



KSSEM
K.S. SCHOOL OF ENGINEERING AND MANAGEMENT

K.S. GROUP OF INSTITUTIONS

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT

15, Mallasandra, Near Vajarahalli, Off. Kanakapura Road, Bengaluru - 560 109.

PRACTICAL RECORD BOOK

Name : VINUTHA.BR

Class : 1st Sem CS 'B'

Lab : Physics

USN :

--	--	--	--	--	--	--	--	--	--





KSSEM
K.S. School of Engineering and Management

Laboratory Certificate

This is to certify that

Mr. / Ms. V.INUTHA..BR.
has satisfactorily completed the course of experiment in
PHYSICS Laboratory. Code BPHYS102
Prescribed by Visvesvaraya Technological University, Belagavi
for the 1st Semester B.E. CSE branch in this
college during in the academic year 2023 - 2024

Name of the Candidate : V.INUTHA..BR.
USN : Lab (with code) BPHYS102

Marks	
Maximum	Obtained

Signature of the
Teacher

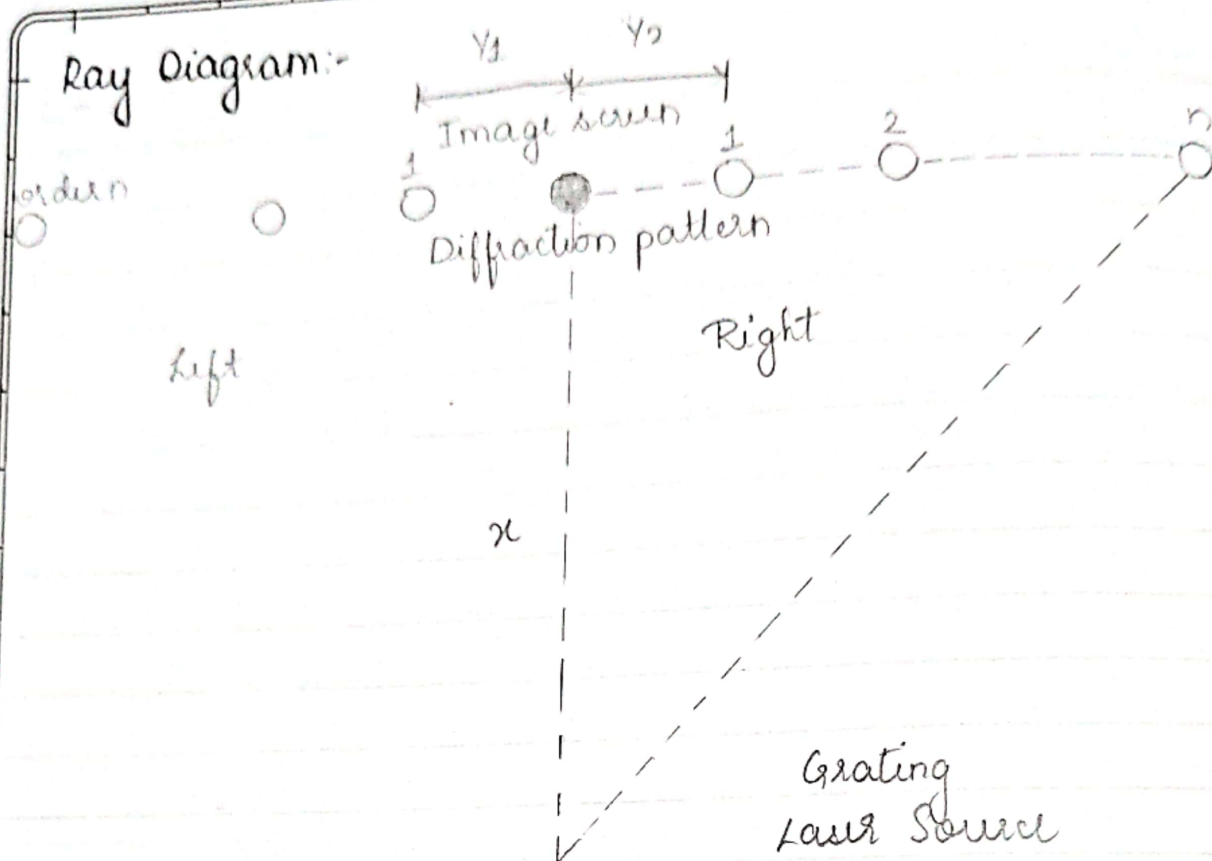
Date : 23/12/23

Head of the Department

CONTENTS

23/12/23

Ray Diagram:-



Number of lines per meter of the grating, $N = 2 \times 10^4$ lines/m
 Distance between the grating and the screen, $x = 100$ cm

Tabular Column

Order of diffraction n	Distance between central maximum of the n^{th} order maximum		Average $Y = \frac{Y_1 + Y_2}{2}$ (cm)	Deviation $\theta = \tan^{-1}\left(\frac{Y}{x}\right)$ (deg)	$\lambda = \frac{\sin \theta}{nN}$ (m)
	Left Y_1 (cm)	Right Y_2 (cm)			
1	1.3	1.3	1.3	0.744	6.492×10^{-7}
2	2.8	2.8	2.8	1.603	6.994×10^{-7}
3	4	4	4	2.290	6.661×10^{-7}
4	5.5	5.5	5.5	3.148	6.850×10^{-7}

Mean $\lambda = 6.749 \times 10^{-7}$ m

aim:-

To determine the wavelength of semiconductor laser using laser diffraction.

Apparatus:-

Diffraction grating, grating holder, diode laser, screen fixed with graph sheet and meter scale.

Principle:-

The ability of a diffraction grating is to physically separate the different wavelengths. If the incoming light is multicolored or consists of more than one wavelength, then the angle of diffraction differs from color to color, resulting in multiple image of the slit opening with different colors. If the incoming light is single colour then different orders of slit images are seen with varying intensities.

A plane diffraction grating consists of a number of equidistant parallel slit or lines, all of same width.

Diffraction occurs when the size or dimension of the obstacle is comparable with the wavelength of the source. When a parallel beam of light is incident on the grating, Fraunhofer diffraction takes place. Maxima of different wavelengths occur on either side of the central maximum.

Formula:-

A laser consists of single wavelength falling on a grating will produce diffraction pattern. The principal maximum intensity of the diffracted light is given by,

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

where, d is grating constant or the distance between two

Calculations :-

Trial 1

$$Y_1 = 1.3 \text{ cm} \quad Y_2 = 1.3 \text{ cm} \quad X = 100 \text{ cm}$$

$$Y = \frac{Y_1 + Y_2}{2} = \frac{1.3 + 1.3}{2} = 1.3 \text{ cm}$$

$$\theta = \tan^{-1}\left(\frac{Y}{X}\right) = \theta = \tan^{-1}\left(\frac{1.3}{100}\right) = \theta = 0.744^\circ$$

$$\lambda = \frac{\sin \theta}{mN} = 6.492 \times 10^{-7} \text{ m}$$

Trial 2:-

$$Y_1 = 2.8 \text{ cm} \quad Y_2 = 2.8 \text{ cm} \quad X = 100 \text{ cm}$$

$$Y = \frac{Y_1 + Y_2}{2} = 2.8 \text{ cm}$$

$$\theta = \tan^{-1}\left(\frac{Y}{X}\right) = 1.603^\circ$$

$$\lambda = \frac{\sin \theta}{mN} = \frac{\sin 1.603}{2 \times 2 \times 10^4} = 6.994 \times 10^{-7} \text{ m}$$

Trial 3:-

$$Y_1 = 4 \text{ cm} \quad Y_2 = 4 \text{ cm} \quad X = 100 \text{ cm}$$

$$Y = \frac{Y_1 + Y_2}{2} = 4 \text{ cm}$$

$$\theta = \tan^{-1}\left(\frac{Y}{X}\right) = 2.290^\circ$$

$$\lambda = \frac{\sin \theta}{mN} = \frac{\sin 2.290}{3 \times 2 \times 10^4} = 6.661 \times 10^{-7} \text{ m}$$

Trial 4:-

$$Y_1 = 5.5 \text{ cm} \quad Y_2 = 5.5 \text{ cm} \quad X = 100 \text{ cm}$$

$$Y = \frac{Y_1 + Y_2}{2} = 5.5 \text{ cm}$$

$$\theta = \tan^{-1}\left(\frac{5.5}{100}\right) = 3.148^\circ$$

$$\lambda = \frac{\sin \theta}{mN} = \frac{\sin 3.148}{4 \times 2 \times 10^4} = 6.850 \times 10^{-7} \text{ m}$$

consecutive ruling, $d = \frac{1}{N}$

N is number of lines per meter on the grating (m)

θ is the angle of diffraction (deg)

$n=1, 2, 3, \dots$ n is called order of diffraction,

λ is the wavelength of the light used (m).

Thus the wavelength of ~~laser~~ is determined using the formula

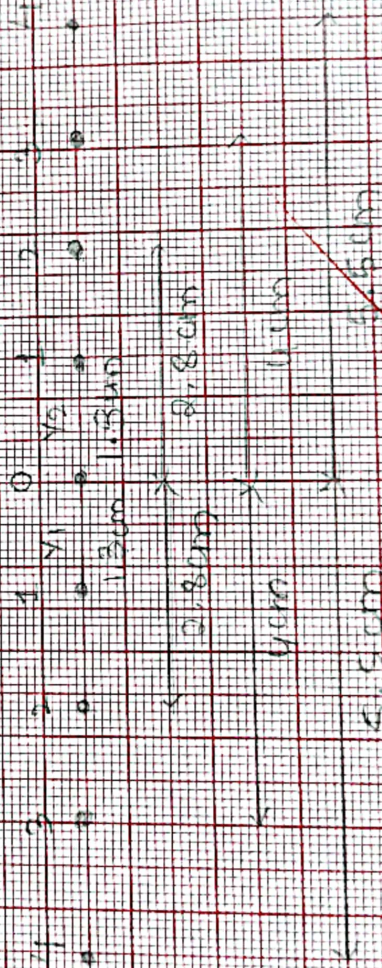
$$\lambda = \frac{\sin \theta}{nN} \text{ in m}$$

Procedure:-

1. The grating is placed on grating stand and the LASER is aligned such that the beam is incident on the grating. Distance between the grating and the screen is adjusted for 1 meter (X) or 100 cm.
2. The laser beam is incident normally on the grating. Diffraction pattern is obtained on the screen as in figure.
3. The screen is adjusted such that the central bright maximum coincides with the zero of the scale fixed on the screen. The separation between central ~~bright~~ maximum and first order maximum to the left of diffraction pattern (say y_1) is measured. Same is repeated for y_2 also.
4. Procedure is repeated to take the readings up to forth. Angle of deviation (θ) for each order is calculated.

Right

Left



~~10/10/2020~~

5. The average wavelength is determined.

Applications:-

Lasers find wide range of applications in the following fields:-

Medicine:- Bloodless surgery, laser healing, surgical treatment, kidney stone treatment, eye treatment, dentistry.

Industry:- Cutting, welding, material heat treatment, marking parts, non-contact measurement of parts.

Military:- Marking targets, guiding munitions, missile defense, electro-optical countermeasures (EOCM), alternative to radar, building troops.

Law enforcement:- used for latent fingerprint detection in the forensic identification field.

Research:- Spectroscopy, laser ablation, laser annealing, laser scattering, laser interferometry, LIDAR, laser capture micro dissection, fluorescence microscopy.

Semiconductor lasers find important use in optical communication, also used as reading devices for CD players.

RESULT:-

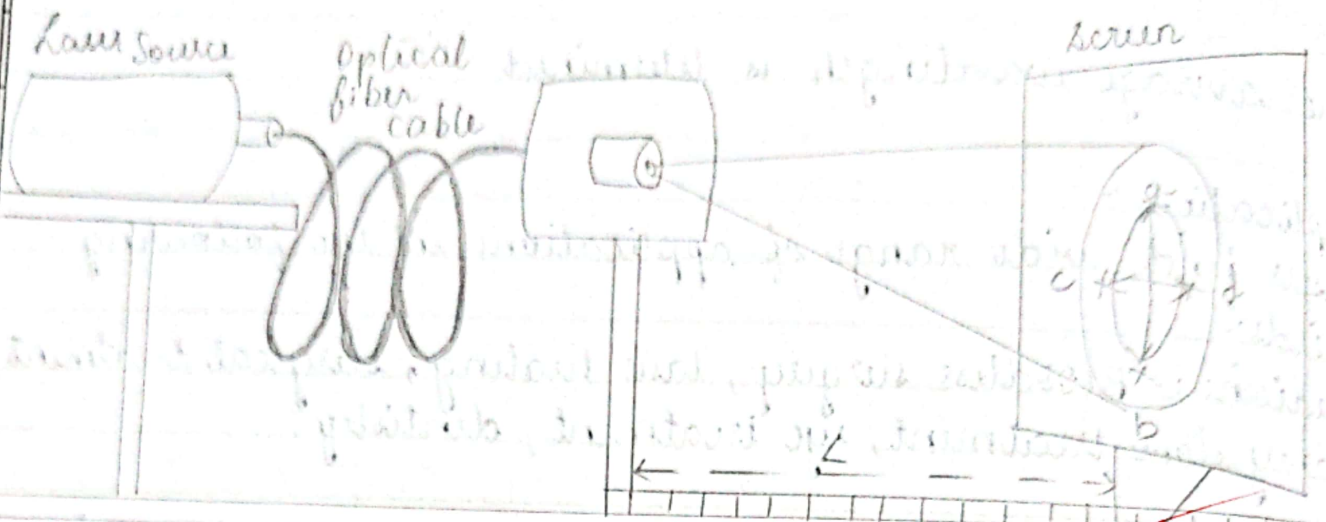
The wavelength of LASER beam is given by $\lambda = 6.749 \times 10^{-7} \text{ m}$

05/05

25/9/23

KSSEM

Diagram:-



Tabular column

Trial No.	L (cm)	Horizontal diameter D_1 (cm)	Vertical diameter D_2 (cm)	Mean diameter (cm)	Acceptance angle $\theta_0 = \tan^{-1}\left(\frac{D}{2L}\right)$ (deg)	Numerical aperture $NA = \sin \theta_0$
1	2	1.5	1.5	1.5	20.556	0.351
2	3	1.7	1.7	1.7	15.819	0.272
3	4	2.4	2.4	2.4	16.699	0.287
4	5	2.9	2.9	2.9	16.1721	0.278

$$(\theta_0)_{\text{mean}} = 17.31 \text{ deg}$$

$$(NA)_{\text{mean}} = 0.297$$

Aim:-

To determine the acceptance angle and numerical aperture of the given optical fiber.

Apparatus:- Laser source, Optical fiber, screen, scale

Principle:-

The sine of the acceptance angle of an optical fiber is known as the numerical aperture of the fiber. The acceptance angle can also be measured as the angle spread by the light signal at the emerging end of the optical fiber. Therefore, by measuring the diameter of the light spot on a screen and by knowing the distance from the fiber end to the screen, we can measure the acceptance angle and thereby the numerical aperture of the fiber.

Formulae:-

Acceptance angle,

$$\theta_0 = \tan^{-1} \left(\frac{D}{2L} \right) \text{ (deg)}$$

where, θ_0 is the acceptance (deg)

D is the diameter of the bright circle formed on screen (m)

L is the distance between the optical fiber end and screen (m)

Numerical aperture,

$$NA = \sin \theta_0$$

Calculations:-

Trial 1

$$D_1 = 1.5 \text{ cm} \quad D_2 = 1.5 \text{ cm} \quad D = 1.5 \text{ cm} \quad L = 2 \text{ cm}$$

$$\theta_0 = \tan^{-1}\left(\frac{D}{2L}\right) = \tan^{-1}\left(\frac{1.5}{4}\right) = 20.556^\circ$$

$$NA = \sin \theta_0 = \sin 20.556^\circ = 0.351$$

Trial 2

$$D_1 = 1.7 \text{ cm} \quad D_2 = 1.7 \text{ cm} \quad D = 1.7 \text{ cm} \quad L = 3 \text{ cm}$$

$$\theta_0 = \tan^{-1}\left(\frac{D}{2L}\right) = \tan^{-1}\left(\frac{1.7}{6}\right) = 15.819^\circ$$

$$NA = \sin \theta_0 = \sin 15.819^\circ = 0.272$$

Trial 3

$$D_1 = 2.4 \text{ cm} \quad D_2 = 2.4 \text{ cm} \quad D = 2.4 \text{ cm} \quad L = 4 \text{ cm}$$

$$\theta_0 = \tan^{-1}\left(\frac{D}{2L}\right) = \tan^{-1}\left(\frac{2.4}{8}\right) = 16.699^\circ$$

$$NA = \sin \theta_0 = \sin 16.699^\circ = 0.287$$

Trial 4

$$D_1 = 2.9 \text{ cm} \quad D_2 = 2.9 \text{ cm} \quad D = 2.9 \text{ cm} \quad L = 5 \text{ cm}$$

$$\theta_0 = \tan^{-1}\left(\frac{2.9}{10}\right) = 16.772^\circ$$

$$NA = \sin \theta_0 = \sin 16.772^\circ = 0.278$$

Procedure:-

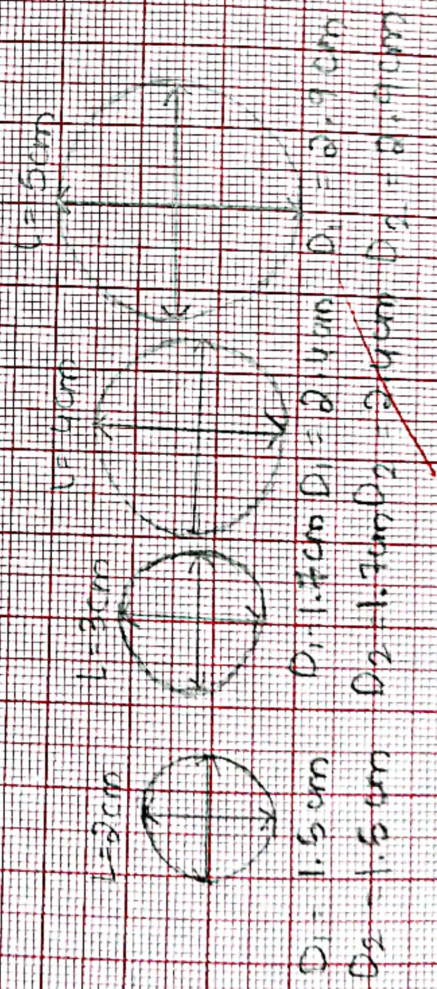
1. Switch on the laser source and adjust the distance between output end of the optical fiber and the screen 'L' (say 5cm)
2. Place a graph sheet on the screen and observe the circle formed on the graph sheet.
3. Mark the points 'a', 'b', 'c' & 'd' on the inner bright circle as shown in the diagram. Note down the horizontal diameter D_1 and vertical diameter D_2 of the inner bright circle in the tabular column.
4. Repeat the above steps for different values of L (for 4cm, 3cm...)
5. Find the acceptance angle from the tabular column and hence the numerical aperture.

Applications:-

The application and uses of optical fiber can be seen in :-

- 1) Medical Industry
- 2) Communications
- 3) Defense
- 4) Industries
- 5) Broadcasting
- 6) Lighting and Decorations
- 7) Mechanical Inspections.

9/10/23



DATE 25.9.23

EXPT. TITLE :

EXP. NO.

PAGE NO.

7

Result:-

1. The angle of acceptance of the given optical fibre is $\theta_c = 17.31^\circ$
2. Numerical aperture of the given optical fibre is $NA = 0.297$

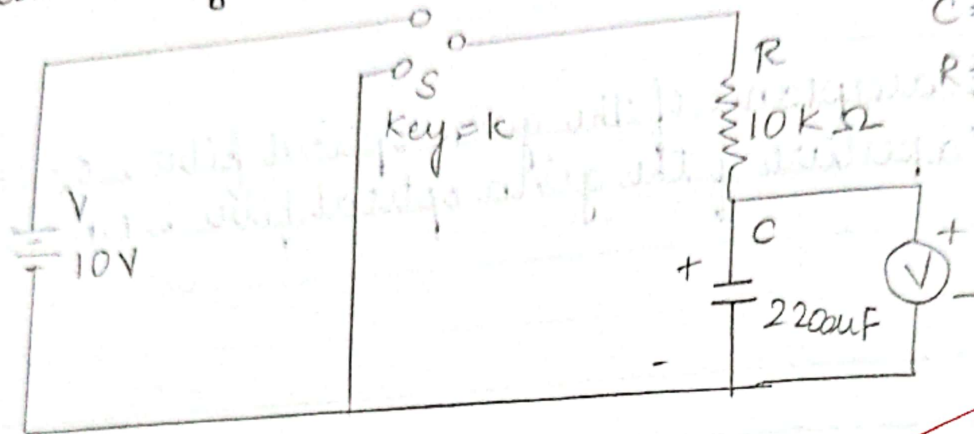
9/10/23

05
05

KSSEM

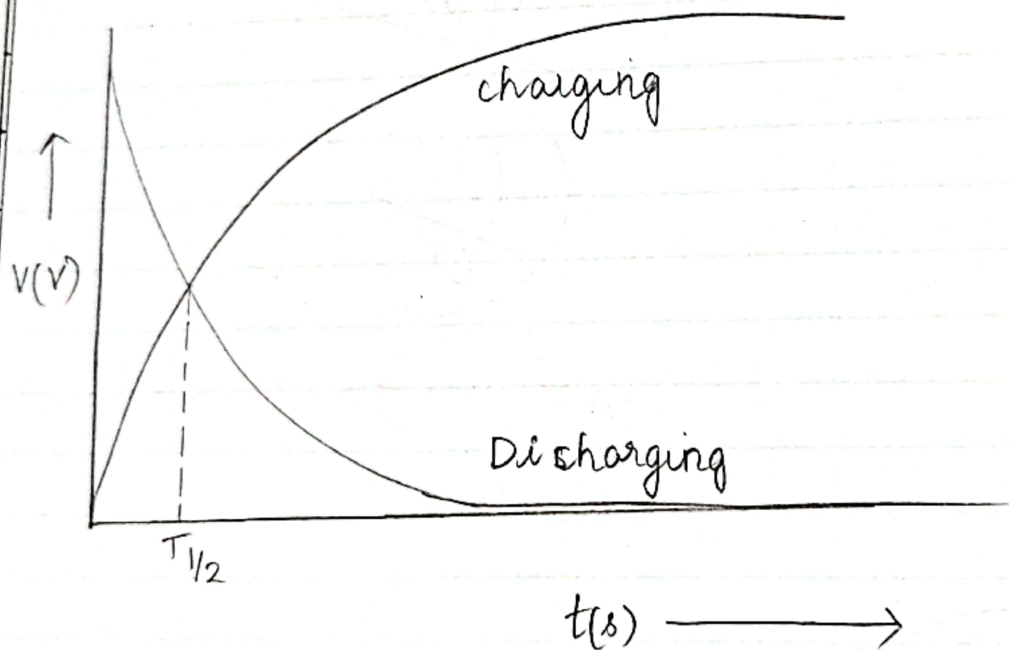


Circuit diagram:-



V = Voltmeter
C = Capacitor
R = Resistor

Expected Graph



Calculations:-

From Graph $T_{1/2} = 15s$

$$\begin{aligned} \epsilon r &= \frac{T_{1/2} d \times 10^{-6}}{0.693 \epsilon_0 R A} \\ &= \frac{15 \times 0.11 \times 10^{-3} \times 10^{-6}}{0.693 \times 8.854 \times 10^{-12} \times 10 \times 10^3 \times 73.6 \times 10^{-14}} = \frac{1.65 \times 10^9}{4.515 \times 10^{10}} = 3.654 \end{aligned}$$

Aim:-

To determine the dielectric constant of the material of the capacitor by the method of charging and discharging.

Apparatus:-

DC regulated power supply, toggle switch, electrolytic capacitor, resistor and voltmeter.

Theory:-

A parallel plate capacitor is formed by keeping two metallic plates parallel to each other. By applying a potential across the two plates an electric field is produced inside the space between the two plates. By placing an electrically insulated material (dielectric) within the plates the capacitance of the capacitor is increased. A capacitor can be charged using a resistor and a DC source. The capacitor will charge exponentially. The instantaneous voltage across the capacitor during charging is given by

$$V_{\text{charge}} = V_0(1 - e^{-t/RC})$$

When the switch is turned to the discharge mode, the capacitor loses its charge and discharges through R. Therefore the voltage across the capacitor starts decreasing until it becomes zero. The instantaneous voltage across the capacitor during discharge is given by

$$V_{\text{discharge}} = V_0(e^{-t/RC})$$

Time (s)	Charging Voltage (V)	Discharging Voltage (V)
0	0	15.47
10	5.14	10.03
20	8.35	5.87
30	10.47	3.46
40	11.94	2.05
50	12.93	1.25
60	13.72	0.75
70	14.23	0.46
80	14.64	0.28
90	14.95	0.18
100	15.16	0.11
110	15.34	0.07
120	15.47	0.04

where R is the resistance in ohms, C is capacitance in Farad, t is the instantaneous time, V_0 is the maximum voltage to which capacitor is charged.

Formula:-

The dielectric constant of the material of the capacitor is determined using the formula

$$\epsilon_r = \frac{T_{1/2} d \times 10^{-6}}{0.693 \epsilon_0 R A}$$

where, ϵ_0 is permittivity of free space $= 8.854 \times 10^{-12} \text{ F/m}$

R is the resistance $= 10 \text{ K}\Omega$

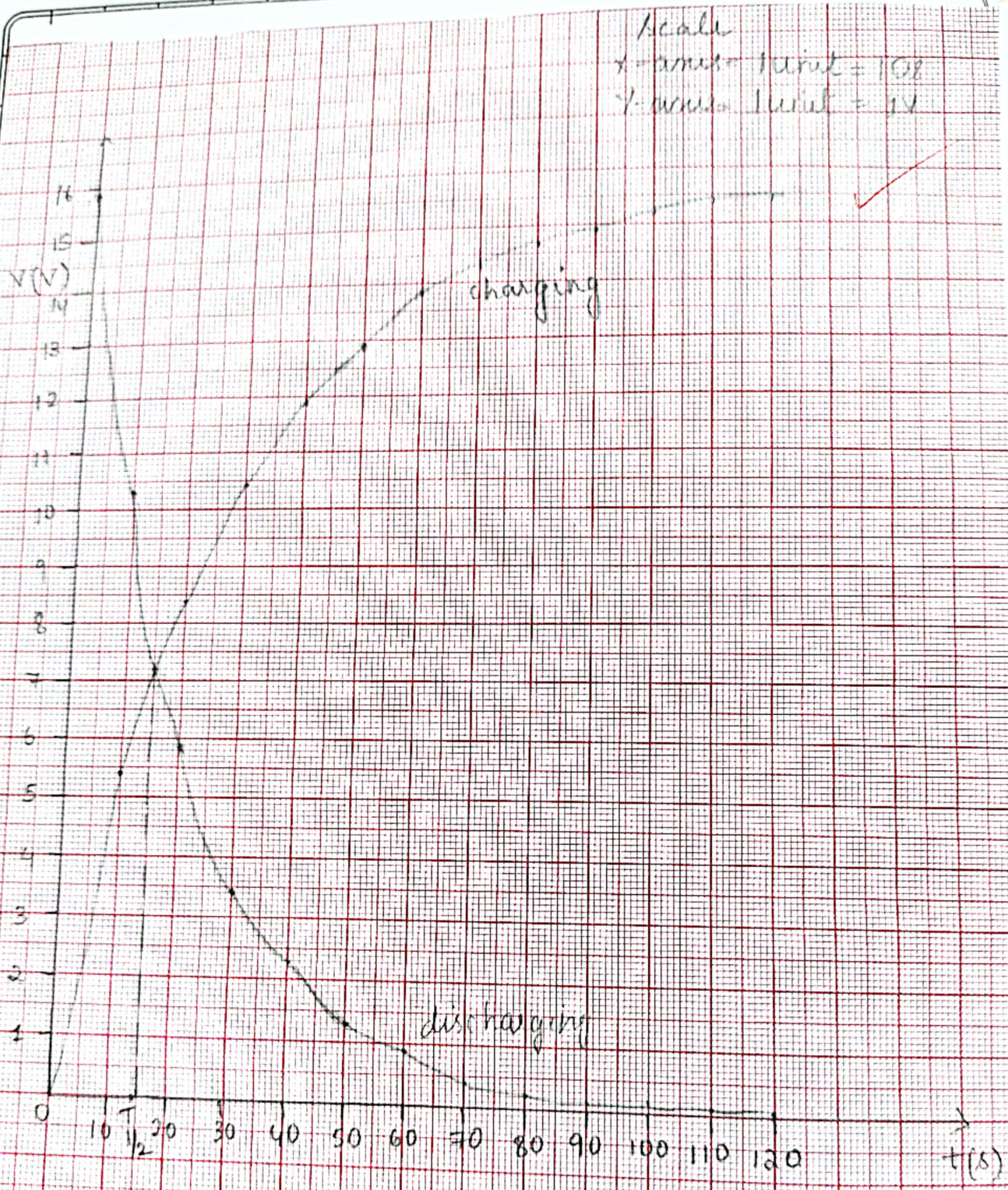
A is area of the plates of the capacitor $= 73.6 \times 10^{-4} \text{ m}^2$

d is the thickness of the dielectric material between plates of the capacitor

$$d = 0.11 \times 10^{-3} \text{ m}$$

Procedure:-

1. The connections are made as shown in the circuit diagram. The charge is removed from the capacitor by shorting its terminals.
2. It is ensured that the toggle switch is at the centre. The toggle switch is turned on for charging mode and simultaneously a stop clock is started.
3. The potential difference across the capacitor is noted for every 10 secs until the saturation is achieved.



4.

5.

6.

9/10/23

4. After the saturation is achieved the toggle switch is turned to centre position. The stop clock is reset to zero.
5. The toggle switch is turned on for discharging mode. The voltage across the capacitor is noted for every 10 sec until the capacitor discharges completely.
6. A graph voltage versus time is plotted on the same graph for both charging and discharging of a capacitor. In graph the meeting point of two curves is noted as time $T_{1/2}$.

Applications:-

A capacitor can store electric energy when disconnected from its charging circuit, so it can be used like a temporary battery. Capacitors are commonly used in electronic devices to maintain power supply while batteries are being charged. In car audio system, large capacitors store energy for the amplifiers on demand. Capacitors are widely used in electronic circuits to perform variety of tasks such as smoothing, filtering, bypassing etc.

Result:-

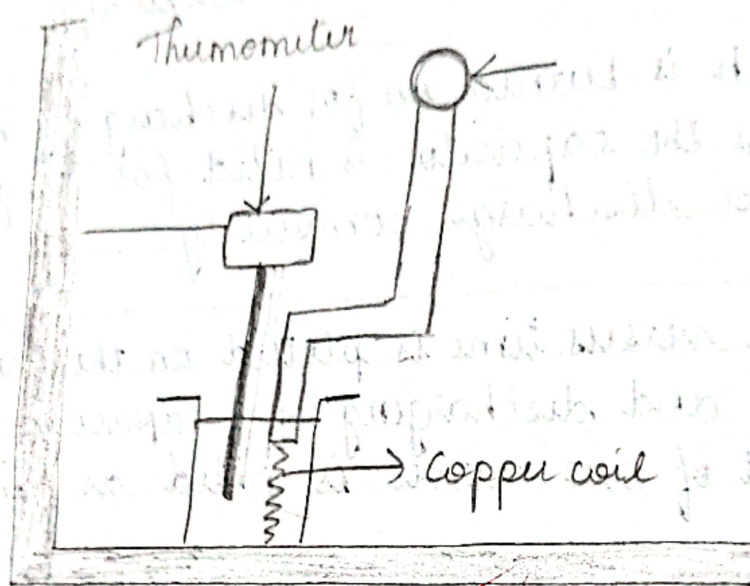
The dielectric constant of the dielectric material of parallel plate capacitor is $\epsilon_r = 3.654$.

9/10/23

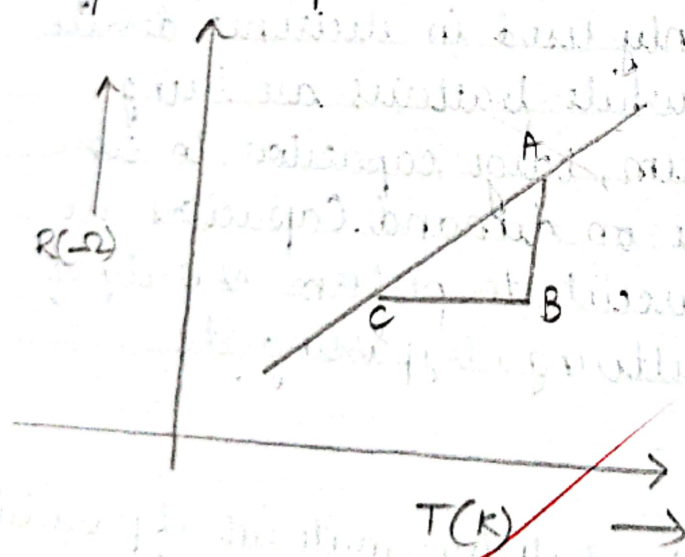
05
05

KSSEM

Circuit Diagram:-



Expected Graph :-



Aim:-

To determine the fermi energy of copper by studying the variation of resistance with temperature

Apparatus:-

Copper coil, Thermomiltes, multimeter, Beaker

Principle:-

The energy of the highest occupied level at zero-degree absolute is called the Fermi energy (E_F) and the energy level is referred to as the fermi level. Fermi energy gives us information about the velocities of the electrons which participate in electrical conduction. Fermi temperature (T_F) is the temperature at which the average thermal energy of free electrons becomes equal to Fermi energy.

Pauli's exclusion principle "it states that no two electrons can have the same four quantum numbers". That is, if n , l and m_l are the same, m_s must be different such that the electrons have opposite spins.

Formula:-

- 1) The Fermi energy of copper is calculated using the formula
- $$E_F = 1.37 \times 10^{-15} \sqrt{\frac{\rho D A}{l}} \text{ J}$$

where, D is Density of copper = $8.96 \times 10^3 \text{ kg/m}^3$

l is the length of the copper wire = 11 m

A is the area of cross section of the wire which is found using the formula,

Tabular Column:-

Sl No	Temperature T(°C)	Temperature T(K)	Resistance R(Ω)
1	85	358	5.4
2	80	353	5.3
3	75	348	5.2
4	70	343	5.1
5	65	338	5.1
6	60	333	5.0

Calculations :-

$$\text{Slope} = 0.02 \Omega/K$$

$$E_F = 1.37 \times 10^{-15} \sqrt{\frac{DAS}{l}} \text{ J}$$

$$A = \frac{\pi d^2}{4} \text{ m}^2$$

$$A = \frac{\pi \times (0.25 \times 10^{-3})^2}{4}$$

$$A = \frac{\pi \times (0.25)^2 \times 10^{-6}}{4}$$

$$A = \frac{3.14 \times 0.0625 \times 10^{-6}}{4}$$

$$A = 4.906 \times 10^{-8} \text{ m}^2$$

$$E_F = 1.37 \times 10^{-15} \sqrt{\frac{8.96 \times 10^3 \times 4.906 \times 10^{-8} \times 0.02}{11}} = 8.93 \times 10^{-15} \text{ J}$$

$$E_F = 1.22 \times 10^{-18} \text{ J}$$

$$\frac{1.22 \times 10^{-18}}{1.6 \times 10^{-19}} = 7.625 \text{ eV}$$

$$A = \frac{\pi d^2}{4} \text{ (m}^2\text{)}$$

d is the diameter of the copper wire $= 0.25 \times 10^{-3} \text{ m}$
 S is the slope in Ω / K

Procedure:-

1. The circuit connections are made as shown in the figure. The copper coil is immersed into the beaker and the beaker is filled with boiling water & a thermometer is introduced into water.
2. Starting with the temperature of 85°C the resistance (R) of the copper coil is measured using multimeter and the temperature of the water is measured using a Digital thermometer.
3. The resistance of the copper coil is measured for every 5°C fall in temperature (T) of water up to 60°C . A graph of Resistance (R) Versus Temperature (T) is plotted. The slope (S) is determined and hence Fermi energy of Cu of copper is calculated.

Application:-

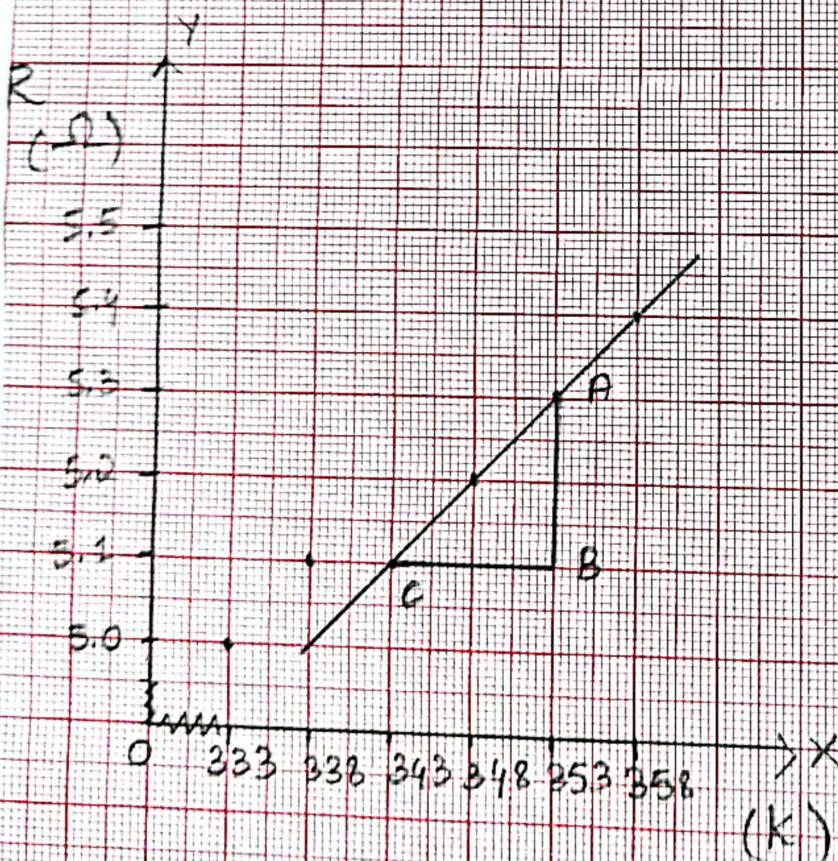
It is used, for example, to describe metals, insulators and semiconductors. It is a very important quantity in the physics of superconductors.

The concept of Fermi energy is crucially important concept for the understanding of the electrical and thermal properties of solids.

scale -

x axis = 1 unit = 5k

y axis = 1 unit = 0.1 Ω



Slope:- $\frac{AB}{BC}$

$$= \frac{2 \times 0.1}{2 \times 5}$$

slope = 0.02 Ω/K

~~16/10/23~~

DATE

EXPT. TITLE :

PAGE NO.

14

EXP. NO.

Result:-

The fermi energy of copper is given by $E_f = 7.625 \text{ eV}$

16/10/23

05

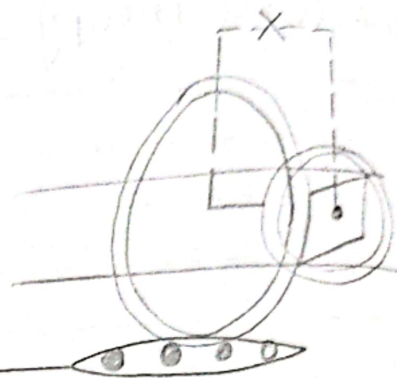
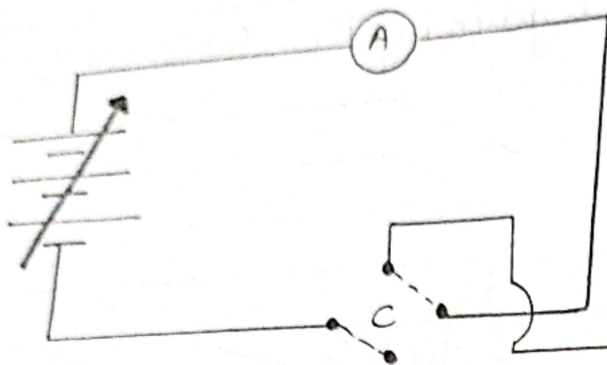
05

05

KSSEM



Diagram:-



Tabular Column

Sl No.	Current (A)	x (m)	Deflection (deg)				Average θ (deg)	B (T)	$B_H = \frac{B}{\tan \theta}$
			θ_1	θ_2	θ_3	θ_4			
1	0.1	0	45	44	46	46	45.25	3.524×10^{-5}	3.49×10^{-5}
2		0.05	30	30	40	40	35	2.33×10^{-5}	3.33×10^{-5}
3		0.1	15	14	20	20	17.25	1.03×10^{-5}	3.33×10^{-5}
4	0.2	0	64	63	60	59	61.5	7.048×10^{-5}	3.826×10^{-5}
5		0.05	48	50	49	48	48.75	4.674×10^{-5}	4.098×10^{-5}
6		0.1	35	34	30	32.5	32.5	2.07×10^{-5}	3.249×10^{-5}

aim: To determine the magnetic field intensity along the axis of a circular coil carrying current and earth's horizontal magnetic field by deflection method.

Apparatus: Deflection magnetometer, spirit level, commutator, ammeter, variable power supply and connecting wires

Principle:

For a circular coil of n turns, carrying current I , the magnetic field at a distance x from the coil and along the axis of the coil is given by

$$B = \frac{\mu_0 n I R^2}{2 (R^2 + x^2)^{3/2}}$$

In this experiment, the coil is oriented such that the plane of the coil is vertical and parallel to the north-south direction. The axis of the coil is parallel to east-west direction. The ~~net~~ field at any point x along the axis is the vector sum of the fields due to the coil $B(x)$ and earth's magnetic field B_H .

Formula:

$$B = \frac{\mu_0 n I R^2}{2 (R^2 + x^2)^{3/2}} \text{ in Tesla}$$

where, B - the ~~magnetic~~ field intensity at the centre of a circular coil (T)

n - Number of turns in the TG coil

R - Radius of the coil (m)

x - Distance between the centre of the coil and pointer in the compass box (m)

μ_0 - Permeability of free space = $4\pi \times 10^{-7} \text{ Hm}^{-1}$

Calculations :-

Trial 1:- $\theta_1 = 45^\circ$ $\theta_2 = 44^\circ$ $\theta_3 = 46^\circ$ $\theta_4 = 46^\circ$ $\theta = 45.25^\circ$ $x = 0m$

$$B = \frac{\mu_0 n I}{2} \cdot \frac{R^2}{(R^2 + x^2)^{3/2}} = \frac{4\pi \times 10^{-7} \times 50 \times 0.1}{2} \times \frac{(8.91 \times 10^{-2})^2}{(8.91 \times 10^{-2})^2} = 3.524 \times 10^{-5} T$$

$$B_H = \frac{B}{\tan \theta} = \frac{3.524 \times 10^{-5}}{\tan(45.25)} = 3.49 \times 10^{-5} T$$

Trial 2:-

$\theta_1 = 30^\circ$ $\theta_2 = 30^\circ$ $\theta_3 = 40^\circ$ $\theta = 35^\circ$ $\theta = 35^\circ$ $x = 0.05m$

$$B = \frac{4\pi \times 10^{-7} \times 50 \times 0.1}{2} \times \frac{(8.91 \times 10^{-2})^2}{((8.91 \times 10^{-2})^2 + (0.05)^2)^{3/2}} = 2.33 \times 10^{-5} T$$

$$B_H = \frac{2.33 \times 10^{-5}}{\tan(35)} = 3.33 \times 10^{-5} T$$

Trial 3:-

$\theta_1 = 64^\circ$ $\theta_2 = 63^\circ$ $\theta_3 = 60^\circ$ $\theta_4 = 59^\circ$ $\theta = 61.5^\circ$ $\theta = 17.25^\circ$
 15° 14° 20° 20° $x = 0.1m$

$$B = \frac{4\pi \times 10^{-7} \times 50 \times 0.1}{2} \times \frac{(8.91 \times 10^{-2})^2}{((8.91 \times 10^{-2})^2 + (0.1)^2)^{3/2}} = 1.03 \times 10^{-5} T$$

$$B_H = \frac{1.03 \times 10^{-5}}{\tan(17.25)} = 3.33 \times 10^{-5} T$$

Trial 4:-

$\theta_1 = 64^\circ$ $\theta_2 = 63^\circ$ $\theta_3 = 60^\circ$ $\theta_4 = 59^\circ$ $\theta = 61.5^\circ$ $x = 0m$ $I = 0.2A$

$$B = \frac{4\pi \times 10^{-7} \times 50 \times 0.1}{2} \times \frac{(8.91 \times 10^{-2})^2}{((8.91 \times 10^{-2})^2 + 0)^{3/2}}$$

$$B_H = 3.826 \times 10^{-5} T$$

Trial 5:-

$\theta_1 = 48^\circ$ $\theta_2 = 50^\circ$ $\theta_3 = 49^\circ$ $\theta_4 = 48^\circ$ $\theta = 48.75^\circ$

$x = 0.05m$ $I = 0.2A$

I - the current through the coil (A)

$$B_H = \frac{B}{\tan \theta}$$

where B - the magnetic field intensity at the centre of a circular coil (T)

B_H - horizontal component of earth's magnetic field (T)

θ - Mean deflection in TG (degree)

Procedure:-

1. The connections are made as shown in the circuit diagram
2. Arrange the deflection of the magnetometer in the magnetic meridian of the earth.
3. Now align the plane of the coil with respect to 90° - 90° line of the magnetometer.
4. Keep the magnetometer exactly at the centre of the coil (for this case $x=0$)
5. Pass a current I (say $0.5 A$) to flow through the coil and the corresponding magnetometer deflections θ_1 and θ_2 are noted
6. The direction of the current is reversed by using the commutator C and the corresponding magnetometer deflections θ_3 and θ_4 are noted
7. Average deflection θ is calculated
8. Calculate the magnetic field B at the centre of the coil by using the given formula.
9. Repeat the experiment for different values of x by sliding the magnetometer along the axis.
10. Find the average of both B and B_H

Calculations:-

$$B = \frac{4\pi \times 10^{-7} \times 50 \times 0.1}{2} \times \frac{(8.91 \times 10^{-2})^2}{((8.91 \times 10^{-2})^2 + (0.05)^2)^{3/2}} = 4.674 \times 10^{-5} \text{ T}$$

$$B_H = \frac{4.674 \times 10^{-5}}{\tan(48.75)} = 4.098 \times 10^{-5} \text{ T}$$

Trial 6:-

$$\theta_1 = 34^\circ \quad \theta_2 = 35^\circ \quad \theta_3 = 31^\circ \quad \theta_4 = 30^\circ \quad \theta = 32.5^\circ \quad \lambda = 0.1 \text{ m}$$

$$B = \frac{4\pi \times 10^{-7} \times 50 \times 0.1}{2} \times \frac{(8.91 \times 10^{-2})^2}{((8.91 \times 10^{-2})^2 + (0.01)^2)^{3/2}} = 2.07 \times 10^{-5} \text{ T}$$

$$B_H = \frac{2.07 \times 10^{-5}}{\tan(32.5)} = 3.249 \times 10^{-5} \text{ T}$$

$$\text{Average of } B = \frac{3.524 \times 10^{-5} + 7.048 \times 10^{-5}}{2} = 5.286 \times 10^{-5} \text{ T}$$

$$\text{Average of } B_H = \frac{3.493 \times 10^{-5} + 3.828 \times 10^{-5}}{2} = 3.659 \times 10^{-5} \text{ T}$$

Result :-

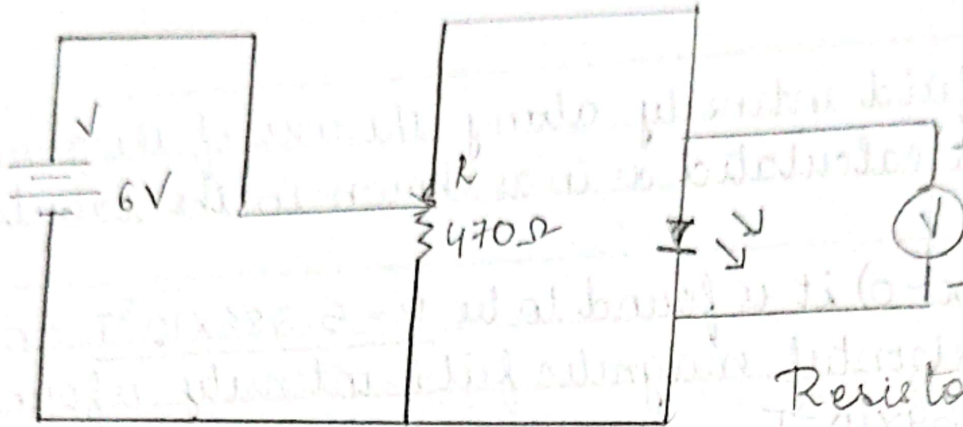
The magnetic field intensity along the axis of the given circular coil is calculated as is shown in the tabular column.

At the centre ($x=0$) it is found to be $B = 5.226 \times 10^{-5} \text{ T}$ and the Earth's horizontal magnetic field intensity is found to be $B_H = 3.659 \times 10^{-5} \text{ T}$

30/10/23

05
05

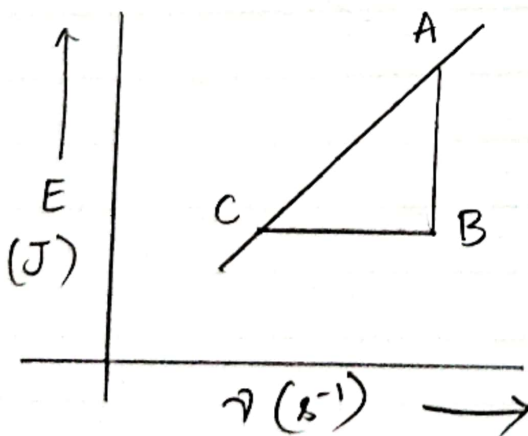
Circuit Diagram:-



Resistor = R
Voltmeter = V

Sl no	LED	Wavelength λ (nm)	Turn-on Voltage V_0 (V)	Energy of Photon $E = eV_0$ (J)	frequency $\gamma = c/\lambda$ s ⁻¹
1	Blue	440	2.37	3.792×10^{-19}	6.818×10^{14}
2	Green	570	1.80	2.88×10^{-19}	5.263×10^{14}
3	Yellow	600	1.71	2.736×10^{-19}	5×10^{14}
4	Orange	620	1.62	2.592×10^{-19}	4.838×10^{14}
5	Red	640	1.59	2.544×10^{-19}	4.687×10^{14}

Expected Graph:-



aim:-

To determine the value of Plank's constant using Light Emitting Diode (LED)

Apparatus:- LED (Red, orange, Yellow, Green, Blue), Battery eliminator 6V, potentiometer, voltmeter

Principle:-

Plank's law states that "a law that is the basis of quantum theory, which states that the energy of electromagnetic radiation is confined to invisible packets (quanta), each of which has an energy equal to the product of the Plank constant the frequency of the radiation".

FORMULA:-

1) The energy E is calculated using the formula

$$E = eV_0 \quad \text{J}$$

where e = charge of electron = $1.6 \times 10^{-19} \text{ C}$,

V_0 = turn on voltage in V

2) The frequency (ν) of the radiation is calculated using the formula,

$$\nu = \frac{c}{\lambda} \quad \text{in s}^{-1}$$

where, c is the velocity of light = $3 \times 10^8 \text{ m s}^{-1}$

λ is wavelength of light in m.

3) Plank's constant is found using the formula,

Calculations:-

Trial 1:-

$$V_0 = 2.37 \text{ V}$$

$$E = eV_0 = 1.6 \times 10^{-19} \times 2.37 = 3.792 \times 10^{-19} \text{ J}$$

$$\gamma = \frac{c}{\lambda} = \frac{3 \times 10^8}{440 \times 10^{-9}} = 6.818 \times 10^{14} \text{ s}^{-1}$$

Trial 2:-

$$V_0 = 1.80 \text{ V}$$

$$E = eV_0 = 1.6 \times 10^{-19} \times 1.80 = 2.88 \times 10^{-19} \text{ J}$$

$$\gamma = \frac{c}{\lambda} = \frac{3 \times 10^8}{570 \times 10^{-9}} = 5.263 \times 10^{14} \text{ s}^{-1}$$

Trial 3:-

$$V_0 = 1.71 \text{ V}$$

$$E = eV_0 = 1.6 \times 10^{-19} \times 1.71 = 2.736 \times 10^{-19} \text{ J}$$

$$\gamma = \frac{c}{\lambda} = \frac{3 \times 10^8}{600 \times 10^{-9}} = 5 \times 10^{14} \text{ s}^{-1}$$

Trial 4:-

$$V_0 = 1.62 \text{ V}$$

$$E = eV_0 = 1.6 \times 10^{-19} \times 1.62 = 2.592 \times 10^{-19} \text{ J}$$

$$\gamma = \frac{c}{\lambda} = \frac{3 \times 10^8}{620 \times 10^{-9}} = 4.838 \times 10^{14} \text{ s}^{-1}$$

Trial 5:-

$$V_0 = 1.59 \text{ V}$$

$$E = eV_0 = 1.6 \times 10^{-19} \times 1.59 = 2.544 \times 10^{-19} \text{ J}$$

$$\gamma = \frac{c}{\lambda} = \frac{3 \times 10^8}{640 \times 10^{-9}} = 4.687 \times 10^{14} \text{ s}^{-1}$$

$$\text{slope} = 6 \times 10^{-34} \text{ Js}$$

$$h = \frac{E}{\nu} \quad \text{J.s}$$

where E is the energy of the photon in J,
 ν is the frequency of radiation in s^{-1}

Procedure:-

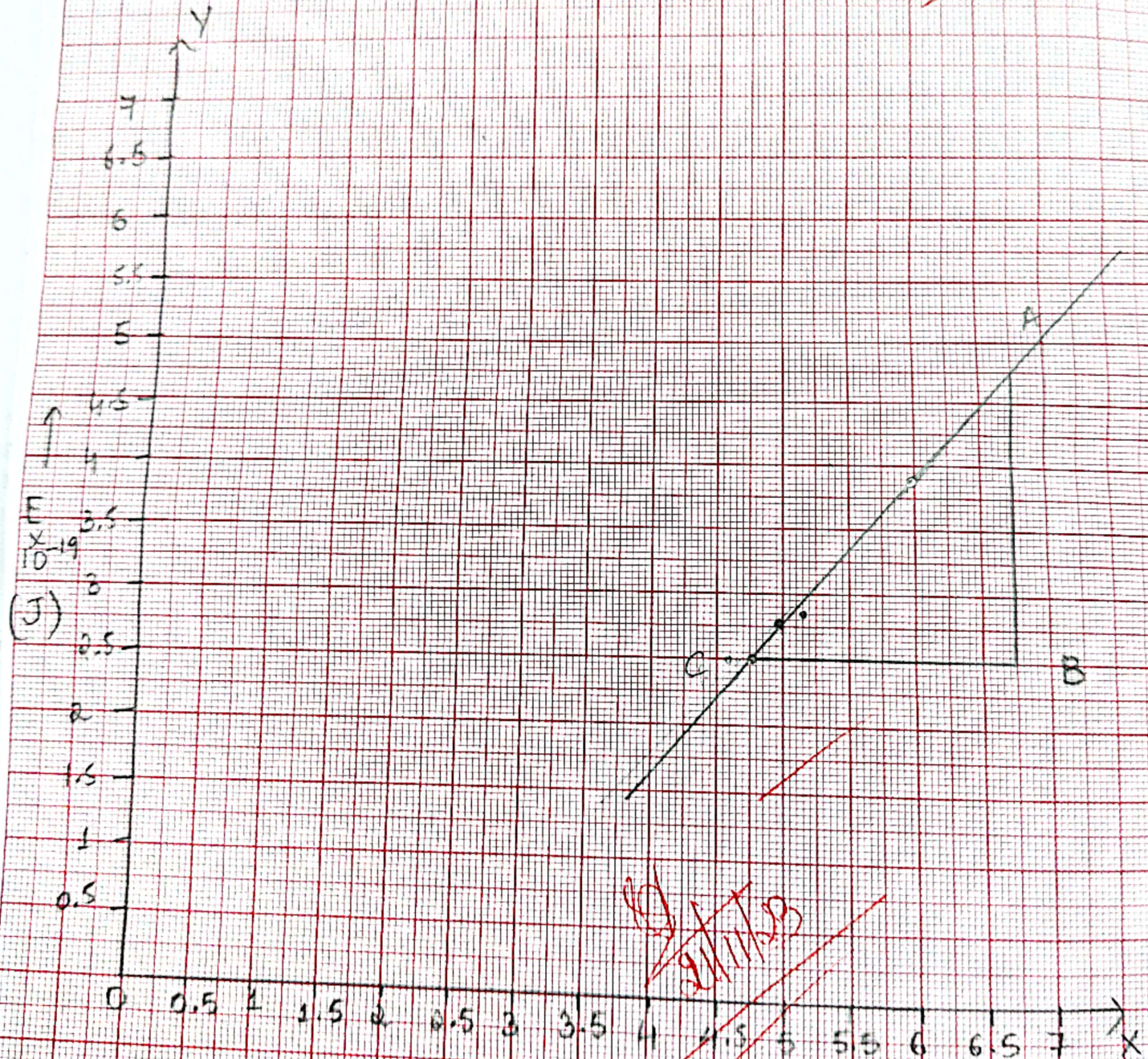
1. The connections are made as shown in figure. The voltmeter is connected across the red LED.
2. The voltage is applied across the diode using the source and is increased by operating the potentiometer until the LED just starts to glow.
3. The turn on voltage (V_0) of the red LED is noted down. The voltage across the diode is reduced to zero.
4. The source and the voltmeter are connected across the orange LED. The turn-on voltage for orange LED is noted. The same is repeated for other LEDs.
5. The energy (E) corresponding to turn on voltage (V_0) and hence the frequency (ν) of the radiation is calculated.
6. A graph of energy (E) versus frequency (ν) is plotted. The slope (S) of straight line obtained which gives the value of Planck's constant.

Application:-

LED's are used in Household appliances, VCR/DVD/stereo/ Audio/ Video devices, Toys/Games Instrumentation, Security Equipment, Switches, as indicator lamps in many devices, street lights and in other architectural lighting where color changing is used.

Scales:-

x axis = 1 unit = $0.5 \times 10^{-14} \text{ s}$
 y axis = 1 unit = $0.5 \times 10^{-19} \text{ J}$



$$\text{slope} = \frac{AB}{BC} = \frac{0.4 \times 0.5 \times 10^{-19}}{1 \times 0.5 \times 10^{-14}} = \frac{1.2 \times 10^{-19}}{2 \times 10^{-14}} = 6 \times 10^{-5} \text{ J} \times 10^{14} (\text{A}^{-1}) \rightarrow$$

Aviation lighting: LEDs are also being used now in airport and heliport lighting. Cameras on mobile phones, where space is at a premium and bulky voltage-raising circuitry is undesirable.

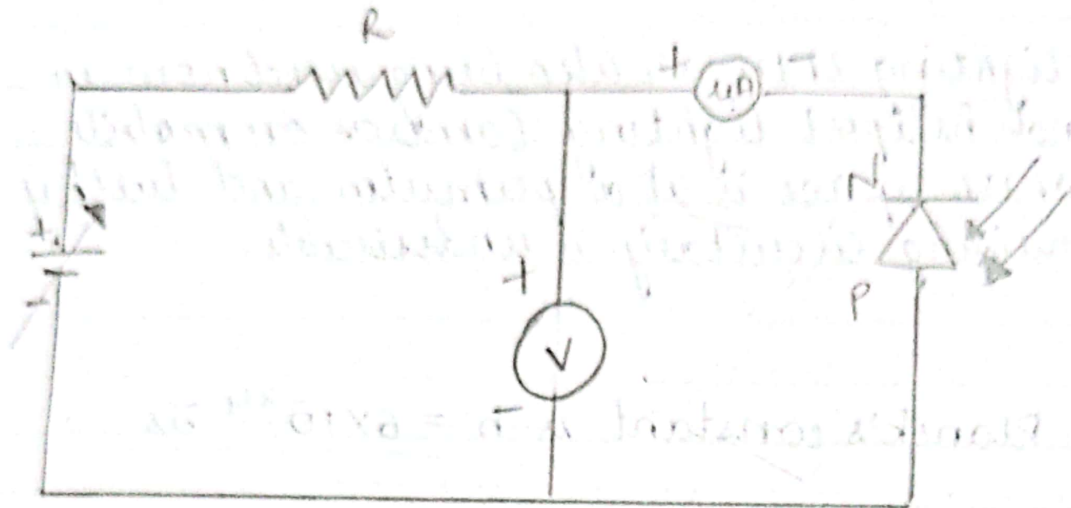
Result:-

The value Planck's constant is $h = 6 \times 10^{-34} \text{ Js}$

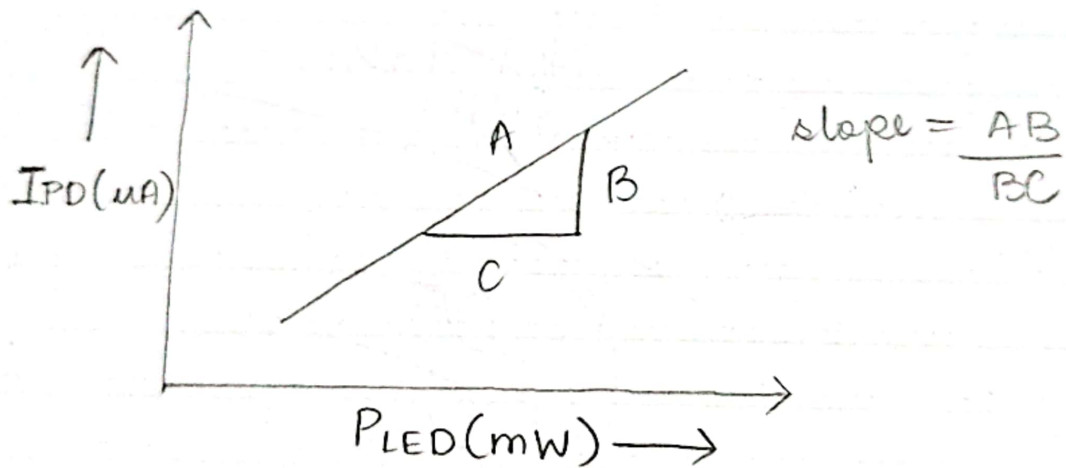
21/11/23

05
05

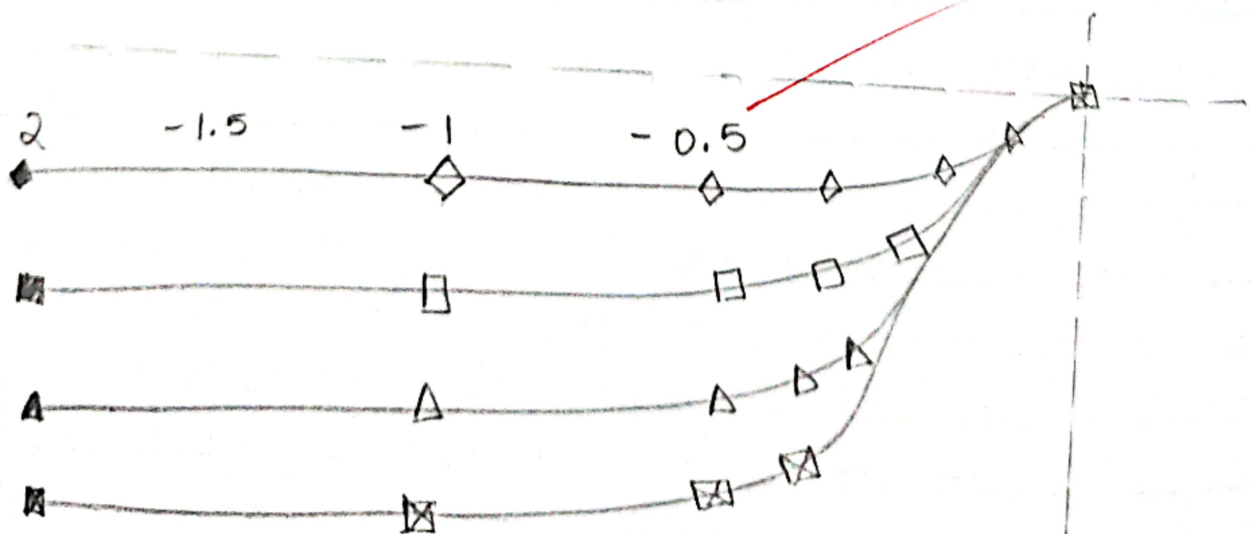
Circuit diagram:-



Expected Graph:-



Variation of photodiode current with LED power



Variation of photodiode voltage with current

Aim:-

To study the I-V characteristics of a photodiode and to determine the responsivity from the variation of photocurrent with the intensity of illumination.

Apparatus:-

Regulated power supply, digital DC current meter, digital DC volt meter, white light LED and photo diode LED type.

Theory:-

A photodiode is a semiconductor device that converts light energy into electrical energy. Radiation sensitive junction is formed in a semiconductor material whose resistivity when illuminated by light. PN junction photodiodes comprise a two-electrode, radiation sensitive junction formed in a semiconductor material, in which the reverse current varies with the amount of illumination. The photo diode behaves as a constant current source when operated with reverse bias. The Photodiodes are optimized to conduct in reverse bias by controlling the level of doping. When there is no light falling on the Photodiode it does not conduct in the reverse bias, hence light is must for conduction in Photodiode.

Formula:- The degree of response of a silicon photodiode to light, is a measure of its sensitivity, and it is

a) Variation of photodiode current with LED power

$P_{LED}(mW)$	$I_{PD}(\mu A)$
10	479
11	499
12	538
13	595
14	637
15	661
16	706
17	768
18	798
19	833
20	855

b) Variation of photodiode voltage with current

$V_{PD}(V)$	$I_{PD}(\mu A)$		
	$P_{LED} = 10 mW$	$P_{LED} = 21 mW$	$P_{LED} = 20 mW$
0	0	0	
0.1	30	26	
0.2	65	89	
0.3	148	177	
0.4	330	391	
0.5	448	709	
1.0	483	901	
2.0	499	942	

defined as the ratio of the photocurrent I_{PD} to the incident light power P_{LED} at a given wavelength λ . Responsivity is given by

$$R_\lambda = \frac{I_{PD}}{P_{LED}} \text{ in A/W}$$

where, I_{PD} is the photodiode current and P_{LED} is the light input power.

Procedure :-

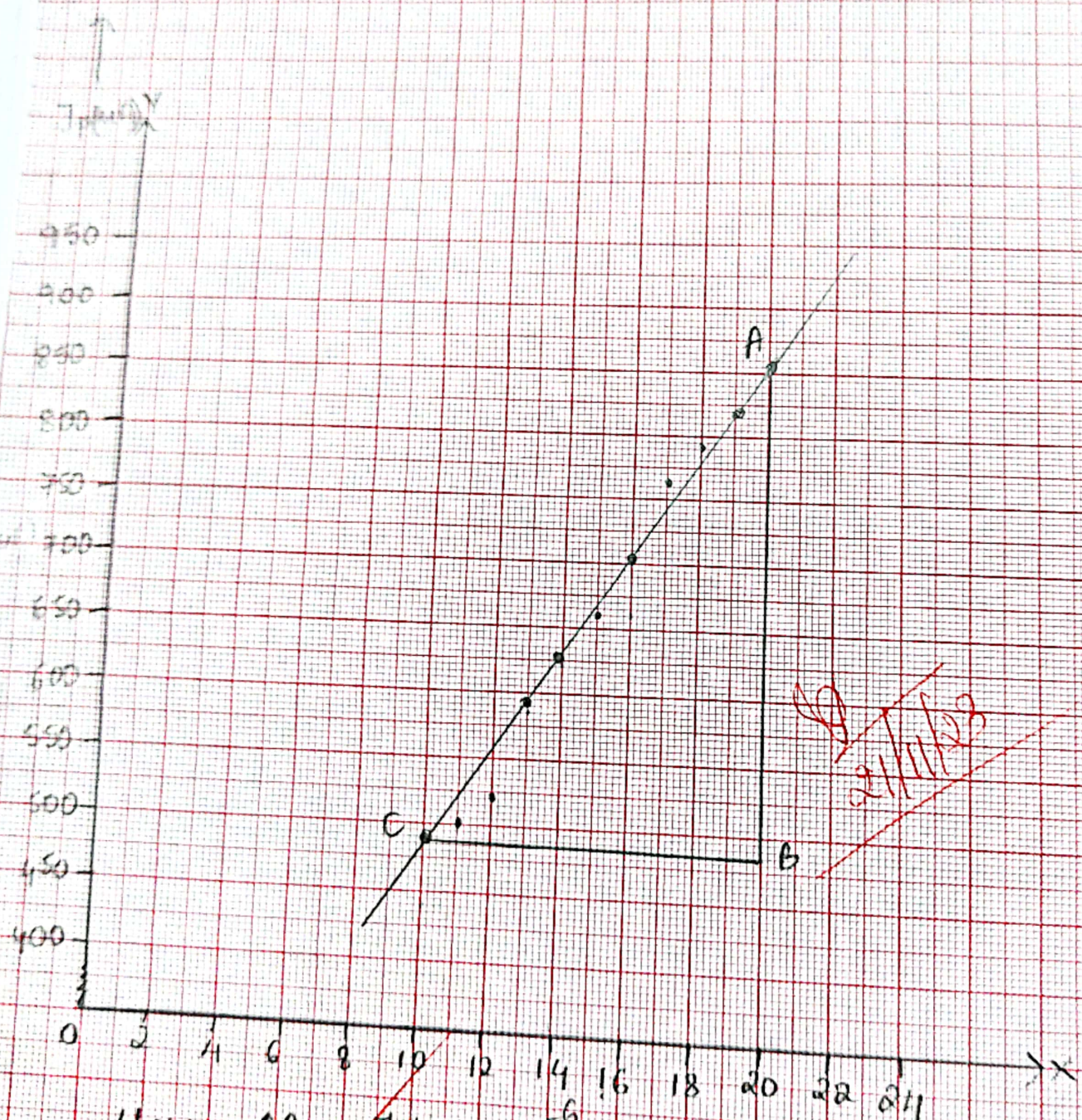
A. Determination of Responsivity :-

The LED (white light) and PD are placed face to face as shown in the figure and the light arrangement is switched on. LED power is set to 10mW by turning the knob to its minimum position. While noting the photodiode current in the meter, the cover is placed so that any external light will not affect the readings. Photodiode is reverse biased by connecting the power supply and negative terminal of the diode to the positive terminal of power supply.

The LED power is increased in steps of 1mW upto 20mW. In each case V_{PD} is set to -1V and I_{PD} is noted in the Table.

A graph showing the variation of P_{LED} on X-axis and I_{PD} on Y-axis is drawn as shown in Figure - 1.2. A straight line graph is obtained and the slope gives the value of responsivity.

Scale:-
 x axis = 1 unit = 2 mW
 y axis = 1 unit = 50 μ A



$$\text{slope} = \frac{AB}{BC} = \frac{7.4 \times 50 \times 10^{-6}}{5 \times 2 \times 10^3} = 0.037 \text{ A/W, PLEO (mW)} \rightarrow$$

B I-V Characteristics of PD:-

1. The LED power is set to 10mW on the dial and V_{PD} is set to -0.1V and the $P. I_{PD}$ is noted
2. Trial is repeated by increasing V_{PD} in suitable steps up to a maximum of 2V. The corresponding I_{PD} is noted in the Table.
3. Experiment is repeated by increasing LED power to 10, 21 and 30mW. In each case variation in V_{PD} and corresponding I_{PD} are noted in Table.
4. A graph is drawn taking V_{PD} along Y axis. The equal spacing between characteristic curves indicates linearity of photo current with light intensity.

Applications

Photodiodes have wide range of applications. Photodiode are used in camera for auto focus and photographic flash control, in medical field as blood particle analyzer, in safety equipment as smoke detector and flame monitors, in automotive industry as sunlight detector, in optical fiber communication system and in industries like bar code scanners, position sensors, light pens etc

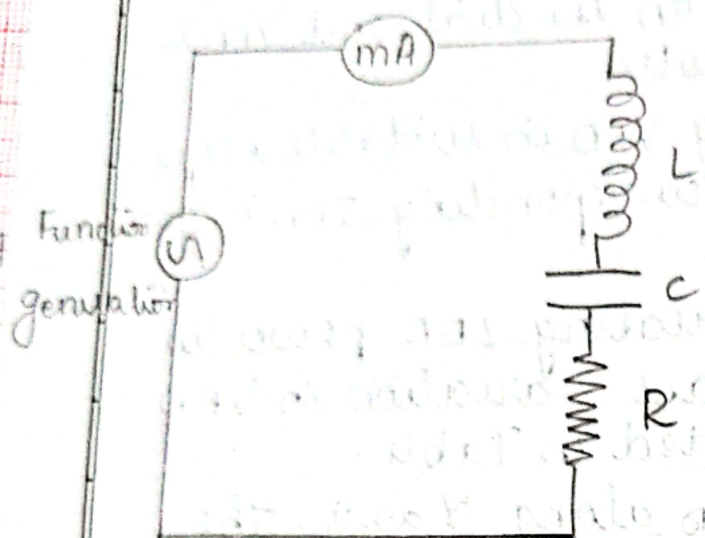
Results:-

1. The responsivity of the photodiode = 0.037 A/W
2. I-V characteristics are drawn from the photo diode and the linearity of photocurrent with light intensity is observed

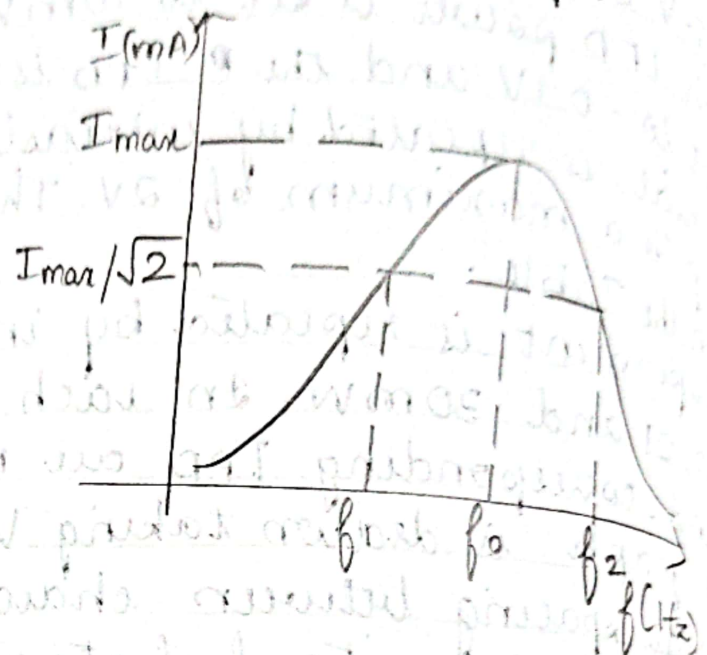
Observation:-

Circuit diagram:-

Series Resonance Circuit

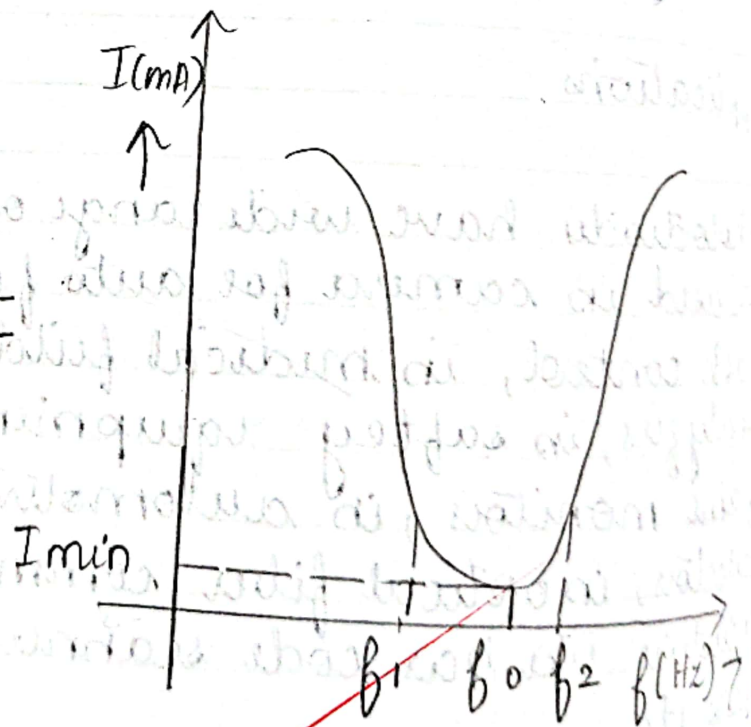
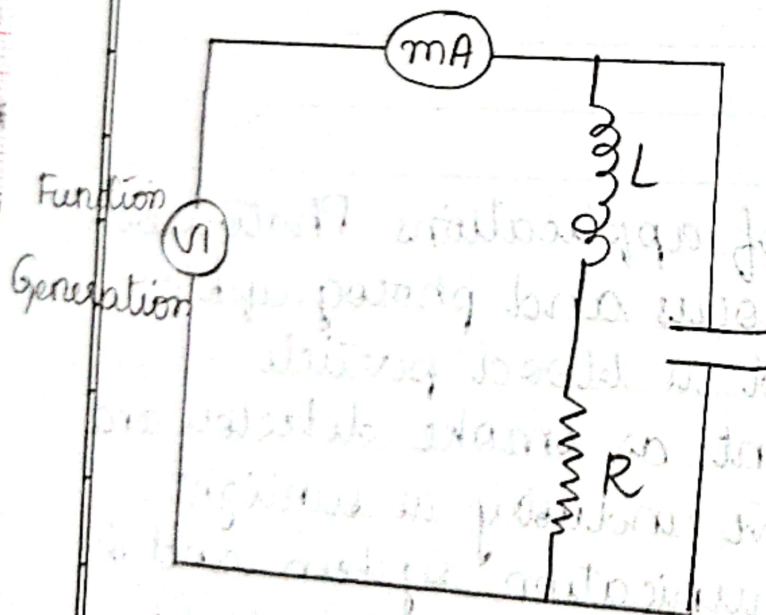


Expected Graph



Parallel Resonance Circuit

Expected Graph



Aim:-

To study the series and parallel LCR resonance and hence to calculate the self-inductance value of the given inductor L , Bandwidth BW and Quality factor Q using series LCR Resonance.

Apparatus:-

Resistor, inductor, capacitor, function generator and AC milli ammeter.

Principle:-

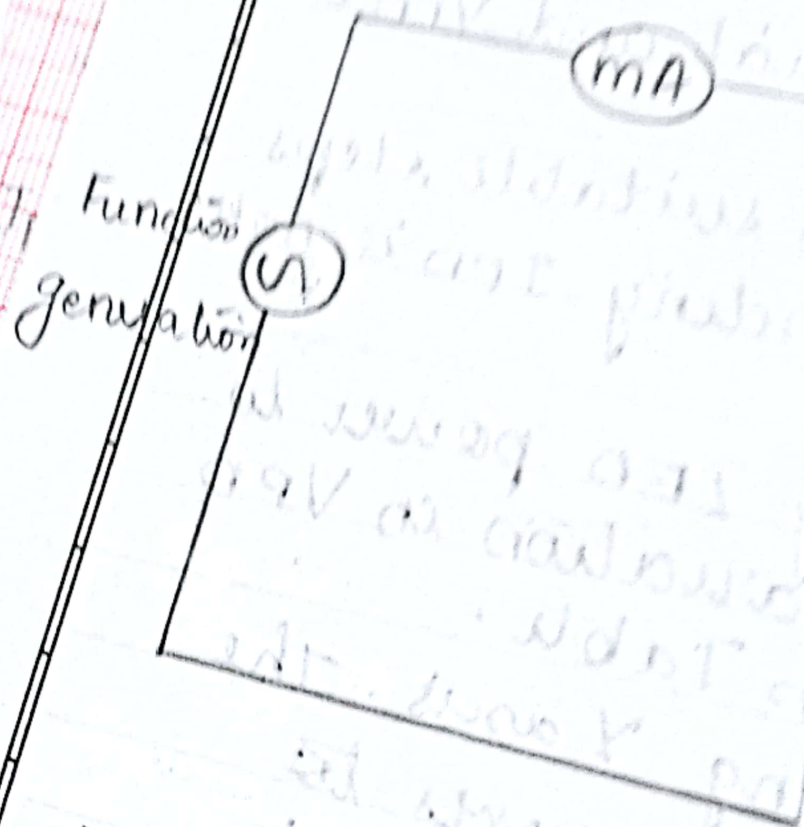
In a series resonance circuit, the current depends on the frequency of the input voltage. With the increase in frequency, the inductive reactance (X_L) increases and capacitive reactance (X_C) decreases. At resonance ($X_L = X_C$), the output voltage and current are in phase and have maximum value. Knowing the capacitance and the resonant frequency, the inductance, bandwidth and quality factor are calculated. But in a parallel resonant circuit, at resonance with resistance in the inductance arm, the current in the inductance arm is equal to the current in the capacitance arm ($I_L = I_C$). The impedance is maximum and hence the current is minimum. The output voltage and current are ~~out of phase~~.

Formula:-

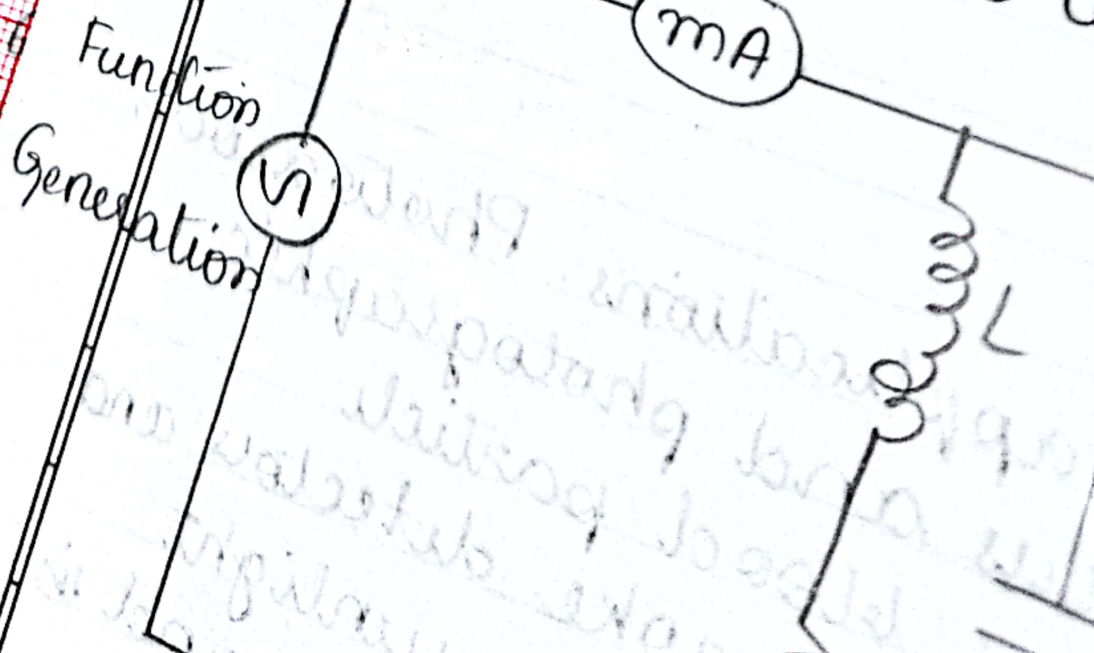
1) The self Inductance of inductor is found using the formula

$$L = \frac{1}{4\pi^2 f_0^2 C}$$

Observation:-
Circuit diagram
Series Resonance



Parallel Resonance



Tabular Column:-
Capacitance of the given capacitor = $47 \times 10^{-9} \text{ F}$

Frequency (Hz)	Series Current (mA)	Parallel Current (mA)
1000	1.03	2.76
1200	1.20	2.07
1400	1.68	1.51
1600	2.60	1.06
1800	4.28	0.63
2000	9.66	0.32
2200	14.40	0.03
2400	6.64	0.17
2600	3.81	0.37
2800	2.90	0.63
3000	2.15	0.76
3200	1.88	1.05
3400	1.53	1.27
3600	1.37	1.46
3800	1.23	1.63
4000	1.05	1.84

Calculations:-

Series circuit:-

$$L = \frac{1}{4\pi^2 f_0^2 C}$$

$$H = \frac{1}{4 \times 3.14^2 \times (2200)^2 \times (47 \times 10^{-9})} = 0.1114 \text{ H}$$

Band width:-

$$\Delta f = f_2 - f_1$$

$$f_2 = 2360 \quad f_1 = 2020 \quad \Delta f = 340$$

where, f_0 is the resonant frequency (Hz)
 C is the value of capacitance (F)

- 2) The Band Width is found using the formula,
$$\Delta f = (f_2 - f_1) \text{ Hz}$$

where, f_1 is the lower cut off frequency (Hz)
 f_2 is the upper cut off frequency (Hz)

- 3) The Quality factor is found using the formula,
$$Q = f_0 / (f_2 - f_1)$$

where, f_0 is the resonant frequency (Hz)

Procedure:-

Series Circuit

1. The circuit connections are made as shown in the figure.
2. The frequency is increased from 1000 to 4000 Hz in steps of 200 Hz and corresponding values of current are recorded.
3. A graph of ~~current~~ versus frequency is plotted. The curve obtained is as shown in figure.
4. The resonant frequency, bandwidth, quality factor are determined with the help of the graph.
5. Using resonant frequency and capacitance value, calculate inductance of the given inductor.

Parallel Circuit

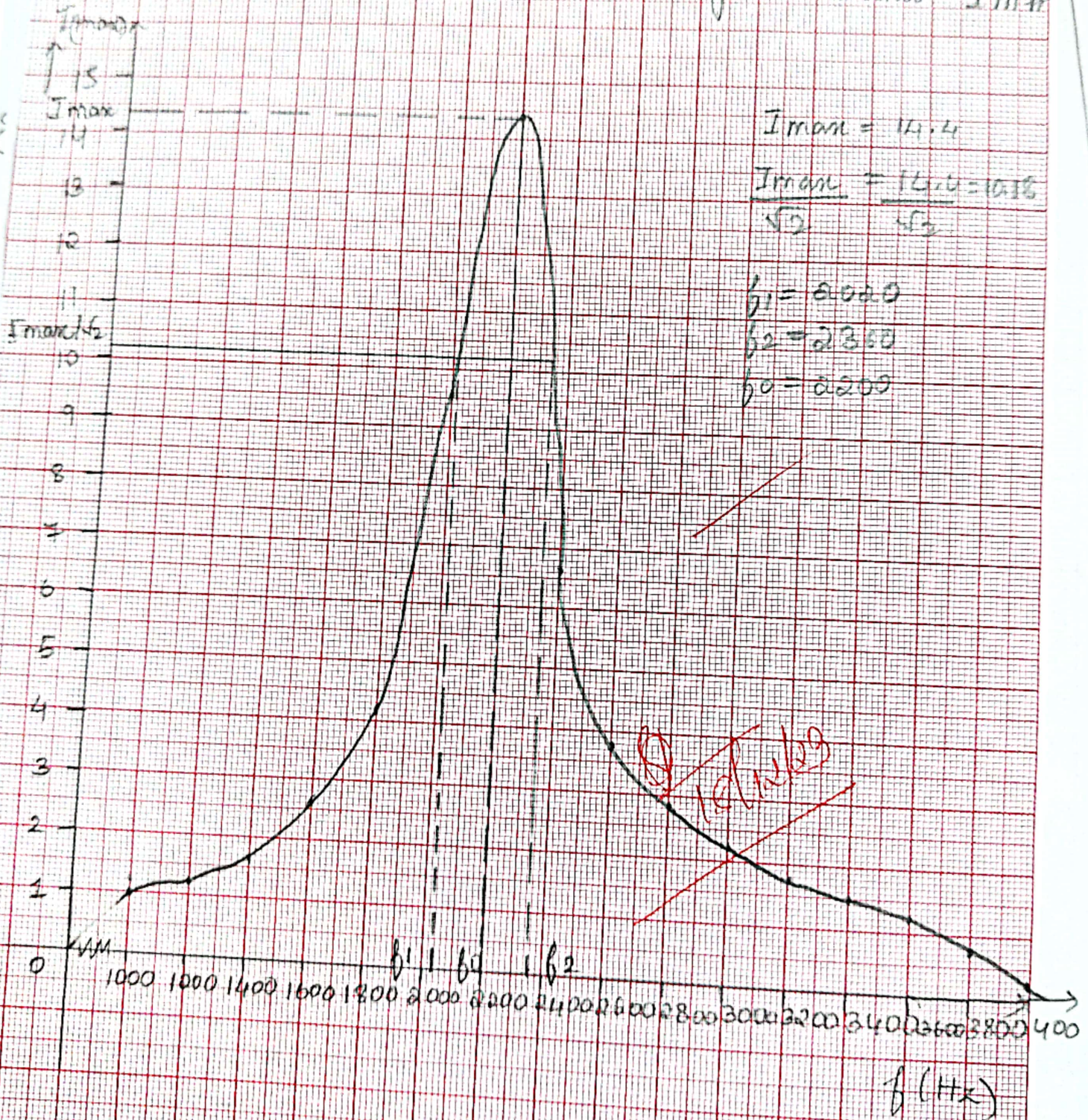
Quality factor:-

$$Q = \frac{f_0}{f_2 - f_1}$$

scale

x axis: 1 unit = 200 Hz

y axis: 1 unit = 1 mA



6. The circuit connections are made as shown in the figure.
7. The experiment is repeated as in the case of series.
8. A graph of current versus frequency is plotted. The curve obtained is as shown in the figure.
9. The resonant frequency is determined with the help of the graph.
10. Using resonant frequency and capacitance value, calculate inductance of the given inductor.

Application:-

They are used in many different types of oscillator circuits. Another important application is for tuning, such as in radio receivers or television sets, where they are used to select a narrow range of frequencies from the ambient radio waves.

One use for resonance is to establish a condition of stable frequency in circuits designed to produce AC signals.

RESULT:-

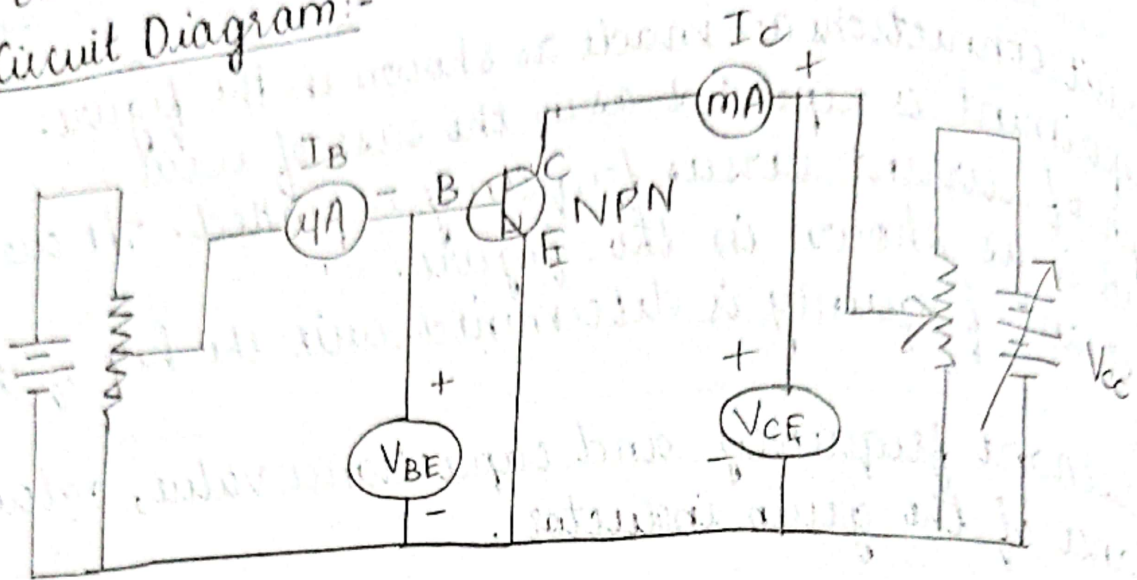
Series LCR

- a) Resonant frequency, $f_0 = 2200$ Hz
- b) Self-inductance of the inductor, $L = 0.1114$ H
- c) Band-width, $\Delta f = 340$ Hz
- d) Quality factor, $Q = 6.470$

Parallel LCR:-

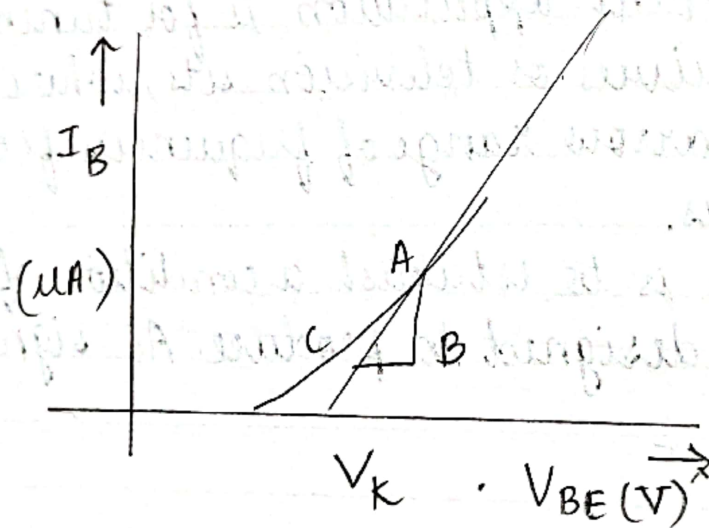
- a) Resonant frequency, $f_0 = 2400$ Hz
- b) Self-inductance of the inductor, $L = 0.0936$ H

Observation:-
Circuit Diagram:-

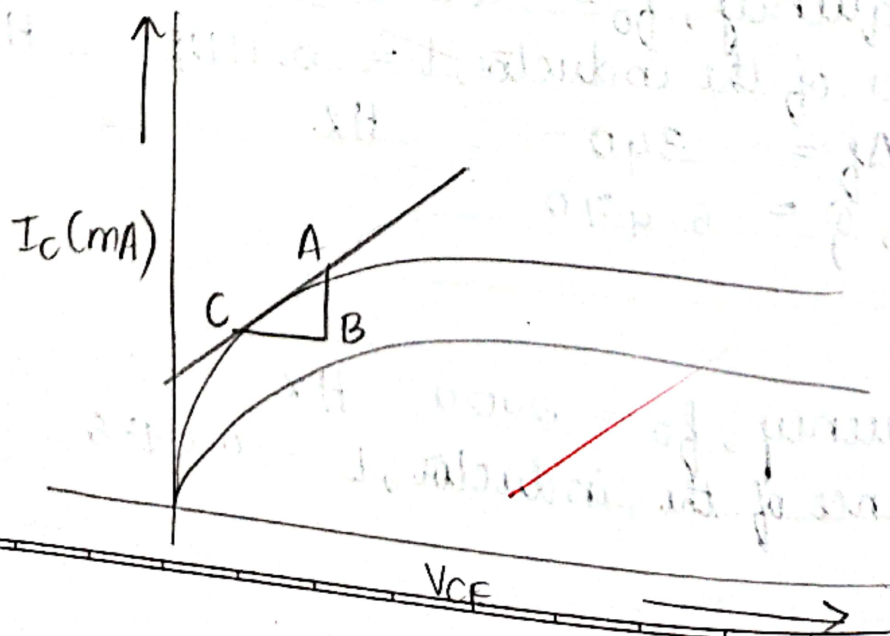


Expected Graph:-

Input characteristics:-



Output Characteristics:-



aim:-

To study the input and output characteristics of the given transistor in C-E mode and to find Input resistance, Output resistance and Amplification factor.

Apparatus:-

Transistor, DC Regulated power supply, DC micro ammeter, DC milli ammeter, DC Voltmeter.

Formula:-

- 1) The input resistance R_i is determined using slope

$$\frac{1}{\text{slope}} = R_i = \frac{\Delta V_{BE}}{\Delta I_B} \text{ in } \Omega$$

- 2) The output resistance is determined using slope

$$\frac{1}{\text{slope}} = R_o = \frac{\Delta V_{CE}}{\Delta I_C} \text{ in } \Omega$$

where, V_{BE} = base-emitter voltage in V

V_{CE} = collector emitter voltage in V

I_B = Base current in μA

I_C = Collector current in mA

- 3) The current amplification factor β is determined using the formula

$$\beta = \frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}}$$

where, I_C is collector current in mA, I_B is base current in μA .

Tabular Column:- Input Characteristics

$V_{CE} = 8V$	
$V_{BE} (V)$	$I_B (\mu A)$
0	0
0.1	0
0.2	0
0.3	0
0.4	0
0.5	7
0.55	24
0.6	52
0.65	83
0.7	123

Output Characteristics

$V_{CE} (V)$	$I_{B1} = 50 \mu A$ $I_{C1} (mA)$	$I_{B2} = 75 \mu A$ $I_{C2} (mA)$
0	0	0
0.2	8	13
0.4	9	14
0.6	9	14
0.8	9	14
1	9	14
2	9	14
3	9	14
4	9	14
5	9	14

Calculations:-

$$\beta = \frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}} = \frac{(14 - 9) \times 10^{-3}}{(75 - 50) \times 10^{-6}} = 200$$

$$R_i = \frac{1}{\text{slope}} = \frac{1}{1.85 \times 10^{-4}} = 5405.405 \Omega$$

$$R_o = \frac{1}{\text{slope}} = \frac{1}{2.8 \times 10^{-3}} = 357.142 \Omega$$

Procedure :-

1. The electrical connections are made as shown in the figure.
2. The voltmeter is connected across collector-emitter junction and V_{CE} is adjusted for 2V.
3. The Voltmeter is now connected across emitter-base junction and V_{BE} is plotted. A tangent is drawn to the increasing portion of the curve and the value of x-axis is taken as knee Voltage V_k .
4. A graph of base emitter voltage V_{BE} V/s base current I_B , for constant V_{CE} is plotted. A tangent is drawn to the increasing portion of the curve and that value of x-axis is taken as Knee Voltage V_k .
5. The voltmeter is connected across collector-emitter junction. The base current I_B is adjusted for 50 μA . The collector-emitter voltage V_{CE} is initially varied in steps of 0.1V starting from 0.1V till 0.3V then in steps of 1V till 8V and the corresponding value of collector current I_C are recorded. The experiment is repeated by adjusting I_B for 75 μA .
6. The graph of V_{CE} V/s I_C is plotted for both the value of I_B . Slope is found at the increasing portion of any one curve.

Application:-

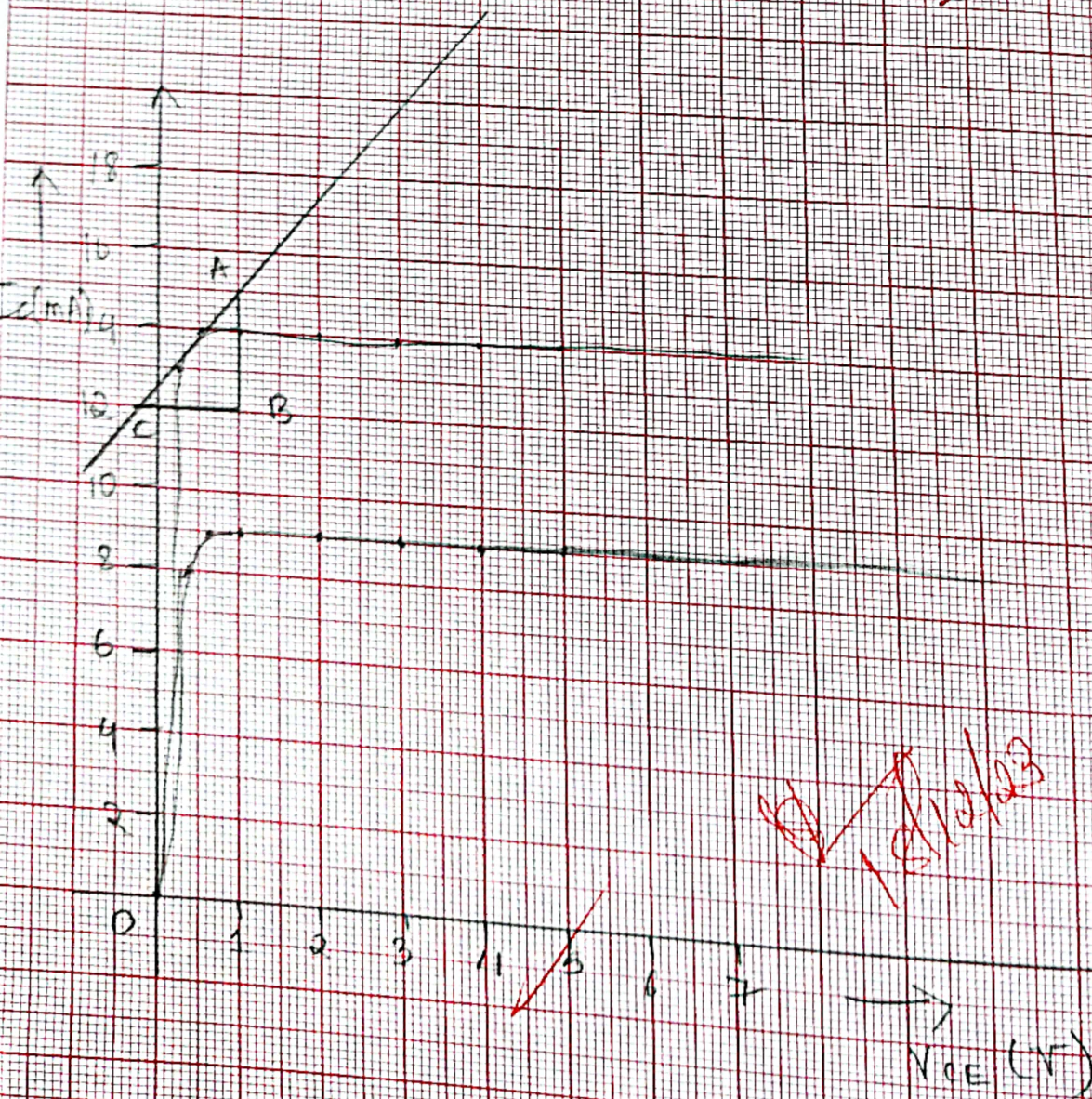
The design of a ~~transistor~~ allows it to function as an amplifier or a switch. From mobile phones to televisions, vast number of products include amplifiers for sound reproduction, radio transmission and signal processing.

Scale:-

x axis - 1 unit = 1V

y axis - 1 unit = 2mA

$$\text{slope} = \frac{AB}{BC} = \frac{1.4 \times 2 \times 10^{-3}}{1 \times 1} = 2.8 \times 10^{-3}$$



Result:-

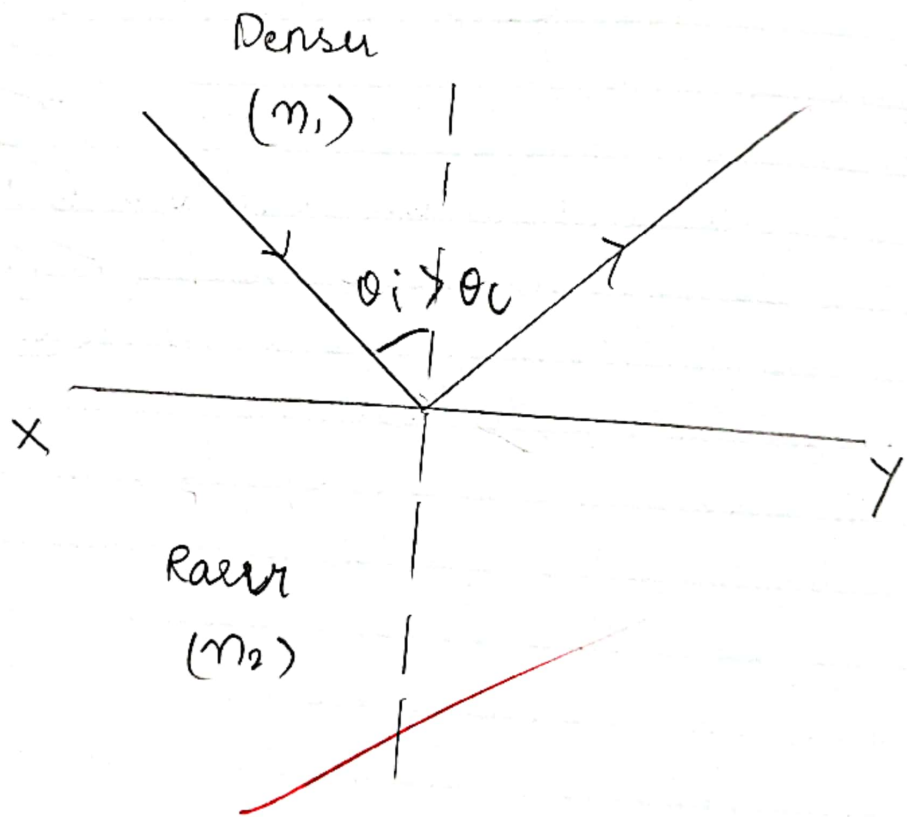
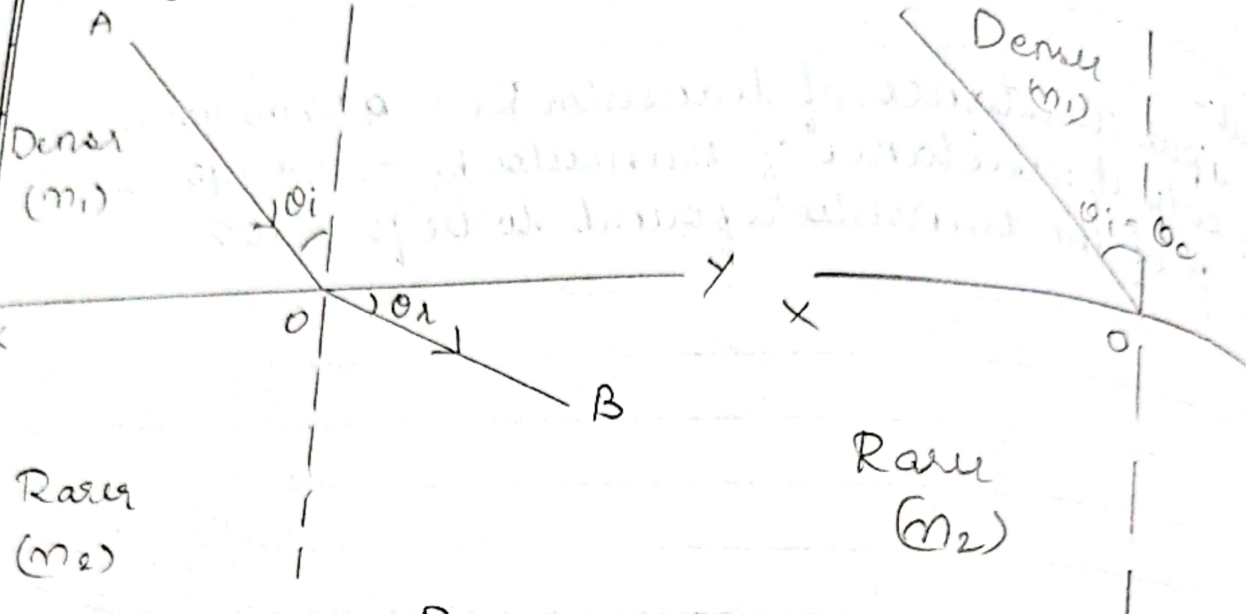
1. The input resistance of transistor $R_i = 954.05405 \Omega$
2. The output resistance of transistor $R_o = 354.112 \Omega$
3. The β of the transistor is found to be $\beta = 200$

~~18/12/23~~

05
05

~~18/12/23~~

Diagram:-



Aim:- To verify critical angle at interface between two medium.

Principle:-

Total internal reflection is a phenomenon of reflection of ray back to the same medium when passing from denser medium to rarer medium in such a way that angle of incidence greater than its critical angle.

Condition for TIR

- 1) The light ray travels from denser to rarer medium.
- 2) The angle of incidence must be greater than the critical angle.

Formula:-

critical angle,

$$\theta_c = \sin^{-1} \left(\frac{n_2}{n_1} \right)$$

where

$n_1 \rightarrow$ R.I of denser medium

$n_2 \rightarrow$ R.I of rarer medium

Conclusion:-

When a ray of light passes from a denser to rarer medium, it is bent away from the normal in the rarer medium.

When the angle of incidence increases, the refracted ray bends more and more away from the normal, at particular angle of incidence, the

Tabular Column:-

Sl No	Angle of incidence θ_i (deg)	Angle of refraction
1	10°	12°
2	15°	15°
3	20°	21°
4	30°	32°
5	45°	50°
6	60°	75°
7	65°	65°
8	70°	70°
9	85°	85°

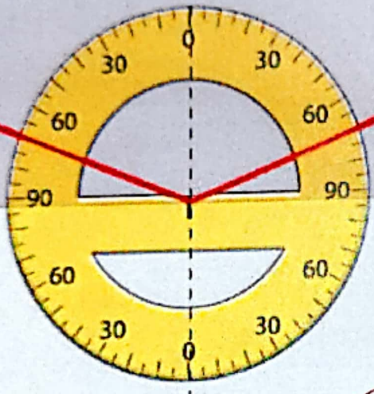
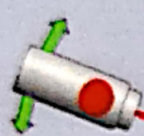
Calculations :-

$$\theta_c = \sin^{-1} \left(\frac{n_2}{n_1} \right)$$

$$n_1 = 1.5 \quad n_2 = 1.33$$

$$\theta_c = \sin^{-1} \left(\frac{1.33}{1.5} \right) = 62.457^\circ$$

☒ Ray
☐ Wave



Material

Index of Refraction (n)

Air Water Glass

Material

Index of Refraction (n)

Air Water Glass

23/12/23

refracted ray grazes along the surface so that angle of refraction becomes 90° . This particular angle of incidence is called critical angle.

As the angle of incidence greater than critical angle, there are no refracted rays at all but the rays are reflected back into the denser medium. This phenomenon is called Total Internal Reflection.

Result:-

The critical angle at interface between two medium as:-

Theoretical value, $\theta_c = 62.457^\circ$

Simulation value, $\theta_c = 65^\circ$

23/12/23

05
05

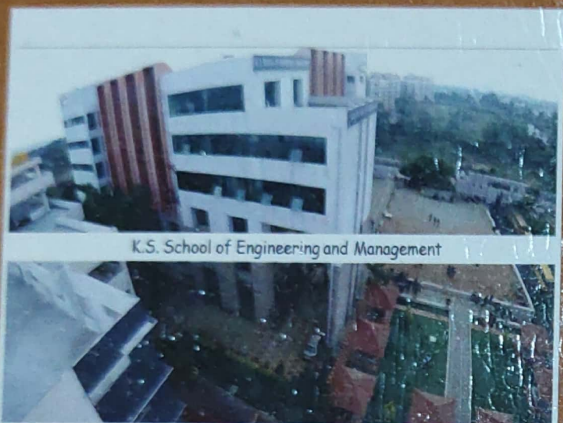


K.S. School of Engineering and Management



VISION STATEMENT

To be recognized as a premier academic institution, imparting quality technical and managerial knowledge and skills to meet the ever-changing social, technological and business needs of the nation, through holistic education and research.



K.S. School of Engineering and Management

- Establish state-of-the-art infrastructure to facilitate effective dissemination of technical and managerial knowledge.

- Provide well-rounded educational experience through a combination of curricular and experiential learning, strengthened by industry interaction.

- Encourage pursuit of research activities and dissemination of knowledge to society.

- Provide avenues for inculcating leadership skills in students, to foster entrepreneurial spirit, for the betterment of the nation.

MISSION



K.S. School of Engineering and Management



K.S. GROUP OF INSTITUTIONS

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT

15, Mallasandra, Near Vajarahalli, Off. Kanakapura Road, Bengaluru - 560 109.

Tel : 080 - 28425012 / 13 / 163, Fax : 080 2842 5164. www.kssem.edu.in

