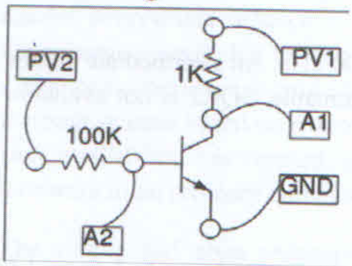
TRANSISTOR CHARACTERISTICS (expEYES-17)

Paste the data sheets here

OBSERVATIONS

Circuit diagram



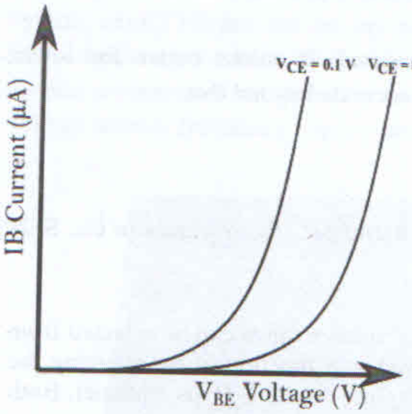
Graph plotting with GNUPLOT

Go to respective folder in which the file is saved.
Right click at the empty area and select **'open in terminal'**
Run the following commands

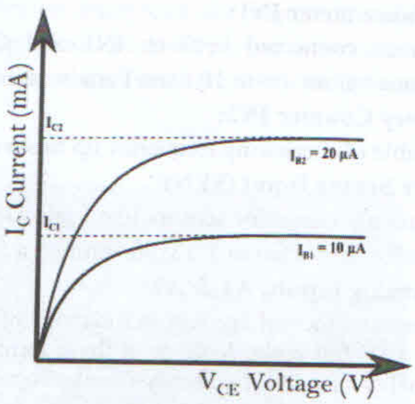
```
gnuplot
set timestamp
set title 'Transistor Characteristics-Raj'
set xlabel 'Voltage in Volts'
set ylabel 'Current in  A'
plot 'transistor-input.txt' w lp
plot 'transistor-output.txt' w lp
```

Model Graph

Input characteristics



Output characteristics



Tabular Column

Input characteristics				Output characteristics			
V_{BE}(V)	I_B(μA)	V_{BE}(V)	I_B(μA)	V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)

Calculations:

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, $\alpha = \frac{\beta}{\beta + 1} =$

Result: Current gain (β) in Common Emitter configuration is ______
Current gain (α) in Common Base configuration is _____

TRANSISTOR CHARACTERISTICS

Experiment No: Date:

Aim: To plot the V-I characteristics of the transistor and calculate the parameters α and β.

Apparatus: Transistor SL100, 1K and 100 K Ω resistors, Bread board, Connecting wires, expeyes kit.

Theory: A transistor has three terminals namely emitter, base and collector. It can be operated in three configurations *i.e.* common base, common emitter and common collector. Common emitter is the most commonly used as it has high current gain.

Procedure:

Instructions for Input Characteristics:

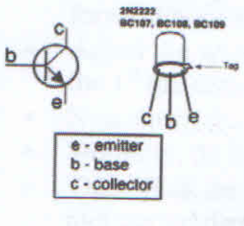
- Make the connections of NPN transistor provided with the kit as shown in the diagram.
- Enter the V_{CE} value as 0.1 volt
- Run the experiment by clicking the Start button.
- Enter the V_{CE} value as 0.5 volt and click on Start button
- save the data values by using the "Save Data" button

Instructions for Output Characteristics:

- The output characteristic curve of an NPN transistor at different base currents is plotted.
- The base current is set by the voltage at PV2.
- Enter the PV2 as 1 volt and press **START** to get a plot for a particular I_{B1}.
- Enter the PV2 as 2 volt and press **START** to get a plot for a particular I_{B2}.
- Save the data value by using the "Save Data" button.

Procedure to plot the graph using a graph sheet.
Note down the sample data points from input & output characteristics and tabulate it.

Transistor Pin Configuration



RESULT: The input and output characteristics have been plotted and

The α & β values are _____ & ______.

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 19-12-2023 Name V. MEGHA.

Dept./Lab Physics lab Class ETE Expt./No. 9

Title Transistor Characteristics.

AIM :- To plot the V-I characteristics of the transistor and calculate the parameters α and β.

APPARATUS :- Transistor SL100, 1K and 100K-Ω resistors, Bread board, connecting wires expeyes kit.

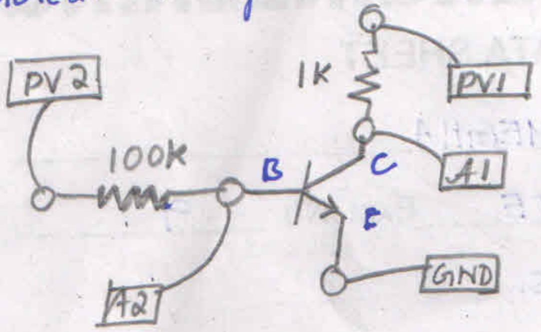
RVCE, DEPARTMENT OF PHYSICS EVALUATION OF EXPERIMENT				
Scheme of Evaluation	Course Outcome	Max Marks	Marks Scored	Initial of the Staff
Data Sheet and experimental Set up (4+6)	CO1	10	4+6	
Conduction of Experiment	CO2	10	10	
Substitution, Calculation & Accuracy	CO3	10	9	
Total Marks Scored		30	29	
Signature of the Faculty				

19/12

Signature of Teacher Incharge

OBSERVATIONS :-

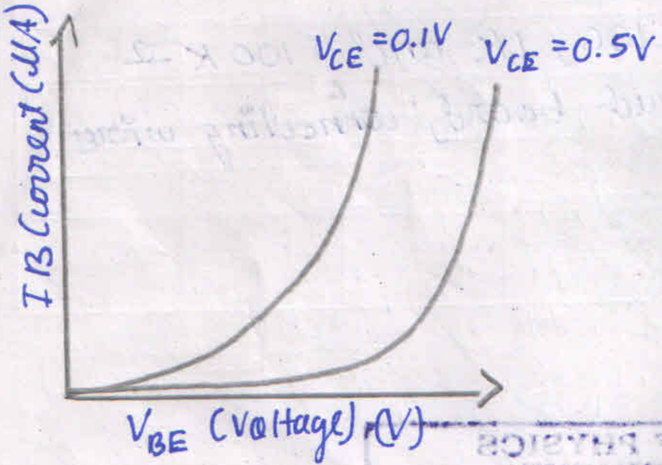
Circuit -Diagram:-

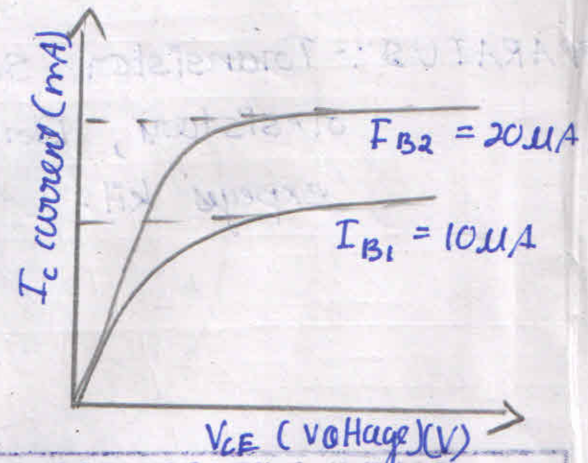


Graph plotting with GNUPLOT

```
gnuplot
set timestamp
set title 'Transistor
    Characteristics - Raj
set xlabel 'Voltage in Volts'
set ylabel 'Current in A'
plot 'transistor - input.txt' w lp
plot 'transistor - output .txt' w lp
```

Model - graph





R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 19-12-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 9

Title Transistor- Characteristics

Input Characteristics | Output - Characteristics

$V_{CE} = 0.1V$		$V_{CE} = 0.5V$		$V_{BE} = 1V$ (μA) $I_{B_1} = 4.279$		$V_{BE} = 2V$ $I_{B_2} = 13.943$	
$V_{BE}(V)$	I_B (μA)	$V_{BE}(V)$	I_B (μA)	V_{CE}	I_c (mA)	V_{CE}	I_c (mA)
0.11	0.53	0.11	0.52	0.02	0.03	0.01	0.04
0.21	0.63	0.21	0.63	0.04	0.06	0.02	0.08
0.33	0.74	0.33	0.74	0.05	0.10	0.03	0.12
0.39	0.85	0.41	0.84	0.06	0.14	0.04	0.21
0.42	0.96	0.45	0.95	0.07	0.18	0.05	0.35
0.43	1.08	0.46	1.07	0.08	0.22	0.06	0.54
0.44	1.19	0.47	1.18	0.09	0.26	0.07	0.73
0.45	1.33	0.48	1.29	0.10	0.30	0.08	0.92
0.46	1.68	0.49	1.53	0.11	0.34	0.09	1.11
0.47	2.35	0.50	1.75	0.15	0.50	0.11	1.39
0.48	3.94	0.51	1.99	0.20	0.60	0.13	1.77
0.49	5.38	0.52	2.48	0.34	0.66	0.36	2.29
0.49	6.02	0.53	4.92	0.44	0.66	0.45	2.30
		0.53	5.93	0.69	0.66	0.85	2.30
				1.05	0.66	0.95	2.30
				2.04	0.66	1.54	2.30
				2.84	0.66	2.59	2.30
				4.35	0.66	2.69	2.30

Signature of Teacher Incharge

CALCULATIONS

To calculate transistor parameters α and β from output - characteristics.

$$\beta = \left[\frac{I_{C_2} - I_{C_1}}{I_{B_2} - I_{B_1}}\right] = \left[\frac{2.30 - 0.66}{13.94 - 4.27}\right] \times 10^3 = \frac{1.64}{9.67} \times 10$$

$$\beta = 0.1696 \times 10^3$$

$$\beta = \underline{169.6}$$

Using the value of β.

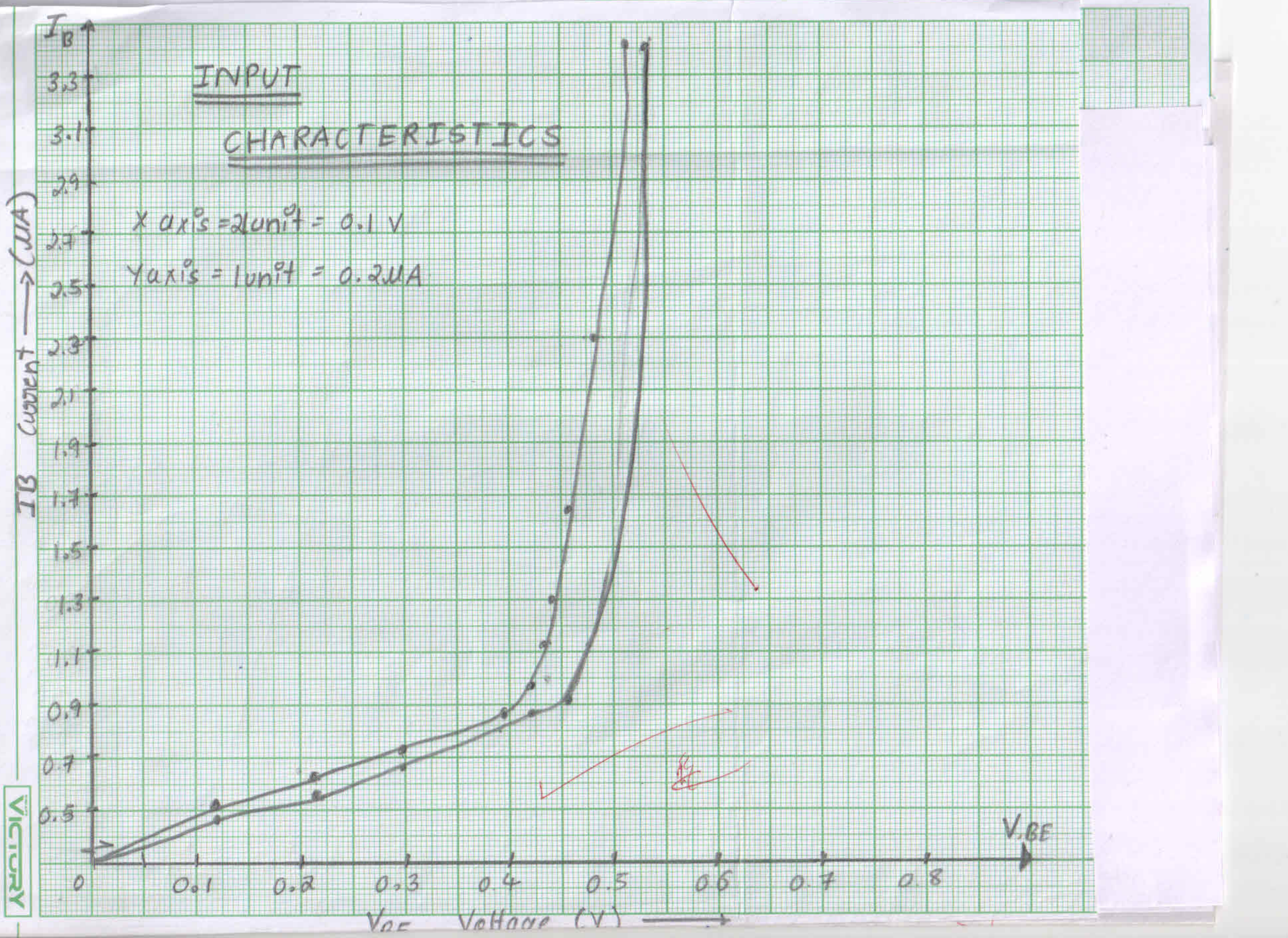
$$\alpha = \frac{\beta}{\beta + 1} = \frac{169.6}{169.6 + 1} = \frac{169.6}{170.6}$$

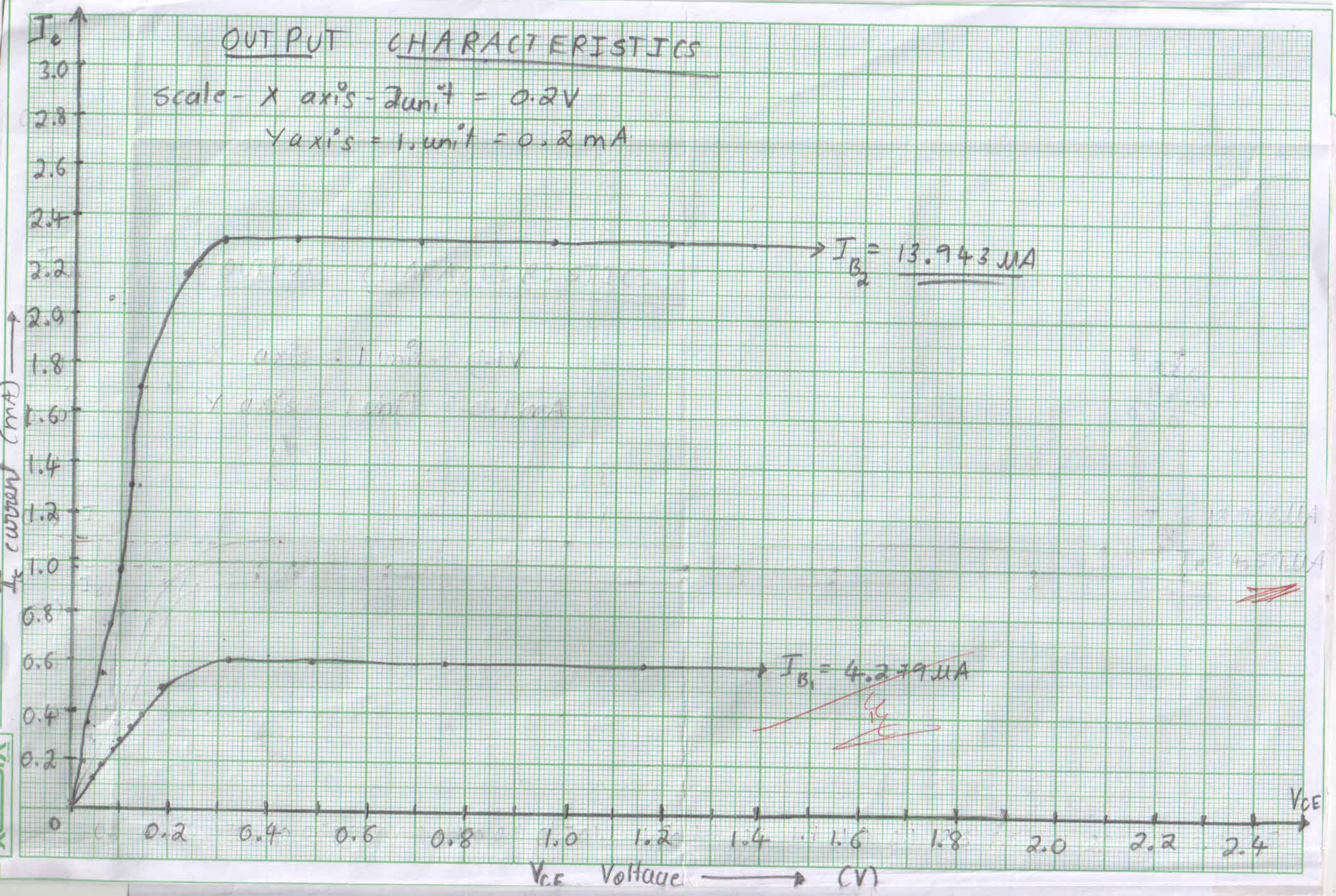
$$\alpha = \underline{0.994}$$

RESULT: Current gain (β) in common-emitter configuration is 169.6.

Current gain (α) in common-Base configuration is 0.994.

26/1/24

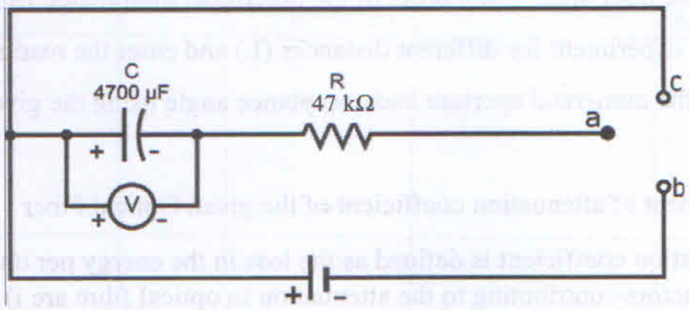

INPUT
CHARACTERISTICS
X axis = 2 unit = 0.1 V
Y axis = 1 unit = 0.2 μA
I_B
IB current ⟶ (μA)
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
3.1
3.3
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
V_{BE}
V_{BE} Voltage (V) ⟶


OUTPUT CHARACTERISTICS
Scale - X axis - 2 unit = 0.2V
Y axis = 1 unit = 0.2 mA
I_C
I_C current (mA)
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
V_{CE}
V_{CE} Voltage (V)
I_{B_2} = 13.943 μA
I_{B_1} = 4.279 μA

DIELECTRIC CONSTANT

OBSERVATIONS

Circuit diagram:



R = <u>47 KΩ</u> **Battery voltage=__________Volt**

Time in seconds (s)	Voltage during charging (V)	Voltage during discharging (V)
0		
30		
60		
90		
120		
.		
.		
.		
.		

Time in seconds (s)	Voltage during charging (V)	Voltage during discharging (V)

Paste the data sheets here

DIELECTRIC CONSTANT

Experiment No: Date:

Aim: To determine the capacity of a parallel plate capacitor and hence to calculate the dielectric constant of the dielectric medium in it.

Apparatus: Battery of ten volts, electrolytic capacitor, digital multi meter, two way key and stop clock.

Principle: When a capacitor and a resistor are in series with a dc source, the capacitor gets charged and at any instant the voltage of the capacitor is $V = V_0(1 - e^{-t/RC})$ where V_0 is the maximum voltage. Where RC = τ is called the time constant of the circuit, it is the time taken for the voltage to reach 63% of V_0. Similarly while discharging the voltage across the capacitor is given by $V = V_0(e^{-t/RC})$. The time constant is the time taken for voltage to decrease to 37% of the maximum value ie V_0

FORMULA:
The capacitance and dielectric constant of the given capacitor are calculated by using the formulae given below:

1. $C = \tau / R$ (F)

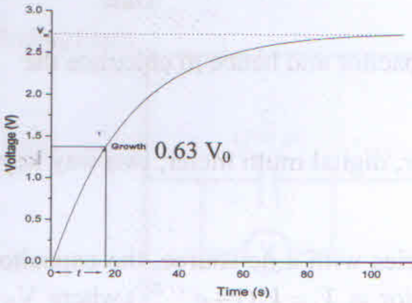
2. $\varepsilon_r = \dfrac{Cd}{\varepsilon_o A}$

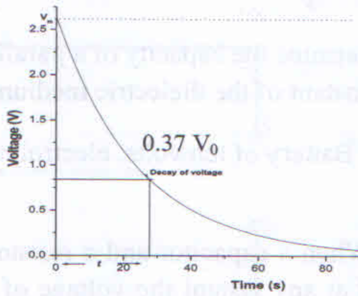
where τ : time constant.
ε_r : relative permittivity or the dielectric constant of the dielectric.
ε_o : Absolute permittivity of free space = 8.854×10^{-12} F/m.
C : capacitance of the capacitor (F).
R: resistance (Ω)
A: area of each plate (m^2).
d: thickness of the dielectric (m).

Data:

C = 3300 μF	C = 4700 μF
R = 47 kΩ	R = 47 kΩ
L = 47 cm	L = 55 cm
B = 1.5 cm	B = 2.5 cm
d = 80 μm	d = 80 μm

(I) Charging Curve **(II) Discharging Curve**:





Charging time constant $\tau_1 =$ _____ s Discharging time constant $\tau_2 =$ _____ s

Average time constant $\tau = \frac{\tau_1 + \tau_2}{2} =$ _____ s

Capacitance of the capacitor $C = \frac{\tau}{R} =$ _____ F

Where R is the resistance and C is the capacitance of the capacitor in the circuit.

Dielectric constant is determined by using the formula, $\varepsilon_r = \frac{Cd}{\varepsilon_o A}$

where τ : time constant, ε_r : dielectric constant of the dielectric.

ε_o : Absolute permittivity of free space = 8.854×10^{-12} F/m.

C: capacitance of the capacitor (F).

Calculation:

Thickness of dielectric medium, d (m)	
Area of each plate A (m^2)	

Result:

1. Capacity of parallel plate capacitor C = ______________ F
2. Dielectric constant of the given dielectric material ε_r = _____

Procedure:

(I) Charging:

The circuit connections are made as shown in the figure. To start with, the key K is closed along **a b**, the voltage across the capacitor increases slowly. For every thirty seconds, the reading of the voltmeter across the capacitor is recorded in tabular column till it reaches maximum (say 2 V). A graph of voltage versus time is drawn as shown in the figure. It is clear from the graph that the voltage increases exponentially with time and attains maximum value V_m after a finite time. The time taken by the voltage to become 63.2% of its maximum value V_m is noted. It is called time constant ($\tau = R \times C$) of the circuit

(II) Discharging

When the voltage across the capacitor is maximum, the two way key K is opened along **a and b** and closed immediately along **a and c.** Then voltage decreases with time, for every thirty seconds the voltage across the capacitor as indicated by the voltmeter is recorded in the tabular column. A graph of voltage versus time is plotted as shown in the figure. The time taken for the voltage to become 36.8% of its maximum value is noted from the graph. This is again time constant (τ).

Note:

Don't connect a wire between *b* and *c*

Multiply the result by 10^{-6}. This correction is needed because the dielectric in the given electrolytic capacitor is not a homogenous medium and it is a paper with alumina deposition by electrolysis

RESULT:

1. Capacity of parallel plate capacitor C = __________________F

2. Dielectric constant of the given dielectric material ε_r = ______

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OBSERVATION / DATA SHEET

Date 07-11-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 3

Title DIELECTRIC CONSTANT

AIM :- To determine the capacity of a parallel plate capacitor and hence to calculate the dielectric constant of the dielectric medium in it.

APPARATUS :- Battery of ten volts, electrolytic capacitor, digital multi-meter, two way key and stop clock.

RVCE, DEPARTMENT OF PHYSICS EVALUATION OF EXPERIMENT				
Scheme of Evaluation	Course Outcome	Max Marks	Marks Scored	Initial of the Staff
Data Sheet and Experimental Set up (4+6)	CO1	10	4 | 4 6 | 6	
Conduction of Experiment	CO2	10	10	
Substitution, Calculation & Accuracy	CO3	10	9	
Total Marks Scored		30	29	
Signature of the Faculty				28/11

Signature of Teacher Incharge

FORMULA :-

The capacitance and dielectric constant of the given capacitor are calculated by using the formulae given below

1) $C = \tau / R$ (F)

2) $\varepsilon_r = \dfrac{Cd}{\varepsilon_0 A}$

where τ :- time constant

ε_r :- relative permittivity or the dielectric constant of the dielectric.

ε_0 :- Absolute permittivity of free-space.

$= 8.854 \times 10^{-12}$ F/m

C :- capacitance of the capacitor (F)

R :- resistance (Ω)

A :- area of each plate (m^2)

d :- thickness of the dielectric (m)

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 07-11-2023 Name V.MEGHA

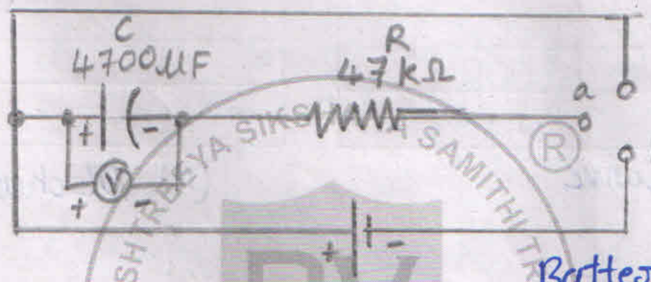
Dept./Lab Physics Lab Class ETE Expt./No. 3

Title DIELECTRIC CONSTANT

graph & 6

OBSERVATIONS :-

Circuit Diagram :-



$R = 47 K\Omega$

Battery voltage = 2 V

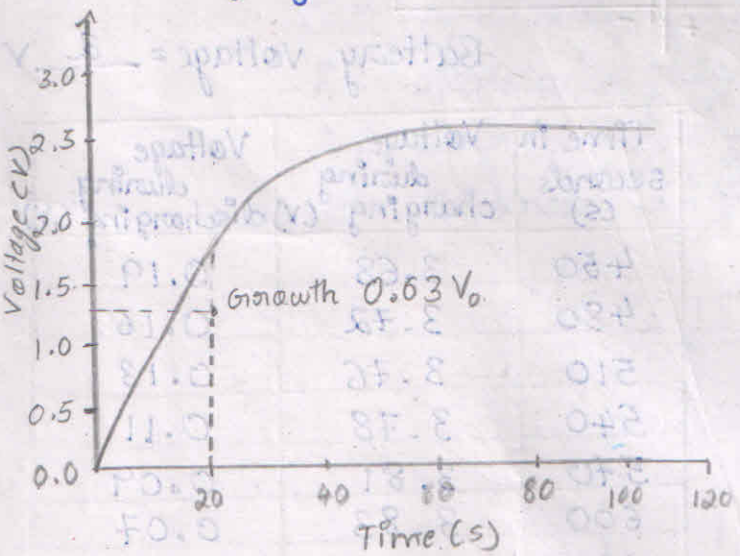
Time in seconds (s)	Voltage during charging (V)	Voltage during discharging (V)
~~00~~ 0	~~0.00~~ 0	4
30	0.75	3.24
60	1.34	2.64
90	1.78	2.15
120	2.19	1.76
150	2.46	1.43
180	2.71	1.17
210	2.91	0.95
240	3.08	0.79
270	3.22	0.64
300	3.34	0.53
330	3.43	0.43
360	3.51	0.35
390	3.58	0.29
420	3.64	0.23

Time in seconds (s)	Voltage during charging (V)	Voltage during discharging (V)
450	3.68	0.19
480	3.72	0.16
510	3.76	0.13
540	3.78	0.11
570	3.81	0.09
600	3.83	0.07
630	3.85	0.06
660	3.87	0.05
690	3.88	0.04
720	3.89	0.03
750	3.90	0.02
780	3.91	0.02

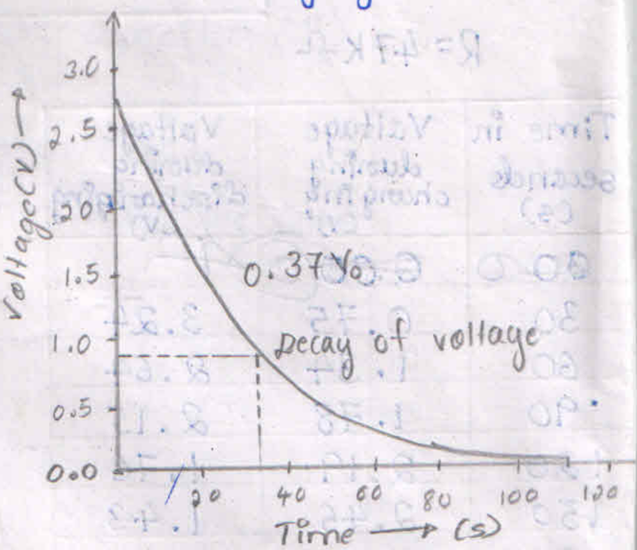
Signature of Teacher Incharge

Time in Seconds (s)	Voltage during charging (V)	Voltage during discharging (V)
810	3.92	0.02
840	3.93	0.01
870	3.94	0.00
900	3.95	0.00
930	3.96	0.00
960	3.96	0.00
990	3.97	0.00
1020	3.97	
1050	3.98	
1080	3.99	
1100	4.00	
1130	4.00	
1160	4.01	
1190	4.01	
1210	4.01	
1240	4.01	

(I) Charging Curve



(II) Discharging Curve.



Charging time constant $\tau_1 = \underline{150}$ s Discharging time constant $\tau_2 = \underline{180}$

Average time constant $\tau = \frac{\tau_1 + \tau_2}{2} = \underline{165}$ s

Capacitance of the capacitor $C = \frac{\tau}{R} = \frac{165}{47 \times 10^3} = \underline{3.510 \times 10^{-3}}$

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 07-11-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 3

Title DIELECTRIC CONSTANT

where R is the resistance and C is the capacitance of the capacitor in the circuit.

Dielectric constant is determined by using the formula $\varepsilon_r = \frac{Cd}{\varepsilon_0 A}$

where τ = time constant.

ε_r = dielectric constant of ~~free space~~ dielectric. $= \cancel{8.8 \times 10^{-12} Fm^{-1}}$

ε_0 = Absolute permittivity of free space

C = Capacitance of the capacitor (F).

CALCULATION :-

Thickness of dielectric medium, d(m)	$80 \mu m = 80 \times 10^{-6} m$
Area of each plate A (m²)	$0.00705 m^2$

Area = L × B = 47 × 1.5 (cm)

$= 70.5 cm^2 = \cancel{0.705 m^2}$

$= 0.00705 m^2$

Capacitance of capacitor $= C = \frac{\tau}{R} = \frac{165}{47 \times 10^3} = 3.510 \times 10^{-3} F$

$C = 3510 \mu F$

Dielectric constant, $\varepsilon_r = \frac{Cd}{\varepsilon_0 A}$

$= \frac{3.510 \times 80 \times 10^{-6} \times 10^{-6}}{8.854 \times 10^{-12} \times 0.00705} = 4.49850 \times 10^6 = 4.49$

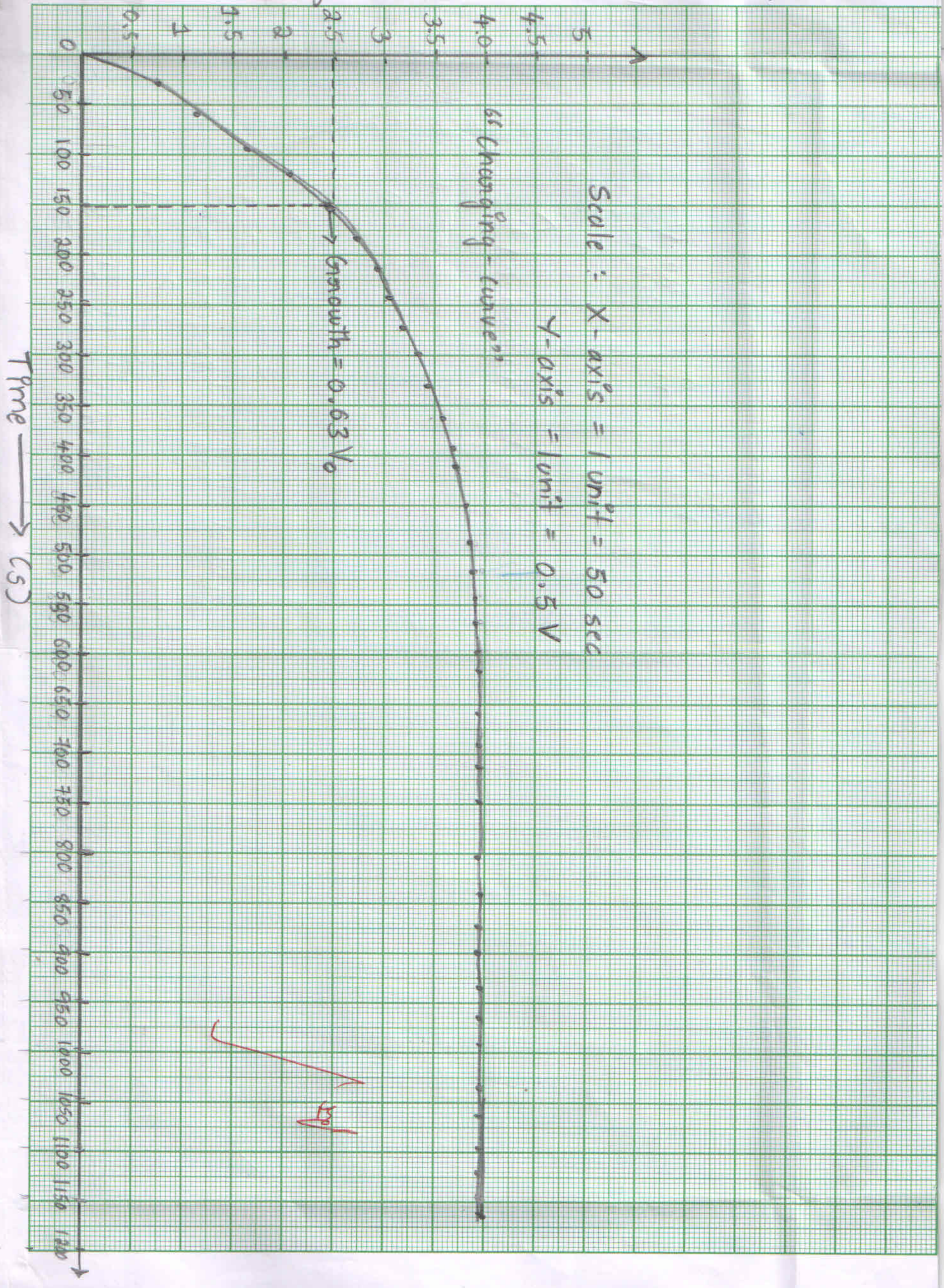
Signature of Teacher Incharge

Result :-

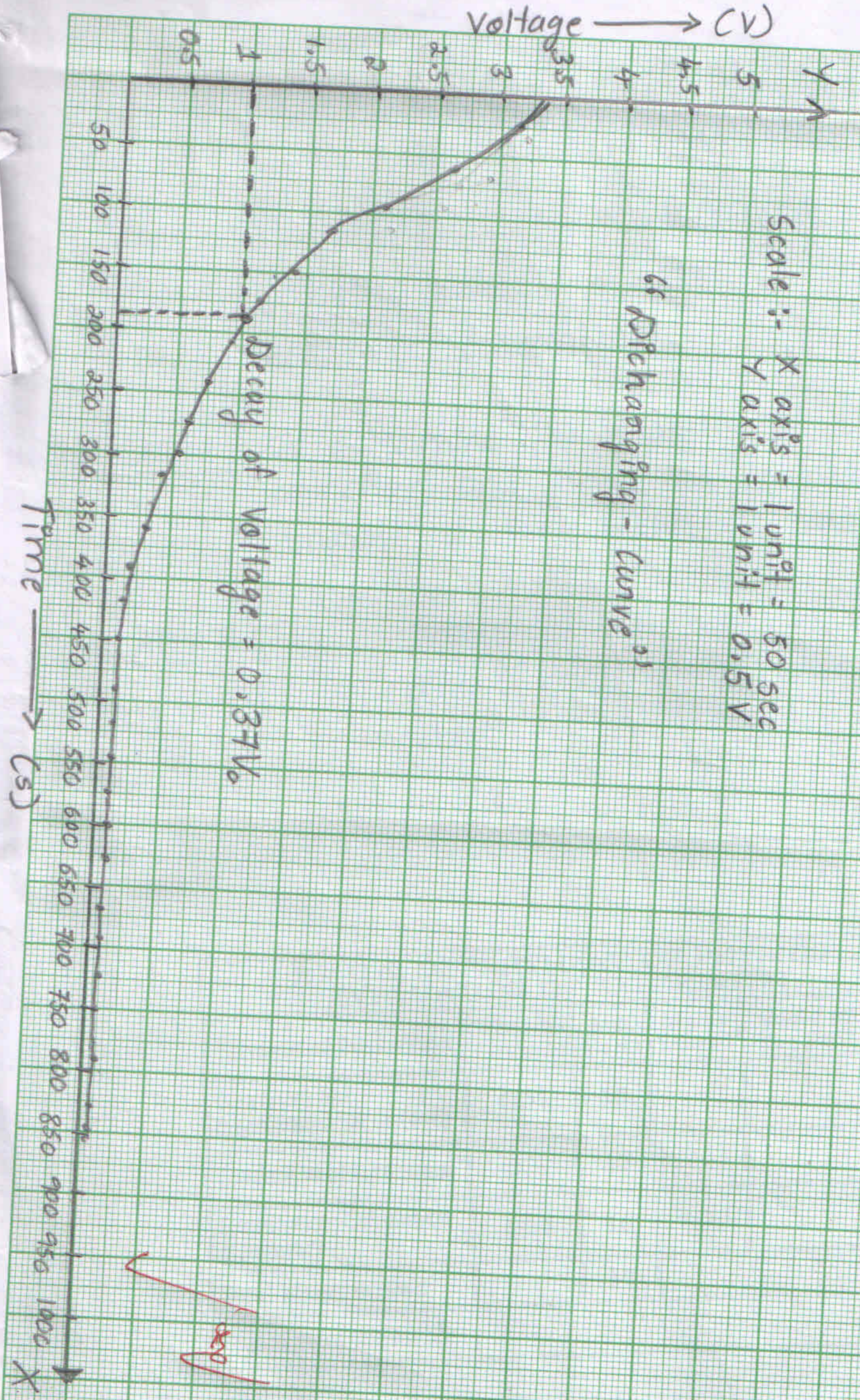
1) Capacity of parallel capacitor $C = \underline{3.510 \times 10^{-3}}\ F$

2) Dielectric constant of the given dielectric material $\varepsilon_r = \underline{4.49}$

07/11/23


Voltage → (V)
Time → (s)
Scale : X-axis = 1 unit = 50 sec
Y-axis = 1 unit = 0.5 V
"Charging curve"
Growth = 0.63 V_0

07/11/23



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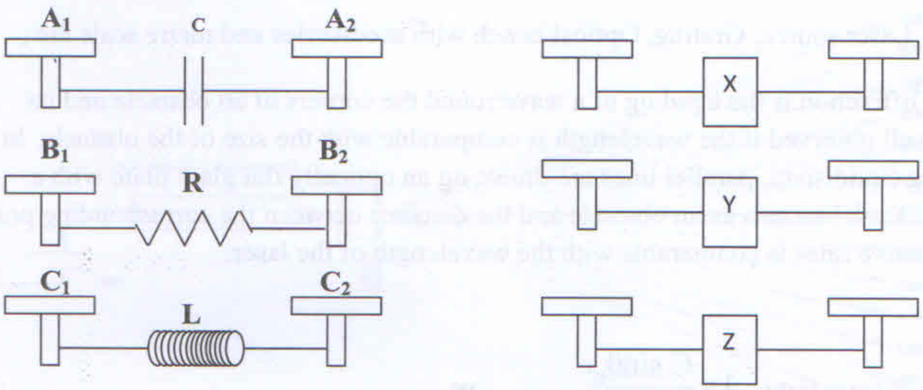
BLACK BOX

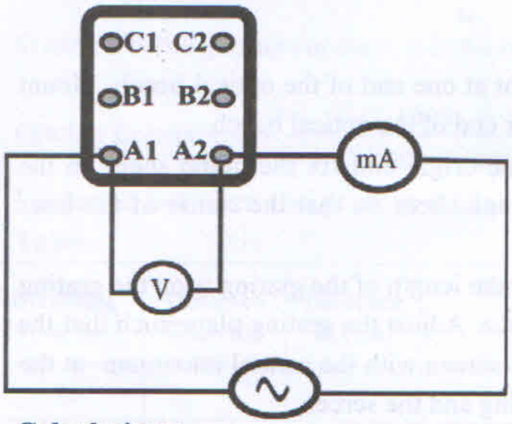
OBSERVATIONS:



Example

X could be a resistor, capacitor or an inductor. The same holds for Y and Z.

Circuit Diagram



Tabular column

TERMINALS A_1 AND A_2

Frequency (Hz)	Voltage, V (Volts)	Current, I (mA)	Component value

Calculations:

Terminals A1 and A2 correspond to ________.

The average value of the component is ________

Paste the data sheets here

BLACK BOX

Experiment No: Date:

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).

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 voltage and current for various frequencies are determined.

Procedure: In the circuit a pair of terminals with a passive component across them is connected in series with an audio oscillator and a milli-ammeter. A voltmeter is connected parallel to the terminals.

For the experiment, the type of signal selected should be sinusoidal. A suitable ac potential is applied across the experimental component (say across A_1 and A_2) using the voltage selector provided in the audio oscillator (or level knob). The frequency range is selected by pressing the corresponding range knob. By switching on the audio oscillator, variable frequency dial of the oscillator is adjusted to the minimum frequency of selected range. By varying the frequency of the applied signal in regular steps the readings of the milli-ammeter and voltmeter are noted for a set of frequencies. The experiment is repeated for terminals B_1 and B_2 and then for the terminals C_1 and C_2.
From the variation of the current and the voltage with the applied frequency the components are identified and their values are calculated as follows

a) Identification and determination of resistance

With the change in the frequency if the current and the voltage are not varying then the component across the terminals is a resistor. When a pure resistor is in an ac circuit then the resistance of the resistor and the current in the circuit are independent of the frequency of the applied voltage.

The value of the resistance is calculated using the formula $R = \frac{V}{I}\ \Omega$

b) Identification and determination of capacitance

During the experiment if the current, I, in the milli-ammeter increases and the voltage, V, in the voltmeter decreases with increase in the frequency of the applied voltage, it can be concluded that the component across the terminals is a capacitor.

TERMINALS B_1 AND B_2

Calculations:

Frequency (Hz)	Voltage, V (Volts)	Current I (mA)	Component value

Terminals B1 and B2 correspond to _________.
The average value of the component is _________

TERMINALS C_1 AND C_2

Frequency (Hz)	Voltage, V (Volts)	Current, I (mA)	Component value

Terminals C1 and C2 correspond to _________.
The average value of the component is _________

Formulae

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

In the case of a capacitor, reactance, X_C, of a capacitor depends upon the frequency f of the applied voltage. The current flowing through it changes with the change in the frequency of the applied voltage. Since capacitive reactance is inversely proportional to the frequency, with the increase in frequency of the applied voltage the reactance decreases, and vice-versa. 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

$C = \frac{1}{2\pi f X_c} = \frac{I}{2\pi f V}$ µF, where f is the frequency of the applied voltage.

C. Identification and determination of inductance of the inductor.

During the experiment, with the increase in frequency, if the current I through the inductor decreases and the voltage V across it increases, the component across the terminals is an inductor

In the case of an inductor the inductive reactance X_L depends upon the frequency f of the applied voltage. The current flowing through it changes with the change in the frequency of the applied voltage. Since inductive reactance is directly proportional to the frequency, it increases with the increase in frequency of the applied voltage and vice-versa. That is $X_L = 2\pi fL$ where L is the inductance of the inductor.

The value of the inductance of the inductor is determined by using the formula $L = \frac{1}{2\pi f X_l} = \frac{V}{2\pi f I}$

Results:

1. The component ____________ of value ________ is connected across terminals A_1 and A_2.
2. The component ____________ of value ________ is connected across terminals B_1 and B_2
3. The component ____________ of value ________ is connected across terminals C_1 and C_2

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OBSERVATION / DATA SHEET

Date 28-11-2023 Name V.MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 4

Title Black Box.

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

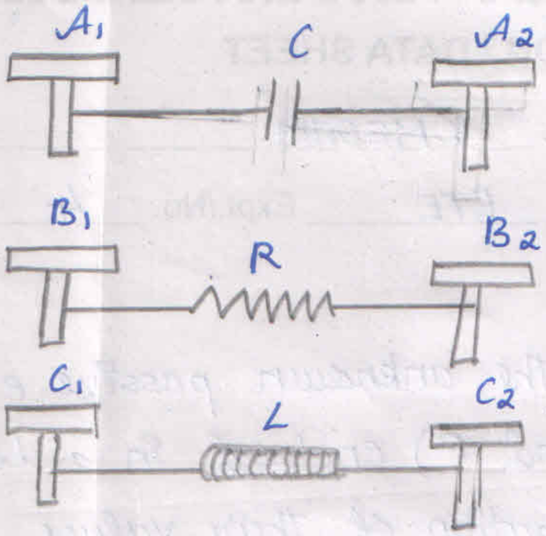
APPARATUS :- Black box, audio frequency oscillator, ac milli-ammeter (0-20mA) and ac voltmeter (digital multimeter in ac voltage mode).

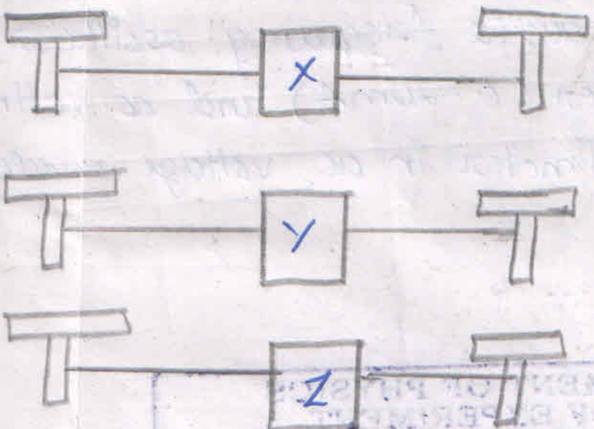
RVCE, DEPARTMENT OF PHYSICS
EVALUATION OF EXPERIMENT

Scheme of Evaluation	Course Outcome	Max Marks	Marks Scored	Initial of the Staff
Data Sheet and Experimental Set up (4+6)	CO1	10	4+6	[signature]
Conduction of Experiment	CO2	10	09	[signature]
Substitution, Calculation & Accuracy	CO3	10	9	
Total Marks Scored		30	28	[signature]
Signature of the Faculty				12/12

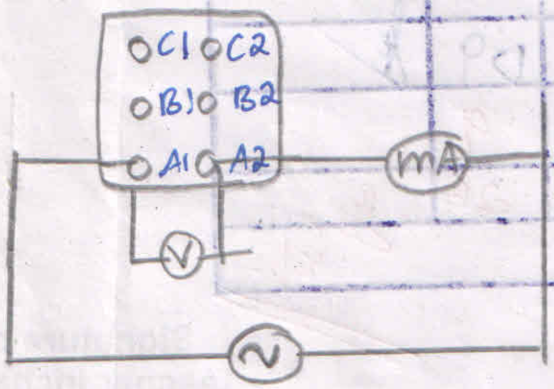
Signature of Teacher Incharge

OBSERVATIONS:-





X could be a resistor, capacitor or an inductor. The same holds for Y & Z.



R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 28-11-2023 Name V. MEGHA.

Dept./Lab Physics Lab Class ETE Expt./No. 4

Title Black Box.

Tabular Column.

Terminals A_1 and A_2.

Frequency (Hz)	Voltage V (Volts)	Current, I (mA)	Component value
100	5.1	43.5	117 Ω
200	4.7	43.5	108 Ω
300	4.5	43.5	103.4 Ω
400	4.5	43.5	103.4 Ω
500	4.5	43.5	103.4 Ω
600	4.5	43.5	103.4 Ω
Average :-			106.4 Ω

CALCULATIONS:- Terminals A1 and A2 correspond to Resistor
The average value of the component = 106.4 Ω

Formulae :- For resistance :- $R = \frac{V}{I}$ (Ω)

Average $= \frac{638.6}{6}$

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

Average $= 106.4\,\Omega$

For capacitance :- $C = \frac{1}{2\pi f V}$ (μF)

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

1) $R = \frac{5.1}{43.5\times10^{-3}} = 117\,\Omega$

2) $R = \frac{4.7}{43.5\times10^{-3}} = 108\,\Omega$

3) $R = \frac{4.5}{43.5\times10^{-3}} = 103.4\,\Omega$

4) $R = \frac{4.5}{43.5\times10^{-3}} = 103.4\,\Omega$

5) $R = \frac{4.5}{43.5\times10^{-3}} = 103.4\,\Omega$

6) $R = \frac{4.5}{43.5\times10^{-3}} = 103.4\,\Omega$

Signature of
Teacher Incharge

Terminals of B_1 and B_2 :-

Frequency (Hz)	Voltage V (Volts)	Current I (mA)	Component value in (μF)
100	7.4	0.2	0.043
200	6.8	0.7	0.082
300	6.6	1.1	0.088
400	6.5	1.6	0.098
500	6.5	2.0	0.098
600	6.3	2.4	0.101

CALCULATIONS :-

$$C = \frac{I}{2\pi f V} \; (\mu F)$$

1) $C_1 = \dfrac{0.2 \times 10^{-3}}{2 \times 3.14 \times 100 \times 7.4} = 4.3 \times 10^{-8} = \underline{0.043 \mu F}$

2) $C_2 = \dfrac{0.7 \times 10^{-3}}{2 \times 3.14 \times 200 \times 6.8} = 8.2 \times 10^{-8} = \underline{0.082 \mu F}$

3) $C_3 = \dfrac{1.1 \times 10^{-3}}{2 \times 3.14 \times 300 \times 6.6} = 8.8 \times 10^{-8} = \underline{0.088 \mu F}$

4) $C_4 = \dfrac{1.6 \times 10^{-3}}{2 \times 3.14 \times 400 \times 6.5} = 9.8 \times 10^{-8} = \underline{0.098 \mu F}$

5) $C_5 = \dfrac{2.0 \times 10^{-3}}{2 \times 3.14 \times 500 \times 6.5} = 9.8 \times 10^{-8} = \underline{0.098 \mu F}$

6) $C_6 = \dfrac{2.4 \times 10^{-3}}{2 \times 3.14 \times 600 \times 6.3} = 10.1 \times 10^{-8} = \underline{0.101 \mu F}$

Average $= \dfrac{0.5100}{6}$

$\doteq \underline{0.0850}$

Terminals B1 and B2 correspond to Capacitor.

The average value of the component is 0.0850 μF.

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 28-11-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 4

Title Black Box.

Terminals C_1 and C_2.

Frequency (Hz)	Voltage V (Volt)	Current I (mA)	Component value
100	2	76.8	0.0414 H
200	2.1	76.8	0.022 H
300	2.2	76.7	0.015 H
400	2.5	73.7	0.014 H
500	2.8	64.0	0.014 H
600	2.8	63.4	0.012 H

CALCULATIONS:-

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

1) $L_1 = \frac{2 \times 1000}{2 \times 3.14 \times 100 \times 76.8} = \underline{0.0414} \ H$

2) $L_2 = \frac{2.1 \times 10^3}{2 \times 3.14 \times 200 \times 76.8} = \underline{0.022} \ H$

3) $L_3 = \frac{2.2 \times 10^3}{2 \times 3.14 \times 300 \times 76.7} = \underline{0.015 H}$

4) $L_4 = \frac{2.5 \times 10^3}{2 \times 3.14 \times 400 \times 73.7} = \underline{0.014 H}$

5) $L_5 = \frac{2.8 \times 10^3}{2 \times 3.14 \times 500 \times 64} = \underline{0.014 \ H}$

6) $L_6 = \frac{2.8 \times 10^3}{2 \times 3.14 \times 600 \times 63.4} = \underline{0.012 \ H}$

Average $= \frac{0.118400}{6}$

$= \underline{0.0196 \ H}$

Terminals C1 and C2 correspond to Inductor

The average value of the component is 0.0196 H

Signature of Teacher Incharge

RESULT :-

1). The component Resistor of value 106.4 Ω is connected across terminals A_1 and A_2.

2) The component Capacitor of value 0.0850 μF is connected across terminals B1 and B2

3) The component Inductor of value 0.0196H is connected across terminals C1 and C_2.

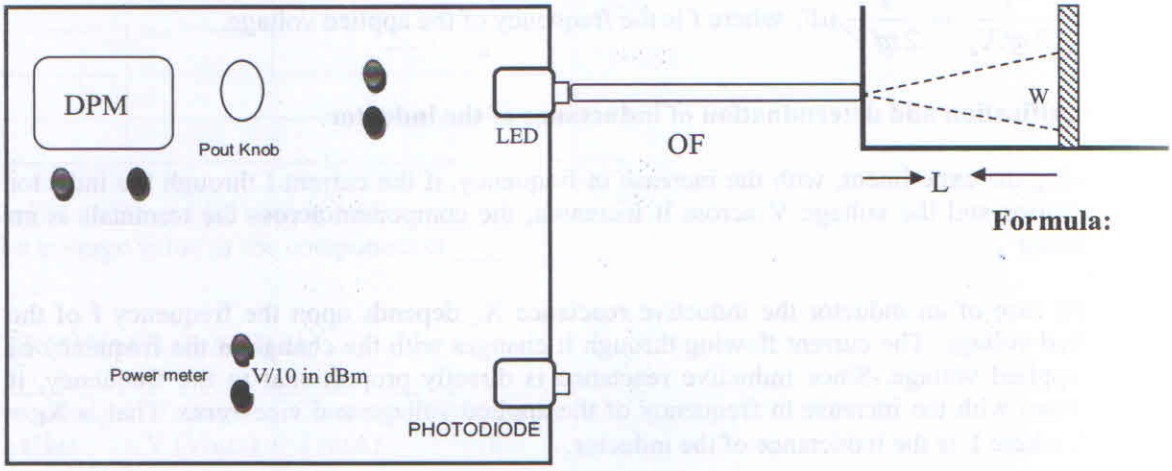
Paste the data sheets here

NUMERICAL APERTURE AND ATTENUATION COEFFICIENT OF AN OPTICAL FIBER

OBSERVATIONS:

Diagram: Experimental Setup:

Part A: Numerical aperture measurement

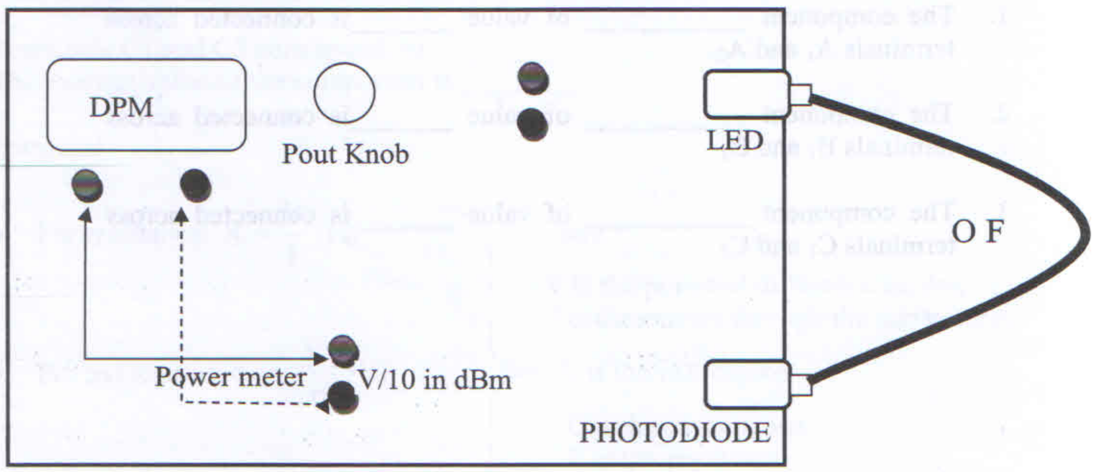


Formula:

Numerical Aperture, $N.A. = \sin\theta_0 = \frac{W}{\sqrt{(4L^2+W^2)}}$,

Where, W→ diameter of the beam spot, L→ distance from the Optical Fiber to the screen

Part B: Measurement of attenuation co efficient



NUMERICAL APERTURE AND ATTENUATION COEFFICIENT OF AN OPTICAL FIBER

Experiment No: Date:

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 from the axis of the optical fibre at which the light ray may enter the fibre so that it will propagate by Total Internal Reflections in the core. The input and output cones of light beams are symmetric, hence the semi vertical cone angle of the emergent beam is equal to the acceptance angle.

Numerical Aperture (NA): It is the light gathering ability of the optical fibre. Sine of acceptance angle gives the numerical aperture.

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

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 indices of the surrounding medium (n_0=1)

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

Where, W→ diameter of the beam spot, L→ distance from the Optical Fibre to the screen

Procedure:

- Connect one end of the optical fibre cable (1-metre or 5 metre) to LED and the other end to the numerical aperture jig as shown in the figure.
- Plug the kit to the AC mains and switch on the circuit board. Light should appear at the end of the fibre on the numerical aperture jig.
- Turn the P_{out} knob clockwise to set to maximum P_{out} for the maximum intensity of the laser spot.
- Hold the white screen in front 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 scale on the screen.
- Avoid bends in the optical fibre.

Paste the data sheets here

Table A:

Sl. No	L (mm)	W_1 (mm)	W_2 (mm)	W= $(W_1+W_2)/2$ (mm)	Numerical aperture(NA)	Acceptance angle, $\theta = \sin^{-1}$(NA) in degree
1.						
2.						
3.						
4.						

Table B:

Length (m)	(A) Attenuation in dB	Length (m)	(B) Attenuation in dB	(B-A) Attenuation for 4m length in dB
1		5		

Attenuation coefficient: Attenuation per unit length (α)

$$\alpha = \frac{\text{Attenuation loss}}{\textit{Length}} = \underline{\qquad} = \underline{\qquad}\ \text{dB/m} = \underline{\quad}\ \text{dB/km}$$

CALCULATIONS:

Result:

1.	The numerical aperture of the given optical fibre is	________
2.	The acceptance angle θ is	________ °
3.	The attenuation coefficient of the fibre α	________ dB/m

- Note down the diameter of the laser beam spot W_1 on the horizontal axis 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= order of the outermost illuminated ring 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 given formulae.

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

Principle: Attenuation coefficient is defined as the loss in the energy 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. These 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. mathematically attenuation coefficient of the fibre is given by,

$$\alpha = -\frac{10 \times \log(P_{out} / P_{in})}{L} \text{ dB/km}$$

Where Pout and Pin 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) to the LED and the other end to the photo diode.
- Connect the Digital Panel Meter (DPM) to the power meter as shown in the figure B
- Plug in AC mains, fix the output power (P_o) knob to some known value in the DPM. This is attenuation in the fibre of one metre length.
- Repeat the above procedure for a different cable length as given in table (say 5m) and note the attenuation of the fibre in the DPM.
- The difference in the DPM readings gives the transmission loss for a known length of the fibre (say 5m -1m =4m).
- Calculate the attenuation coefficient α (transmission loss / length)

Result:

1.	The numerical aperture of the given optical fibre is	________
2.	The acceptance angle θ is	________ °
3.	The attenuation coefficient of the fibre α	________ dB/m

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 28-11-2023 Name V. MEGHA

Dept./Lab Physics lab Class ETE Expt./No. 5

Title Numerical Aperture and Attenuation Coefficient of an Optical Fiber

AIM :- Part A :- To determine the Numerical aperture of the given Optical Fibre.

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

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

RVCE, DEPARTMENT OF PHYSICS EVALUATION OF EXPERIMENT				
Scheme of Evaluation	Course Outcome	Max Marks	Marks Scored	Initial of the Staff
Data Sheet and Experimental Set up (4+6)	CO1	10	4+6	
Conduction of Experiment	CO2	10	10	
Substitution, Calculation & Accuracy	CO3	10	09	
Total Marks Scored		30	29	
Signature of the Faculty				

Signature of Teacher Incharge

FORMULA :-

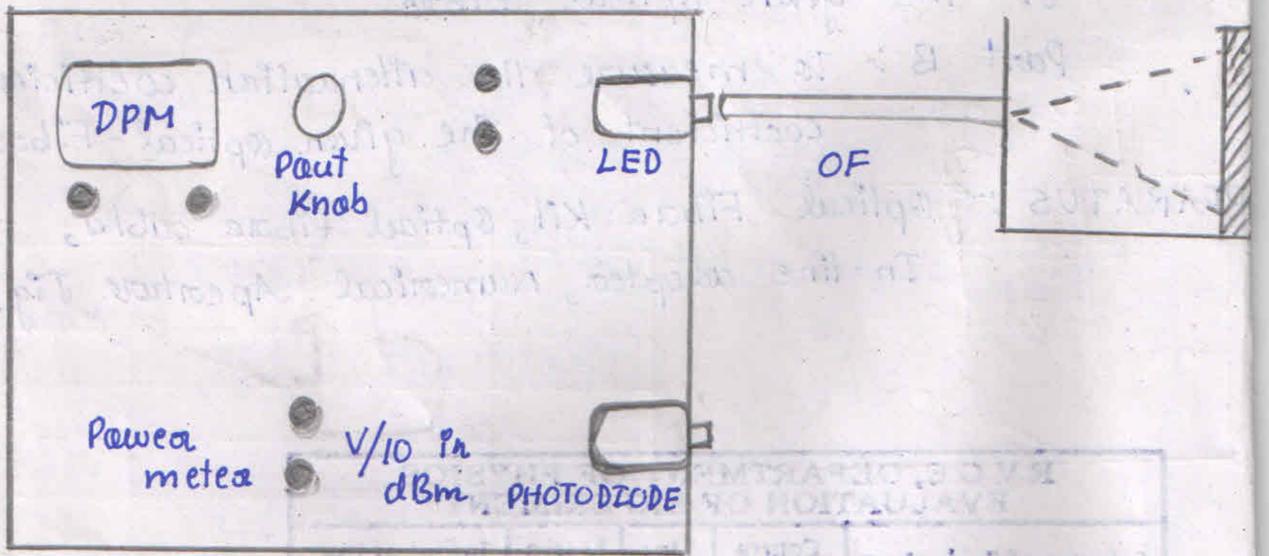
$$NA = \sin\theta_0 = \frac{W}{\sqrt{(4L^2+W^2)}},$$

Where, W → diameter of the beam spot
L → distance from the optical Fibre to the scr

OBSERVATIONS :-

Diagram : Experimental setup :-

PART A :- Numerical aperture measurement.



Numerical Aperture $N.A = \sin\theta_0 = \frac{W}{\sqrt{(4L^2+W^2)}},$

Where, W → diameter of the beam spot,
L → distance from the Optical Fiber to the screen.

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OBSERVATION / DATA SHEET

Date 28-11-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 5

Title Numerical Aperture and Attenuation Coefficient of an optical-fiber

ART-B :- Measurement of attenuation co-efficient.

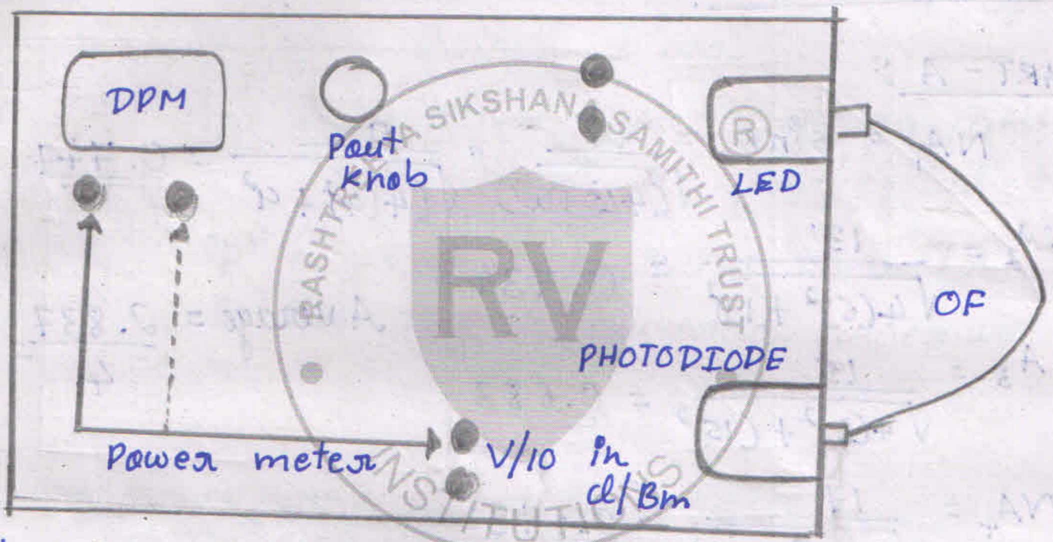


Table-A :-

SL NO	L (mm)	W_1 (mm)	W_2 (mm)	$W = (W_1+W_2)/2$	Numerical Aperture (NA)	Acceptame angle $\theta = \sin^{-1}(NA)$ in
1)	4	8	10	$\frac{8+10}{2} = 9$	0.747	48.33°
2)	6	12	14	$\frac{12+14}{2} = 13$	0.734	47.22°
3)	8	14	16	$\frac{14+16}{2} = 15$	0.683	43.07°
4	10	16	18	$\frac{16+18}{2} = 17$	0.673	42.29°

Signature of Teacher Incharge

Table - B :-

Length (m)	(A) Attenuation in dB	Length (m)	(B) Attenuation in dB	(B-A) Attenuation for 4m length
1	-5.22	5	-5.11	-0.0275

Attenuation coefficient :- Attenuation per unit length (α)

$$\alpha = \frac{\text{Attenuation loss}}{\text{Length}} = \frac{-0.11}{4} = \underline{0.0275\ dB/m}$$

CALCULATIONS :-

PART - A :-

1) $NA_1 = \sin\theta_0 = \frac{W}{\sqrt{(4L^2+W^2)}} = \frac{9}{\sqrt{(4(4)^2+9^2}} = \underline{0.747}$

2) $NA_2 = \frac{13}{\sqrt{4(6)^2+(13)^2}} = \underline{0.734}$

3) $NA_3 = \frac{15}{\sqrt{4(8)^2+(15)^2}} = \underline{0.683}$

4) $NA_4 = \frac{17}{\sqrt{4(10)^2+(17)^2}} = \underline{0.673}$

Average $= \frac{2.837}{4} = \underline{0.709}$

$\theta = \sin^{-1}(NA) \Rightarrow \theta_1 = \sin^{-1}(0.747) = 48.33°$

$\theta_2 = \sin^{-1}(0.734) = 47.22°$

$\theta_3 = \sin^{-1}(0.683) = 43.07°$

$\theta_4 = \sin^{-1}(0.673) = 42.29°$

Average $= \frac{180.91}{4} = \underline{45.22°}$

RESULT :-

1) The numerical aperture of the given optical fibre is $= \underline{0.709}$

2) The acceptance angle θ is $= \underline{45.22°}$

3) The attenuation coefficient of the fibre $\alpha = \underline{0.0275\ dB/m}$

FERMI ENERGY OF COPPER

Experiment No: Date:

Aim: To determine the Fermi energy of copper

Apparatus: Multi meter, Beaker, Thermometer and copper wire.

Theory: In a conductor, the electrons fill the available energy states starting from the lowest energy level. Therefore at 0K, all the levels with an energy E less than a certain value $E_{F(0)}$ will be filled with electrons, whereas the levels with E greater than E_{F0} will remain vacant. The energy E_{F0} is known as Fermi energy at absolute zero and corresponding energy level is known as Fermi level. For temperature greater than zero Kelvin, Fermi energy is the average energy of the electrons participating in electrical conductivity. By measuring the resistance of the copper wire at different temperatures Fermi energy is calculated by the following formula.

$$E_F = 1.36 \times 10^{-15} \sqrt{\frac{\rho\, A\, m}{l}} \text{ J}$$

Where, E_F is the Fermi energy
T is the reference temperature (K),
A is area of cross section of the given copper wire (m^2)
l is the length of the copper wire (m)
Charge of the electron, $e = 1.602 \times 10^{-19}$ C.
ρ is the density of copper $= 8960$ Kg/m^3
m is the slope of the straight line obtained by plotting resistance of the metal against absolute temperature of the metal.

Procedure:

- Connect the copper coil to the digital multi meter.
- Set the multi meter to 200 Ω mode.
- Immerse the copper coil in a beaker containing cold water, note down the resistance in multi meter and enter the readings in the tabular column.
- Immerse the copper coil in a beaker containing hot water at about 90°C.
- Note down the resistance in multi meter for every decrement of 5°C to about 50°C and enter the readings in the tabular column.
- Plot a graph of resistance along y-axis and temperature along x-axis and calculate the value of slope m of the resulting graph (m = AB/BC)
- Calculate the Fermi energy of the material by using the relevant formula.

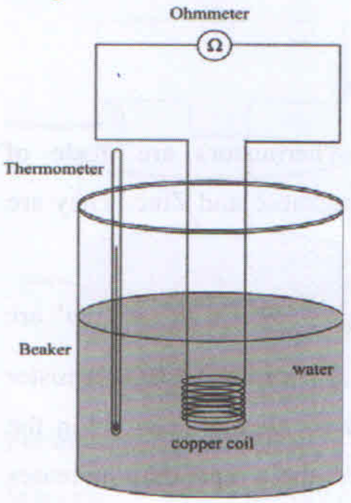
Result: The Fermi energy of copper is E_F = ________________ J, ____________eV.

Paste the data sheets here

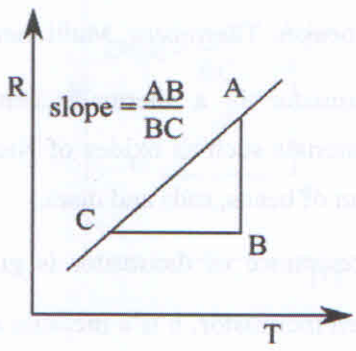
FERMI ENERGY OF COPPER

OBSERVATIONS:

Diagram:



Model Graph:



Formula:

$$E_F = 1.36\times10^{-15}\sqrt{\frac{\rho A m}{l}} \quad \text{(in J)}$$

$$E_F = \frac{1.36\times10^{-15}\sqrt{\frac{\rho A m}{l}}}{1.6\times10^{-19}} = ...eV$$

$$\text{Slope} = m = \frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{n\sum x^2 - \left(\sum x\right)^2}$$

$$\text{y-intercept} = c = \frac{\left(\sum y\right)\left(\sum x^2\right) - \left(\sum x\right)\left(\sum xy\right)}{n\sum x^2 - \left(\sum x\right)^2}$$

Tabular Column:

Sl. No	Temp (^{0}C) (x)	R (Ω) (y)	x^2	xy
Room Temp				
1.				
2.				
3.				
4.				
5.				
6.				
Sums	Σx =	Σy =	Σx^2 =	Σxy =

Calculations:

m =

c =

x	y = mx + c
30	
80	

E_F =

Result: The Fermi energy of copper is E_F = ________________ J, ____________eV

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 05-12-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 6

Title Fermi Energy Of Copper

AIM :- To determine the Fermi energy of copper.

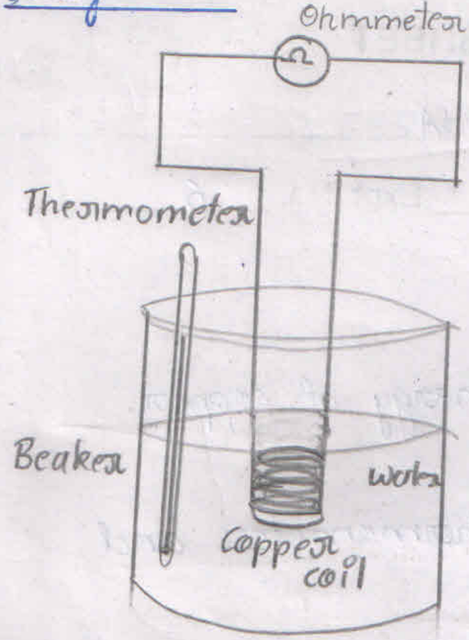
APPARATUS :- Multi meter, Beaker, Thermometer and copper-wire.

RVCE, DEPARTMENT OF PHYSICS EVALUATION OF EXPERIMENT				
Scheme of Evaluation	Course Outcome	Max Marks	Marks Scored	Initial of the Staff
Data Sheet and Experimental Set up (4+6)	CO1	10	3/4 + 6	
Conduction of Experiment	CO2	10	9	
Substitution, Calculation & Accuracy	CO3	10	9	
Total Marks Scored		30	28	
Signature of the Faculty				

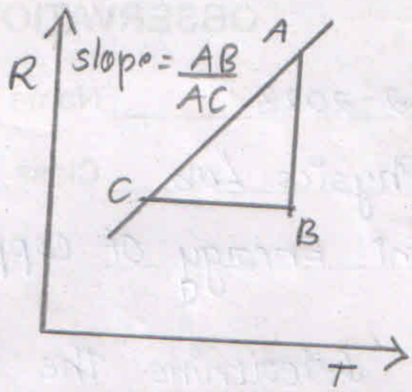
Signature of Teacher Incharge

OBSERVATIONS :-

Diagram :-



Model - Graph :-



l = Length of copper-wire = 15m

A = Area of cross-section = πr^2 =

ρ = density of copper = 8960 k

m = slope.

l ?

A ?

m ?

FORMULA :-

$$E_F = 1.36 \times 10^{-15} \sqrt{\frac{\rho A m}{l}} \text{ (in J)}$$

$$\text{Slope} = m = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2}$$

$$E_F = \frac{1.36 \times 10^{-15} \sqrt{\frac{\rho A m}{l}}}{1.6 \times 10^{-19}} = \underline{\hspace{2cm}} eV$$

$$\text{y-intercept} = c = \frac{(\sum y)(\sum x^2) - (\sum x)(\sum xy)}{n\sum x^2 - (\sum x)^2}$$

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 05-12-2023 Name V.MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 6

Title Fermi Energy Of Copper.

Tabular Column:-

SL NO	Temp (°C) (x)	R (Ω) (y)	x^2	xy
Room Temp	30.6	9	936.36	275.4
1.	80.3	10.9	6448.09	875.27
2.	75	10.7	5625	802.5
3.	70	10.5	4900	735
4.	65	10.4	4225	676
5.	60	10.3	3600	618
6.	55	10.0	3025	550
Sums	$\Sigma x = 435.9$	$\Sigma y = 71.8$	$\Sigma x^2 =$	$\Sigma xy =$

x	$y = mx + c$
30	17.695
80	19.617

$\Sigma x = 30.6 + 80.3 + 75 + 70 + 65 + 60 + 55 = \underline{435.9}$

$y = 0.037(30) + 16.585 = 17.695$

$y = 19.617$

CALCULATIONS:-

$$E_F = 1.36 \times 10^{-15} \sqrt{\frac{\rho A m}{l}}$$

$\Sigma y = 9 + 10.9 + 10.7 + 10.5 + 10.4 + 10.3 + 10 = \underline{71.8}$

$$\text{Slope} = m = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{n\Sigma x^2 - (\Sigma x)^2}$$

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Teacher Incharge

~~Slope = m = 6x~~

$\Sigma x^2 = 936.36 + 6448.09 + 5625 + 4900 + 4225 + 3600 + 3025 = \underline{28759.45}$

$\Sigma xy = 275.4 + 875.27 + 802.5 + 735 + 676 + 618 + 550 = \underline{4532.17}$

$$E_F = \frac{1.36 \times 10^{-15} \sqrt{\frac{\rho A m}{l}}}{1.6 \times 10^{-19}}$$

$A = \pi r^2$
$= 3.14 \times 0.1 \times 0.1 \times 10^{-6}$
$A = \underline{0.0314 \times 10^{-6}}$

$$E_F = 1.36 \times 10^{-15} \sqrt{\frac{8960 \times 0.0314 \times 10^{-6} \times 3.79 \times 10^{-2}}{15}}$$

$$m = \frac{7 \times 4532.17 - (435.9)(71.8)}{7(28759.45) - (435.9)^2}$$

$$E_F = 1.36 \times 10^{-15} \sqrt{7.11 \times 10^{-1} \times 10^{-8}}$$

$$E_F = 1.36 \times 10^{-15} \times \sqrt{71.1 \times 10^{-8}}$$

$$m = \frac{4.28 \times 10^2}{1.13 \times 10^4}$$

$$E_F = 1.15 \times 10^{-4} \times 10^{-15}$$

$$E_F = \cancel{1.15 \times 10^{-18}}\ J \quad 1.15 \times 10^{-19} J$$

$m = \underline{3.79 \times 10^{-2}}$

$m = \underline{0.0379}$

$$= \frac{\cancel{1.15}\ 11.5 \times 10^{-19}}{1.6 \times 10^{-19}} = \cancel{0.719 eV} = \underline{7.19 eV}$$

0.0379

RESULT :-

The Fermi energy of Copper is $E_F = \underline{1.15 \times 10^{-19}} J$,

~~0.719~~ eV.

7.19eV

-yoogh

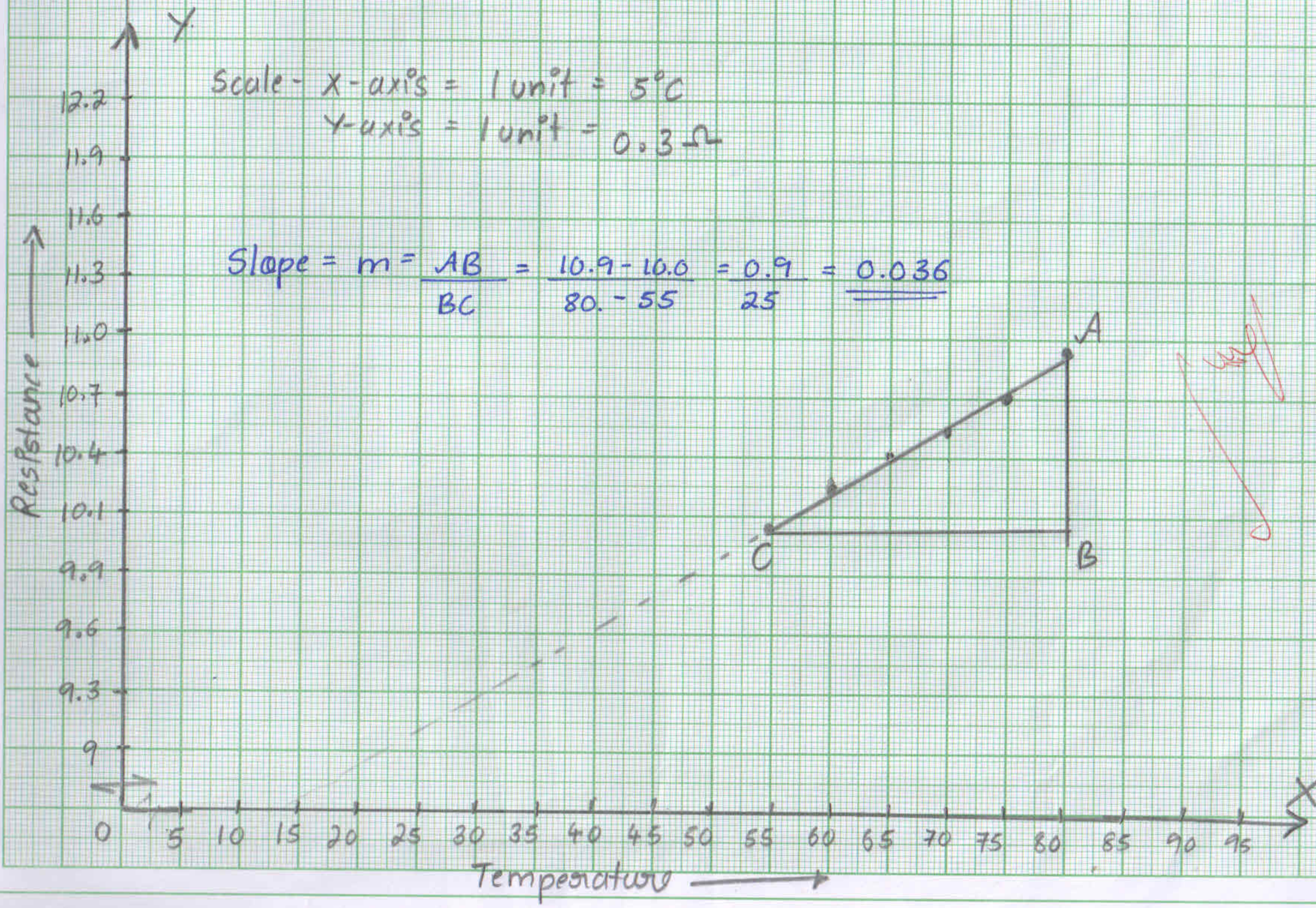
Name :

Date :

Scale - X-axis = 1 unit = 5°C

Y-axis = 1 unit = 0.3 Ω

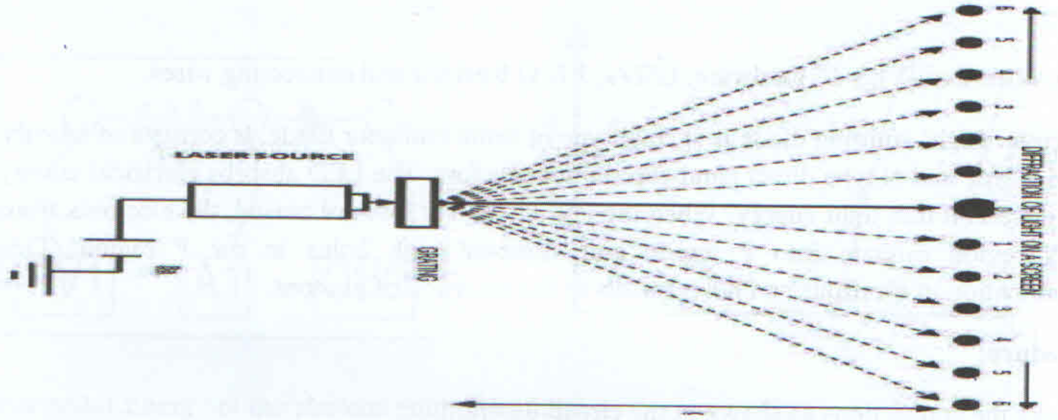
$$\text{Slope} = m = \frac{AB}{BC} = \frac{10.9 - 10.0}{80. - 55} = \frac{0.9}{25} = \underline{\underline{0.036}}$$



LASER DIFFRACTION

OBSERVATIONS:

Diagram:



Formula:

Wavelength of Laser source $\lambda = \dfrac{C \sin\theta_n}{n}$ .... m

Where C is the grating constant, n is the order of the maximum, θ is the angle of diffraction

Grating Constant: $C = \dfrac{1\,\text{inch}}{\text{No. of lines (N) per inch}} = \dfrac{2.54\times10^{-2}\,m}{500} = 5.08\times10^{-5}\,\text{m}$

Distance between the grating and the screen, d = ________ cm

Table:

Diffraction order (n)	Distance $2X_n$(cm)	Distance X_n(cm)	Diffraction angle (θ_n) $\theta_n = \tan^{-1}\left(\frac{X_n}{d}\right)$	Wavelength λ (nm) $\lambda = \frac{C \sin\theta_n}{n}$
1.				
2.				
3.				
4.				
5.				
6.				

Calculations:

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

Paste the data sheets here

Experiment No:

LASER DIFFRACTION

Date:

Aim: To determine the wavelength of a given laser beam

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

Principle: Diffraction is the bending of a wave round the corners of an obstacle and its effects are well observed if the wavelength is comparable with the size of the obstacle. In the given grating equidistant, parallel lines are drawn on an optically flat glass plate with a diamond tip. Each line acts as an obstacle and the distance between the corresponding points on the successive lines is comparable with the wavelength of the laser.

Formula:

Wavelength of laser light, $\lambda = \frac{C \sin\theta_n}{n}$ .... m

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,

Procedure:

- Mount the laser on an upright and fix the upright at one end of the optical bench. Mount a screen on another upright and fix it at the other end of the optical bench.
- Mark four quadrants on a graph with 'O' as the origin and fix the graph sheet on the screen using pins. Adjust the position of the graph sheet, so that the centre of the laser spot coincides with the origin O.
- Mount the grating on the grating stand such that the length of the grating is on the grating stand and move the stand closer to the laser source. Adjust the grating plane such that the diffraction pattern is along the horizontal on the screen with the central maximum at the origin. Note down the distance 'd' between grating and the screen.
- Mark the centres of the central maximum and secondary maxima on the graph sheet using pencil and remove the graph sheet from the stand. Measure the distance between the first order maxima on either side of the central maximum as $2X_1$, for the 2^{nd} order maxima measure the distance as $2X_2$, continue this for all the pairs of 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.

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

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 12-12-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 7

Title Laser Diffraction

AIM :- To determine the wavelength of a given laser beam.

APPARATUS :- Laser source, Grating, optical bench with accessories and metre scale etc :-

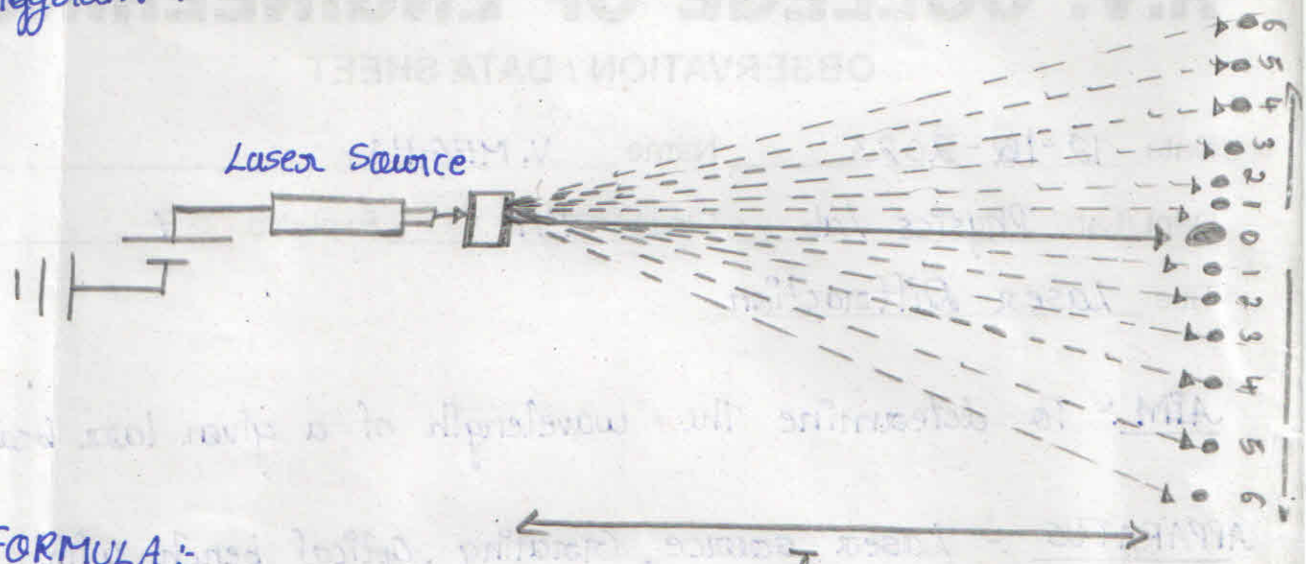
RVCE, DEPARTMENT OF PHYSICS EVALUATION OF EXPERIMENT				
Scheme of Evaluation	Course Outcome	Max Marks	Marks Scored	Initial of the Staff
Data Sheet and Experimental Set up (4+6)	CO1	10	4+6	
Conduction of Experiment	CO2	10	10	
Substitution, Calculation & Accuracy	CO3	10	10	
Total Marks Scored			30	

12/12

Signature of Teacher Incharge

OBSERVATIONS :-

Diagram :-



FORMULA :-

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

Where C is the grating constant, n is the order of the maximum, θ is the angle of diffraction.

Grating Constant : $C = \frac{1 \text{ inch}}{\text{No. of lines (N) per inch}} = \frac{2.54 \times 10^{-2} m}{500} = 5.08 \times 10^{-5} m$

Distance between the grating and the screen, d = 87 cm.

Table :-

Diffraction order (n)	Distance $2X_n$ (cm)	Distance X_n (cm)	Diffraction angle (θ_n) $\theta_n = \tan^{-1}\left(\frac{X_n}{d}\right)$	Wavelength λ (nm) $\lambda = \frac{C \sin\theta_n}{n}$
1)	2.5	1.25	0.8021	711
2)	4.8	2.4	1.546	685
3)	7.3	3.65	2.405	711
4)	9.7	4.85	3.1481	697
5)	12.1	6.05	3.9757	704
6)	14.5	7.25	4.7617	703
			Average =>	$\frac{4211}{6}$ = 701.83

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 12-12-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 7

Title Laser Diffraction

CALCULATIONS :-

$$\boxed{\theta_n = \tan^{-1}\left(\frac{x_n}{d}\right)}$$

1) $\theta_n = \tan^{-1}\left(\frac{1.25}{87}\right) = \tan^{-1}(0.014)$

$\theta_n = 0.8021$

2) $\theta_n = \tan^{-1}\left(\frac{2.4}{87}\right) = \tan^{-1}(0.027)$

$\theta_n = 1.546$

3) $\theta_n = \tan^{-1}\left(\frac{3.65}{87}\right) = \tan^{-1}(0.042)$

$\theta_n = 2.405$

4) $\theta_n = \tan^{-1}\left(\frac{4.85}{87}\right) = \tan^{-1}(0.055)$

$\theta_n = 3.1481$

5) $\theta_n = \tan^{-1}\left(\frac{6.05}{87}\right) = \tan^{-1}(0.0895)$

$\theta_n = 3.9757$

6) $\theta_n = \tan^{-1}\left(\frac{7.25}{87}\right) = \tan^{-1}(0.0833)$

$\theta_n = 4.7617$

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

1) $\lambda = \frac{5.08 \times 10^{-5} \times \sin(0.8021)}{1}$

$\lambda = 0.0711 \times 10^{-5}$

$\lambda = 711 \times 10^{-9}\,m$

$\boxed{\lambda = 711\,nm}$

2) $\lambda = \frac{5.08 \times 10^{-5} \times \sin(1.546)}{2}$

$\lambda = 0.0685 \times 10^{-5} = 685\,nm$

3) $\lambda = \frac{5.08 \times 10^{-5} \times \sin(2.405)}{3}$

$\lambda = 0.0711 \times 10^{-5} = 711nm$

4) $\lambda = \frac{5.08 \times 10^{-5} \times \sin(3.1481)}{4}$

$\lambda = 0.0697 \times 10^{-5} = 697\,nm$

5) $\lambda = \frac{5.08 \times 10^{-5} \times \sin(3.975)}{5}$

$\lambda = 0.0704 \times 10^{-5} = 704nm$

6) $\lambda = \frac{5.08 \times 10^{-5} \times \sin(4.7617)}{6}$

$= 0.0703 \times 10^{-5}$

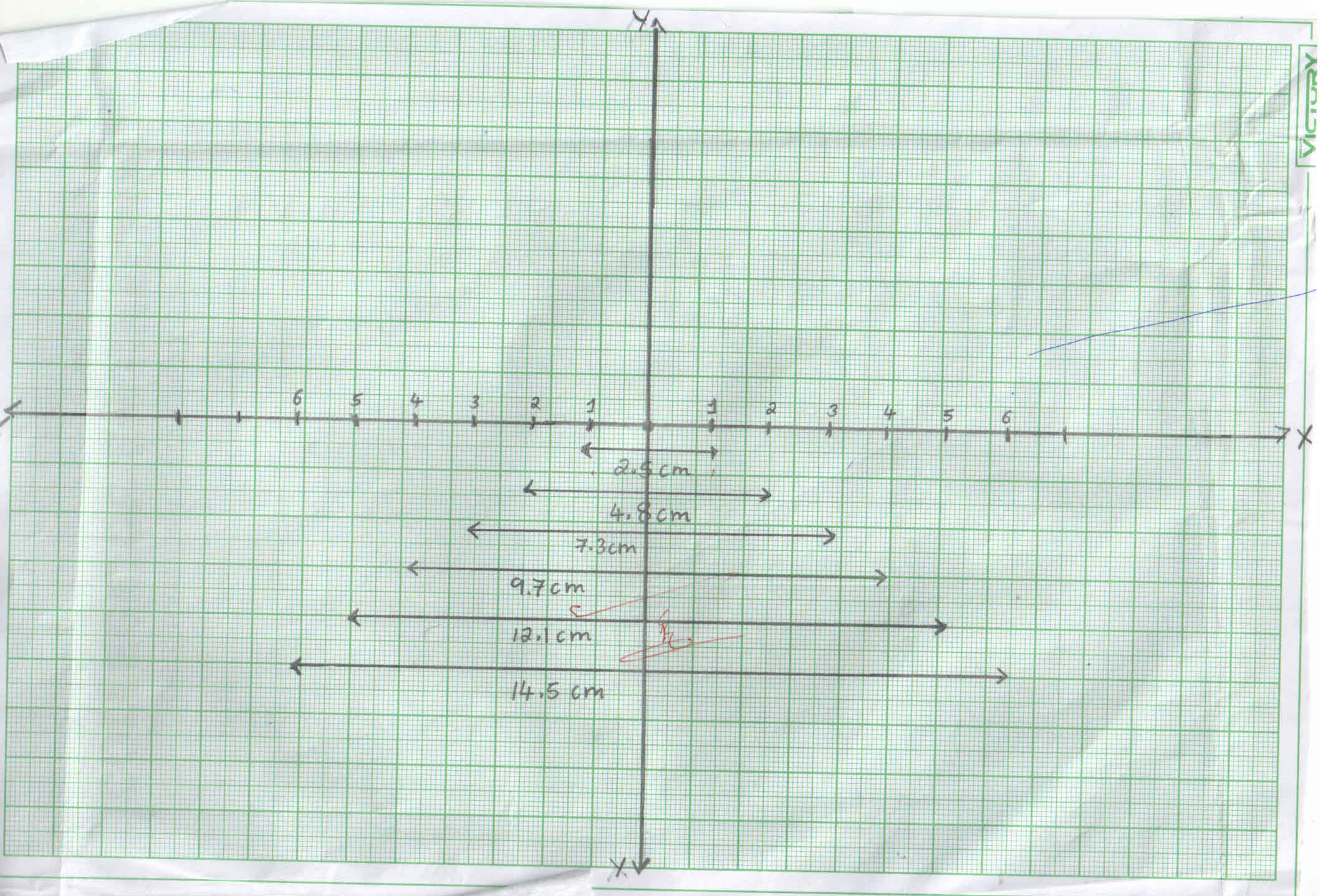
$= 703nm$

Average $= \frac{4211}{6} = 701.83\,nm$

Signature of Teacher Incharge

RESULT :-

The wavelength of laser light is found to be 701.83. nm.



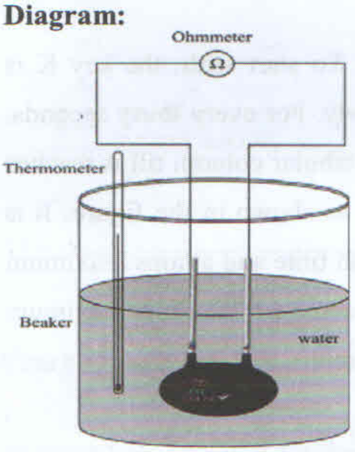
Y
X
X'
Y'
6 5 4 3 2 1 1 2 3 4 5 6
2.5 cm
4.8 cm
7.3cm
9.7cm
12.1cm
14.5 cm

Paste the data sheets here

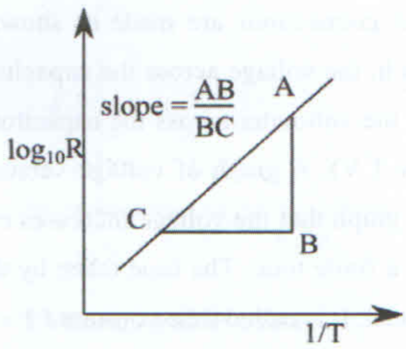
BAND GAP OF A THERMISTOR

OBSERVATIONS:

Diagram:



Model Graph:



Formula: $E_g = \frac{4.606 \times k \times m}{1.6 \times 10^{-19}}$ 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 ($\times 10^{-3}$ K^{-1})**
Room Temp					
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

CALCULATIONS:

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

BAND GAP OF A THERMISTOR

Experiment No: Date:

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 and 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 in a beaker containing tap water, thermistor and note down the resistance at room temperature.
- Immerse the thermistor in hot water at about 90°C.
- Note down the resistance 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'.
- Calculate the energy gap of a given thermistor using relevant formula.

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

R.V. COLLEGE OF ENGINEERING®

OBSERVATION / DATA SHEET

Date 12-12-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 8

Title Band Gap of A Thermistor

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

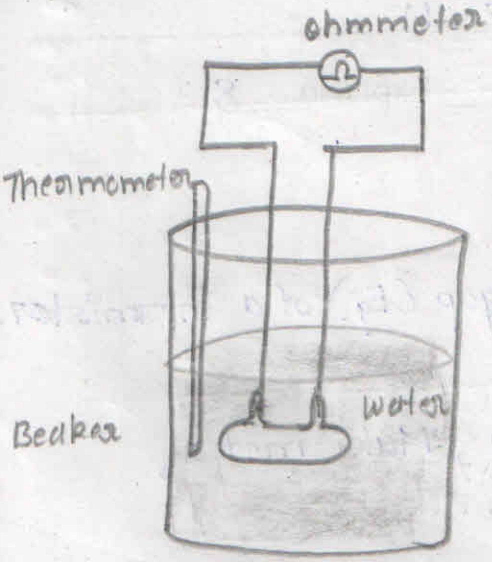
APPARATUS :- Glass beaker, Thermistor, Multi-meter, Thermometer.

RVCE, DEPARTMENT OF PHYSICS EVALUATION OF EXPERIMENT				
Scheme of Evaluation	Course Outcome	Max Marks	Marks Scored	Initial of the Staff
Data Sheet and Experimental Set up (4+6)	CO1	10	4+6	
Conduction of Experiment	CO2	10	10	
Substitution, Calculation & Accuracy	CO3	10	10	
Total Marks Scored		30	30	
Signature of the Faculty				

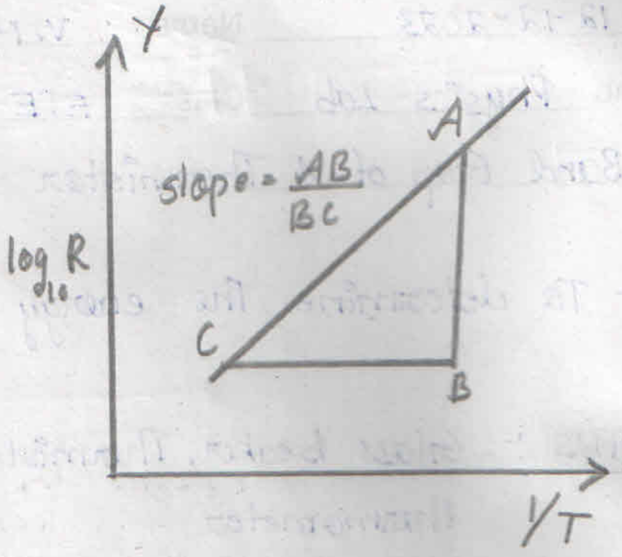
Signature of Teacher Incharge

OBSERVATIONS :-

Diagram:-



Model - Graph :-



FORMULA :-

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

Where E_g = Energy gap of a given Thermistor in eV.

k = Boltzmann constant $= 1.381 \times 10^{-23}$ J/K

m = slope of the graph.

R.V. COLLEGE OF ENGINEERING

OBSERVATION / DATA SHEET

Date 12-12-2023 Name V. MEGHA

Dept./Lab Physics Lab Class ETE Expt./No. 8

Title Band Gap of A Thermistor

Table

SL NO	Temp t °C	Temp T(K)	R(Ω)	log R	1/T ($\times 10^{-3} K^{-1}$)
1)	77	350	7.5	0.8751	2.85
2)	75	348	7.8	0.8921	2.87
3)	73	346	7.9	0.8976	2.89
4)	71	344	8.1	0.9085	2.90
5)	69	342	8.5	0.9294	2.92
6)	67	340	8.9	0.9494	2.94
7)	65	338	9.3	0.9685	2.95
8)	63	336	10.1	1.0043	2.97
9)	61	334	10.7	1.0294	2.99
10)	59	332	11.5.	1.0607	3.01
Room Temperature	32	305	30.4.	1.4829	3.27

CALCULATIONS :-

°C + 273 K = K.

1) 77 + 273 = 350 K

2) 75 + 273 = 348 K

3) 73 + 273 = 346 K

4) 71 + 273 = 344 K

5) 69 + 273 = 342 K

6) 67 + 273 = 340 K

7) 65 + 273 = 338 K

8) 63 + 273 = 336 K

9) 61 + 273 = 334 K

10) 59 + 273 = 332 K

Signature of Teacher Incharge

CALCULATIONS :-

log R		$1/T \times 10^{-3}\,K^{-1}$
1)	log (7.5) = 0.8751	1) $1/350 = 2.85 \times 10^{-3}\,K^{-1}$
2)	log (7.8) = 0.8921	2) $1/348 = 2.87 \times 10^{-3}\,K^{-1}$
3)	log (7.9) = 0.8976	3) $1/346 = 2.89 \times 10^{-3}\,K^{-1}$
4)	log (8.1) = 0.9085	4) $1/344 = 2.90 \times 10^{-3}\,K^{-1}$
5)	log (8.5) = 0.9294	5) $1/342 = 2.92 \times 10^{-3}\,K^{-1}$
6)	log (8.9) = 0.9494	6) $1/340 = 2.94 \times 10^{-3}\,K^{-1}$
7)	log (9.3) = 0.9685	7) $1/338 = 2.95 \times 10^{-3}\,K^{-1}$
8)	log (10.1) = 1.0043	8) $1/336 = 2.97 \times 10^{-3}\,K^{-1}$
9)	log (10.7) = 1.0294	9) $1/334 = 2.99 \times 10^{-3}\,K^{-1}$
10)	log (11.5) = 1.0607	10) $1/332 = 3.01 \times 10^{-3}\,K^{-1}$
11)	log (30.4) = 1.4829.	11) $1/305 = 3.27 \times 10^{-3}\,K^{-1}$

<u>slope from graph :-</u>

$$slope = \frac{AB}{BC} = \frac{0.96-0.92}{(2.95-2.91)\times 10^{-3}}$$

$$slope = m = \frac{0.04}{0.04 \times 10^{-3}}.$$

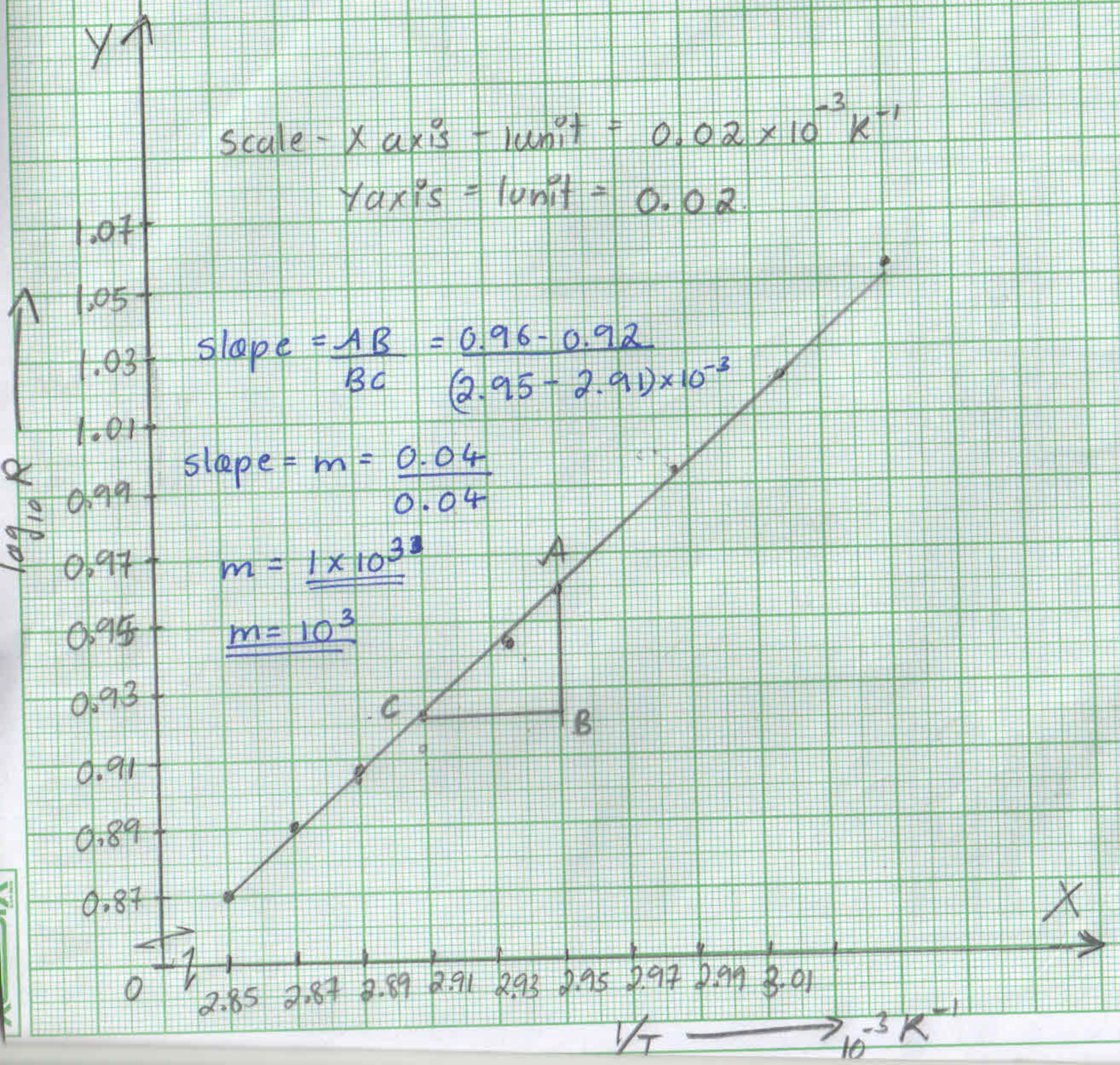
$$\boxed{m = 10^{3}}$$

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

$$E_g = 3.975 \times 10^{-1}$$

$$E_g = \underline{0.3975\ eV}$$

RESULT :- The energy (band - gap) of the given thermistor is <u>0. 3975.</u> eV.



Scale - X axis - 1unit = $0.02 \times 10^{-3} K^{-1}$

Y axis = 1unit = 0.02

$$\text{slope} = \frac{AB}{BC} = \frac{0.96 - 0.92}{(2.95 - 2.91) \times 10^{-3}}$$

$$\text{slope} = m = \frac{0.04}{0.04}$$

$$m = 1 \times 10^{3}$$

$$m = 10^{3}$$