and temperature(t) from falling of temperature from 90°C downwards.
8. Tabulate the readings in given table.
9. Plot the graph between the readings  $10^3/T$  on X-axis and  $\log I_s$  on y-axis. the graph should become straight line cutting both X-axis and Y-axis.
10. Determined the slope of the line and calculated the energy band gap of given semiconductor p-N diode using the following formula.

$$\text{Band gap } (\Delta E) = \text{Slope} / 5.036 \text{ electron volts}$$

**Observations:**

S.No	Temperature (t) °c	Temperature (T=273+t) in K	$\frac{10^3}{T}$ in K <sup>-1</sup>	Current (I) in $\mu\text{A}$	Log $I_s$

**Calculation:**

**Precautions:**

1. Do not operate above 90°C temperature.
2. Temperatures are to be note accurately.
3. Readings should be taken without parallax error.

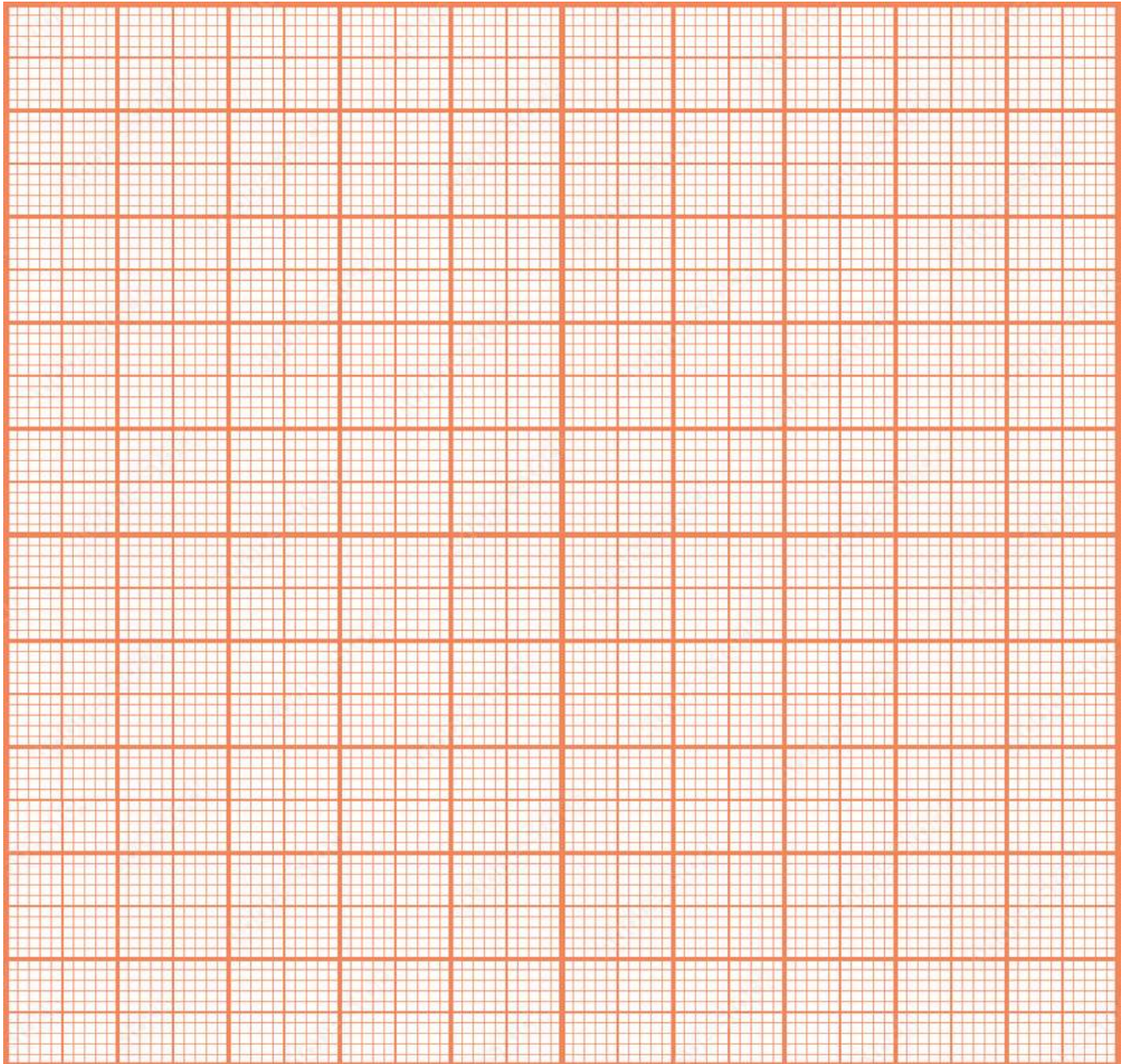
**Graph:**

A graph is drawn between  $10^3/T$  along X-axis and  $\log I_s$  along Y-axis.

**Scale:**

On X - axis 1Unit =

On Y - axis 1 Unit =



**Result:**

The energy gap of given semiconductor is calculated.

Energy gap = \_\_\_\_\_ eV



# VARIATION OF MAGNETIC FIELD ALONG THE AXIS OF A CURRENT CARRYING CIRCULAR COIL

Experiment. No: \_\_\_\_\_

Date: \_\_\_\_\_

**Aim:** To study the variation of magnetic field with distance along the axis of a circular Coil carrying current.

**Apparatus:** Stewart - Gee Type Galvanometer, Battery, Plug Key, Commutator, Rheostat, Ammeter and connecting wires.

**Scope of the experiment:**

A current passing through a coil produces a magnetic field. This is the basic idea behind electro-magnetic coils. A wire coil that is carrying a current produces a magnetic field  $B(r)$  where  $r$  is the distance from the center of the coil to the field point. For large distances from the coil the shape of the magnetic field of a coil is identical to the electric field produced by a point electric dipole.

**Description:**

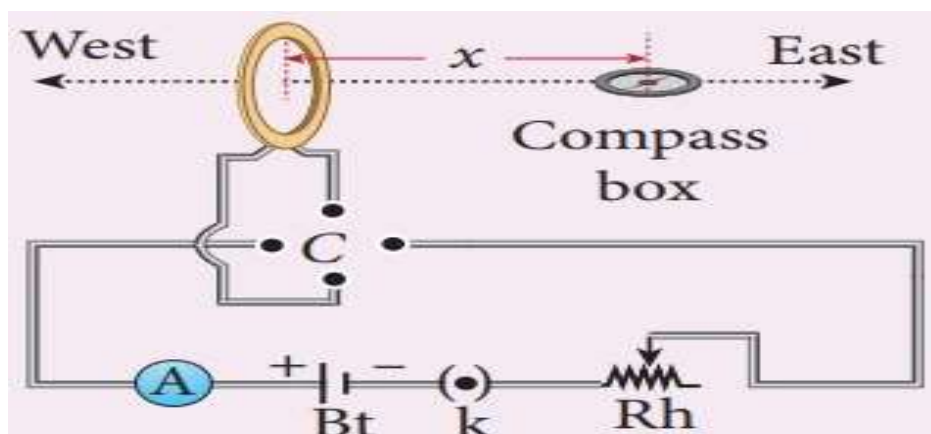
Its construction resembles that of tangent galvanometer and deflection magnetometer. It consists of a circular coil in a vertical plane fixed to a horizontal bench at its middle point. The ends of the coil are connected to binding screws. A magnetic compass box is arranged such that it can be sided along a horizontal scale passing through the center of the coil. The length of the scale is perpendicular to the plane of the coil.

The compass box consists of a short magnetic needle and a long aluminum pointer attached at its mid-point perpendicular to it and they are pivoted at the center of a horizontal circular scale. The circular scale consists of four quadrants, each of which measures angles from  $0^\circ$  to  $90^\circ$ . A plane mirror is provided below the pointer so that the deflections can be observed without parallax.

**Formula:** The magnetic field at a point on the axis of a circular coil carrying current at a distance 'x' from the center is given by  $B = \frac{2\pi nIa^2}{10(x^2 + a^2)^{3/2}}$

Here,  $n$  = number of turns,  $a$  = radius of the coil,  $I$  = current in amperes the coil.

**Circuit Diagram:**



**Observations:**

**Table:** Determination of Magnetic field intensity (B)

Current passing through the coil, I = \_\_\_\_\_ A

No. of turns of the coil, n = \_\_\_\_\_

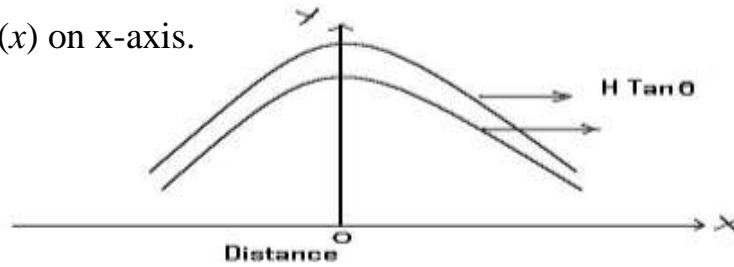
S.No.	Distance, x from the centre of the coil (cm)	Deflections in the magnetic compass box when the current is flowing in					Tan $\theta$	Magnetic field intensity (B) in Gauss	
		Direct position		Reverse position		Mean $\theta$		B = H Tan $\theta$	$B = \frac{2\pi nIa^2}{10.(x^2 + a^2)^{3/2}}$
		$\theta_1$	$\theta_2$	$\theta_3$	$\theta_4$				
	LHS 8								
	6								
	4								
	2								
	Center O								
	RHS 2								
	4								
	6								
	8								

Horizontal component of earth's magnetic field, H = 0.38 Oersted

Radius of the coil (a) = \_\_\_\_\_ cm

**Calculations:**

**Graph:** A graph is drawn between  $H \tan \theta$  & distance ( $x$ ).  $\frac{2\pi nIa^2}{10(x^2 + a^2)^{3/2}}$  is taken on Y-axis and distance ( $x$ ) on x-axis.



**Procedure:**

The circuit is constructed as shown in the figure. The primary adjustments of the instruments are made. The coil of the instrument is set along the magnetic meridian. The aluminum pointer is made to read  $0^\circ - 0^\circ$  with no current. The ends of the coil are connected to the Commutator and through it to the battery rheostat and ammeter. When the circuit is closed with plug key, current flows through the circular coil. A magnetic field is produced on the axis of the coil. The magnetic needle in the compass is subjected to the horizontal component of earth's magnetic field ( $H$ ) and magnetic field ( $B$ ) due to circular coil carrying current. These two magnetic fields act at right angles to each other. The magnetic needle is deflected through an angle  $\theta$  from the direction of ( $H$ ), the horizontal component of earth's magnetic field.  $B = H \tan \theta$ .

The current in the circuit is adjusted such that the deflection lies between  $30^\circ$  and  $60^\circ$  using the rheostat. The compass box is displaced by 5cm or 10cm along the horizontal seal and the deflection of the needle is measured at every distance by reading both ends of the pointer. Let the readings be  $\theta_1$  and  $\theta_2$ . The readings  $\theta_3$  and  $\theta_4$  are observed after reversing the direction of current. The experiment is repeated for points on the other side of the coil. If  $\theta$  is the average of the four deflection readings,  $\tan \theta \propto B$  (intensity of magnetic field due to the current in the circular coil).

**Precautions:**

1. The plane of the coil should be set in magnetic meridian and the center of the magnetic needle should lie on the axis of the coil during the experiment.
2. All magnets, magnetic substances or current carrying substances from the vicinity of the apparatus are removed.
3. The current should remain constant during experiment. Parallax error between the needle and its image should be avoided while taking the readings.

**Graph:**

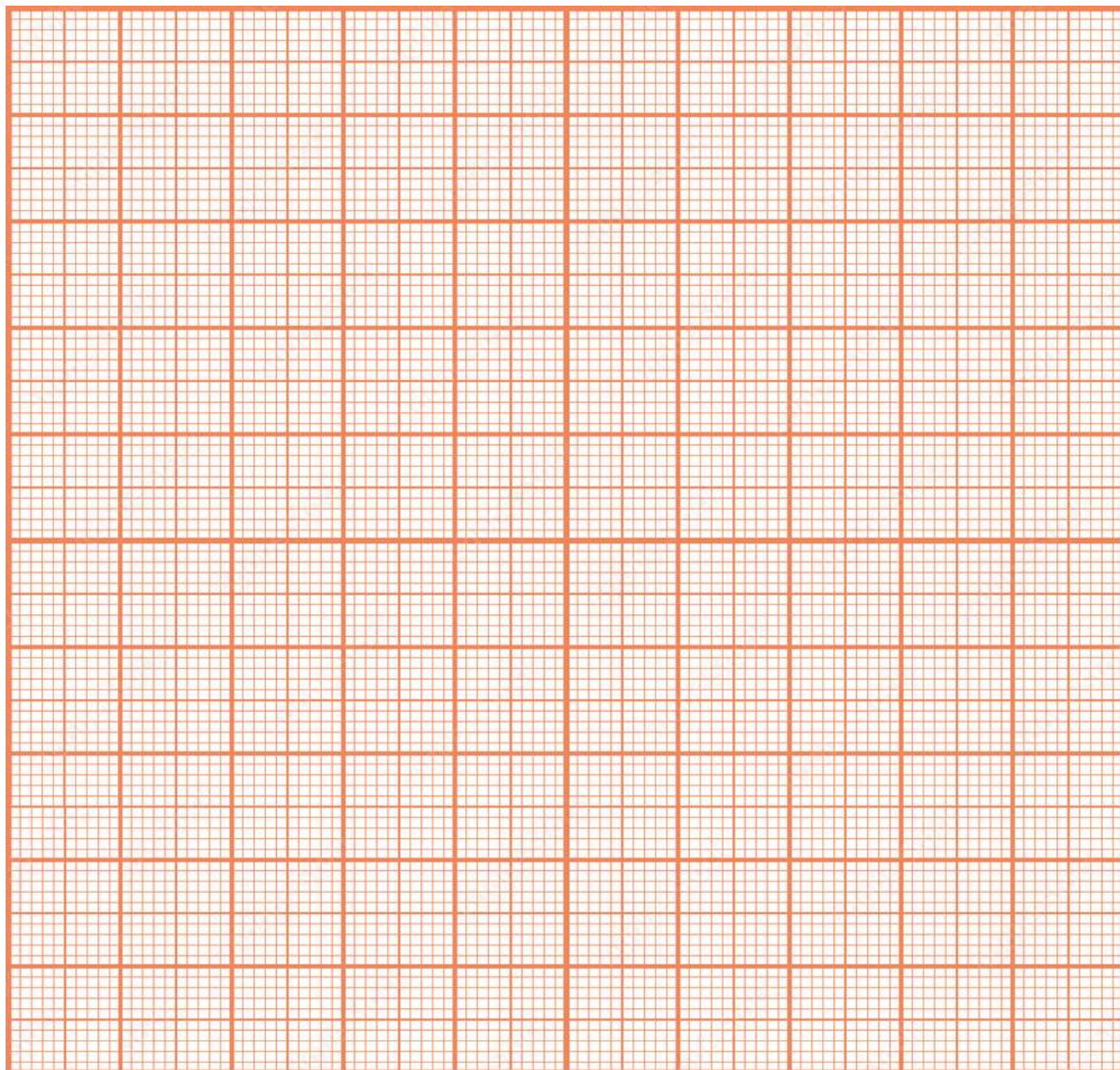
Graph is drawn between  $H \tan \theta$  & distance ( $x$ ).

$\frac{2\pi nIa^2}{10(x^2 + a^2)^{3/2}}$  is taken on Y-axis and distance ( $x$ ) on x-axis

**Scale:**

On X - axis 1Unit =

On Y - axis 1Unit =



**Result:**

Studied the variation of magnetic field along the axis of a current carrying circular coil.

# HALL EFFECT EXPERIMENT

**Experiment. No:**

**Date:**

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**Aim:** To study the Hall effect and determine the Hall coefficient of a given semiconductor.

**Apparatus:** Hall-effect apparatus, Semiconductor sample (probe), a DC electromagnet, digital milli voltmeter, milli ammeter, constant current source, power supply and connecting wires.

**Scope of the experiment:**

Hall discovered that when a magnetic field is applied perpendicular to a conductor/ semiconductor carrying a current, a voltage is developed across the conductor/semiconductor. The direction of the voltage is perpendicular to both the current and the magnetic field. This voltage is called Hall voltage and this phenomenon is known as Hall – Effect.

**Hall – Voltage:** Hall voltage is the potential created across a current carrying semiconductor/conductor, when it is placed in a magnetic field perpendicular to the current flow in it.

**Hall – Coefficient:** Hall-coefficient is defined as the ratio of the induced electric field to the product of the current density and the applied magnetic field.

**Electromagnets:**

It is a double coiled electromagnet, the field of which is variable by moving mild steel rods. The gap of magnetic poles can be adjusted by rotating knobs given at the end of electromagnets. Electromagnet is mounted on a wooden board with a rod fitted for fitting crystal and hall probe so that it is easy to operate. Two terminals are provided for connecting supply to the electromagnets.

**Power supply for electromagnets:**

The power supply consists of one current meter; A.C/ON switch to ON the power, level knob to control current in electromagnets. The magnetic strength can be varied by this knob; output terminals are to take output from power supply to connect it to electromagnets.

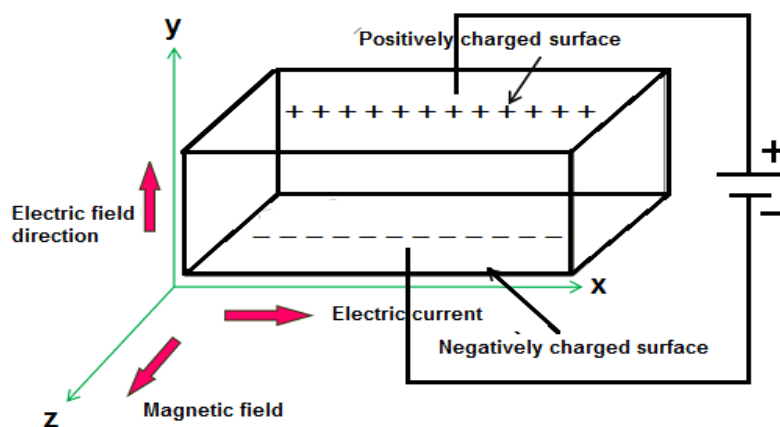
**Formulae:** 1) **The Hall-Voltage** ,  $V_H = \frac{IB}{ned}$

Here, I is the current, e is charge of electron, B is the magnetic field, n is the density of charge carriers; d is the thickness of semiconductor.

2) **Hall coefficient**,  $R_H = \frac{E_H}{B.J}$  Here, ‘B’ is magnetic field applied, ‘J’ is Current density, ‘E<sub>H</sub>’ is Hall electric field.

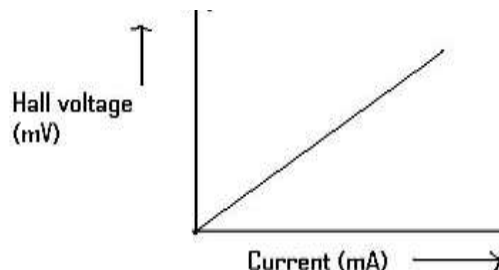


## Circuit diagram:



## Graph:

A graph is drawn between  $I_x$  and  $V_H$  taking  $V_H$  on Y-axis and  $I_x$  on X-axis.



## Procedure:

This experimental set-up consists of 3 main instrumental parts.

- 1) **Digital Gaussmeter with Hall probe:** - Hall probe cable is to be plugged-in to the socket of the digital gauss meter and the power should be given to the gauss meter. This probe also operates basing on the principle of Hall effect.
- 2) **Electromagnet with constant current supply:** - Two Insulated Copper wires are wound on two soft iron bars whose faces are facing each other. When a D.C. current (in amperes) from a constant current source is sent through the coils, the faces of the iron bars acts as the two poles of a magnet (electromagnet) creating a magnetic field in between them. The gap between poles can be varied, in general, the gap should be in small.
- 3) **Hall effect board with Hall probe semi-conductor specimen mounted on sun mica PCB:** - A specimen of rectangular semi-conductor slab in which Hall effect is to be studied is fixed to a printed circuit board (PCB). The Hall effect board has 2 uses. A) To pass current ( $I_x$ ) through the specimen & to measure that current. B) To measure the Hall voltage ( $V_H$ ) developed across the specimen. To meet these two purposes a two mode switch is arranged to the digital meter of the board. First mode is to measure the current ( $I_x$ ), sent through the specimen and the second mode is to measure the Hall voltage ( $V_H$ ) developed across the specimen.

In the 1<sup>st</sup> part give the power supply to the gauss meter. Keep the range switch of the gauss meter in minimum range and adjust the zero adjustment such that the reading in the gauss meter shows zero. If the gauss meter does not come to zero, then keep its value at minimum and take it as zero error. This zero error is to be corrected while taking the final reading of magnetic induction ( $B_y$ ).

Now adjust the distance between the poles of the electromagnet equal to small & pass 1 mA current through the electromagnet from its constant current source, then some magnetic field ( $B_Y$ ) is created between the poles of electromagnet. This magnetic field or magnetic induction ( $B_Y$ ) is measured by the gauss meter by keeping its probe between the poles of the electromagnet.

Keep the mode switch of the current source of the semiconductor specimen in the current mode and pass 0.5 mA (or) 1 mA current ( $I_X$ ) through the specimen. Place this specimen between the poles of the electromagnet such that the faces of the specimen are perfectly vertical and note the voltage ( $V$ ) developed between the upper and lower faces of the specimen.

**Observations:**

**Table:** Hall current vs Hall voltage

S.No.	Hall Current (I) in mA	Magnetic Field B =
		Hall Voltage ( $V_H$ ) in mV

**Precautions:**

1. Handle the Hall probe of Gauss meter with care; it may be damaged in mishandling.
2. Do not use electromagnets continuously at full current. It may heat the system.
3. Gap between poles of electromagnet must remain fixed while taking the reading.
4. Readings should be taken without parallax error.

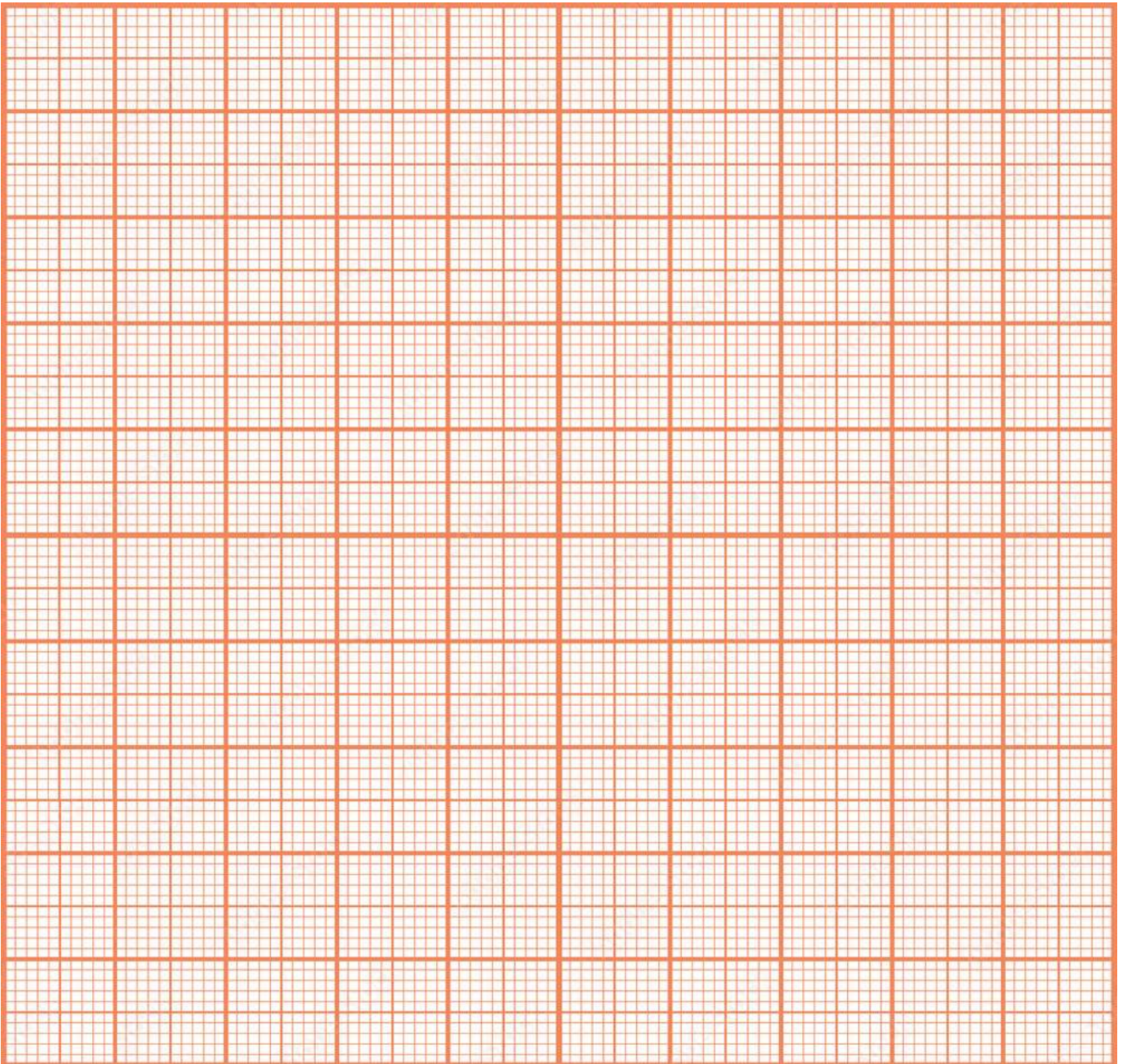
**Graph:**

The graph is drawn for current ( $I_x$ ) along X-axis and voltage ( $V_H$ ) along Y-axis passing through semiconductor.

**Scale:**

On X - axis 1Unit =

On Y - axis 1Unit =



**Result:**

Verified the Hall effect using a semiconductor.