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PRACTICAL HAND BOOK

HIGHER SECONDARY SECOND YEAR

இயற்பியல்

PHYSICS

PREPARED BY

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INSTRUCTIONS TO STUDENTS

01. Before coming to the laboratory, a student should plan the experiment in advance by consulting with his / her friends and reading this book.

02. As separate observation Note Book must be used and everything regarding the experiment **must be written before coming to the laboratory.**

03. Write the date, experiment number, aim, apparatus required, formula, procedure and result in the right-hand page and diagram (Ray diagrams, and Circuit diagrams), tabulations, observations and calculations, in the **left-hand page of the observation note book / record note book.**

04. After the completion of experiment with all observations in the laboratory, the **student should get the signature of the teacher. Within three days** of the experiment the **student should complete the calculations** and **get the signature of the teacher.**

05. Enter the observed reading with the relevant units (gram, cm, mm…) but the **final calculation must be done with SI units only**. The result must be given with proper SI Unit.

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PHYSICS PRACTICAL – SCHEME OF EVALUATION

Internal Assessment	: 15 Marks
External Examination	: 15 Marks
Total Marks	**: 30 Marks**

Internal Assessment (15)

(Teacher should maintain the Assessment Register and the Head of the Institution should monitor it)

Attendance (Above 80.01%)	:	02 Marks
Test	:	04 Marks
Assignment	:	02 Marks
Performance (while doing the experiment In the laboratory	:	02 Marks
Record Note Book	:	03 Marks
Co-curricular Activities	:	02 Marks

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External Examination (15)

01. Formula (mere expression –1, explanation of notations –1)	:	02 Marks
02. Brief Procedure	:	03 Marks
03. Observations	:	05 Marks
04. Calculations (Including graphs)	:	04 Marks
05. Result (Correct Value –½ Mark, Mentioning SI Unit – ½ Mark)	:	01 Mark

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LIST OF EXPERIMENTS

1. Determination of the specific resistance of the material of the given coil using Metre Bridge.

2. Determination of the value of the horizontal component of the Earth's magnetic field using tangent galvanometer.

3. Comparison of emf of two cells using potentiometer

4. Determination of the refractive index of the material of the prism by finding angle of prism and angle of minimum deviation using spectrometer.

5. Determination of the wavelength of a composite light by normal incidence method using diffraction grating and spectrometer (The number of lines per metre length of the grating is given).

6. Investigation of the voltage-current (V-I) characteristics of PN junction diode.

7. Investigation of the voltage-current (V-I) characteristics of Zener diode.

8. Investigation of the static characteristics of a NPN Junction transistor in common emitter configuration.

9. Verification of the truth table of the basic logic gates using integrated circuits.

10. Verification of De Morgan's theorems using integrated circuits.

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Ex. No. : 1 **Date :**

SPECIFIC RESISTANCE OF THE MATERIAL OF THE COIL USING METRE BRIDGE

AIM:

To determine the specific resistance of the material of the given coil using metre bridge.

APPARATUS REQUIRED:

Meter Bridge, Galvanometer, Key, Resistance box, Connecting wires, Lechlanche cell, Jockey and High resistance.

FORMULA:

$$\rho = \frac{X\pi r^2}{L}\ (\Omega m)$$

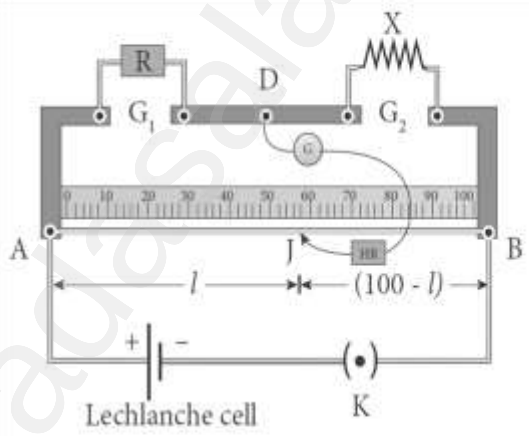
Where, X ⟶ Resistance of the given coil (Ω)

R ⟶ Known resistance (Ω)

L ⟶ Length of the coil (m)

r ⟶ Radius of the wire (m)

CIRCUIT DIAGRAM:



PROCEDURE:

A resistance box R is connected in the left gap and the unknown resistance X in the right gap. A Lechlanche cell is connected across the wire of length 1 m through a key. A sensitive galvanometer G is connected between the central strip and the jockey through a high resistance (HR). With a suitable resistance included in the resistance box, the circuit is switched on.

To check the circuit connections, the jockey is pressed near one end of the, say A. The galvanometer will show deflection in one direction. When the jockey is pressed near the other end of the wire B, the galvanometer will show deflection in the opposite directions. This ensures that the circuit connections are correct.

By moving the jockey over the wire, the point on the wire at which the galvanometer shows null deflection i.e., balancing point J is found. The balancing length AJ = l is noted.

The unknown resistance X_1 is found using the formula $X_1 = \frac{R\,(100-l)}{l}$

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The experiment is repeated for different values of R. The same procedure is repeated after interchanging R and X.

The unknown resistance X_2 is found using the formula $X_2 = \frac{Rl}{(100-l)}$

The experiment is repeated for same values of R as before. The resistance of the given coil is found from the mean value of X_1 and X_2. The radius of the wire r is found using screw gauge. The length of the coil L is measured using meter scale. From the values of X, r and L, the specific resistance of the material of the wire is determined.

OBSERVATION:

Length of the coil **L = 100 cm = 1 m.**

Table 1: To find the resistance of the given coil

S. No.	Resistance (R) (Ω)	Before interchanging		After interchanging		Mean $X = \frac{X_1+X_2}{2}$ (Ω)	$\rho = \frac{X\pi r^2}{L}$ (Ωm)
		Balancing length l (cm)	$X_1 = \frac{R(100-l)}{l}$ (Ω)	Balancing length l (cm)	$X_2 = \frac{Rl}{(100-l)}$ (Ω)		
1	1	14.3	5.993	85.7	5.993	**5.993**	**1.750**
2	2	25.1	5.968	74.9	5.968	**5.968**	**1.742**
3	3	33.4	5.982	66.6	5.982	**5.982**	**1.746**
4	4	41.3	5.685	58.7	5.685	**5.685**	**1.660**
5	5	45.9	5.893	54.1	5.893	**5.893**	**1.720**
Mean / Average						**5.904**	**1.723**

Table 2: To find the radius of the wire

Zero error = **No Error**; LC = **0.01mm**; Zero correction = **No Correction**

S. No.	PSR (mm)	HSC (Div.)	Total Reading = PSR + (HSC x LC)+ZC (mm)	Corrected Reading = TR + ZC (mm)
1	0	60	60	0.60
2	0	60	60	0.60
3	0	61	61	0.61
4	0	62	62	0.62
5	0	62	62	0.62
Mean / Average (2r) =				0.61 mm
Radius of the wire r =				0.305 mm
r =				**0.305×10^{-3} m**

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CALCULATION:

S. No.	$X_1 = \frac{R\,(100-l)}{l}$ (Ω)	$X_2 = \frac{Rl}{(100-l)}$ (Ω)	$\rho = \frac{X\pi r^2}{L}$ (Ωm)
01	$= \frac{1\,(100-14.3)}{14.3} = \frac{85.7}{14.3}$ $X_1 = 5.993\ \Omega$	$= \frac{1\,(85.7)}{(100-85.7)} = \frac{85.7}{14.3}$ $X_2 = 5.993\ \Omega$	$\rho = \frac{5.993 \times 3.14 \times (0.305 \times 10^{-3})^2}{1}$ $= \frac{5.993 \times 3.14 \times 0.0930 \times 10^{-6}}{1}$ $\rho = \mathbf{1.750 \times 10^{-6}}$ **(Ωm)**
	$X = \frac{X_1+X_2}{2}$; $= \frac{5.993+5.993}{2}$; $= \frac{11.986}{2}$ $X = 5.993\ \Omega$		
02	$= \frac{2\,(100-25.1)}{25.1} = \frac{149.8}{25.1}$ $X_1 = 5.968\ \Omega$	$= \frac{2\,(74.9)}{(100-74.9)} = \frac{149.8}{25.1}$ $X_2 = 5.968\ \Omega$	$\rho = \frac{5.968 \times 3.14 \times (0.305 \times 10^{-3})^2}{1}$ $= \frac{5.968 \times 3.14 \times 0.0930 \times 10^{-6}}{1}$ $\rho = \mathbf{1.742 \times 10^{-6}}$ **(Ωm)**
	$X = \frac{X_1+X_2}{2}$; $= \frac{5.968+5.968}{2}$; $= \frac{11.936}{2}$ $X = 5.968\ \Omega$		
03	$= \frac{3\,(100-33.4)}{33.4} = \frac{199.8}{33.4}$ $X_1 = 5.982\ \Omega$	$= \frac{3\,(66.6)}{(100-66.6)} = \frac{199.8}{33.4}$ $X_2 = 5.982\ \Omega$	$\rho = \frac{5.982 \times 3.14 \times (0.305 \times 10^{-3})^2}{1}$ $= \frac{5.982 \times 3.14 \times 0.0930 \times 10^{-6}}{1}$ $\rho = \mathbf{1.746 \times 10^{-6}}$ **(Ωm)**
	$X = \frac{X_1+X_2}{2}$; $= \frac{5.982+5.982}{2}$; $= \frac{11.964}{2}$ $X = 5.982\ \Omega$		
04	$= \frac{4\,(100-41.3)}{41.3} = \frac{234.8}{41.3}$ $X_1 = 5.685\ \Omega$	$= \frac{4\,(58.7)}{(100-58.7)} = \frac{234.8}{41.3}$ $X_2 = 5.685\ \Omega$	$\rho = \frac{5.685 \times 3.14 \times (0.305 \times 10^{-3})^2}{1}$ $= \frac{5.685 \times 3.14 \times 0.0930 \times 10^{-6}}{1}$ $\rho = \mathbf{1.660 \times 10^{-6}}$ **(Ωm)**
	$X = \frac{X_1+X_2}{2}$; $= \frac{5.685+5.685}{2}$; $= \frac{11.370}{2}$ $X = 5.685\ \Omega$		
05	$= \frac{5\,(100-45.9)}{45.9} = \frac{270.5}{45.9}$ $X_1 = 5.893\ \Omega$	$= \frac{5\,(54.1)}{(100-54.1)} = \frac{270.5}{45.9}$ $X_2 = 5.893\ \Omega$	$\rho = \frac{5.893 \times 3.14 \times (0.305 \times 10^{-3})^2}{1}$ $= \frac{5.893 \times 3.14 \times 0.0930 \times 10^{-6}}{1}$ $\rho = \mathbf{1.720 \times 10^{-6}}$ **(Ωm)**
	$X = \frac{X_1+X_2}{2}$; $= \frac{5.893+5.893}{2}$; $= \frac{11.786}{2}$ $X = 5.893\ \Omega$		

RESULT:

The specific resistance of the material of the given coil ρ = **1.723×10^{-6} (Ωm)**

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Ex. No. : 2 **Date :**

HORIZONTAL COMPONENT OF EARTH'S MAGNETIC FIELD USING TANGENT GALVANOMETER

AIM:

To determine the horizontal component of the Earth's magnetic field using tangent galvanometer.

APPARATUS REQUIRED:

Tangent galvanometer (TG), Commutator, Battery, Rheostat, Ammeter, key and Connecting wires.

FORMULA: $B_H = \frac{\mu_0 nk}{2r}$ (Tesla)

Where, B_H → Horizontal component of the Earth's magnetic field (T)

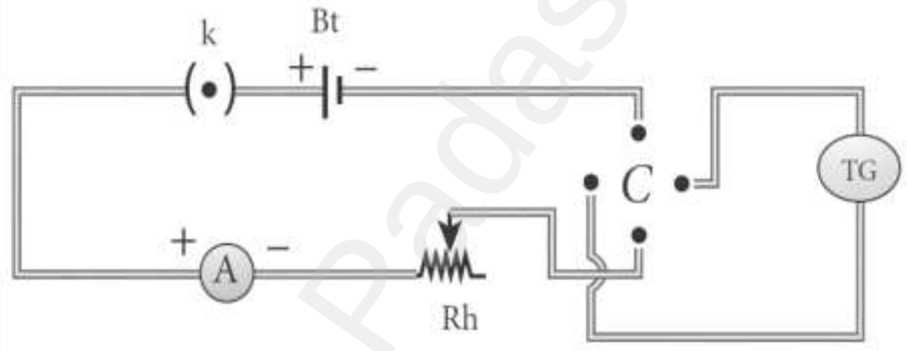
μ_0 → Permeability of free space ($4\pi\times10^{-7}$ Hm^{-1})

n → Number of turns of TG in the circuit (No unit)

k → Reduction factor of TG (A)

r → Radius of the coil (m)

CIRCUIT DIAGRAM:



PROCEDURE:

The preliminary adjustments are carried out as follows. The leveling screws at the base of TG are adjusted so that the circular turn table is horizontal and the plane of the circular coil is vertical.

The circular coil is rotated so that its plane is in the magnetic meridian i.e., along the north-south direction. The compass box alone is rotated till the aluminium pointer reads $0^0 - 0^0$. The connections are made as shown in circuit. The number of turn's n is selected and the circuit is switched on.

The range of current through TG is chosen in such a way that the deflection of the aluminium pointer lies between $30^0 - 60^0$. A suitable current is allowed to pass through the circuit; the deflections θ_1 and θ_2 are noted from two ends of the aluminium pointer. Now the direction of current is reversed using commutator C, the deflections θ_3 and θ_4 in the opposite direction are noted. The mean value θ of θ_1, θ_2, θ_3 and θ_4 is calculated and tabulated.

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The reduction factor k is calculated for each case and it is found that k is a constant. The experiment is repeated for various values of current and the readings are noted and tabulated. The radius of the circular coil is found by measuring the circumference of the coil using a thread around the coil.
From the values of r, n and k, the horizontal component of Earth's magnetic field is determined.

OBSERVATION:

Number of turns of the coil (n) = 5

Circumference of the coil (2πr) = 49.5×10^{-2} m

Radius of the coil (r) = $2\pi r = 49.5 \times 10^{-2}$ m

$$r = \frac{49.5 \times 10^{-2}}{2\pi};$$

$$= \frac{49.5 \times 10^{-2}\ \mathrm{m}}{2 \times 3.14};$$

$$= \frac{49.5 \times 10^{-2}}{6.28}$$

r = 7.882 x 10^{-2} m

S. No.	Current I (A)	Deflection of T.G. (Degree)				Mean θ	tan θ	$k = \frac{I}{\tan\theta}$ (A)	$B_H = \frac{\mu_0 nk}{2r}$ (Tesla)
		θ_1	θ_2	θ_3	θ_4				
1	0.6	32	32	33	33	$32^0 30'$	0.637	0.941	3.748
2	0.8	39	39	40	40	$39^0 30'$	0.824	0.970	3.864
3	1.0	45	45	46	46	$45^0 30'$	1.017	0.983	3.915
4	1.2	50	50	51	51	$50^0 30'$	1.213	0.989	3.939
							Mean / Average	**0.970**	**3.866**

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CALCULATION: To find horizontal component of the Earth's magnetic field

S. No.	$k = \frac{I}{\tan\theta}$	$B_H = \frac{\mu_0 nk}{2r}$ (Tesla)
01	$k = \frac{0.6}{\tan 32^0 30'}$; $= \frac{0.6}{0.637}$; **k = 0.941 A**	$B_H = \frac{4\pi \times 10^{-7} \times 5 \times 0.941}{49.5 \times 10^{-2}/\pi}$; $= \frac{4\pi^2 \times 10^{-7} \times 5 \times 0.941}{49.5 \times 10^{-2}}$ $= \frac{4 \times 3.14 \times 3.14 \times 10^{-7} \times 5 \times 0.941}{49.5 \times 10^{-2}}$; $= \frac{185.557 \times 10^{-7}}{49.510^{-2}}$ **B_H = 3.748 x10^{-5} (Tesla)**
02	$k = \frac{0.8}{\tan 39^0 30'}$; $= \frac{0.8}{0.824}$; **k = 0.970 A**	$B_H = \frac{4\pi \times 10^{-7} \times 5 \times 0.970}{49.5 \times 10^{-2}/\pi}$; $= \frac{4\pi^2 \times 10^{-7} \times 5 \times 0.970}{49.5 \times 10^{-2}}$ $= \frac{4 \times 3.14 \times 3.14 \times 10^{-7} \times 5 \times 0.970}{49.5 \times 10^{-2}}$; $= \frac{191.276 \times 10^{-7}}{49.510^{-2}}$ **B_H = 3.864 x10^{-5} (Tesla)**
03	$k = \frac{1.0}{\tan 45^0 30'}$; $= \frac{1.0}{1.017}$; **k = 0.983 A**	$B_H = \frac{4\pi \times 10^{-7} \times 5 \times 0.983}{49.5 \times 10^{-2}/\pi}$; $= \frac{4\pi^2 \times 10^{-7} \times 5 \times 0.983}{49.5 \times 10^{-2}}$ $= \frac{4 \times 3.14 \times 3.14 \times 10^{-7} \times 5 \times 0.983}{49.5 \times 10^{-2}}$; $= \frac{193.839 \times 10^{-7}}{49.510^{-2}}$ **B_H = 3.915 x10^{-5} (Tesla)**
04	$k = \frac{1.2}{\tan 50^0 30'}$; $= \frac{1.2}{1.213}$; **k = 0.989 A**	$B_H = \frac{4\pi \times 10^{-7} \times 5 \times 0.989}{49.5 \times 10^{-2}/\pi}$; $= \frac{4\pi^2 \times 10^{-7} \times 5 \times 0.989}{49.5 \times 10^{-2}}$ $= \frac{4 \times 3.14 \times 3.14 \times 10^{-7} \times 5 \times 0.989}{49.5 \times 10^{-2}}$; $= \frac{195.022 \times 10^{-7}}{49.510^{-2}}$ **B_H = 3.939 x10^{-5} (Tesla)**

RESULT:

The horizontal component of Earth's magnetic field is found to be

B_H = 3.866 x 10^{-5} Tesla

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Ex. No. : 3 **Date :**

COMPARISON OF EMF OF TWO CELLS USING POTENTIOMETER

AIM:

To compare the emf of the given two cells using a potentiometer.

APPARATUS REQUIRED:

Battery eliminator, key, rheostat, DPDT switch, Lechlanche and Daniel cells, galvanometer, high resistance box, pencil jockey and connecting wires.

FORMULA:

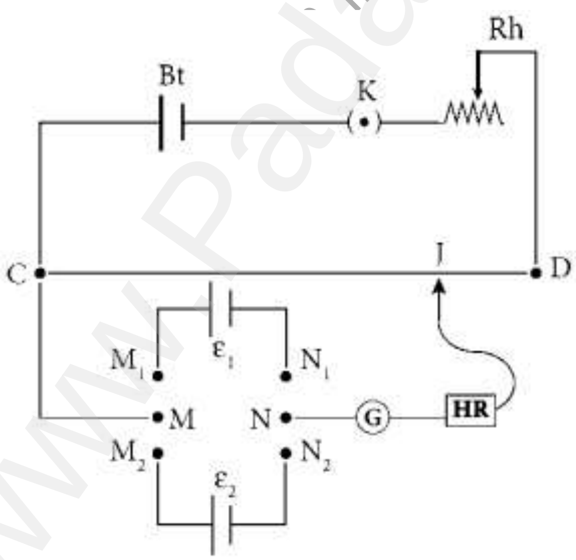
$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2} \text{ (No Unit)}$$

Where,

ε_1 and ε_2 → The emf of Lechlanche and Daniel cells respectively (V)

l_1 and l_2 → The balancing lengths for Lechlanche and Daniel cells respectively (cm)

CIRCUIT DIAGRAM:



PROCEDURE:

The apparatus is arranged as shown in the circuit diagram.

The primary circuit consisting of battery, key and rheostat is connected to the potentiometer in series.

The positive poles of the cells are connected to terminals M_1 & M_2 and the negative poles to terminals N_1 & N_2 of the DPDT switch. The potentiometer is connected to the common terminals M and N as shown in the circuit.

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Using the two-way key, Lechlanche cell is included in the circuit. By sliding the jockey on the potentiometer wire, the balancing point is found and the corresponding balancing length is measured.
Similarly, the balancing length is found by including Daniel cell in the circuit. The experiment is repeated for different sets of balancing lengths by adjusting the rheostat. From different values of l_1 and l_2 , the ratio of emf of the two cells is calculated.

OBSERVATION:
To find the ratio of emf of two cells;

S. No.	Balancing length for Lechlanche cell, l_1 (cm)	Balancing length for Daniel cell, l_2 (cm)	$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$
1	625	458	1.364
2	636	459	1.385
3	647	473	1.367
4	658	478	1.376
5	668	481	1.388
6	680	497	1.368
		Mean $\frac{\varepsilon_1}{\varepsilon_2}$	1.374

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CALCULATION:

S. No.	$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$
1	$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2} = \frac{625}{458}$ = 1.364 (No Unit)
2	$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2} = \frac{636}{459}$ = 1.385 (No Unit)
3	$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2} = \frac{647}{473}$ = 1.367 (No Unit)
4	$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2} = \frac{658}{478}$ = 1.376 (No Unit)
5	$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2} = \frac{668}{481}$ = 1.388 (No Unit)
6	$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2} = \frac{680}{497}$ = 1.368 (No Unit)

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Mean :

$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{1.364 + 1.385 + 1.367 + 1.376 + 1.388 + 1.368}{6}$$

$$\frac{\varepsilon_1}{\varepsilon_2} = 1.374 \text{ (No unit)}$$

RESULT:

Ratio of emf of the given two cells = 1.374 (No unit)

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Ex. No. : 4 **Date :**

REFRACTIVE INDEX OF THE MATERIAL OF THE PRISM

AIM:

To determine the refractive index of the material of a prism using spectrometer.

APPARATUS REQUIRED:

Spectrometer, prism, prism clamp, sodium vapour lamp, spirit level.

FORMULA:

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)} \text{ (No unit)}$$

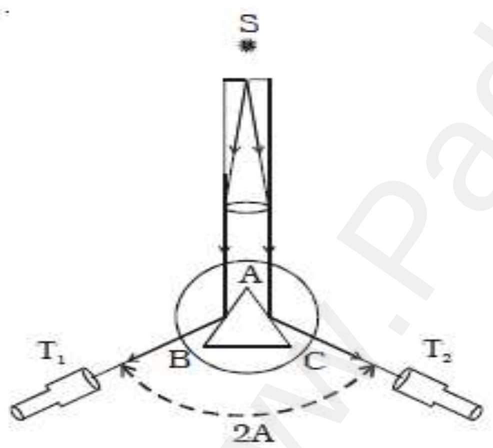
Where, μ ⟶ Refractive index of the material of the prism (No unit)

A ⟶ Angle of the prism (degree)

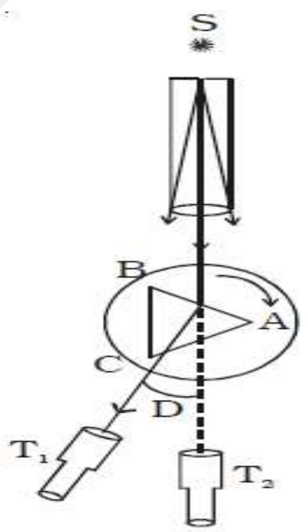
D ⟶ Angle of minimum deviation (degree)

DIAGRAMS:

To find the Angle of Prism:



To find the Angle of Minimum Deviation:



PROCEDURE:

1) Initial adjustments of the spectrometer:

Eye-piece:

The eye-piece of the telescope is adjusted so that the cross-wires are seen clearly.

Slit:

The slit of the collimator is adjusted such that it is very thin and vertical.

Base of the spectrometer:

The base of the spectrometer is adjusted to be horizontal using leveling screws.

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Telescope:

The telescope is turned towards a distant object and is adjusted till the clear inverted image of the distant object is seen. Now the telescope is adjusted to receive parallel rays.

Collimator:

The telescope is brought in line with the collimator. Collimator is adjusted until a clear image of the slit is seen in the telescope. Now the collimator gives parallel rays.

Prism table:

Using a spirit level, the prism table is adjusted to be horizontal with the three leveling screws provided in the prism table.

2) Determination of angle of the prism (A):

The slit is illuminated by yellow light from sodium vapour lamp. The given equilateral prism is placed on the prism table in such a way that refracting edge of the prism is facing the collimator. The light emerging from the collimator is incident on both reflecting faces of the prism and is reflected. Telescope is rotated towards left to obtain reflected image of the slit from face 1 of the prism and is fixed. Using tangential screws, the telescope is adjusted until the vertical cross-wire coincides with the reflected image of the slit.

The main scale reading and vernier coincidence are noted from both vernier scales. The telescope is now rotated towards right to obtain the reflected image from face 2 of the prism. As before, the readings are taken.

The difference between the two readings gives 2A from which the angle of the prism A is calculated.

3) Determination of angle of minimum deviation (D):

The prism table is rotated such that the light emerging from the collimator is incident on one of the refracting faces of the prism, gets refracted and emerges out from the other refracting face. The telescope is turned to view the refracted image. Looking through the telescope, the prism table is rotated in such a direction that the image moves towards the direct ray. One particular position, the refracted ray begins to retrace its path. The position where the refracted image returns is the position of minimum deviation.

The telescope is fixed in this position and is adjusted until the vertical cross-wire coincides with the refracted image of the slit. The readings are taken from both vernier scales. The prism is now removed and the telescope is rotated to obtain the direct ray image and the readings are taken.

The readings are tabulated and the difference between these two readings gives the angle of minimum deviation D. From the values of A and D, the refractive index of the material of the glass prism is determined.

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OBSERVATION:

Table 1: To find the angle of the prism (A)

RAY	VERNIER A (Degree)			VERNIER B (Degree)		
	MSR	VC	TR = MSR+ (VC×LC)	MSR	VC	TR = MSR+ (VC×LC)
Reflected image from face 1	60^0	7	$60^0\ 7'$	240^0	7	$240^0\ 7'$
Reflected image from face 2	299^0	3	$299^0\ 3'$	119^0	3	$119^0\ 3'$
Difference 2A	$2A = R_1 \sim R_2$		**$121^0\ 4'$**	$2A = R_1 \sim R_2$		**$121^0\ 4'$**
				Mean / Average 2A =		**$121^0\ 4'$**
				Mean / Average A =		**$60^0\ 32'$**

Table 2: To find the angle of minimum deviation (D)

Image	VERNIER A (Degree)			VERNIER B (Degree)		
	MSR	VC	TR = MSR+ (VC×LC)	MSR	VC	TR = MSR+ (VC×LC)
Reflected image (R3)	319^0	14	$319^0\ 14'$	139^0	14	$139^0\ 14'$
Direct image (R4)	0^0	0	$0^0\ 0'$	180^0	0	$180^0\ 0'$
Difference D	$D = R_3 \sim R_4$		**$40^0\ 46'$**	$D = R_3 \sim R_4$		**$40^0\ 46'$**
				Mean / Average 2D =		**$81^0\ 32'$**
				Mean / Average D =		**$40^0\ 46'$**

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CALCULATION:

To find "A" (Vernier – A)

$2A = R_1 \sim R_2 = 299^0\, 3' - 60^0\, 7' = 238^0\, 56'$

This value is larger Obtuse angle, so, it must be subtracted from 360^0

$2A = 360^0 - 238^0\, 56' = 121^0\, 4'$

To find "A" (Vernier – B)

$2A = R_1 \sim R_2 = 240^0\, 7' - 119^0\, 3' = 121^0\, 4'$

$$\text{Average } 2A = \frac{121^0 4' + 121^0\, 4'}{2} \; ; = \frac{242^0 8'}{2} = 121^0\, 4'$$

$$= \frac{121^0 4'}{2} \; ; \; \mathbf{A = 60^0\, 32'} \text{ (Degree)}$$

To find "D" (Vernier – A)

$D = R_3 \sim R_4 = 319^0\, 14' - 0^0\, 0' = 319^0\, 14'$

$\mathbf{D} = 360^0 - 319^0\, 14' = 40^0\, 46'$

To find "D" (Vernier – B)

$\mathbf{D} = R_3 \sim R_4 = 180^0\, 0' - 139^0\, 14' = 40^0\, 46'$

$$\text{Average } D = \frac{40^0 46' + 40^0\, 46'}{2} \; ;$$

$$= \frac{81^0 32'}{2} \; ; \; \mathbf{D = 40^0\, 46'} \text{ (Degree)}$$

To find "μ" :

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)} \text{ (No unit)}$$

$$= \frac{\sin\left(\frac{60^0 32' + 40^0 46'}{2}\right)}{\sin\left(\frac{60^0 32'}{2}\right)} \; ; = \frac{\sin\left(\frac{101^0 18'}{2}\right)}{\sin\left(\frac{60^0 32'}{2}\right)} \; ;$$

$$= \frac{\sin(50^0\ 39')}{\sin(30^0 16')}$$

$$= \frac{0.7732}{0.5040}$$

$\mu =$ **1.534 (No Unit)**

RESULT:

1. Angle of the Prism $\mathbf{A = 60^0\, 32'}$ **(Degree)**
2. Angle of the minimum deviation of the prism $\mathbf{D = 40^0\, 46'}$ **(Degree)**
3. Refractive index of the material of the Prism $\mu =$ **1.534 (No Unit)**

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Ex. No. : 5 **Date :**

WAVELENGTH OF THE CONSTITUENT COLOURS OF A COMPOSITE LIGHT USING DIFFRACTION GRATING AND SPECTROMETER

AIM:

To find the wavelength of the constituent colours of a composite light using diffraction grating and spectrometer.

APPARATUS REQUIRED:

Spectrometer, mercury vapour lamp, diffraction grating, grating table, and spirit level.

FORMULA:

$$\lambda = \frac{\sin\theta}{nN}\ \text{Å}$$

Where, λ ⟶ Wavelength of the constituent colours of a composite light (Å)

N ⟶ Number of lines per metre length of the given grating (No unit)

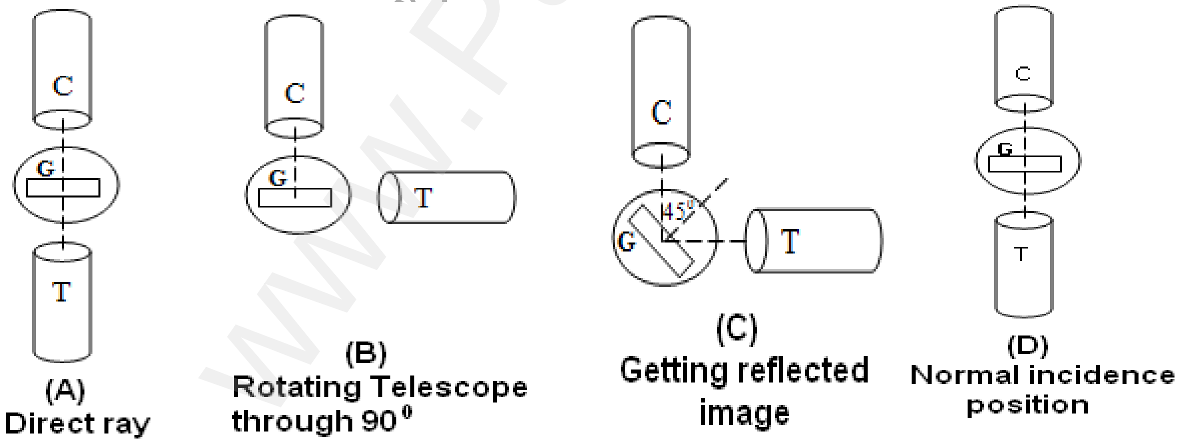
(The value of N for the grating is given)

n ⟶ Order of the diffraction (No unit)

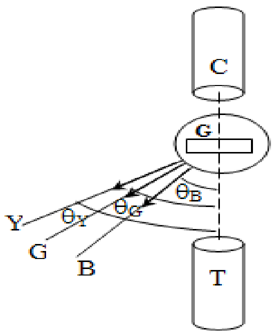
θ ⟶ Angle of diffraction (degree)

DIAGRAMS:

ADJUSTING THE GRATING FOR NORMAL INCIDENCE: (NOT FOR EXAMINATION)



DETERMINATION OF ANGLE OF DIFFRACTION: (NOT FOR EXAMINATION)



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PROCEDURE:

1) Initial adjustments of the spectrometer

Eye-piece:

The eye-piece of the telescope is adjusted so that the cross-wires are seen clearly.

Slit:

The slit of the collimator is adjusted such that it is very thin and vertical.

Base of the spectrometer:

The base of the spectrometer is adjusted to be horizontal using leveling screws.

Telescope:

The telescope is turned towards a distant object and is adjusted till the clear image of the distant object is seen. Now the telescope is adjusted to receive parallel rays.

Collimator:

The telescope is brought in line with the collimator. Collimator is adjusted until a clear image of the slit is seen in the telescope. Now the collimator gives parallel rays.

Grating table:

Using a spirit level, the grating table is adjusted to be horizontal with the three leveling screws provided in the grating table.

2) Adjustment of the grating for normal incidence:

The slit is illuminated with a composite light (white light) from mercury vapour lamp. The telescope is brought in line with the collimator. The vertical cross-wire is made to coincide with the image of the slit (Figure (a).

The vernier disc alone is rotated till the vernier scale reads 0^0 - 180^0 and is fixed. This is the reading for the direct ray. The telescope is then rotated (anti-clockwise) through an angle of 90^0 and fixed (Figure (b).

Now the plane transmission grating is mounted on the grating table.

The grating table alone is rotated so that the light reflected from the grating coincides with vertical cross-wire of the telescope.

The reflected image is white in colour (Figure (c). Now the vernier disc is released. The vernier disc along with grating table is rotated through an angle of 45^0 in the appropriate direction such that the light from the collimator is incident normally on the grating (Figure (d).

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3) Determination of wave length of the constituent colours of the mercury spectrum:

The telescope is released and is brought in line with the collimator to receive central direct image. This un-dispersed image is white in colour. The diffracted images of the slit are observed on either side of the direct image.

The diffracted image consists of the prominent colours of mercury spectrum in increasing order of wavelength. The telescope is turned to any one side (say left) of direct image to observe first order diffracted image. The vertical cross-wire is made to coincide with the prominent spectral lines (Violet, Blue, Yellow and Red) and the readings of both vernier scales for each case are noted.

Now the telescope is rotated to the right side of the direct image and the first order image is observed. The vertical cross-wire is made to coincide with the same prominent spectral lines and the readings of both vernier scales for each case are again noted. The readings are tabulated.

The difference between these two readings gives the value of 2θ for the particular spectral line. The number of lines per metre length of the given grating N is noted from the grating. From the values of N, n and θ, the wave length of the prominent colours of the mercury light is determined using the given formula.

OBSERVATION:

To find the wave length of prominent colours of the mercury spectrum:

Colour of Light	Diffracted Ray Reading (Degree)												**Difference 2θ (Degree)**			θ (Degree)
	Left						Right									
	VERNIER A			VERNIER B			VERNIER A			VERNIER B						
	MSR	VSC	TR	MSR	VSC	TR	MSR	VSC	TR	MSR	VSC	TR	VER. - A	VER. - B	Mean	
Blue	302°	0	302° 0′	122°	0	122° 0′	327°	0	327° 0′	147°	0	147° 0′	25° 0′	25° 0′	25° 0′	**12° 30′**
Green	299°	0	299° 0′	119°	0	119° 0′	330°	30	330° 30′	150°	30	150° 30′	31° 30′	31° 30′	31° 30′	**15° 45′**
Yellow	298°	0	298° 0′	118°	0	118° 0′	331°	30	331° 30′	151°	30	151° 30′	33° 30′	33° 30′	33° 30′	**16° 45′**
Red	296°	0	296° 0′	116°	0	116° 0′	333°	30	333° 30′	153°	30	153° 30′	37° 30′	37° 30′	37° 30′	**18° 45′**

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CALCULATION:

S. No.	Colour	$\lambda = \frac{\sin\theta}{nN}$ Å
01	**Blue**	$= \frac{\sin 12^0 30^0}{1 \times 5 \times 10^5}$; $= \frac{0.2164}{5 \times 10^5}$; $= 0.04328 \times 10^{-5}$ $\boldsymbol{\lambda} = 4328 \times \mathbf{10^{-10}}$ m (or) $\boldsymbol{\lambda} = 4328$Å
02	**Green**	$= \frac{\sin 15^0 45^0}{1 \times 5 \times 10^5}$; $= \frac{0.2714}{5 \times 10^5}$; $= 0.05428 \times 10^{-5}$ $\boldsymbol{\lambda} = 5428 \times 10^{-10}$ m (or) $\boldsymbol{\lambda} = 5428$ Å
03	**Yellow**	$= \frac{\sin 16^0 45^0}{1 \times 5 \times 10^5}$; $= \frac{0.2881}{5 \times 10^5}$; $= 0.05763 \times 10^{-5}$ $\boldsymbol{\lambda} = 5763 \times \mathbf{10^{-10}}$ m (or) $\boldsymbol{\lambda} = 5763$Å
04	**Red**	$= \frac{\sin 18^0 45^0}{1 \times 5 \times 10^5}$; $= \frac{0.3214}{5 \times 10^5}$; $= 0.06428 \times 10^{-5}$ $\boldsymbol{\lambda} = 6428 \times \mathbf{10^{-10}}$ m (or) $\boldsymbol{\lambda} = 6428$Å

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RESULT:

1. The wavelength of blue line $\boldsymbol{\lambda} = 4328 \times \mathbf{10^{-10}}$ m (or) $\boldsymbol{\lambda} = 4328$Å
2. The wavelength of green line $\boldsymbol{\lambda} = 5428 \times 10^{-10}$ m (or) $\boldsymbol{\lambda} = 5428$ Å
3. The wavelength of yellow line $\boldsymbol{\lambda} = 5763 \times \mathbf{10^{-10}}$ m (or) $\boldsymbol{\lambda} = 5763$Å
4. The wavelength of red line $\boldsymbol{\lambda} = 6428 \times \mathbf{10^{-10}}$ m (or) $\boldsymbol{\lambda} = 6428$Å

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Ex. No. : 6 **Date :**

VOLTAGE - CURRENT CHARACTERISTICS OF A PN JUNCTION DIODE

AIM:

To draw the voltage-current (V- I) characteristics of the PN junction diode and to determine its knee voltage and forward resistance.

APPARATUS REQUIRED:

PN junction diode (IN4007), variable DC power supply, milli-ammeter, micro-ammeter, voltmeter, resistance and connecting wires.

FORMULA:

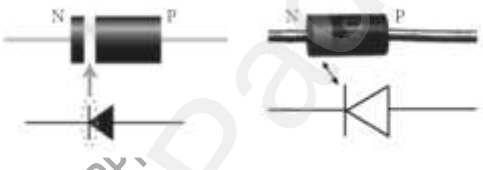
$$R_F = \frac{\Delta V_F}{\Delta I_F} \ (\Omega)$$

Where, R_F ⟶ Forward resistance of the diode (Ω)

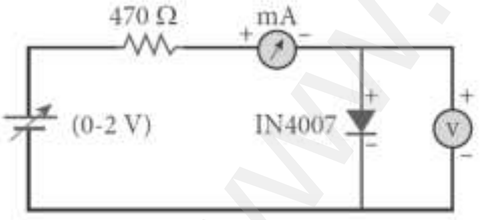
ΔV_F → The change in forward voltage (volt)

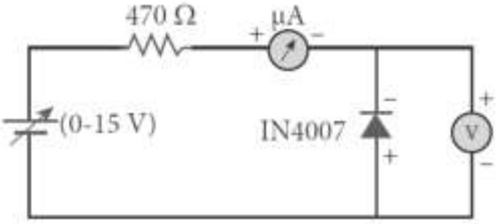
ΔI_F → The change in forward current (mA)

CIRCUIT DIAGRAM:



(PN Junction diode and its symbol (Silver ring denotes the negative terminal of the diode)





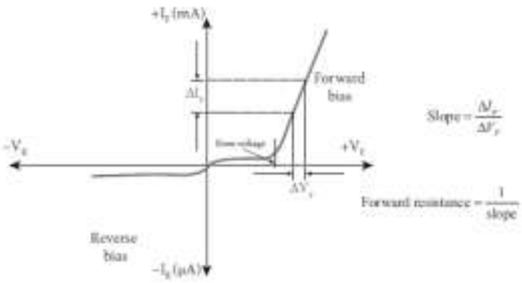
(PN Junction diode in forward bias) (PN Junction diode in reverse bias)

PROCEDURE:

i) Forward bias characteristics:

In the forward bias, the P- region of the diode is connected to the positive terminal and N-region to the negative terminal of the DC power supply. The connections are given as per the circuit diagram. The voltage across the diode can be varied with the help of the variable DC power supply.

The forward voltage (V_F) across the diode is increased from 0.1 V in steps of 0.1 V up to 0.8 V and the forward current (I_F) through the diode is noted from the milli-ammeter. The readings are tabulated.



The forward voltage V_F and the forward current I_F are taken as positive. A graph is drawn taking the forward voltage (V_F) along the x-axis and the forward current (I_F) along the y-axis.

The voltage corresponding to the dotted line in the forward characteristics gives the knee voltage or threshold voltage or turn-on voltage of the diode. The slope in the linear portion of the forward characteristics is calculated. The reciprocal of the slope gives the forward resistance of the diode.

ii) Reverse bias characteristics:

In the reverse bias, the polarity of the DC power supply is reversed so that the P- region of the diode is connected to the negative terminal and N-region to the positive terminal of the DC power supply. The connections are made as given in the circuit diagram. The voltage across the diode can be varied with the help of the variable DC power supply.

The reverse voltage (V_R) across the diode is increased from 1 V in steps of 1 V up to 5 V and the reverse current (I_R) through the diode is noted from the micro-ammeter. The readings are tabulated. The reverse voltage V_R and reverse current I_R are taken as negative. A graph is drawn taking the reverse bias voltage (V_R) along negative x-axis and the reverse bias current (I_R) along negative y-axis.

OBSERVATION:

Table 1

Forward bias characteristic curve

S. No.	Forward Bias Voltage V_F (V)	Forward Bias Current I_F (mA)
1	0.1	0
2	0.2	0
3	0.3	0
4	0.4	0
5	0.5	0
6	0.6	3.5
7	0.7	17.5

Table 2

Reverse bias characteristic curve

S. No.	Reverse Bias Voltage V_F (V)	Reverse Bias Current I_R (μA)
1	1	50
2	2	70
3	3	90
4	4	100
5	5	110
6	6	120
7	7	130

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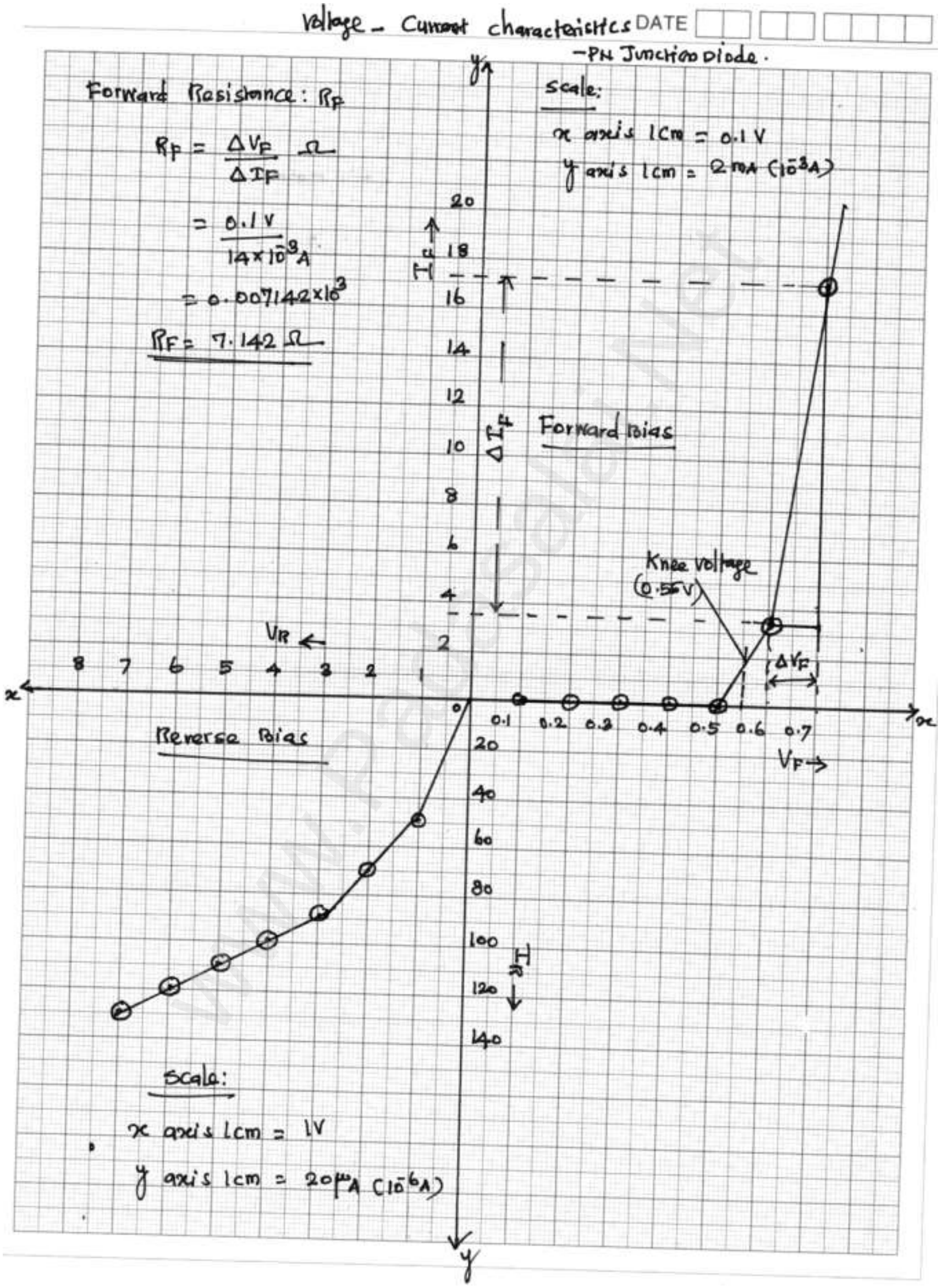

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CALCULATION:

(i) Forward resistance $R_F = \frac{\Delta V_F}{\Delta I_F}\ \Omega$

$$= \frac{0.1\ V}{14 \times 10^{-3}\ A}$$

$$= 0.007142 \times 10^3$$

$$R_F = 7.142\ \Omega$$

(ii) Knee voltage = **0.55 V (From Graph)**

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RESULT:

The V-I characteristics of the PN junction diode are studied.

i) Knee voltage of the PN junction diode = **0.55 V (From Graph)**

ii) Forward resistance of the diode **R_F = 7.142 Ω**

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Ex. No. : 7 **Date :**

VOLTAGE - CURRENT CHARACTERISTICS OF A ZENER DIODE

AIM:

To draw the voltage-current (V-I) characteristic curves of a Zener diode and to determine its knee voltage, forward resistance and reverse breakdown voltage.

APPARATUS REQUIRED:

Zener diode IZ5.6V, variable dc power supply (0 – 15V), milli ammeter, volt meter, 470 Ω resistance, and connecting wires.

FORMULA:

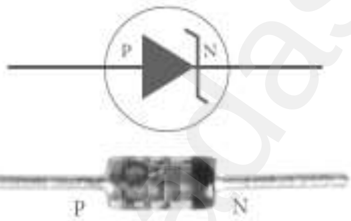
$$R_F = \frac{\Delta V_F}{\Delta I_F} \ (\Omega)$$

Where, R_F ⟶ Forward resistance of the diode (Ω)

ΔV_F → The change in forward voltage (volt)

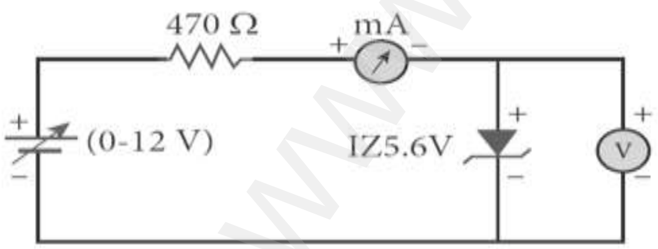
ΔI_F → The change in forward current (mA)

CIRCUIT DIAGRAM

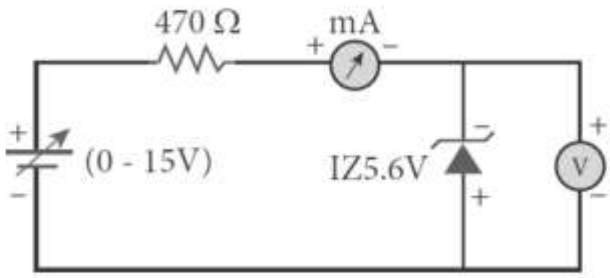


Zener diode and its symbol

(The black colour ring denotes the negative terminal of the Zener diode)



Zener diode in forward bias



Zener diode in reverse bias

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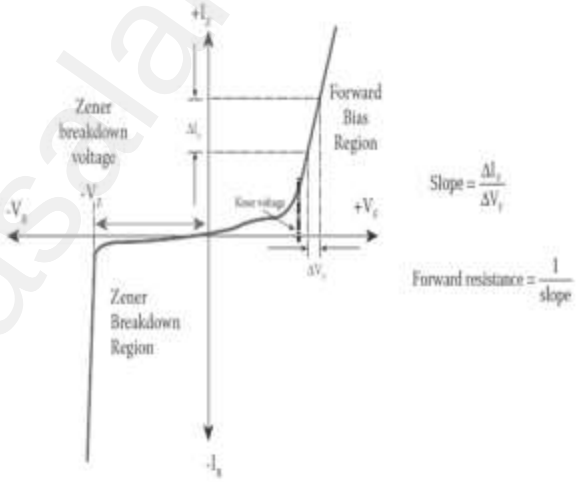
PROCEDURE:

i) Forward bias characteristics:

In the forward bias, the P- region of the diode is connected to the positive terminal and N-region to the negative terminal of the DC power supply. The connections are given as per the circuit diagram. The voltage across the diode can be varied with the help of the variable DC power supply.

The forward voltage (V_F) across the diode is increased from 0.1V in steps of 0.1V up to 0.8V and the forward current (I_F) through the diode is noted from the milli-ammeter. The readings are tabulated. The forward voltage and the forward current are taken as positive.

A graph is drawn taking the forward voltage along the x-axis and the forward current along the y-axis. The voltage corresponding to the dotted line in the forward characteristics gives the knee voltage or threshold voltage or turn-on voltage of the diode.



The slope in the linear portion of the forward characteristics is calculated. The reciprocal of the slope gives the forward resistance of the diode.

ii) Reverse bias characteristics:

In the reverse bias, the polarity of the DC power supply is reversed so that the P- region of the diode is connected to the negative terminal and N-region to the positive terminal of the DC power supply. The connections are made as given in the circuit diagram. The voltage across the diode can be varied with the help of the variable DC power supply.

The reverse voltage (V_R) across the diode is increased from 0.5V in steps of 0.5V up to 6V and the reverse current (I_R) through the diode is noted from the milli-ammeter. The readings are tabulated. Initially, the voltage is increased in steps of 0.5V. When the breakdown region is approximately reached, then the input voltage may be raised in steps of, say 0.1V to find the breakdown voltage.

The reverse voltage and reverse current are taken as negative. A graph is drawn taking the reverse bias voltage along negative x-axis and the reverse bias current along negative y-axis. In the reverse bias, Zener breakdown occurs at a particular voltage called Zener voltage V_Z (~5.6 to 5.8V) and a large amount of current flows through the diode which is the characteristics of a Zener diode. The breakdown voltage of the Zener diode is determined from the graph as shown.

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OBSERVATION:

Table 1

Forward bias characteristic curve

S. No.	Forward Bias Voltage V_F (V)	Forward Bias Current I_F (mA)
1	0.1	0
2	0.2	0
3	0.3	0
4	0.4	0
5	0.5	0
6	0.6	0
7	0.7	0
8	0.8	4
9	0.9	14

Table 2

Reverse bias characteristic curve

S. No.	Reverse Bias Voltage V_F (V)	Reverse Bias Current I_R (μA)
1	1	0
2	2	0
3	3	0
4	4	0
5	5	0
6	6	0
7	6.2	0.2
8	6.4	10
9	6.5	11

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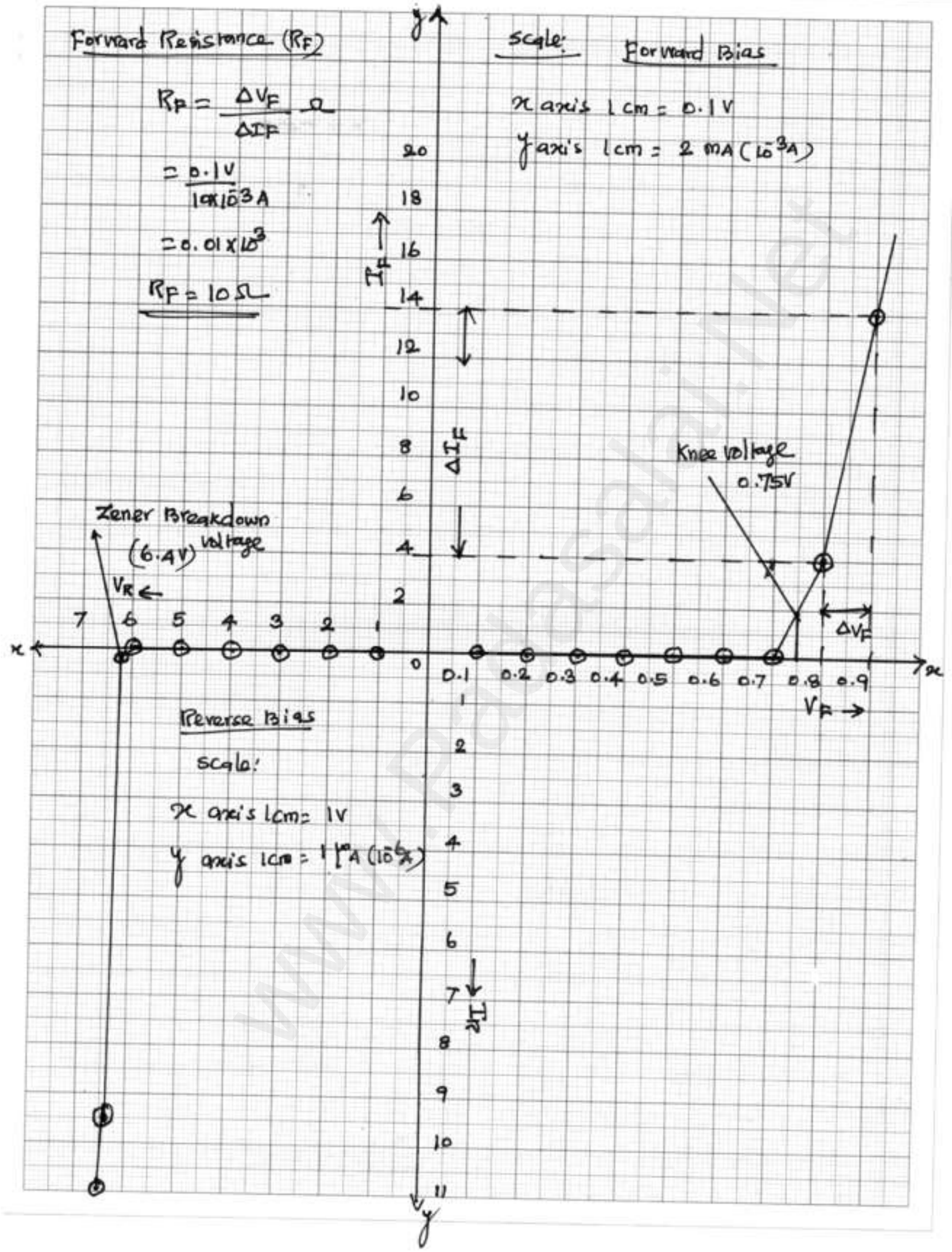
Voltage – Current characteristics - Zener Diode.



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CALCULATION:

(i) Forward resistance $R_F = \frac{\Delta V_F}{\Delta I_F}\ \Omega$

$$= \frac{0.1\ \text{V}}{10 \times 10^{-3}\ \text{A}} \quad ; = 0.01 \times 10^3$$

$R_F = 10\ \Omega$

(ii) Knee voltage = **0.75 V (From Graph)**

(iii) The breakdown voltage of the Zener diode **V_Z = 6.4 V (From Graph)**

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RESULT:

The V-I characteristics of the Zener diode are studied.

(i) Forward resistance **R_F = 10 Ω**

(ii) Knee voltage = **0.75 V (From Graph)**

(iii) The breakdown voltage of the Zener diode **V_Z = 6.4 V (From Graph)**

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Ex. No. : 8 **Date :**

CHARACTERISTICS OF A NPN-JUNCTION TRANSISTOR IN COMMON EMITTER CONFIGURATION

AIM:

To study the characteristics and to determine the current gain of a NPN junction transistor in common emitter configuration.

APPARATUS REQUIRED:

Transistor - BC 548/BC107, bread board, micro ammeter, milli ammeter, voltmeters, variable DC power supply and connecting wires.

FORMULA :

$$r_i = \left[\frac{\Delta V_{BE}}{\Delta I_B}\right]_{V_{CE}} (\Omega), \quad r_0 = \left[\frac{\Delta V_{CE}}{\Delta I_C}\right]_{B} (\Omega), \quad \beta = \left[\frac{\Delta I_C}{\Delta I_B}\right]_{V_{CE}} \text{(No unit)}$$

Where, r_i ⟶ Input impedance (Ω)

ΔV_{BE} ⟶ The change in base-emitter voltage (volt)

ΔI_B ⟶ The change in base current (μA)

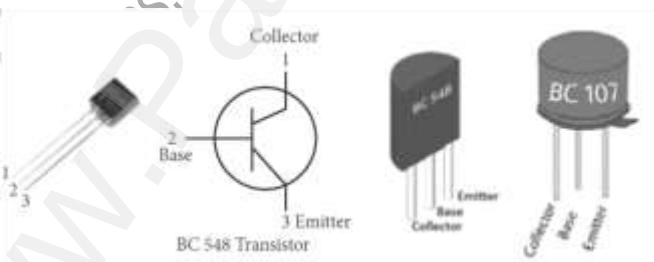
r_o ⟶ Output impedance (Ω)

ΔV_{CE} ⟶ The change in collector-emitter voltage (volt)

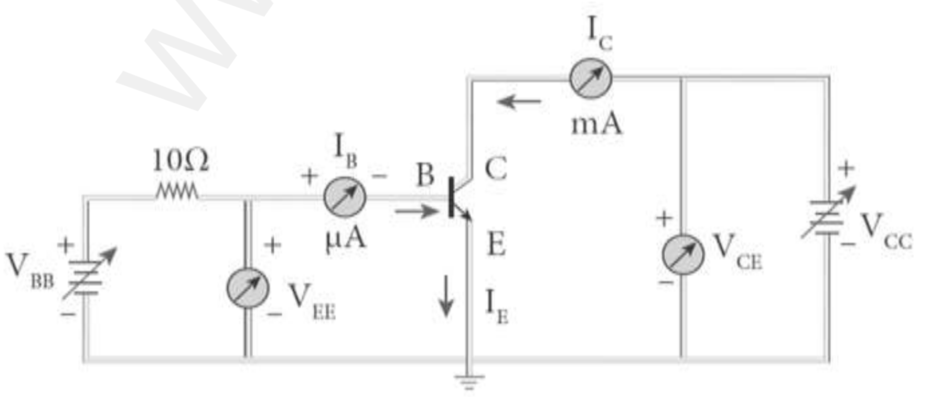
ΔI_C ⟶ The change in collector current (mA)

β ⟶ Current gain of the transistor (No unit)

CIRCUIT DIAGRAI



NPN - Junction transistor and its symbol
(Transistor is held with the flat surface facing us)



NPN junction transistor in CE configuration

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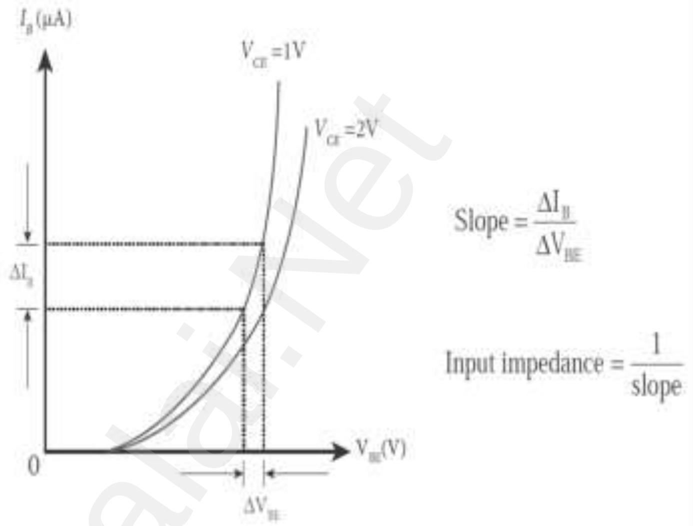
PROCEDURE:

The connections are given as shown in the diagram. The current and voltage at the input and output regions can be varied by adjusting the DC power supply.

(i) Input characteristic curve: V_{BE} vs I_B (V_{CE} constant):

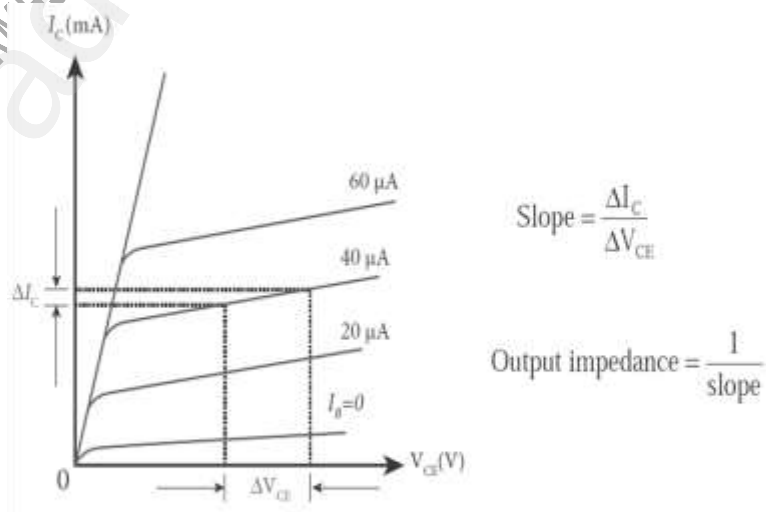
The collector-emitter voltage V_{CE} is kept constant. The base-emitter voltage V_{BE} is varied in steps of 0.1V and the corresponding base current (I_B) is noted. The readings are taken till V_{CE} reaches a constant value. The same procedure is repeated for different values of V_{CE}. The readings are tabulated.



A graph is plotted by taking V_{BE} along x-axis and I_B along y-axis for both the values of V_{CE}. The curves thus obtained are called the input characteristics of a transistor. The reciprocal of the slope of these curves gives the input impedance of the transistor.

(ii) Output characteristic curve: V_{CE} vs I_C (I_B constant):

The base current IB is steps of 1V and the corresponding collector current I_C is noted. The readings are taken till the collector current becomes almost constant.



Initially I_B is kept at 0 mA and the corresponding collector current is noted. This current is the reverse saturation current I_C. The experiment is repeated for various values of I_B. The readings are tabulated. A graph is drawn by taking V_{CE} along x-axis and I_C along y-axis for various values of I_B.

The set of curves thus obtained is called the output characteristics of a transistor. The reciprocal of the slope of the curve gives output impedance of the transistor.

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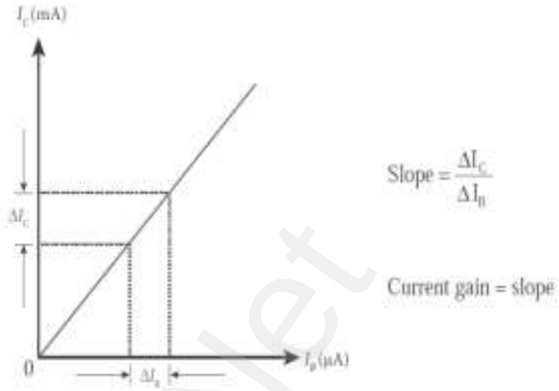
(iii) Transfer characteristic curve: I_B vs I_C (V_{CE} constant):

The collector-emitter voltage V_{CE} is kept constant. The base current IB is varied in steps of 10 μA and the corresponding collector current I_C is noted.



This is repeated by changing the value of V_{CE}. The readings are tabulated.

The transfer characteristics is a plot between the input current IB along x-axis and the output current IC along y-axis keeping V_{CE} constant. The slope of the transfer characteristics plot gives the current gain β can be calculated.

OBSERVATION:

(i) Input characteristic curve: V_{BE} vs I_B (V_{CE} constant):

S. No.	V_{CE} = 2 V		V_{CE} = 5 V	
	V_{BE} (V)	I_B (μA)	V_{BE} (V)	I_B (μA)
1	0	0	0.1	0
2	0.1	0	0.2	0
3	0.2	0	0.3	0
4	0.3	0	0.4	0
5	0.4	0	0.5	0
6	0.5	25	0.6	12
7	0.55	80	0.7	48
8	0.6	140	0.8	86
9	0.9	-	0.9	148
10	1.0	-	1.0	200

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(ii) Output characteristic curve: V_{CE} vs I_C (I_B constant):

S. No.	$I_B = 20\ \mu A$		$I_B = 40\ \mu A$	
	V_{CE} (V)	I_C (mA)	V_{CE} (V)	I_C (mA)
1	0	0	0	0
2	0.2	5.5	0.2	8
3	0.4	7	0.4	9.5
4	0.6	8	0.6	10.5
5	0.8	8.5	0.8	11
6	1.0	9	1.0	11
7	2.0	9	2.0	11
8	3.0	9	3.0	11

(iii) Transfer characteristic curve: I_B vs I_C (V_{CE} constant):

S. No.	$V_{CE} = 5$ V		S. No.	$V_{CE} = 5$ V	
	I_B (μA)	I_C (mA)		I_B (μA)	I_C (mA)
1	0	0	5	40	5
2	10	1.25	6	50	6.25
3	20	2.5	7	60	7.5
4	30	3.75	8	70	8.75

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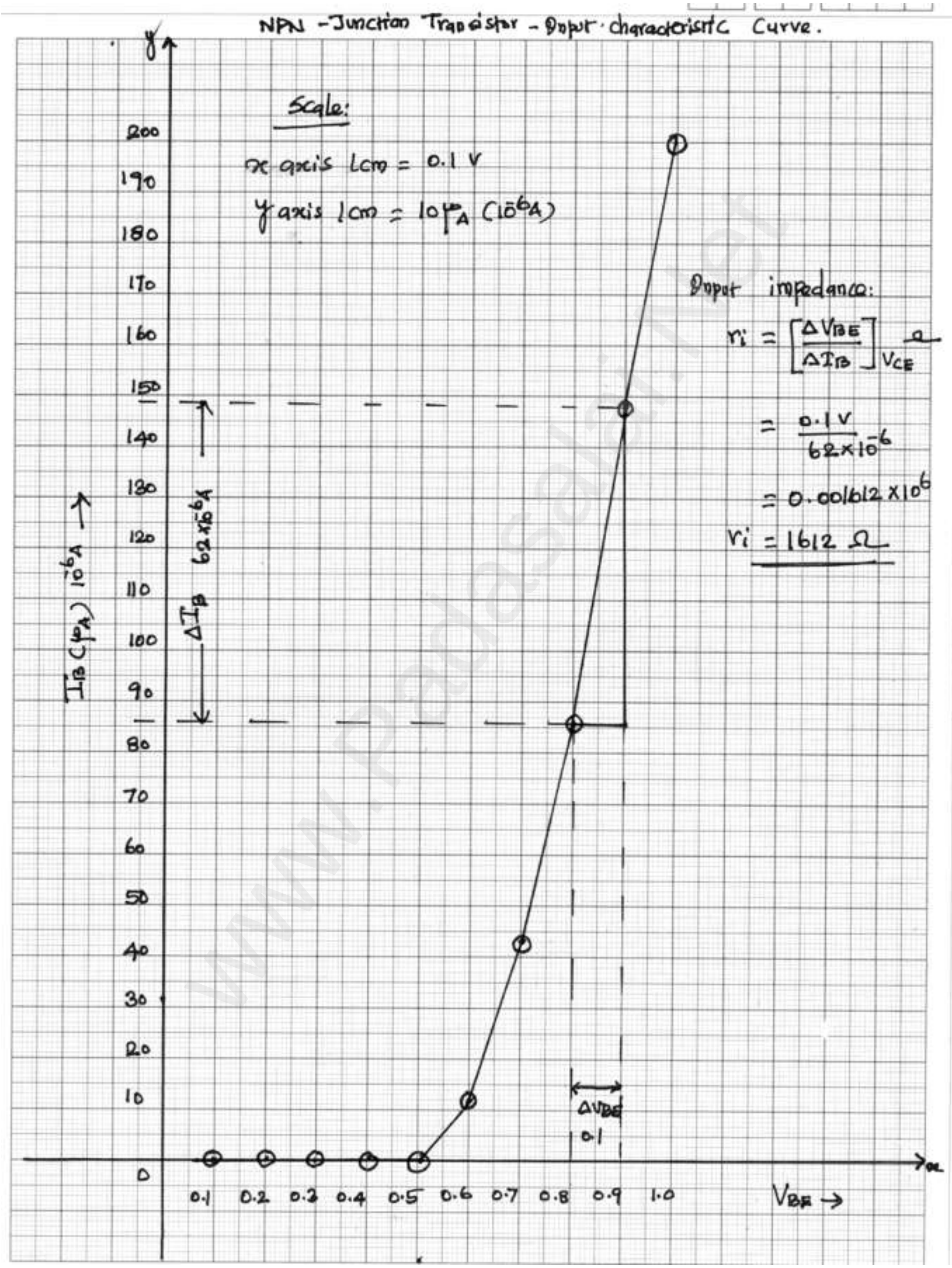
(i) Input characteristic curve: V_{BE} vs I_B (V_{CE} constant):



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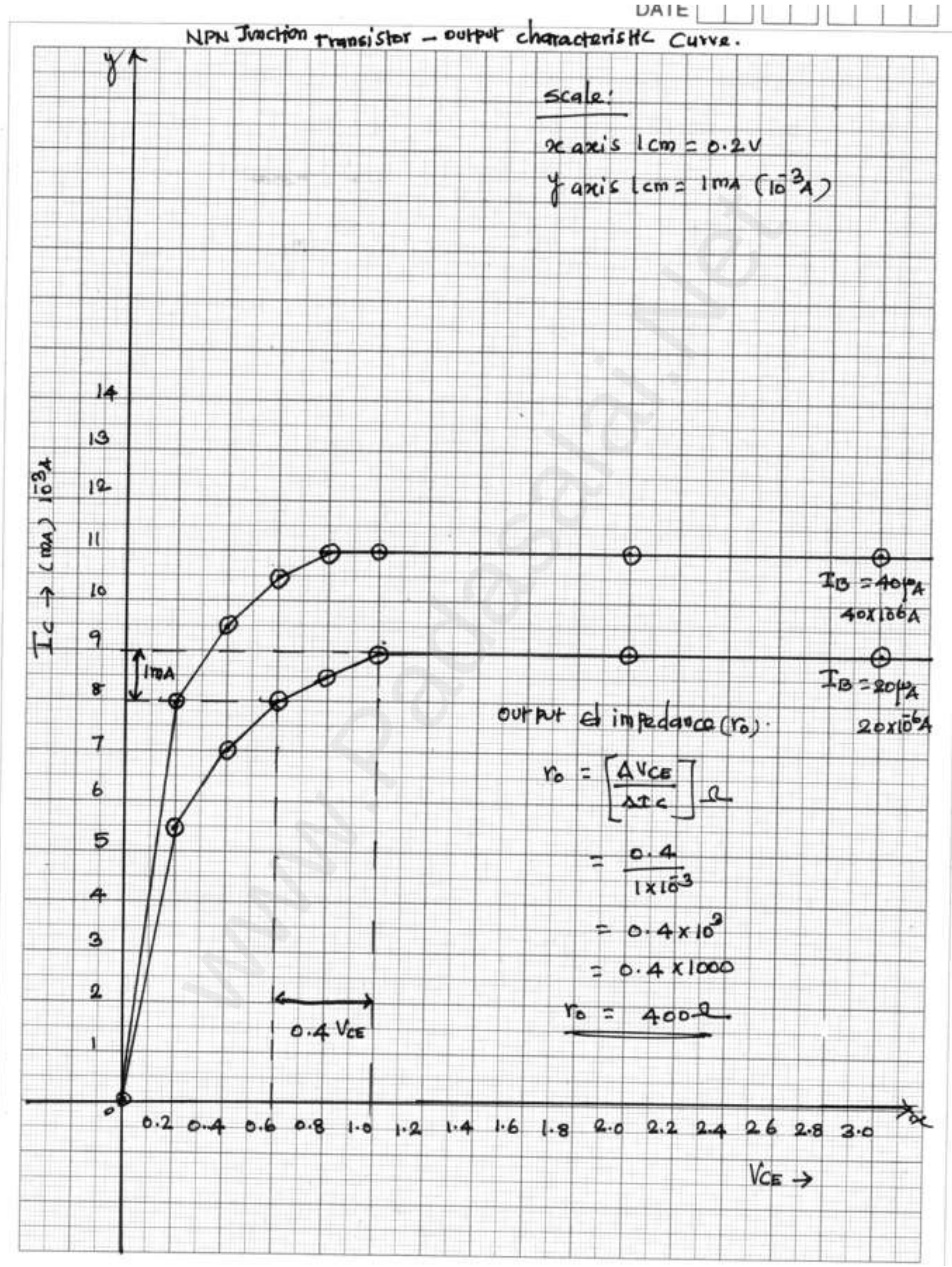
(ii) Output characteristic curve: V_{CE} vs I_C (I_B constant):



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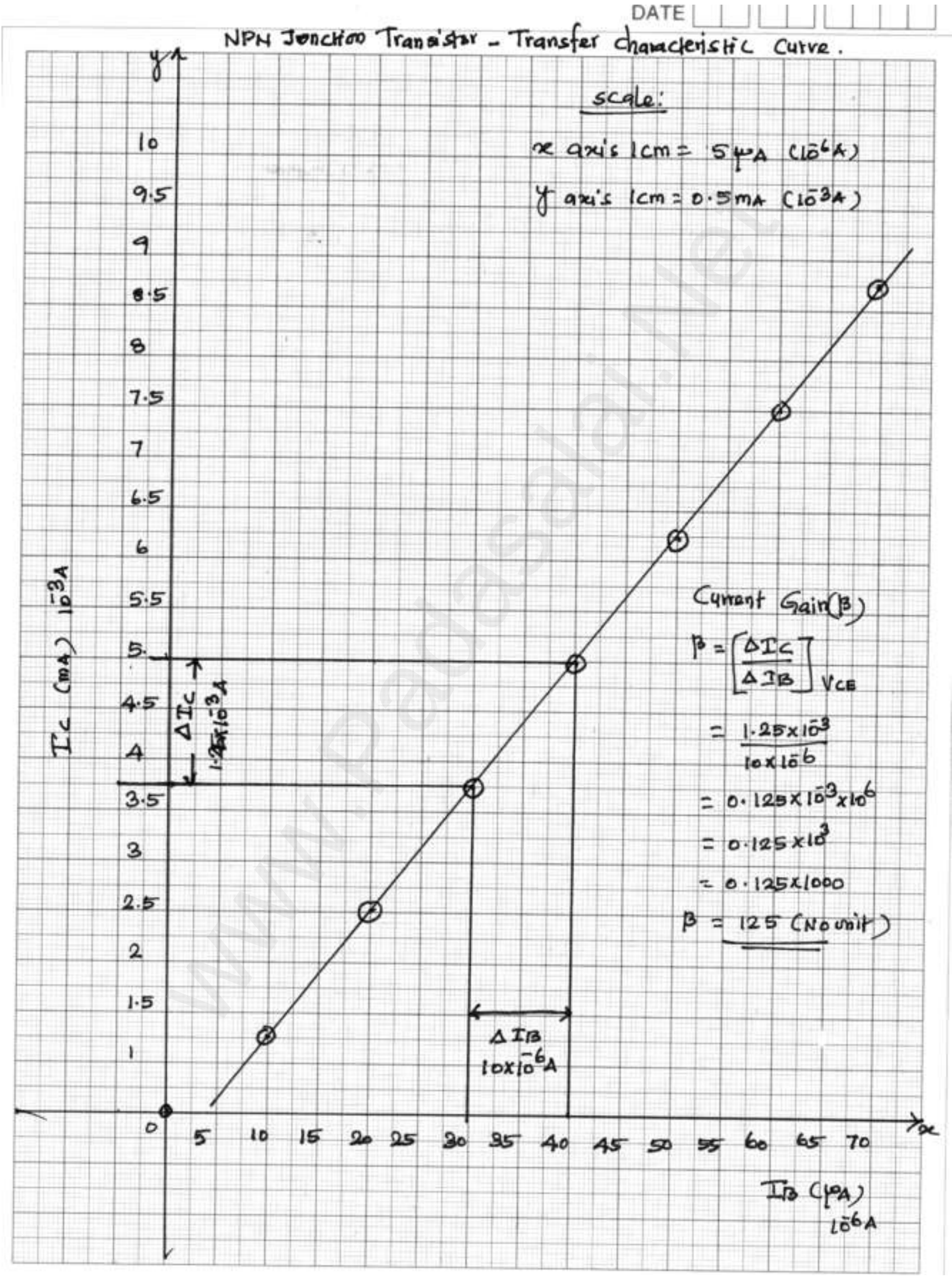
(iii) Transfer characteristic curve: I_B vs I_C (V_{CE} constant):



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CALCULATION:

i) Input impedance (r_i) : $r_i = \left[\frac{\Delta V_{BE}}{\Delta I_B}\right]_{V_{CE}}$ (Ω)

ΔV_{BE} – 0.9 – 0.8 = 0.1 V ; ΔI_B - 148 – 86= 62μA

$r_i = \frac{0.1}{62 \times 10^{-6}}$;

= 0.001612×10^6

= 1612

$r_i =$ **1612 Ω**

ii) Output impedance (r_0) : $r_0 = \left[\frac{\Delta V_{CE}}{\Delta I_C}\right]_B$ (Ω)

ΔV_{CE} – 1.0 – 0.6 = 0.4 V ; ΔI_C - 9 – 8 = 1mA

$r_0 = \frac{0.4}{1 \times 10^{-3}}$;

= 0.4×10^3

= 0.4 x 1000

$r_0 =$ **400 Ω**

iii) Current Gain (β) : $\beta = \left[\frac{\Delta I_C}{\Delta I_B}\right]_{V_{CE}}$ (No unit)

ΔI_B - 40 – 30 = 10μA; ΔI_C - 5 – 3.75 = 1.25mA

$\beta = \frac{1.25 \times 10^{-3}}{10 \times 10^{-6}}$;

= $0.125 \times 10^{-3} \times 10^6$

= 0.125×10^3

= 0.125 x 1000

$\beta =$ **125 (No Unit)**

RESULT:

i) The input, output and transfer characteristics of the NPN junction in common emitter mode are drawn.

ii) (a) Input impedance $\mathbf{r_i} =$ **1612 Ω**

(b) Output impedance $\mathbf{r_0} =$ **400 Ω**

(c) Current gain $\boldsymbol{\beta} =$ **125 (No Unit)**

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Ex. No. : 9 **Date :**

VERIFICATION OF TRUTH TABLES OF LOGIC GATES USING INTEGRATED CIRCUITS

AIM:

To verify the truth tables of AND, OR, NOT, EX-OR, NAND and NOR gates using integrated circuits

COMPONENTS REQUIRED:

AND gate (IC 7408), NOT gate (IC 7404), OR gate (IC 7432), NAND gate (IC 7400), NOR gate (IC 7402), X-OR gate (IC 7486), Power supply, Digital IC trainer kit, connecting wires.

BOOLEAN EXPRESSIONS:

Logic 1 represents TRUE or high voltage 5V or LED ON

Logic 0 represents FALSE or low voltage 0V or LED OFF

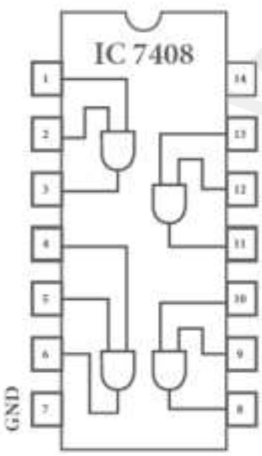
OR Function	When any one input or all inputs are true, output is true Y =A + B
AND Function	only when all inputs are true, output is true Y = AB
NOT Function	Output is the complement of input Y = $\overline{A}$
NOR Function	only when all inputs are false, output is true Y = $\overline{A + B}$
NAND Function	When any one of the inputs is false, output is true Y=$\overline{A \cdot B}$
EXOR Function	Only when the inputs are different, output is true

$$Y = A \oplus B = A\overline{B} + \overline{A}B$$

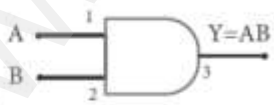
CIRCUIT DIAGRAM:

AND Gate:

PIN DIAGRAM-IC 7408



SYMBOL

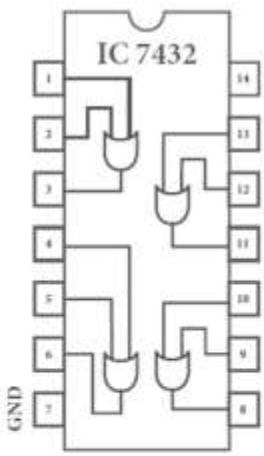


TRUTH TABLE

A	B	Y=AB
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate:

PIN DIAGRAM-IC 7432



SYMBOL

TRUTH TABLE

A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

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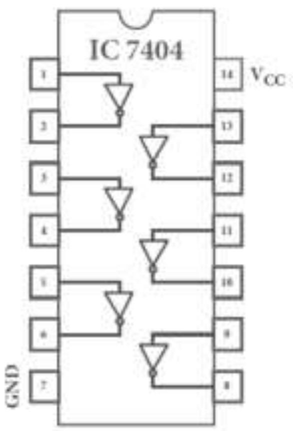
NOT Gate:

PIN DIAGRAM-IC 7404



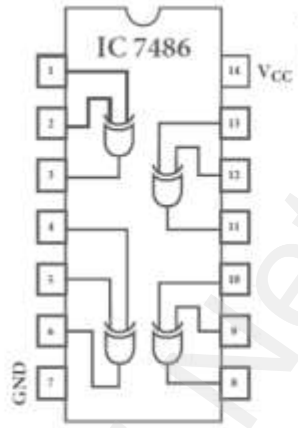
SYMBOL

TRUTH TABLE

A	$Y=\bar{A}$
0	1
1	0

X-OR Gate :

PIN DIAGRAM-IC 7486



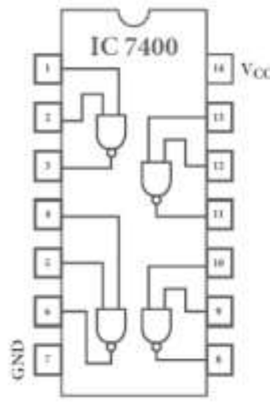
SYMBOL

TRUTH TABLE

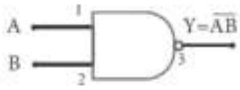
A	B	$Y=\bar{A}B+A\bar{B}$
0	0	0
0	1	1
1	0	1
1	1	0

NAND Gate:

PIN DIAGRAM-IC 7400



SYMBOL

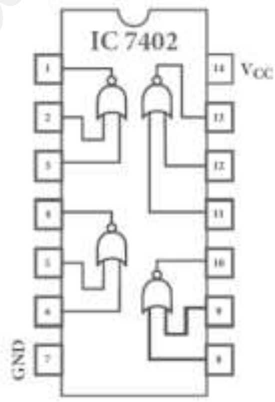


TRUTH TABLE

A	B	$Y=\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate:

PIN DIAGRAM-IC 7402



SYMBOL

TRUTH TABLE

A	B	$Y=\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

PROCEDURE:

To verify the truth table of a logic gate, the suitable IC is taken and the connections are given using the circuit diagram.

NAND Gate:

Power supply +5V is connected to pin 14 and ground to pin 7 of the IC. Inputs A & B are connected to pins 1 & 2 of the IC. Output pin 3 of the IC is connected to logic level indicator. Both inputs A & B are kept at logic 0 and output LED is observed, Then the inputs are changed as logic 0 & logic 1, logic 1 & logic 0 and logic 1 & logic 1 and the outputs are observed each time. The inputs and outputs are tabulated in the truth table.

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AND, OR and EX-OR Gates:

ICs 7408 (AND), 7432 (OR) and 7486 (EXOR) are placed on the board arid the same procedure is followed as for NAND gate and outputs are tabulated in the truth table.

NOR Gate:

IC 7402 is placed on the board. Power supply and ground are connected as before. The inputs are connected to pins 2 & 3 and the output to pin 1 of IC. Then the same procedure is repeated and tabulation is done in the truth table.

NOT Gate:

IC 7404 is placed on the board. One input A is connected to pin 1 and the output to pin 2 of IC. Input is kept at logic 1 and then at logic 0 and the outputs are found and tabulated in the truth table.

In this way, the truth table of a logic gate is verified.

OBSERVATION:

INPUT		AND Gate	OR Gate	NOT Gate	EX - OR Gate	NAND Gate	NOR Gate
A	B	Y = A.B	Y = A+B	$Y = \overline{A}$	$Y = A.\overline{B} + \overline{A}.B$	$Y = \overline{A.B}$	$Y = \overline{A+B}$
0	0	0	0	1	0	1	1
0	1	0	1	1	1	1	0
1	0	0	1	0	1	1	0
1	1	1	1	0	0	0	0

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CALCULATION:

AND Gate:

1) A = 0 , B = 0 ; Y = A . B = 0 . 0 = 0
2) A = 0 , B = 1 ; Y = A . B = 0 . 1 = 0
3) A = 1 , B = 0 ; Y = A . B = 1 . 0 = 0
4) A = 1 , B = 1 ; Y = A . B = 1 . 1 = 1

OR Gate:

1) A = 0 , B = 0 ; Y = A + B = 0 + 0 = 0
2) A = 0 , B = 1 ; Y = A + B = 0 + 1 = 1
3) A = 1 , B = 0 ; Y = A + B = 1 + 0 = 1
4) A = 1 , B = 1 ; Y = A + B = 1 + 1 = 1

NOT Gate:

1) A = 0 , Y = $\bar{A}$ = $\bar{0}$ = 1
2) A = 1 , Y = $\bar{A}$ = $\bar{1}$ = 0

EX - OR Gate:

1) A = 0 , B = 0 ; Y = $\bar{A}$ B + A$\bar{B}$ = = $\bar{0}$ 0 + 0$\bar{0}$ = 1.0 +0.1 = 0+0 = 0
2) A = 0 , B = 1 ; Y = $\bar{A}$ B + A$\bar{B}$ = = $\bar{0}$ 1 + 0$\bar{1}$ = 1.1 +0.0 = 1+0 = 1
3) A = 1 , B = 0 ; Y = $\bar{A}$ B + A$\bar{B}$ = = $\bar{1}$ 0 + 1$\bar{0}$ = 0.0 +1.1 = 0+1 = 1
4) A = 1 , B = 1 ; Y = $\bar{A}$ B + A$\bar{B}$ = = $\bar{1}$ 1 + 1$\bar{1}$ = 0.1 +1.0 = 0+0 = 0

NAND Gate:

1) A = 0 , B = 0 ; Y = $\overline{A.B}$ = $\overline{0.0}$ = $\bar{0}$ = 1
2) A = 0 , B = 1 ; Y = $\overline{A.B}$ = $\overline{0.1}$ = $\bar{0}$ = 1
3) A = 1 , B = 0 ; Y = $\overline{A.B}$ = $\overline{1.0}$ = $\bar{0}$ = 1
4) A = 1 , B = 1 ; Y = $\overline{A.B}$ = $\overline{1.1}$ = $\bar{1}$ = 0

NOR Gate:

1) A = 0 , B = 0 ; Y = $\overline{A+B}$ = $\overline{0+0}$ = $\bar{0}$ = 1
2) A = 0 , B = 1 ; Y = $\overline{A+B}$ = $\overline{0+1}$ = $\bar{1}$ = 0
3) A = 1 , B = 0 ; Y = $\overline{A+B}$ = $\overline{1+0}$ = $\bar{1}$ = 0
4) A = 1 , B = 1 ; Y = $\overline{A+B}$ = $\overline{1+1}$ = $\bar{1}$ = 0

RESULT:

The truth table of logic gates AND, OR, NOT, Ex-OR, NAND and NOR using integrated circuits is verified.

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Ex. No. : 10 **Date :**

VERIFICATION OF DE MORGAN'S THEOREMS

AIM:

To verify De Morgan's first and second theorems.

COMPONENTS REQUIRED:

Power Supply (0 – 5V), IC 7400, 7408, 7432, 7404, and 7402, Digital IC trainer kit, connecting wires.

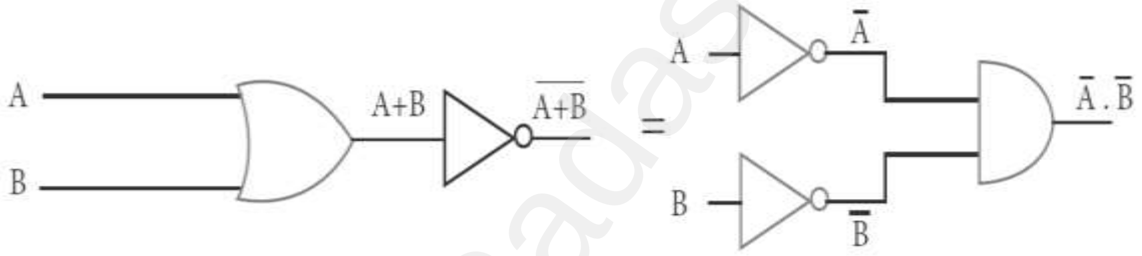
FORMULA:

De Morgan's first theorem $\overline{\mathbf{A}+\mathbf{B}} = \overline{\mathbf{A}}\,.\,\overline{\mathbf{B}}$

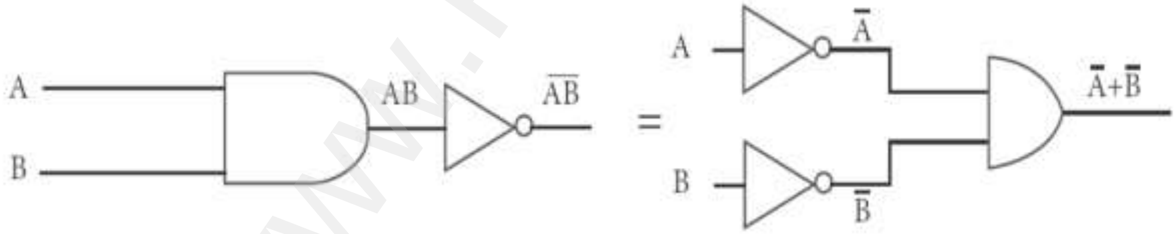
De Morgan's second theorem $\overline{\mathbf{A}\,.\,\mathbf{B}} = \overline{\mathbf{A}} + \overline{\mathbf{B}}$

CIRCUIT DIAGRAM:

De Morgan's First Theorem:



De Morgan's Second theorem:



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PROCEDURE:

i) Verification of De Morgan's first theorem

The connections are made for LHS $[\overline{\mathbf{A}+\mathbf{B}}]$ of the theorem as shown in the circuit diagram using appropriate ICs. The output is noted and tabulated for all combinations of logical inputs of the truth table. The same procedure is repeated for RHS $[\overline{A}\,.\,\overline{B}]$ of the theorem.

From the truth table, it can be shown that $\overline{\mathbf{A}+\mathbf{B}} = \overline{\mathbf{A}}\,.\,\overline{\mathbf{B}}$

ii) Verification of De Morgan's second theorem

The connections are made for LHS $[\overline{\mathbf{A}\,.\,\mathbf{B}}]$ of the theorem as shown in the circuit diagram using appropriate ICs. The output is noted and tabulated for all combinations of logical inputs of the truth table. The same procedure is repeated for RHS $[\overline{A} + \overline{B}]$of the theorem.

From the truth table, it can be shown that $\overline{\mathbf{A}\,.\,\mathbf{B}} = \overline{\mathbf{A}} + \overline{\mathbf{B}}$

OBSERVATION:

De Morgan's First Theorem: Truth Table

A	B	A+B	$\overline{A+B}$	$\overline{A}$	$\overline{B}$	$\overline{A}\,.\,\overline{B}$
0	0	0	**1**	1	1	**1**
0	1	1	**0**	1	0	**0**
1	0	1	**0**	0	1	**0**
1	1	1	**0**	0	0	**0**

De Morgan's Second Theorem: Truth Table

A	B	A.B	$\overline{A.B}$	$\overline{A}$	$\overline{B}$	$\overline{A} + \overline{B}$
0	0	0	**1**	1	1	**1**
0	1	0	**1**	1	0	**1**
1	0	0	**1**	0	1	**1**
1	1	1	**0**	0	0	**0**

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CALCULATION:

De Morgan's First Theorem:

$$\overline{\mathbf{A}+\mathbf{B}} = \overline{\mathbf{A}}\,.\,\overline{\mathbf{B}}$$

1) A = 0 , B = 0 $\quad \overline{A+B} = \overline{0+0} = \overline{0} = 1 \quad \overline{A}\,.\,\overline{B} = \overline{0}\,.\,\overline{0} = 1\,.\,1 = 1$

2) A = 0 , B = 1 $\quad \overline{A+B} = \overline{0+1} = \overline{1} = 0 \quad \overline{A}\,.\,\overline{B} = \overline{0}\,.\,\overline{1} = 1\,.\,0 = 0$

3) A = 1 , B = 0 $\quad \overline{A+B} = \overline{1+0} = \overline{1} = 0 \quad \overline{A}\,.\,\overline{B} = \overline{1}\,.\,\overline{0} = 0\,.\,1 = 0$

4) A = 1 , B = 1 $\quad \overline{A+B} = \overline{1+1} = \overline{1} = 0 \quad \overline{A}\,.\,\overline{B} = \overline{1}\,.\,\overline{1} = 0\,.\,0 = 0$

De Morgan's Second Theorem:

$$\overline{\mathbf{A}\,.\,\mathbf{B}} = \overline{\mathbf{A}} + \overline{\mathbf{B}}$$

1) A = 0 , B = 0 $\quad \overline{A\,.\,B} = \overline{0\,.\,0} = \overline{0} = 1 \quad \overline{A} + \overline{B} = \overline{0} + \overline{0} = 1 + 1 = 1$

2) A = 0 , B = 1 $\quad \overline{A\,.\,B} = \overline{0\,.\,1} = \overline{0} = 1 \quad \overline{A} + \overline{B} = \overline{0} + \overline{1} = 1 + 0 = 1$

3) A = 1 , B = 0 $\quad \overline{A\,.\,B} = \overline{1\,.\,0} = \overline{0} = 1 \quad \overline{A} + \overline{B} = \overline{1} + \overline{0} = 0 + 1 = 1$

4) A = 1 , B = 1 $\quad \overline{A\,.\,B} = \overline{1\,.\,1} = \overline{1} = 0 \quad \overline{A} + \overline{B} = \overline{1} + \overline{1} = 0 + 0 = 0$

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RESULT:

De Morgan's first and second theorems are verified.

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SUGGESTED QUESTIONS FOR THE PRACTICAL EXAMINATION

1. Determine the resistance of a given wire using metre bridge. Also find the radius of the wire using screw gauge and hence determine the specific resistance of the material of the wire. Take at least 4 readings.
2. Determine the value of the horizontal component of the Earth's magnetic field, using tangent galvanometer. Take at least 4 readings.
3. Compare the emf of two cells using potentiometer.
4. Using the spectrometer, measure the angle of the given prism and angle of minimum deviation. Hence calculate the refractive index of the material of the prism.
5. Adjust the grating for normal incidence using the spectrometer. Determine the wavelength of green, blue, yellow and red lines of mercury spectrum (The number of lines per metre length of the grating can be noted from the grating).
6. Draw the V-I characteristics of PN junction diode and determine its forward resistance and knee voltage from forward characteristics.
7. Draw the V-I characteristics of Zener diode and determine its forward resistance and knee voltage from forward characteristics. Also find break down voltage of the Zener diode from reverse characteristics.
8. Draw the input and transfer characteristic curves of the given NPN junction transistor in CE mode. Find the input impedance from input characteristics and current gain from transfer characteristics.
9. Draw the output and transfer characteristic curves of the given NPN junction transistor in CE mode. Find the output impedance from output characteristics and current gain from transfer characteristics.
10. Verify the truth table of logic gates AND, NOT, Ex-OR and NOR gates using integrated circuits.
11. Verify the truth table of logic gates OR, NOT, Ex-OR and NOR gates using integrated circuits.
12. Verify De Morgan's first and second theorems.

“NeH i kahd K awrpay; fp i l j;j
n twwpapd; %y khf f; fp i l f;Fk; k fpo r;rpapd;
rpfuj; i j ahUk; ms f;fNt KbahJ.”

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