ENGINEERING PHYSICS LAB MANUAL

*I/II Semester (*18PH1ILPHY/18PH2ILPHY*)*

Name of the Student :

Semester/ Section :

USN :

Batch :

DAYANANDA SAGAR COLLEGE OF ENGINEERING
Accredited by National Assessment & Accreditation Council (NAAC) with 'A' Grade
(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi
ISO 9001:2008, ISO 14001:2004 and ISO 22000:2005 Certified)
ENGINEERING PHYSICS DEPARTMENT
SHAVIGE MALLESWARA HILLS, KUMARASWAMY LAYOUT
BENGALURU-560078

ENGINEERING PHYSICS PRACTICALS LAB MANUAL

DEPARTMENT OF PHYSICS

DAYANANDA SAGAR COLLEGE OF ENGINEERING

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Physics Practicals Laboratory Manual

Name:...

USN:...

Semester:... Year:..

Batch:.. Section:...

Roll No.:...

Bonafide Manual

Lab in charge

Head of the Department

DEPARTMENT OF PHYSICS

VISION

TO BE A COMPETENT PHYSICS DEPARTMENT WHICH ADDRESSES GLOBAL CHALLENGES EMPHASIZING ON DEVELOPMENT OF A SUSTAINABLE AND INCLUSIVE TECHNOLOGY

MISSION

- **TO TRAIN STUDENTS IN PRINCIPLES AND TECHNIQUES IN PHYSICS**
- **TO GIVE HANDS ON EXPERIENCE ON VARIOUS EXPERIMENTS AND MEASURING INSTRUMENTS**
- **TO SUPPORT STUDENTS IN UNDERSTANDING THE IMPORTANCE OF SUSTAINABLE AND INCLUSIVE TECHNOLOGY AND TO GAIN KNOWLEDGE IN INTERDISCIPLINARY AREAS OF SCIENCE AND TECHNOLOGY**

Program Educational Objectives

- **Preparation:** To support the engineering students to develop a scientific attitude in their professional advancement with a basic knowledge in the developments in Science and Technology.
- **Core Competence:** To impart basic knowledge in Science and Technology and to create a scientific temper in approaching a problem.
- **Breadth:** To support the students in gaining knowledge in various principles of Science and Engineering and to train the students in using various scientific measuring equipments.
- **Professionalism:** To train the students to acquire skills in various principles and equipments in the field of Science and technology.
- **Learning Environment:** To provide the students for a professional learning environment to progress themselves to serve the society with a professional manner following the ethics.

Programme Outcomes

- Students can understand the importance of Physics in the practical applications.
- Students gain knowledge in various techniques and working principles related to devices or components.
- Students get an understanding of the characteristics of various types of materials.
- Students will be able to demonstrate an ability to visualize and work in the Physics laboratory and multidisciplinary tasks.

HOD PHYSICS

ENGINEERING PHYSICS Laboratory

Sub Code: 18PH1ILPHY/18PH2ILPHY	**CIE:50**
Hrs/ Week: 02	**SEE:50**
Total Hrs: 50	**Credits:1**

Course objectives:

1. To give hands on experience on various experiments.
2. To acquire knowledge in various techniques and working principles in Physics.
3. To impart knowledge in the field of semiconductors and their applications.
4. To train students in techniques and principles related to various devices or components.
5. To acquire ability to use measuring instruments.
6. To assess the importance of Optics, Modern Physics and Engineering.

Course Outcomes: After completion of the course, the graduates will be able to

CO1	Acquire hands on experience on optics, electrical, electronics and Modern Physics experiments.
CO2	Utilize basic Physics concepts for practical applications such as working components like capacitors, diodes and transistors.
CO3	Develop the ability to use various measuring instruments like ammeters, voltmeters and signal generators.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-

Experiments

IMPORTANT INSTRUCTIONS FOR STUDENTS

1. Students should maintain smart and clean dress code in the lab.
2. Collarless and Sleeveless T-shirts are not permitted in the Lab and also in the campus.
3. Compulsorily wear ID cards in the campus.
4. Students are not permitted to bring their mobile in the lab, even in the student's pocket.
5. Use only BLACK pens for writing. Write readings with black pen only. Writing readings roughly with pencil is also not allowed. Pencil can be used for drawing graphs.
6. Students should get the manual corrected and can transfer it to the Physics records.
7. Students should prepare for viva questions.
8. Students once entering the lab for exams, listen to the instructions given by the examiners.
9. Usually Procedure, Principle and Theory are not requested to write for the internal and external exams.

1. STUDY OF ZENER DIODE CHARACTERISTICS

Aim of the experiment:
To study the current voltage characteristics of the given Zener diode.

Apparatus and components:
Zener diode apparatus. [contains D.C power supply, Voltmeter, Ammeter and Zener diode]

Theory:

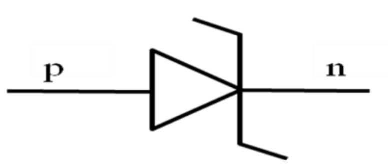
A zener diode is a junction diode in which the P-type and N-type material are heavily doped and hence the depletion width is narrow. As a result in the reverse bias condition the diode exhibits a sharp break down at a particular voltage after showing high resistance at lower voltages.

At this break down voltage the bottom of the conduction band in the N-type material assumes a position lower in the energy than the top of the valance band in the P-type resulting in a large tunneling current to flow across the junction. The voltage limiting characteristics of the Zener diode makes it a good voltage reference source and hence used in voltage stabilizers.

The current across the junction is given by the equation $I = I_o[exp(eV/kT)-1]$ where I_O is saturation current and V is the applied voltage. When V is positive (forward bias) the current varies exponentially with the voltage. When V is negative (reverse bias) the current is practically constant at I_O as shown in I Vs V graph.

PROCEDURE:

Connect the forward bias circuit as shown in the fig.1. Vary the source voltage gradually and note down the voltage across the diode and note down the corresponding current values. Remove the circuit connections and reconnect as shown in fig.2, which is the reverse bias circuit. Change the values of voltage in the range (0-15V for 14V rated diode (for 6V give a maximum of 7V), in steps of 1V) (reverse applied voltage depends upon the Zener breakdown voltage rating) and the corresponding current values. Plot the I Vs V graph as shown in fig.3.



Zener Diode

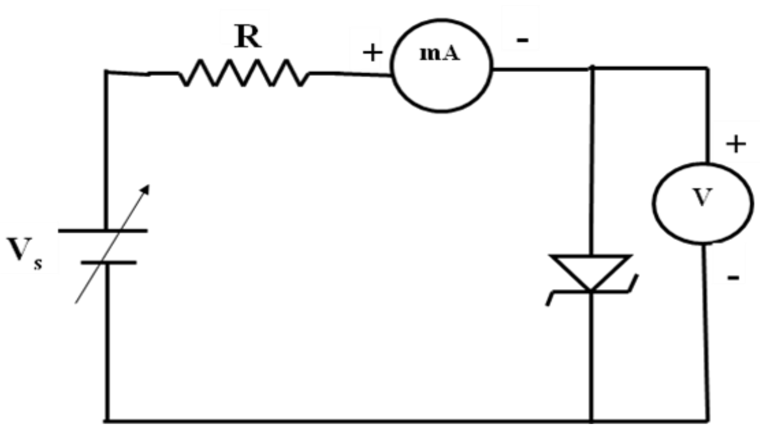


Fig.1: Forward Bias

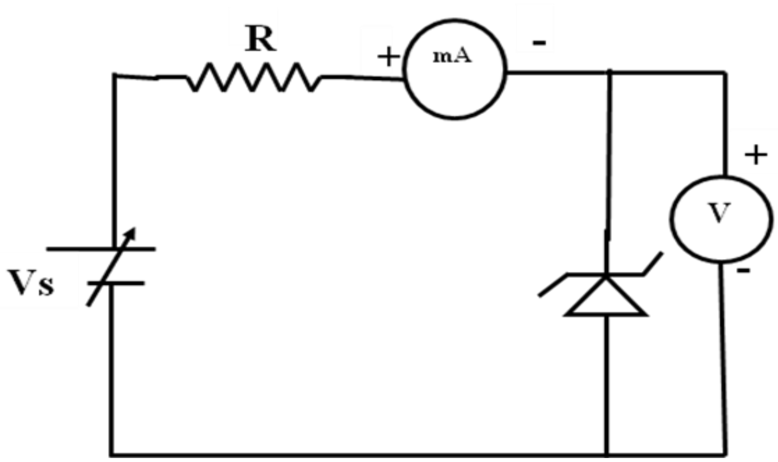


Fig.2: Reverse Bias

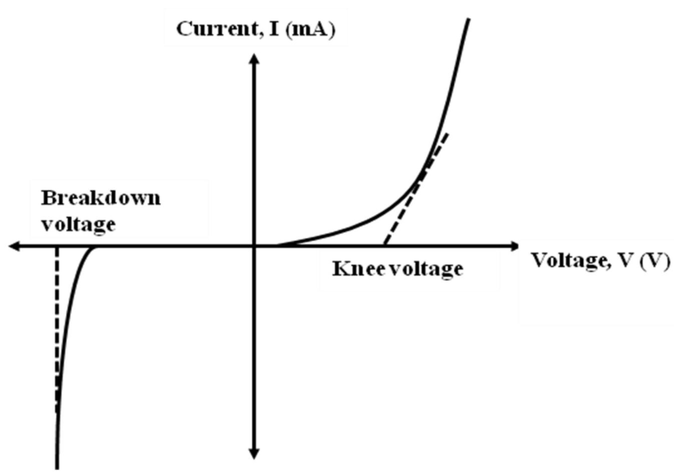


Figure (3): *I-V* plot of Zener diode

OBSERVATIONS:

FORWARD BIAS

Voltage, *V* (V)	Current, *I* (mA)

REVERSE BIAS

Voltage, *V* (V)	Current, *I* (mA)

RESULT:

i) The current-voltage characteristics of the given Zener diode are studied.
ii) The cut-off voltage or knee voltage = …………. V
iii) The break down voltage of the Zener diode = ………….. V

VIVA

1. What is a Zener diode?

Heavily doped PN junction diode is called Zener diode. It has a very narrow depletion region, which is operated under reverse bias condition.

2. What are the differences between Zener diode and the ordinary PN junction diode?

In Zener diode both P and N sections are heavily doped but in case of an ordinary diode they are lightly doped. Zener diode has a sharp breakdown voltage and is generally used under reverse bias. Zener diode is used as a voltage regulator in reverse bias whereas ordinary diode is used as rectifier. The breakdown mechanism in Zener diode is called Zener breakdown which is due to tunneling of electrons but in case of ordinary diode the breakdown mechanism is avalanche breakdown which is due to impact ionization.

3. Why Zener diode is used as a voltage regulator?

Beyond the breakdown voltage, the voltage across the Zener diode remains constant even there is sharp increase in reverse current. Output voltage remains constant even for variation in input voltage. Applications: for use in constant voltages required (charger, ipod or similar gadget power supplies)

4. What is turn over or breakdown voltage?

The critical value of reverse voltage at which the reverse current increases rapidly is called turn over or breakdown voltage.

5. How zener diode acts in forward bias conditions?

Just like an ordinary PN junction diode. Both Zener diode and ordinary diode operate in similar way in forward bias.

6.What happens if the polarity of battery is reversed across the N-type or P-type germanium?

Reversing the polarity of the battery across N-type or P-type germanium crystal will not affect the amount of current flowing. It will merely reverse its direction.

7. When the diode is said to be under forward bias?

The diode is said to be under forward bias when the P-section of the diode is connected to positive terminal of the battery & the N-section to the negative terminal of the battery.

8. When the diode is said to be under reverse bias?

The diode is said to be under reverse bias when the P-section of the diode is connected to negative terminal of the battery & the N-section to the positive terminal of the battery.
9. What is Zener breakdown voltage?

Zener breakdown voltage is the maximum reverse voltage applied to P-N junction at which an excessive reverse current flows.

10. What is this reverse current due to?
This reverse current is due to conduction of thermally generated electron-hole pairs within both the P and N type materials. This is so because some covalent bonds always break down due to normal heat energy of the crystal molecules.

11. Which are the minority charge carriers in N & P type materials?
Electrons are the minority carriers in P-type material and holes are the minority carriers in N-type material.

12. What is depletion region?
The region around the junction in which there are no free charge carriers is called depletion region. The region gets depleted due to the recombination of electrons and holes near the junction.

13. What happens if the reverse bias voltage is made very high?
When the reverse bias voltage is made very high, the covalent bonds near the junction break down and hence a large number of electron-hole pairs will be liberated, then reverse current increases abruptly to larger value.

14. What is the practical use of the semi-conductor diode?
Semi-conductor diodes are extensively used as rectifiers and detectors.

15. What is the order of voltages in the two directions?
In forward biasing the voltage of a few volts should be applied, whereas in reverse biasing the voltage applied should be in a fraction of volts.

16. What happens when the forward voltage is increased to a high value?
The sudden increase of the forward voltage to a high value damages the P – N junction due to heat.

17. What is Zener voltage?
Zener voltage is the maximum voltage applied to the Zener diode in reverse bias mode beyond which excessive reverse current flows through the Zener diode.

18. What are the applications of zener diode?
It can be used as a voltage Stabilizer, ac regulation & wave shaping

19. Define break down voltage?
It is that reverse voltage at which current starts increasing sharply due to break down mechanism. Break down voltage depends on the amount of doping, as doping level increases the break down occurs at lower voltage.

2. FOUR PROBE TECHNIQUE–RESISTIVITY MEASUREMENT OF A SEMICONDUCTOR

Aim:

To determine the resistivity of a semiconductor.

Apparatus used:

Probes arrangement, Ge crystal sample, oven, four probe set-up (measuring unit).

Formula:

$$\rho = \frac{V}{I} 2\pi S$$

Where,

ρ is the resistivity of the germanium crystal.
V is the voltage and I is the current flowing,
S is the distance between the probes (S = 2 mm).

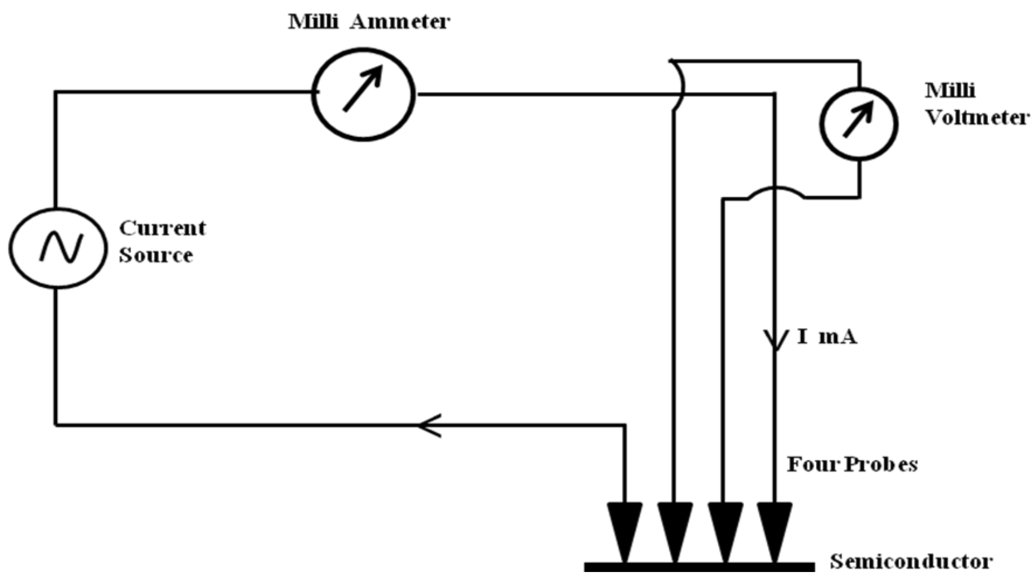


Fig: Circuit for resistivity measurement

Procedure:

1. Put the sample on the base plate of the four probe arrangement. Unscrew the pipe holding the four probes and let the four probes rest in the middle of the sample.

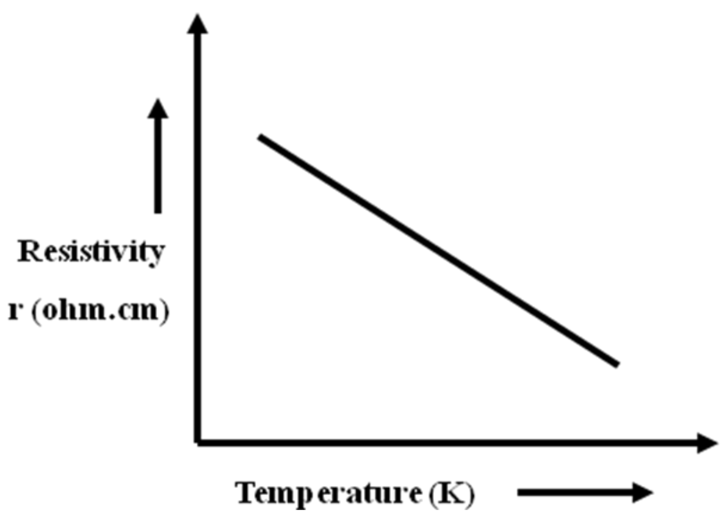
Apply a very gentle pressure on the probes and tighten the pipe in this position. Check the continuity between the probes for proper electrical contacts.

2. Connect the outer pair of probes (red / black) leads to the constant power supply and the inner pair (Yellow / green) leads to the probe voltage terminals.
3. Place the four probe arrangement in the oven and fix the thermometer in the oven through the hole provided.
4. Switch on the AC mains of four probe setup and put the digital panel meter in current mode. Adjust the current to say 2 mA.
5. Now put the digital panel meter into voltage mode. Read the voltage between the probes.
6. Connect the oven power supply. Rate of heating may be selected as low or high. Switch on the power to oven.

Observation:
Current (I) = **2 mA** (Set current to a constant value)

S. No.	**Temperature (^{0}C)**	**Voltage(V)**	**Temperature (K)**	**Resistivity, ρ (ohm.cm.)**

Model graph



Result:
Resistivity of the given semiconductor ________________ with increase in temperature.

1. What is a band gap?

This is the energy gap between the conduction and valence bands of a semiconductor (or insulator).

2. What is band gap in a good conductor?

There is no band gap as the two bands overlap in their case.

3. How do you differentiate between a conductor, an insulator and a semiconductor in relation to energy gap?

In conductors, the valence and conduction bands overlap each other. In insulators, there is large energy gap between valence and conduction bands, while in semiconductors this energy gap is not too large so that at room temperature the thermal energy gained by some of the electrons in the valence band is sufficient to make them jump to conductions band, crossing this energy gap.

4. What are intrinsic and extrinsic semiconductor?

A pure or natural semiconductor is called an intrinsic semiconductor e.g., silicon and germanium. But it has small electrical conductivity. In order to increase the conductivity when some pentavalent (like arsenic) or trivalent (like boron) impurity is added to it then it is called an extrinsic semiconductor.

3. NEWTONS RINGS

Aim:

To determine the radius of curvature of a plano convex lens by Newton's ring method.

Apparatus used:

Newton's ring apparatus, traveling microscope, Monochromatic light source etc.

Formula:

$$\mathbf{R = \frac{D_m^2 - D_n^2}{4(m-n)\lambda} \ m}$$

where, D_m = diameter of the m^{th} dark ring
D_n = diameter of the n^{th} dark ring
$(m-n)$ = difference between the m^{th} and n^{th} dark ring
λ = Wavelength of sodium light $=5893 \times 10^{-10}$ m

Figure:

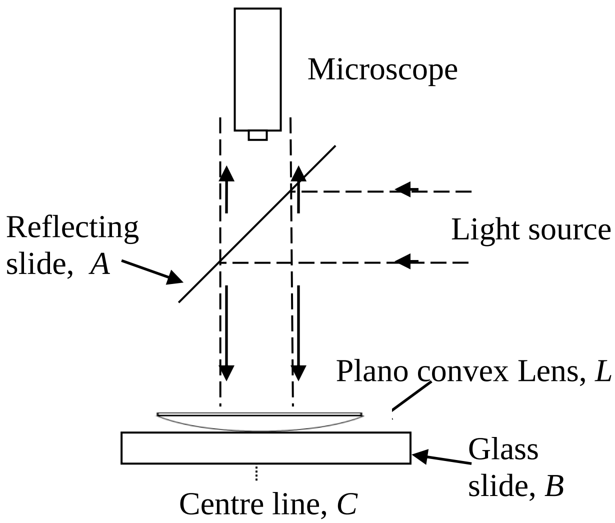


Figure 1: Ray diagram

Procedure:

The apparatus is set up as shown in the figure. The travelling microscope is placed such that its objective is directly above the plano–convex lens. The inclined glass plate is tilted so that the light rays from the monochromatic source are reflected on the plane glass plate and the field of view is brightly illuminated. The focus of the microscope is adjusted such that the Newton's rings are clearly seen. The traveling microscope is adjusted such that the point of intersection of the cross wires coincides with the center of the ring system. The microscope is moved towards the left so that the vertical cross wire is tangential to the 8th dark ring and the reading of microscope is taken. The microscope is now moved towards right and the reading of every ring is noted down till the 8th dark ring on the other side is reached. The reading are entered in the tabular column and the mean value of ($Dm^2 - Dn^2$) is calculated. Knowing the wavelength of source light, the radius of curvature of the plano convex lens is calculated using the formula,

$$R = \frac{D_m^2 - D_n^2}{4(m-n)\lambda} \text{ m}$$

Observations:

Least count of the traveling microscope

$$\text{Pitch} = \frac{\text{Distance moved on the pitch scale}}{\text{No. of rotations given to the head scale}} = \_\_\_\_\_\_\_\_\_\text{mm}$$

$$\text{L.C.} = \frac{\text{Pitch}}{\text{No of division on the head scale}} = \_\_\_\_\_\_\_\_\_\_\text{mm}$$

1. to find D_m^2:

Ring No. "m"	T.M. Reading LEFT			T.M. Reading RIGHT			Ring diameter (mm)	Dm^2 in (mm^2)
	PSR mm	HSR	TR R_1 mm	PSR mm	HSR	TR R_2 mm	$Dm = R_2 \sim R_1$	
8								
7								
6								
5								

2. to find Dn^2:

Ring No. "n"	T.M. Reading LEFT			T.M. Reading RIGHT			Ring diameter (mm)	Dn^2 (mm^2)	$Dm^2 - Dn^2$ (mm^2) **(For m-n = 4)**
	PSR mm	HSR	TR R_3 mm	PSR mm	HSR	TR R_4 mm	$Dn = R_4 \sim R_3$		
4									
3									
2									
1									

Here (m-n) = 4 Mean ($D_m^{2} - D_n^2$) = mm^2

= $\times 10^{-6}\ m^2$

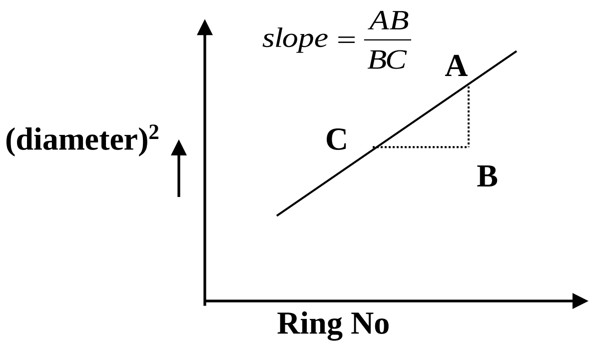
Result: The radius curvature of the given plano convex lens = m

Graphical Method (Optional):

$$R = \frac{1}{4\lambda} \times \text{slope} \left(\frac{AB}{BC} \right) = \qquad m.$$

<u>Model graph</u>

1.



1. How newtons rings are formed?
They are formed by the interference between two wave fronts reflected between the two surfaces. Interference is caused by the path difference between two rays arriving at the microscope.

2. What are newtons rings?
The phenomenon of Newton's rings, named after Isaac Newton, is an interference pattern caused by the reflection of light between two surfaces - a spherical surface and an adjacent flat surface.

3. How the rings are alternate dark and bright?
The light rings are caused by constructive interference between the light rays reflected from both surfaces, while the dark rings are caused by destructive interference.

4. What is interference?
It is the superposition of two or more waves resulting in a new wave pattern.

5. What is constructive and destructive interference?
When two or more waves come together, they will interfere with each other. This interference may be constructive or destructive. If you take two waves and bring them together, they will add wherever a peak from one matches a peak from the other. That's constructive interference. Wherever a peak from one wave matches a trough in another wave, however, they will cancel each other that is destructive interference.

4. DETERMINATION OF DIELECTRIC CONSTANT

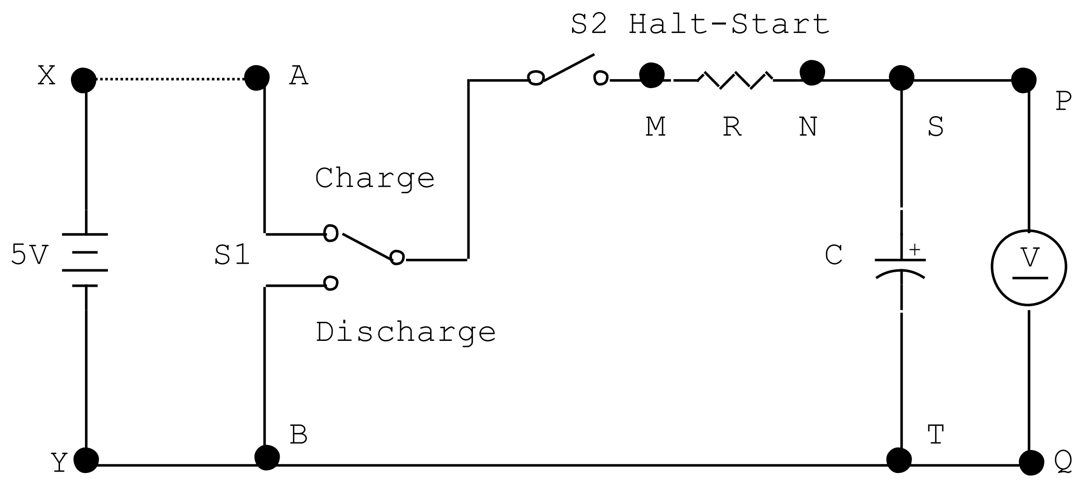
Aim:

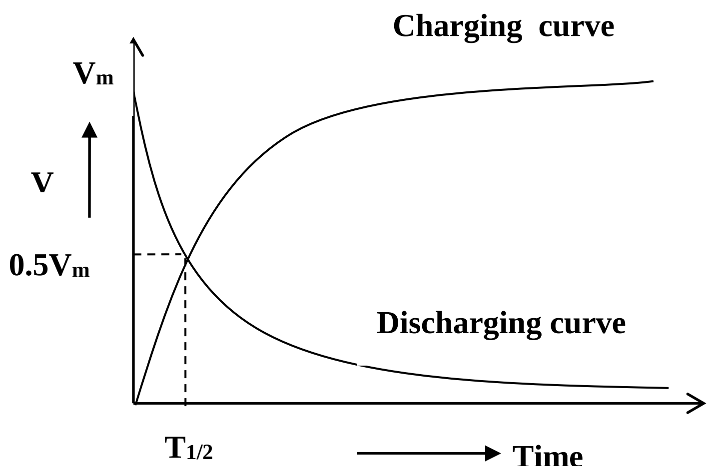
To determine the dielectric constant of the dielectric material of the given capacitor using RC charging and discharging circuit.

Apparatus and components used:

Dielectric constant apparatus [consists of power supply, digital voltmeter, timer resistor, capacitor etc]

Circuit Diagram:





Formula:

The dielectric constant (k) of the material of the dielectric used in the capacitor is determined using the relation,

$$k = \frac{1.44T_{1/2} \times d10^{-6}}{\varepsilon_o AR}$$

where, d is the distance between the plates, A is the area of the plates, ε_0 = 8.854 x 10^{-12} F/m is the permittivity of free space, R is the resistance of the resistor used in the circuit in Ω and Tp is time in seconds.

Table 1: *Physical dimensions of capacitor*

Capacitor	C1	C2	C3
Length(mm)	47	114	183
Breadth (mm)	5	5	6
Separation (mm)	0.075	0.075	0.075

Experimental Procedure

The circuit connections are made as shown in Figure-1. R is selected as 100 KΩ and capacitor C1 is selected and connected to the circuit using patch cords.

1. The digital stop clock is reset by pressing reset button. The display indicates 00.0.
2. The digital DC voltmeter and 5V-power supplies are connected to the circuit as shown in Figure-1.
3. Switch S1 (Charge-discharge) is thrown to the charge position.
4. Switch S2 (Halt-Start) is thrown to the start position watching the digital stop clock and the voltmeter.
5. The clock is stopped by controlling Halt-Start switch after 5 seconds and the voltmeter reading is noted. The capacitor is charged for 5 seconds and voltage across the capacitor after 5 second is noted from the voltmeter in Table-2.
6. The capacitor is further charged by starting the clock. After 10, 15, 20 seconds the clock is stopped to note down voltage across the capacitor. The readings obtained are noted in Table-2.

7. Trial is repeated until the capacitor is charged to 4.5Volts. In each case the capacitor voltage is noted at an interval of 5 seconds and noted in Table-2.

8. When the capacitor is charged to maximum voltage (4.5V and above), the charging is stopped and the charge discharge switch is thrown to discharge position and clock is reset.

9. The voltage across the discharging capacitor is noted after 5 seconds interval by stopping clock after five seconds. This is done until the capacitor is discharged fully.

10. Experiment is repeated for different capacitance values. And the corresponding readings are noted in Table-2.

11. A graph is drawn taking time on X-axis and voltage along the Y-axis as shown in Figure-2. The charging and discharging curve intersects at a point P, where the voltage across the capacitor during charging and discharging remains the. The time at which voltage across the capacitor during charging and discharging is noted.

Observations:
Table-2

Time (sec)	Voltage (volts)					
	C_1 = R= 100KΩ		C_2 = R= 100KΩ		C_3 = R= 100KΩ	
	Charging	Discharging	Charging	Discharging	Charging	Discharging

Result

Parameters	C1	C2	C3
$T_{1/2}$ (sec) **(for C_1 = 7.5, C_2 = 12.5, C_3 = 17.5)**			
Capacitance (pF) **(C_1 = 27 pF, C_2 = 100 pF, C_3 =150 pF)**			
k ***(k_1 = 3.2, k_2 = 2.9, k_3 =2.7)***			

Probable viva questions:

1. What is a capacitor?

Capacitor is having two parallel plates (conducting metal) with a dielectric material in between.

2. What happens if the dielectric material is removed?

Capacitance decreases if it is removed.

3. What is the function of a capacitor?

A capacitor stores energy. It is used in ceiling fans and motors as the energy storage element in the generation of higher voltages than the input voltage to start the motors.

4. What is a dielectric material?

A dielectric material (dielectric) is an electrical insulator that can be polarized by an applied electric field.

5. Give examples of dielectric material?

Examples include porcelain (ceramic), mica, glass, plastics, and the oxides of various metals. Some liquids and gases can serve as good dielectric materials. Dry air is an excellent dielectric and is used in variable capacitors.

6. What is dielectric constant?

Dielectric constant, property of an electrical insulating material (a dielectric) is equal to the ratio of the capacitance of a capacitor filled with the given material to the capacitance of an identical capacitor in a vacuum without the dielectric material. The insertion of a dielectric between the plates of, say, a parallel-plate capacitor always increases its capacitance, or ability to store opposite charges on each plate, compared with this ability when the plates are separated by a vacuum. If C is the value of the capacitance of a capacitor filled with a given dielectric and C_0 is the capacitance of an identical capacitor in a vacuum, the dielectric constant, symbolized by the Greek letter kappa, κ, is simply expressed as $\kappa = C/C_0$. The dielectric constant is a number without dimensions.

Materials and Dielectric Constants: Vacuum: 1; Glass: 5-10; Mica. 3-6;

5. YOUNG'S MODULUS BY UNIFORM BENDING

Aim :

To determine the Young's modulus of the material (wooden scale) of the given beam by uniform – bending.

Apparatus and components needed:

Travelling Microscope, Two knife edge supports, two weight hangers, slotted weights, Pin, Screw gauge, Vernier Calipers.

Formula:

Young's Modulus of the given material of the beam

$$Y = \frac{3mgxl^2}{2bd^3\delta} \text{ Nm}^{-2}$$

where

Y = Young's Modulus of the material of the beam (N/m^2)

m = Mass kept either side of the scale pans

x = is the distance between knife edge and the point of suspension of the nearer scale pan

b = Breadth of the beam (m)

d = Thickness of the beam (m)

δ = Mean value

Theory:

Young's Modulus is named after Thomas Young, a British Scientist. Young's modulus is defined as the ratio of the longitudinal stress over longitudinal strain, in the range of elasticity the Hook's law holds. It is measure of stiffness of elastic material.
If a wire of length 'L' and area of cross section 'a' be stretched by a force 'F' and if a change of length 'l' is produced then,

Young's Modulus = Normal Stress/ Longitudinal strain $= \dfrac{F/a}{l/L}$

Procedure:

The given beam is placed over the two knife edges at a distance of 50 cm (l). Two weight hangers are suspended, one each on either side of the knife edge at equal distance (x = 15 cm) from the knife edge. Since the load is applied at both points of the beam, the bending is uniform throughout the beam and the bending of the beam is called Uniform Bending. A pin is fixed vertically exactly at the centre of the beam.

A travelling microscope is placed in front of this arrangement. Taking the weight hangers alone as the dead load, the tip of the pin is focused by the microscope and is adjusted in such a way that the tip of the pin just touches the horizontal cross wire. The reading on the vertical scale of the travelling microscope is noted.

Now equal weights are added on both weight hangers, in steps of 50 gms. Each time the position of the pin is focused and the readings are noted from the microscope. The procedure is followed until the maximum load is reached. The same procedure is repeated by unloading the weight from both the weight hangers in steps of same 50 grams and the readings are tabulated in the tabular column. The thickness and the breadth of the beam are measured using screw gauge and vernier calipers respectively and are tabulated. By substituting all the values in the given formula, the Young's modulus of the given material of the beam can be calculated.

Observations:

Thickness of the beam (d) = 0.535 cm (given)

Breadth of the beam (b) = 2.55 cm (given)

$$Least\ Count\ of\ the\ Travelling\ Microscope = L.C. = \frac{Smallest\ division\ the\ main\ scale}{Total\ number\ of\ divisions\ on\ the\ vernier\ scale}$$

= 0.5 cm/50 = 0.001 cm

Distance between two knife edges (l) = _________ $\times \mathbf{10^{-2}}\ \boldsymbol{m}$

Distance between the weight hanger and any one of the adjacent knife edge x = _______ x 10^{-2} Meters

Calculations:
Young's Modulus of the given material of the beam is calculated using the formula

$$Y = \frac{3mg\,xl^2}{2bd^3\delta}\ Nm^{-2}$$

Result: ***The Young's modulus of the material (wood) of the given beam by uniform bending method is***
Y = -------- N/m².

Viva-Voce:

1. What is stress? Give its unit.
   The force applied on a body per unit is known as stress. Its unit is N/m^2

2. What is strain? Give its unit.
   The ratio of change in dimension to original dimension is called as strain. It is a ratio, hence it has no unit.

3. What is elasticity?
   The property of the body to regain its original shape and size, after the removal of the applied stress.

4. What are the factors affecting the elasticity of a material?
   a. Effect of mass
   b. Effect of change in temperature
   c. Effect of impurities
   d. Effect of hammering, rolling and annealing
   e. Effect of crystalline nature

5. What is uniform bending?
   The bending is uniformly loaded on its both the ends, the bent forms an arc of a circle and elevation is made on the beam. This bending is called uniform bending.

6. Define Young's Modulus? And what is the SI unit of Young's Modulus?
   Longitudinal Stress to Longitudinal Strain within the elastic limit is called Young's Modulus.

The SI unit of Young's Modulus is N/m^2.

7. Is the Young's Modulus changes with the change in dimensions of beam?
   No, because Young's Modulus depends only on the material of the beam not the dimensions.

8. Mention the applications of Young's Modulus.
   To find the elasticity of the Iron, Plastic, Wood etc…

Tabular Column:

Load m_1 (gm)	Reading of T.M.						Mean (I+D)/2 (cm) R_1	Load m_2 (gm)	Reading of T.M.						Mean (I+D)/2 (cm) R_2	Elevation $\delta = R_1 \sim R_2$ (cm)
	Load Increasing			Load Decreasing					Load Increasing			Load Decreasing				
	MSR (cm)	CVD	T.R (cm) I	MSR (cm)	CVD	T.R (cm) D			MSR (cm)	CVD	T.R (cm) I	MSR (cm)	CVD	T.R (cm) D		
00								150								
50								200								
100								250								

Mean δ = ……..X 10^{-2} meters

6. I-V CHARACTERISTICS OF A PHOTO DIODE

Aim:

To determine the IV characteristics of photo diode and to find the variation of photo current as a function of light intensity.

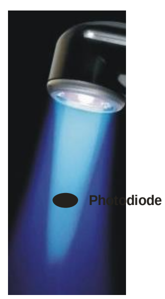
Apparatus used

Photodiode experimental setup consisting of 0-3V regulated power supply, 0-2mA digital dc current meter, 0-20V digital dc volt meter, white light LED module and photo diode LED type. A transistor drive for LED is used. The LED power ($P_{LED}=V_{LED}\ I_{LED}$) is directly read from the dial marked on the LED power supply.

Formula:

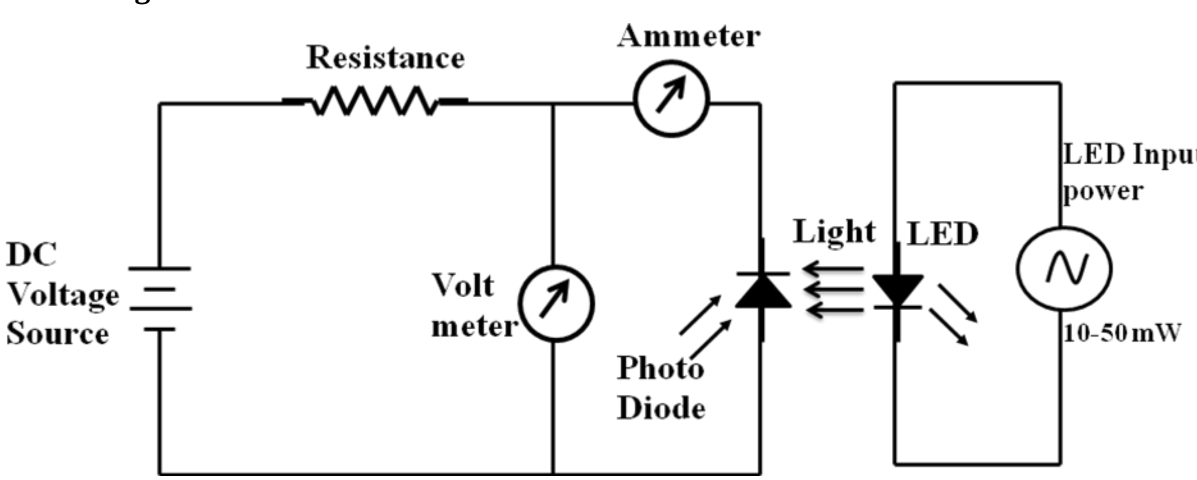
Responsivity (R_λ) of a silicon photodiode = Ipd / P

where Ipd is the photodiode current and P is the light input power.



LED light falling on photodiode

Circuit diagram



Procedure

1. Determination of Responsivity:

- The LED is switched on and LED power is set to 10mW by positioning the knob to its minimum position. After confirming that the LED is glowing and PD current in the meter, the cover is placed so that external light will not affect the readings. Positive of the Photo Diode(PD) is connected to the negative of the power supply and Negative of the PD is connected to the positive of the power supply. This reverse biases the photo diode.

- The voltage across PD is set to -1V by varying 0-3V power supply. The PD current I_{PD} is noted.

- The LED power is increased to 11mW and V_{PD} is again set to -1V and the corresponding PD current is noted in Table-1.

- Trial is repeated for input power 12, 13mW etc up 50mW. In each case V_{PD} is set to -1V and I_{PD} is noted in Table-1.

- A graph showing the variation of LED power on X-axis and PD current on Y axis is drawn. A straight line graph is obtained, slope of which gives Responsivity.

Responsivity (R_{λ}□□) of a silicon photodiode = slope (from the graph).

Observation:

Table-1: PD current variation with LED power

P_{LED}(mW)	I_{PD}(μA)

II. I-V Characteristics of PD:

In this part of the experiment, PD current and voltage are recorded for different LED input power.

1. The LED power is set to 10mW on the dial and V_{PD} is set to -0.10V and the I_{PD} is noted.

2. Trial is repeated by increasing V_{PD} in suitable steps up to a maximum of -2V. The corresponding I_{PD} is noted in Table-2.
3. Experiment is repeated by increasing the LED power to 20, 30, 40 and 50mW. In each case variation in V_{PD} and corresponding I_{PD} are noted in Table-2.
4. A graph is drawn taking V_{PD} along X-axis and I_{PD} along Y-axis. The equal spacing between characteristic curves indicates linearity of photo current with light intensity.

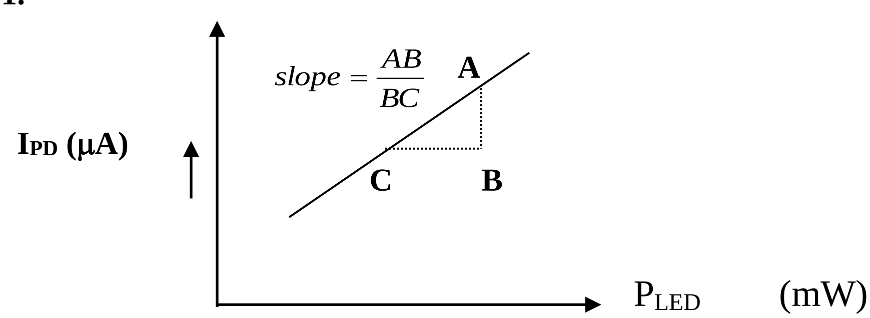
Table 2: Variation of PD voltage with current

V_{PD}(V)	I_{PD}(μA)				
	P_{LED} =10mW	P_{LED} =20mW	P_{LED} =30mW	P_{LED} =40mW	P_{LED} =50mW
0	0	0	0	0	0
-0.1					
-0.2					
-0.3					
-0.4					
-0.5					
-1.0					
-2.0					

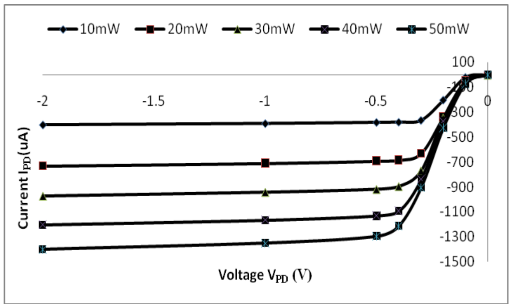
Results:
The responsivity of the photodiode = ______________mA/W and *IV* characteristics is drawn for the photo diode in the third quadrant and studied.

Model graphs

1.



2.



1. What are photodiodes?

Photodiodes are semiconductor devices responsive to high energy particles and photons.

2. What are photons?

Photons are quantized packets of light.

3. What is responsivity of a photodiode?

It is the measure of its sensitivity to light and is defined as the ratio of the photocurrent Ipd to the incident light power P at a given wavelength.

4. How does the photodiode works?

It is made up of radiation sensitive material whose resistivity changes when illuminated.

5. Which are the available varieties of photodiodes?

a) PN junction photodiode b) PIN junction photodiode c) Avalanche photodiode

6. What happens if the photodiode is biased with a voltage larger than the specified maximum reverse bias?

A device may experience reverse bias breakdown if biased over the maximum value we specify, a high current will flow through the device which could lead to the destruction of the photodiode.

7. What are the applications of a photodiode?

P-N photodiodes are used in photoconductors, charge-coupled devices, and photomultiplier tubes. Photodiodes are used in consumer electronics devices such as compact disc players, smoke detectors and the receivers for remote controls in VCRs and televisions.

7. DETERMINATION OF THE WAVELENGTH OF A GIVEN LASER SOURCE USING A DIFFRACTION GRATING

Aim of the experiment:

To determine the wave length of the given laser light using diffraction grating of known grating constant.

Apparatus and components needed:

Laser source (a laser pointer), Mount and stand for the laser, grating, scale and a screen.

Formula used: $\theta_n = \tan^{-1}\left(\frac{x_n}{f}\right)$ $\lambda = \frac{d \sin \theta_n}{n}$

Grating constant d (Reciprocal of no. of lines/inch, d = 1/No. of lines per inch)

1. For 200 lines,
   $= 2.54 \times 10^{-2} / 200 = 1.27 \times 10^{-4}$ meters

2. 500 lines,

   $= 2.54 \times 10^{-2} / 500 = 5.08 \times 10^{-5}$ meters

Theory:

A plane diffraction grating is an optical glass plate containing a large number of parallel equidistant slits of the same width. If the width of each transparent portion be 'a' and each opaque portion be 'b', then d = a + b is called grating constant. It is the reciprocal of the number of lines per unit length (N) of grating.

When a beam of monochromatic light falls normally, on the grating surface, its wavelength λ is calculated using the formula,

$$d \sin\theta = n\lambda \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where d=[1/N] is the grating constant, θ is the angle of diffraction and n is the order of spectrum.

In this equation all the terms except θ are constant. The angle θ can be measured by measuring the distance between source and image and distance between the consecutive maximums. Different orders of diffraction are the results of different incident angles θ. Hence to specify order θ has been rewritten as θ_n, which indicate the diffraction angle for n-th order. Fig.1. indicates process of diffraction, using laser light and grating. The n-th order diffraction angle is given by

$$\theta_n = \tan^{-1} (X_n/f) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where X_n is the distance of nth order diffraction pattern from the centre of the diffraction pattern and f is the distance between the screen and the grating. Substituting θ_n in Eq (1), the wave length λ can be calculated using the formula

$$\lambda = \frac{d \sin \theta_n}{n} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

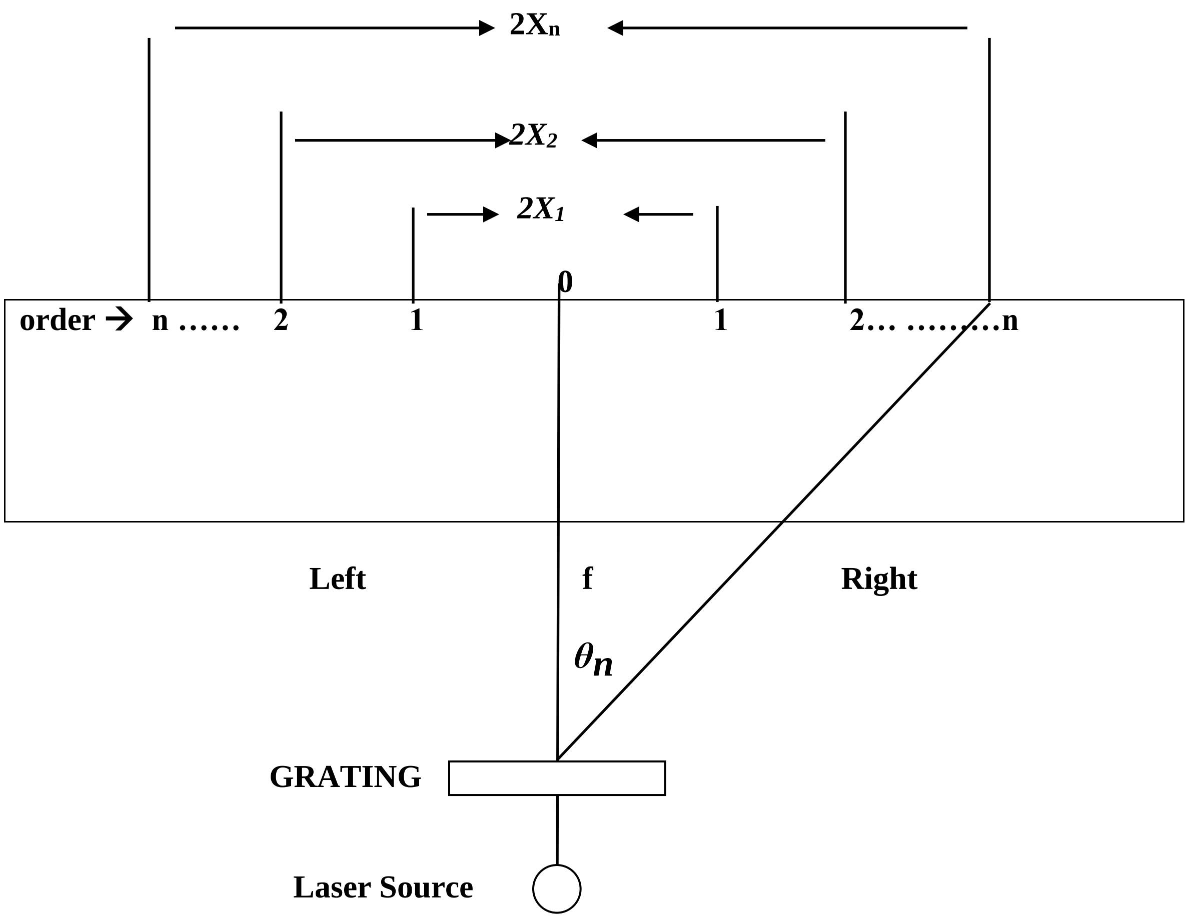


Fig.1: Process of diffraction using grating

Observations:

Trial 1: The distance between the screen and the grating, f = m

Diffraction order, n	**Distance, $2X_n$ (m)**	**Distance, X_n (m)**	**Diffraction angle, $\theta_n = \tan^{-1}(X_n/f)$**	**Wavelength, λ (nm)**

Mean value of λ = nm

Trial 2: The distance between the screen and the grating f = m

Diffraction order, n	**Distance, $2X_n$ (m)**	**Distance, X_n (m)**	**Diffraction angle, $\theta_n = \tan^{-1}(X_n/f)$**	**Wavelength, λ (nm)**

Mean value of λ = nm

Mean value of λ of trial 1 and trial 2 =

PROCEDURE:

The laser source is placed on a table and switched on. At about 1 to 2 meters away on the path of the laser a white screen is placed. The laser beam is made to fall exactly at the centre of the screen.

The grating is placed on the grating stand close to the laser source and the diffraction pattern is observed. The distance between the grating and the screen is measured. Equally spaced diffracted laser light spots will be observed. The total numbers of spots are counted. The distance between consecutive orders of diffraction is measured using a scale and tabulated. Using Eq. (2) diffraction angles are calculated for each order of diffraction. The wave length is calculated in each case using Eq. (3). The average value of wavelength is calculated. The experiment is repeated for another distance between the screen and the grating.

RESULT: The wavelength of the given laser source = nm.

1. What is meant by diffraction & classify.
Bending of light around the edge of an obstacle is called diffraction. It is classified into fresnel and fraunhoffer diffraction.

2. What is the condition for diffraction?
Size of the object should be comparable with that of the wave length of the light source. Since greeting constant and wave length are of the same order (10^{-6} meter. Diffraction takes place.

3. What is a grating?
A. grating is a plane glass plate on which ruling ruled using diamond point. The distance between two rulings is called a grating constant. Width of opaque and transmitted line is called grating element.

4. What are the function of collimator and telescope?
Collimator renders parallel rays where as telescope converges different rays at the focal point of high piece.

5. What kind of diffraction we are studying?
We are studying fraunhoffer diffraction

6. What do you understand by angle minimum deviation?
It is that angle of incidence at which deviation is minimum and intensity is maximum.

7. What is the effect of no. of rulings on the diffraction spectrum?
Higher the no. of rulings we get less orders with more gaps.

8. DETERMINATION OF PLANCK'S CONSTANT USING LED

Aim of the experiment:

To determine the Planck's constant using LED.

Apparatus and components needed:

Planck's constant apparatus: [includes wave generator, digital peak reading voltmeter, six different known wave length LED's, resistance etc.]

Theory:

LED is a two terminal solid state lamp, which emits light with very low voltage and current. The light energy radiated by forward biasing is given by equation

$$E = \frac{hc}{\lambda} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where c is the velocity of light, λ the wave length of light emitted and h is Planck's constant.

If V is the forward voltage applied across the LED terminals that makes it emit light (it is also called forward knee voltage) then the energy given to the LED is given by

$E = eV$ ……………… (2) where e is electronic charge.

LEDs are very high efficiency diodes and hence this entire electrical energy is converted into light energy, then equating equations 1 and 2,

$$eV = \frac{hc}{\lambda} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

From this equation Planck's constant is given by, $h = \frac{eV\lambda}{c}$ …………… (4)

For different wavelengths of light, the forward knee voltage is determined and the value of h is calculated. Moreover, $\frac{e}{c} =$ 5.33x10^{-28} coulomb-sec/meter is a universal constant and hence the product λV must be a constant. This enables the determination of Planck's constant. The wavelength of IR LED can be determined by noting the knee voltage V_{IR} and the value substituted in the equation,

$$\lambda_{IR} = \frac{\lambda V(average)}{V_{IR}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Formula:

i) Planck's constant:

$h = \frac{e\lambda V_{average}}{c}$, where h is the Planck's constant = 6.625 x 10^{-34} Js, e is the charge of the electron = 1.6 x 10^{-19} C and c is the velocity of light = 3 x 10^{8} m/s

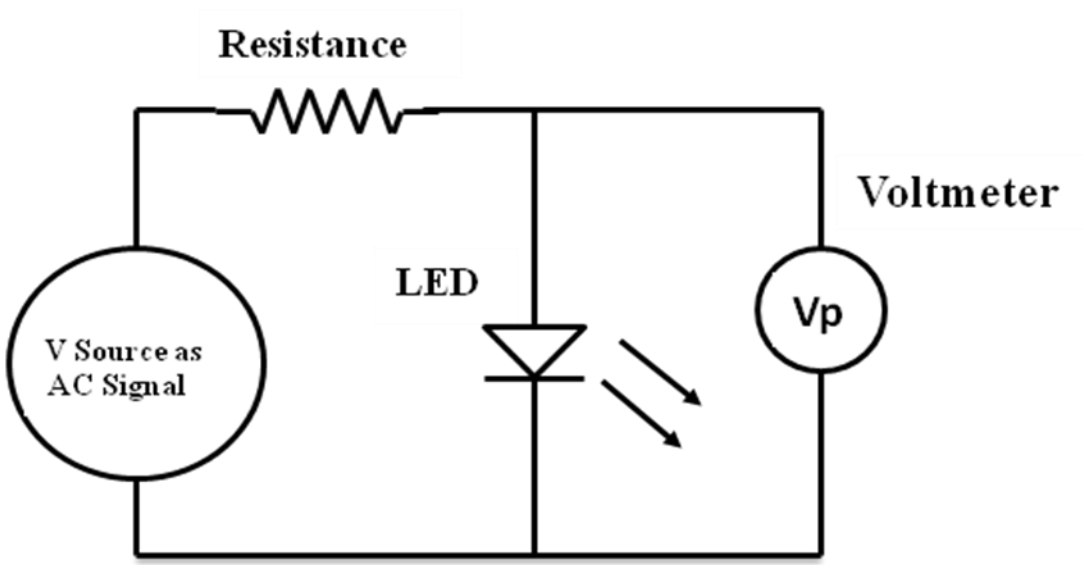
ii) To determine the wavelength of IR LED: $\lambda_{IR} = \frac{\lambda V_{average}}{V_{IR}}$

PROCEDURE:

The circuit is connected as shown in fig.1. The input to the LED is an ac signal. Using a digital peak reading voltmeter the voltage across the LED is measured and recorded. For given colour LED light. Trial is repeated by changing the LED and the corresponding knee voltage is noted. The product of wavelength and knee voltage is determined and its average value is calculated. Planck's constant is calculated using equation 4.

The IR LED is now connected and the knee voltage V_{IR} is observed. The wave length is calculated using Eq.5.

CIRCUIT DIAGRAM:



Observations:

Colour	Wavelength λ (nm)	Knee voltage (V)	λV (nmV)
Orange	555		
Yellow	535		
Green	500		
Blue	350		
Red	600		

Average value, $\lambda V_{(average)}$ = nm$V$

Calculations:

i) Planck's constant:

$$h = \frac{e\lambda V_{average}}{c} = \quad \text{Js}$$

ii) To determine the wavelength of IR LED:

$$\lambda_{IR} = \frac{\lambda V_{average}}{V_{IR}} = \quad \text{nm}$$

RESULT:

Parameters	Theoretical	Experimental
Planck's constant (Js)	6.626×10^{-34}	
Wave length of IR LED (nm)	910	
λ V (nmV)	1240	

9. SERIES AND PARALLEL LCR CIRCUIT

Aim:

a) To study the frequency response of the series and parallel resonance circuits.
b) To determine the inductance value of the given inductor.
c) To determine the band width and quality factor of the circuit in series resonance.

Apparatus and components required:

Audio frequency oscillator and LCR apparatus [consists of a.c. milliammeter, inductors of unknown value, resistors and capacitors of known values.]

Theory:

In series LCR circuit the current in the circuit is given by

$I = \dfrac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$ where X_L is the inductive reactance, X_C is the capacitive reactance. When $X_L = X_C$, the resonance occurs and the current reaches its maximum value. i.e., $\omega L = \dfrac{1}{\omega C}$. Thus, resonance frequency, $f_r = \dfrac{1}{2\pi\sqrt{LC}}$;

Therefore, $L = \dfrac{1}{4\pi^2 f_r^2 C}$ ------------- (1)

In parallel resonance the current in the circuit is minimum and is given by $I_{min} = \dfrac{V}{\frac{L}{CR}}$

The quality factor Q is defined as the ratio of the energy stored in the coil to the energy dissipated in it. It gives the figure of merit and is used to compare different coils.

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

In series circuit, inductor, capacitor and resistance are connected in series to the Voltage source, V_s and in parallel circuit, inductor and capacitor are connected in parallel to the Voltage source, V_s as shown in the circuit diagram. In parallel circuit, no need to include resistance as in the figure 3.

CIRCUIT DIAGRAM:

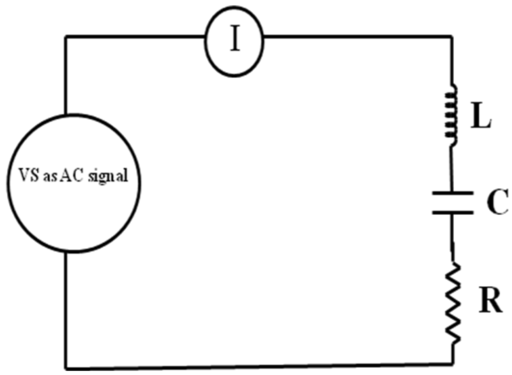


Fig.1: series resonance circuit

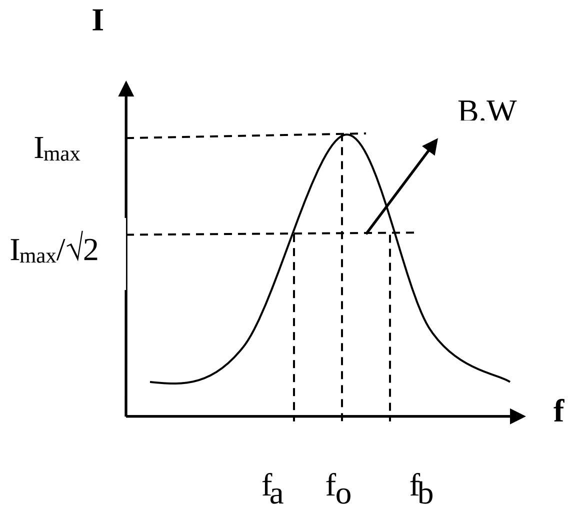


Fig.2. : Series resonance curve

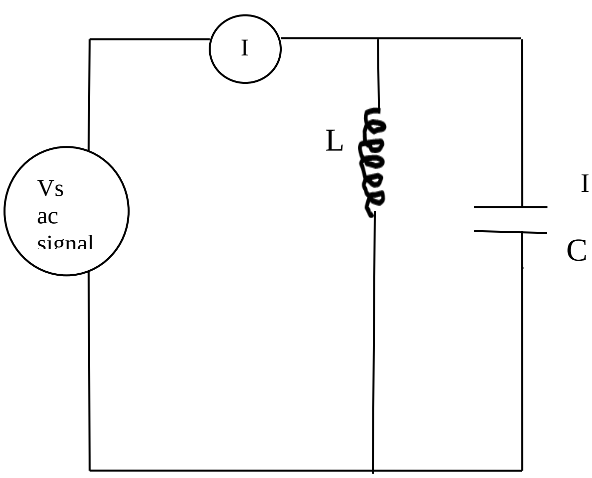


Fig.3: Parallel resonance circuit

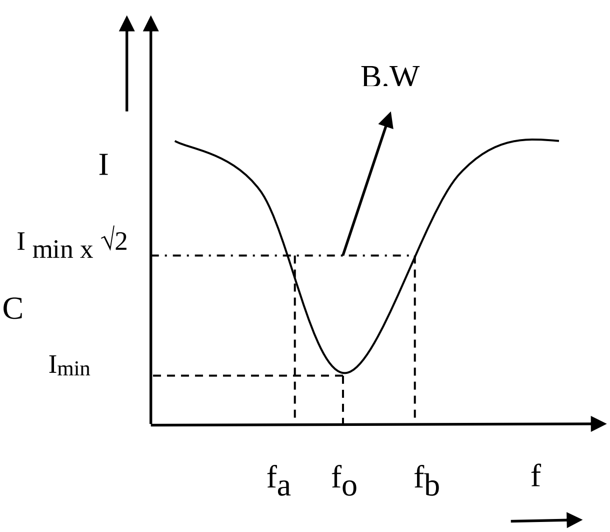


Fig.4. : Parallel resonance curve

Observations:

R= C= R= C=

Frequency (in Hz)	**Series resonance I (in mA)**	**Parallel resonance I (in mA)**

In the frequency response curve, the frequency points where the power dissipation is half the maximum are marked f_a and f_b. These points are at $\frac{I_{max}}{\sqrt{2}}$ on either side of the I_{max}. Then $\Delta f = (f_b - f_a)$ is called the bandwidth.

The Q from the graph is, Q graph = fo/Δf ------------- (2)

PROCEDURE:

The circuit is connected as shown in the fig.1. The output voltage of the oscillator is set to some suitable value and kept it constant throughout the experiment. The frequency f is increased in suitable steps (100 Hz- 2 kHz, in steps of 100 Hz and 2 kHz - 8 kHz in steps of 1 kHz) and the corresponding current is noted. The resonance frequency for a maximum current must be determined with maximum accuracy. A graph of I *vs* f is plotted as shown in fig.2. The resonance frequency is noted from the graph. The inductance value of the coil is determined using Eq. (1). The quality factor Q of the circuit is evaluated using Eq. (2)

For parallel resonance, the circuit is done as in fig.3. The experiment is repeated as in series resonance. The readings are plotted as shown in fig.4. From the graph the resonance frequency for minimum current is noted. The unknown inductance value is determined using Eq. (1).

RESULTS:

Results	**Series Circuit**	**Parallel Circuit**
1. Inductance (H) (~0.176 H for series and parallel)		
2. Band Width (Hz) (~1250 Hz)		
3. Quality Factor		

Calculations: C_S = F ; C_p = F ;

In series resonance,

$$L_s = \frac{1}{4\pi^2 f_o^{\,2} C_s} = \qquad H$$

In parallel resonance,

$$L_p = \frac{1}{4\pi^2 f_o^{\,2} C_P} = \qquad H$$

1. Define resistance(R), Capacitance(C) & Inductance(L)?
Resistance is the opposition offered by the material for the flow of current. Its SI unit is ohm (Ω). Capacitance of a capacitor is defined as the ability of the capacitor to store electric charges, it is expressed in Farad(F). Self inductance of the coil is defined as the emf induced in the coil when the current through the circuit varies at one ampere per second. Its SI unit is Henry(H). Capacitor is short for ac but open for dc. Inductor is short for dc but open for ac.

2. Distinguish between acceptor and rejector circuits?
In series LCR circuit current becomes maximum at resonance frequency due to minimum impedance of the circuit. Hence the circuit is called an acceptor circuit.
In parallel LCR circuit current becomes minimum at resonance frequency due to maximum impedance of the circuit. Hence it is called a rejector circuit.

3. Define quality factor and impedance?
Quality factor (voltage magnification) is defined as the ratio of the voltage across the capacitor or inductor to the applied voltage. Higher the quality factor higher will be the selectivity and longer will be the distortion. It depends on the values of R, L and C. Lower R makes Q value high.

Resistance offered by the circuit for the flow of ac is called impedance.

4. Define a choke?
It is an inductor which offers very high resistance for the flow of ac (so that no current flows).

5. Define mutual inductance?

It is the phenomenon of inducing emf in one coil by varying the current in the other.

6. Define wave amplitude, period, frequency, rms and average current?
Amplitude of a wave is the maximum value of current or voltage.

Period is the time taken by the current or voltage to complete one cycle.

rms value of an ac is the value of the dc which produces same amount of heat in the same time in the same conductor. One complete cycle of positive and negative values of an ac is called a cycle.

Number of cycles per second is called frequency.

Form factor is the ratio of rms current to its average value.

7. What is the condition for resonance?
In LCR circuit resonance occurs when the capacity reactance (X_C) becomes equal to inductive reactance (X_L) i.e $X_L = X_C$

8. What is meant by time constant?
It is the time taken by the capacitor to get charge to 63% of its maximum value t =1/RC.

10. DETERMINATION OF THE CHARACTERISTICS OF A TRANSISTOR

Aim:

To draw the input and output characteristics of a transistor and hence transistor to determine its current gain and the knee voltage.

Apparatus and components required:

Transistor Characteristics Apparatus: [includes Variable DC sources, ammeters, voltmeters, transistor and resistors]

Theory:

A transistor is a semiconductor device, which consists of three terminals emitter, base and collector. It is regarded as two diodes joined back to back. The base region is lightly doped and made very thin. The doping level in the emitter is more than in the collector. The emitter-base junction is forward biased and hence junction resistance is low. The collector base junction is reverse biased and hence the junction resistance is large. At the base of an NPN transistor, the electrons coming from the emitter are attracted by the reverse biased collector. The collector current I_C is slightly less than the emitter current I_E. Due to the recombination of the electrons at the base, a small base current I_B flows through the base terminals.. Always $I_E = I_C + I_B$.

Fig.1. shows the NPN transistor in common emitter configuration. The two current gains are defined as $\alpha = \frac{I_C}{I_E}$ and $\beta = \frac{I_C}{I_B}$ where α is the emitter current amplification factor and β is base current amplification factor. Input characteristics is a plot of input voltage and input current with output voltage kept constant as shown in the table for input characteristics.

From the input characteristics, the input resistance can be calculated using the formula (ie: from the slope)

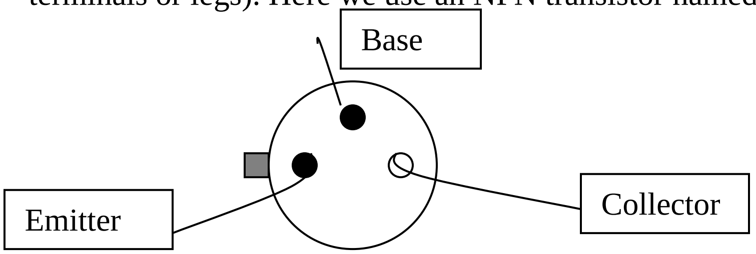
$$R_i = \frac{\Delta V_{BE}}{\Delta I_B}$$

From the output characteristic the current gains can be calculated using the formula

$$\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}} \qquad \text{Current gain } \alpha = \frac{\beta}{1+\beta}$$

Transistor terminals

(Hold the transistor towards your face, Terminals looks like a triangle, Left is emitter, Next top is base and right one is collector, Remember EBC clockwise to identify terminals or legs). Here we use an NPN transistor named SL 100 from BEL, INDIA)



CIRCUIT DIAGRAM:

Fig.1: Common emitter (CE) configuration
(as emitter is common to both input side and output side)

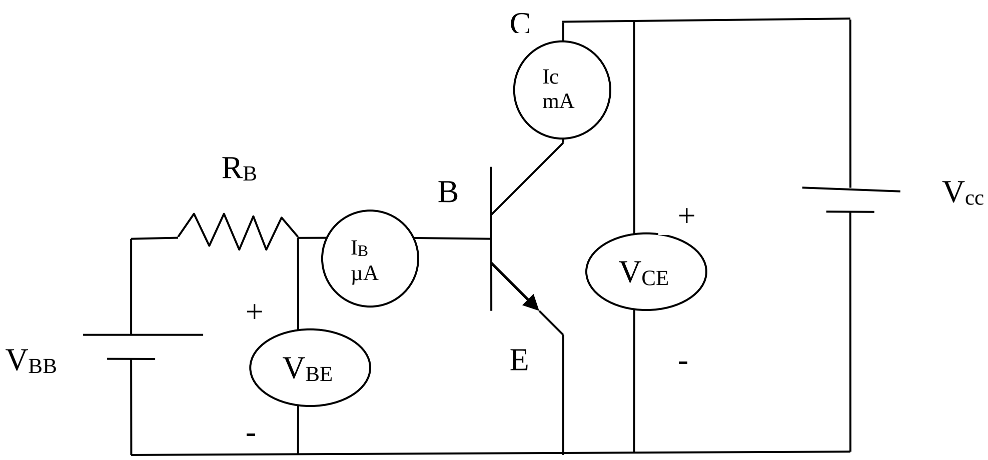


Fig.2: Input characteristics

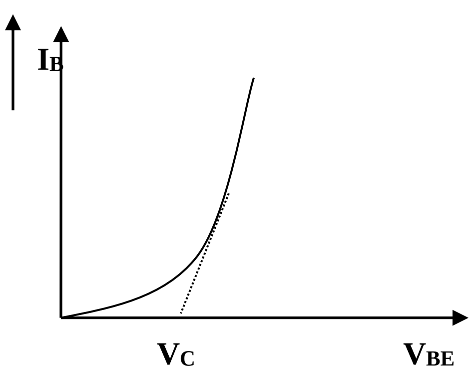
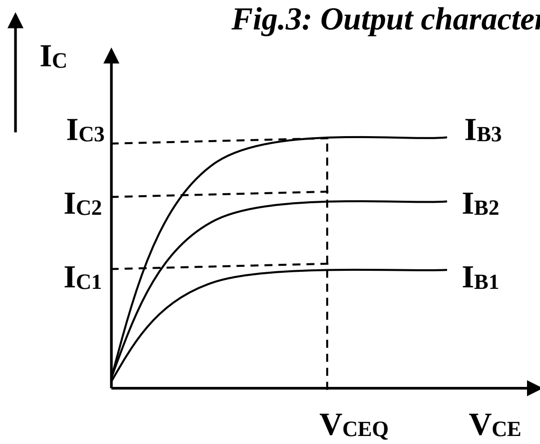


Fig.3: Output characteristics



PROCEDURE:

The circuit connections are made as shown in the fig.1. To draw the input characteristic set the value of voltage V_{CE} for some convenient value, say 2V. Then by varying the source voltage V_{BE} for different values (0 – 0.8V in steps of 1V and 0.2 V), base current I_B is note down. The graph of V_{BE} versus I_B is drawn from which the input resistance Ri is calculated. The knee voltage can be determined by the graph as shown in the fig.2.

To draw the output characteristics set the value of I_B for some convenient value, say 25 µA. Then for different values of V_{CE} (0-5V, steps of 1V) note down the current I_C. A graph of V_{CE} versus I_C is drawn. Repeat the experiment for two more values of I_B. Then current gains α and β can be calculated.

OBSERVATIONS:

a) **INPUT CHARACTERISTICS:** Dependence of I_B on V_{BE} for constant V_{CE}

V_{BE} (V)	Set V_{CE} = 2V (Output side set to 2V)
	I_B (μA)

Calculations:

From the graph 1: **Knee voltage = V.**

$$R_i = \frac{\Delta V_{BE}}{\Delta I_B} = \frac{AB \times X - Scale}{BC \times Y - Scale} =$$

b) Output characteristics: Dependence of I_C on V_{CE} for constant I_B

Trial 1		**Trial 2**		**Trial 3**	
I_{B1}= 25 µA		**I_{B2}= 50 µA**		**I_{B3}= 75 µA**	
V_{CE}(volt)	**I_C(mA)**	**V_{CE}(volt)**	**I_C(mA)**	**V_{CE}(volt)**	**I_C (mA)**

Calculations:

Evaluation of current amplification factor, $\beta = \frac{\Delta I_c}{\Delta I_B} = \frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}} =$, Current gain, $\alpha = \frac{\beta}{1+\beta}$

From the output graph: Output resistance =

RESULTS:

Knee voltage	
Input resistance (< 2kΩ)	
Output resistance ~ (100-200 Ω)	
Current Gain (α) (~0.9)	
Current Amplification Factor (β) (< 200)	

1.What is a transistor? Why is it so called?
Transistor is a three terminal device with two PN junctions. It is used to amplify signals applied at its input terminals.
It transforms the input signal from low resistance region to a high resistance region. Due to this transfer of signal across a resistance, it is called as transistor (transfer resistor).

2. Mention its advantages over vacuum electron tubes?
The transistor is much smaller in size and has no filament and hence requires no cathode heating power. It has greater operating efficiency than a compare to electron tube. It can withstand sufficiently higher strains than a vacuum tube. These are mechanically rugged and have practically unlimited life.

3. How do transistors differ from valves?
In contrast to electron tubes, which utilize the flow of free electrons through vacuum or gas, the transistor utilizes for its operation the movement of charge carriers through a semiconductor.

4. What function can be performed by transistors?
Junction transistor can work as an amplifier or oscillator like a triode tube.

5. How can a transistor be made?
A transistor can be made by sandwitching one type semiconductor between two other type.

6. What are the two types of transistors?
There are two types namely NPN & PNP transistors.

7. What does a transistor consists of?

A transistor consists of three region namely emitter, base & collector. The emitter is heavily doped, collector is lightly doped. Base is a thin layer compared to emitter & collector.

8. What are the configurations by which a transistor can be connected?
There are three ways or modes:
1. Common emitter mode (CE), 2. Common base mode (CB) & 3. Common collector mode (CC)

9. Which configuration is widely used?
The most widely used configuration is CE mode, because of its high current gain, voltage gain & power gain. In CE mode input resistance is high and output resistance is less. Hence current gain is more.

10. Define current gain of a transistor?
It is defined as the ratio of output current to the input current. It is also called as current amplification factor. The symbols which are used to represent current gains in CB mode, CE mode & CC mode are α, β & γ.