ST.ANN'S

MATRIC. HR. SEC. SCHOOL

PANAGUDI

RECORD NOTE BOOK

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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

1.) Meter bridge
2.) galvanometer
3.) Key
4.) resistance box
5.) connecting wires
6.) Lechlanche cell
7.) jockey
8.) high resistance

FORMULA

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

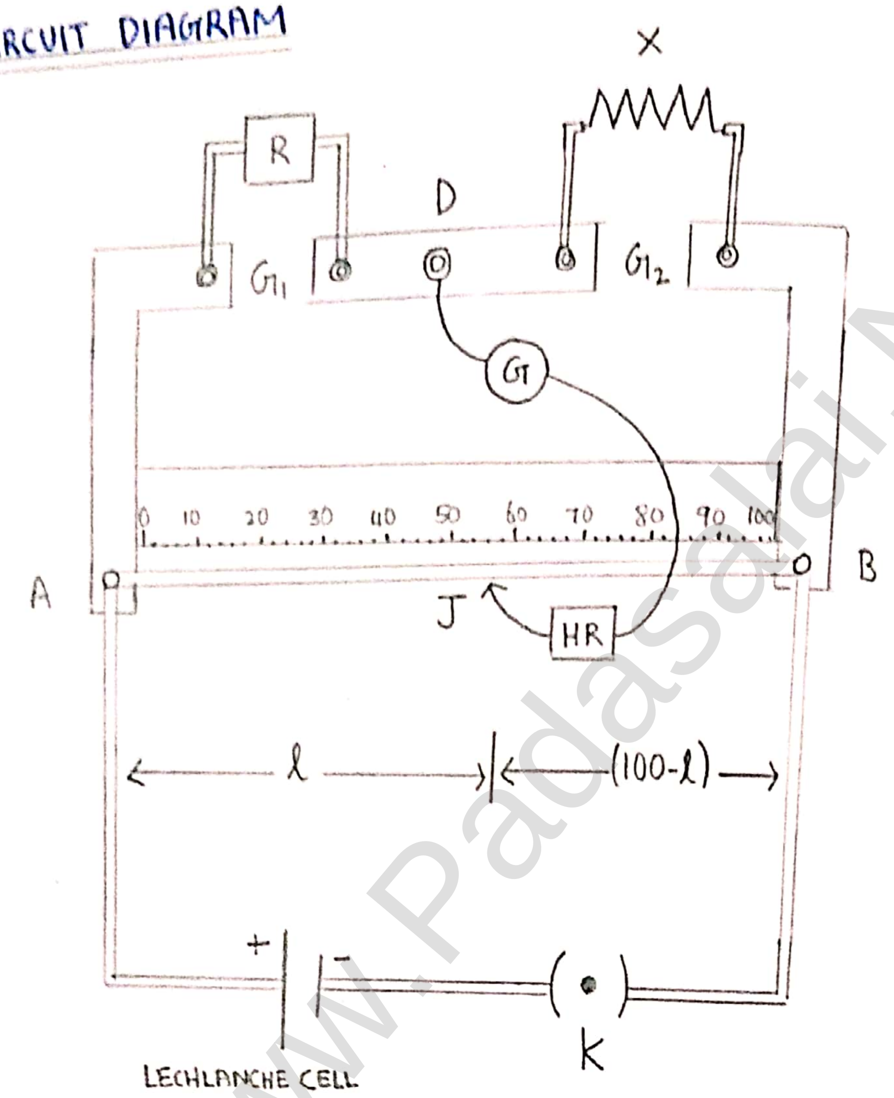
where, X → Resistance of the given coil (Ω)

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 1m 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 wire, 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.

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

- 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

= 1m

Table 1

To find the resistance of the given coil

S.No	Resistance R (Ω)	Before Interchanging		After Interchanging		Mean
		Balancing length l (cm)	$X_1 = \frac{R(100-l)}{l}$ (Ω)	Balancing length l (cm)	$X_2 = \frac{Rl}{(100-l)}$ (Ω)	$X = \frac{X_1+X_2}{2}$ (Ω)
1.	1	38	$\frac{1\times 62}{38} = 1.632$	62	$\frac{1\times 62}{38} = 1.632$	1.632
2.	2	54	$\frac{2\times 46}{54} = 1.704$	45	$\frac{2\times 45}{55} = 1.637$	1.6705
3.	3	64	$\frac{3\times 36}{64} = 1.688$	35	$\frac{3\times 35}{65} = 1.615$	1.652
4.	4	70	$\frac{4\times 30}{70} = 1.714$	30	$\frac{4\times 30}{70} = 1.714$	1.714
5.	5	74	$\frac{5\times 26}{74} = 1.757$	25	$\frac{5\times 25}{75} = 1.667$	1.712
6.	6	77	$\frac{6\times 23}{77} = 1.792$	22	$\frac{6\times 22}{78} = 1.692$	1.742
					Mean	1.687

TABLE 2

To find the radius of the wire

Zero error = Nil
Zero correction = Nil

Least count = 0.01 mm

Sl.No	PSR (mm)	HSC (div.)	Total reading (mm) = PSR + (HSC x LC)	corrected reading = TR ± ZC (mm)
1.)	0	54	0.54	0.54
2.)	0	54	0.54	0.54
3.)	0	54	0.54	0.54

Mean diameter, $2r = 0.54 \times 10^{-1}$ cm
Radius of the wire, $r = 0.27 \times 10^{-1}$ cm
$r = 0.27 \times 10^{-3}$ m
$r^2 = 0.0729 \times 10^{-6}$ m^2

CALCULATION

i) $\rho = \frac{X\pi r^2}{L} = 1.687 \times \pi \times 0.0729 \times 10^{-6}$

$= 3.863 \times 10^{-7}$ Ωm

RESULT

The specific resistance of the material of given coil $= 3.86 \times 10^{-7}\ \Omega m$

HORIZONTAL COMPONENT OF EARTH'S MAGNETIC FIELD (using tangent galvanometer)

AIM

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

APPARATUS REQUIRED

1) tangent galvanometer (TG)
2) commutator
3) battery
4) rheostat
5) ammeter key
6) connecting wires.

FORMULA

$$B_H = \frac{\mu_0 n k}{2r} \text{ (Tesla)}$$

$$k = \frac{I}{\tan\theta} \text{ (A)}$$

where B_H → Horizontal component of earth's magnetic field (T)

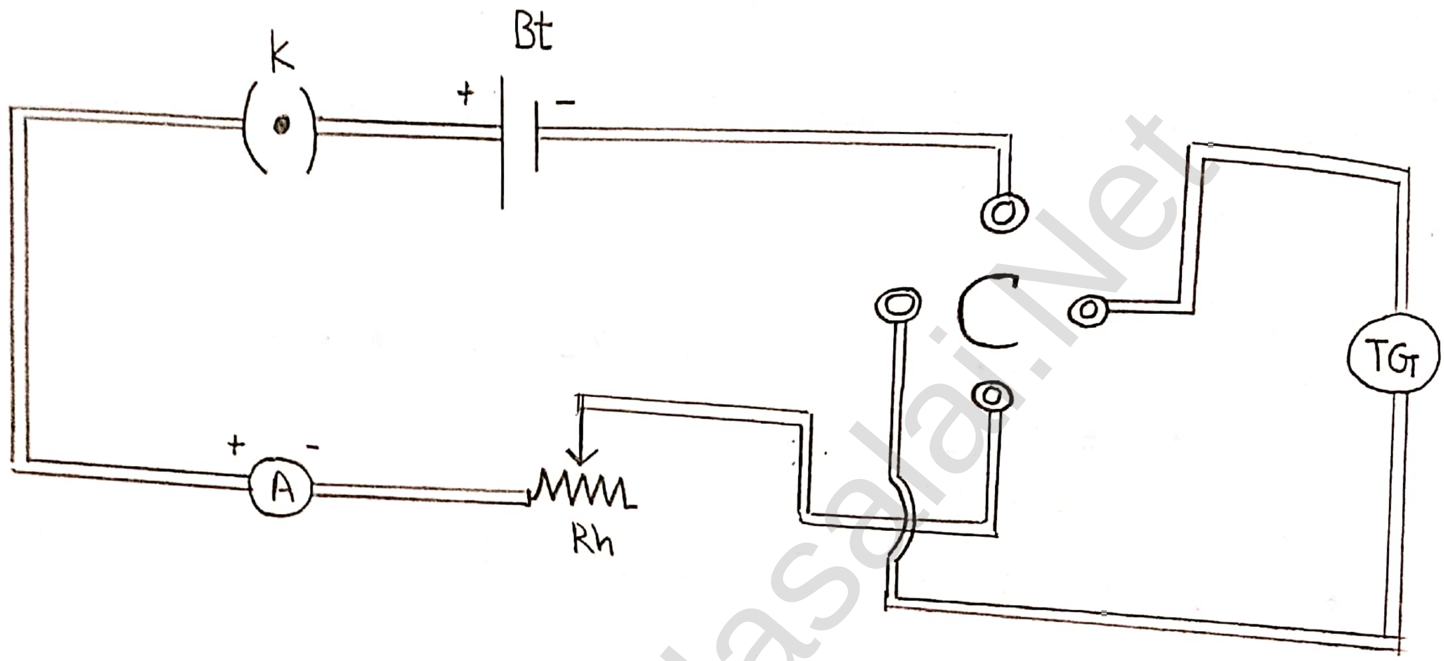
k → Reduction factor of TG (A)

μ_0 → Permeability of free space ($4\pi \times 10^{-7}\ Hm^{-1}$)

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

r → radius of the coil (m)

CIRCUIT DIAGRAM



PROCEDURE

- The preliminary adjustments are carried out as follows

a.) 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.

b.) The circular coil is rotated so that its plane is in the magnetic meridian i.e, along the north-south direction.

c.) The compass box alone is rotated till the aluminium pointer reads 0°–0°.

- The connections are made as shown in figure
- The number of turns 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°–60°.
- 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.

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- 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.

- 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 measu[ring] the circumference of the coil using a thread arou[nd] the coil.

- From the values of r, n and K, the horizont[al] component of Earth's magnetic field is determined.

OBSERVATION

Number of turns of the coil, n = 5

circumference of the coil $(2\pi r)$ = 48.7×10^{-2}

Radius of the coil, r = $\frac{48.7 \times 10^{-2}}{2\pi}$ m

S.No	current I (A)	Deflection in TG (degree)				Mean θ (degree)	$K = \frac{I}{\tan\theta}$
		θ_1	θ_2	θ_3	θ_4		
1)	1	47	47	45	45	46°	0.97
2)	0.9	43	43	42	42	42.5°	0.98
3)	0.8	40	40	40	40	40°	0.95
4)	0.7	38	38	38	38	38°	0.89
						Mean	0.948

CALCULATION

$$B_H = \frac{\mu_0 n k}{2r} = \qquad [\mu_0 = 4\pi \times 10^{-7}]$$

$$= \frac{4\pi \times 10^{-7} \times 5 \times 0.948}{2 \times \frac{48.7}{2\pi} \times 10^{-2}}$$

$$= \frac{4\pi^2 \times 10^{-7} \times 5 \times 0.948}{48.7 \times 10^{-2}}$$

$$= 3.842 \times 10^{-5}\ T$$

RESULT

The horizontal component of Earth magnetic field = 3.842×10^{-5} T

REFRACTIVE INDEX OF THE MATERIAL OF THE PRISM

AIM

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

APPARATUS REQUIRED

1) spectrometer
2) prism
3) prism clamp
4) sodium Vapour lamp
5) spirit level.

FORMULA

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

where

$\mu \rightarrow$ Refractive index of material of prism (No unit)

$A \rightarrow$ Angle of prism (degree)

$D \rightarrow$ Angle of minimum deviation (degree)

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 to receive parallel rays. i.e adjusted till the clear inverted image of the distant object is seen.

• collimator : The telescope is brought in line with 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 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

• The telescope is now 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 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.

• At one particular position, the refracted ray begins to retrace its path e.

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- 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.

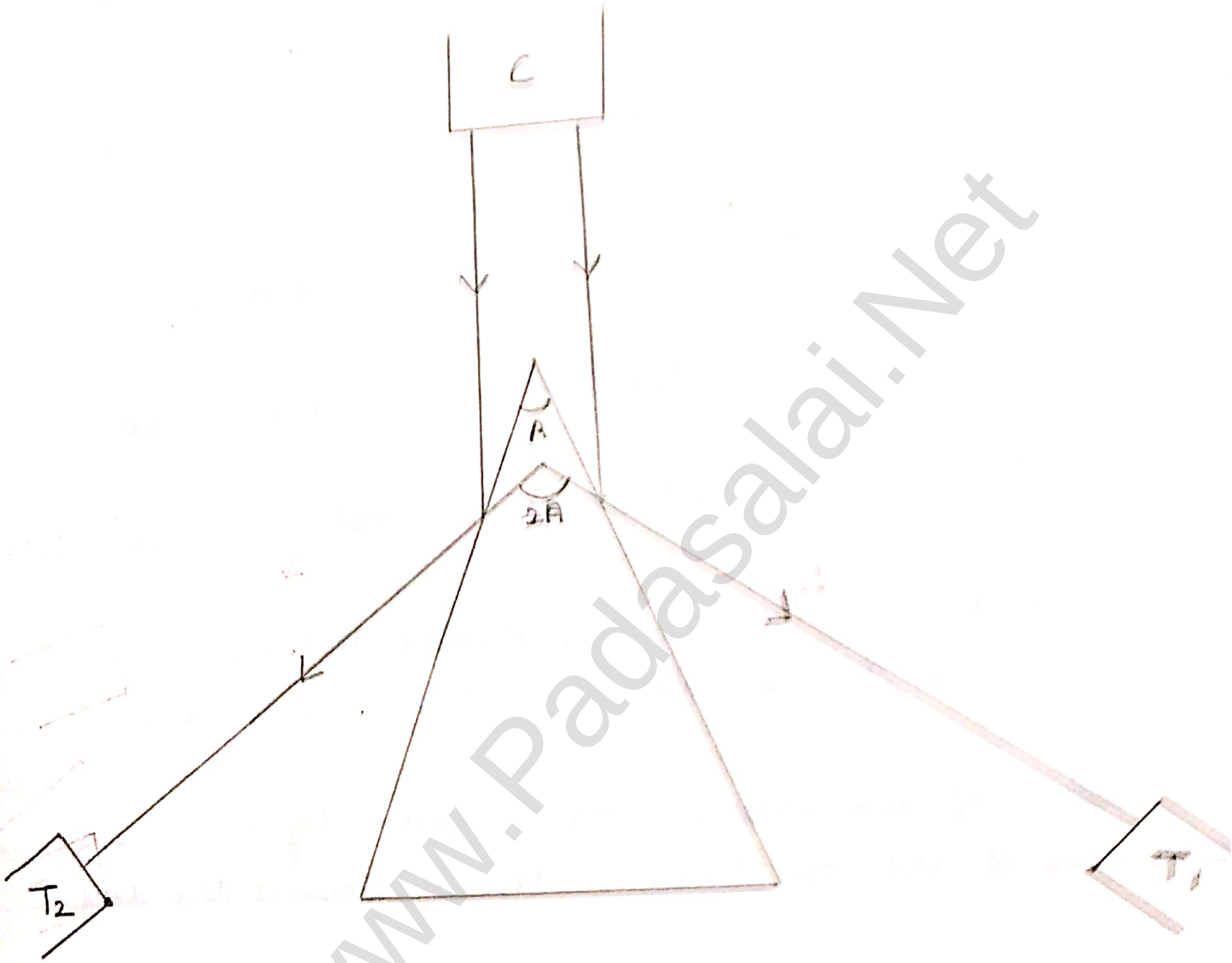
- The readings are taken from both vernier scales.

- The prism is now removed and the telescope is rotated to obtain the direct ray image and the readings are taken.

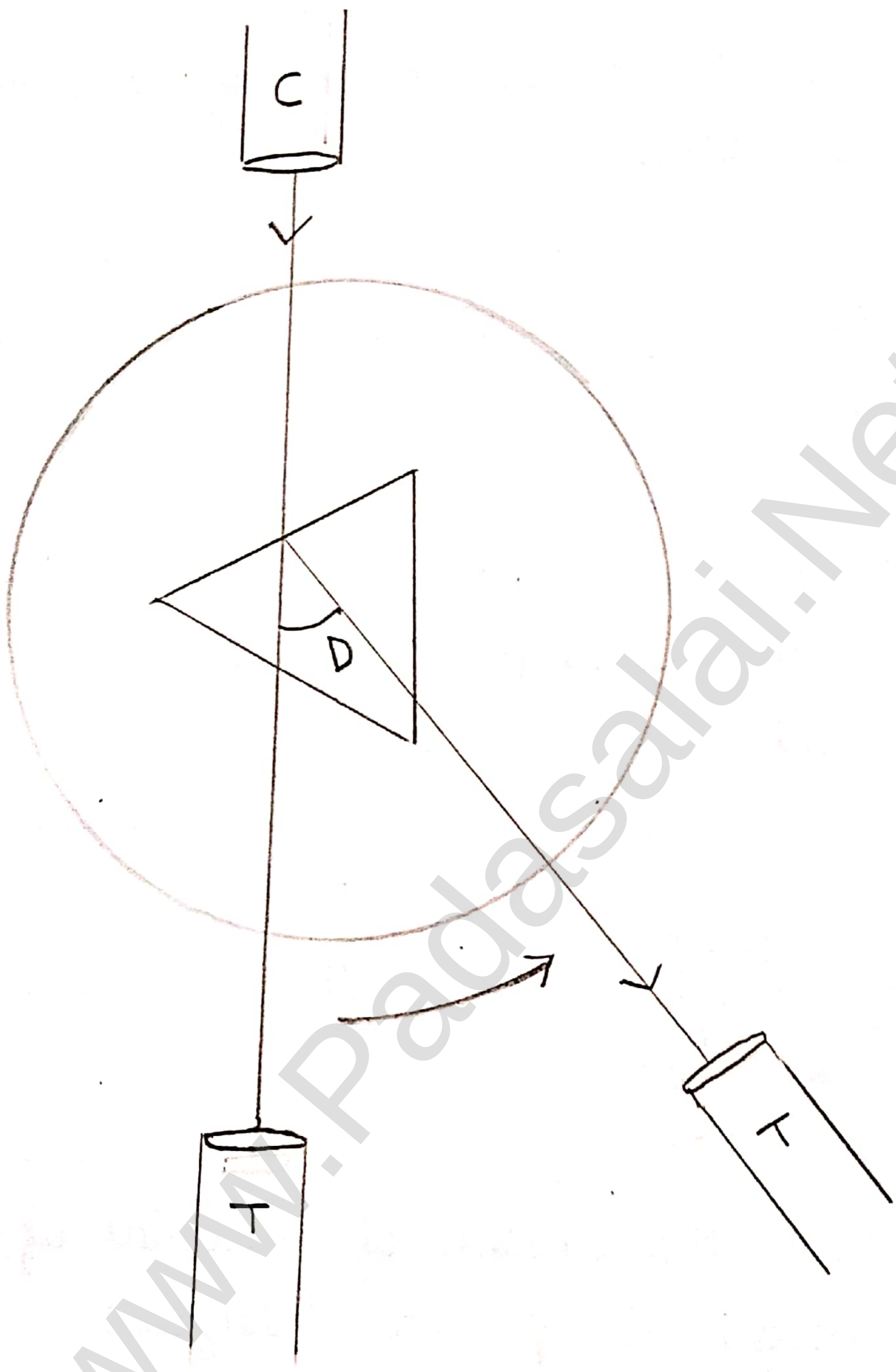
- The readings are tabulated and the difference between those two readings gives the angle of minimum deviation D.

- From the values of A and D, the refractive index of the material of the glass prism is determined.

DIAGRAM



ANGLE OF THE PRISM



ANGLE OF MINIMUM DEVIATION

LEAST COUNT

1 MSD = 30′

Number of vernier scale divisions = 30

For spectrometer, 30 Vernier scale divisions will cover 29 main scale divisions.

∴ 30 VSD = 29 MSD

or 1 VSD = 29/30 MSD

Least count (LC) = 1MSD − 1VSD

= 1/30 MSD

= 1′

OBSERVATION

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

Image	Vernier A (Degree)			Vernier B (Degree)		
	MSR	VSC	TR	MSR	VSC	TR
Reflected image from face 1	127°30′	10′	127°40′	307°30′	10′	307°40′
Reflected image from face 2	249°30′	10′	249°40′	69°30′	10′	69°40′
Difference 2A	122°			122°		

Mean 2A = 122°

Mean A = 61°

Table 2

To find the angle of minimum deviation (D)

Image	Vernier A (Degree)			Vernier B (Degree)		
	MSR	VSC	TR	MSR	VSC	TR
Refracted image	155°	10′	155° 10′	335°	10′	335° 10′
Direct image	195°	10′	195° 10′	15°	10′	15° 10′
Difference D	40°			40°		

Mean D = 40°

Calculation

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$= \frac{\sin\left(\frac{61^\circ+40^\circ}{2}\right)}{\sin\left(\frac{61^\circ}{2}\right)} = \frac{\sin 50^\circ 30'}{\sin 30^\circ 30'}$$

$$= \frac{0.77162}{0.5075}$$

$$\mu = 1.52$$

RESULT

1.) Angle of the prism (A) = 61° (degree)

2.) Angle of the minimum deviation of prism (D) = 40° (degree)

3.) Refractive index of material of the prism (μ) = 1.52 (No unit)

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

AIM

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

APPARATUS REQUIRED

1) spectrometer
2) mercury vapour lamp.
3) diffraction grating
4) grating table
5) spirit level

FORMULA

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

where $\lambda \rightarrow$ wavelength of the constituent colours of a composite light (Å)

$N \rightarrow$ Number of lines per metre length of the given grating (No unit) (the value of N for the grating is given)

$n \rightarrow$ order of the diffraction (No unit)

$\theta \rightarrow$ Angle of diffraction (degree).

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 so 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.

• 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.

• The Vernier disc alone is rotated till the Vernier scale reads 0°-180° and is fixed. This is the reading for direct ray.

• The telescope is then rotated (anti-clockwise) through an angle of 90° and fixed.

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• 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.

• Now the Vernier disc is released. The Vernier disc along with grating table is rotated through an angle of 45° in the appropriate direction such that the light from the collimator is incident normally on the grating.

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 undispersed 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 wave length.

• The telescope is turned to any oneside (say left) of direct image to observe first order diffracted image.

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• The Vertical cross-wire is made to coincide with the prominent spectral lines (Violet, blue, yellow, red) and the readings of both Vernier scales for each case are noted.

• Now the telescope is rotated to the right side of direct image and the first order image is observed.

• The Vertical cross wire is made to coincide with the prominent spectral lines (same) and reading of Vernier scale for each case is again noted

• The readings are tabulated.

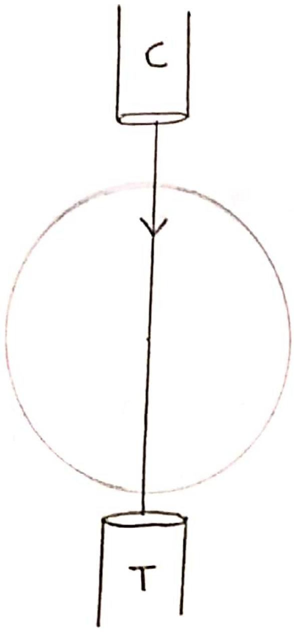
• The difference between these two readings gives the Value of 2θ for the particular spectral line.

• The number of lines per metre length of the given grating N is noted from the grating.

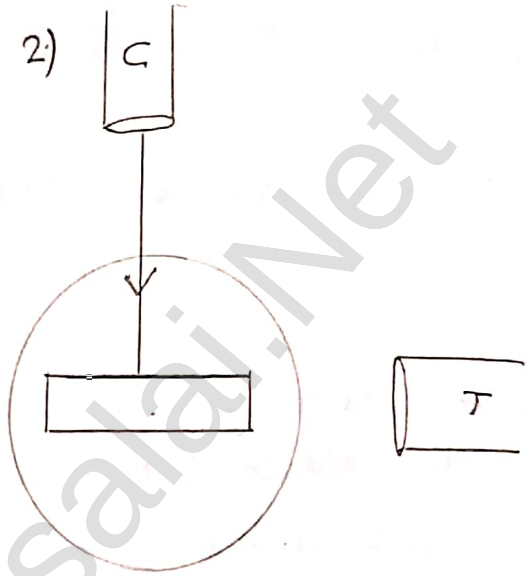
• From the values of N, n and θ, the wavelength of prominent colours of the mercury light is determined using the given formula.

DIAGRAMS

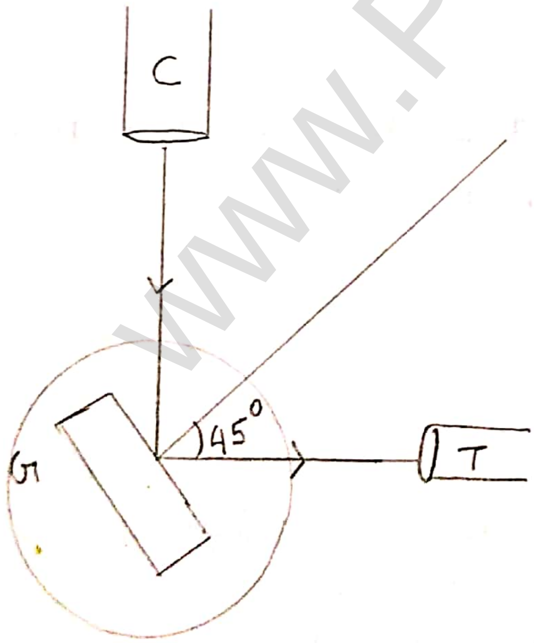
1)



2)



3)



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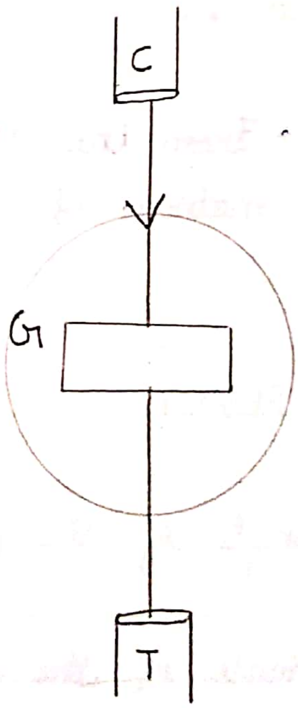
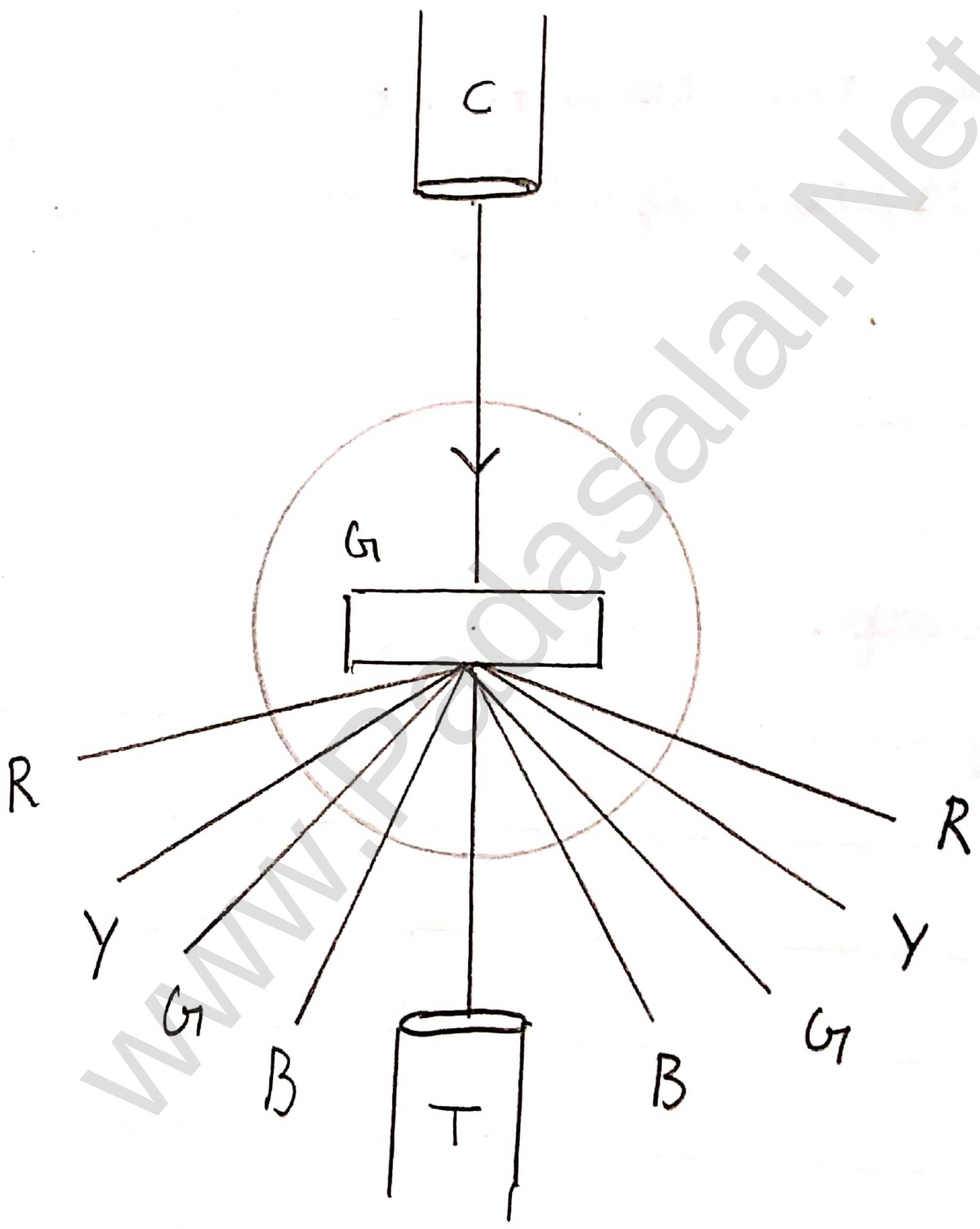


a) NORMAL INCIDENCE

Angle of diffraction



OBSERVATION

To find the wavelength 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	301° 30'	10'	301° 40'	121° 30'	10'	121° 40'	333° 30'	10'	333° 40'	153° 30'	10'	153° 40'	32°	32°	32°	16°
Green	299° 30'	10'	299° 40'	119° 30'	10'	119° 40'	335° 30'	10'	335° 40'	155° 30'	10'	155° 40'	36°	36°	36°	18°
Yellow	297°	10'	297° 40'	117°	10'	117° 10'	337°	10'	337° 10'	157°	10'	157° 10'	40°	40°	40°	20°
Red	294°	10'	294° 40'	114°	10'	114° 10'	340°	10'	340° 10'	160°	10'	160° 10'	46°	46°	46°	23°

CALCULATION $[n=1, N=5.9\times10^5]$

i) For blue, $\lambda = \frac{\sin\theta}{Nn}$

$\lambda = \frac{\sin 16^\circ}{5.9\times10^5}$

$= \frac{0.263589}{5.9\times10^5}$

$\lambda = 0.04671\times10^{-5}$

$\lambda = 4671\ \text{Å}$

ii) For green, $\lambda = \frac{\sin\theta}{Nn}$

$\lambda = \frac{\sin 18^\circ}{5.9\times10^5}$

$= \frac{0.308983}{5.9\times10^5}$

$\lambda = 0.05237\times1$

$\lambda = 5237\ \text{Å}$

iii) For yellow, $\lambda = \frac{\sin\theta}{Nn}$

$\lambda = \frac{\sin 20^\circ}{5.9\times10^5}$

$\lambda = \frac{0.341964}{5.9\times10^{-5}}$

$\lambda = 0.05796\times10^{-5}$

$\lambda = 5796\ \text{Å}$

iv) For red, $\lambda = \frac{\sin\theta}{Nn}$

$\lambda = \frac{\sin 23^\circ}{5.9\times10^5}$

$\lambda = \frac{0.390698}{5.9\times10^5}$

$\lambda = 0.06622\times10^{-5}$

$\lambda = 6622\ \text{Å}$

RESULT

1. The wavelength of blue line = 4671×10^{-10} m
2. The wavelength of green line = 5237×10^{-10} m
3. The wavelength of yellow line = 5796×10^{-10} m
4. The wavelength of red line = 6622×10^{-10} m

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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

1.) PN junction diode (1N4007)
2.) Variable DC power supply
3.) milli-ammeter
4.) micro-ammeter
5.) voltmeter
6.) resistance
7.) connecting wires

FORMULA

$$R_F = \frac{\Delta V_F}{\Delta I_F}$$

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)

PROCEDURE

i) forward bias characteristics

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• In the forward bias, the P-region of the diode is connected to the positive terminal and N-region to negative terminal of DC power supply.

• The connections are given as per the circuit diagram.

• The voltage across the diode can be varied with the help of 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 forward current along 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.

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ii) Reverse bias characteristics

• In the reverse bias, the polarity of DC power supply is reversed so that P-region of diode is connected to negative terminal and N-region to the positive terminal of the DC power supply.

• The connections are made as given in circuit diagram.

• The voltage across the diode can be varied with the help of variable DC power supply.

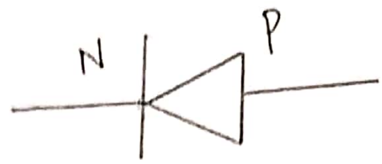
• The reverse voltage (V_R) across the diode is increased from 1V in steps of 1V up to 5V and the reverse current through diode is noted from micro-ammeter. The readings are tabulated.

• The reverse voltage V_R and reverse current I_R are taken as negative.

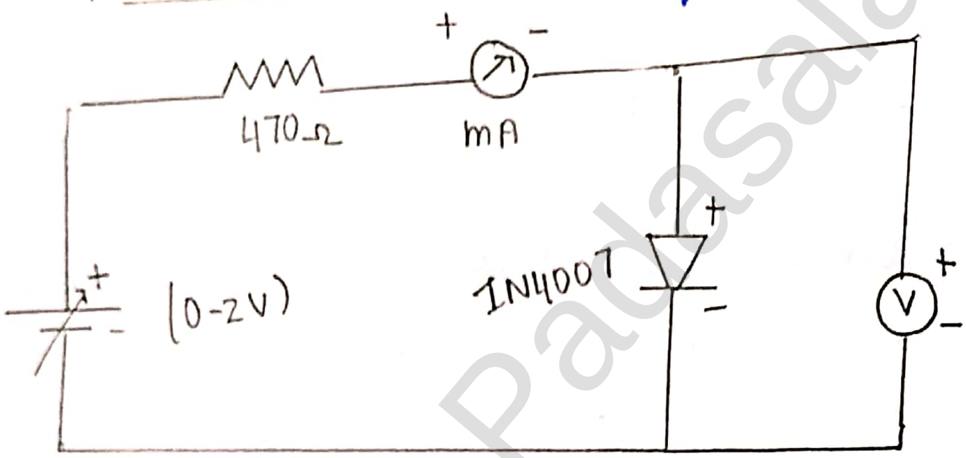
• A graph is drawn taking the reverse bias voltage (V_R) along negative x-axis and reverse bias current (I_R) along negative y-axis.

CIRCUIT DIAGRAM

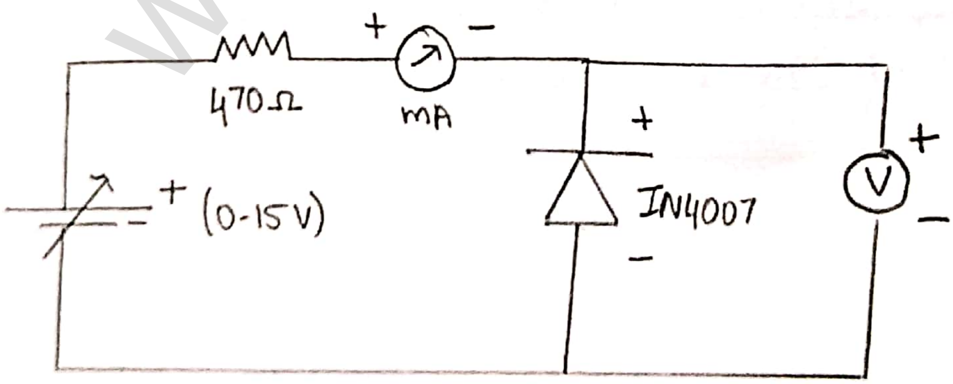
a) PN Junction diode and its symbol



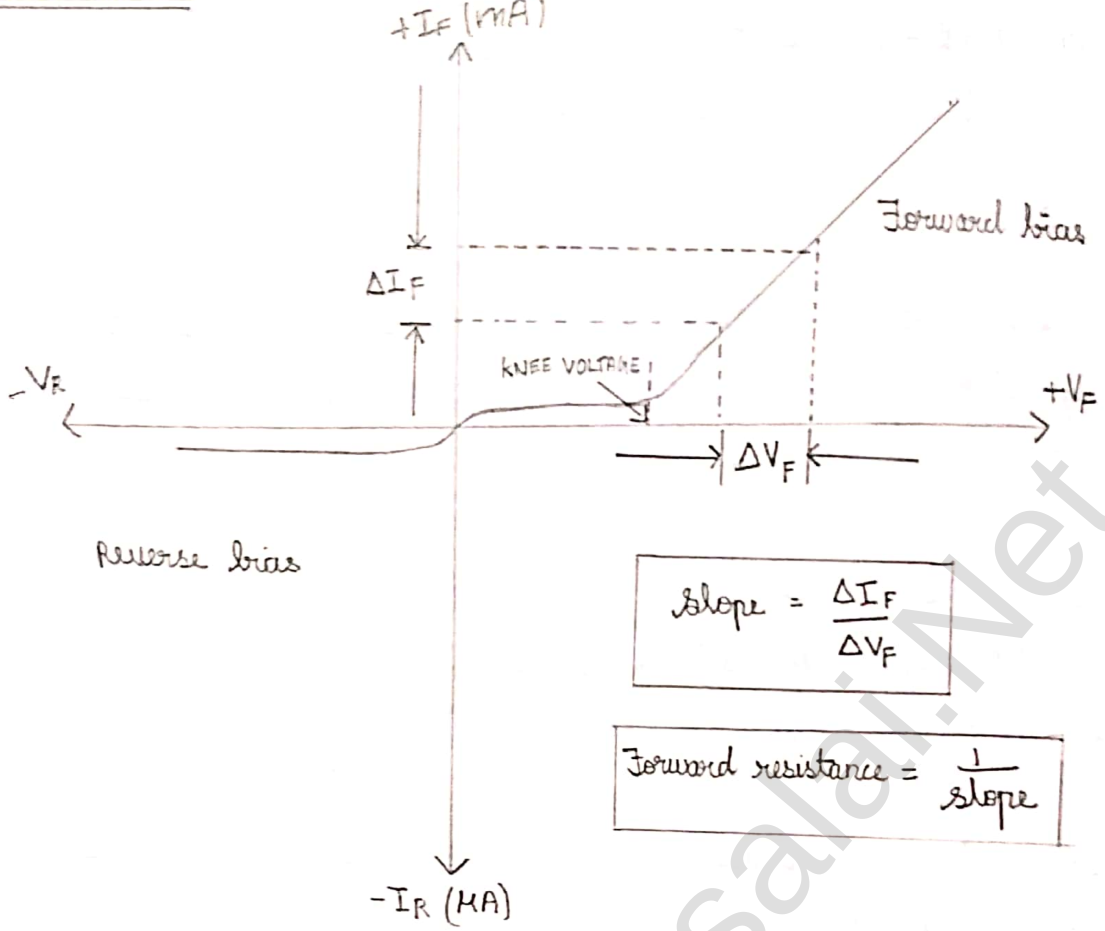
b) PN Junction diode in forward bias



c) PN Junction diode in Reverse bias



MODEL GRAPH



$$\text{Slope} = \frac{\Delta I_F}{\Delta V_F}$$

$$\text{Forward resistance} = \frac{1}{\text{slope}}$$

OBSERVATION

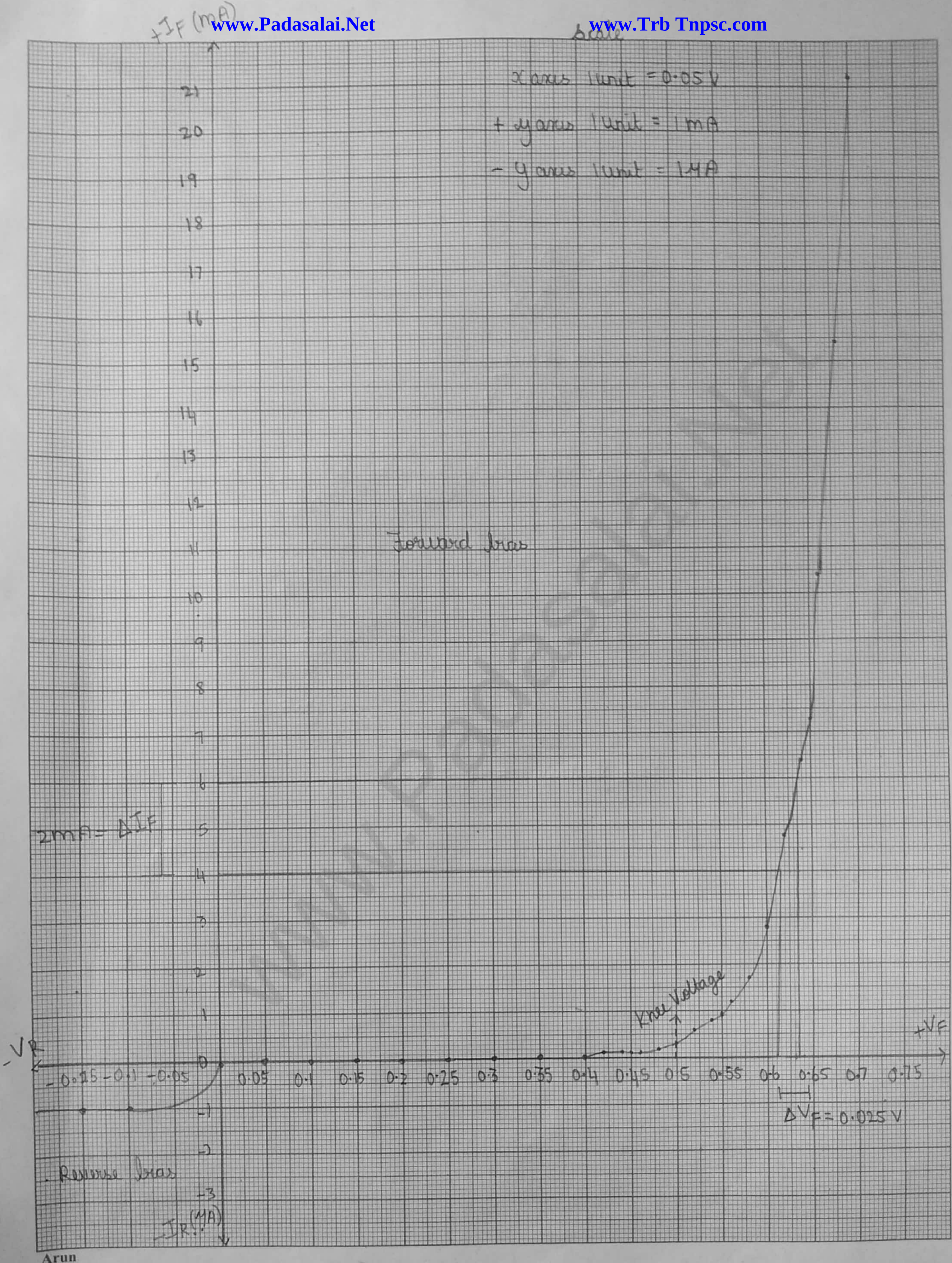
Table 1 Forward bias characteristic curve

S.NO	Forward bias Voltage V_F (Volt)	Forward bias current I_F (mA)
1)	0.42	0.1
2)	0.45	0.1
3)	0.48	0.2
4)	0.5	0.3
5)	0.55	0.9
6)	0.6	2.8
7)	0.65	7.3
8)	0.7	21.2
9.)	0.75	68.5

Forward bias Voltage VF (Volt)	Forward bias current IF (mA)
0	0
0.42	0.1
0.44	0.1
0.46	0.1
0.48	0.2
0.5	0.3
0.52	0.6
0.54	0.8
0.56	1.2
0.58	1.7
0.6	2.8
0.62	4.8
0.64	6.4
0.66	10.4
0.68	15.4

Table 2 Reverse bias characteristic curve

S.No	Reverse bias voltage V_R (Volt)	Reverse bias current I_R (μA)
1.)	0.1	1
2.)	0.15	1
3.)	0.2	1
4.)	0.3	1
5.)	0.4	1
6.)	0.5	1
7.)	0.6	1
8.)	0.7	1



+IF (mA)
Scale
x axis 1 unit = 0·05 V
+ y axis 1 unit = 1 mA
- y axis 1 unit = 1µA
Forward bias
2mA = ΔIF
Knee Voltage
+VF
-VR
ΔVF = 0·025 V
Reverse bias
-IR (µA)

Arun

$$\text{Slope} = \frac{\Delta I_F}{\Delta V_F}$$

$$= \frac{2\,mA}{0.025\ V}$$

$$\text{Forward resistance} = \frac{1}{\text{slope}} = \frac{0.025}{2 \times 10^{-3}}\ \Omega$$

$$= \frac{0.025 \times 10^{3}}{2}\ \Omega$$

$$= \frac{25}{2}$$

$$= 12.5\ \Omega$$

$$\text{Knee Voltage} = 0.5\ V$$

RESULT

The V-I characteristics of PN Junction diode are studied.

i) knee voltage of PN Junction diode = 0.5 V

ii) forward resistance of diode = 12.5 Ω

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VOLTAGE – CURRENT CHARACTERISTICS OF A ZENER DIODE

AIM

To draw the voltage-current (V-I) characteristics 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
- Voltmeter
- 470 Ω resistance
- connecting wires

FORMULA

$$R_F = \frac{\Delta V_F}{\Delta I_F}$$

where

$R_F \rightarrow$ forward resistance of the diode (Ω)
$\Delta V_F \rightarrow$ The change in forward voltage (Volt)
$\Delta I_F \rightarrow$ The change in forward current (mA)

PROCEDURE

i) Forward bias characteristics

- In the forward bias, the P region of diode is connected to positive terminal, N region to negative terminal of DC Power supply.

• The connections are given as per the circuit diagram.

• The voltage across the diode can be varied with Variable DC power supply.

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

• The forward voltage and the forward current are taken as +ve.

• A graph is drawn taking the forward voltage along x axis and forward current along the y axis.

• The voltage corresponding to the dotted line in 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 characteristic is calculated. The slope reciprocal gives forward resistance of diode.

ii) Reverse bias characteristics

• In the reverse bias, the polarity of the DC power supply is reversed so that P region of diode is connected to -ve terminal. N region to +ve terminal of DC power supply.

• The connections are made as given in circuit diagram.

• The voltage across the diode can be varied with the help of Variable DC Power supply.

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- 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 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 input voltage may be raised in steps of say 0.1V to find the break down voltage.

- The reverse voltage and reverse current are taken as −ve.

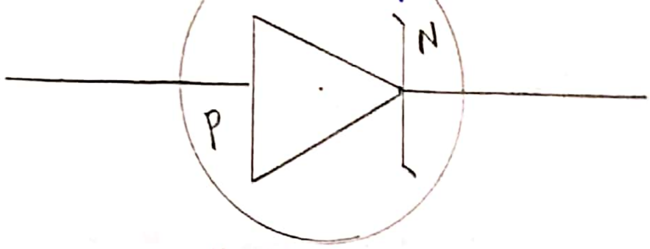
- A graph is drawn taking the reverse bias voltage along −ve x axis and reverse bias current along −ve y axis.

- In the reverse bias, Zener breakdown occurs at a particular voltage called Zener voltage V_Z (~5.6 to 5.8 V) and a large amount of current flows through the diode which is a characteristic of zener diode.

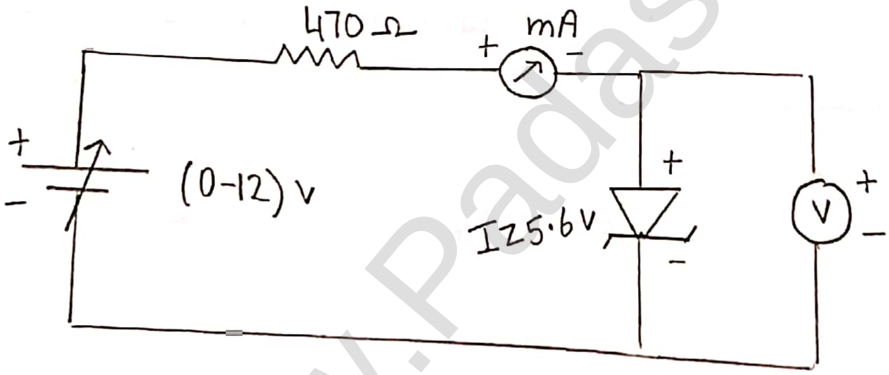
- The breakdown voltage of zener diode is determined from graph as shown.

CIRCUIT DIAGRAM

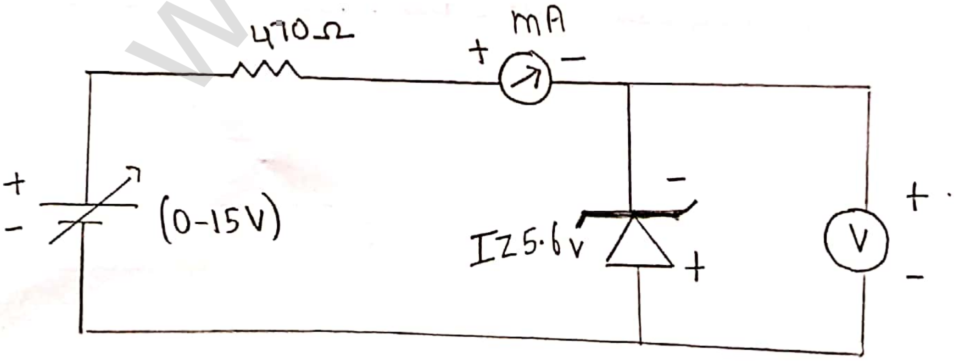
a) Zener diode and Its symbol (The black colour Ring denotes the Negative Terminal of the Zener diode



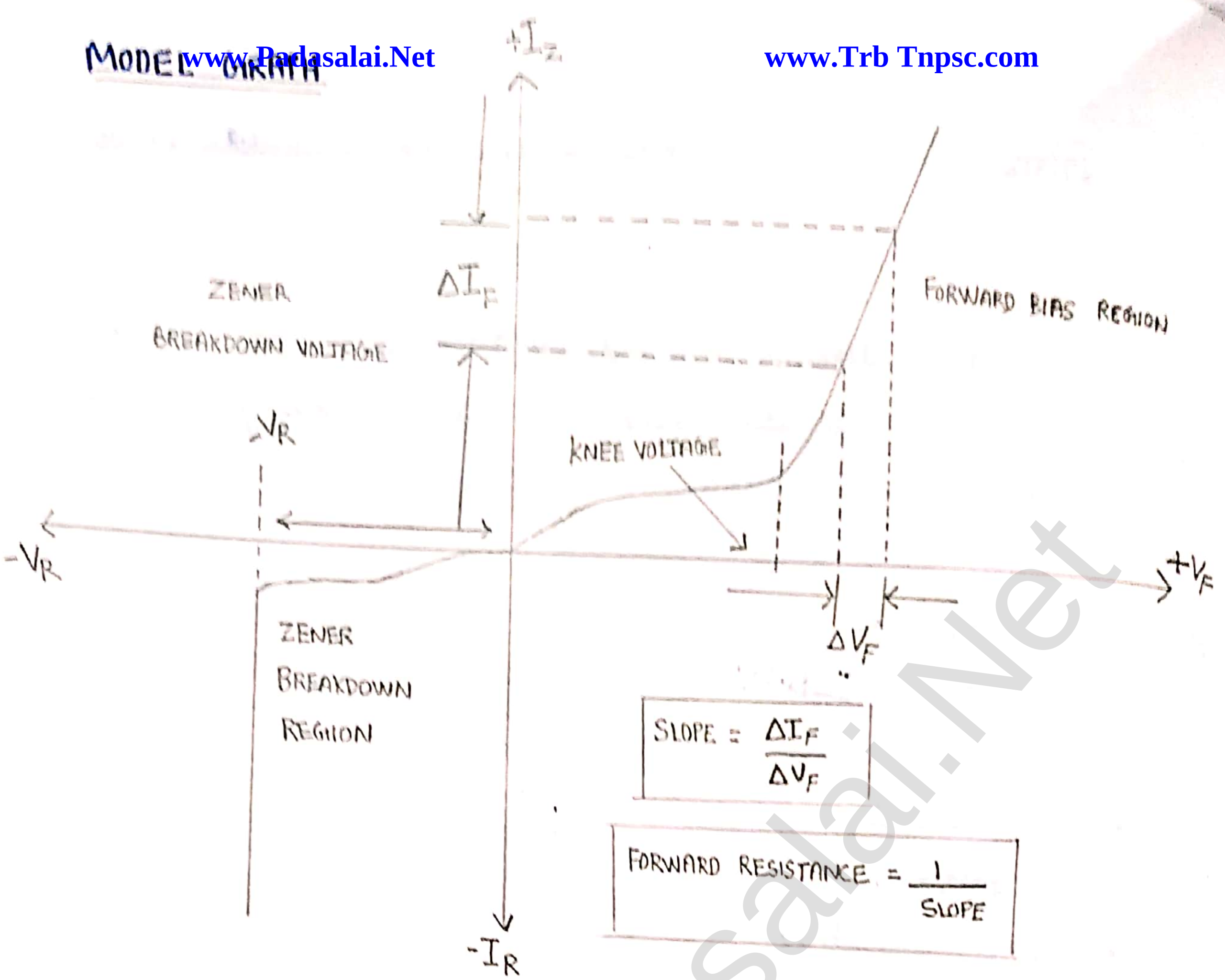
b) Zener diode in Forward Bias



c) Zener diode in Reverse Bias



MODEL GRAPH



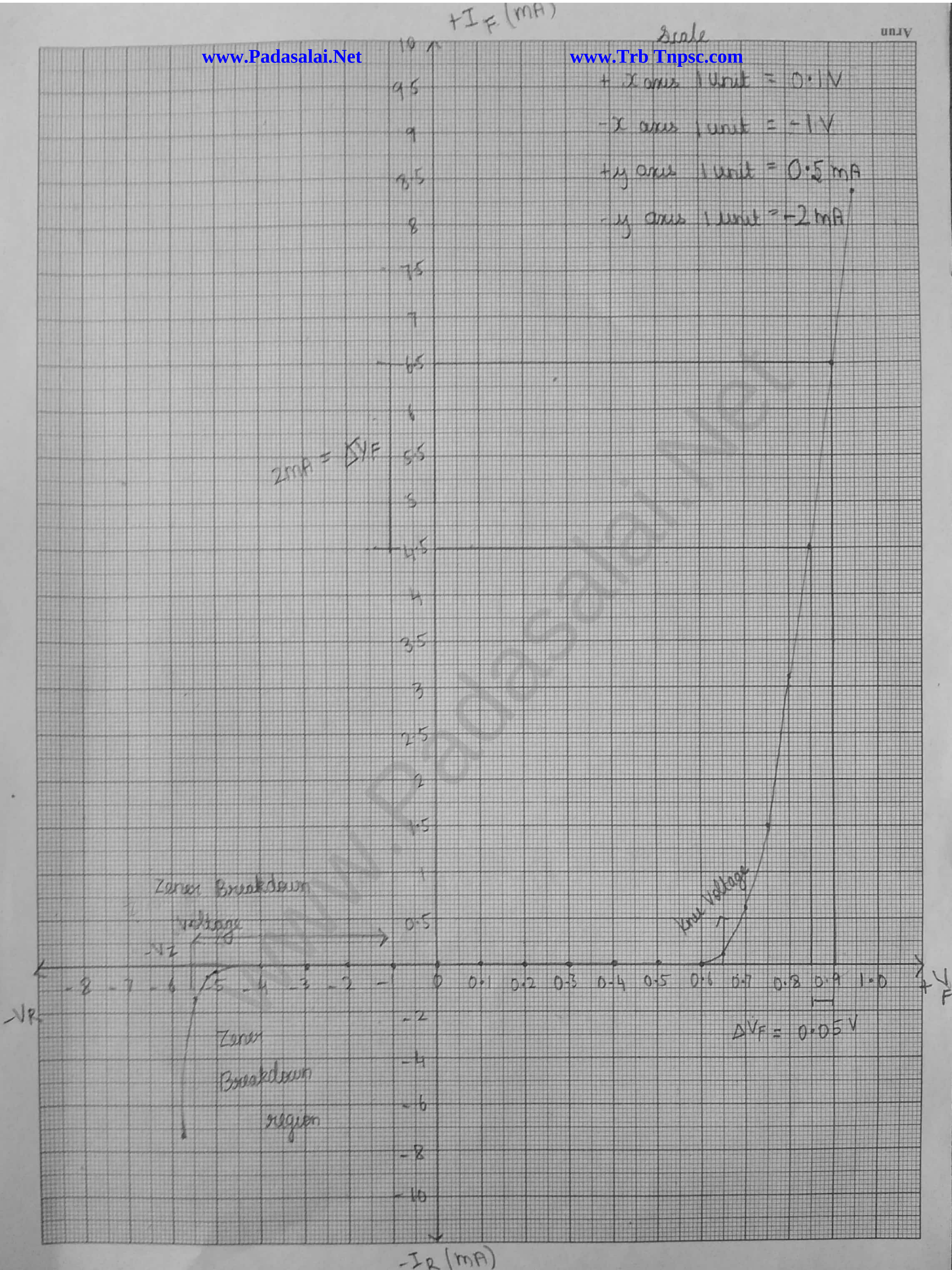
OBSERVATION

Table : 1 Forward bias characteristic curve

S.No	Forward bias voltage V_F (Volt)	Forward bias current I_F (mA)
1.)	0.1	0
2.)	0.6	0
3.)	0.65	0.1
4.)	0.7	0.6
5.)	0.75	1.5
6.)	0.8	3.1
7.)	0.85	4.5
8.)	0.9	6.5
9.), 10.)	0.95, 1	8.4, 10.8

Table 2 Reverse bias characteristic curve

S.No	Reverse bias voltage V_R (Volt)	Reverse bias current I_R (mA)
1)	4.5	0.1
2)	4.75	0.1
3)	5	0.2
4)	5.25	0.4
5)	5.5	1.4
6)	5.75	7.3
7)	6.0	17
8)	6.25	26
9)	6.5	36.2



$+I_F$ (mA)
Scale
+ x axis 1 unit = 0.1 V
- x axis 1 unit = -1 V
+y axis 1 unit = 0.5 mA
-y axis 1 unit = -2 mA
2mA = ΔVF
Zener Breakdown voltage
-Vz
Knee voltage
-VR
Zener Breakdown region
ΔVF = 0.05 V
+VF
$-I_R$ (mA)

RESULT

The V-I characteristics of the zener diode are studied

i) Forward resistance, R_F = 25 Ω

ii) Knee voltage = 0.65 V

iii) The breakdown voltage of zener diode V_Z = -5.6 V

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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 | BC 107
- bread board
- micro ammeter
- milli ammeter
- Voltmeters
- Variable DC power supply
- connecting wires

FORMULA

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

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)

PROCEDURE

• The connections are given as shown in the digram.

• 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 0.1 V 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 input characteristic 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 I_B is kept constant.

- V_{CE} is varied in 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_{CEO}.

- 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.

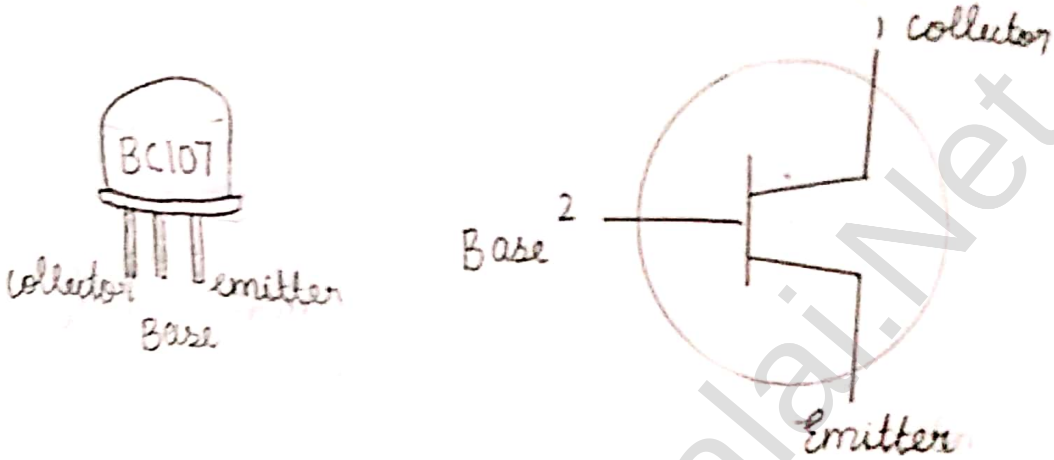
- The reciprocal of the slope of the curve gives output impedance of the transistor.

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

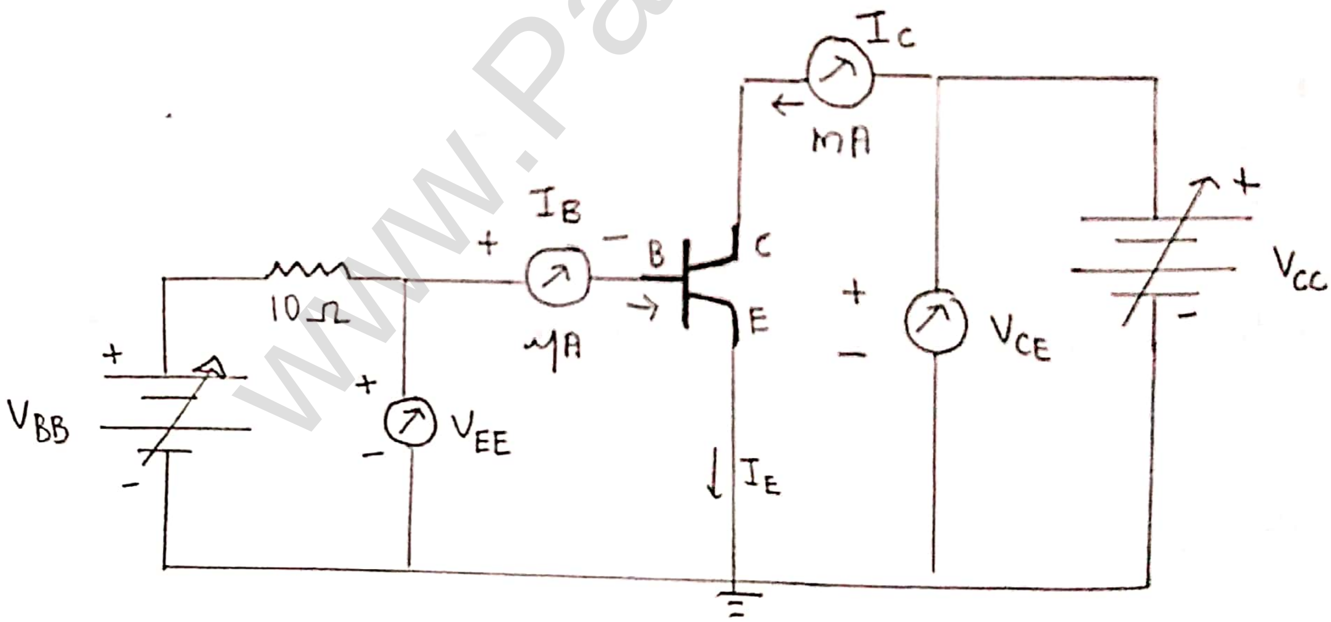
- The collector-emitter voltage V_{CE} is kept constant.
- The base current I_B is varied in steps of 10 μA and the corresponding collector current I_C is noted.
- This is repeated by changing the value of V_{CE}. The readings are tabulated.
- The transfer characteristics is a plot between the input current I_B along x-axis and the output current I_C along y-axis keeping V_{CE} constant.
- The slope of the transfer characteristics plot gives the current gain β can be calculated.

CIRCUIT DIAGRAM

a.) NPN-Junction transistor and its symbol

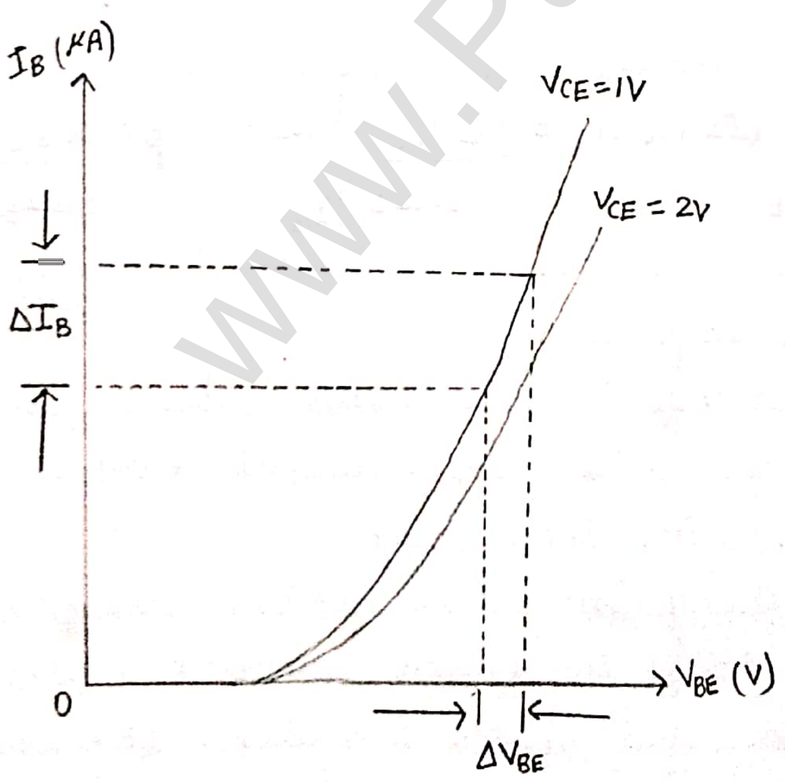


b.) NPN Junction transistor in CE configuration



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

S.NO	V_{CE} = 1V		V_{CE} = 2V	
	V_{BE} (V)	I_B (μA)	V_{BE} (V)	I_B (μA)
1	0.1	0	0.1	0
2	0.2	0	0.2	0
3	0.3	0	0.3	0
4	0.4	0.1	0.4	0.1
5	0.5	0.7	0.5	0.8
6	0.6	4.1	0.6	4.1
7	0.7	23.8	0.7	25.4
8	0.8	81.5	0.8	84.3
9	0.9	159.5	0.9	174



$$\text{Slope} = \frac{\Delta I_B}{\Delta V_{BE}}$$

$$\text{Input impedance} = \frac{1}{\text{slope}}$$


IB(μA)
Scale
x axis 1 unit = 0.05 V
y axis 1 unit = 1 μA
ΔIB
9 μA
ΔVBE
0.05 V
VBE (V)
Arun
0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

$$\text{slope} = \frac{\Delta I_B}{\Delta V_{BE}}$$

$$= \frac{9\,\mu A}{0.05\ V}$$

$$\text{Input Impedance} = \frac{0.05}{9\times10^{-6}}\ \Omega$$

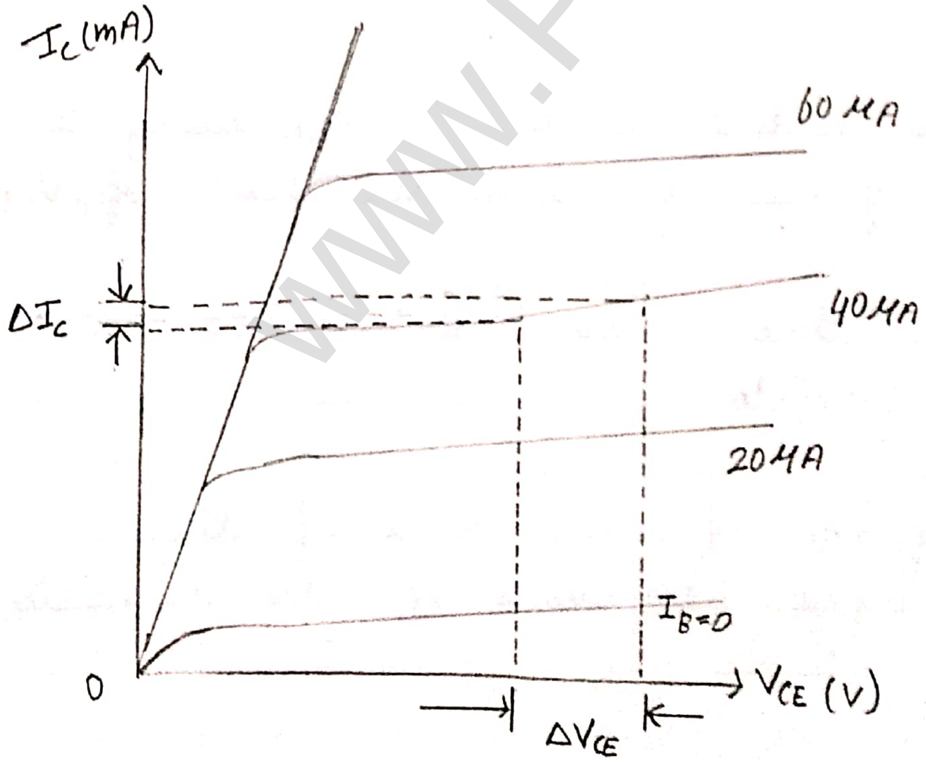
$$= \frac{0.05\times10^{-6}}{9}\ \Omega$$

$$= \frac{50000}{9}\ \Omega$$

$$= 5555.556\ \Omega$$

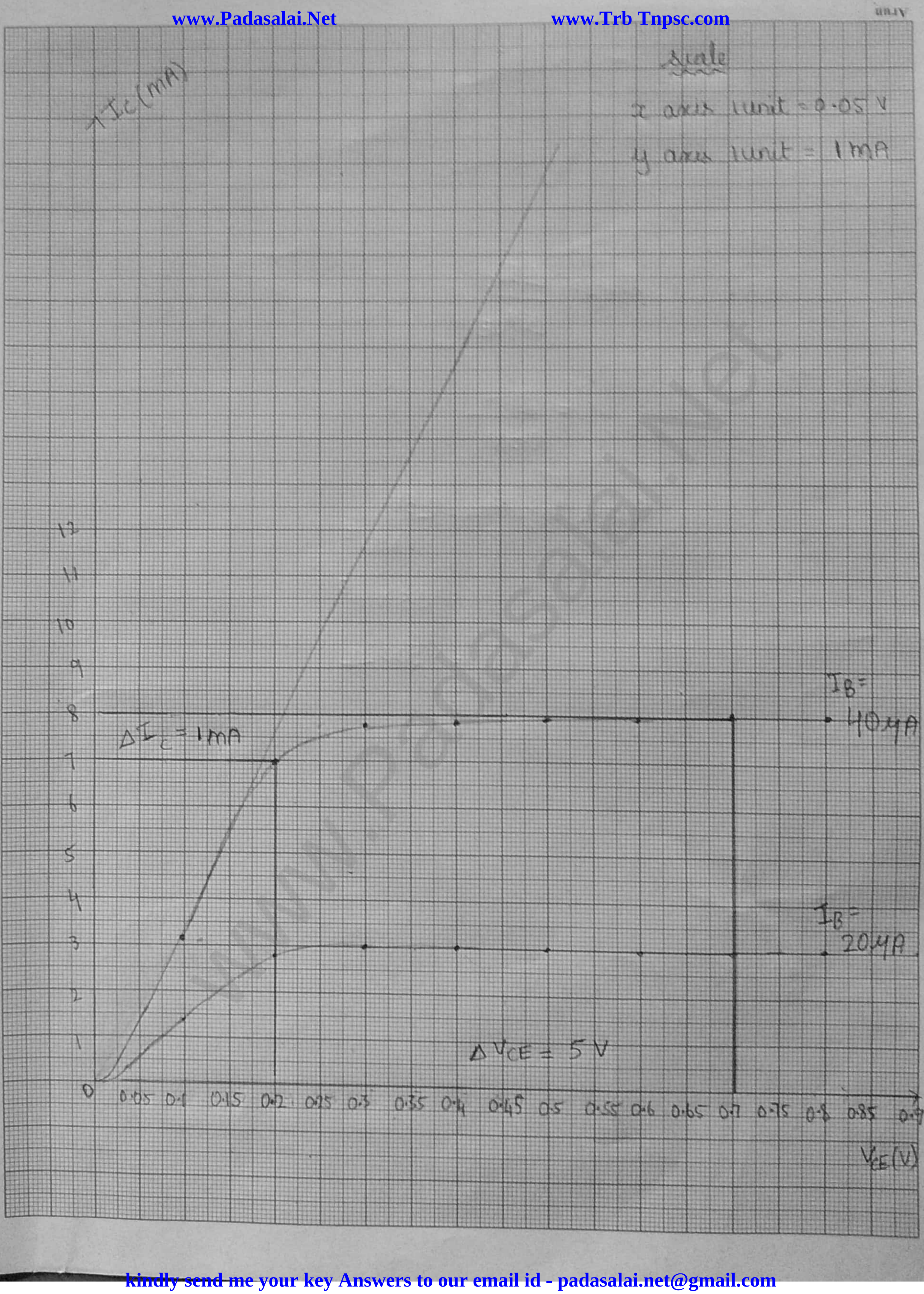
ii) output characteristic curve : V_{CE} vs I_C (I_B constant)

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.)	0.1	1.4	0.1	3.1
2.)	0.2	2.8	0.2	7
3.)	0.3	3.0	0.3	7.7
4.)	0.4	3.0	0.4	7.8
5.)	0.5	3.0	0.5	7.9
6.)	0.6	3.0	0.6	7.9
7.)	0.7	3.0	0.7	8
8.)	0.8	3.0	0.8	8
9.)	0.9	3.0	0.9	8



$$\text{slope} = \frac{\Delta I_C}{\Delta V_{CE}}$$

$$\text{output impedance} = \frac{1}{\text{slope}}$$


Scale
x axis 1unit = 0.05 V
y axis 1unit = 1mA
Ic(mA)
ΔIc = 1mA
ΔVCE = 5V
IB = 40μA
IB = 20μA
VCE(V)

$$\text{Slope} = \frac{\Delta I_C}{\Delta V_{CE}}$$

$$= \frac{1mA}{0.5V}$$

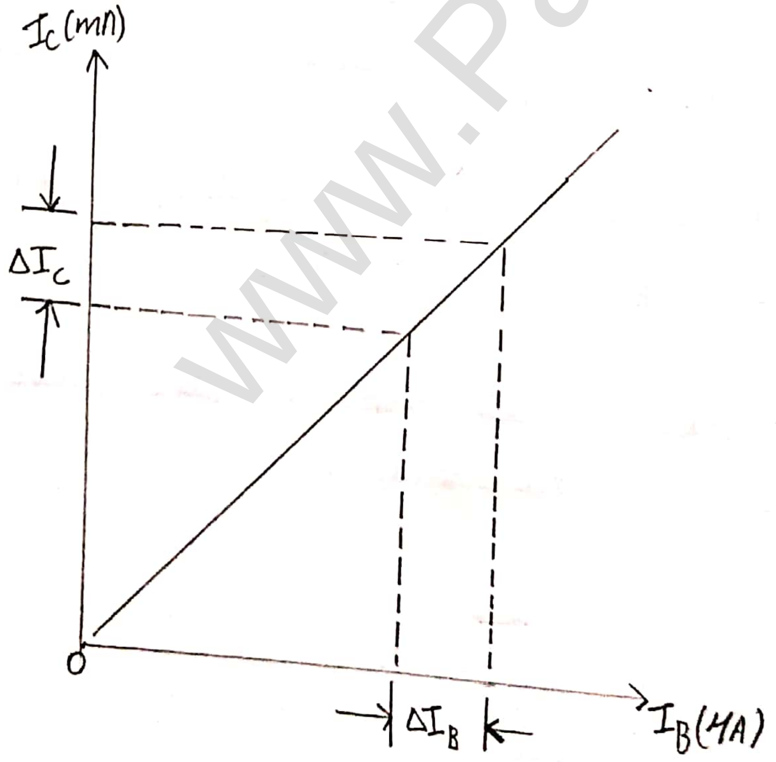
$$\text{Output Impedance} = \frac{0.5V}{1 \times 10^{-3}}$$

$$= 0.5 \times 10^{3}$$

$$= 500\,\Omega$$

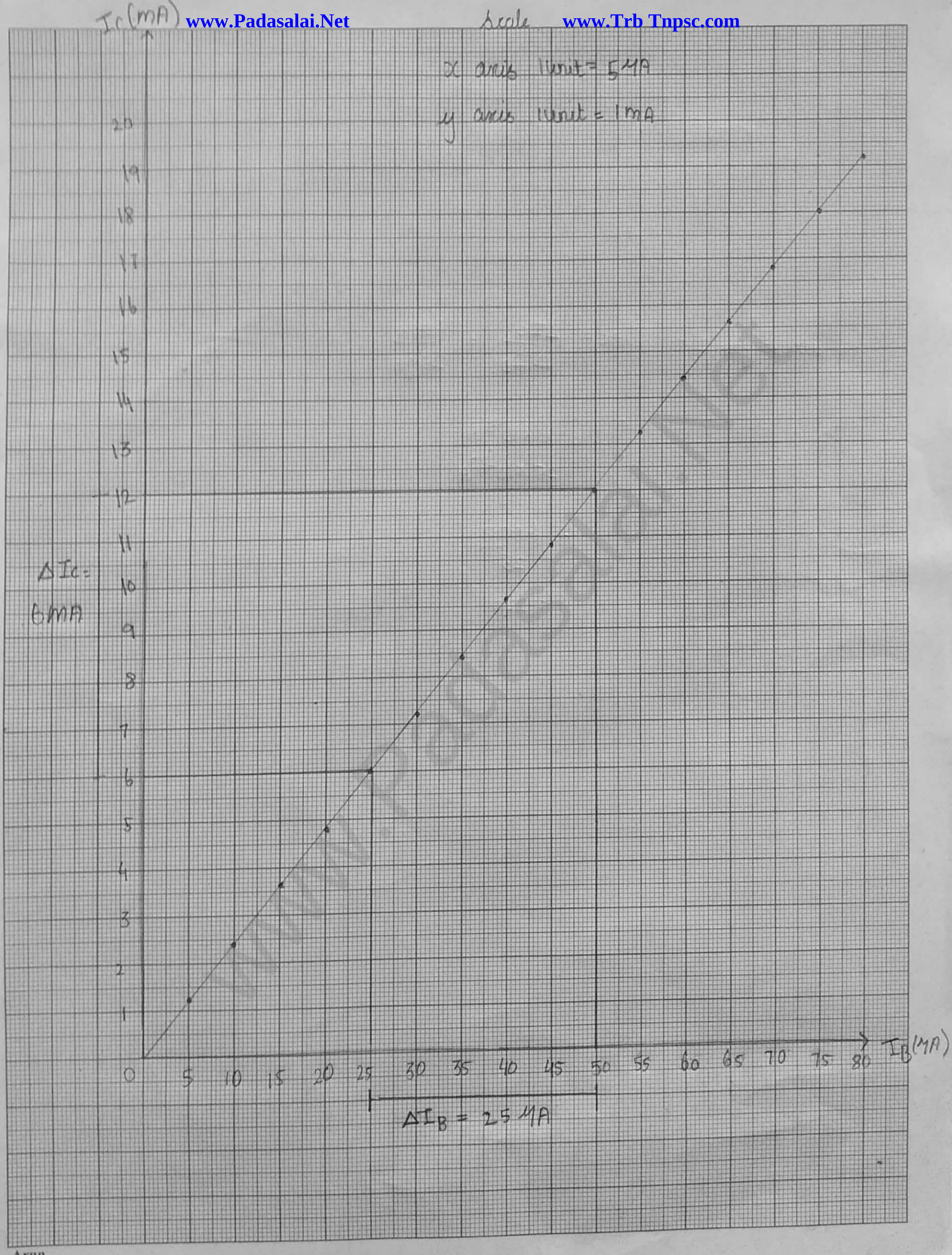
iii) Transfer characteristic curve : V_{CE} Vs I_C (I_B constant)

S.No	$V_{CE} = 1V$		$V_{CE} = 2V$	
	I_B (μA)	I_C (mA)	I_B (μA)	I_C (mA)
1	10	2.4	10	2.4
2	20	4.8	20	4.8
3	30	7.2	30	7.2
4	40	9.6	40	9.6
5	50	12	50	12
6	60	14.4	60	14.4
7	70	16.8	70	16.8



$$\text{slope} = \frac{\Delta I_C}{\Delta I_B}$$

current gain = slope



I_C (mA)
Scale
x axis 1 unit = 5 μA
y axis 1 unit = 1 mA
ΔI_C = 6 mA
ΔI_B = 25 μA
I_B (μA)

Current gain β = Slope = $\frac{\Delta I_C}{\Delta I_B} = \frac{6 mA}{25 \mu A}$

$= \frac{6 \times 10^{-3} A}{25 \times 10^{-6} A}$

$= \frac{6000}{25}$

$= 240$

RESULT

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

ii) (a) Input impedance = 5555 Ω
(b) output impedance = 500 Ω
(c) current gain β = 240 (No unit)

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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

i) AND gate (IC 7408)
ii) NOT gate (IC 7404)
iii) OR gate (IC 7432)
iv) NAND gate (IC 7400)
v) NOR gate (IC 7402)
vi) Ex-OR gate (IC 7486)
vii) power supply
viii) Digital IC trainer kit
ix) connecting wires

BOOLEAN EXPRESSIONS

i) AND gate $Y = A \cdot B$
ii) OR gate $Y = A + B$
iii) NOT gate $Y = \bar{A}$
iv) Ex-OR gate $Y = \bar{A}B + A\bar{B}$
v) NAND gate $Y = \overline{A \cdot B}$
vi) NOR gate $Y = \overline{A + B}$

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PROCEDURE

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

- For all the ICs, 5V is applied to the pin 14 while pin 7 is connected to the ground.

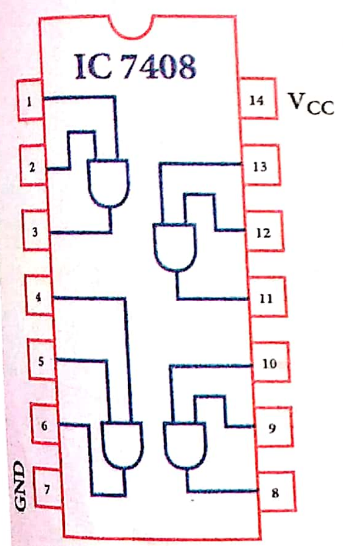
- The logical inputs of the truth table are applied and the corresponding output is noted.

- similarly the output is noted for all other combinations of input

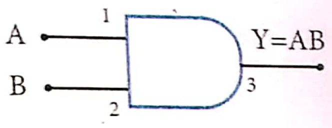
- In this way, the truth table of a logic gate is verified.

AND Gate:

PIN DIAGRAM-IC 7408



SYMBOL

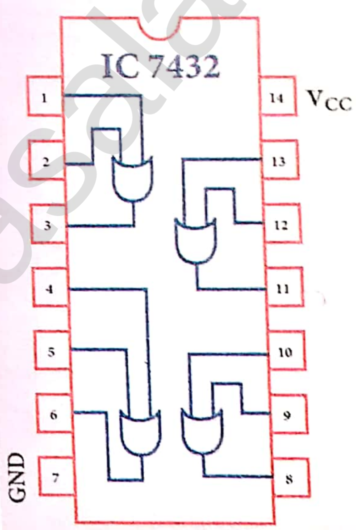


TRUTH TABLE

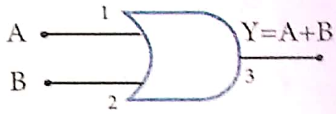
A	B	Y=AB
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate:

PIN DIAGRAM-IC 7432



SYMBOL

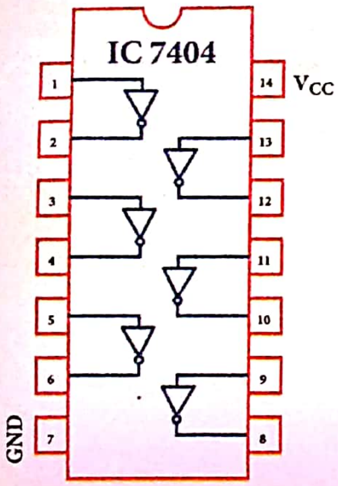


TRUTH TABLE

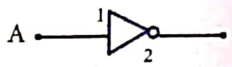
A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

NOT Gate:

PIN DIAGRAM-IC 7404



SYMBOL

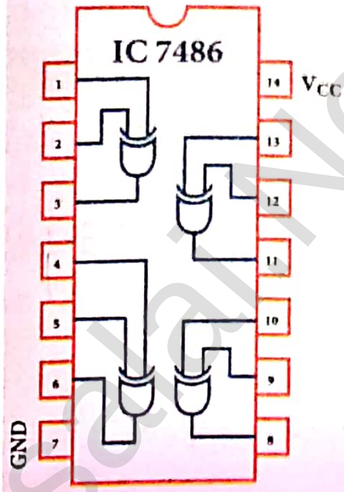


TRUTH TABLE

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

X-OR Gate :

PIN DIAGRAM-IC 7486



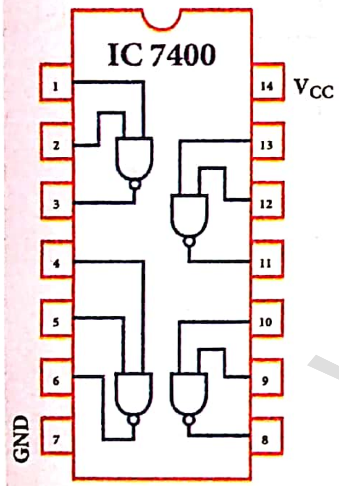
SYMBOL

TRUTH TABLE

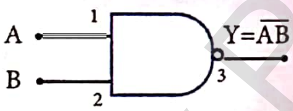
A	B	$Y=\bar{A}B+A\bar{B}$
0	0	0
0	1	1
1	0	1
1	1	0

NAND Gate:

PIN DIAGRAM-IC 7400



SYMBOL

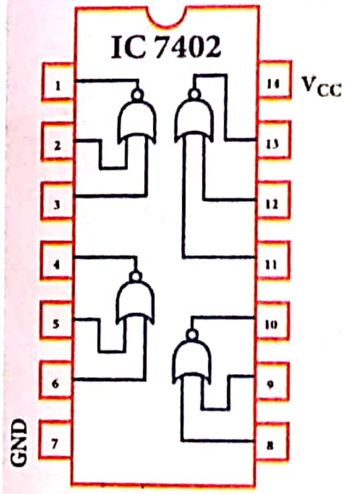


TRUTH TABLE

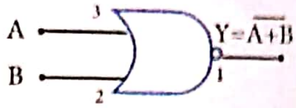
A	B	$Y=\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate:

PIN DIAGRAM-IC 7402



SYMBOL



TRUTH TABLE

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

RESULT

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

10. 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.

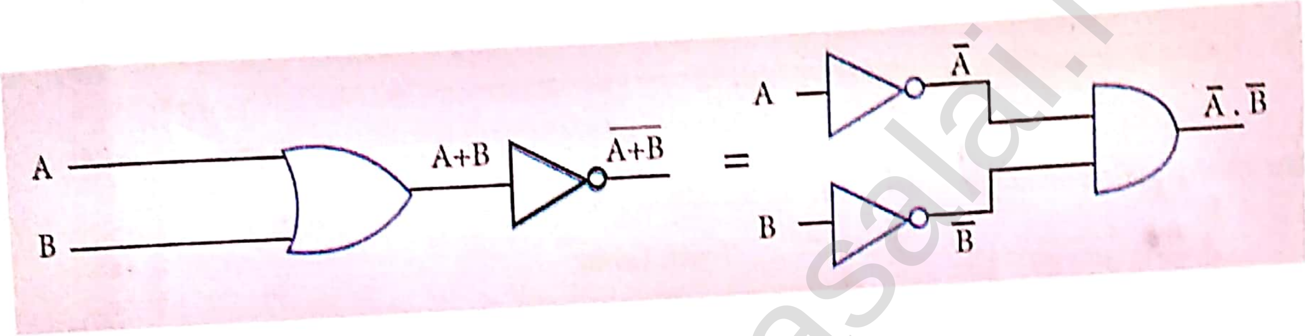
FORMULA

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

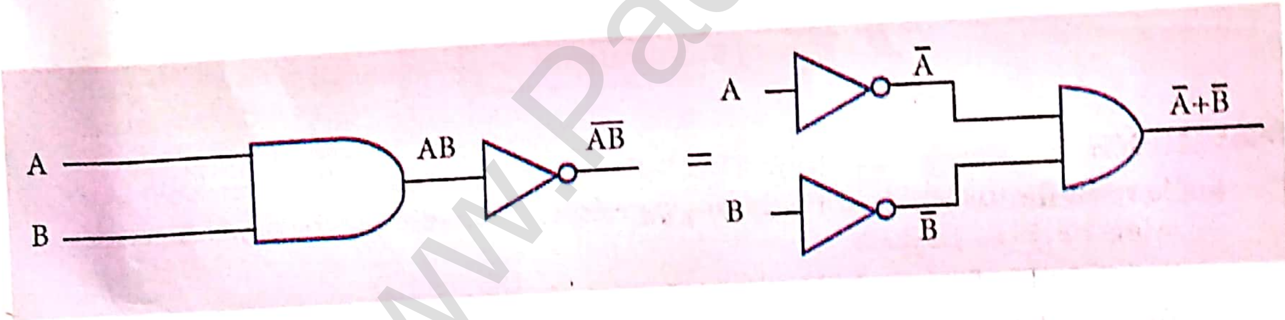
De Morgan's second theorem $\overline{A.B} = \bar{A}+\bar{B}$

CIRCUIT DIAGRAM:

De Morgan's first theorem



De Morgan's second theorem



PROCEDURE:

i) Verification of De Morgan's first theorem

- The connections are made for LHS $\left[\overline{A+B}\right]$ 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 $\left[\bar{A}.\bar{B}\right]$ of the theorem.
- From the truth table, it can be shown that $\overline{A+B} = \bar{A}.\bar{B}$.

ii) Verification of De Morgan's second theorem

- The connections are made for LHS $\left[\overline{A.B}\right]$ 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 $\left[\overline{A}+\overline{B}\right]$ of the theorem.
- From the truth table, it can be shown that $\overline{A.B}=\overline{A}+\overline{B}$.

OBSERVATION

De-Morgan's first theorem

Truth Table

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

De-Morgan's second theorem

Truth Table

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

RESULT

De Morgan's first and second theorems are verified.