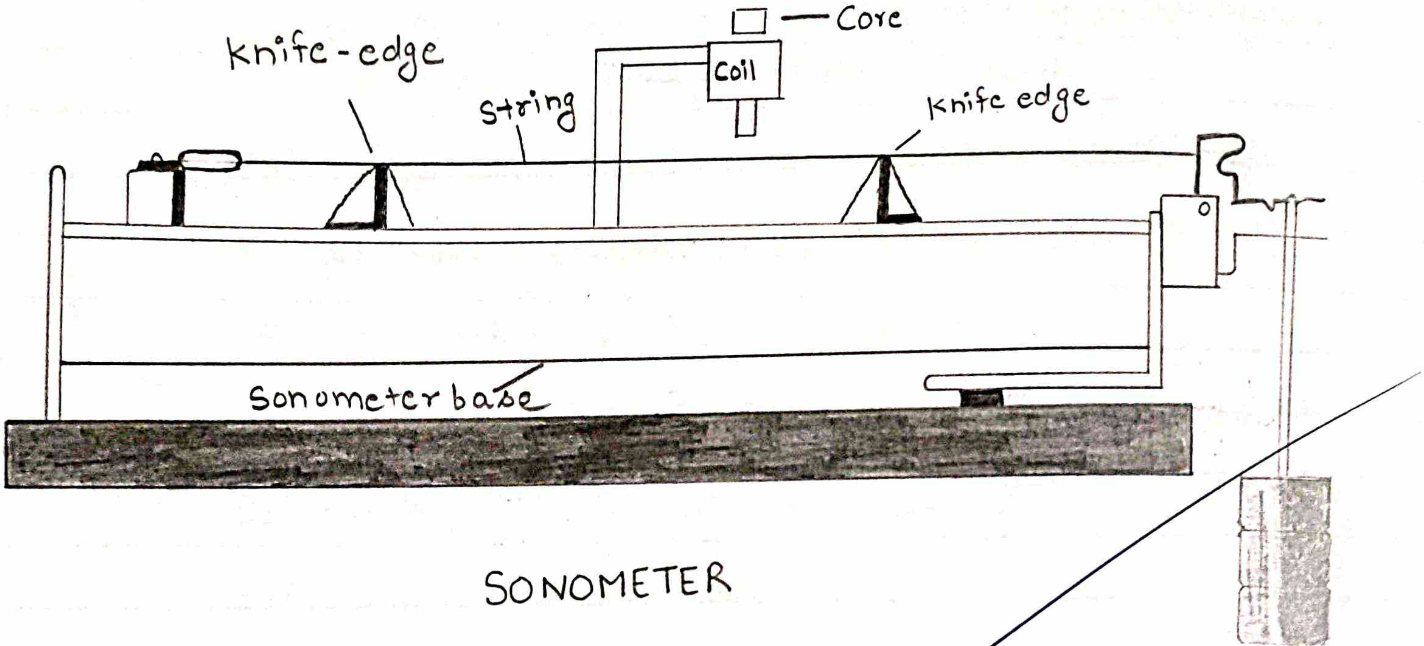


SONOMETER

SONO METER

OBJECTIVE:

To determine the frequency of AC mains using sonometer.

APPARATUS USED: Sonometer with metallic wire, Inbuilt AC supply, electromagnet, meter scale, slotted half kg weights, two knife edges.

THEORY AND FORMULA USED:

A sonometer is a device which consists of a thin wire stretched over two bridges that are usually mounted on a soundboard and which is used to measure the vibration frequency, tension, density, or diameter of the wire, or to verify relations between these quantities.

ELECTROMAGNET:

An electromagnet is a type of magnet in which the magnetic field is produced by the flow of electric current. The magnetic field disappears when the current ceases. A wire with an electrical current passing through it generates a magnetic field around it of strength proportional to the amount of current. The main advantage of an electromagnet over a permanent magnet is that the magnetic field can be rapidly manipulated over a wide range by controlling the amount of electric current. However, a continuous amount of electrical energy is required to maintain the field.

FREQUENCY OF AC MAINS: The utility frequency or main frequency is the frequency at which electric current, Alterting current (AC)

is transmitted from a power plant to the end user.
To find the frequency of AC mains using an electro-magnet and a sonometer, the AC is passed through the primary of a step down transformer (220-230 to 4-6 volts). The two ends of the secondary coil of the step-down transformer are connected to the two ends of the winding of the electromagnet which consists of a coil of insulated copper wire wound over a soft iron core provided with an insulated handle. As the A.C. from the secondary of the step-down transformer passes through the electromagnet it gets magnetized twice in each cycle, first with one of its faces as a north pole and then with the same face as the south pole. The electro-magnet is kept close to and vertically above the sonometer steel wire. The wire is attracted and pulled twice in each cycle of the AC. Mains supply; once when the end of the electromagnet just above the wire is a north pole and again after half a cycle when this end is a sound pole. In other words, the natural frequency (f) of the sonometer wire is this end is a sound pole. The natural frequency (f) of the sonometer wire is double the frequency (n) of the A.C mains. The natural frequency of the wire is given by

$$f = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

OBSERVATION:

Mass per unit length of the wire (m) $<$ 0.0056 kg/m.

S.No	Load in Kg	Tension in N ($T = W \times 9.8$)	Resonating length of wire						Frequency (Hz) $f = \frac{1}{2l}\sqrt{\frac{T}{m}}$
			Position of bridges increasing (l_1)		position of bridges decreasing (l_2)		Mean resonating length (l)		
			cm	m	cm	m	cm	m	
1.	0.6	5.88	13.2	0.132	17.5	0.17	15.35	0.153	105.89
2.	1.1	10.72	~~23.8~~ 23.8	0.238	24.9	0.24	24.35	0.243	90.21
3.	1.6	15.68	29.1 ~~15.68~~	0.291	29	0.29	29.05	0.29	91.23
4.	2.1	20.58	32.6	0.326	34.5	0.34	33.55	0.33	91.85

Date

Expt. No.

CALCULATION:

Using the formula $F = \frac{1}{2l}\sqrt{\frac{T}{m}}$

Compute frequency of vibration of the wire for each observation and find out the mean frequency.

$$n = \frac{f}{2}$$

The frequency of A.C mains is given by $n = \frac{1}{2} = \frac{94.8}{2} = 47.4$

RESULT:

The frequency of AC mains = 47.4 Hz.

Standard Result – The frequency of A.C mains = 50 Hz.

PERCENTAGE ERROR:

$$\frac{\text{Standard value} - \text{Calculated value}}{\text{standard value}} \times 100$$

$$\frac{50 - 47.4}{50} \times 100$$

$$\Rightarrow \frac{2.6}{50} \times 100$$

$$2.6 \times 2$$

$$5.2\%$$

Percentage error = 5.2%

PRECAUTIONS AND SOURCE OF ERROR:

① The wire should be of a uniform Area of cross-section, free from kinks and should be tight.

17-11-21

Teacher's Signature

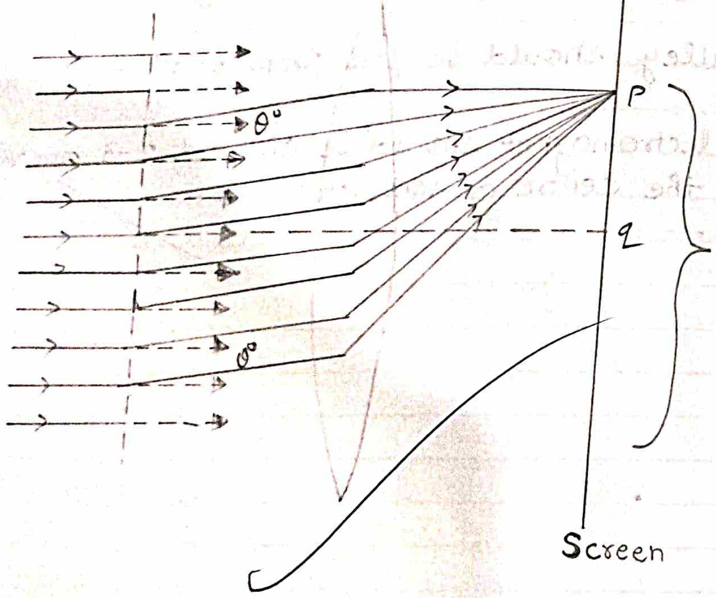
② The Observation should start with minimum distance between the two knife edges.

③ The resonance position should be obtained by first slowly increasing the distance between knife edges and then slowly decreasing it.

④ The weight of Hanger should always be included in the load.

⑤ The Pulley should be free from friction.

⑥ The Electromagnet should be clamped 2-3 mm vertically above the centre of sonometer wire.



Expt. No. 8 Page No. 5

Date

Objective :-

To find the wavelength of monochromatic light with the help of a plane transmission diffraction grating and spectrometer.

Apparatus :-
A spectrometer, a sprit level, a source of monochromatic light (sodium lamp), diffracting grating with clamping arrangement.

Formula Used :-

The wavelength 'λ' of any spectral line can be calculated by the formula $(a+b)\sin\theta = n\lambda$

or, $\lambda = \{(a+b)\sin\theta\}/n$

where,

$(a+b)$ = grating element

θ < angle of diffraction

n = order of spectrum

Theory :-

A plane diffraction grating consists of an optically plane glass plate on which large no. of equidistant parallel lines are ruled. These lines divide the glass plate into opacities and transparencies, the thickness of which are of the order of the wavelength of the visible light. The region where a line is drawn becomes opaque and the space between the two lines is transparent.

When a parallel beam of monochromatic light is incident normally on the grating, it suffers diffraction. The transmitted light gives rise to primary maxima in certain directions gives by the relation, $(a+b)\sin\theta = n\lambda$ as shown

Teacher's Signature

In the figure 1, where 'a' is the width of transparency and 'b' is that of n^{th} order maxima and λ is the wavelength of light.

For the first order spectrum, n = 1

Therefore $(a+b)\sin\theta_1 = \lambda$

For the second order spectrum, n = 2

and $(a+b)\sin\theta_2 = 2\lambda$

The number of lines ~~are~~ n per inch are marked on the grating. The value of the grating element (a+b) is given by,

$$(a+b) = \frac{2.54}{n} \text{ cm}$$

Spectrometer: An spectrometer is basically an instrument for measuring the angular division of light ray. A prism produces this angular deviation of light ray or grating which is wavelength dependent. The emergent light from these component is dispersed into a spectrum in which wavelength is a function of angle. Spectrometer consists of mainly three parts: Collimator, Prism table and Telescope.

Observations:

observation

(A) DETERMINATION OF LEAST COUNT OF SPECTROMETER:

Reading of one smallest division on M.S 'a' = 1/5

Total no. of division on vernier scale 'b' = 300

Least count of spectrometer = $\frac{a}{b} = \frac{1}{60}$

Second V2	Second V1	First V2	First V1	Order of Spectrum / no. of Vernier Scale : V1, V2	
65.5	24.6	68.5	24.85	M.S reading (deg - min - sec)	Reading of the Telescope for left side spectrum
$10 \times \frac{1}{60}$	$28 \times \frac{1}{60}$	$5 \times \frac{1}{60}$	$28 \times \frac{1}{60}$	V.S reading (div.)	
65.16	246.46	68.58	248.96	Total reading 'a' (deg - min - sec)	
91	277.5	93.5	274.5	M.S reading (deg - min - sec)	Reading of the Telescope for right side spectrum.
$30 \times \frac{1}{60}$	$24 \times \frac{1}{60}$	$30 \times \frac{1}{60}$	$5 \times \frac{1}{60}$	V.S reading (div.)	
91.5	277.9	94	274.58	Total Reading 'b' (deg - min - sec)	
26.34	31.44	25.42	25.62	Angle '2θ' = a - b (deg - min - sec)	
28.89		25.52		Mean '2θ' (deg - min - sec)	
14.45		12.76		Angle 'θ' (deg - min - sec)	

(B) DETERMINATION OF GRATING ELEMENT OF DIFFRACTION GRATING:

no. of lines per inch on the grating 'n'=

∴ Grating element

$(a+b) = \frac{2.54}{n}$ cm $= 0.000169$ cm

$= 1.69 \times 10^4$ Å

(C) DETERMINATION OF ANGLE OF DIFFRACTION 'θ':

Calculations:

first order spectrum: wavelength of spectral lines of first order ($n=1$) can be calculated by -

$\lambda_1 = (a+b)\sin\theta$

$\lambda_1 = 3.73 \times 10^3$ A°

Calculate λ for other spectral lines.

Second Order Spectrum:-

Wavelength of spectral lines of second order ($n<2$) is given by:-

$\lambda_2 < \{(a+b)\sin\theta_2\}/2$

$\lambda_2 = 3.73 \times 10^3$ A

Mean of $\lambda < (\lambda_1 + \lambda_2)/2$ Å

Result:-

The wavelength of the given monochromatic light is 4.2×10^3 Å.

Teacher's Signature 4200 A°

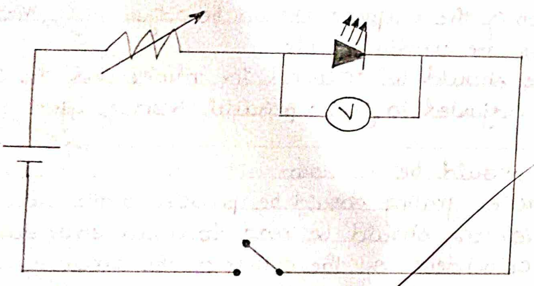
Percentage error :-

% Error < [(Standard value - Experimental value) x 100] / Standard value.

Precautions :-

1. The axis of the telescope, the collimator and the plane of the prism table should be horizontal.
2. The position of the eyepiece should be adjusted so that the cross wires are clearly visible.
3. The telescope should be focused for infinity and the collimator should be adjusted to give a parallel beam of light.
4. The slit should be narrow.
5. The diffraction grating should be parallel to the slit.
6. Both the verniers should be read to avoid error due to the non-coincidence of the center of the circular scale with the axis of rotation of the telescope ~~of~~ or the table.

5/1/2022



Circuit Diagram

OBJECTIVE :-

To determine Planck's constant using Light Emitting Diode (LED).

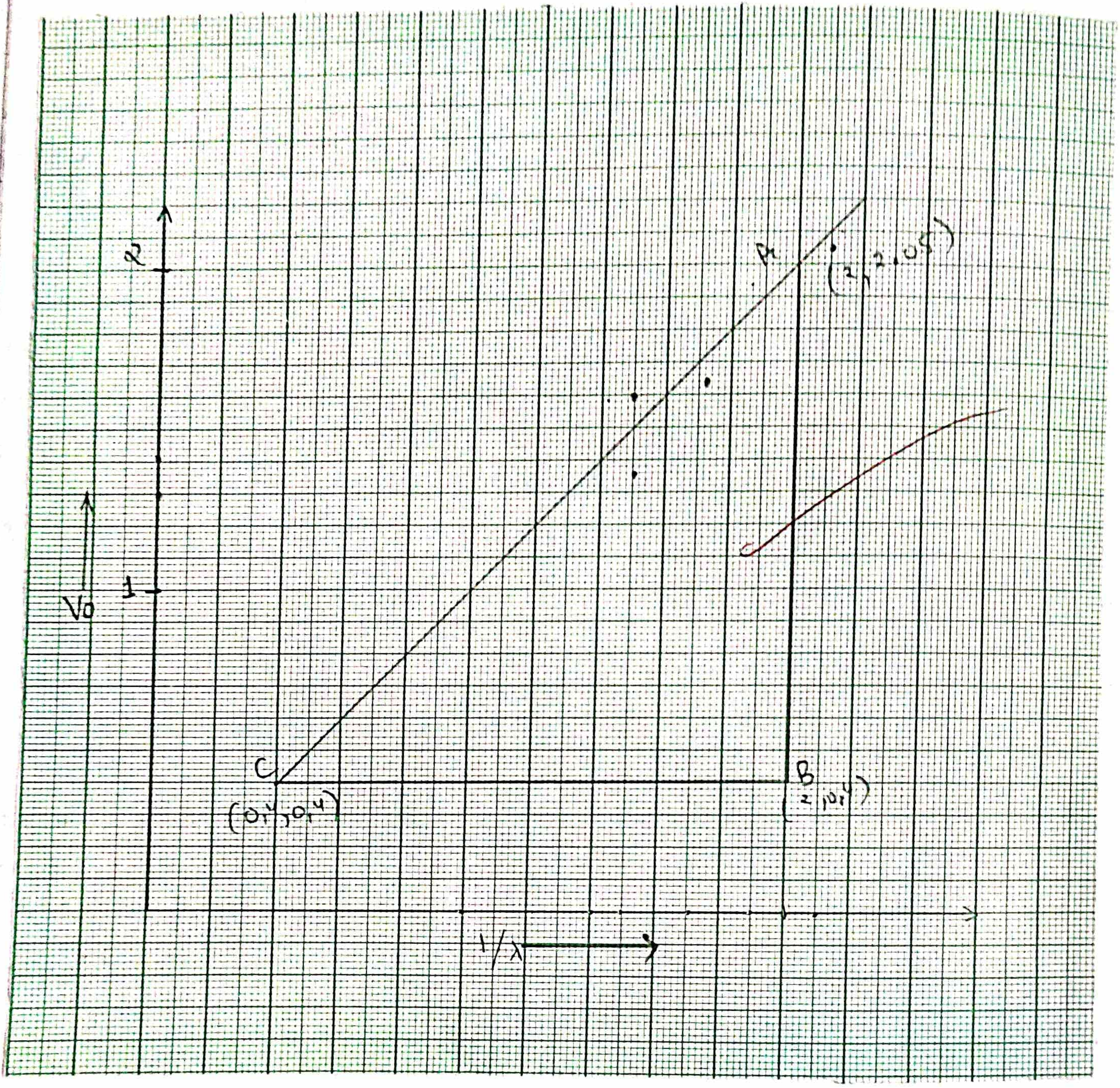
APPARATUS USED :-

Trainer kit, Super Bright LEDs and variable power supply. (0-5 volt).

THEORY AND FORMULA USED:-

In this experiment, we are using Light emitting diodes (LEDs) to measure Planck's constant. LEDs are semiconductor diodes that emit electromagnetic radiation in optical and near optical frequencies, when operated in forward bias, above a minimum threshold voltage. In this condition, an electron hole pair is created in the diode and thus current starts flowing. Above the threshold value, the current ~~starts flowing~~ & increases exponentially with voltage. A quantum of energy is required to create an electron hole pair and this energy is released when an electron and a hole recombine. In most diodes, this energy is absorbed by the semiconductor as heat, but in LEDs this energy produces photons with frequencies (or wave-length) in the visible range. The energy of a ~~quantum~~ photon is releated to its wavelength as:-

$$E < h\nu < hc/\lambda \quad \text{---} \quad (1)$$



2
1
Vo
A
(2, 2.05)
C
(0.4, 0.4)
B
(2, 0.4)
1/λ

By using semiconductors of specific band gap, the wavelength emitted by the LED can be varied and thus the light emitted by LEDs may span a range of discrete wavelengths. When the applied voltage is just sufficient to supply the energy required to create a electron hole pair in a semiconductor; the LED will just start glowing. This voltage is called threshold voltage or turn on voltage (V_0) and depends on the band gap of the semiconductor. The relation between the wavelength emitted by the LEDs, λ, and the turn-on-voltage, V_0 is given as.

$$hc/\lambda < eV_0 \quad \text{or} \quad h < eV_0\lambda/c \text{ ——— } (2)$$

where, h is Planck's constant (6.625×10^{-34} Js), e is the electronic charge (1.6×10^{-19} C), V_0 is the threshold voltage, λ is wavelength emitted by the LEDs and c is the velocity of light (3×10^8 m/s).

If the turn on voltage V_0 is measured for several diodes. which emit different colours (i.e., different wavelength) and a graph is plotted between V_0 and $1/\lambda$, it should be linear (figure 1). The slope of this graph is given by.

$$\text{slope} < AB/BC < hc/e. \quad \text{or} \quad h = \text{slope} \times \frac{e}{c}$$

Using the known values of c and e, we can compute h.

S.No	Colour	wavelength	$\frac{1}{\lambda}(m^{-1}) \times 10^{-6}$	V_0
1.	Blue	470	2.127	2.13
2.	Yellow	570	1.754	1.70
3.	Green	510	1.961	2.04
4.	Red	650	1.538	1.46
5.	Infrared	700	1.428	1.35

CALCUATIONS :-

Plot a graph between V_0 and $1/\lambda$. It will be a straight line.

$$\text{Slope} = \frac{AB}{BC} = \frac{hc}{e}$$

$$\text{or} \quad h = \text{slope} \times \frac{e}{c} = 1.22 \times 10^{-6}$$

RESULT :-

Planck's constant is 5.499×10^{-34} J
standard value :- 6.625×10^{-34} Js

$$\%\ \text{Error} = \text{Percentage error} = \frac{100(\text{std. value} - \text{exp. value})}{\text{std. value}}$$

$= 16.99\%$

PRECAUTIONS AND SOURCE OF ERROR :-

1. Make sure all the connections are tight.
2. Note the threshold voltage carefully. when LED just starts glowing.
3. Make sure that the LED is in the forward bias.
4. Handle the equipment carefully.

$1\,nm = 10^{-9}$ m

$470\,nm = 470 \times 10^{-9}$ m

$1/m = 1/470 \times 10^{-9}$ m

$= \frac{10^9}{470}$ m $= \frac{1000 \times 10^6}{470\,m}$

08.12.21

Teacher's Signature

HE-NE LASER

OBJECTIVE :- To determine the wavelength of He-Ne Laser using diffraction grating.

Apparatus :- He-Ne Laser Source, Diffraction grating with it mount, optical bench, a screen with millimeter scale.

THEORY :- Diffraction is the bending of wave around an obstacle or small aperture whose size is comparable to the wavelength of light. If source and screen are ~~far~~ from each other than fraunhofer diffraction occurs.

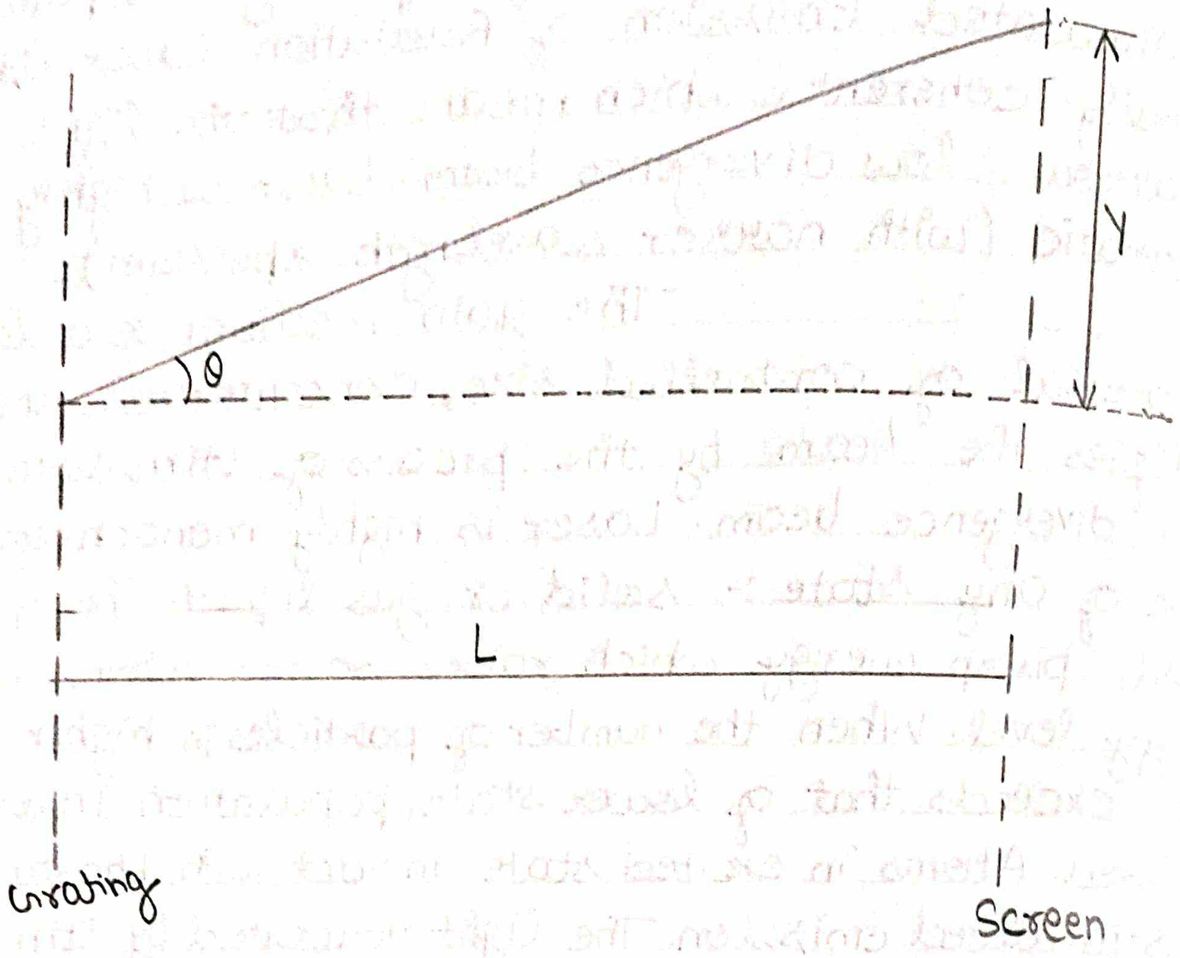
A plane diffraction grating consist of an optically plane glass on which a number of equidistant lines are ruled. These lines divide the glass plate in to opaque and transparent places, the width of which is of the order of the wavelength of visible light. The region where a line is drawn becomes whereas the space between the two line is transparent and act as slit. These slits diffract the light waves there by producing a large number of beams which interfere in such a way to produce spectra. if a parallel beam of monochromatic light is incident normally on the plane transmission diffraction grating, bright diffraction maxima are observed on the other side of grating element, 'a' is the separation between two slits and 'b' is the slit with

As, $d = a + b$

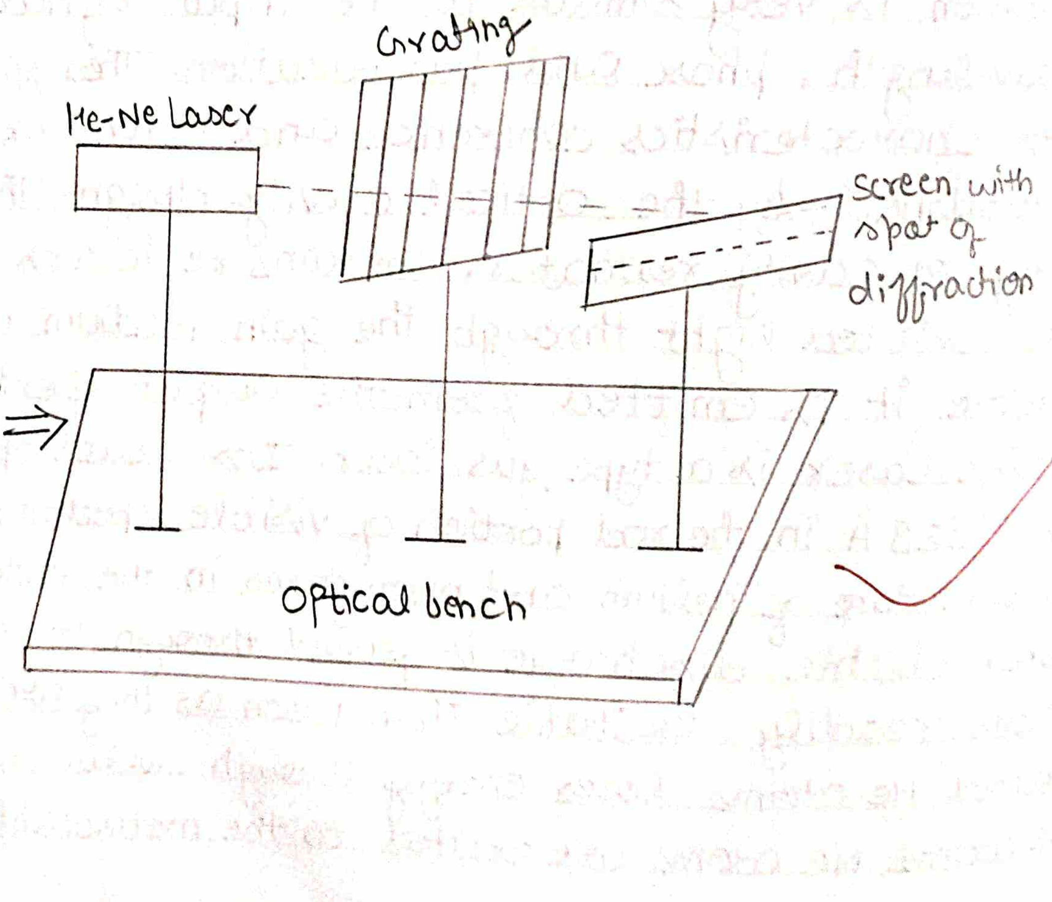
The term laser is an acronym for light amplification by stimulated Emission of Radiation. Laser light is spatially coherent, which means that the light emitted is narrow, low divergence beam. Laser is highly mono-chromatic (with narror wavelength spectrum).

The gain medium of a laser is a material of controlled size, concentration and shape - amplifies the beam by the process of stimulated emission, x low divergence beam. Laser is highly monochromatic. It can be of any state :- solid or gas liquid. The gain medium absorb pump energy which raises some electrons into higher - energy level. When the number of particles in higher excited state exceeds that of lower state, population inversion is achieved. Atoms in excited state intract with photon resulting in stimulated emission. The light generated by stimulated emission is very similar to the input signal in terms of wavelength, phase and polarization. This gives laser light its characteristics coherence and often monochromaticity established by the optical cavity design. The optical cavity, a type of cavity resonator, contains reflectors which reflect the emitted light through the gain medium more than once before it is emitted from the output aperture.

He-Ne Laser is a type gas laser. Its usual operation wavelength is 6328 Å in the red portion of visible spectrum. It consists of a mixture of helium and neon gases in the ratio of about 10:1. When electric discharge is passed through it He atoms are more readily excitable than Neon as they are lighter. The excited He atoms loses energy through collision with unexcited Ne atoms, Ne atoms are excited to the metastable states giving



Experiment setup for Diffraction



rise to stimulated emission.

WORKING FORMULA :- If a parallel beam of monochromatic light is incident normally on the plane diffraction grating, maxima and minima occurs due to diffraction. The condition for diffraction maxima is :-

$$d \sin\theta_n = n\lambda$$

$$\boxed{\lambda = \frac{dy}{n\sqrt{y^2+L^2}}}$$

where,

$$d = \frac{1}{N}$$

N = Number of slits/cm
y = mean average of distance of maxima from center.
n = order of maxima
L = Distance b/w grating and screen.

OBSERVATION :- Number of lines per on the grating, N =

Now, Grating element,

$$d = \frac{1}{N} =$$

Calculation :-

Grating element $d = \frac{1}{N} = \frac{1}{3000}$ cm

$$\lambda_{mean} = \frac{\lambda_1 + \lambda_2 + \lambda_3 + \cdots + \lambda_n}{n}$$

$$= \frac{6140 + 5790 + 6189 + 6450 + 6400 + 6410}{6}$$

$$= 6230.83\ \text{Å}$$

S.No	Distance b/w grating & Screen (L) cm	Order of maxima (n)	Dist. of maxima from center: on left side (y_1) in cm	on right side (y_2) in cm	Mean $y = \frac{y_1+y_2}{2}$	$\lambda = \frac{dy}{n\sqrt{y^2+L^2}}$ (Å)	λ mean (Å)
1.	8	1	1.5	1.5	1.5	6140	
	8	2	3	3.5	3.25	5790	
2	10	1	1.8	2.2	2	6189	
	10	2	3.9	4.05	4.2	6450	
3	12	1	2.2	2.5	2.35	6406	
	12	2	4.6	5.4	5	6410	

CALCULATIONS :-

$$\lambda = \frac{dy}{n\sqrt{y^2+L^2}}$$

Calculate λ for all readings and find mean λ.

$$\lambda_{mean} = \frac{\lambda_1+\lambda_2+\lambda_3+\cdots+\lambda_n}{n} = 5.422 \text{ (Å)}$$

RESULT

The wavelength of given laser source, λ = 5.422 Å

The standard value of He-Ne laser source is 6328 Å.

22/12/21

Teacher's Signature

PERCENTAGE ERROR :-

% Error = [(Standard value − Experimental value) × 100] / standard value.

$$\Rightarrow \frac{\lambda_{mean} - 6328}{6328} \times 100 = 1.53\%$$

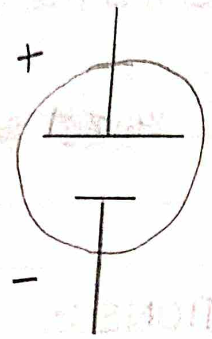
SOURCE OF ERROR AND PRECAUTIONS :-

(i) Never look directly into the laser source.
(ii) Gratings should ~~be~~ not be touched by fingers.
(iii) Grating should be set normal to the incident light.

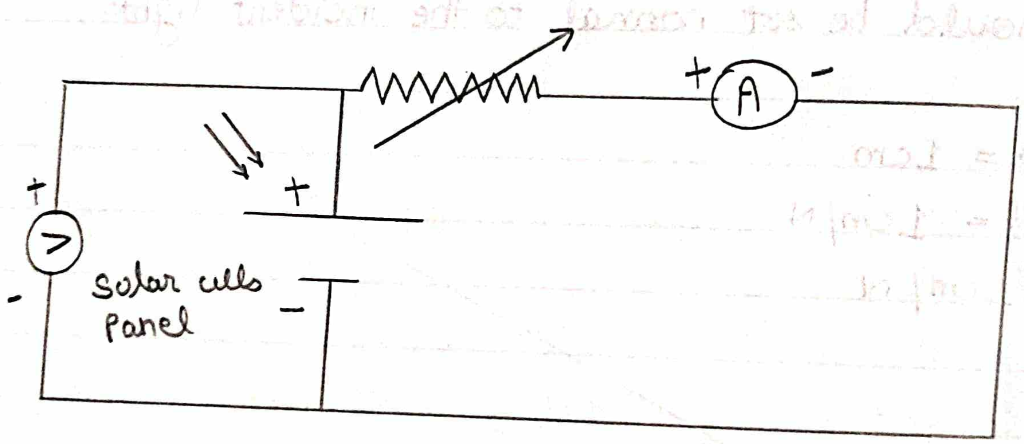
N slits = 1 cm
1 slit = 1 cm/N
d = 1 cm/N

• <u>Circuit Diagram</u>

Screnatic Symbol of a Solar Cell



Schematic Representation of
Solar cell for use in Circuit Diagram.



Date

Expt. No. 3

Page No.

SOLAR CELL

OBJECTIVE

To draw the characteristics of solar cell and to estimate fill factor (FF) of solar cell.

APPARATUS REQUIRED

Solar cell, rheostat, ammeter, voltmeter, illumination source, Bulb and connecting wires.

THEORY AND FORMULA USED:

Solar cell is basically a two terminal p-n junction device designed to absorb photon absorption through the electrical signal or power in the external circuits. Therefore it is necessary to discuss the physics of semiconductor p-n junction diode, which converts the optical energy into electrical signals. Photovoltaic systems convert sunlight directly into electrical energy. The backbone of this technology is semi-conducting material such as silicon. A typical solar cell consists of two differently doped semiconductor. Doping is the controlled introduction of impurities ~~of two~~ into the host material. Starting out with a pure semiconductor crystal this is achieved by substituting some of the atoms in the crystal lattice with elements that have one more or less valence electron than the host material (valence electrons are the electron that determine the chemical behaviour of a material, they are located in the outermost orbital shell of the atom). Semiconducting elements have four valence electrons all of which are used for bonding in the crystal lattice.

Teacher's Signature

* Observation Table

S.No	Voltage (volts)	Current (s) (MA)	Power calculated P=VI (watt)	P= V.I (watt) P= VI/100
1	0	Isc=104	0	0
2	0.5	103.8	0.0519	5.19
3	1	102.5	0.1025	10.25
4	1.5	101.5	0.15225	15.225
5	2	101.2	0.2024	20.24
6	2.5	150.3	0.25075	25.075
7	3	99.6	0.2988	29.88
8	3.5	98.7	0.34545	34.545
9	4	98.4	0.3936	39.36
10	4.5	98	0.441	44.1
11	5	97.1	0.4855	48.55
12	5.5	94.5	0.51975	55.975
13	6	91.3	0.5478	55.78
14	Vm= 6.5	Im= 85.4	0.5551	55.57
15	7	79.1	0.5537	55.37
16	7.5	72.9	0.54675	51.675
17	8	64.2	0.5736	51.36
18	8.5	56	0.476	47.6
19	9	45.8	0.4122	41.22
20	9.5	28	0.266	26.6
21	9.7	18.6	0.18042	18.042
22	Voc= 10.2	0	0	0

Expt. No. ____ Date ____ Page No. ____

Characteristics of a Solar Cell: The usable voltage from solar cells depends on the semiconductor material material. In silicon it amounts to approximately 0.5 V. Terminal voltage is only weakly dependent on light radiation, while the current intensity increases with higher luminosity. A $100 cm^2$ silicon cell, for example, reaches a maximum current intensity of approximately 2 A when radiated by $1000 W/m^2$.

The output (product of electricity and voltage) of a solar cell, ~~for~~ is temperature dependent. Higher cells temperatures lead to lower output, and hence to lower efficiency. The level of efficiency indicates how much of the radiated quantity of light is converted into useable electrical energy.

Fill Factor (FF): The fill factor (FF) percentage measures the "squareness" of the I-V curve. It states the degree to which the voltage at the maximum power point (Vmp) matches the open circuit voltage (Voc) and that the current at the maximum power point (Imp) matches the short-circuit current (Isc). Therefore, a more "squared" I-V curve will have a higher fill factor.

$$FF = \frac{V_m I_m}{V_{sc} I_{sc}} = \frac{8.02 \times 121.2}{10.01 \times 155} = 0.626$$

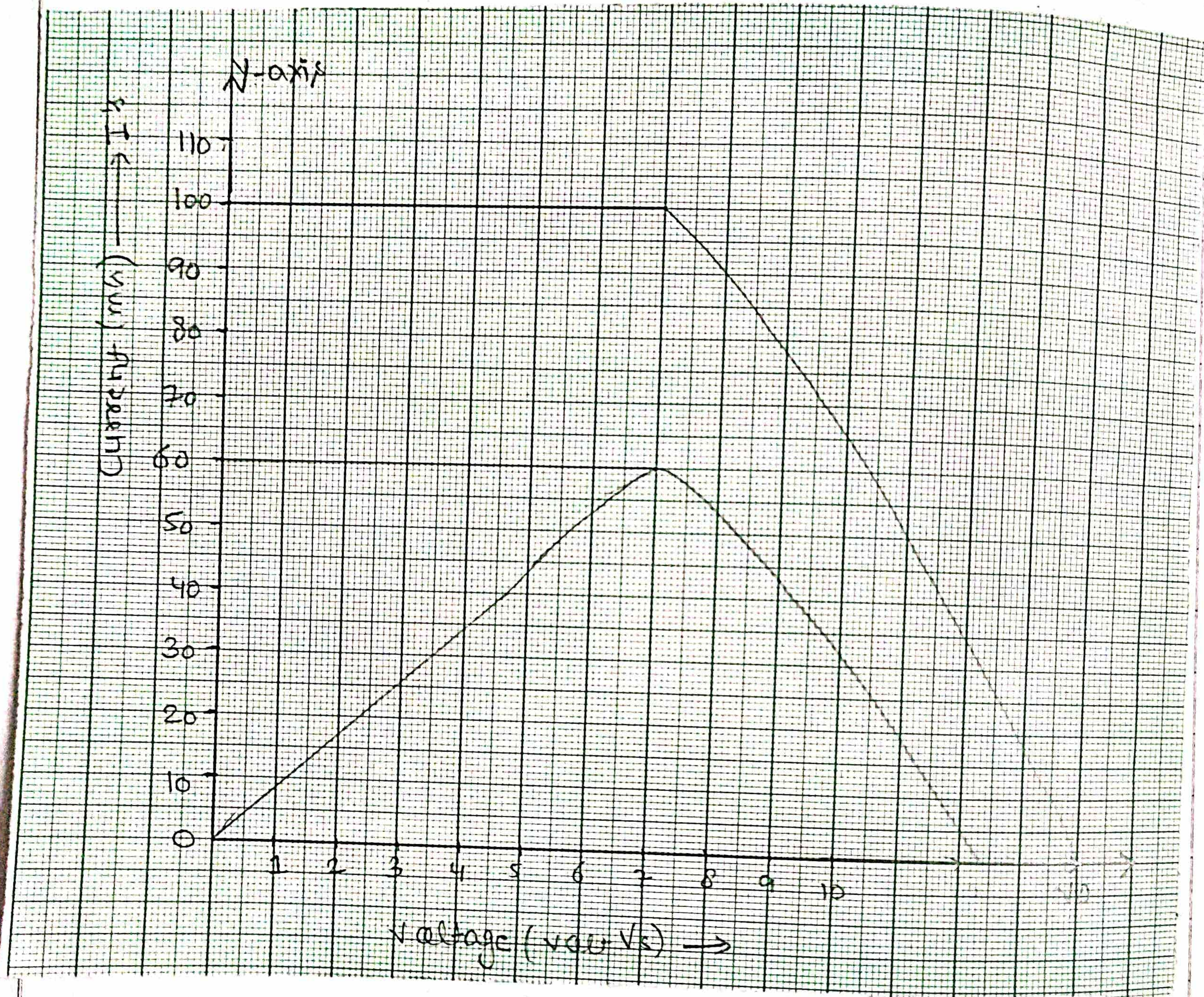
Efficiency of Solar Cell: The efficiency of the solar cell is the ratio of produced electrical power (Pout) and the incident radiant power (Pin). Efficiency of solar cell,

$$\eta = \frac{P_{out}}{P_{in}}$$

Teacher's Signature ____

- GRAPH

→ I-V curve of the Solar cells.



Date

Expt. No. Page No.

where Pout is the electrical power (maximum power point) Pin is calculated by multiplying approximated irradiance ("irradiance" means radiant power of the light incident per unit area) by the effective area of the solar cell on the panel.
This method used the fact that the practical value of the current (maximum photoelectric current measured) is proportional to the photons (radiation) striking the solar cell. This current is therefore proportional to the incident radiant power of the light.
The open circuit voltage depends on the semiconductor material of which solar cell is made. It is not proportional to the incident radiant power and therefore cannot be used for this measurement.

Calculation :-

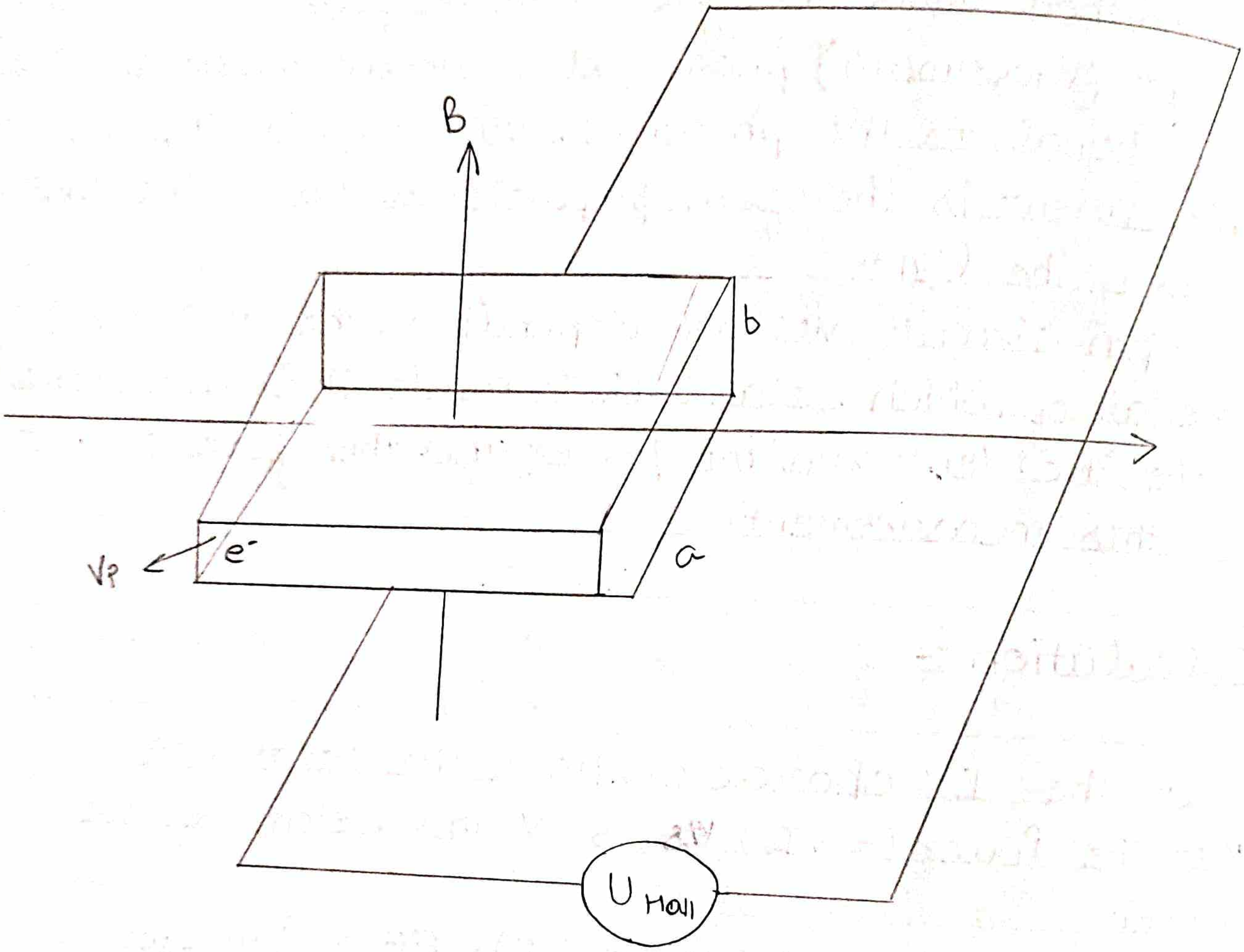
1. Plot the IV characteristic of the solar cell.
2. Plot the Power (= VI) vs. V and determine the maximum power.

Determine the fill factor (FF). $FF = \frac{V_m I_m}{V_{sc} I_{sc}}$

PRECAUTIONS

1. Make sure that all the connection are tight.
2. Wait for few minutes to avoid errors due to temperature fluctuations.
3. To measure the resistance of potentiometer at any position, first remove the patch cords from P1 and P2 and then measure the resistance by a multimeter.

Teacher's Signature



• Schematic Diagram and Circuit of Hall Effect

OBJECTIVE :- To study the Hall effect and to determine the hall coefficient, charge carrier-concentration (n= density) and carrier mobility of given semiconductor material using Hall setup.

APPARATUS REQUIRED: Gauss and Tesla meter, measurement unit, Constant current power supply, Electromagnet, Hall Probe, In- As Probe etc.

THEORY AND FORMULA USED: If an electric current flow 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 the most evident in a thin flat conductor ~~this~~ as illustrated. A build 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 the measurable transverse voltage is called the Hall effect after E.H Hall who discovered it in 1879.

The hall coefficient is given by $R_H = \frac{V_H d}{BI} = \frac{1}{ne}$

where, V_H = Hall voltage	n = Charge carrier density
d = thickness of S.C	e = electron charge = 1.6×10^{-19}
B = magnetic field	
I = Probe current	

SNo	I (mA)	+B				−B				V_H
		$V_1(V+I)$ (mV)	$V_2(V_2-I)$ (mV)	$V_3(-V+I)$ (mV)	$V_4(-V+I_1)$ (mV)	$V_1(+V_1+I)$ (mV)	$V_2(+V-I)$ (mV)	$V_3(-V+I)$ (mV)	$V_4(-V_1-I)$ (mV)	
1.	0.5	7	−5.3	−5.3	5.3	−3.4	3.5	3.4	−3.3	4.52
2.	1.0	14.7	−10.4	−10.4	10.3	−7.0	6.8	6.8	−6.7	9.11
3.	1.5	21.2	−15.4	−15.3	15.4	−10.6	10.2	10.3	−10.1	13.56
4.	2.0	28.4	−20.4	−20.5	20.6	−14	13.6	13.5	−13.4	18.05
5.	2.5	35.5	−25.4	−25.7	25.8	−17.4	16.9	16.8	−16.7	22.56
6.	3.0	42.9	−25.7	−31.0	30.9	−20.7	20.3	20.1	−19.9	27.08
7.	3.5	50.0	−30.9	−36.1	35.9	−23.9	23.6	23.1	−23.3	31.48
8.	4.0	57.4	−36.0	−41.5	41.0	−27.1	26.7	26.1	−26.3	35.91
9.	4.5	64.7	−41.2	−46.8	46.2	−29.9	30.0	29.1	−29.6	40.33
10	5.0	71.0	−46.7	−52.2	51.3	−32.8	33.2	31.8	−32.8	42.13
11.	5.5	78.6	−51.5	−57.9	56.8	−35.9	36.3	34.6	−36	46.33
12.	6.0	86.2	−56.6	−63.4	62.0	−38.8	39.3	37.3	−38.9	50.41
13	6.5	93.3	−66.9	−68.6	67.0	−41.4	42.3	40.0	−42.2	54.41
14	7.0	100.9	−72.0	−74.3	72.3	−44	45.4	42.7	−45.5	58.52

Date

Expt. No. Page No.

- **Linear Regression :-**

$y = mx + c$ $x \rightarrow$ current (in mA)
$y \rightarrow$ voltage (in mV)

slope of line from graph (m) = 8.22 V/A
using linear regression
y-intercept (c) = 1.66 mV

CALCULATIONS :

since, $V_H = \frac{R_H I B}{d}$

$\therefore$ slope of V_H Vs I graph $= \frac{R_H B}{d}$

Since, $B = 2000$ Gauss $= 2000 \times 10^{-4}$ T $= 2 \times 10^{-2}$ T
and $d = 0.5$ mm $= 0.5 \times 10^{-3}$ m $= 5 \times 10^{-4}$ m

$\therefore \quad 8.22 = \frac{R_H \times 2 \times 10^{-2} \times 10}{5 \times 10^{-4}}$

$\therefore R_H$ (Hall coefficient) $= 0.02055$ Vm/AT
$= 2.055 \times 10^{-2}$ Vm/AT

Since, charge density $(n) = \frac{1}{R_H q} = \frac{1}{0.02055 \times 1.6 \times 10^{-19}}$

$n = 3.041 \times 10^{20}$ c/m³

mobility $(\mu) = \sigma R_H = \frac{1}{\rho} R_H = \frac{1}{5 \times 10^{-2}} \times \frac{0.2055}{10}$

$\{ \because \rho = 5 \Omega \text{ cm}^2 \}$

Teacher's Signature

Expt. No. ______ Date ______

Page No. ______

$\because$ Mobility $(\mu) = 4.11 \times 10^{-1}\ T^{-1} = 0.411/T$

RESULT :-

The Hall coefficient $(R_H) = 2.055 \times 10^{-2}\ Vm/AT$

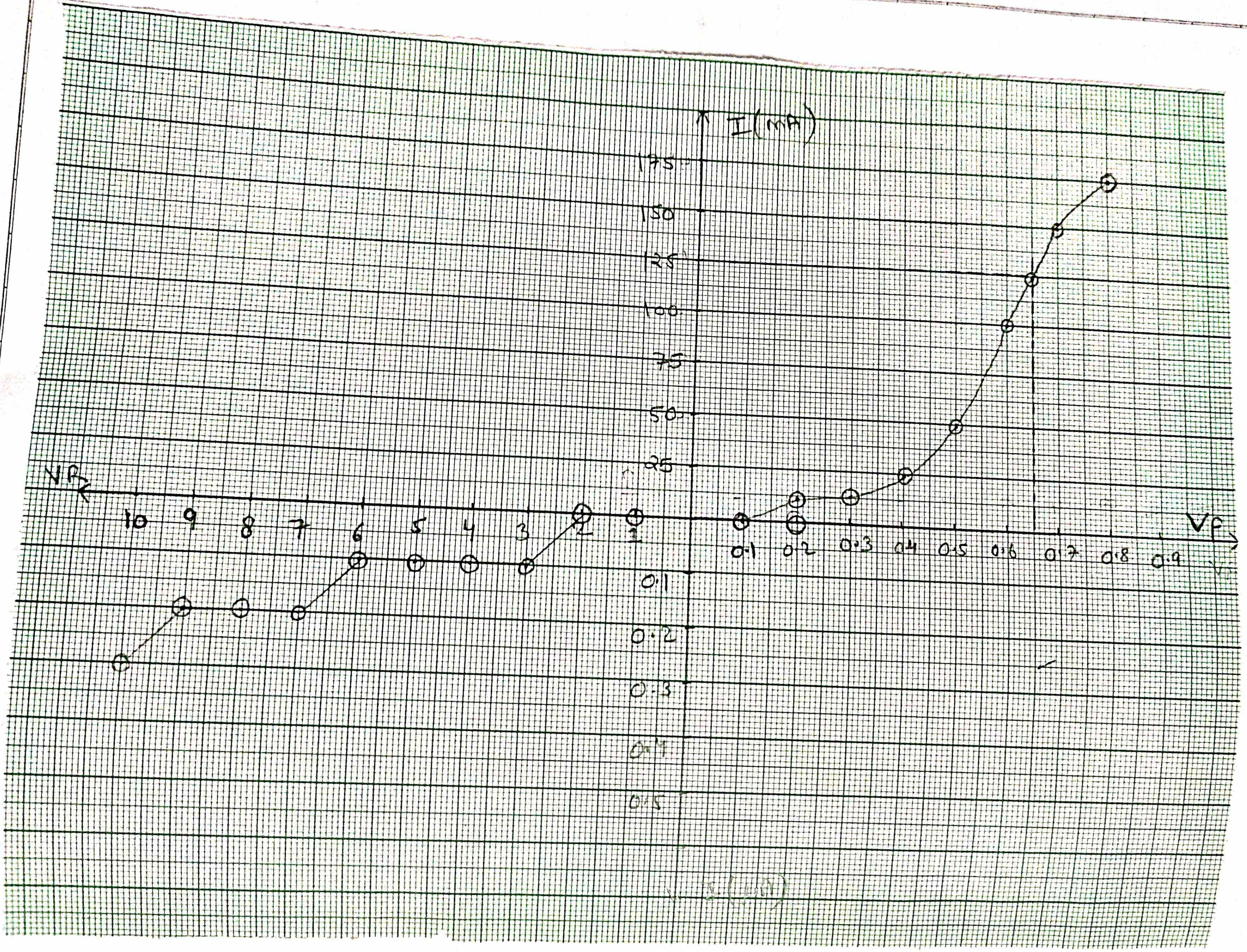
The value of charge density $(n) = 3.041 \times 10^{20}\ m^3$

The value of charge mobility $(\mu) = 0.411 T^{-1}$

PRECAUTIONS :

1. Hall probe should be placed in the middle of the poles of electromagnet.
2. While connecting the electromagnet with constant current source the direction of current should be same in both the coils.
3. In Gauss and Tesla meter, zero reading should be set on display by zero Adjust potentiometer.
4. Zero field Potential will be substracted from Hall voltage Reading.

Teacher's Signature ______


I (mA)
175
150
125
100
75
50
25
VR
10 9 8 7 6 5 4 3 2 1
0·1 0·2 0·3 0·4 0·5 0·6 0·7 0·8 0·9
VF
0·1
0·2
0·3
0·4
0·5

Date

Expt. No. 7

Page No.

I-V CHARACTERISTICS OF P-N JUNCTION

Objective: To draw (V-I) characteristics of P-n junction diode and to estimate dynamic and static resistance.

Formula:-

$$I_D = I_s \{exp.(eV_D / K_B T) - 1\}$$

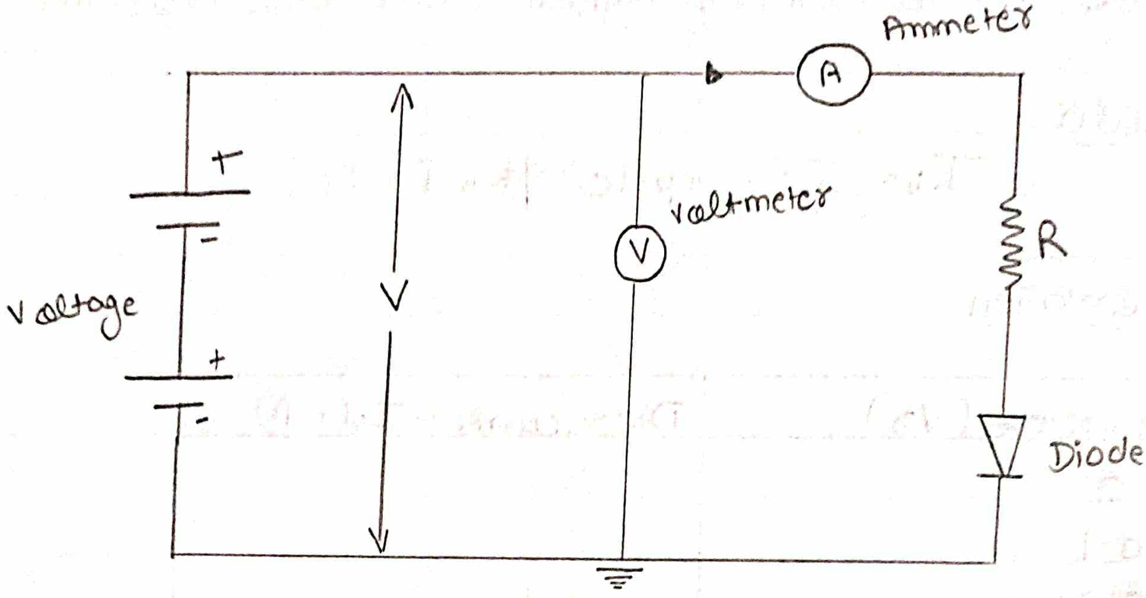
Observation:-

S.No	Diode voltage (V_D)	Diode current I_D(mA)
1	0	0
2	0.1	0
3	0.2	0.1
4	0.3	0.5
5	0.4	13.3
6	0.5	34.3
7	0.6	94.2
8	0.7	167.2
9	0.8	194.3

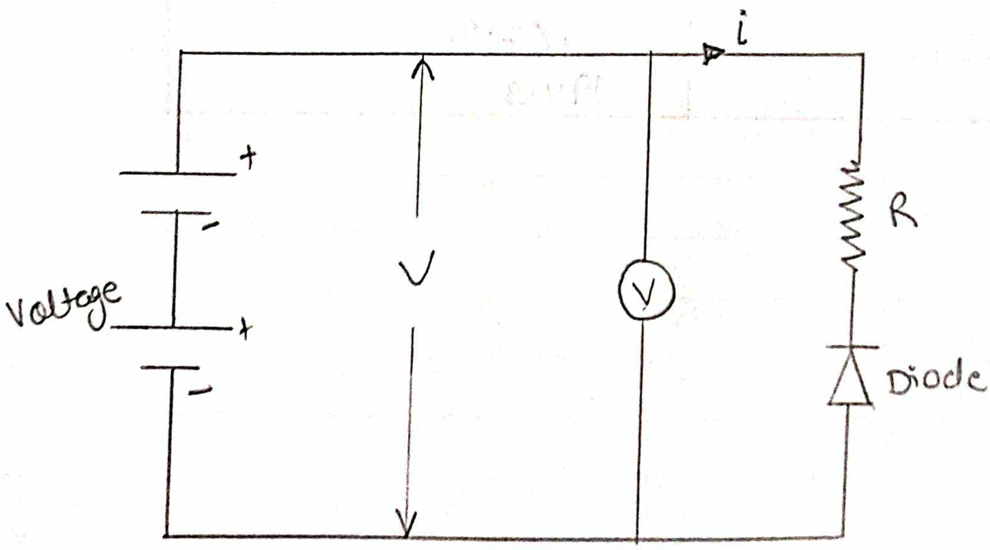
Teacher's Signature

Circuit Diagram :-

(i) For Forward Bias :-



(ii) Reverse bias :-



Date

Expt. No.

Page No.

SNO	Diode Voltage V_D	Diode current $I_D(\mu A)$
1	1	0
2	2	0
3	3	0.1
~~8~~4	4	0.1
5	5	0.1
6	6	0.1
7	7	0.2
8	8	0.2
9	9	0.2
10	10	0.3

Calculations:-

- forward Bias

Static Resistance $R_S = \frac{0.65}{125} = 0.0052\ \Omega$

Dynamic Resistance $R_D = \frac{DV}{DI} = \frac{0.75-0.59}{175-75}$

$= \frac{0.16}{100} = 0.0016\ \Omega$

Result:-

The IV characteristic of the diode are shown in the forward and reverse bias. The static and dynamic resistance are 0.0052 Ω and 0.0016 Ω.

Teacher's Signature

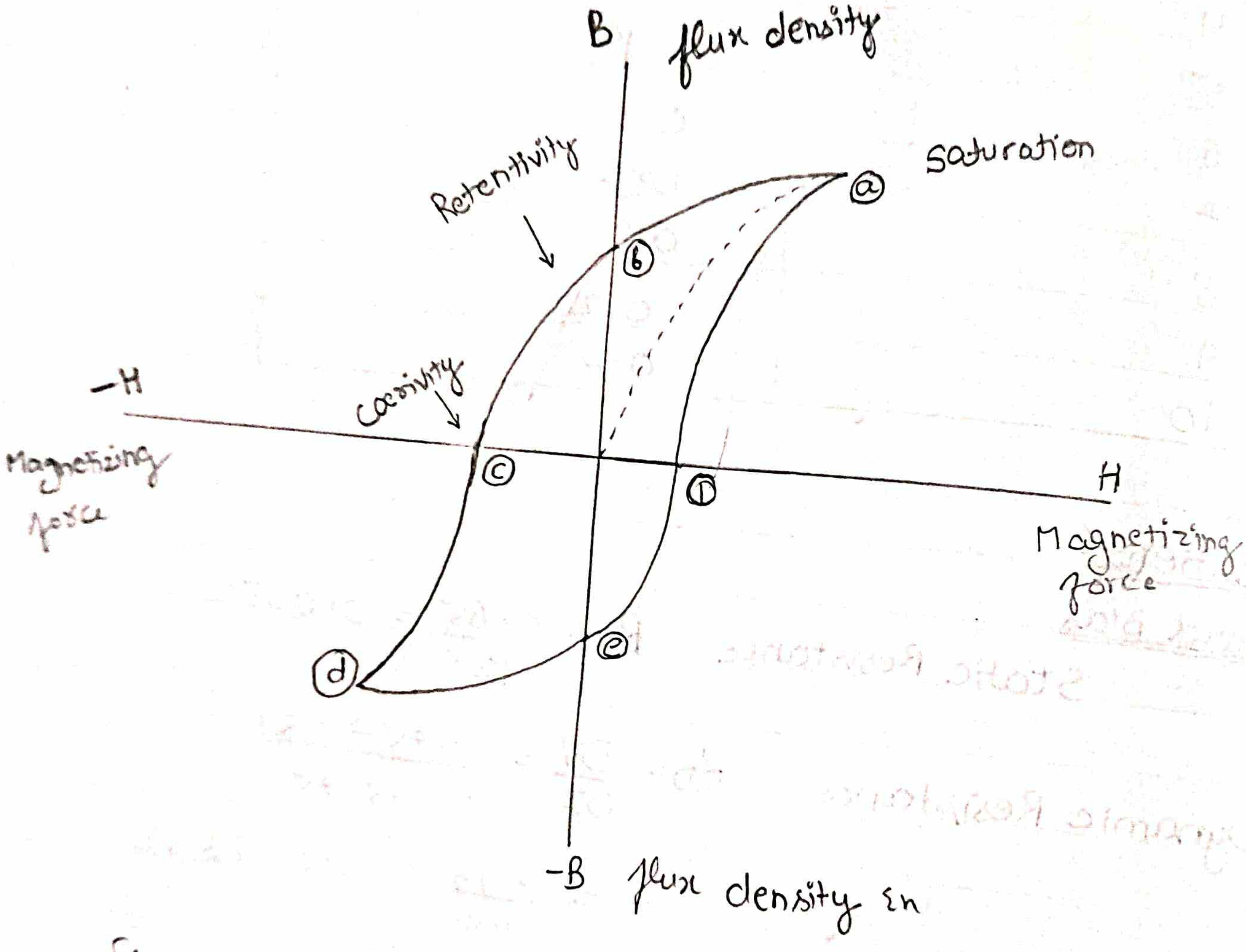


Figure:- A typical hysteresis loop

Expt. No. ____________ Date ____________

Page No. ____________

OBJECTIVE :- To draw the hysteresis curve feromagnetic material and to determine retentivity, coffiviety and hysteresis loss.

APPARATUS REQUIRED : CRO, feromagnetic specimen, solenoid hysteresis loop traces.

THEORY AND FORMULA USED : The Loop is generated by measuring the magnetic flux density (B) feromagnetic material while the magnetic field (H) is changed. A ferromagnetic material that has been priviously magnetized or has been throughly demagnetized will follow the dashed line as (H) is increased. At point "a" almost all the magnetic domains are aligned and all additional increase in B. The material has reached the point of magnetic saturation when 'H' is reduced to zero, the curve will move from point "a" to Point "B". At this point it can be seen that B remain non-zero in the material even through H is zero.

- Retentivity :- A measure of the material residual flux density corresponding to the saturation induction of a magnetic material. In other words, it is a magnetic ability to retain a certain amount of residual magnetic field when the magnetizing force is removed after archieving saturation (The value of B at Point "b" on the hysteresis curve).

- Coercivity :- The amount of reverse magnetic field which must be applied to a magnetic material to make

Teacher's Signature ____________

the magnetic flux return to zero. (The value of H at Point 'c' on the hysteresis).

- Hysteresis Loss: The energy loss per cycle Per unit volume is hysteresis loss and ~~it~~ is given by $\frac{1}{4\pi}$ (Area of B-H curve).

CALCULATION:

Note:- All the calculations should done at the highest applied field to ensure that the sample has saturated.

Actual loop width = (observed loop width)/3

$= \frac{W}{3} = 1.6\,V$

Intercept $= \frac{Y}{2} = 1.1\,V$

Tip to tip height $= T = 1.5\,V$

a) Coercivity (Hc) ex $= \frac{1}{2} \times$ Actual loop width

$$H_C = \frac{G_0\, e x}{\frac{A_S}{A_C} - N} = \frac{34.28 \times 24}{0.135 - 0.0033} = \frac{82.032}{0.1317} = 622.87 \text{ Gauss}$$

b) Hysteresis loss Per unit volume Per cycle (loss)

A = Area of B-H curve is V^2

$$= \frac{G_0}{\frac{A_S}{A_C} - N} \times \frac{G_0 g x}{g\,y\left(\frac{A_S}{A_C} - N\right)4\pi} \times A \quad \text{ergs/cycle/cm}^2$$

- **Observation:**

Given

Total gain of both amplifiers, $g_x = 100$, $g_y = 1$

Diameter of the sample 1·20 mm ($2r_1$);

Diameter of the Pickup coil = 3·26 mm ($2r_2$)

Area ratio $[A_s/A_c] = r_1^2/r_2^2 = 0{\cdot}135$

Demagnetizing factor (N) = 0·0033, G_0 = 34·18

- **Observation table:-**

S.No	Magnetic field (Gauss)	Observed loop width (W) (in volts)	Tip to tip height (T) (in volts)	Positive intercept to negative intercept distance. (Y) in Volt
1	194	12 × 0·4 = 4·8	22 × 0·1 = 2·2	15 × 0·1 = 1·5

Date

Expt. No. Page No.

(c) Retentivity e_y = Intercept = ____ V

intercept $(e_y) = 1.5$ V

$$M_r = \frac{G_0 g_x e_y}{\left(\frac{AS}{AC} - N\right) 4\pi} = \frac{34.18 \times 100 \times 1.5}{1 \times (0.135 - 0.0033) 4\pi}$$

$$= \frac{5.127}{1.654} = 3099.75 \text{ Gauss}$$

(d) Saturation Magnetic flux density:

t_r = Tip to tip height $\times 0.5 = 1.1$ V

$$B_s = \frac{G_0 g_x t_r}{g_y \left(\frac{AS}{AC} - N\right) 4\pi} = \frac{34.18 \times 100 \times 1.1}{1.654} = 21273.153 \text{ Gauss}$$

- **RESULT:**

B-H curve of the given feromagnetic material is traced.

The calculated value of :-

(i) Coercivity is 622.87 Gauss

(ii) Retentivity is 3399.75 Gauss

(iii) Saturation Magnetic flux density is 2213.154 Gauss

Teacher's Signature