Experiment no: 1

DETERMINATION OF THE ACCEPTANCE ANGLE AND NUMERICAL APERTURE OF AN OPTICAL FIBER

Aim:To determine the acceptance angle and numerical aperture of an optical fiber.

Apparatus: Single stand plastic optical fibers of different core diameter/length, laser source and screen.

Formula:

Numerical aperture presents the light gathering capacity of an optical fiber.

It is given by NA = $\sin\theta_o = \sqrt{n_1^2 - n_2^2}$

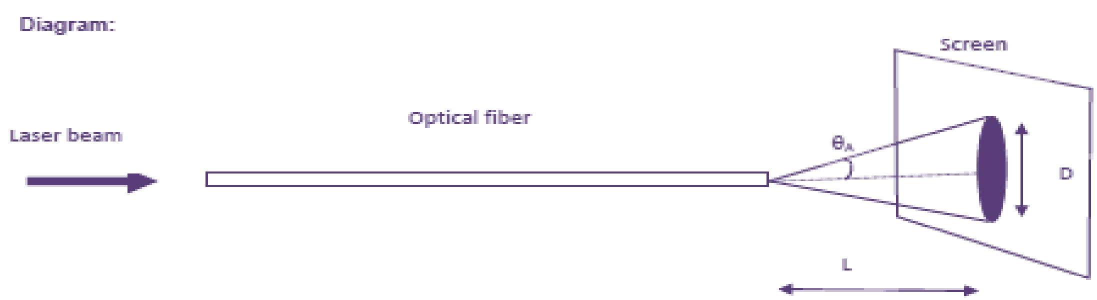
Here n_o is the refractive index of the medium from which light is entering.

Θ_o is the angle of acceptance.

n_1 is the refractive index of the core.

n_2 is the refractive index of cladding.

Diagram



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Procedure:

1. Connect the fiber to the Laser source.
2. Take the other end of the fiber and project the light output onto the screen to obtain a bright circular spot.
3. Determine the diameter Do the bright spot and the distance L from the fiber end to the screen.
4. Calculate the acceptance angle using the formula $\theta_o = \tan^{-1}\left(\frac{D}{2L}\right)$
5. Numerical aperture is given by NA=$\sin\theta_0$.
6. Repeat this procedure for at least four other value so distance L and calculate the acceptance angle and numerical aperture in each cas e.
7. Finally take the average of the four numerical aperture values.

ObservationTable:

TrialNo.	L(cm)	D (cm)		Average D (cm)	Angleof Acceptance $\theta_o = \tan^{-1}\left(\frac{D}{2L}\right)$	Numerical aperture NA=sinθ_o
		D_H	D_V			

Average Acceptance angle(**θ_o**)=**………………..**

Average Numerical aperture(NA)=………………………….

Result: The Numerical aperture & acceptance angle for the given optical fiber is found to be …………..and .... respectively.

CourseOutcome:

CO1	**Interpret the wave particle duality nature,wavepackets &their quantum application.**

CO-POmapping:

PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	2	-	-	3

Signature of Lab Course Coordinator ________________
(Prof.Rahul .M .Ingle)

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Date: ________________

Experiment NO: 2

Aim: Determine the value of specific value of specific charge of electron by Thompson Method.

Objective: Application of motion of electron in electric and magnetic field.

Apparatus : e/m Power Supply ,C.R.T ,magnetometer,Pair of bar magnets.

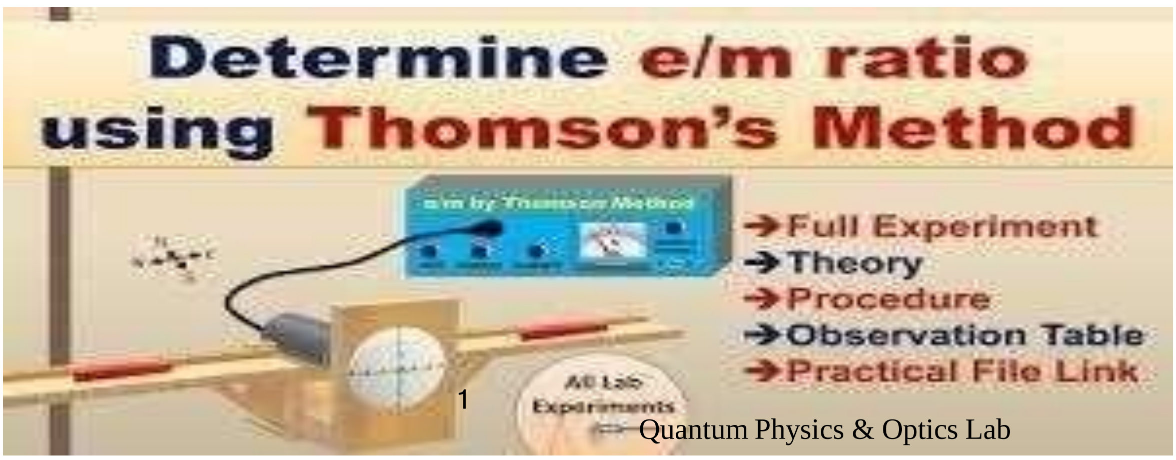
Formula:

$$e/m = yV/KB^2$$

where $B = B_H \tan\theta$

e /m = Specific charge of electron
e = charge of electron
m = mass of electron .
y = Deflection of spot produced by magnetic field B.
V = Voltage required to neutralize the deflection.K= constant for C.R.T.
l = length of deflection plate (3.1)
L = distance of the screen from the edges of the plates (12.3cm)
d= 2.8cm

Figure:



Observations:

. S..N	Position of the magnet (D)cm	Spot deflectio n (y)cm	y- deflecting voltage (v)	Deflection θ		θ	Tanθ
				Θ1	Θ2		
1							
2							
3							

Experiment NO: 2

Aim: Determine the value of specific value of specific charge of electron by ThompsonMethod.

Objective: Application of motion of electron in electric and magnetic field.

Apparatus : e/m Power Supply ,C.R.T ,magnetometer,Pair of bar magnets.

Formula:

$$e/m = yV/KB^2$$

where $B = B_H \tan\theta$

e /m	= Specific charge of electron
e	= charge of electron
m	= mass of electron .
y	= Deflection of spot produced by magnetic field B.
V	= Voltage required to neutralize the deflection.
K	= constant for C.R.T.
l	= length of deflection plate (3.1 cm)
L	= distance of the screen from the edges of the plates (12.3cm)
d	= 2.8cm

.

Theory:

Cathode Ray Tube (CRT) consists of three basic components :

1. Electron Gun :- FF is a filament which when heated emits electrons.

G(control grid) carries a negative charge, so sends out a beam of electrons which are accelerated by the anodes.

2. Deflecting System :- This system deflects the beam of electrons either electrically ormagnetically.

3. Fluorescent Screen :- When beam impings on it spot is produced. The value of elm is independent the nature of gas and material of the cathode of the discharge tube which

indicate that electrons are fundamental of all materials. The present accepted value ofelm 1.7*107 e.m.u / Gm.

Length of Y plates. (L) mm :-

12.3cm.Length of X plates. (I)

mm : 3.1 cm Width of Y plate

: 2.8cm

$K = 12.3 \times 3.1 \times 2.8 = 106.7 cm^2 = 106.7 \times 10^{-4} m^4$

Procedure:

1. The magnetic meridian, giving the direction of earth's North-South magnetic field,is marked on the center of a study table.
2. The U-shaped stand is placed on the table and its two arms are made perpendicular to the magnetic meridian.
3. The CRT is now placed in the arms of the U-shaped stand. In this position the axis of the CRT is parallel to the earth's magnetic field.
4. The CRT is now connected to the power supply kept away from the CRT and is switched on. The brightness and focus knobs are adjusted to get a bright spot on the CRT screen. With X- and Y-deflection voltage knobs turned to the "0" position, the position of the spot on the screen in noted.
5. The two bar magnets are placed on either side with opposite poles and at equal distance from the tube on the two arms of the U-shaped deflection magnetometer stand. The distance D, is read from the scale.

   D = 3cm on the left arm and 3cm on the right arm
6. The spot moves up or down (Y-direction) depending on how the bar magnets are placed.
7. The distance moved by the spot on the screen is noted. This is the 'y' deflection.
8. The Y-deflection voltage is now applied so that the spot comes back to its original postion at 0.0. The direction voltage is read from the meter. This gives the value of V.
9. This completes the first trial. The Y-deflection voltage is now brought back 0.0V and the magnets are positioned at 4cm on both the arms to repeat the experiment. The distance moved by the spot.
10. The trial is repeated by keeping the two magnets at different distances on the arms and applying volatge to bring the spot back to 0.0 positions. The readings obtained are tabulated in table.

Calculations:

Results: The value of specific value of specific charge of electron by Thompson Method is found to be--------------------

Viva Voce Question Bank

the interference fringes in near normal direction. What is the shape of the fringes? Why?

1. What is the function of CRT?
2. What is the standard value of e/m?
3. What is the value e?
4. What is the mass of electron ?
5. What is a "thin" for yellow light. Is it "thin" for X-ray? Is it thin for microwaves?
6. Suppose instead of air film between the lens L and plate P you had a water film, what will happen?

Course Outcome:

CO2	Illustrate the concept of motion of charged particle in electric field, magnetic field and cross configured field. .

CO-PO mapping:

PO→	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO2	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**

Signature of lab course Coordinator---------------------

(Prof.Rahul.M.Ingle)

Experiment No: 3

Aim: Determine the ripple factor ‘r’ and efficiency ‘η’ for Half Wave and Full Wave rectification.

Objective: Rectification of the Half and Full wave with the help diode on CRO and obtain the tracings.

Apparatus: CRO and rectifier kit with components – step down transformer (12V-0-12V), diodes (IN 4007), load resistance (1 kΩ).

Formula: 1) Ripple factor:

For HWR: $r = \left[\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1\right]^{\frac{1}{2}}$, $V_{rms} = \frac{V_p}{2}$, $V_{dc} = \frac{V_p}{\pi}$

For FWR $r = \left[\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1\right]^{\frac{1}{2}}$, $V_{rms} = \frac{V_p}{\sqrt{2}}$, $V_{dc} = \frac{2V_p}{\pi}$

2) Rectification Efficiency

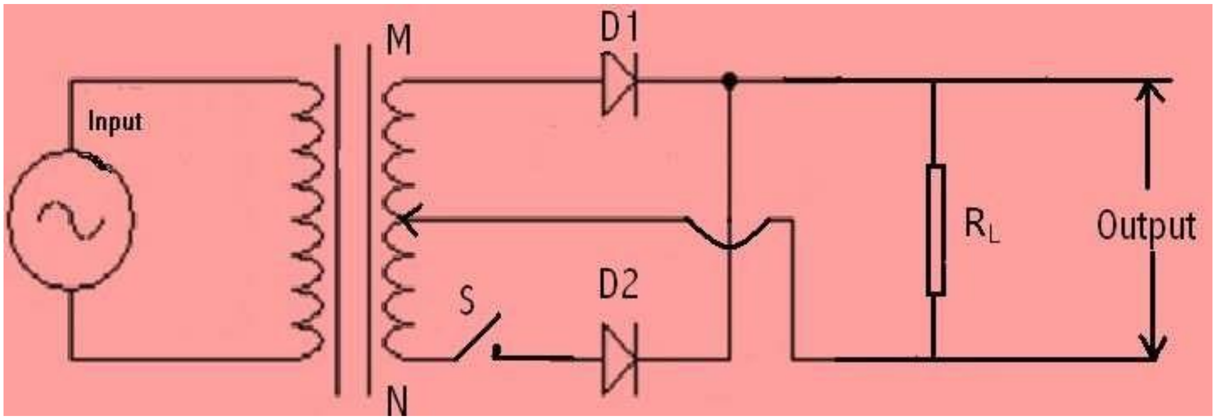
For HWR and FWR $\eta = \left(\frac{V_{dc}}{V_{rms}}\right)^2$

Where, “V_{rms}” is rms value of ripple voltage,

“V_{dc}” is dc value of output voltage,

“V_p” is the peak value of output voltage.

Circuit diagram:



Theory:

Electronic circuits need a source of dc power. Batteries are a source of dc power supply to limited extent. The proper alternative for this is conversion of ac to dc. The process of converting ac to dc is called as rectification. A p-n junction diode can be used as a rectifier. The junction has a depletion region and a barrier potential at the junction, because which diode conducts only in one direction. The diode conducts when it is connected in forward bias. It blocks the flow of current when it is connected in reverse bias. Using this property, the Half and Full wave rectifier can be built. In half wave rectifier, single diode is used as shown in figure. In full wave rectifier, two diodes are used.

When an alternating voltage is applied to a half wave rectifier, along with a load resistance, during the positive half cycle of the input ac voltage, the diode D1 is forward biased (ON) and conducts. While conducting the diode acts as a short-circuit so that circuit current flows and hence positive half cycle of the input ac voltage is dropped across R_L. During the negative input half cycle, the diode is reverse biased (OFF) and so it does not conduct i.e. there is no voltage drop across R_L. Thus, the output is not a steady dc but only a pulsating dc having ripple frequency equal to that of the input voltage frequency. This wave can be observed by CRO connected across R_L. Since, only one half cycle of the input wave is used, it is called a half wave rectifier.

In full wave rectifier both half cycles of the input are utilized. For the full wave rectification, use of transformer is essential (though it is optional for half wave rectification). When input ac supply is switched on, the ends M and N of the transformer at secondary become positive and negative alternatively. During the positive half cycle of the ac input, terminal M is positive and N is at negative potential. Hence, being forward biase4d, diode D1 conducts (but not D2 which is reverse biased). As a result, positive half cycle of the voltage appears across RL. In negative half cycle, when terminal N becomes positive, then D2 conducts. In both half cycles of ac input, the current keeps on flowing through RL in the same direction. This way, both the positive and negative cycles get converted into positive cycles, which look like a ripple pulsating dc. This ripple can be reduced by using proper filter circuits.

Procedure:

Diode as half wave rectifier

1) Keep the key ‘S’ open.
2) Connect ‘Y’ input of CRO across the transformer, so as to obtain a simple ac signal (sine wave).
3) Take the trace of this s ine wave from CRO screen (Volt/div = 10, 5 V).
4) Connect ‘Y’ input of CRO across the output terminal of the circuit to obtain a half wave rectifier signal on the screen of the CRO. In order to compare, draw the trace of half wave signal (Volt/div = 10, 5 V).
5) Measure peak to peak distance (Y) from the CRO screen. Write the observation in table.

Diode as full wave rectifier

1) Close the key ‘S’.
2) Connect ‘Y’ input of CRO across the output terminal of the circuit to obtain a full wave rectifier signal on the screen of the CRO. In order to compare, draw the trace of half wave signal (Volt/div = 10, 5 V).
3) Measure peak to peak distance (Y) from the CRO screen. Write the observation in table.

Observations:

For Half wave rectifier

Volt/div (X)	Y	Vp = X*Y	$V_{rms} = \frac{V_p}{2}$	$V_{dc} = \frac{V_p}{\pi}$	$r = [(\frac{V_{rms}}{V_{dc}})^2 - 1]^{\frac{1}{2}}$	$\eta = (\frac{V_{dc}}{V_{rms}})$

For Full wave rectifier

Volt/div (X)	Y	Vp = X*Y	$V_{rms} = \frac{V_p}{\sqrt{2}}$	$V_{dc} = \frac{2V_p}{\pi}$	$r = [(\frac{V_{rms}}{V_{dc}})^2 - 1]^{\frac{1}{2}}$	$\eta = (\frac{V_{dc}}{V_{rms}})^2$

Calculations:

Calculate ripple factor and rectification efficiency for both half wave rectifier and full wave rectifier

Result:

1) For half wave rectifier ripple factor is found to be 2.978 and rectification efficiency is 0.101.
2) For full wave rectifier ripple factor is found to be0.4835 and rectification efficiency is 0.8105 .

Precautions:

1) The connections should be tight.
2) CRO must be on calibration mode.
3) Steady pattern should be obtained on the screen of CRO.

Course Outcome:

CO2	**Illustrate the concept of diffraction, reflection and motion of charged particle in electric ,magnetic field.**

CO-PO mapping:

PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO2	3	3	-	-	-	-	-	-	2	-	-	3

Signature of lab course Coordinator ----------------------
(Prof.Rahul.M.Ingle)

Experiment No:4

Aim: Determine cut-in voltage and forward dynamic resistance of P-N junction diode in Forward and reverse biased.

Objectives:

To Plot V-I characteristics of P-N junction diode in forward & reverse bias mode.

Formula:

$$r_f = \frac{\Delta V_{df}}{\Delta I_{df}}$$

Where,

r_f- is the forward dynamic resistance of the diode
ΔV_{df}-is the voltage across junction in forward bias
ΔI_{df}-is the current through diode in forward bias

Circuitdiagram:

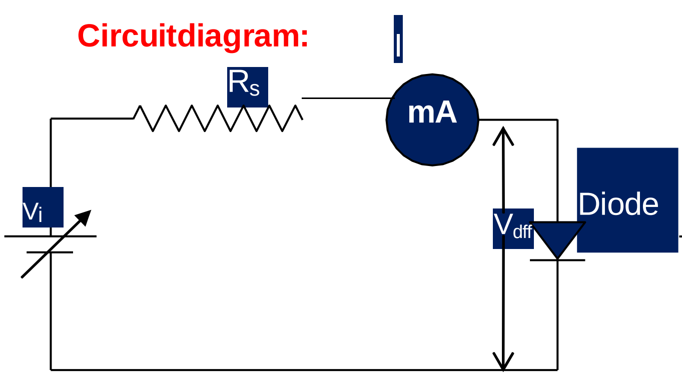


Fig.a: Circuit diagram of forward biased p-n junction diode

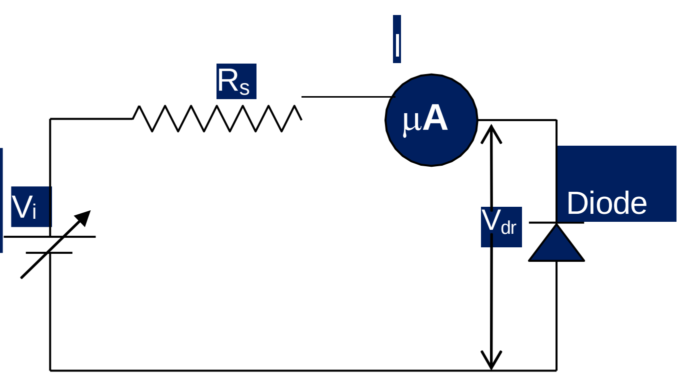


Fig.b: Circuit diagram of reverse biased p-n junction diode

Theory

If donor (pentavalent)impurities are introduced on one side and acceptors (trivalent) on the other side of a single crystal of an intrinsic semiconductor like germanium or silicon, a p-n junction is formed as shown in Fig.1. The donor ion is indicated schematically by a plus sign because when this impurity atom "donates" an electron, it becomes a positive ion. The acceptor ion is indicated by a minus sign because, when this atom accepts an electron, it becomes a negative ion. Initially, there are n-type carriers to the right of the junction and only p-type carriers to the left.On account of density gradient across the junction, holes will diffuse to the right across the junction, and electrons to the left. As a result of the displacement of the charges, an electric field appears across the junction. Equilibrium is established when the field becomes large enough to restrain the process of diffusion. The positive holes, near the junction in p-type germanium, disappear as a result of recombination with electrons, which diffuse across the junction.

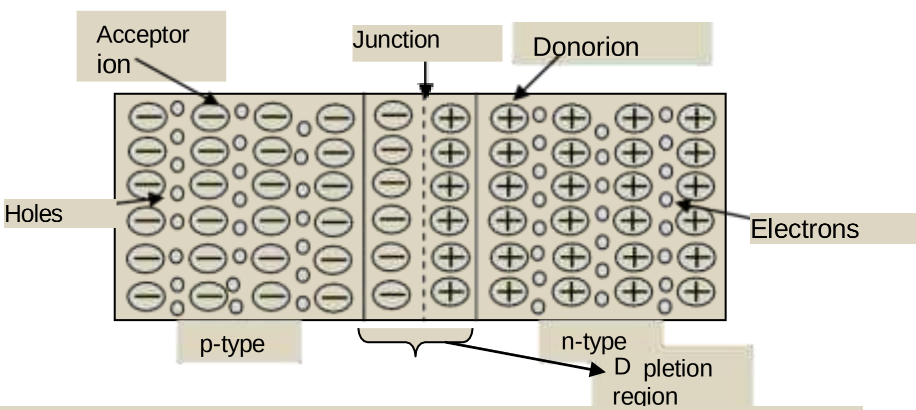


Fig.1:Formation of depletion region in a p-n junction

Similarly, the electrons in the n-type semiconductor combine with holes, which cross the junctionfromthep-side.Sincetheregionofthejunctionisdepletedofmobilecharges,itis called the depletion region, or a potential barrier.

Forward Bias:

An external voltage applied with the polarity shown in Fig.2 is called a forward bias. The height of the potential barrier at the junction is lowered by the applied forward voltage. In other words we can say that p-n junction diode is connected to an external battery in such away that depletion region is eliminated. The positive terminal of the battery repels the holes on the p-side and pushes them towards the junction. The negative terminal of the battery repels the electrons and pushes them towards the junction. This collapses the depletion region. With the depletion region gone, the diode can conduct.

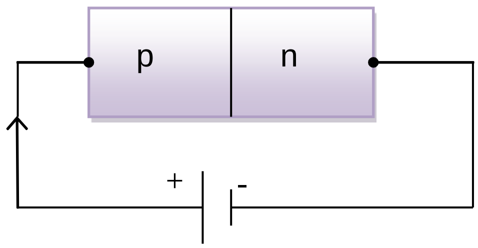


Fig.2:Forward biased p-n junction

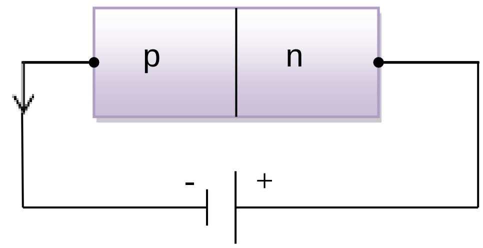


Fig.3:Reversebiasedp-njunction

Reverse Bias:

An external voltage applied with polarity shown in **Fig.3** is called reverse bias. When reverse bias is applied to a junction diode the depletion region does not collapse. In fact, it becomes wider. The positive side of the battery is applied to the n-type material. This attracts the free electrons away from the junction. The negative side of the battery attracts the holes in p-type material away from the junction. This makes the depletion region wider then it was when no voltage is applied. The depletion region is an insulator, and it will block the flow of current. Actually a small current will flow because of minority carriers. The p-type material has a few minority electrons. These are pushed to the junction by the repulsion of the negative side of the battery. The n-type material has few minority holes. These are also pushed towards the junction. Reverse bias forces the minority carriers together, and a small current (leakage current) results.

Procedure:

PartA: Forward characteristics

The circuit is assembled as per the circuit diagram (a) such that, p-type material is connected to positive terminal of the battery through a milli-ammeter and a current limiting resistor R_S ; and n-type material is connected to negative terminal. This type of biasing is known as forward biasing.

The input voltage $V_i$is increased from 0to3volts in .1voltinitially and in larger

stepssays0.2Vand for each value of voltage,current (mA)is recorded in observation **tableI**(forGeOA79diode)and then in table II(forSidiode)(**1N7001**). The voltage drop across diode in forward bias is calculated as $V_{df}=V_i-\left(I_{df}\times R_S\right)$

PartB: Reverse characteristics

The circuit is assembled as per the circuit diagram (b) such that n-type material is connected to positive terminal of the battery through a micro-ammeter and a current limiting resistor R_s; and p-type material is connected to negative terminal of the battery. This type of biasing is known as reverse biasing.

The input voltage $V_i$is increased from 0 to 5 volts in the steps of 0.5 volt and the corresponding currentI_{dr}in microamperes (µA) through diode is recorded in observation table III (for GeOA79 diode) and **table IV** (for Ge DR25 diode).

The voltage drop across diode in reverse bias is calculated as $V_{dr} = V_i - (I_{dr} \times R_s)$

Characteristic curves of diode:

Fig.4 shows **V-I** characteristic curve for a typical p-n junction diode. It is seen that the curve is not linear. With 0 V across the diode, the diode will not conduct, the diode will not begin to conduct until a few tenths of a volt are applied across it. This is the voltage needed to overcome the potential barrier. It requires about **0.2V** to turn on a germanium diode and about **0.6 V** to turn on a silicon diode. Fig.4 also shows what happens when reverse bias is applied to a diode. At increasing level so reverse voltage, the curve shows some reverse current. This leakage current is caused by minority carries. It is usually very small.

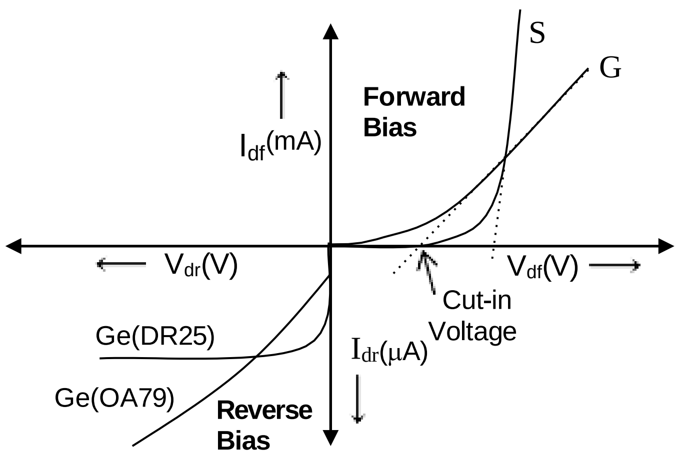


Fig.4V-ICharacteristicsofp-njunction Diode

ObservationTables:

TableI: Forward Characteristics for Ge(OA 79):RS=________________Ω

Sr.No.	V_i(V)	I_{df}(mA)	$V_{df}=V_i-(I_{df} x R_s)$(V)

TableIII: Reverse Characteristics for Ge(OA79):RS=________________Ω

Sr.No.	V_i(V)	I_{dr}(μA)	$V_{dr}=V_i-(I_{dr} x R_s)$(V)

Calculations:

Result:

The cut-in voltage of ***Ge*** diode is__________________Volt .

The forward dynamic resistance **r_f ,** of ***Ge***________ **I_{df}**=________________mA.

Precautions:

- Check polarities of DC power supply while biasing the diodes.
- Avoid application of large reverse voltage (more than PIV), otherwise the diode will be damaged forever.
- GettheconnectionscheckedbeforeswitchingONthepowersupply;elsethecurrent meter will be damaged.

Course Outcome:

CO3	Explain PN junction diode, Zener diode, Light emitting diode and transistor with their application in engineering field.

CO-PO mapping:

PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3	3	3	-	-	-	-	-	-	2	-	-	3

Signature of lab course Coordinator---------------------

(Prof.Rahul.M.Ingle)

DEPARTMENTOFBASICSCIENCES&HUMANITIES

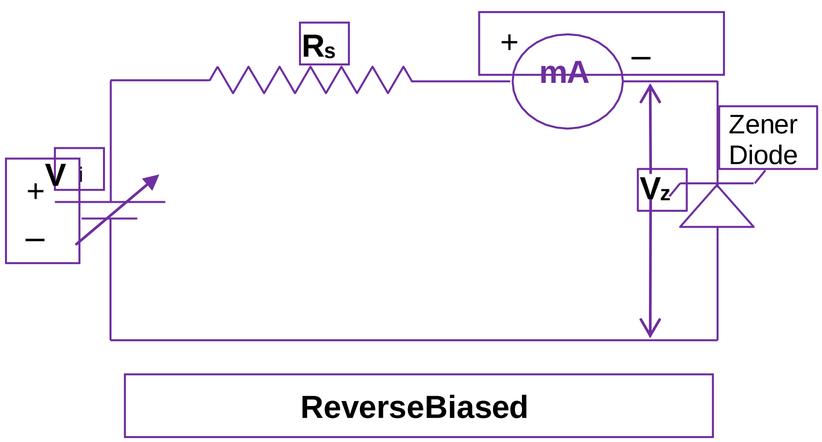
ExperimentNo: 5

Aim: Determine the Break down Voltage and Dynamic Resistance of Zener Diode

Objective: To plot V-I characteristics of Zener diode in reverse bias mode.

Formula: $r_Z = \frac{\Delta V_Z}{\Delta I_Z} = \frac{1}{slope}$ (*InZenerbreakdownregion*)

Circuit diagram:



Where, V_z-is Voltage across Zener Diode
I_s-is Current through Zener Diode and
r_z-is Dynamic resistance of Zener Diode.

Theory

An ordinary pn- junction normally does not conduct when it is reverse biased. If the reverse bias is increased,a point is reached when the junction breaks down and starts conducting heavily. The critical value of the voltage is called the break down voltage of the junction. Once the breakdown occurs, a very small increase in voltage causes a large change in the reverse current. The resistance offered by the junction will be nearly zero at this point.

A Zener diode is heavily doped p-n junction designed to operate in the breakdown region under reverse bias condition. A Zener diode maintains a constant voltage V_Z across its terminal when the reverse bias exceeds the breakdown voltage. Therefore it acts like a constant voltage source. For this reason it is often used as a voltage reference diode.

When the reverse voltage across pn- junction diode in which both p and n regions are heavily doped with acceptor and donor impurity respectively, is increased, the reverse current increases very rapidly at certain voltage around 6 V. The breakdown of junction at such low reverse voltage explained on the basis of Zener effect.

In a p-n junction diode in which both p and n regions are heavily doped, the width of depletion region is very small; about 5 x 10^{-8} meters, therefore the electric field at the junction is given by

$$E_0 = \frac{2(V_0 + V)}{d}$$

Where,

V_0= Internal potential barrier(0.6V)

V=Applied voltage across the junction d

= the width of the depletion region

If the reverse voltage is

$$V = 5V$$

$$E_0 = \frac{2(0.6+5)}{5\times 10^{-8}}$$

$$E_0 = 2.25\times 10^{8} V/m$$

An electric field of such high amplitude exerts a large force on valence electrons in depletion region. Consequently the covalent bonds are broken and a large number of electrons – hole pairs are produced. These carriers are accelerated away from the junction by applied voltage. Hence reverse current rapidly increases. This process in which covalent bonds in the depletion region are directly broken by strong electric fieldis called as Zener break down and the reverse voltage at which the break down takes place is called Zener break down voltage. The mechanism of removal of electrons from valence bands to the conduction bands by strong electric field in an insulator was first proposed by Clarence Zener in 1934 to explain electrical breakdown of insulators. Therefore it is called as Zener Effect.

The symbolic representation of such having doped diode differs from normal diode by making Z like representation in the n-type region.

Procedure:

1. Zener diode is connected as shown in circuit diagram such that p-type material is connected to negative terminal of battery through millimeter and current limiting resistor Rs and n-type to positive terminal of battery.

2. The input voltage is applied from 0 to 9 volts in step of 1V initially. When the Zener starts conducting thenthe voltage is increased in smaller step viz.0.2 volts and the corresponding current is recorded in observation Table.
3. The drop across Zener is calculated by subtracting drop across resistor from input voltage. [$V_Z = V_i - (I_Z \times R_S)$]

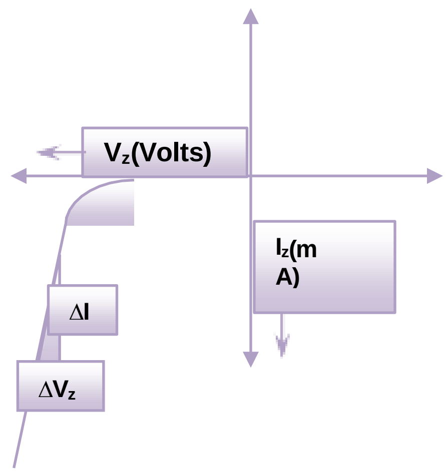
Observations:

Input resistance: R_s =________________Ω.

Sr.No.	Input Voltage V_i (V)	I_z(mA)	$V_z = V_i - (I_z \times R_s)$(V)

Calculations:

Plot a graph between Voltage ***Vz***along X-axis and current ***Iz***along Y-axis for reverse bias for the zener diode on the graph paper. Use convention as positive polarity of voltage and current in forward bias configuration and negative polarity of voltage and current in reverse bias configuration. Inverse of slope (□*Vz*/ □*Iz*) represents dynamic resistance of the diode.



Result:

1. The Zener break down voltage(Vz) for given diode is found tobe ____ volts.
2. The dynamic resistance of Zener Diode is found to be______________________□at IZ = _______________mA.

Course Outcome:

CO3	Explain PN junction diode, Zener diode, Light emitting diode and transistor with their application in engineering field.

CO-PO mapping:

PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**

. Signature of Lab Course Cordinator-----------------

Date of Approved-15/06/2023 Signature of HOD-------------- Version3
(Dr.Mamta .V.Takarkhede)

Experiment No:6

Aim: Determination of dynamic resistance and current gain of transistor in common base (CB) configuration

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Objective:

i) To plot and study the input characteristics.
ii) To plot and study the output characteristics of transistor in common base mode.
iii) Calculate transistor parameters: (a) input resistance, r_i (b) output resistance r_o and (c) current gain $\propto$ from the characteristics.

Formula:

$$\text{Input resistance, } r_i = \left[\frac{\Delta V_{EE}}{\Delta I_E}\right] \text{at } V_{CC} = \text{Constant.}$$

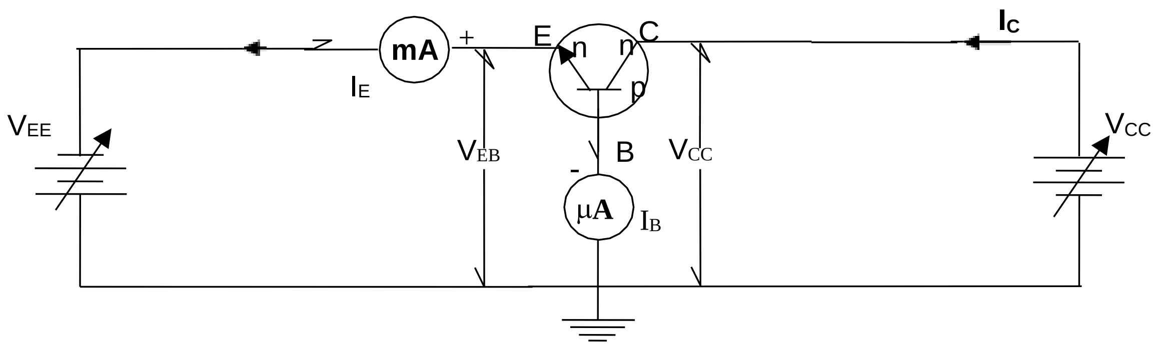
$$\text{Output resistance, } r_o = \left[\frac{\Delta V_{CC}}{\Delta I_C}\right] \text{ at } I_E = \text{Constant}$$

$$\text{Current gain, } \alpha = \left[\frac{\Delta I_C}{\Delta I_E}\right] \text{ at } V_{CC} = \text{Constant}$$

Where

I_C is Collector Current.
I_E is Emitter Current
V_{CC} is Collector Power Supply
V_{EE} is Emitter Power Supply
α is current gain

Circuit Diagram:



D

Theory:

Same as given in study of transistor in CE mode experiment

Procedure:

A. Input Characteristics

1. Make connections as per circuit diagram.
2. Keep the output voltage i.e. Collector to base voltage, V_{CC} constant say 2V.
3. Increase the voltage V_{EE}, in smaller steps of 0.1V till 1V and then increase the step to 0.2 V till 2V and then 0.5V till 4V and note the corresponding emitter current I_E.

B. Output characteristics

1. Keep the emitter current I_E at a constant value say 2 mA.
2. Increase the collector to base voltage V_{CC} from zero in step of 0.5 volt till 5 V. Note the corresponding base current and calculate collector current by using the formula $I_C=I_E-I_B$.
3. Repeat the above procedure for two more fixed values of emitter current say 4mA and 6mA.

Observation:

a)* Input Characteristics: *V_{CC}

Sr. No.	V_{EE} (Volts)	I_E (mA)

b) Output Characteristics:

Sr. No	V_{CC} (Volts)	I_E =		I_E =		I_E =	
		I_B (μA)	$I_C = I_E - I_B$(mA)	I_B (μA)	$I_C = I_E - I_B$(mA)	I_B (μA)	$I_C = I_E - I_B$(mA)

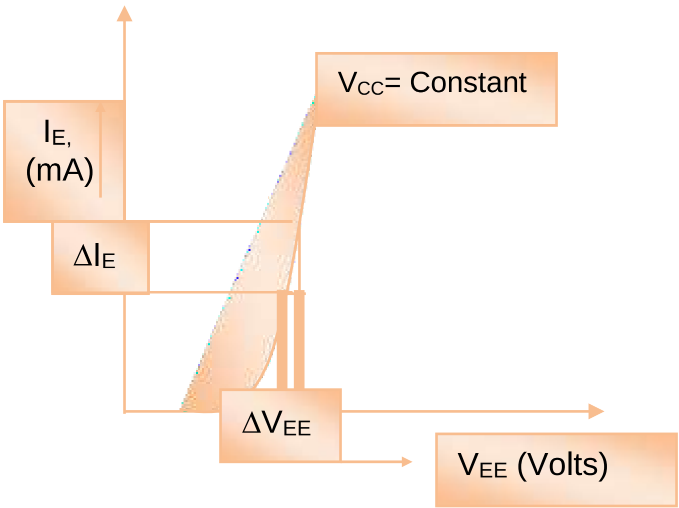
Calculations:

$\frac{3-2}{25}$

Graph :

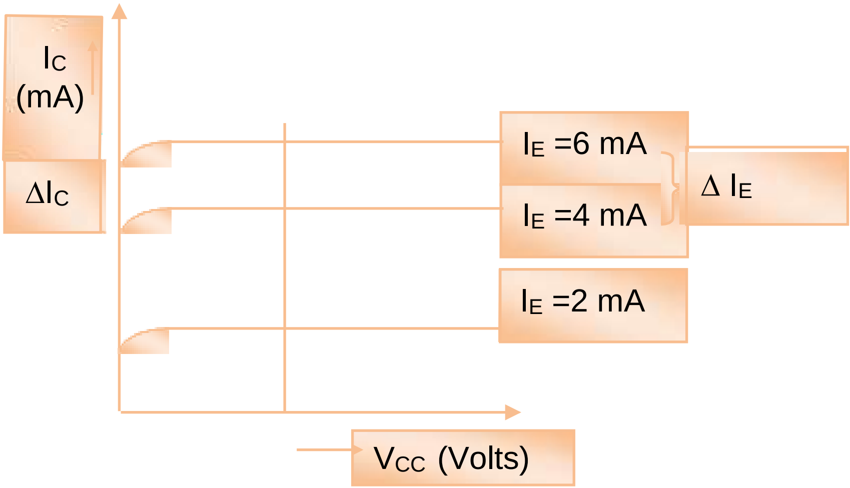
a) Input Characteristics:

1. Plot a graph between V_{EE} (along X-axis) and I_E (along Y-axis) for constant V_{CC}.
2. Calculate slope at any value of I_E & then find input resistance by using r_i = [1/ slope].



b) Output Characteristics:

1. Plot graph between V_{CC}(along X-axis) and I_C (along Y-axis) for different values of constant Emitter currents I_E.
2. Calculate slope and then find output resistance by using r_o = [1 / slope].
3. Calculate current gain $\alpha = [\,\Delta I_C\, /\, \Delta I_E\,]$ for Vcc=constant.


I_C (mA)
ΔI_C
I_E =6 mA
I_E =4 mA
Δ I_E
I_E =2 mA
V_{CC} (Volts)

Result:

1. Input resistance r_i4Ω= at I_E = &V_{CC} =
2. Output resistance r_o =
3. Current gain □ = , at V_{CC} = __________.

Precautions:

1. Check polarities of sources used for biasing the transistor.
2. Do not exceed the rated current value specified for the given transistor.

Connect the meters of proper range in the circuit

Viva Voce Question Bank

1. What are intrinsic and extrinsic semiconductors? Find out from a book the typical doping concentration in p and n type extrinsic semiconductor?
2. What is current gain? Why is it less than 1?
3. What is the full form of transistor?
4. Why is collector large in size?
5. Why the emitter is heavily doped?
6. Define doping.
7. What are intrinsic and extrinsic semiconductors? Find out from a book the typical doping concentration in p and n type extrinsic semiconductor?
8. What is current gain? Why is it less than 1?
9. What is the full form of transistor?
10. Why is collector large in size?
11. Why the emitter is heavily doped?
12. What are the principle carriers in a NPN transistor?
13. What are cut off, active & saturation regions in the o/p characteristics of a transistor?
14. What are the basic differences between CE and CB configuration?
15. What are the ranges of input and output resistance in this mode? Where is this feature applied

Course Outcome:

CO3	Explain PN junction diode, Zener diode, Light emitting diode and transistor with their application in engineering field.

CO-PO mapping:

PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3	3	3	-	-	-	-	-	-	2	-	-	3

Signature of Lab Coordinator--------------

ExperimentNo:7

Aim: Determination of dynamic resistance and current gain of transistor in common emitter (CE) configuration

Objective: To plot and study the input and output characteristics of n-p-n transistorin common emitter mode and hence calculate transistor parameters from the characteristics.

$$\text{Input resistance,} \quad r_i = \left[\frac{\Delta V_{BE}}{\Delta I_B}\right]$$

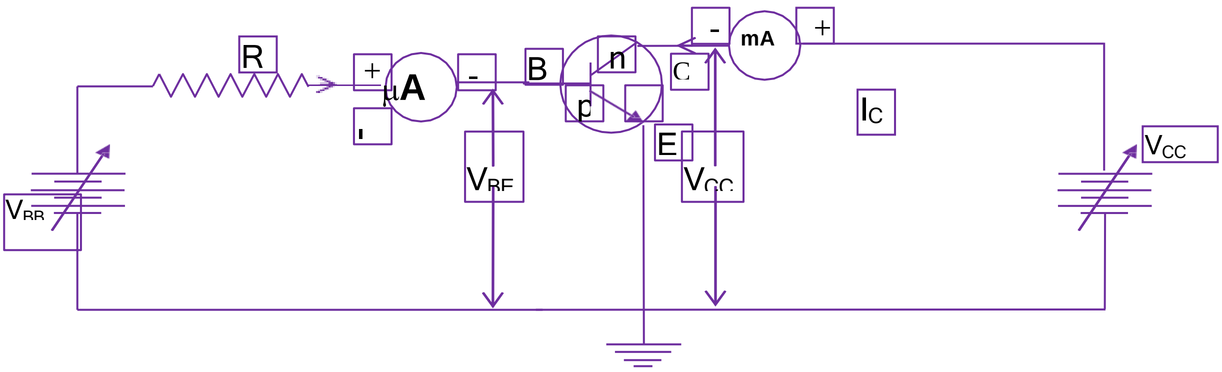
$$\text{Output resistance,} \quad r_o = \left[\frac{\Delta V_{CC}}{\Delta I_C}\right]$$

$$\text{Current gain,} \quad \beta = \left[\frac{\Delta I_C}{\Delta I_B}\right]$$

Formula:

Where *VBE* is Base to Emitter Voltage
IC is Collector Current.
IB is Base Current
VCC is Collector Power Supply
VBB is Base Power Supply

CircuitDiagram:



Experiment No.7

Aim: Determination of dynamic resistance and current gain of transistor in common emitter (CE) configuration

Objective: To plot and study the input and output characteristics of n-p-n transistor in common Emitter mode and hence calculate transistor parameters from the characteristics.

Apparatus: Transistor, circuit board, millimeter, micro ammeter, resistor,Connecting wires,DC dual power supply etc

Formula:

Input resistance, $r_i = \left[\frac{\Delta V_{BE}}{\Delta I_B}\right]$

Output resistance, $r_o = \left[\frac{\Delta V_{CC}}{\Delta I_C}\right]$

Current gain, $\beta = \left[\frac{\Delta I_C}{\Delta I_B}\right]$

Where

V_{BE} isBasetoEmitterVoltage
I_C isCollectorCurrent.
I_B isBaseCurrent
V_{CC} isCollectorPowerSupply
V_{BB} isBasePowerSupply
β iscurrentgain

Theory:

In common base configuration,the base is made common to both inputand ou tput circuits. Input is applied between collector and emitter and the output is taken between collector and emitter terminals.

a) InputCharacteristics:

The common base input characteristics are plotted between collector currentI_B and the base- emitter voltage V_{BE} ,while the collector emitter voltage V_{CC},is held constant.Typical input characteristics for a npn transistor are shown in Fig.3.

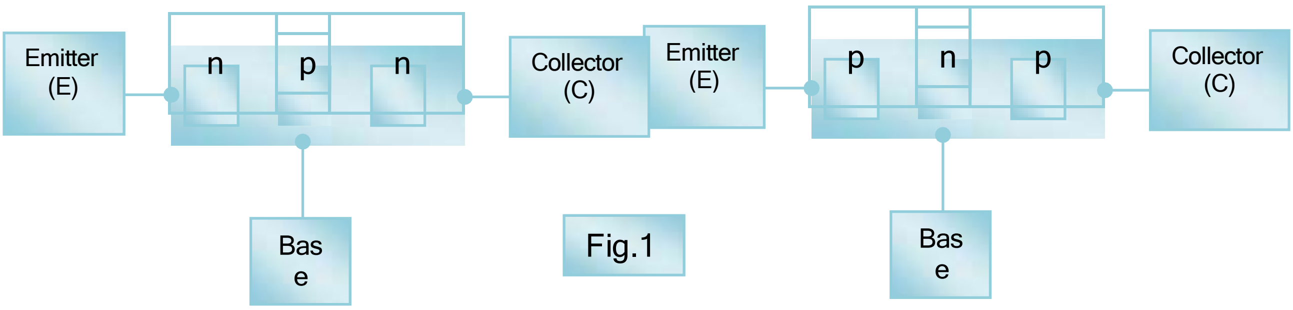


Fig.1

It is seenthat thecommonbaseinput characteristics arealsoidentical tothe forwardcharacteristicsofap-njunction.Inthecaseofthetransistor,$I_B$isonlyasmallfractionofthetotalcurrentI_E,whichflowsacrosstheforwardbiased base-emitterjunction.Thedynamicinputresistance,$r_i$ofthetransistorisgiven bythereciprocaloftheslopeofthecurve.(Fig.3).

$$\text{Inputresistance}, r_i = \left[\frac{\Delta V_{BE}}{\Delta I_B}\right]$$

b) OutputCharacteristics

Thecommonemitteroutputcharacteristicsareplottedbetweenthecollector current$I_C$andthecollector-emittervoltageV_{CE}keepingthebasecurrentI_B constant.AsetofcurvesisobtainedwithdifferentsettingsofI_B.Typicalcurves are shown in Fig.4. Thesalientpointsareasfollows:

i) Intheactiveregion,thecollectorcurrent$I_C$increasesslowlyas$V_{CC}$is increased.WhenV_{CC}isreduced,$I_C$sharplydecreases.Theoutputresistance, r_O,isgivenbythereciprocaloftheslopeofthecurveforanyoneconstant setting of I_B.

Outputresistance, $r_o = \left[\frac{\Delta V_{CC}}{\Delta I_C}\right]$

Procedure:

a. InputCharacteristics:

1. Keep the collector to emitter voltageconstantsay2V.
2. Increased.c.voltage applied to the forward biased base emitter in small steps of 0.1volts and noted own the corresponding base currentI_B.Take atleast10 readings.

b. Outputcharacteristics:

1. Keep the base currentI_B constant at say20 microamperes.
2. Increase the collector to emitter voltageV_{CC}insteps of 0.1Voltsandforeach value of V_{CC}, record corresponding collector current I_C.
3. Repeat the above procedure for different values ofconstantbasecurrentsay40μA,60μA,80μA

Observations:

a) InputCharacteristics:R_B=0kΩ,V_{CC}=4V(constant)

Sr.No.	V_{BB}Volt	I_B(μA)	$V_{BE}=V_{BB}-(I_B R_B)$(Volts)

b) OutputCharacteristics:

Sr.No	V_{CC}	I_B=50μA	V_{CC}	I_B=100μA	V_{CC}	I_B= 150μA
		I_C(mA)	(Volt)	I_C(mA)	(Volt)	I_C(mA)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Calculations:

Result:

1. Inputresistance r_i=
2. Outputresistance r_o=
3. Currentgain β= ____________, at V_{CC}= ____4V____.

Course Outcome:

Course Outcome:

CO3	Explain PN junction diode, Zener diode, Light emitting diode and transistor with their application in engineering field.

CO-POmapping:

PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3	3	3	-	-	-	-	-	-	2	-	-	3

Graph:

a) InputCharacteristics:

1. Plot a graph between V_{BE} and I_B for constant V_{CC}.
2. Calculate slope and then find in put resistance by using r_i=1/slope

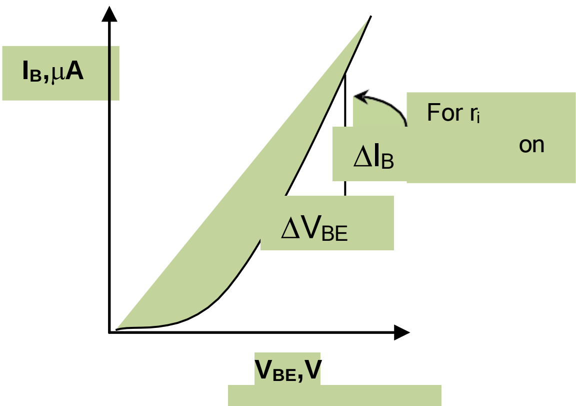


Fig.3

b) OutputCharacteristics:

1. Plot graph between (V_{CC}) and corresponding collector current I_C for different values of constant current(I_B).
2. Calculate output resistance by calculating slope and then by using r_o=1/ slope.
3. Calculate $\beta=[\Delta I_C/\Delta I_B]$ at constant value of V_{CC}.

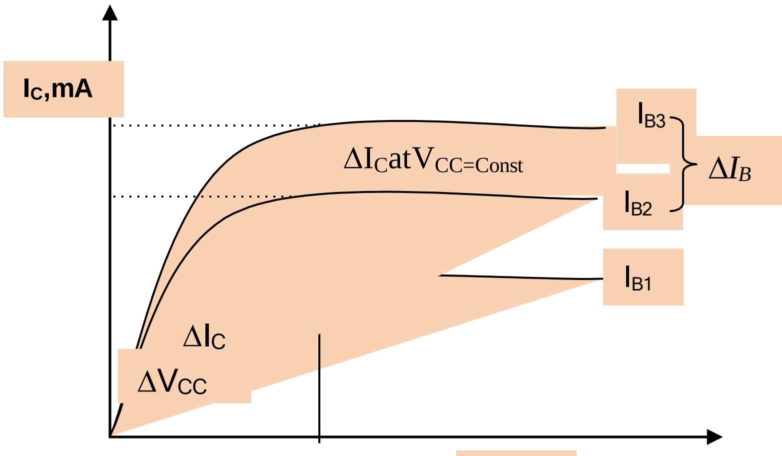


Fig.4

Result:

1. Input resistance r_i= …………………… ,at I_B= ……. & V_{CC}= …….

2. Output resistance r_o= ....,atV_{CC}= ....& I_B=........

3. Current gain β= ____________, at V_{CC}= ____4V_____.

CourseOutcome:

CO3	Explain PN junction diode, Zener diode, Light emitting diode and transistor with their application in engineering field.

CO-POmapping:

PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3	3	3	-	-	-	-	-	-	2	-	-	3

Signature of lab course Coordinator----------

Precautions:

1. Check polarities of sources while biasing the transistor.
2. Do not exceed the rated current &voltage values specified for the given transistor.
3. Get the connections checked before switching on the power supply else the current meter will be damaged.

Marks:________/10 **Signature________________**

Viva Voce Question Bank

1. In the symbol of transistor what does an arrow on the emitter indicate?
2. Give the two-diode analogy for a NPN transistor?
3. Why a transistor is an on-linear device?
4. Draw ideal Output Characteristics of CE Configuration & show different region on it?
5. Why transistor identification (PNP/NPN) is important? How are they identified?
6. What is doping level of 3 different regions of transistor?
7. What are the advantages of a transistor over a vacuum triode?
8. What do you mean by current gain?
9. Whati s the normal way in which at ransisto ris biased?
10. Explain the formation of depletion region?
11. What are the applications of transistors?
12. What istransistor?Howmanyregionsarethere?
13. Which lawleadstoI_E=I_B+I_C. State thelaw.
14. Whyaremostof thetransistorNPN typeandnotPNPtypes?
15. CanaNPNtransistorinanalreadyexistingcircuitreplaceapnptransistor? Why?
16. Transistor is en capsulatedi n Metallic Cap.Why?
17. Whythetransistorisreferredasthecurrentcontrolleddeviceratherthanvoltage controlled device.
18. What are differen ttype sof biasing for a transistor?

ExperimentNo:8

Aim: Determine the wavelength of sodium light by Newton's rings

Objective: Study the application of interference of light by Newton's rings experiment.

Formula:

$$\lambda = \frac{Slope}{4R}$$

Where,

Slope = $(D^2_{n+p} - D^2_n) / p$

R = radius of curvature of a Plano convex lens = 1m.

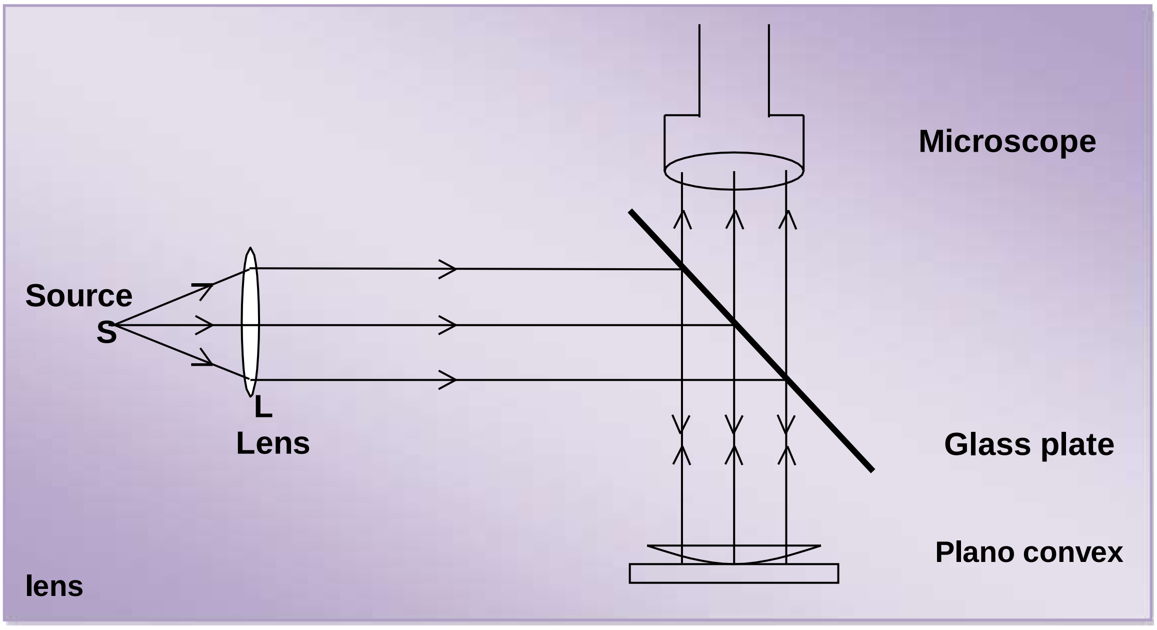
D_{n+p} = Diameter of $(n+p)^{th}$ ring .

D_n = Diameter of n^{th} ring.

λ = Wavelength of monochromatic light.

p = number of rings.

Figure:



Observations:

1. For least count of microscope:
   Smallest division of main scale = X mm= 1mm.
   Total number of divisions on vernier scale = Y div =100
   Least count of Microscope = X/Y=_______0.01_____mm.

Theory:

Circular interference fringes can be produced by enclosing a very thin film of air of any thickness between plane glass plate and a convex lens of large radius of curvature. Such fringes were first obtained by Newton and are called Newton's Rings.

To produce Newton's Rings monochromatic light from a source is rendered parallel by a convex lens L. It falls on the glass plate G inclined at an angle of 45° to the incident beam and is reflected normally on to a Plano convex lens N of large radius of curvature placed on glass plate P as shown in the figure. The combination of Plano convex lens N and glass plate P forms a thin circular air film of progressively increasing thickness in all directions around the point of contact of the lens and the glass plate (resembling a circular wedge).

Light rays reflected upward from the top and the bottom surfaces of the air film formed between the lens and the glass plate superimpose each other with a path difference depending upon the air thickness in between. Due to interference of these rays the dark and bright circular rings are seen with monochromatic light if we observe through microscope. The fringes are circular because the air film is symmetrical about the point of contact of lens N and the glass plate P. At a particular radial distance from the point of contact of the air film, thickness will remain constant along the circular path. With the help of Microscope the diameter of the rings can be measured.

Procedure:

1. Find the least count of the traveling microscope.
2. Arrange the apparatus as shown in Figure.
3. Adjust the angle of inclination of the glass plate G till you get circular rings with central spot as dark.
4. After getting the circular rings, adjust the center of the cross wire of the microscope to coincide with the center of the rings (dark spot).
5. Move the microscope slowly either towards left or right of the center. Stop the microscope when the thickness of the crosswire is comparable to that of the ring thickness. Now reverse its motion and after skipping some three four rings adjust the vertical cross wire tangential to the dark ring and note the microscope reading.
6. Gradually move the microscope towards center using the vernier screw and take readings skipping 4 rings at a time. Note down the ring number for which last reading is taken. Then generates the ring numbers of all previous readings.
7. The microscope is now moved in the same direction on to the opposite side of the center. After crossing the central spot, readings for the noted ring numbers are to be recorded to get the diameters of the respective rings.

----

2. For diameter of rings:

Ring's number	**Reading on R.H.S. "A" (mm)**			**Reading on L.H.S. "B" (mm)**			**D_n mm**	**D^2_n mm^2**

Graph:

Plot a graph between D^2_n along Y-axis and n along X-axis. The resultant graph will be straight line passing through zero. Find out the slope of straight line and hence calculate λ.

Results:

`

The wavelength of sodium light is found to be 2.26A^{o} _ A.

Precautions:

1. Take minimum 6 readings at the interval of 4 rings.
2. The micrometer -screw of the microscope should be moved only in one direction to avoid backlash error.
3. The readings should be noted carefully.

`

Calculations:

Results:

The wavelength of sodium light is found to be ,,,

Course Outcome:

CO4	Differentiate interference phenomenon in parallel and wedge-shaped thin film and their application in engineering field.

CO-PO mapping:

PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO4	3	3	-	-	-	-	-	-	2	-	-	3

Signature of Lab Coordinator-----------

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Viva Voce Question Bank

1. If the glass-air glass is replaced by glass-water glass film in your experiment what will be the diameter of 10th ring?
2. Suppose you have a thin wedge shaped air between two flat glass pieces and you view the interference fringes in near normal direction. What is the shape of the fringes? Why?
3. What are interference fringes of equal thickness?
4. What are interference fringes of equal inclination?
5. For getting good interference fringes you need a "thin" film. What does this thin means?
6. If the microscope arm is not vertical how will it affect your experiment?
7. What is a "thin" for yellow light. Is it "thin" for X-ray? Is it thin for microwaves?
8. Suppose instead of air film between the lens L and plate P you had a water film, what will happen?

Course Outcome:

CO4	**Demonstrate the behavior of interference of light in thin film ,lenses**.

CO-PO mapping:

PO→	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO4	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**3**

Signature of Lab Course Coordinator---------

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ExperimentNo:9

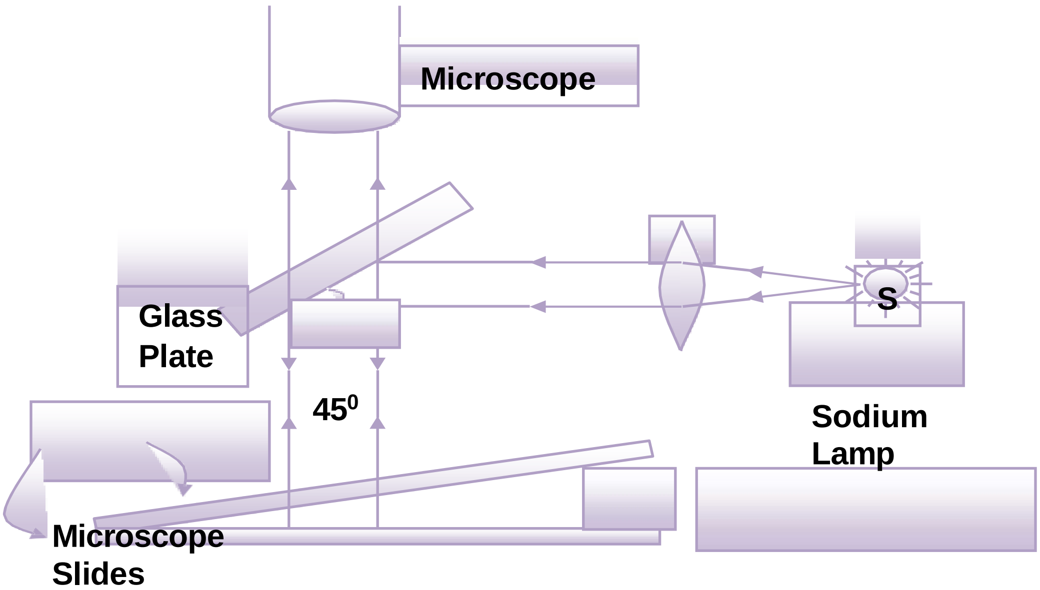
Aim: Determine the thickness of a thin foil by using wedge shaped thin film.
Objective: To apply the concept of interference darkness and brightness condition in shaped thin film. .

Formula: 1) $\theta = \frac{\lambda}{2\beta}$ *where* $\beta = \frac{x_{n+p} - x_n}{p}$

2) $t = L \cdot \theta$

Where, "θ" is the wedge angle,
"t" is the thickness of the foil,
"p" is the number of dark fringes,
"β" is fringe width,
"x_n" is the position of the n^{th} dark fringe,
"x_{n+p}" is the position of then $+p^{th}$ dark fringe,
"L" is the length of air wedge, &
"λ" is the wavelength of monochromatic light used. λ=5893 Å

Figure:



Date: ________________

Theory:

A wedge is a transparent plate or film of varying thickness having zero thickness at one end and progressively increasing to a particular thickness at the other end. A thin wedge of air can be formed by two microscope slides resting on each other at one end and separated by a thin foil or wire at the opposite edge. The wedge so formed has a very small angle θ. When the light is incident on the wedge from above, it gets partially reflected from the glass to air boundary at the top of the air film and part of the transmitted component gets reflected at the air to glass boundary at the bottom of the air film. The two reflected rays are coherent as they are produced through division of amplitude of the parent ray. Therefore they interfere and produce interference pattern.
When the incident light is monochromatic, alternating dark and bright fringes that arestraight, equidistant and parallel to edge of the wedge are observed.

Procedure:

1. The least count of the microscope is determined.
2. The slide system is kept on the platform of the traveling microscope. The light from the sodium vapour lamp is made incident on a plane glass plate held over the wedge at an angle of 45^0 with the vertical. The light falling on the plate is partially reflected which in turn incident normally on the air wedge. Adjust the arrangement properly to obtain fringes, which are brighter and focused.
3. Move the microscope slowly either towards left or right till the fringes are clearly visible. Stop the microscope. Now reverse its motion and after skipping some three four fringes adjust the vertical cross wire tangential to the dark ring and note the microscope reading.
4. The microscope is moved further along the length of the air film skipping four fringes and noting down the reading for every fifth dark fringe. Thus six readings are taken by moving microscope in the same direction.

The length of the air wedge is measured as distance between edge so microscope slide to inner edge of the thin foil.

Observations:

1) Least count of the microscope:

Smallest division of main scale=Xcm= cm Total no.

division on vernier scale = Y = 100

Least count of Microscope=X/Y=0.01cm.

2) Length of the air wedge L=7.5cm

3) Fringe width:

Sr. No.	Number of Dark fringe(n)	Position of the n^{th} dark fringe (cm)			Fringe width (cm) $\beta = \frac{x_{n+p} - x_n}{p}$	Mean β(cm)
		MSR	VSR	TR		

Calculations:

Calculate the wedge angle“θ”and hence find
the thickness off oil “t”.

Result: The thickness of the foil is foundt
o be 7.9μm.

Precautions:

1) Whileusingmicroscopetomeasurefringewidth,itismovedinonedirectiononly,so that backlash error is avoided.
2) Toachievegoodaccuracyinthemeasurement,morenumberofobservationsaretaken.

CourseOutcome:

CO4	.Differentiate interference phenomenon in parallel and wedge-shaped thin film and their application in engineering field.

CO-POmapping:

PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO4	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**

Signature of lab course Coordinator-----------

DateofApproved-15/06/2023 Signature of HOD----------- Version3
(Dr.Mamta ,V.Takarkhede)

Department Of Basic Science & Humanities
EXPERIMENT NO :10

Aim : Determination of Planck's constant

Apparatus :

Optical bench, meter stick, LEDs with 1000Ω resistor mounted (green, yellow, red), plastic holder, diffraction grating, power supply, multimeter + 1 lead, 1 alligator cable, 2 banana cables.

Theory:

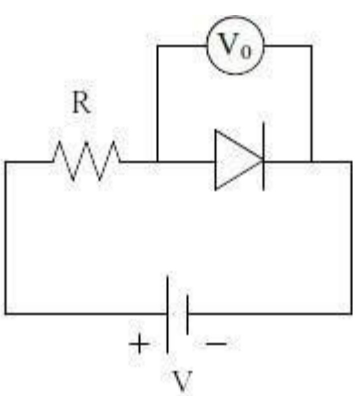
Planck's constant *h* is a fundamental constant of quantum physics. For example it used to describe the energy of a photon which is smallest unit of energy of light of a given frequency. The photon energy is

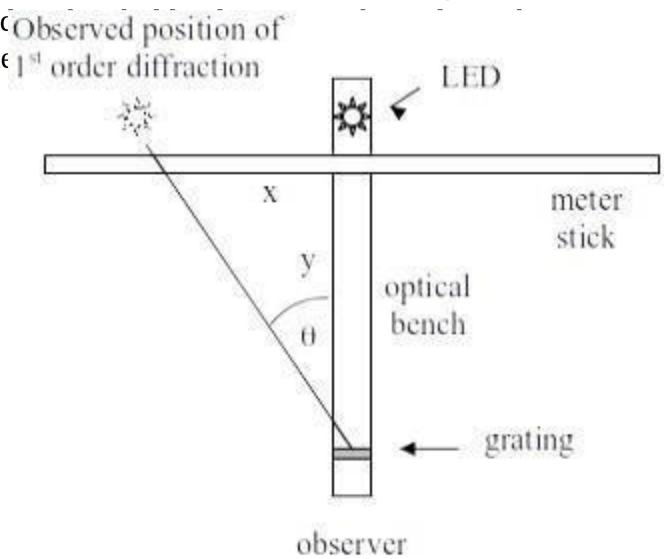
$$E = hf = h\frac{c}{\lambda}$$

where *h* is the Planck's constant, *f* and [redacted] are the frequency and wavelength and *c* is the speed of light in vacuum. In this experiment, you will measure Planck's constant by measuring *E* and [redacted]

The source of the photons is a light emitting diode (LED). A diode is an electronic device that allows current to preferentially flow in one direction. Current flows through the diode when the forward voltage across the diode excee f the emitted photon is $E = Ev_0$ where *e* is the

Diagram :





Procedure:

In the laboratory room you will use there LEDs which emit light of different colors red, blue and green.

Step 1. Pick one of the LED connected to its holder and insert it the white plastic support. It does not matter which color you start with.

Step 2. Place the white plastic support at one end of the optical bench.

Step 3. Connect the LED to the power supply using the two cables. Connect the multimeter to the LED using the alligator cables. You want to use the multimeter to measure the voltage across the LED only and not the voltage across of the series combination of the LED and the resistor *R*.

Step 4. Gradually increase the current through the LED by increasing the supply DC voltage until light emission barely becomes visible. The voltage measure with the multimeter at this point is V_0. If the LED does not light up, then reverse the cable connections at the power supply. Use the table in the next page to collect your data.

Next you want to measure the wavelength of the light emitted by the LED. To do so you will use a diffraction grating and set up the equipment as showed below.

Step 5. Place the meter stick on one end of the optical bench and perpendicular to it.

Step 6. Place the grating on the other end of the optics bench. Adjust the distance between the grating and meter stick *y* to about 50 cm.

Step 7. One lab partner is the observer and look at the LED through the grating. In addition to the central image, there is the 1st order diffraction images to the right (or the left) of the central image. The image will look like a short line, having an angular spread because the light emitted by the LED has small distribution of wavelengths. A second lab partner moves a pencil along the meter stick to locate the position of the image. The value of *x* is the distance between the LED (at the center of the optical bench) and this 1st order diffraction image.

Step 8. Calculate the angle using *tan* = *x/y*.

1. What is the number of lines per mm indicated on your diffraction grating?

$N =$

2. The spacing between the lines *d* is obtained as $d = 1/N$

$d =$_________(m)

Observation :

To calculate the wavelength use *m*[redacted]= *d sin* with *m* =1. Then repeat all the measurements using the other two colors of the L[redacted].

3. Collect your data here

LED color	V_0 (volt)	*x* (m)	*y* (m)	□ °	[redacted]m)	1/ (m^{-1})
Red						
Yellow						
Green						

By equating the energies of the two equations we obtain $eV_0 = h\frac{c}{}$ [redacted] or $V_0 = \left(\frac{hc}{e}\right)$ [redacted].

4. Make a plot of V_0 vs $1/\lambda$, that means V_0 on the *y*-axis and $1/\lambda$ on the *x*-axis. Do a linear fit and find the slope

slope =

5. Calculate *h* from the slope and knowing that $c = 3.0 \times 10^8$ m/s and $e = 1.6 \times 10^{-19}$ C

$h =$__________J·s

6. Calculate the %error with the actual value of $h = 6.626 \times 10^{-34}$ J·s

%error = ________

Preliminary Questions

7. The turn-on voltage for a light emitting diode is 2.1 volts. What is the wavelength of the light? What is its color?

8. Refer to Fig. 2 in the laboratory procedures. If the diffraction grating has 1000 lines per mm, x = 0.3 m, and y = 0.5 m, what is the wavelength of the light source?

Course Outcome:

CO5	Classify types of optical fiber and their application in various fields**.**

CO-PO mapping:

PO→	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO5	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**

Signature Of Lab Course Coordinator ______________________
(Prof.Rahul.M.Ingle)