R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 5/6/25 Name Avishkar Nivas More

Dept./Lab Physics LAB B1 Class CY B1 Expt./No. ~~1~~ 9

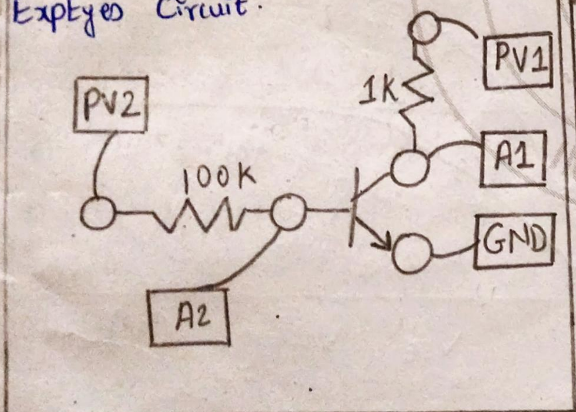
Title Transistor Characteristics

Aim: To plot the I-V characteristics of the NPN transistor and calculate the current gain in common base mode (α) and current gain in common emitter mode (β).

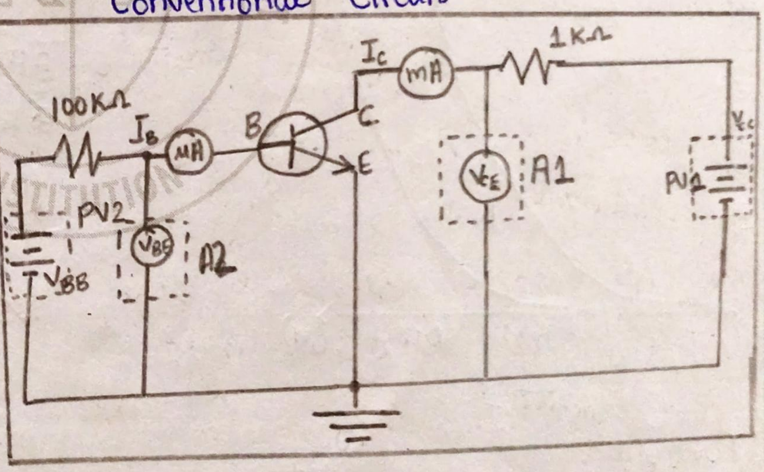
Apparatus: Transistor SL 100, 1k and 100 kΩ resistors, Bread board, Connecting wires, ExpEYES-17 hardware

Circuit Diagrams:

ExpEyes Circuit:



Conventional Circuit:



Particulars	Max Marks	Marks Obtained	Faculty Signature
Data Sheet + Experimental setup + Viva Voce	10	4+6	RJ
Conduction of Experiment	10	10	
Substitution + Calculation + Accuracy	10	10	
Total Marks	30	30	RJ

12/6

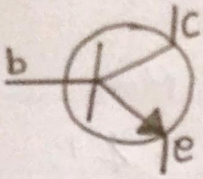
RJ

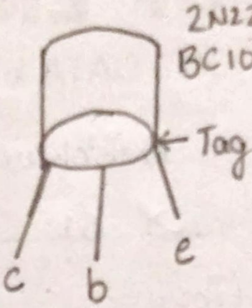
Signature of Teacher Incharge

Vce (V) →

~~Observations~~

Transistor Pin Configuration:

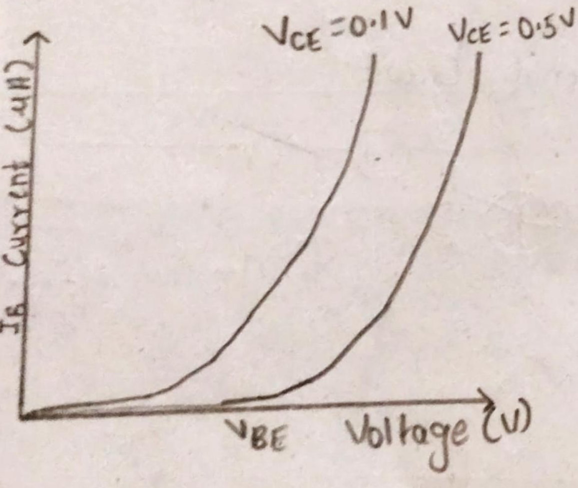




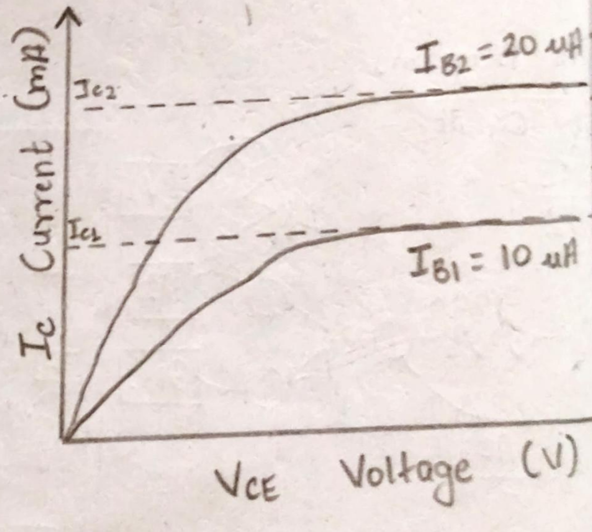
e → emitter
b → base
c → collector

Model Graph:

Input characteristics



Output Characteristics



Formula:

To calculate transistor parameters α and β from output characteristics

$$\beta = \left[\frac{I_{C_2} - I_{C_1}}{I_{B_2} - I_{B_1}}\right]_{V_{CE}} =$$

Using the value of β, $\alpha = \frac{\beta}{\beta+1} =$

where I_{C_1}, I_{C_2} = Collector current in mA
I_{B_1}, I_{B_2} = Base current in uA

I : Current
α : Current gain in CB config
β : Current gain in CE config.

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OBSERVATION / DATA SHEET

ate 5/6/25 Name Avishkar More

ept./Lab Physics LAB B1 Class CY B1 Expt./No. ~~1~~9

itle Transistor Characteristics

abular Column:

put Characteristics:

V_{CE1} = 0.1 V		V_{CE2} = 0.5 V	
BE (V)	I_B (uA)	V_{BE} (V)	I_B (uA)
.0902	0.1054	0.0891	0.1159
.2258	0.2285	0.2253	0.2531
.3616	0.3890	0.3627	0.3781
.4444	0.5605	0.4491	0.5138
.4696	0.8077	0.4841	0.6634
.4831	1.1731	0.5081	0.9222
.4907	1.5962	0.5245	1.2584
.4954	2.0494	0.5354	1.6492
.4992	2.5104	0.5436	2.0667
.5020	2.9825	0.5505	2.4973
.5041	3.4605	0.5539	2.9628
.5069	3.9322	~~0.5577~~	~~3.4442~~
.5076	4.4249	0.5588	5.4117
.5096	4.9051	0.5586	5.9139
.5111	5.3891	0.5599	6.4003
.5124	5.8762	0.5557	3.4442
.5132	6.3676	0.5577	3.9241
		~~0.5576~~ 577	4.9237

Output Characteristics:

I_{B1} = 4.319 uA		I_{B2} = 13.998 uA	
V_{CE} (V)	I_C (mA)	V_{CE} (V)	I_C (mA)
0.007	-0.006	0.007	-0.006
0.047	0.051	0.029	0.070
0.072	0.127	0.044	0.155
0.090	0.209	0.055	0.244
0.106	0.293	0.064	0.336
0.123	0.377	0.071	0.429
0.143	0.456	0.077	0.522
0.175	0.524	0.084	0.616
0.243	0.557	0.089	0.711
0.338	0.562	0.095	0.805
0.541	0.559	0.100	0.900
0.838	0.563	0.105	0.995
1.140	0.561	0.110	1.091
1.237	0.564	0.115	1.185
1.434	0.565	0.120	1.280
1.734	0.566	0.126	1.375
1.933	0.567	0.132	1.468
2.332	0.568	0.139	1.562
2.731	0.569	0.146	1.655

~~Calculations~~: Coloumn :

2.831	0.570
3.230	0.571
3.329	0.572
3.626	0.573
3.725	0.575
4.125	0.574
4.224	0.576
4.322	0.578
4.421	0.579

0.156	1.746
0.166	1.833
0.183	1.915
0.213	1.986
0.280	2.019
0.376	2.023
0.474	2.026
0.574	2.025
0.672	2.027
0.772	2.028
0.871	2.029
~~0.971~~ 1.168	2.032
~~1.071~~ 1.367	2.034
~~1.168~~ 1.666	2.035
1.764	2.037
2.060	2.039
2.359	2.040
2.459	2.041
2.657	2.042
2.757	2.043
2.856	2.044
2.955	2.045

$I_{C_1} = 0.579\,\mu A$ $\quad I_{B_2} = 13.998\,\mu A$

$I_{C_2} = 2.045\,\mu A$

$I_{B_1} = 4.319\,\mu A$

Calculations:

$$\beta = \frac{I_{C_2} - I_{C_1}}{I_{B_2} - I_{B_1}} = \frac{2.045 - 0.579}{13.998 - 4.319} \times 100$$

$$\underline{\beta = 151.46}$$

$$\alpha = \frac{\beta}{\beta + 1} = \frac{151.46}{152.46} = 0.9934$$

$$\underline{\alpha = 0.9934}$$

$\frac{4}{4}$ 6.

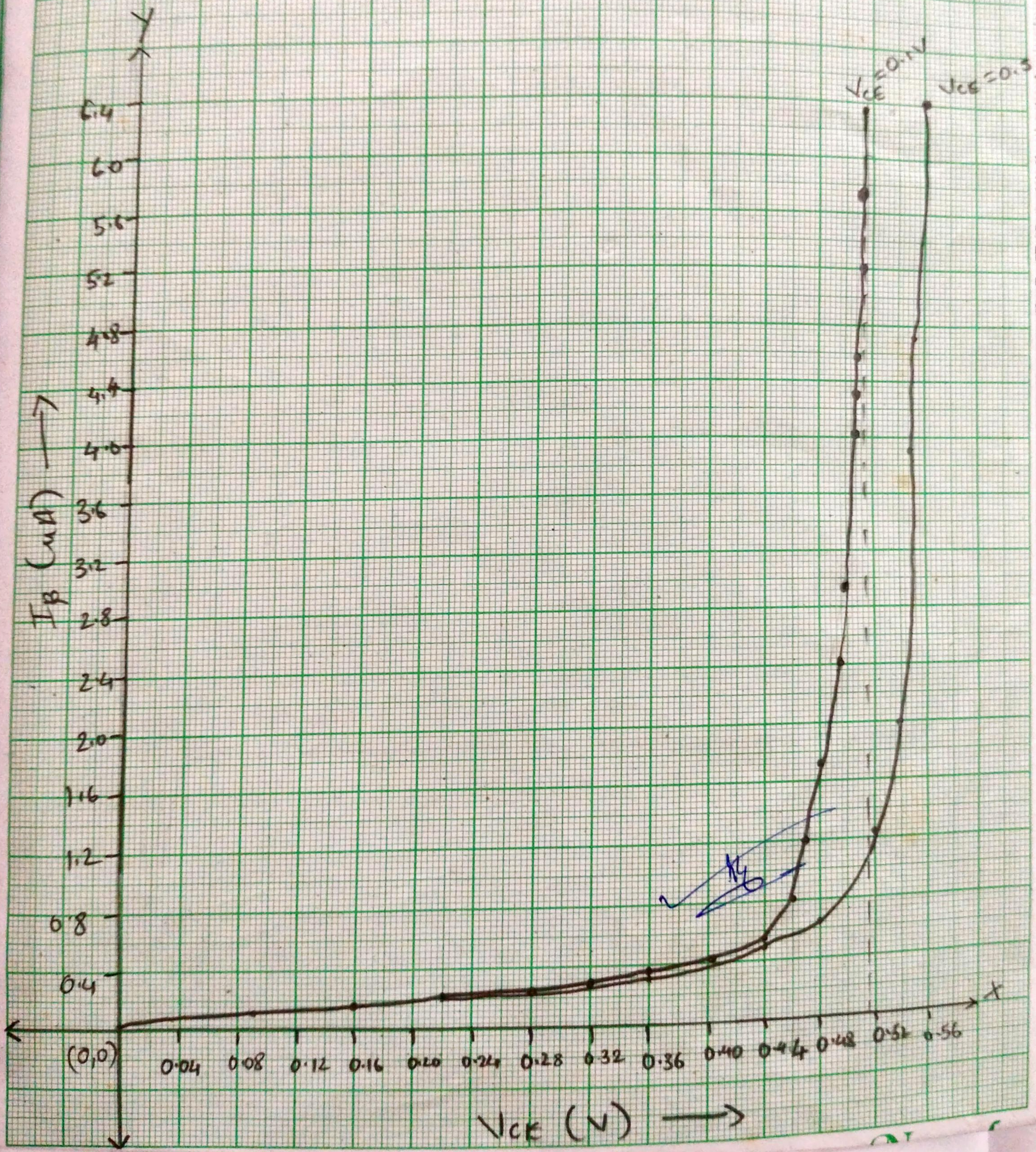
Result: Current Gain in Common Base configuration, $\alpha =$ 0

Current Gain in Common Emitter configuration, β

CY Avishkar More
007 81

Transistor
Input Characteristics

Scale: Y axis: 1unit = 0.4
X axis: 1unit = 0.04

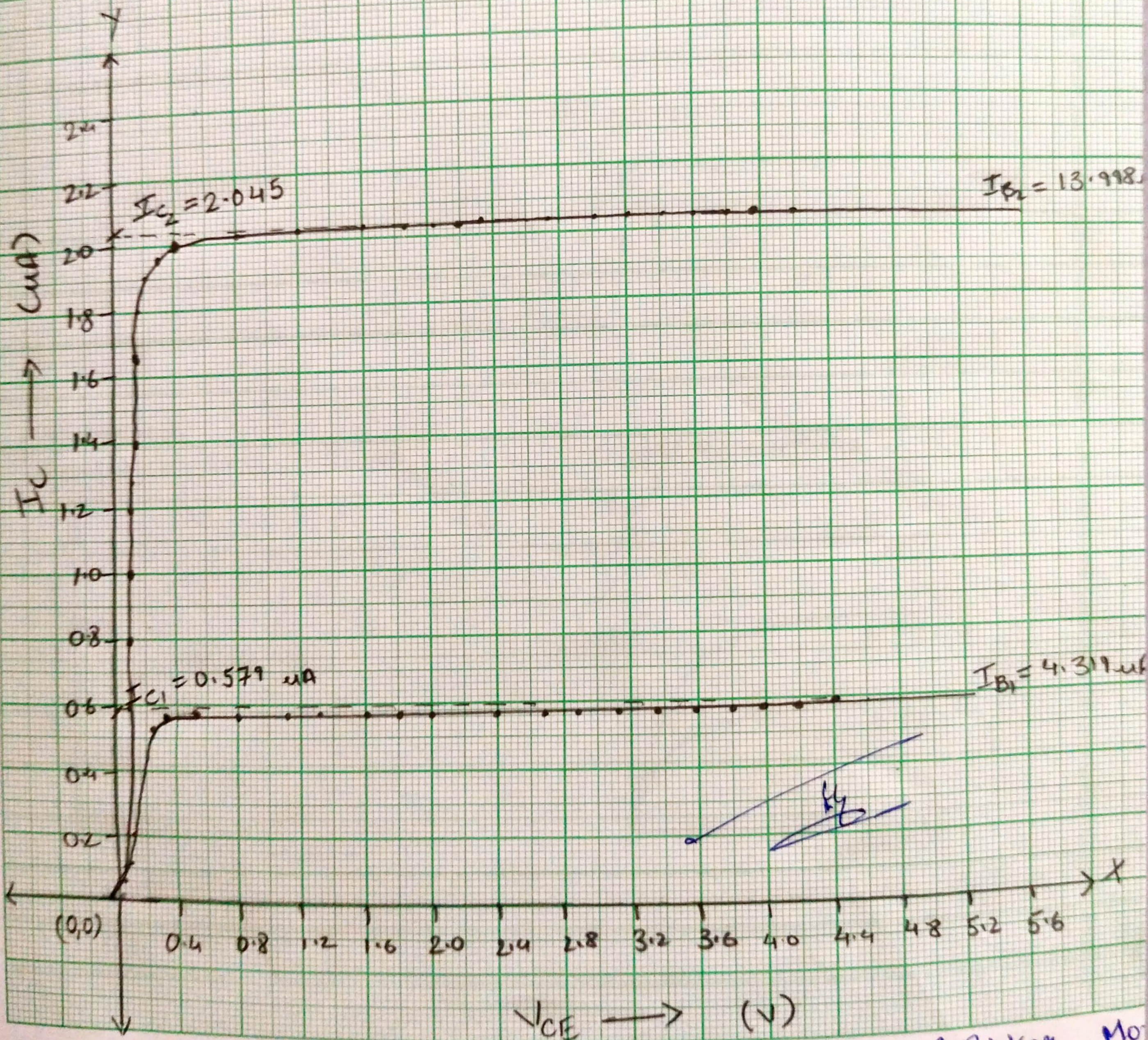


Scale: Y axis = 1 unit = 0.2

X axis = 1 unit = 0.4

Transistor

Output Characteristics



TRANSISTOR CHARACTERISTICS

Experiment No: 9 Date: 5/6/25

Aim: To plot the I-V characteristics of the NPN transistor and calculate the current gain in common base mode (α) and current gain in common emitter mode (β).

Apparatus: Transistor SL100, 1K and 100 K Ω resistors, Bread board, Connecting wires, ExpEYES-17 hardware.

Principle: A transistor is a semiconductor device composed of three layers of semiconductor material, arranged in either an NPN or PNP configuration. It features three terminals: the emitter, base, and collector, along with two junctions, the base-emitter junction and the collector-base junction. Transistors can operate in three configurations: Common Base (CB), Common Emitter (CE), and Common Collector (CC).

Among the configurations, the Common Emitter (CE) setup is the most widely used due to its high current gain. When an NPN transistor is used as an amplifier, its operation is based on controlling the current flow from the collector to the emitter by adjusting the base current. A small input current at the base terminal regulates a significantly larger current at the collector, enabling current amplification.

Common Emitter Configuration:

- In CE mode, the emitter terminal is common to both the input and output circuits.
- The input is applied between the base and the emitter, and the output is measured from the collector and the emitter.
- The input characteristic is a plot of base current (I_B) versus the base-emitter voltage (V_{BE}) at constant collector emitter voltage (V_{CE}). The output characteristic is a plot of collector current (I_C) versus collector-emitter voltage (V_{CE}) at constant base current.

Tabular Column:

Input Characteristics

V_{CE1} = 0.1 V		V_{CE2} = 0.5 V	
V_{BE}(V)	I_B(μA)	V_{BE}(V)	I_B(μA)
0.0902	0.1054	0.0891	0.1159
0.2258	0.2485	0.2253	0.2531
0.3616	0.3890	0.3627	0.3781
0.4444	0.5605	0.4491	0.5138
0.4696	0.8072	0.4841	0.6634
0.4831	1.1731	0.5081	0.922
0.4907	1.5962	0.5245	1.2584
0.4954	2.0494	0.5354	1.6492
0.4992	2.5104	0.5436	2.0667
0.5020	2.9815	0.5506	2.4923
0.5041	3.4605	0.5539	2.9628
0.5069	3.9372	0.5583	5.4112
0.5076	4.4249	0.5586	5.9139
0.5096	~~5.384~~ 4.9051	0.5597	6.4003
0.5111	~~5.853~~ 5.3391	0.5557	3.442
0.5124	5.8762	0.5577	3.9241
0.5132	6.3476	0.5577	4.9237

Output Characteristics

I_{B1} = 4.319 μA		I_{B2} = 13.998 μA	
V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)
0.007	-0.006	0.007	-0.0[illegible]
0.047	0.051	0.029	0.0[illegible]
0.072	0.127	0.044	0.15[illegible]
0.090	0.209	0.055	0.24[illegible]
0.106	0.293	0.064	0.3[illegible]
0.123	0.377	0.071	0.4[illegible]
0.143	0.456	0.077	0.5[illegible]
0.175	0.524	0.084	0.6[illegible]
0.243	0.557	0.089	0.7[illegible]
0.338	0.562	0.095	0.8[illegible]
0.541	0.559	0.100	0.9[illegible]
0.838	0.563	0.105	0.9[illegible]
1.140	0.561	0.110	1.09[illegible]
1.237	0.564	0.115	1.185
1.434	0.565	0.120	1.28[illegible]
1.734	0.566	0.126	1.3[illegible]
1.933	0.567	0.132	1.44[illegible]
2.332	0.568	0.139	1.56[illegible]
2.731	0.569	0.146	1.655
2.831	0.570	0.871	2.029
3.725	0.575	1.764	2.037
4.125	0.574	2.955	2.045
4.421	0.579		

Calculations:

Formula

To calculate transistor parameters α and β from output characteristics

$$\beta = \left[\frac{I_{C_2} - I_{C_1}}{I_{B_2} - I_{B_1}}\right]_{V_{CE}} = \frac{2.045 - 0.579}{13.998 - 4.319} \times 1000 = 151.46$$

Using the value of β, $\alpha = \frac{\beta}{\beta+1} = \frac{151.46}{152.46} = 0.9934$

Where, I_{C1} & I_{C2} are collector current in mA; I_{B1} & I_{B2} are base current in μA

$I_{C_1} = 0.579$ mA $\quad I_{B_1} = 4.319$ μA

$I_{C_2} = 2.045$ mA $\quad I_{B_2} = 13.998$ μA

RESULTS:

The input and output characteristics have been plotted	
Current gain in Common Base configuration α	0.9934
Current gain in Common Emitter configuration β	151.46

30/30

Procedure: Experiment conduction consists of three steps.

Step 1: To find the resistance value of the given resistors:

1. In the ExpEyes hardware, connect one end of resistor to SEN pin and other to ground pin. Interface the ExpEyes hardware with the CPU and click on ExpEyes icon on the monitor.
2. To find out resistance value, go to electronics tab and select oscilloscope (default screen) and note the value of resistance displayed on the screen.

Step 2: Study of Input characteristics

1. Identify the transistor terminals (emitter, base and collector) with respect to notch as shown in transistor pin configuration diagram. (Terminal closer to the notch is a emitter, middle terminal is a base and farthest terminal is a collector)
2. Make the circuit connections using transistor in CE mode as shown in the circuit diagram.
3. On the ExpEyes screen, go to RVCE tab, select NPN Transistor Characteristics experiment.
4. On the graphical user interface (GUI) window of transistor characteristics experiment, enter your **name, branch, section and roll number**
5. The input characteristics of a Common Emitter (CE) transistor configuration describe the relationship between the base current (I_B) and the base-emitter voltage (V_{BE}) by keeping the collector-emitter voltage (V_{CE}) constant. (The graph typically resembles the forward characteristics of a PN junction).
6. For the first trial, enter Vcc value (via 1kΩ) to set V_{CE}. Click on the start button. Record emitter-base voltage (V_{BE}) the corresponding base current (I_B) values in the tabular column. Repeat the same procedure for second trial. Note: Set the V_{CC} value between 0 and 0.5 volts. (eg., 0.1, 0.2, 0.3, 0.4, 0.5)
7. Plot input characteristics graph as I_B (base current) versus V_{BE} (base-emitter voltage) for a fixed value of V_{CE} (for 2 trials).

Step 3: Study of Output Characteristics

1. The output characteristics of a Common Emitter (CE) transistor configuration describe the relationship between the collector current (I_C) and the collector-emitter voltage (V_{CE}) for different values of base current (I_B).
2. For the first trial, enter V_{BE} value (via 100kΩ) to set base current (I_B). Note: Set the V_{BE} value between 1 and 3 volts. (eg., 1, 1.5, 2, 2.5, 3)
3. Click on the start button and record the collector-emitter voltage (V_{CE}) the corresponding collector current (I_C) values in the tabular column **up to three to four saturation values** of collector current (I_C). Note down the base current (I_{B1}) and the saturation collector current (I_{c1}).
4. Repeat the same procedure for second trial with different value of V_{BE}. Note down the base current (I_{B2}) and the saturation collector current (I_{c2}).
5. Plot the output characteristics graph as I_C (collector current) versus V_{CE} (collector-emitter voltage) for different constant values of base current I_B (for 2 trials).
6. Calculate current gain in Common Base configuration (α) and Current gain in Common Emitter configuration (β) using the relevant formulae and tabulate the results.

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OBSERVATION / DATA SHEET

Date: 5/6/25 Name: Avishkar More

Dept./Lab: Physics LAB B1 Class: CY B1 Expt./No.: 2 10

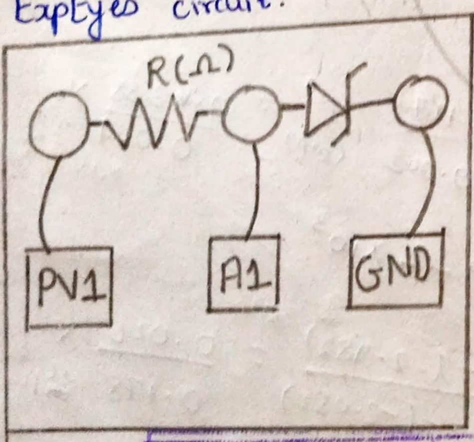
Title: Zener Diode Characteristics

Aim: To study forward and reverse bias characteristics of a zener diode and to determine the forward and reverse bias dynamic resistances, knee voltage and zener breakdown voltage.

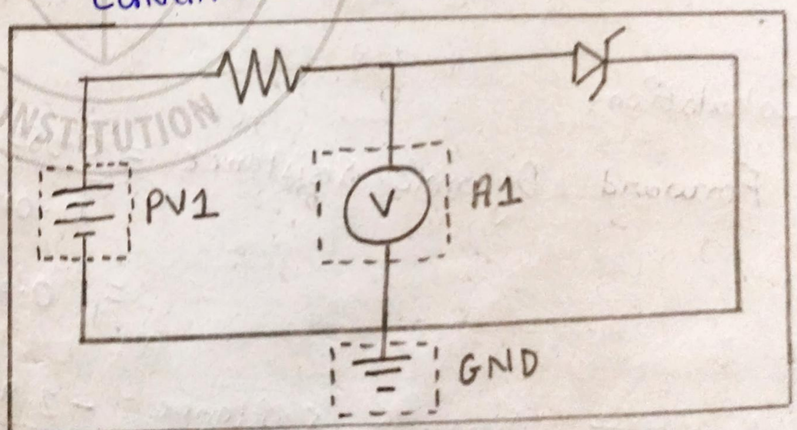
Apparatus: ExpEYES-17 hardware, Zener diode, Resistor, Bread board and Connecting wires

Circuit Diagrams:

ExpEyes circuit:



Conventional Circuit:

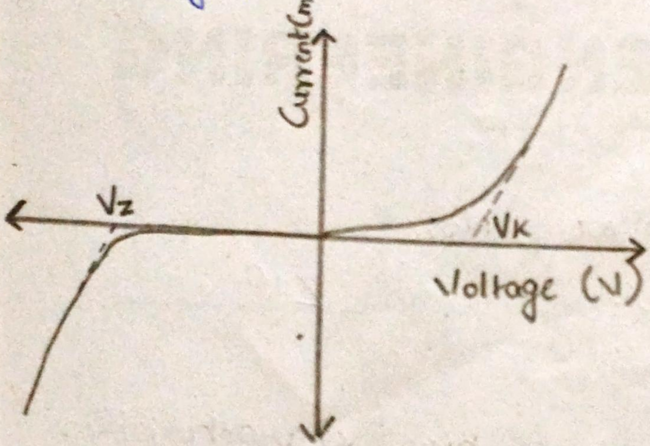


Particulars	Max Marks	Marks Obtained	Faculty Signature
Data Sheet + Experimental setup + Viva Voce	10	4+6	Ry
Conduction of Experiment	10	10	
Substitution + Calculation + Accuracy	10	9	
Total Marks	30	29	

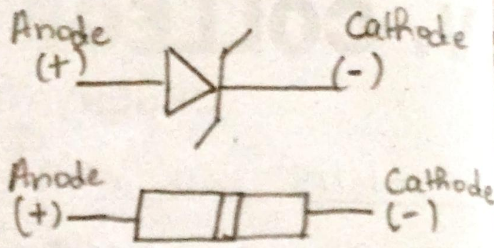
Ry

Signature of Teacher Incharge

Model Graph



Symbolic Representation



Formula:

V: Voltage
r: Resistance
I: Current

The forward dynamic resistance is given by $r_f = \frac{\Delta V_f}{\Delta I_f}$

ΔV_f : Change in forward bias voltage in Volts;
ΔI_f : Change in forward bias current in Ampere;

Reverse dynamic resistance, $r_r = \frac{\Delta V_r}{\Delta I_r}$

Calculations

Forward Dynamic Resistance $= \frac{0.585 - 0.117 \ (V)}{0.015 - 0.002 \ (mA)} = \frac{0.388}{0.007}$

$= 0.4875 \ \Omega \times 10^{3}$

~~Backward~~ Reverse Dynamic Resistance $= \frac{-2.957 - (-2.983)}{-1.874 - (-2.052)} = \frac{0.026}{0.178}$

$= 1.2857 \ \Omega \times 10^{6}$

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OBSERVATION / DATA SHEET

ate 5/6/25 Name Avishkar More

ept./Lab Physics LAB B1 Class CY B1 Expt./No. 10

tle Zener Diode Characteristics

bular column : x int.= 0.6967

rward Bias : m = 61.5649

y int = +42.845

m = 3.8740

x int. = -2.4747

Reverse Bias : y int = 9.5870

f (V)	I_f (mA)	V_f (V)	I_f (mA)	V_R (V)	I_r (µA)	V_r (V)	I_r (µA)
0.601	0.001	0.730	1.698	-2.983	-2.052	-1.929	-0.071
0.402	0.003	0.733	1.899	-2.957	-1.874	-1.763	-0.038
0.200	0.001	0.736	2.100	-2.922	-1.707	-1.585	-0.016
0.001	0.003	0.738	2.301	-2.884	-1.541	-1.396	-0.005
0.197	0.002	0.741	2.502	-2.842	-1.381	-1.200	-0.001
0.397	0.002	0.742	2.704	-2.799	-1.221	-1.001	+0.0001
·585	0.015	0.745	2.906	-2.750	-1.069	-0.800	0.000
0.658	0.144	0.747	3.107	-2.696	-0.920	~~-0.601~~	
0.682	0.324	0.748	3.309	-2.637	-0.776	~~-0.406~~	
0.695	0.514	0.750	3.509	-2.572	-0.639	~~-0.200~~	
0.705	0.707	0.752	3.711	-2.497	-0.511	~~-0.001~~	
0.712	0.904	0.754	4.116	-2.414	-0.393		
0.717	1.103			-2.317	-0.288		
0.722	1.302			-2.207	-0.196		
0.726	1.498			-2.077	-0.124		

Signature of
Teacher Incharge

Calculations:

Static:

$\frac{I\ (mA)}{V\ (V)} = \frac{1}{R}\ (\Omega^{-1} \times 10^{-3})$ $\qquad$ $\frac{I\ (\mu A)}{V\ (V)} = \frac{1}{R}$

$m_f = 61.56\ \Omega^{-1} \times 10^{-3}$ $\qquad$ $m_r = 3$

Forward = $\frac{1}{m_f} = 0.0162\ \Omega \times 10^{3}$

Dynamic

Backward = $\frac{1}{m_r} = 0.2581\ \Omega \times 10^{6}$

4/5

m_f: forward bias slope

m_r: reverse bias slope

Result:

The knee voltage = 0.6967 V

The forward dynamic resistance = $0.4375 \times 10^{3}\ \Omega$

The reverse dynamic resistance = $1.2857 \times 10^{6}\ \Omega$

The breakdown voltage = −2.4747 V

The forward static resistance = $0.0162\ \Omega \times 10^{3}$

= $16.2\ \Omega$

The reverse static resistance = $0.2581 \times 10^{6}\ \Omega$

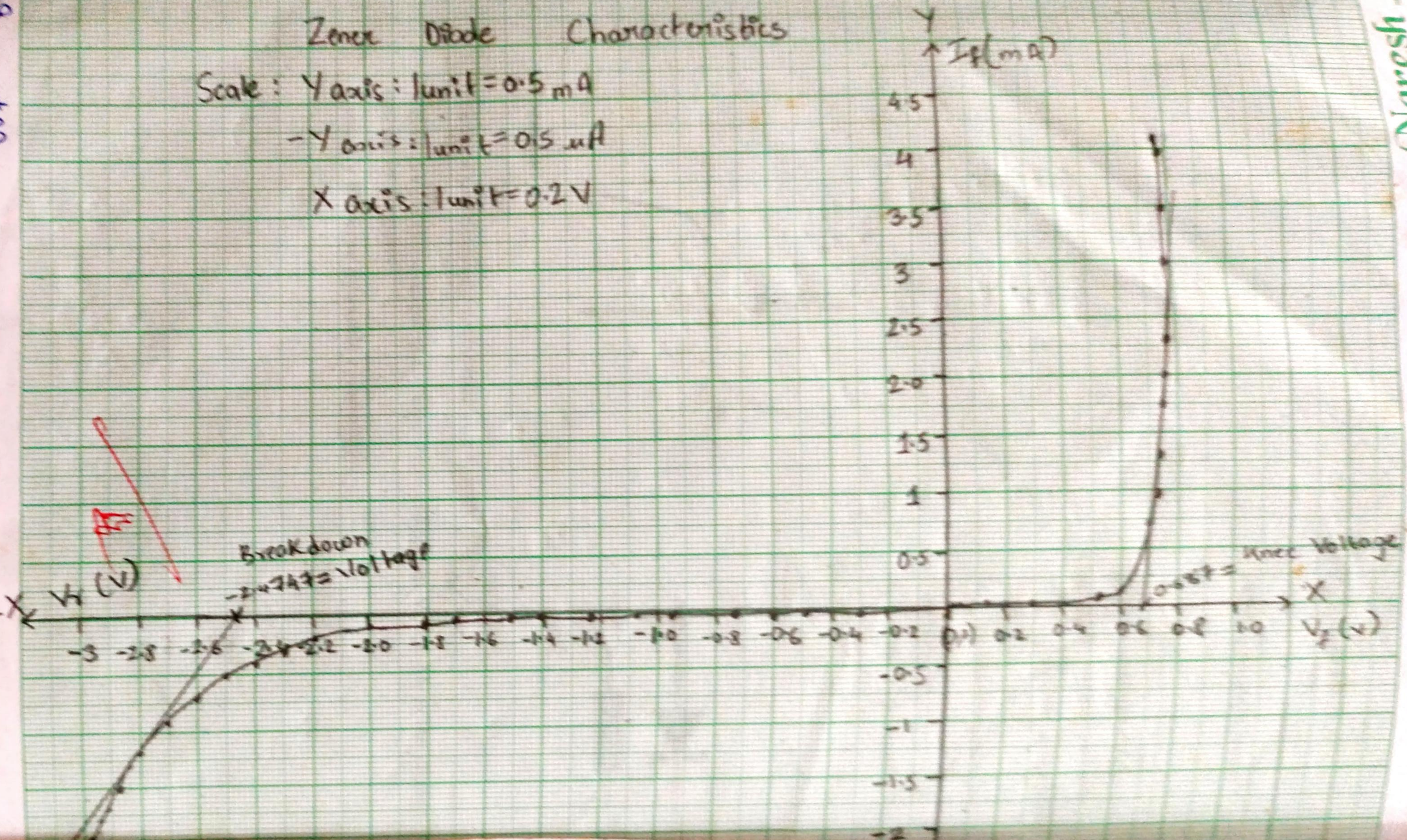
= $2.581 \times 10^{5}\ \Omega$

Zener Diode Characteristics

Scale : Y axis : 1 unit = 0.5 mA

-Y axis : 1 unit = 0.5 mA

X axis : 1 unit = 0.2 V

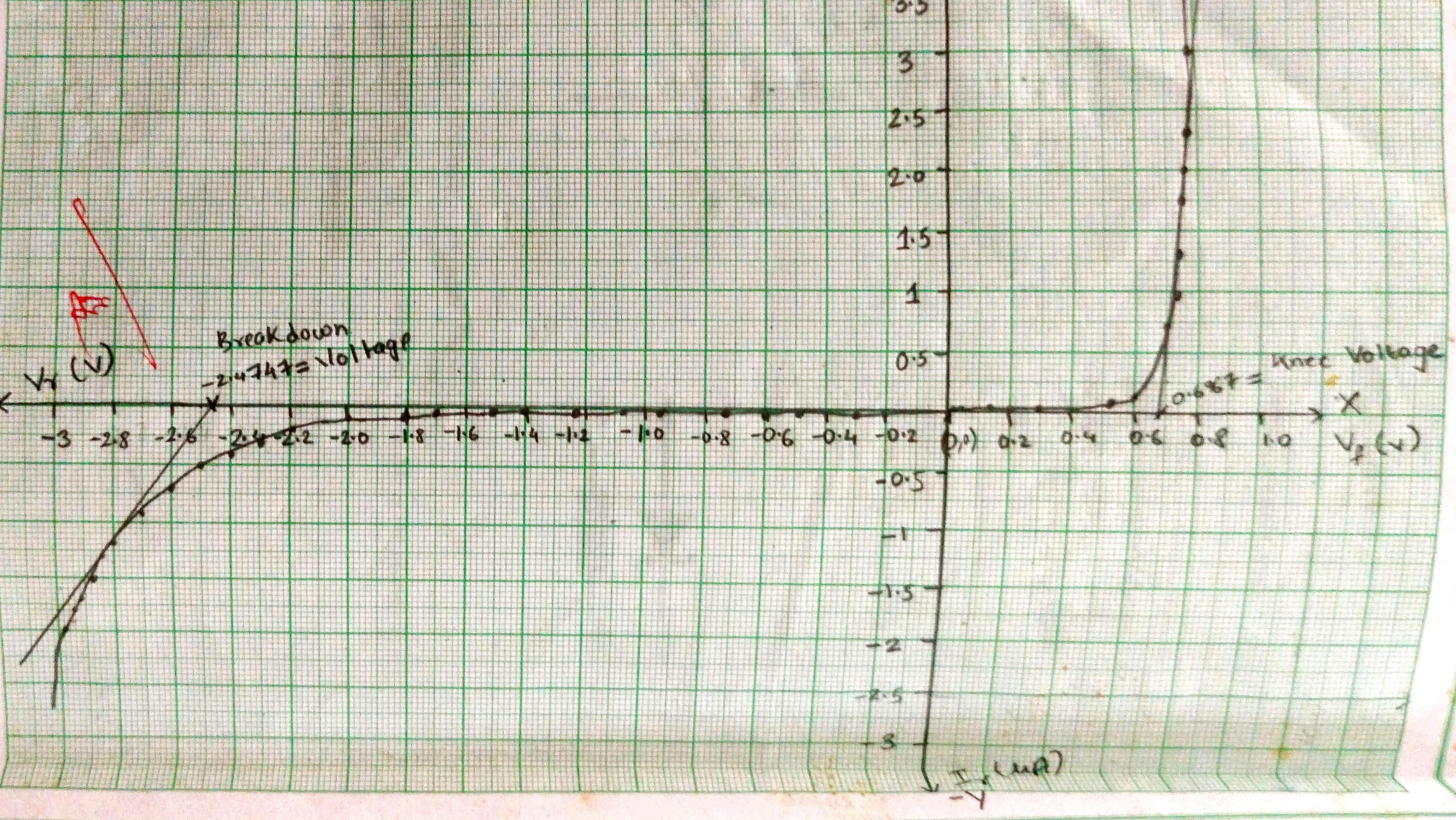


Zener Diode Characteristics

Scale : Y axis : 1unit = 0.5 mA

-Y axis : 1unit = 0.5 uA

X axis : 1unit = 0.2 V



ZENER DIODE CHARACTERISTICS

Experiment No: 10

Date: 5/6/25

Aim: To study forward and reverse bias characteristics of a zener diode and to determine the forward and reverse bias dynamic resistances, knee voltage and zener breakdown voltage.

Apparatus: ExpEYES-17 hardware, Zener diode, Resistor, Bread board and Connecting wires.

Principle: A heavily doped semiconductor diode which is designed to operate in reverse bias is known as the zener diode.

Forward Bias:

- In forward bias, the zener diode behaves like a regular diode, allowing current to pass through it easily once the forward voltage (around 0.7 V for silicon diodes) is reached.

Reverse Bias:

- In reverse bias, the zener diode blocks current, up to a point. Once the reverse voltage applied across the diode exceeds the zener breakdown voltage, the diode begins to conduct in the reverse direction.
- The Zener diode maintains a nearly constant voltage across it, regardless of variations in the current flowing through it, making it ideal for applications such as voltage regulation.

Procedure: Experiment conduction consists of two steps.

Step 1: To find the resistance value of the given resistor:

1. In the ExpEyes hardware, connect one end of resistor to SEN pin and other to ground pin. Interface the ExpEyes hardware with the CPU and click on ExpEyes icon on the monitor.
2. To find out resistance value, go to electronics tab and select oscilloscope (default screen) and note the value of resistance displayed on the screen.

Step 2: Study of forward and reverse bias I-V characteristics of a given Zener diode:

1. Identify the n (black notch) and p (brown region) terminals of zener diode as shown in the symbolic representation diagram.
2. Make circuit connections using zener diode and resistor as shown in the circuit diagram. On the screen go to RVCE tab and select zener diode characteristics experiment.
3. And then, on the graphical user interface (GUI) window of zener diode characteristics experiment, enter your **name, branch, section and roll number**.
4. Enter the value of resistance in the box. Click on START to plot the I/V characteristics for forward bias and reverse bias.
5. **Forward bias:** After plotting the graph, adjust the width of the Region of Interest (RO) (the shaded area) along the linear portion of the curve in the first quadrant, then click on the "FIT with I = V/R" option. A tangent to the curve will appear, note down the slope (m) and the knee voltage V_k, (the x intercept).

Tabular Column: Forward Bias

V_f(V)	I_f(mA)	V_f(V)	I_f(mA)
-0.601	0.001	0.736	2.100
-0.402	0.003	0.738	2.301
-0.200	0.001	0.741	2.502
-0.001	0.003	0.742	2.704
0.197	0.002	0.745	2.906
0.397	0.002	0.747	3.107
0.585	0.015	0.748	3.309
0.658	0.144	0.750	3.509
0.682	0.324	0.752	3.711
0.695	0.514	0.754	4.116
0.705	0.707		
0.712	0.904		
0.717	1.103		
0.722	1.302		
0.726	1.498		
0.730	1.698		
0.733	1.899		

Tabular Column: Reverse Bias

V_r(V)	I_r(µA)	V_r(V)	[illegible]
-2.983	-2.052	-1.585	[illegible]
-2.957	-1.874	-1.396	[illegible]
-2.922	-1.707	-1.200	[illegible]
-2.884	-1.541	-1.001	[illegible]
-2.842	-1.381	-0.800	[illegible]
-2.799	-1.221	0	
-2.750	-1.069		
-2.696	-0.920		
-2.637	-0.776		
-2.572	-0.689		
-2.497	-0.511		
-2.414	-0.393		
-2.317	-0.288		
-2.207	-0.196		
-2.0077	-0.124		
-1.929	-0.071		
-1.763	-0.038		

Calculations

Forward bias slope m_f = 61.56 Ω^{-1} $\times 10^{-3}$

Forward bias resistance $r_f = 1/m_f$ = 0.0162 Ω $\times 10^{3}$

Reverse bias slope m_r = 3.874 Ω^{-1} $\times 10^{-6}$

Reverse bias resistance $r_r = 1/m_r$ = 0.2581 Ω $\times 10^{6}$

From graph

$V_{Knee} = 0.6967$ V

$V_{Breakdown} = -2.4747$ V

Forward dynamic resistance $= \frac{0.585 - 0.197 \text{ V}}{0.015 - 0.02 \text{ mA}} = \frac{0.388}{0.007} \times 10^3 = 0.487 \times 10^3 \Omega = 487.5 \Omega$

Reverse dynamic resistance $= \frac{-2.957 - (2.983)}{-1.874 - (-2.052)} = \frac{0.026 \text{ V}}{0.178 \text{ µA}}$

$= 1.2857 \times 10^6 \Omega$

Results:

Forward bias		Reverse bias	
The Knee voltage	0.6967 V	The breakdown voltage	-2.4747 V
The forward dynamic resistance	0.487×10^3 Ω	The reverse dynamic resistance	1.2857×10^6 Ω

6. **Reverse bias:** Adjust the width of RO (region of interest in a color shade) on the linear portion of the curve in the third quadrant and then click on the **FIT with I= V/R** option. The tangent to the curve will appear. Note down the slope (m) and breakdown voltage V_b (the x-intercept).
   Then click on the **Save data** and save the file in .txt form (example: name zener.txt)
7. Record the voltage and current values from the .txt file in the tabular column and plot the graph of Current (I) versus Voltage (V).
8. Calculate the forward and reverse dynamic resistance as the reciprocals of the respective slopes.
9. Tabulate the forward and reverse bias dynamic resistance, knee voltage and zener breakdown voltage.

Calculation:

$m_f = 61.56 \times 10^{-3} \Omega^{-1}$

$m_r = 3.874 \times 10^{-6} \Omega^{-1}$

Dynamic resistance provides a more precise measure of resistance for small changes in voltage or current, crucial for AC or small-signal analysis.

Forward static resistance $= \frac{1}{m_f} = \frac{1}{61.56 \times 10^{-3}} = 0.0162 \times 10^3 \Omega$

$= 16.2 \Omega$

Reverse static resistance $= \frac{1}{m_r} = \frac{1}{3.874 \times 10^{-6}} = 0.2581 \times 10^6 \Omega$

Results:

Forward bias		Reverse bias	
The Knee voltage	0.6967 V	The breakdown voltage	-2.4747 V
The forward static resistance	0.0162×10^3 Ω	The reverse static resistance	0.2581×10^6 Ω
The forward dynamic resistance	0.487×10^3 Ω	The reverse dynamic resistance	1.2857×10^6 Ω

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R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 17/04/25 Name Avishkar More

Dept./Lab Physics LAB B1 Class CY B1 Expt./No. 31

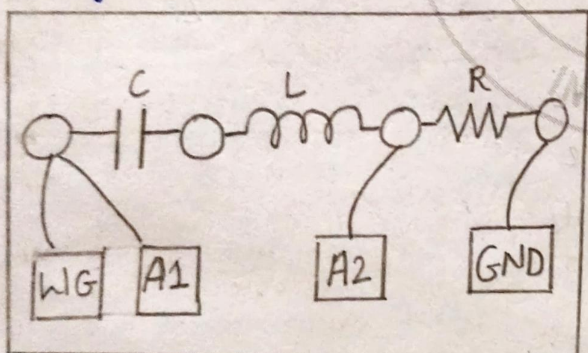
Title Series LCR Circuit

Aim: To study the frequency response of LCR circuit and determination of a) Self inductance of the given coil b) Quality factor (Q value) c) Band width

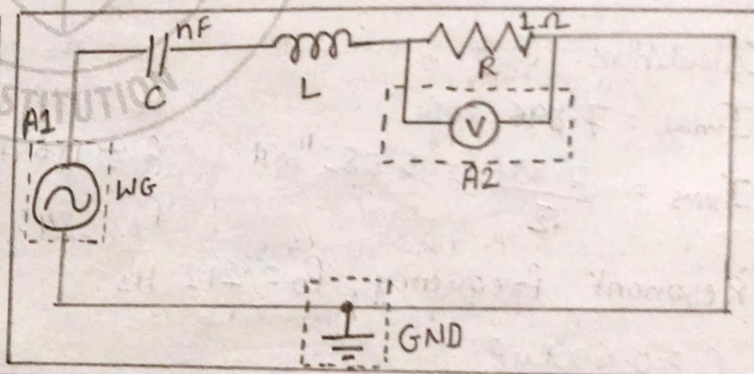
Apparatus: ExpEYES-17 hardware, Resistor, Capacitor, Inductor, Bread Board and Connecting wires.

Circuit Diagram:

ExpEyes Circuit:



Conventional Circuit:



Particulars	Max Marks	Marks Obtained	Faculty Signature
Data Sheet + Experimental setup + Viva Voce	10	4+6	R.g.
Conduction of Experiment	10	10	[signature]
Substitution + Calculation + Accuracy	10	9.	
Total Marks	30	29	[signature]

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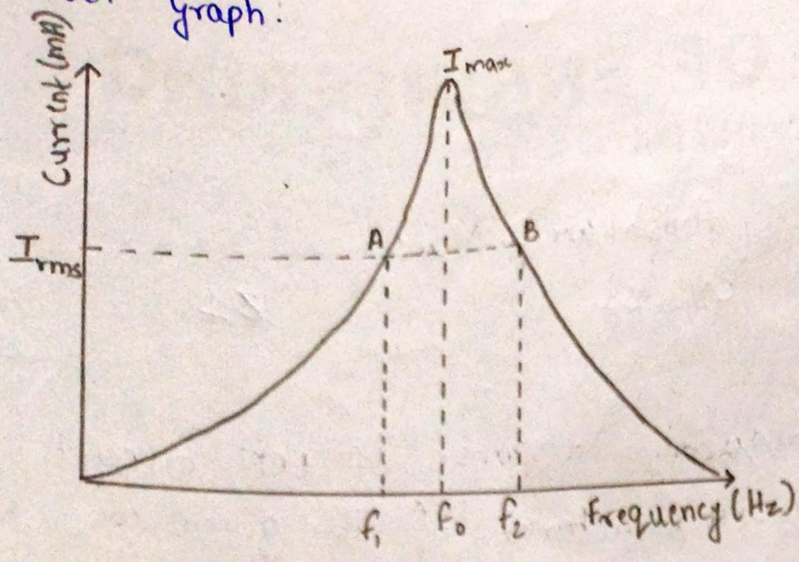
17/4

Signature of Teacher Incharge

Model Graph:



Formula:

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

C: Capacitance

I_{max}: peak current

$$I_{RMS} = \frac{I_{max}}{\sqrt{2}}$$

f_0: Resonant frequency

f_1: Lower Cut off freq

f_2: Upper Cut off freq

$\Delta f = f_2 - f_1$: Band width

Quality factor : $Q = \frac{f_0}{\Delta f}$

Calculations:

$I_{max} = 7.896$ mA

$I_{RMS} = \frac{7.896}{\sqrt{2}} = 5.583$ mA

$f_0 = 212$ Hz

$f_1 = 186$ Hz

$f_2 = 245$ Hz

Resonant frequency, $f_0 = 212$ Hz

$C = 0.4551\,\mu F$

$R = 173\,\Omega$

$$L = \frac{1}{4\pi^2 f_0^2 C} = \frac{1}{4(\pi)^2(212)^2(0.4551\times10^{-6})} = 1.2384 \text{ H}$$ = Self inductance given coil

Bandwidth $= f_2 - f_1 = 245 - 186 = 59$ Hz $= (\Delta f)$

Quality factor $= \frac{f_0}{\Delta f} = \frac{212}{59} = 3.5932$

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 17/4/25 Name Avishkar More

Dept./Lab Physics LAB B1 Class CY B1 Expt./No. ~~3~~ 1

Title Series LCR Circuit

f_0 = 212 Hz

C = 455.1 nF = 0.455 uF R = 173 Ω

Tabular Column :

Sl No	Frequency (Hz)	Current (mA)	Sl No.	Frequency (Hz)	Current (mA)
1	50 Hz	0.446 R.G	16	319.693	2.522
2	68.009	0.634	17	337.838	2.214
3	86.029	0.853	18	356.125	1.968
4	103.993	1.119	19	374.251	1.785
5	121.951	1.444	20	391.850	1.631
6	139.978	1.915	21	409.836	1.504
7	158.028	2.598	22	428.082	1.407
8	176.056	3.694	23	446.429	1.316
9	194.099	5.735	24	482.625	1.174
10	211.864	7.896	25	500.00	1.110
11	230.203	7.201	26	464.429	1.3241
12	248.016	5.524			
13	265.957	4.294			
14	284.091	3.464			
15	301.932	2.899			

Signature of
Teacher Incharge

Result:

1. Resonant frequency of the circuit, $f_0 = 212$ Hz
2. Self inductance of the given coil, $L = 1.2384$ H
3. Quality factor from graph, $Q = 3.5932$
4. Bandwidth, $\Delta f = f_2 - f_1 = 59$ Hz

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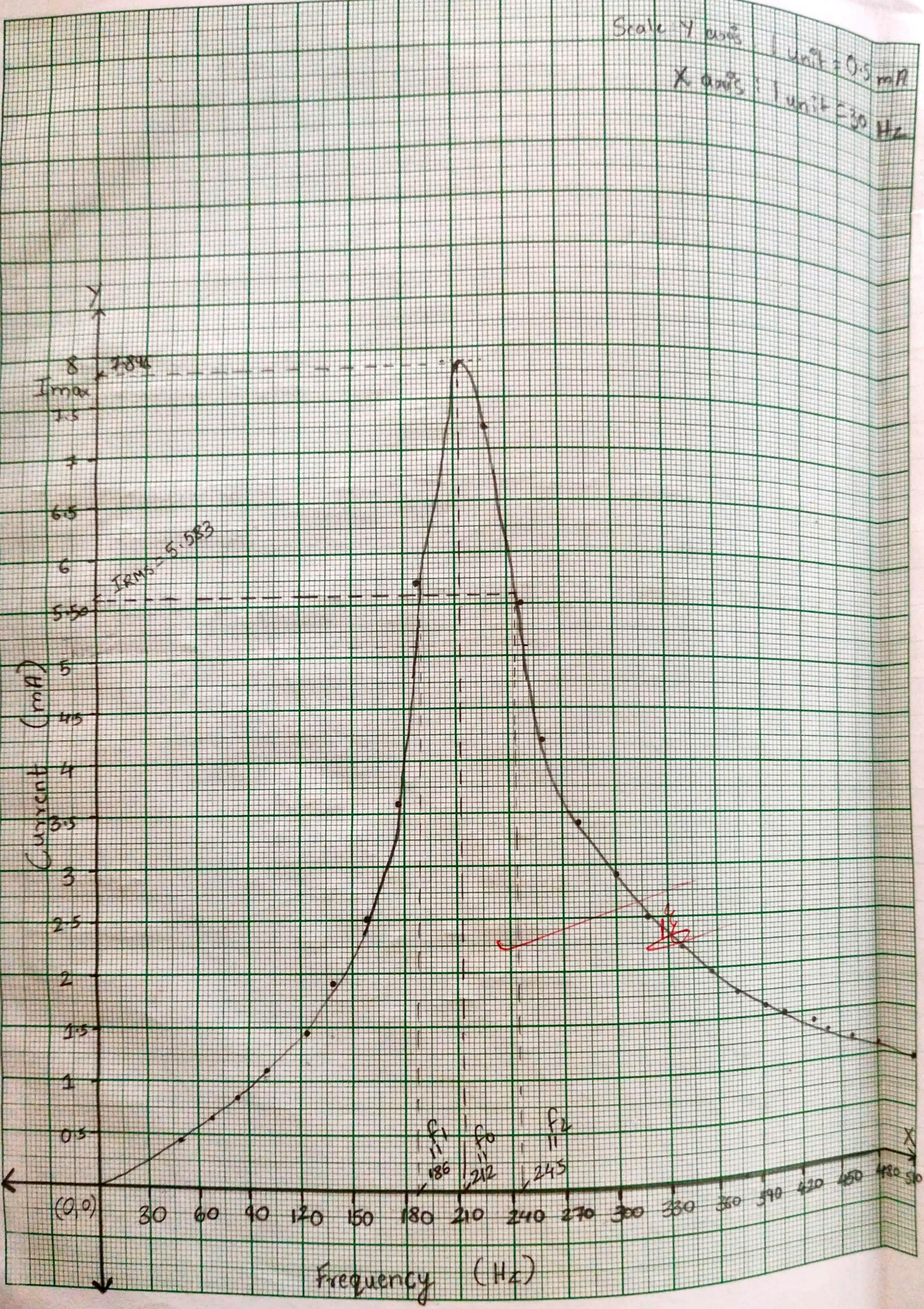
Avishkar More

CY 007 B1

LCR



SERIES L-C-R CIRCUIT

Experiment No: 1

Date: 17/4/25

Aim: To study the frequency response of LCR circuit and determination of a) Self-inductance of the given coil, b) Quality factor (Q- value) and c) Band-width

Apparatus: ExpEYES-17 hardware, Resistor, Capacitor, Inductor, Bread board and Connecting wires.

Principle: The phenomenon of resonance is common among systems that have a tendency to oscillate at a particular frequency. This frequency is called the system's natural frequency. If such a system is driven by an energy source at a frequency that is near the natural frequency, the amplitude of oscillation is found to be large.

An interesting characteristic of the series RLC circuit is the phenomenon of resonance. Resonance occurs when the inductive reactance equals the capacitive reactance, i.e., $X_L = X_C$. $\omega L = \frac{1}{\omega C}$; At resonance, the impedance of the circuit is purely resistive, and the circuit's total impedance is minimum, leading to maximum current flow. The resonant angular frequency ω_0 is: $\omega_0 = \frac{1}{\sqrt{LC}}$. The corresponding resonant frequency f_0 is: $f_0 = \frac{1}{2\pi\sqrt{LC}}$

Theory:

A Series L-C-R circuit is a fundamental electrical circuit consisting of three components: an inductor (L), a capacitor (C) and a resistor (R) are connected in series. The principle of the Series L-C-R circuit lies in the interplay between the inductor, capacitor, and resistor when an AC voltage is applied across the circuit. The inductor and capacitor store energy in magnetic and electric fields, respectively and exhibit opposition to changes in current and voltage while the resistor dissipates energy as heat.

An interesting characteristic of the series RLC circuit is the phenomenon of resonance.

At Resonance:

- The voltage across the inductor and capacitor cancels each other out, leaving the voltage across the resistor to equal the applied voltage. The circuit exhibits a maximum current I_{max} and minimum impedance (Z).
- **Impedance (*Z*):** The impedance in the series L-C-R circuit is: $|Z| = \sqrt{R^2 + (X_L - X_C)^2}$
- ***Quality Factor (Q-Factor):*** The Quality Factor (Q-factor) is a measure of the sharpness of resonance in the Series L-C-R circuit. It is given by: $Q = \frac{X_L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$, A higher Q-factor indicates a sharper resonance peak, meaning the circuit is more selective in its response to frequencies near the resonant frequency.
- **Applications:** Tuning Circuits, Filters, Impedance Matching etc.,

Tabular Column:

Sl No	Frequency (Hz)	Current (mA)	Sl No	Frequency (Hz)	Current (mA)
1	50	0.446	24	464.429	1.241
2	68.004	0.674	25	482.625	1.178
3	86.028	0.853	26	500	1.110
4	103.983	1.119			
5	121.951	1.444			
6	139.978	1.915			
7	158.028	2.58			
8	176.056	3.884			
9	194.079	5.735			
10	211.864	7.386			
11	230.203	7.201			
12	248.016	5.524			
13	265.957	4.284			
14	283.991	3.464			
15	301.932	2.894			
16	319.683	2.522			
17	338.338	2.214			
18	356.125	1.988			
19	374.251	1.785			
20	391.850	1.631			
21	409.836	1.524			
22	428.082	1.407			
23	446.429	1.316			

Result:

1.	Resonant frequency of the circuit f_0	212 Hz ~~1.238~~ Hz
2.	Self-inductance of the given coil L	1.2384 H
3.	Quality factor from graph Q	3.5832
4.	Band width $\Delta f = f_2 - f_1$	59 Hz

Procedure: Experiment conduction consists of two steps.

Step 1: To find the resistance and capacitance value of the given resistor and capacitor.

1. In the ExpEyes hardware, connect one end of resistor to SEN pin and other to ground pin. Interface the ExpEyes hardware with the CPU and click on ExpEyes icon on the monitor.
2. To find out resistance value, under electronics tab, go to oscilloscope (default screen) and note the value of resistance displayed on the screen.
3. To find the capacitance value, connect one end of capacitor to IN1 pin and other to ground pin. Click on capacitance option and note the value of capacitance.

Step 2: Study of frequency response of LCR circuit

1. Make the series LCR circuit connection as shown in the diagram. On the screen go to RVCE tab and select Series LCR Resonance experiment.
2. On the graphical user interface (GUI) window of Series LCR Resonance experiment, enter your **name, branch, section and roll number**.
3. Enter the frequency range and frequency interval steps in the right side of GUI window.
4. Click on START button to plot the current (I) versus frequency (f).
5. After plotting the graph, select the "Point" option under "Add Marker," place the marker at the maximum current and record the resonant frequency f_0 (y co-ordinate) and maximum current I_{max} (x co-ordinate) values under observation in the data sheet.
6. Calculate $I_{RMS} = \frac{I_{max}}{\sqrt{2}}$. Under the "Add Marker" option, select Horizontal Line (HLine), then position it on the curve corresponding to the RMS current value.
7. To determine the Bandwidth (BW), identify the cutoff frequencies by selecting the "Vertical Line (VLine)" option. Move the VLine to the points on the curve corresponding to the RMS current value and note down the upper cut off frequency (f_2) and lower cut off frequency (f_1).
8. Then click on the **Save data** and save the file in .txt form (example: Student's name LCR.txt)
9. Record the current and frequency values from the .txt file in the tabular column and plot the graph of current (I) versus frequency (f).
10. Find the self-inductance of the given coil, Quality factor and Band width using the relevant formulae and tabulate the result.

Results:

1.	Resonant frequency of the circuit f_0	212 Hz
2.	Self-inductance of the given coil L	1.2384 H
3.	Quality factor from graph Q	3.5832
4.	Band width $\Delta f = f_2 - f_1$	53 Hz

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Tabular Column:

SI No	Frequency (Hz)	Current (mA)	SI No	Frequency (Hz)	Current (mA)
1	50	0.446	24	464.429	1.241
2	68.009	0.634	25	482.625	1.174
3	86.029	0.853	26	500	1.110
4	103.993	1.119			
5	121.951	1.444			
6	139.978	1.915			
7	158.028	2.598			
8	176.056	3.694			
9	194.019	5.735			
10	211.864	7.896			
11	230.203	7.201			
12	248.016	5.524			
13	265.957	4.294			
14	284.091	3.464			
15	301.932	2.899			
16	319.693	2.522			
17	337.838	2.214			
18	356.125	1.968			
19	374.251	1.785			
20	391.850	1.631			
21	409.836	1.504			
22	428.082	1.407			
23	446.429	1.316			

Result:

1.	Resonant frequency of the circuit f_0	212 Hz
2.	Self-inductance of the given coil L	~~1.2384~~ Hz
3.	Quality factor from graph Q	1.2384 H
4.	Band width $\Delta f = f_2 - f_1$	3.5932
		59 Hz

Procedure: Experiment conduction consists of two steps.

Step 1: To find the resistance and capacitance value of the given resistor and capacitor.

1. In the ExpEyes hardware, connect one end of resistor to SEN pin and other to ground pin. Interface the ExpEyes hardware with the CPU and click on ExpEyes icon on the monitor.
2. To find out resistance value, under electronics tab, go to oscilloscope (default screen) and note the value of resistance displayed on the screen.
3. To find the capacitance value, connect one end of capacitor to IN1 pin and other to ground pin. Click on capacitance option and note the value of capacitance.

Step 2: Study of frequency response of LCR circuit

1. Make the series LCR circuit connection as shown in the diagram. On the screen go to RVCE tab and select Series LCR Resonance experiment.
2. On the graphical user interface (GUI) window of Series LCR Resonance experiment, enter your **name, branch, section and roll number**.
3. Enter the frequency range and frequency interval steps in the right side of GUI window.
4. Click on START button to plot the current (I) versus frequency (f).
5. After plotting the graph, select the "Point" option under "Add Marker," place the marker at the maximum current and record the resonant frequency f_0 (y co-ordinate) and maximum current I_{max} (x co-ordinate) values under observation in the data sheet.
6. Calculate $I_{RMS} = \frac{I_{max}}{\sqrt{2}}$. Under the "Add Marker" option, select Horizontal Line (HLine), then position it on the curve corresponding to the RMS current value.
7. To determine the Bandwidth (BW), identify the cutoff frequencies by selecting the "Vertical Line (VLine)" option. Move the VLine to the points on the curve corresponding to the RMS current value and note down the upper cut off frequency (f_2) and lower cut off frequency (f_1).
8. Then click on the **Save data** and save the file in .txt form (example: Student's name LCR.txt)
9. Record the current and frequency values from the .txt file in the tabular column and plot the graph of current (I) versus frequency (f).
10. Find the self-inductance of the given coil, Quality factor and Band width using the relevant formulae and tabulate the result.

Results:

1.	Resonant frequency of the circuit f_0	212 Hz
2.	Self-inductance of the given coil L	1.2384 H
3.	Quality factor from graph Q	3.5932
4.	Band width $\Delta f = f_2 - f_1$	59 Hz

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R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 17/4/25 Name Avishkar More

Dept./Lab Physics LAB B1 Class CY B1 Expt./No. #2

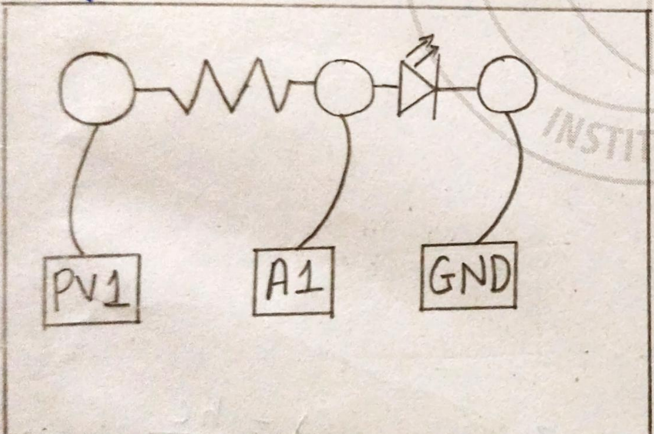
Title Wavelength of Light Emitting Diodes

Aim: To study the I-V charactoristics of a diode and determine the wavelength of the given LED's.

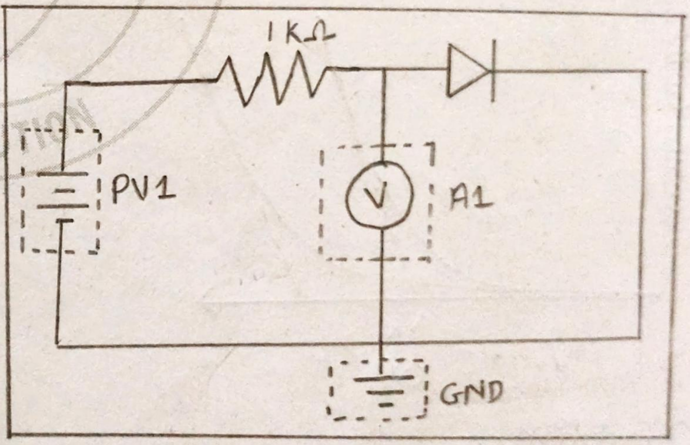
Apparatus: ExpEYES-17 hardware, LED's, 1kΩ Resistor, Bread board and Connecting wires.

Circuit Diagram:

ExpEyes circuit:



Conventional Circuit:



Particulars	Max Marks	Marks Obtained	Faculty Signature
Data Sheet + Experimental setup + Viva Voce	10	4+6	
Conduction of Experiment	10	10	
Substitution + Calculation + Accuracy	10	9	
Total Marks	30	29	

Signature of Teacher Incharge

Colour of LED	Knee Voltage (V_k)	Wavelength (λ) in nm
Orange	1.84 R.Y. V	674.76 nm
Blue	2.6 V	477.52 nm
Red	1.72 V	721.84 nm
White	2.56 V	484.98 nm

Formula:

$E = \frac{hc}{\lambda} = eV_K$

$\lambda = \frac{hc}{eV_K}$ nm

E: Energy of photons emitted by LED

λ: wavelength of LED

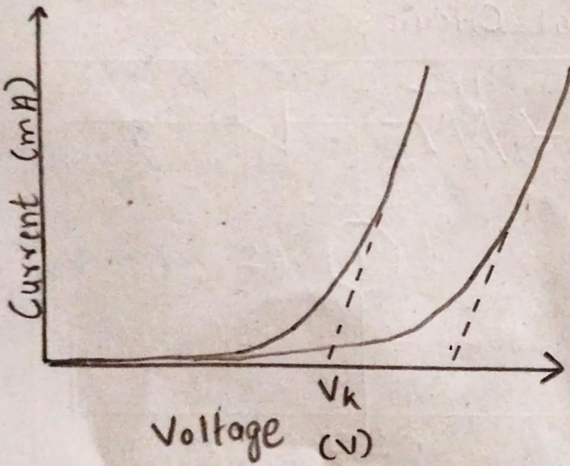
h: plancks constant $= 6.63 \times 10^{-34}$ J s

c: speed of light $= 3 \times 10^{8}$ m/s

$e = 1.602 \times 10^{-19}$ C

V_K = Knee voltage of LED

Model graph:



Calculations:

$\lambda = \frac{hc}{eV_K}$

$$\lambda_{orange} = \frac{(6.63 \times 10^{-34})(3 \times 10^{8})}{(1.602 \times 10^{-19})(1.84)} = 6.7476 \times 10^{-7} \text{ m} = 674.76 \text{ nm}$$

$$\lambda_{Blue} = \frac{(6.63 \times 10^{-34})(3 \times 10^{8})}{(1.602 \times 10^{-19})(2.6)} = 4.7752 \times 10^{-7} \text{ m} = 477.52 \text{ nm}$$

$$\lambda_{Red} = \frac{(6.63 \times 10^{-34})(3 \times 10^{8})}{(1.602 \times 10^{-19})(1.72)} = 7.2184 \times 10^{-7} \text{ m} = 721.84 \text{ nm}$$

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OBSERVATION / DATA SHEET

te 17/4/25 Name Avishkar More

pt./Lab Physics LAB B1 Class CYB1 Expt./No. ~~4~~2

e Wavelength of LED

lculations:

$$\lambda_{white} = \frac{(6.63\times10^{-34})(3\times10^{8})}{(1.602\times10^{-19})(2.56)} = 4.8498\times10^{-7}\ m$$

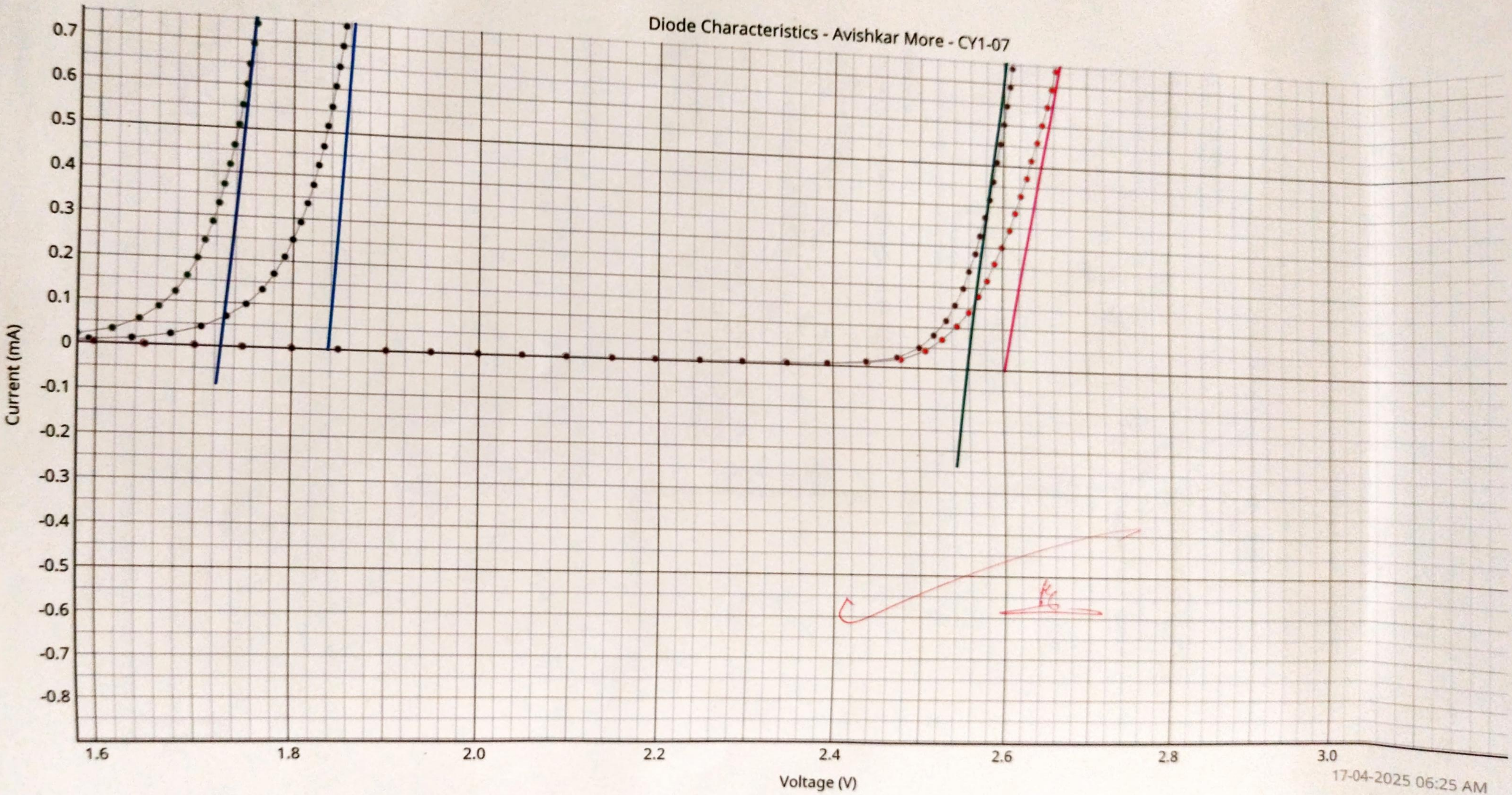
$$= 484.98\ nm$$

ult :

udied the I-V characteristics of a diode and the velengths of the given LED's are determined.

23/4

Signature of
Teacher Incharge


Diode Characteristics - Avishkar More - CY1-07
Current (mA)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
Voltage (V)
17-04-2025 06:25 AM

WAVELENGTH OF LIGHT EMITTING DIODES

Experiment No: 2 Date: 17/4/25

Aim: To study the I-V Characteristics of a diode and determine the wavelength of the given LED's.

Apparatus: ExpEYES-17 hardware, LED's, 1 K Ω Resistor, Bread board and Connecting wires.

Principle: Light Emitting Diode (LED) is special type of semiconductor diode. It consists of heavily doped P type and N type, direct band gap semiconducting materials. The LED absorbs electrical energy and converts it into light energy. When the PN junction is forward biased, electrons from the N-region move into the P-region and combine with holes. This electron-hole recombination results in the emission of photons.

Procedure: Experiment conduction consists of two steps.

Step 1: To find the resistance value of the given resistor:

1. In the ExpEyes hardware, connect one end of resistor to SEN pin and other to ground pin. Interface the ExpEyes hardware with the CPU and click on ExpEyes icon on the monitor.
2. To find out resistance value, go to electronics tab and select oscilloscope (default screen) and note the value of resistance displayed on the screen.

Step 2: Study of forward bias I/V characteristics of a given LEDs:

1. Identify the n (shorter) and p (longer) terminals of LED.
2. Make circuit connections using LED and resistor as shown in the circuit diagram.
3. Interface the circuit with the CPU and click on ExpEyes icon on the monitor screen. On the screen under RVCE tab and select Diode Characteristics experiment.
4. And then, on the graphical user interface (GUI) window of diode characteristics experiment, enter your **name, branch, section and roll number**.
5. Enter the value of resistance in the box. Click on START to plot the I/V characteristics for forward bias.
6. After plotting the graph, adjust the width of the Region of Interest (RO) (the shaded area) along the linear portion of the curve in the first quadrant, click on the "FIT with I = V/R" option. A tangent to the curve will appear, note down the knee voltage V_k, (the x intercept) for the corresponding color of the LED in the tabular column.
7. Without clearing the traces on the screen, repeat the same procedure for three more LEDs.
8. Click on Export to PDF for current versus voltage I-V graph of LEDs.(Store the PDF file in a thumb drive and take a print out)
9. Calculate the wavelength of each LEDs using the given formula and tabulate the result.

Result: Studied the I-V Characteristics of a diode and the wavelengths of the given LED's are:

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OBSERVATION / DATA SHEET

Date 24/4/25 Name Avishkar More

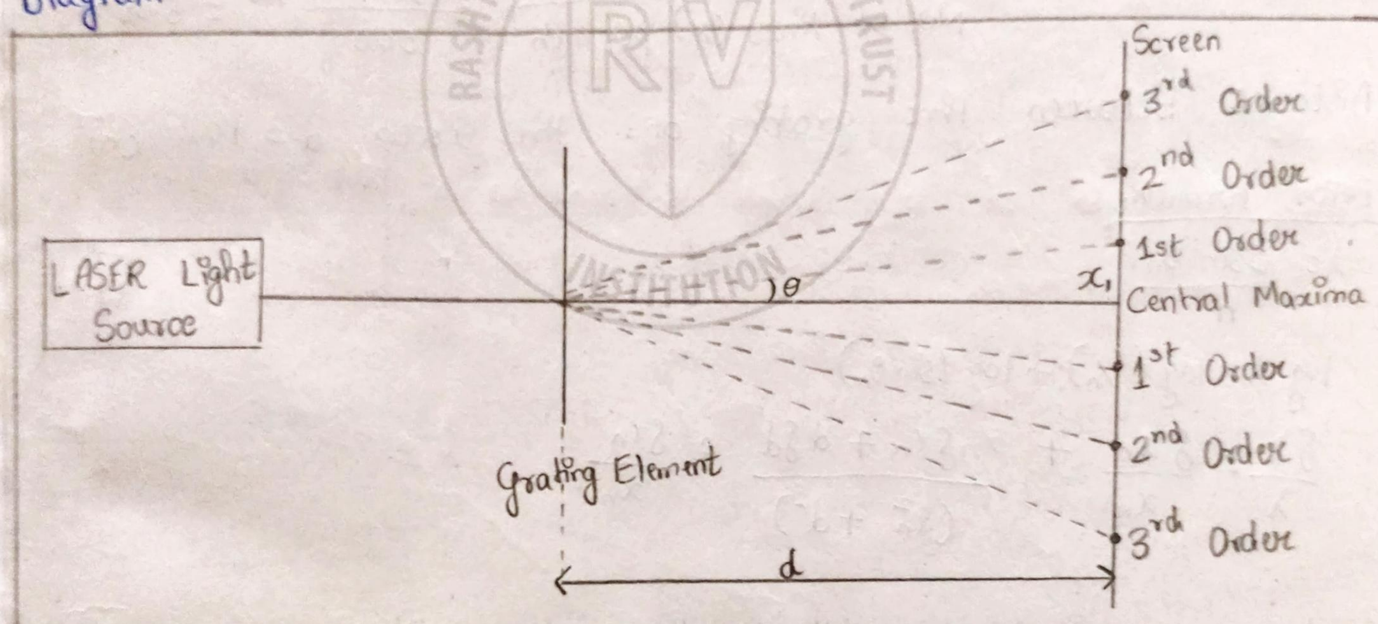
Dept./Lab Physics LAB B1 Class CY B1 Expt./No. 5 3

Title Laser Diffraction

Aim: To determine the wavelength of a given laser beam.

Apparatus: Laser source, Grating, Optical bench with accessories and meter scale etc.

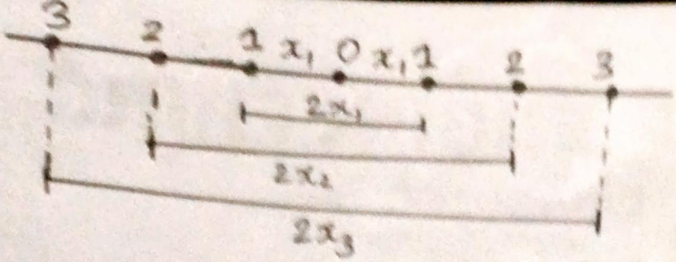
Diagram:



Particulars	Max Marks	Marks Obtained	Faculty Signature
Data Sheet + Experimental setup + Viva Voce	10	4+6	R.G
Conduction of Experiment	10	10	RG
Substitution + Calculation + Accuracy	10	10	R.G.
Total Marks	30	30	R.G

R.G

Signature of Teacher Incharge



Diffraction angle θ_n

$\tan \theta_n = \frac{x_n}{d}$ $(n = 1, 2, 3)$

x_n = Distance between the maximum $(n=0)$ and the nth secondary maximum

d = Distance between grating the screen

Formulae:

Wavelength of Laser source : $\lambda = \frac{C \sin \theta_n}{n}$

C: grating constant   n: order of maximum   θ: Angle of diff

Grating constant, $C = \frac{1 \text{ inch}}{\text{No. of lines } (N) \text{ per inch}} = \frac{2.54 \times 10^{-2}}{500} m = 5.08$

Distance between the grating and the screen, $d = 102$ cm

Error Formulae:

$$\lambda = \frac{C \sin \theta_n}{n}$$

$$\log \lambda = \log (C/n) + \log (\sin \theta_n)$$

$$\frac{\delta \lambda}{\lambda} = \frac{\delta x_n}{x_n} + \frac{x_n \delta x_n + d \delta d}{(x_n^2 + d^2)} \approx \frac{\delta x_n}{x_n}$$

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OBSERVATION / DATA SHEET

te 24/4/25 Name Avishkar More

pt./Lab Physics LAB B1 Class CY B1 Expt./No. ~~8~~ 3

e LASER Diffraction

$d = 102$ cm

le:

ractfon er (n)	Distance $2x_n$ (cm)	Distance x_n (cm)	Diffraction angle (θ_n in degree) $\theta_n = \tan^{-1}\left(\frac{x_n}{d}\right)$	Wavelength λ(nm) $\lambda = \frac{C\sin\theta_n}{n}$	Fractional error $\left(\frac{\delta\lambda}{\lambda}\right)$
1	3.0	1.5	0.8425	746.76	0.0666
2	5.8	2.9	1.6285	721.61	0.0344
3	8.6	4.3	2.4139	713.06	0.02325
4	11.25	5.625	3.1564	699.27	0.0177
5.	14.20	7.1	3.4818	705.50	0.01408
erage wavelength for the laser and fractional error				$\lambda = 717.24$ nm	

culations:

$$\frac{(5.08\times10^{-5})(\sin(0.8425^\circ))}{1} = (5.08\times10^{-5})(0.01470) = 0.074676\times10^{-5}\,m$$
$$= 746.76\ nm$$

$$= \frac{(5.08\times10^{-5})(\sin(1.6285^\circ))}{2} = \frac{(5.08\times10^{-5})(0.02841)}{2} = 0.144322\times10^{-5}\,m/2 = 0.072161\times10^{-5}\,m$$
$$= \cancel{1443.22\ nm}\ 721.61\ nm$$

$$= \frac{(5.08\times10^{-5})(\sin(2.4139^\circ))}{3} = \frac{(5.08\times10^{-5})(0.04211)}{3} = 0.213918\times10^{-5}\,m/3 = 0.071306\times10^{-5}\,m$$
$$= \cancel{2139.18\ nm}$$
$$713.06\ nm$$

Signature of Teacher Incharge

Calculations:

$$\lambda_4 = \frac{(5.08 \times 10^{-5})(\sin(3.1564°))}{4} = \frac{(5.08 \times 10^{-5})(0.055061)}{4} = 0.069927 \times 10^{-5}\ m$$

$$= 699.27\ nm$$

$$\lambda_5 = \frac{(5.08 \times 10^{-5})(\sin(3.9818°))}{5} = \frac{(5.08 \times 10^{-5})(0.069451)}{5} = 0.070550 \times 10^{-5}\ m$$

$$= 705.50\ nm$$

$$\lambda_{avg} = \frac{\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5}{5} = \frac{746.76 + 721.61 + 713.06 + 699.27 + 705.5}{5}$$

$$= 717.24\ nm$$

$$\delta x_n = 0.1\ cm$$

$$\frac{\delta x_1}{x_1} = \frac{0.1}{1.5} = 0.0666$$

$$\frac{\delta x_2}{x_2} = \frac{0.1}{2.9} = 0.0344$$

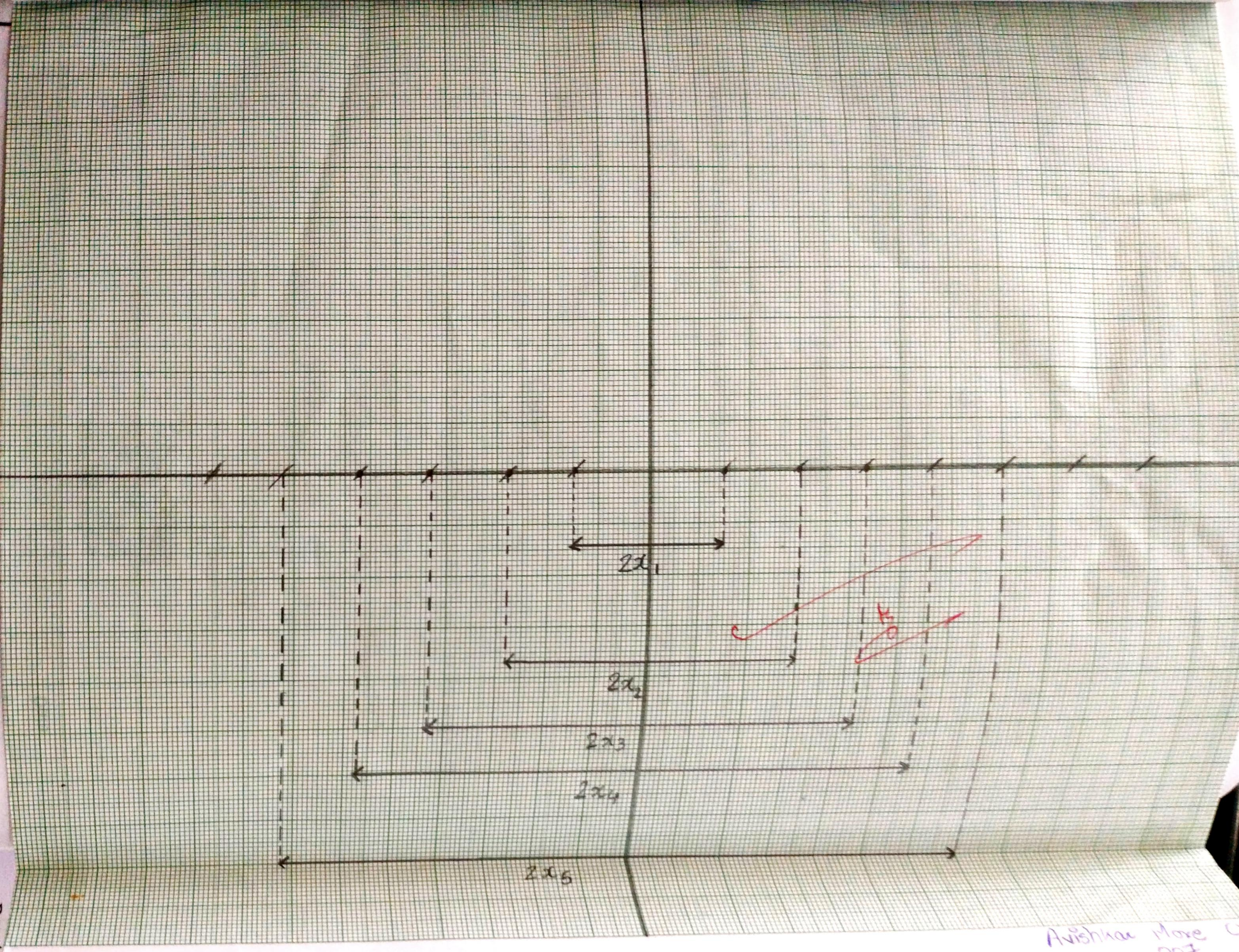
$$\frac{\delta x_3}{x_3} = \frac{0.1}{4.3} = 0.02325$$

$$\frac{\delta x_4}{x_4} = \frac{0.1}{5.625} = 0.01$$

$$\frac{\delta x_5}{x_5} = \frac{0.1}{7.1} = 0.014$$

Result:

The wavelength of laser light is found to be 717.24 nm



2x1
2x2
2x3
2x4
2x5

LASER DIFFRACTION

Experiment No: 3

Date: 24/4/25

Aim: To determine the wavelength of a given laser beam

Apparatus: Laser source, Grating, Optical bench with accessories and metre scale etc.,

Principle: The principle of the experiment is diffraction and it is the bending of a waves round the corners of an obstacle, its effects are well observed if the wavelength is comparable with the size of the obstacle. Grating is a plane glass plate on which equidistant, parallel lines are ruled with a diamond tip. The ruled portion is opaque and the space between the rulings acts as slit. The number of lines are ruled such that the width of the line is of the order of wavelength of the light used. When the laser beam is incident on the grating the rulings on the grating will act as obstacles and the laser light will undergo diffraction. The diffraction pattern consists of a central maximum, secondary maxima and minima on either side of the central maximum. On a screen placed behind the grating the diffraction pattern is seen with a central bright laser spot (the central maximum) and bright spots of decreasing brightness (secondary maxima) on either side of the central bright spot. The angle of diffraction is measured and it is used to calculate the wavelength of the laser light.

Formula:

Wavelength of laser light, $\lambda = \dfrac{C \sin\theta_n}{n}$ 717.24nm

Where C is the grating constant and it is the distance between corresponding points of two successive lines on the grating, n is the order of the maximum, θ_n is the angle of diffraction of the n^{th} maximum (in degrees).

Procedure:

- Mount the laser source on an upright stand at one end of the optical bench (or on a table). Attach a screen to another upright stand and place it at the opposite end of the laser source.
- Mark four quadrants on a graph sheet and mark the origin O, fix the graph sheet to the screen. Adjust the graph sheet's position so that the centre of the laser spot aligns with the origin 'O'.
- Mount the grating holder on an upright stand between the laser source and the screen.
- Mount the grating in the grating holder such that the lines on the grating are vertical. Note down the distance '*d*' between the grating and the screen (i.e the length of the grating on the grating stand).

<u>*Note: If the diffraction pattern on the graph sheet is inclined to the horizontal line, adjust the plane of the grating such that the diffraction pattern is on the horizontal line.*</u>

Distance between the grating and the screen = d = 102 cm

Table:

Diffraction order (n)	Distance $2X_n$(cm)	Distance X_n(cm)	Diffraction angle (θ_n in degree) $\theta_n = \tan^{-1}\left(\frac{x_n}{d}\right)$	Wavelength λ (nm) $\lambda = \frac{C \sin\theta_n}{n}$	Fractional error $\left(\frac{\delta\lambda}{\lambda}\right)$
1.	3	1.5	0.8425	746.76	0.0666
2.	5.8	2.9	1.6285	721.61	0.0344
3.	8.6	4.3	2.4139	713.06	0.02325
4.	11.25	5.625	3.1564	699.27	0.0177
5.	14.20	7.1	3.9818	706.50	0.01408
Average wavelength of the laser and fractional error				λ = 717.24 nm	0.031206

Error Formula:

The formula used wavelength of laser light is $\lambda = \frac{C \sin\theta_n}{n}$

Taking the logarithm, $\log\lambda = \log(C/n) + \log(\sin\theta)$

Simplifying, we get the relative uncertainty (or fractional uncertainty) in λ is given by:

$$\frac{\delta\lambda}{\lambda} = \frac{\delta_{x_n}}{x_n} + \frac{x_n\delta_{x_n} + \delta_d}{(x_n^2 + d^2)} \approx \frac{\delta x_n}{x_n}$$

Substitute the least count values of (x_n) distance between the central maxima and the order of diffraction and (d) distance between grating and the screen as δx_n and δd, respectively to calculate the value of $\delta\lambda/\lambda$.

Calculations:

$\lambda_1 = \frac{(5.08\times10^{-5})(0.01470)}{1} = 746.76$ nm

$\lambda_2 = \frac{(5.08\times10^{-5})(0.02841)}{2} = 721.61$ nm

$\lambda_3 = \frac{(5.08\times10^{-5})(0.04211)}{3} = 713.06$ nm

$\lambda_4 = \frac{(5.08\times10^{-5})(0.05501)}{4} = 699.27$ nm

$\lambda_5 = \frac{(5.08\times10^{-5})(0.069459)}{5} = 705.50$ nm

$\lambda_{avg} = \frac{\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5}{5} = 717.24$ nm

Result: The wavelength of laser light is found to be 717.24 nm

- Mark the centres of the central maximum and all the secondary maxima seen on the graph sheet using a pencil and remove the graph sheet from the stand.
- Measure the distance between the first-order secondary maxima on either side of the central maximum as $2X_1$. For the second-order secondary maxima, measure the distance as $2X_2$, and repeat this process for all pairs of secondary maxima on the screen.
- By using the grating constant C and the angle of diffraction θ_n, calculate the wavelength of laser light for all the orders. Finally, find the average value of wavelength.
- Calculate the fractional error $\delta\lambda/\lambda$ and tabulate the result.

$\frac{\delta\lambda}{\lambda} = \frac{\delta x_n}{x_n}$

$\Rightarrow \frac{\delta x_1}{x_1} = 0.0666$

$\frac{\delta x_2}{x_2} = 0.0344$

$\frac{\delta x_3}{x_3} = 0.02325$

$\frac{\delta x_4}{x_4} = 0.0177$

$\frac{\delta x_5}{x_5} = 0.01408$

$\left(\frac{\delta\lambda}{\lambda}\right)_{avg} = \frac{\frac{\delta x_1}{x_1} + \frac{\delta x_2}{x_2} + \frac{\delta x_3}{x_3} + \frac{\delta x_4}{x_4} + \frac{\delta x_5}{x_5}}{5}$

$= 0.031206$ → Fractional Error

Result: The wavelength of laser light is found to be 717.24 nm

30/30 R.G 08.05.25

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OBSERVATION / DATA SHEET

Date 24/4/25 Name Avishkar More

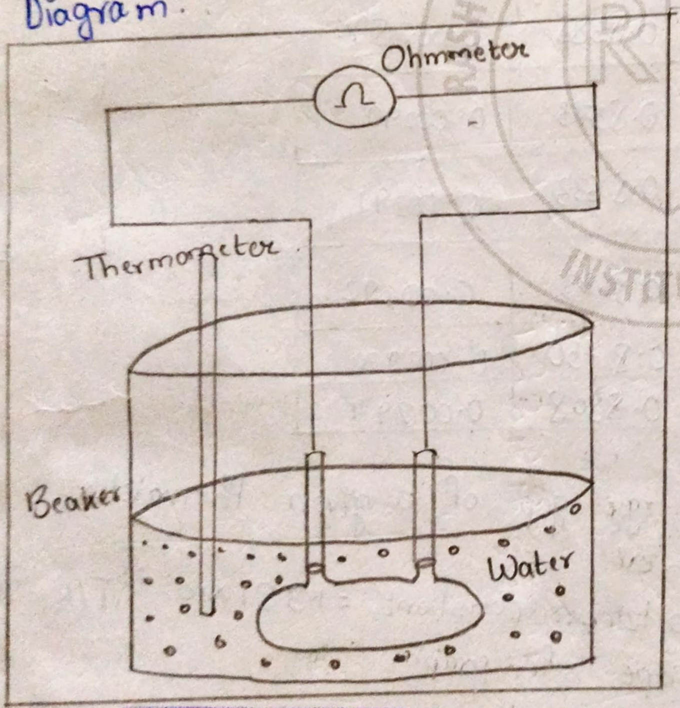
Dept./Lab CY B1 Physics LAB Class CY B1 Expt./No. 6 4

Title Band gap of a Thermistor

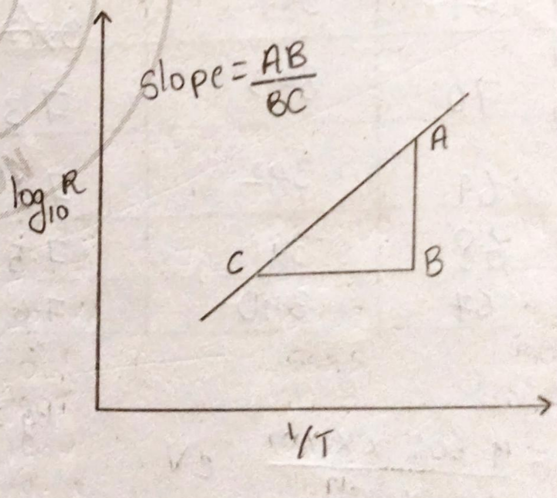
Aim: To determine the energy gap (E_g) of a Thermistor

Apparatus: Glass beaker, Thermistor, Multimeter, Thermometer

Diagram:



Model Graph:



Particulars	Max Marks	Marks Obtained	Faculty Signature
Data Sheet + Experimental setup + Viva Voce	10	4+6	R.G
Conduction of Experiment	10	9	R.G.
Substitution + Calculation + Accuracy	10	9	R.G
Total Marks	30	28	R.G

R.G

Signature of Teacher Incharge

Table:

Sl. No	Temp t°C		Temp T(K)	R (Ω)	log R	1/T
1.	Room Temp	29°C	302	30.7	1.4871	0.00331
2	80		353	~~0.6~~6.0	0.7781	0.00283
3	79		352	~~0~~6.1	0.7853	0.002840
4	78		351	~~0~~6.2	0.7923	0.002849
5	77		350	~~0~~6.3	0.7993	0.00285
6	76		349	~~0~~6.4	0.8061	0.00286
7	75		348	~~0~~6.5	0.8129	0.00287
8.	74		347	~~0~~6.7	0.8260	0.00288
9	73		346	~~0~~6.8	0.8325	0.002890
10.	72		345	~~0~~6.9	0.8388	0.002895
11.	71		344	~~0.72~~ 7.2	0.8573	0.00290
12.	70		343	7.3	0.8633	0.00291
13.	69		342	7.3	0.8633	0.00292
14.	68		341	7.5	0.8750	0.00293
15.	67		340	7.6	0.8808	0.00294

Formula:

$$E_g = \frac{4.606 \times K \times m}{1.6 \times 10^{-19}} \text{ eV}$$

E_g : Energy gap of a given thermistor in eV

K : Boltzman constant $= 1.381 \times 10^{-23}$ J/

m : slope of graph

More

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 24|4|25 Name Avishkar More

Dept./Lab Physics Lab B1 Class CY B1 Expt./No. 4

Title Band Gap of Thermistor

Calculations

From graph,
A $(3.1400 \times 10^{-3}, 1.0798)$
B $(3.1400 \times 10^{-3}, 0.8500)$
C $(2.9199 \times 10^{-3}, 0.8500)$

$$m = \frac{AB}{BC} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{(1.0798 - 0.8500)10^{+3}}{(3.1400 - 2.9199)} = \frac{(0.2298)10^{+3}}{0.2201} = 1.0440 \times 10^{+3}$$

$$\log(R) = \log(30.7) = 1.4871$$

$$\frac{1}{T} = \frac{1}{302} = 0.00331 = 3.31 \times 10^{-3}$$

$$E_g = \frac{4.606 \times K \times m}{1.6 \times 10^{-19}} \text{ eV} \qquad K = 1.381 \times 10^{-23}$$

$$= \frac{4.606 \times 1.381 \times 1.044 \times 10^{-23} \times 10^{3}}{1.6 \times 10^{-19}}$$

$= \cancel{4.1504 \times 10^{-1}}$ $\quad 4.1504 \times 10^{-1}$

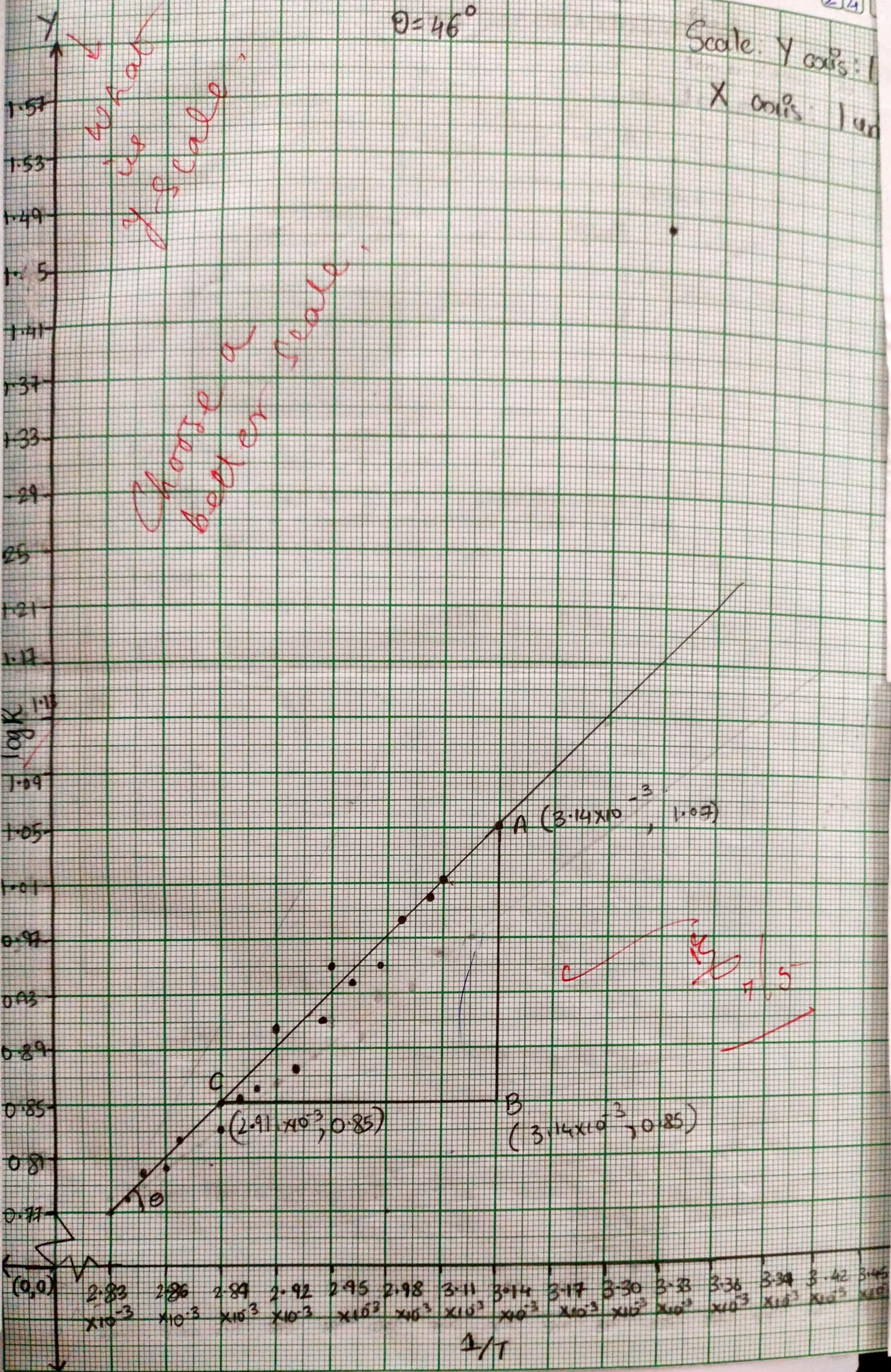
$\boxed{\cancel{E_g = 0.41504 \text{ eV}}}$ $\quad \boxed{E_g = 4.1504 \times 10^{-1} \text{ eV} = 0.41504 \text{ eV}}$

Result:
The energy gap (band gap) of the given thermistor is 0.41504 eV

Signature of Teacher Incharge

Aishkar More

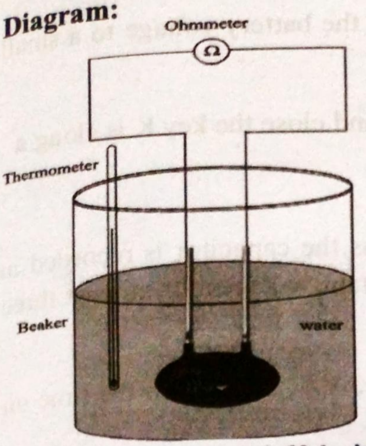
CY 007 DATE : 24



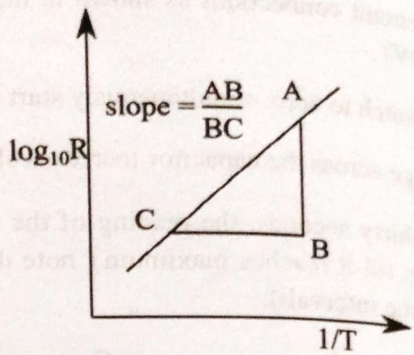
BAND GAP OF A THERMISTOR

OBSERVATIONS:

Diagram:



Model Graph:



Formula: $E_g = \dfrac{4.606 \times k \times m}{1.6 \times 10^{-19}}$ eV

Where E_g = Energy gap of a given thermistor in eV

k = Boltzmann constant = 1.381×10^{-23} J/K

m = Slope of the graph

Table:

Sl. No	Temp t°C		Temp T(K)	R (Ω)	log R	1/T
1.	Room Temp	29	302	30.7	1.4871	0.00331
2.	80		353	6.0	0.7781	0.00283
3.	78		351	6.2	0.7923	0.002849
4.	76		349	6.4	0.8061	0.00286
5.	74		347	6.7	0.8261	0.00288
6.	72		345	6.9	0.8388	0.002895
7.	70		343	7.3	0.8633	0.00291
.	68		341	7.5	0.8750	0.00293
.	67		340	7.6	0.8808	0.00294
.	71		344	7.2	0.8573	0.00290

CALCULATIONS:

$E_g = \dfrac{4.606 \times k \times m}{1.6 \times 10^{-19}}$ eV

$m = 1.044 \times 10^{3}$

$\log R = 1.4871$

$1/T = 3.31 \times 10^{-3}$

$E_g = \dfrac{4.606 \times 1.381 \times 10^{-23} \times 1}{1.6 \times 10^{-19}}$

$= 4.1504 \times 10^{-1}$

$E_g = 0.41504$ eV

Result: The energy gap (band gap) of the given thermistor is 0.41504 eV.

BAND GAP OF A THERMISTOR

Experiment No: 4 Date: 24/4/25

Aim: To determine the energy gap (E_g) of a Thermistor.

Apparatus: Glass beaker, Thermistor, Multi meter, Thermometer.

Principle: A thermistor is a thermally sensitive resistor. Thermistors are made of semiconducting materials such as oxides of Nickel, Cobalt, Manganese and Zinc. They are available in the form of beads, rods and discs.

The variation of resistance of thermistor is given by $R = a\,e^{\frac{b}{T}}$ where 'a' and 'b' are constants for a given thermistor, b is a measure of the band gap. The resistance of thermistor decreases exponentially with rise in temperature. At absolute zero all the electrons in the thermistor are in valence band and conduction band is empty. As the temperature increases electrons jump to conduction band, as the charge carriers are increasing with increase in temperature the conductivity increases and hence resistance decreases. By measuring the resistance of thermistor at different temperatures the energy gap is determined.

Formula: $E_g = \dfrac{4.606 \times k \times m}{1.6 \times 10^{-19}} eV$

Where, E_g = Energy gap of a given thermistor in eV, k = Boltzmann constant = 1.381×10^{-23} J/K.

m = Slope of the graph of log R vs 1/T.

Procedure:

- Make the circuit connection as shown in the figure.
- Keep the multi meter in resistance mode (200 Ω range).
- Insert the thermometer and thermistor into a beaker containing tap water, and note down the resistance of the and the room temperature of the thermister.
- Immerse the thermistor in hot water at about 90°C.
- Note down the resistance (R) of the thermistor for every decrement of 1°C in the beginning and a decrement of 2^0 up to 60°C.
- Plot the graph of log R versus 1/T and calculate the slope 'm'. (T is the temperature of the thermistor in kelvin)
- Calculate the energy gap of a given thermistor using relevant formula.

28/30

Result: The energy gap (band gap) of the given thermistor is 0.41504 eV.

08.05.25

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OBSERVATION / DATA SHEET

Date 8/5/25 Name Avishkar More

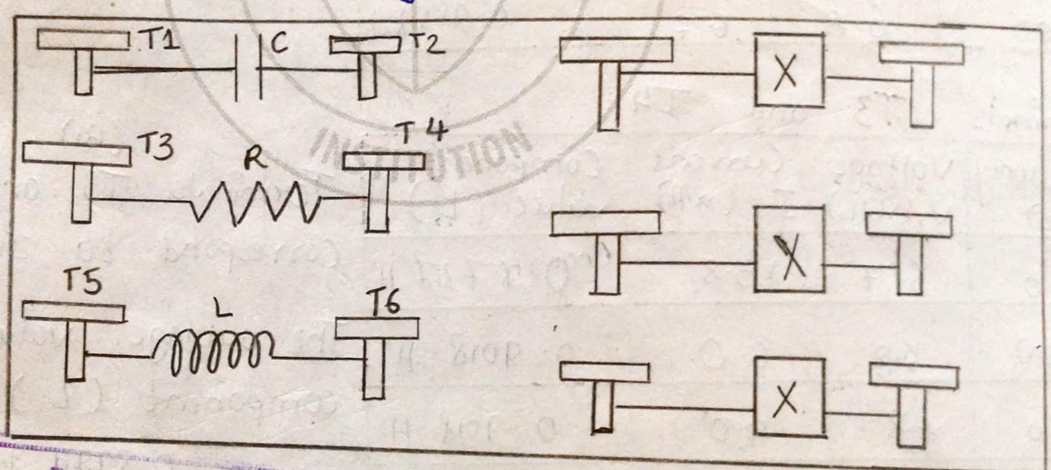
Dept./Lab Physics LAB B1 Class CY B1 Expt./No. ~~7~~ 5

Title Black Box

Aim: Identification of the unknown passive electrical components (L, C and R) enclosed in a blackbox and determination of their values.

Apparatus: Black box, audio frequency oscillator, ac milli-ammeter (0-20 mA) and ac voltmeter (digital multi meter in ac voltage mode).

Observations:



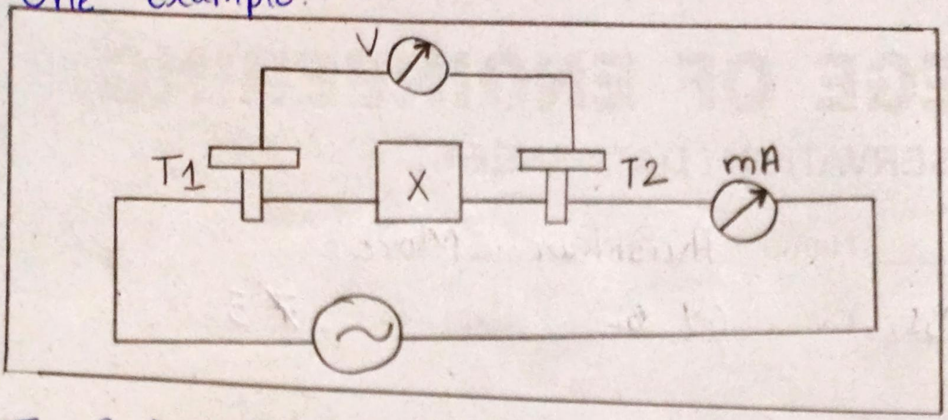
X could be a resistor, capacitor or an inductor.

Particulars	Max Marks	Marks Obtained	Faculty Signature
Data Sheet + Experimental setup + Viva Voce	10	4+6	Rg
Conduction of Experiment	10	10	Rg
Substitution + Calculation + Accuracy	10	10	Rg
Total Marks	30	30	Rg

Rg

Signature of Teacher Incharge

One example:



Terminals T1 and T2:

Frequency (Hz)	Voltage, V (Volts)	Current, I (mA)	Component value (R)
100	6.9 ~~6.87~~	6.7	1.0298 KΩ
200	6.8	6.7	1.0149 KΩ
300	6.7	6.7	1 KΩ
400	6.6	6.7	0.985 KΩ
500	6.6	6.7	0.985 KΩ
600	6.6	6.7	0.985 KΩ

Terminals T1 (A1) and T2 (A2) correspond to Resistor

The average value of the component (R) is 999.48 Ω

Terminals T3 and T4:

Frequency (Hz)	Voltage V, (Volts)	Current I, (mA)	Component value (L)
100	6.7	13.8	0.7727 H
200	6.8	6.0	0.9018 H
300	6.8	4.0	0.9018 H
400	6.8	2.9	0.9329 H
500	6.8	2.3	0.9410 H
600	6.8	1.9	0.9493 H

Terminals T3 (B1) and T4 (B2) correspond to Inductor

The average value of the component (L) is 0.8999 H

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OBSERVATION / DATA SHEET

ate 8/5/25 Name Avishkar More

ept./Lab Physics LAB B1 Class CY B1 Expt./No. ~~7~~ 5

tle Black Box

rminals T5 (C1) and T6 (C2):

equency (Hz)	Voltage V, (Volts)	Current I, (mA)	Component value (C)
100	6.8	0.07	0.1638 μF
200	6.7	1.7	0.2019 μF
300	6.8	2.7	0.2106 μF
400	6.8	3.8	0.2223 μF
500	6.7	4.7	0.2232 μF
600	6.7	5.8	0.2296 μF

Terminals T5 and T6 correspond to Capacitor

The average value of the component (C) is ~~0.2296~~.

0.2085 μF

mulae:

resistance: $R = \frac{V}{I}$ (Ω)

inductance: $L = \frac{V}{2\pi f I}$ (H)

capacitance: $C = \frac{I}{2\pi f V}$ (μF)

where
V : Potential difference across
I: Current through the component
L: Inductance
C: Capacitance
R: Resistance
f: frequency of applied signal

Signature of
Teacher Incharge

Calculations:

$R = \frac{V}{I}$

$R_1 = \frac{6.9}{6.7\times10^{-3}} = 1.0298\times10^{3}\,\Omega$

$R_2 = \frac{6.8}{6.7\times10^{-3}} = 1.0149\times10^{3}\,\Omega$

$R_3 = \frac{6.7}{6.7\times10^{-3}} = 1\times10^{3}\,\Omega$

$R_4 = \frac{6.6}{6.7\times10^{-3}} = 0.985\times10^{3}\,\Omega = R_5 = R_6$

$R_{avg} = \frac{R_1+R_2+R_3+R_4+R_5+R_6}{6} = \frac{5.9999\times10^{3}}{6} = 0.99998\times10^{3}$

$= 999.98\,\Omega$

Inductor: $L = \frac{V}{2\pi f . I}$

$L_1 = \frac{6.7}{2(\pi)(100)(13.8)\times10^{-3}} = 0.7727\ H$

$L_2 = \frac{6.8}{2\pi(200)(6\times10^{-3})} = 0.9018\ H$

$L_3 = \frac{6.8}{2\pi(300)(4\times10^{-3})} = 0.9018\ H$

$L_4 = \frac{6.8}{2\pi(400)(2.9\times10^{-3})} = 0.932$

$L_5 = \frac{6.8}{2\pi(500)(2.3\times10^{-3})} = 0.94$

$L_6 = \frac{6.8}{2\pi(600)(1.9\times10^{-3})} = 0.94$

$L_{avg} = \frac{L_1+L_2+L_3+L_4+L_5+L_6}{6} = \frac{5.3995}{6} = 0.8999\ H$

Capacitor: $C = \frac{I}{2\pi f V}$

$C_1 = \frac{0.7\times10^{-3}}{2\pi(100)(6.8)} = 1.638\times10^{-7} = 0.1638\ \mu F$

$\cancel{= 16.38\times10^{-6} =}$

$C_2 = \frac{1.7\times10^{-3}}{2\pi(200)(6.7)} = 0.2019\ \mu F$

$C_3 = \frac{2.7\times10^{-3}}{2\pi(300)(6.8)} = 0.2106\ \mu F$

$C_4 = \frac{3.8\times10^{-3}}{2\pi(400)(6.8)} = 0.2223\ \mu F$

$C_5 = \frac{4.7\times10^{-3}}{2\pi(500)(6.7)} = 0.2232\ \mu F$

$C_6 = \frac{5.8\times10^{-3}}{2\pi(600)(6.7)}$

$= 0.2296\ \mu$

$C_{avg} = \frac{C_1+C_2+C_3+C_4+C_5+C_6}{6}$

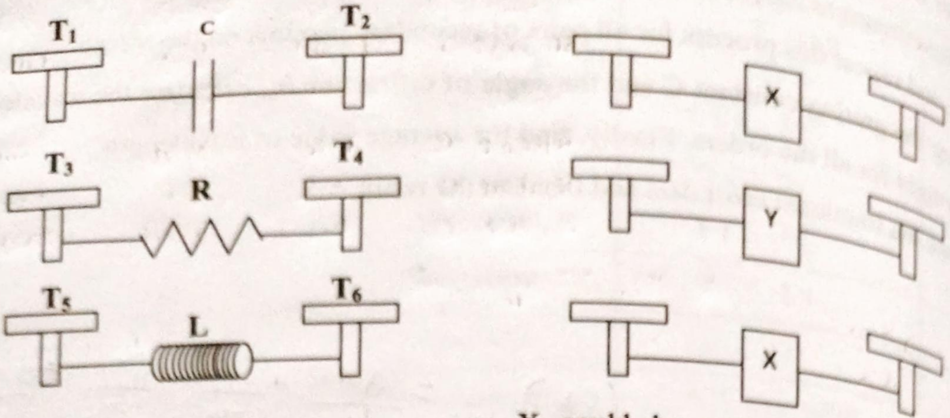
$= \frac{1.2514}{6}$

$C_{avg} = 0.2085\ \mu F$

Paste the data sheets here

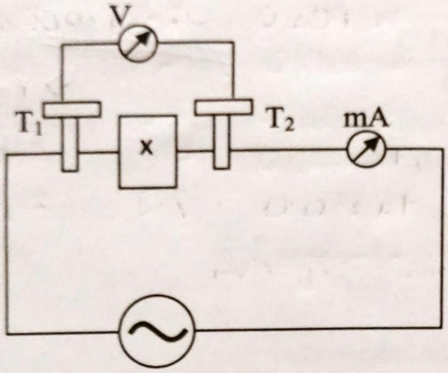
BLACK BOX

OBSERVATIONS:



One Example

X could be a resistor, capacitor or an inductor.



Audio Oscillator

TERMINALS T_1 AND T_2

Frequency (Hz)	Voltage, V (Volts)	Current, I (mA)	Component value (R)
100	6.9	6.7	1.02298 KΩ
200	6.8	6.7	1.0149 KΩ
300	6.7	6.7	1 KΩ
400	6.6	6.7	0.985 KΩ
500	6.6	6.7	0.985 KΩ
600	6.6	6.7	0.985 KΩ

Terminals T_1 and T_2 correspond to resi

The average value of the component (R) i

Average = 0.99498 KΩ

BLACK BOX

Experiment No: 5 Date: 8|5|25

Aim: Identification of the unknown passive electrical components (L,C and R) enclosed in a black box and determination of their values.

Apparatus: Black box, audio frequency oscillator, ac milli-ammeter (0-20 mA) and ac voltmeter (digital multimeter in ac voltage mode).

Theory: In an AC circuit containing pure resistance (Ohmic), the current and the potential difference across the resistance are related according to the relation, $V_{rms} = I_{rms} R$. The value of R does not change by changing frequency. In a pure inductive AC circuit, the induced emf opposes the variation of current through it. Also, the induced emf is equal in magnitude and opposite in direction to the applied emf. The current in the circuit lags behind the voltage by $\pi/2$. In an AC circuit containing capacitor only, the current leads the applied voltage by $\pi/2$.
Resistance: It is the opposition to the flow of electric current through the conductor. R = V/I.
Inductive Reactance: It is the opposition offered by the inductor to the alternating current. $X_L = L2\pi f$. Capacitive reactance: It is the opposition offered by the capacitor to the alternating current $X_C = \dfrac{1}{C2\pi f}$. Reactance: It is the difference of Inductive reactance and Capacitive reactance $X = X_L \sim X_C$. Impedance: It is the effective opposition due to the resistance and reactance $Z = \sqrt{R^2 - (X_L - X_C)^2}$.

Description: Black box is a closed box, which consists of an inductor, a capacitor and a resistor. One passive component is connected across each pair of terminals. At a time one pair of terminals is connected in the circuit and the frequency response of the element is studied. The black box is a device or system that can be viewed in terms of its input, output, or transfer characteristics without any knowledge of the terminal inside.

Procedure:

1. Make the circuit connection as shown in the diagram selecting a pair of terminals in the box corresponding to one circuit element inside the black box.
2. Press the selector knob (at the extreme left bottom) in the Audio Oscillator. The digital display shows the voltage of the ac source. Set the voltage to some suitable value by adjusting the level knob.
3. Release the selector knob (at the extreme left bottom) in the Audio Oscillator. The digital display shows the frequency of the ac source. Set the frequency to 1000Hz range by pressing the frequency selector knob
4. Gradually vary the frequency of the applied signal from a small value, note down in the tabular column, the voltqge across the terminals selected and the current through the circuit.
5. Repeat the experiment for terminals T_3 and T_4 then for the terminals T_5 and T_6.
6. From the measured data identify the component across each pair of terminals and the value of the component.

TERMINALS T_3 AND T_4

Frequency (Hz)	Voltage, V (Volts)	Current I (mA)	Component value (L)
100	6.7	13.8	0.7727 H
200	6.8	6.0	0.9018 H
300	6.8	4.0	0.9018 H
400	6.8	2.9	0.9329 H
500	6.8	2.3	0.9410 H
600	6.8	1.9	0.9493 H

Average = 0.8999 H

Terminals T_3 and T_4 correspond to inductor

The average value of the component (L) is 0.8999

TERMINALS T_5 AND T_6

Frequency (Hz)	Voltage, V (Volts)	Current, I (mA)	Component value C
100	6.8	0.7	0.1638 μF
200	6.7	1.7	0.2019 μF
300	6.8	2.7	0.2106 μF
400	6.8	3.8	0.2223 μF
500	6.7	4.7	0.2232 μF
600	6.7	5.8	0.2216 μF

Average = 0.2085 μF

Terminals T_5 and T_6 correspond to capacitor

The average value of the component (C) is 0.2

Formulae

- For resistance: $R = \frac{V}{I}$ (Ω)
- For inductance: $L = \frac{V}{2\pi f I}$ (H)
- For capacitance: $C = \frac{I}{2\pi f V}$ (μF)

where

V is the potential difference across,
I is the current through the component.
L is the inductance
C is the capacitance
R is the resistance
f is the frequency of applied signal

Calculations:

$L_1 = \frac{6.7}{2\pi(100)(13.8)\times10^{-3}} = 0.7727$ H

$L_2 = 0.9018$ H

$L_3 = \frac{6.8}{2\pi(300)(4\times10^{-3})} = 0.9018$ H

$L_4 = 0.9329$ H

$L_5 = 0.9410$ H

$L_6 = 0.9493$ H

$R_1 = \frac{6.9}{6.7\times10^{-3}}$ = 1

$R_2 = \frac{6.8}{6.7\times10^{-3}}$ = 1.01

$R_3 = 1$ KΩ

$R_4 = \frac{6.6}{6.7\times10^{-3}} = 0.985$ KΩ

$= R_5 = R_6$

a) Identification and determination of resistance

If the current and the voltage are not varying with the change with frequency then the component across the terminals is a resistor. When a pure resistor is in an ac circuit the resistance of the resistor doesn't vary with frequency. The value of the resistance is calculated using the formula $R = \frac{V}{I}$ Ω

b) Identification and determination of capacitance

If the current I, through the element increases and the voltage V across its ends decreases with increase in the of the source, it can be concluded that the component across the terminals is a capacitor

The capacitive reactance X_C, varies inversely with the frequency. That is $X_C = 1/2\pi fC$ where C is the capacitance of the capacitor. The value of the capacitance of the capacitor is calculated using the formula

$$C = \frac{1}{2\pi f X_c} = \frac{I}{2\pi f V}$$

where f is the frequency of the applied voltage.

c) Identification and determination of inductance of the inductor.

If the current I, through the element decreases and the voltage V across its ends increases with increase in the frequency of the source, it can be concluded that the component across the terminals is an inductor.

The inductive reactance X_L, varies directly with the frequency. That is $X_L = L2\pi f$ where L is the inductance of the inductor. The value of the inductance of the inductor is determined by using the formula $L = \frac{1}{2\pi f X_l} = \frac{V}{2\pi f I}$

$C_1 = \frac{0.7\times10^{-3}}{2\pi(100)(6.8)} = 1.638\times10^{-7} = 0.1638$ μF

$C_2 = \frac{1.7\times10^{-3}}{2\pi(200)(6.7)} = 0.2019$ μF

$C_3 = \frac{2.7\times10^{-3}}{2\pi(300)(6.8)} = 0.2106$ μF

$C_4 = 0.2223$ μF

$C_5 = 0.2232$ μF

$C_6 = \frac{5.8\times10^{-3}}{2\pi(600)(6.7)}$

$C_6 = 0.2296$ μF

Results:

1. The component resistor of value 999.98 Ω is connected across terminals T1 and T2.
2. The component inductor of value 0.8999 H is connected across terminals T3 and T4
3. The component capacitor of value 0.2085 μF is connected across terminals T5 and T6

$R_{avg} = \frac{R_1+R_2+R_3+R_4+R_5+R_6}{6} = \frac{5.9999\times10^3}{6} = 0.99998\times10^3 = 999.98$ Ω

$C_{avg} = \frac{\sum_1^6 C_n}{6} = \frac{1.2514}{6} = 0.2085$ μF

$L_{avg} = \frac{\sum_1^6 L_n}{6} = \frac{5.3995}{6} = 0.8999$ H

30

15/05/25

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OBSERVATION / DATA SHEET

Date 8/5/25 Name Avishkar More

Dept./Lab Physics LAB B1 Class CY B1 Expt./No. ~~8~~ 6

Title Numerical Aperture and Alternuation coefficient of an Optical Fiber

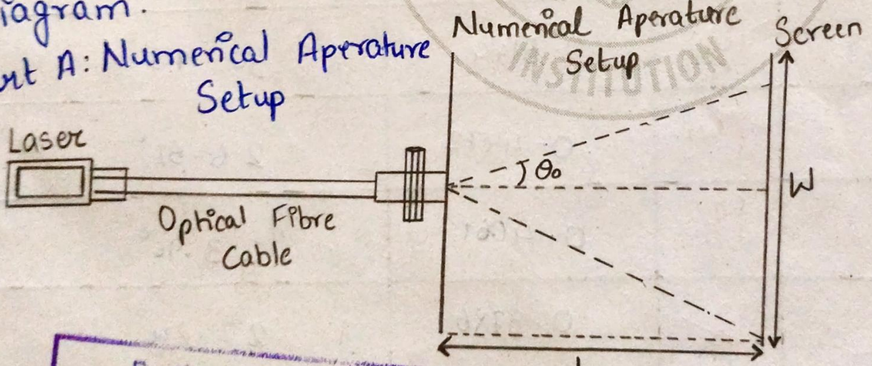
Aim: Part A: To determine the Numerical apperture of the given Optical Fiber.

Part B: To measure the alternuation coefficient of the given Optical Fiber.

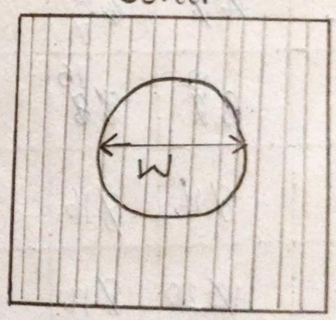
Apparatus: Optical Fibre Kit, Optical Fibre Cables, In-line adapter, Numerical Aperture. Jig.

Diagram:

Part A: Numerical Aperature Setup



Screen



W = Width of the light spot

Particulars	Max Marks	Marks Obtained	Faculty Signature
Data Sheet + Experimental setup + Viva Voce	10	4+5	R.y
Conduction of Experiment	10	9	R.y
Substitution + Calculation + Accuracy	10	10	R.y
Total Marks	30	28	R.y

R.y

Signature of Teacher Incharge

$NA = \sin\theta_0 = \frac{W}{\sqrt{(4L^2+W^2)}}$

W: Diameter of the beam spot in mm

L: Distance from Optical to the screen in mm

Part B: Measurement of attenuation coefficient

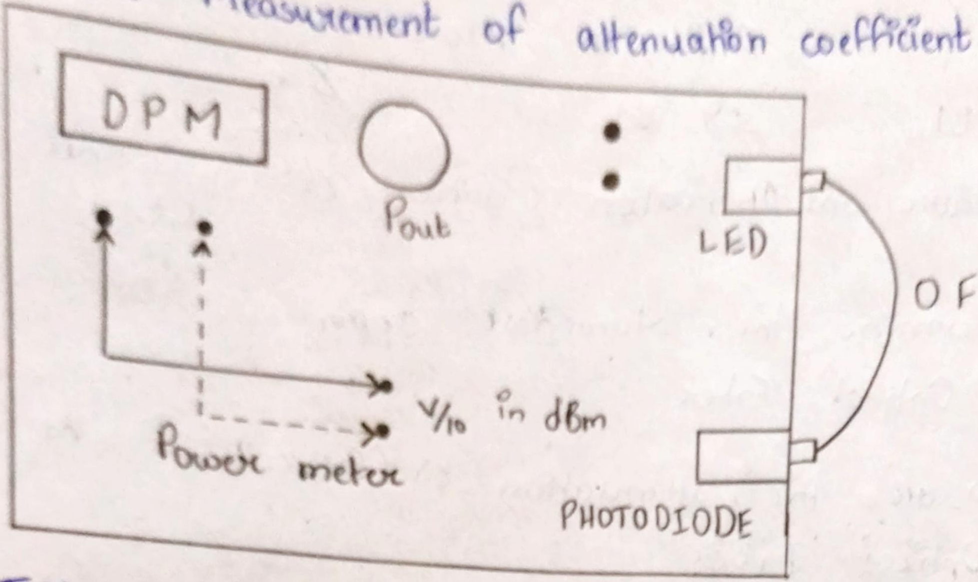


Table A: Numerical Aperature

SI No.	W1 (mm) Dia	W2 (mm)	$W=\frac{(W_1+W_2)}{2}$	L (mm)	$NA=\sin\theta_0=\frac{W}{\sqrt{(4L^2+W^2)}}$	Acceptance angle $\theta=\sin^{-1}(NA)$ in d
1	~~4 8~~ 12	~~6~~ 12	12	10	0.5144	30.95°
2	~~8 8~~ 12	~~8 8~~ 16	14	14	0.4472	26.56°
3	~~8~~ 16	~~8~~ 16	16	18	0.4061	23.96°
4	~~10~~ 20	~~8~~ 16	18	22	0.3786	22.24°

Average: $1.7463/4 = 0.4365$ 25.92°

Table B: Attenuation coefficient

Length, L (m)	A (P_{o_1}) Output Power	Length L (m)	B (P_{o_5}) Output Power	(B − A) Attenuation for 4m length in dB
1	−15	5	−18.22	−3.22

Attenuation = B − A = −18.22 − (−15)

= −3.22

Length, L = 4m

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OBSERVATION / DATA SHEET

Date 8/5/25 Name Avishkar More

Dept./Lab Physics LAB B1 Class CY B1 Expt./No. ~~8~~ 6

Title Numerical Aperture and Attenuation coefficient of an Optical Fibre

Calculations:

Attenuation per unit length = $\frac{\text{Attenuation loss}}{\text{length}} = \frac{-3.22}{4} = -0.805$

$B - A = -18.22 - (-15)$

$= -3.22 \Rightarrow$ ~~10 log (+3.22) =~~

$\frac{W}{\sqrt{4L^2+W^2}} \Rightarrow$ 1) $\frac{12}{\sqrt{4.100+144}} = 0.5144$ 3) $\frac{16}{\sqrt{4.324+256}} = 0.4061$

2) $\frac{14}{\sqrt{4.196+196}} = 0.4472$ 4) $\frac{18}{\sqrt{4.484+324}} = 0.3786$

$\sin^{-1}(0.5144) = 30.95^\circ$

$\sin^{-1}(0.4472) = 26.56^\circ$

$\sin^{-1}(0.4061) = 23.96^\circ$

$\sin^{-1}(0.3786) = 22.24^\circ$

$\sin^{-1}(0.4365) = 25.89^\circ$

average (NA) $= \frac{0.5144+0.4472+0.4061+0.3786}{4} = \frac{1.7463}{4} = 0.4365$

average $(\theta_0) = \frac{30.95' + 26.56 + 23.96 + 22.24}{4} = 25.92^\circ$

Signature of
Teacher Incharge

Attenuation loss $= -10 \log (P_o/P_i)$

$P_o = -18.22$ $\Rightarrow -10 \log \left(\frac{+18.22}{+15}\right)$

$P_i = -15$

$\Rightarrow -0.8445$ dB

Attenuation per unit length $= \frac{\text{Attenuation loss}}{\text{length}} = \frac{-0.8445}{4}$

$= -0.2111$ dB/m

NUMERICAL APERTURE AND ATTENUATION COEFFICIENT OF AN OPTICAL FIBER

Experiment No: 6

Date: 8/5/25

Aim: Part A: To determine the Numerical aperture of the given Optical Fibre

Part B: To measure the attenuation coefficient of the given Optical Fibre

Apparatus: Optical Fibre Kit, Optical fibre cables, In-line adapter, Numerical Aperture Jig.

Part A: To determine the Numerical aperture of Optical Fibre

Principle:

Optical fibres are wave guides that transmit light from one point to another. The principle behind the propagation of light in the optical fibre is Total Internal Reflection (TIR) at the core-cladding interface.

Acceptance angle (θ_0) is the maximum angle of incidence with the axis of the optical fiber at which a light ray can enter the fiber and propagates through the core by total internal reflection. If a light ray enters the fiber at an angle greater than this acceptance angle, it will not undergo total internal reflection and will instead is lost from core through the cladding.

The input and output cones of light beams are symmetric in an optical fibre. The acceptance angle (θ_a) is the semi-vertical angle of the input cone. Due to this symmetry, the semi-vertical angle of the emergent cone at the output end of the fibre is equal to the acceptance angle.

Numerical Aperture (NA): It is the light gathering ability of the optical fibre and it is equal to Sine of acceptance angle.

$$\sin\theta_0 = \frac{n_1}{n_0}\sqrt{1-\frac{n_2^2}{n_1^2}} = \frac{\sqrt{n_1^2-n_2^2}}{n_0}$$

Where, n_1 and n_2 are the refractive indices of the core and cladding of the optical fibre respectively, n_0 is the refractive index of the surrounding medium (for air or vacuum n_0=1)

Procedure:

- Plug the kit to the AC mains and switch on the circuit board. Light should appear at the end of the LED coupler.
- Connect one end of the optical fibre cable (1-metre) to LED and the other end to the numerical aperture jig as shown in the figure. Avoid bends in the optical fibre.
- Turn the P_{out} knob clockwise to set to maximum power for the maximum intensity of the laser spot.
- Place the white screen at a distance L from the output end of the optical fibre such that the light coming out of the fibre falls on the screen and the centre of the spot coincides with the centre of the circular scale on the screen.

Paste the data sheets here

Table A: Numerical aperture

Sl. No	W_1 (mm)	W_2 (mm)	W= $(W_1+W_2)/2$	L(mm)	$NA = \sin\theta_o = \frac{W}{\sqrt{(4L^2+W^2)}}$	Acceptance angle, $\theta = \sin^{-1}(NA)$ in degree
1.	12	12	12	10	0.5144	30.96^0
2.	12	16	14	14	0.4472	26.56^0
3.	16	16	16	18	0.4061	23.96^0
4.	20	16	18	22	0.3786	22.24^0

Average: 0.4365 25.92^0

Table B: Attenuation coefficient

Length L in (m)	A Output power P_{o1}	Length L in (m)	(B) Output power P_{o5}	(B-A) Attenuation for 4m length in dB
1	-15	5	-18.22	- 3.22

Attenuation = B-A = -3.22 Length L= 4m

CALCULATIONS:

Attenuation per unit length $\frac{\textit{Attenuation loss}}{\textit{length}} = \frac{-0.8445}{4}$ dB/m = ~~-0.2111~~ -211.142 dB/km

Attenuation loss $= -10\log(P_o/P_i) = -10\log\left(\frac{-15.12}{-15}\right) = -0.8445$ dB

Attenuation loss per unit length $= \frac{\text{Attenuation loss}}{\text{length}} = \frac{-0.8445}{4} = -0.21114$ dB/m

$= -211.142$ dB/km

$\frac{W}{\sqrt{4L^2+W^2}} \Rightarrow 1.\ \frac{12}{\sqrt{4.100+144}} = 0.5144 = NA_1$

$\Rightarrow NA_2 = 0.4472$ $NA_3 = 0.4061$ $NA_4 = 0.3786$

Result:

1.	The numerical aperture of the given optical fibre	0.4365
2.	The acceptance angle θ_o	25.92 °
3.	The attenuation coefficient of the fibre α	-0.211142 dB/m

$NA_{avg} = 0.4365$

- Note down the diameter of the laser spot W_1 on the horizontal axis and W_2 on the vertical axis of the scale and find the average width W of the laser spot. (Width of the laser spot = W= number of rings illuminated in the spot x 4mm).
- Repeat the experiment for different distances (L) and enter the readings in the table-A. Compute the numerical aperture and acceptance angle using the relevent formulae.

Part B: Measurement of attenuation coefficient of the material of the given Optical Fiber

Principle: Attenuation coefficient is defined as the loss in the energy of the propagating signal per unit length of the fibre. The major factors contributing to the attenuation in optical fibre are i) Absorption loss, ii) Scattering loss, iii) Bending loss, iv) Intermodal dispersion loss and v) Coupling loss or a combination of these errors. The losses are a consequence of material, composition, structural design of the fibre and can be minimized by taking proper care in selection of materials, design and the operating wavelengths.

Attenuation in fibre is measured in terms of attenuation coefficient, (α). It is denoted by symbol α and it is the attenuation per unit length. Mathematically attenuation coefficient of the fibre is given by, $\alpha = -\frac{10 \times \log(P_{out}/P_{in})}{L}$

Where P_{out} and P_{in} are the output power and input power of the signal respectively, and L is the length of the fibre.

Procedure:

- Connect one end of optical fibre cable (1 meter long) to the LED and the other end to the photo diode.
- Connect the output power terminals (near the photo diode) to the Digital Panel Meter (DPM) using a pair of wires and note down the out-put power (P_{o1}) for the 1m cable and record the reading in the table.
- Now Connect one end of optical fibre cable (5 meter long) to the LED and the other end to the photo diode.
- Connect the out-put power terminals (near the photo diode) to the Digital Panel Meter (DPM) using a pair of wires and note down the out-put power P_{o5} and record the reading in the table.
- The output power (P_{O1}) will be the input power at one metre from the source in the five metre cable.
- Calculate the attenuation coefficient ά using the formula

$ά = \frac{\textit{Attenuation loss}}{\textit{length}} = \frac{-0.8445}{4}$ dB/m $= -0.211142$ dB/m $= -211.142$ dB/km

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Result:

1.	The numerical aperture of the given optical fibre is	0. 4365
2.	The acceptance angle θ is	25.92 °
3.	The attenuation coefficient of the fibre α	-0.211142 dB/m

$\sin^{-1}(0.5144) = 30.95^0$ 23.96^0

$\sin^{-1}(0.4472) = 26.56$ 22.24^0

$\theta_{avg} = 25.92°$