DEPARTMENT OF PHYSICS

K. S. SCHOOL OF ENGINEERING AND MANAGEMENT

KAMMAVARI SANGHAM (R) 1952

APPLIED PHYSICS FOR CSE STREAM

LAB MANUAL

COURSE CODE: BPHYS102/202

(For the First / Second Semester B.E)

(As per NEP revised VTU Syllabus)

NAME: ____

BRANCH & SEM: ____________________________________

USN NO.: ____

BATCH:____

INSTRUCTIONS TO BE FOLLOWED IN LABORATORY

1) Students should come to lab in full uniform.
2) No student will be allowed to attend the lab if absent for the Physics theory class that week.
3) Mobile phones are not allowed inside the lab. The student should bring his/her own calculator, pen, pencil, eraser, etc.
4) Every week students should enter the lab with the following accessories without fail
    - Record book
    - Lab manual
    - Observation book
    - Graph book
5) Should use only black ball point pen for all purposes in lab - for writing in observation book, lab manual, record book, drawing (Do not use pencil to record values)
6) The observation book must contain entries like *aim of the experiment, apparatus required, circuit diagram or the diagram of the experimental setup, tabular columns, the necessary formulae* of the experiments as given in the left hand side page of the lab manual.
7) Conduction of experiments:
    - Students are required to read and come well prepared to conduct the experiments. However, a brief instruction to conduct an experiment will be given.
    - Go to the respective apparatus and build/setup the circuit/experiment.
    - Show the setup to the in-charge lecturer/instructor and then switch on the circuit/or start doing the experiment.
    - Note down all the readings in the observation book using pen.
    - Once the experiment is done switch off the circuit, disconnect the apparatus and leave the apparatus to its initial state.
    - Do the calculations and obtain the results for both the experiments and get it corrected.
    - Transfer the data into the lab manual and get it corrected on the same day if not students will lose marks for late correction.
8) Students are required to stay in the lab during the lab hours.
9) Students are required to produce their completed record book on the subsequent week of conduction of experiment. Late submission will not be entertained.
10) Each experiment will be evaluated for the lab internals. After the lab internals, students are required to attend the labs to continue repetitions.
11) No additional lab test will be given for the students who are absent for the IA test.
12) Lab internals marks are allotted in the following way.

Daily Performance Based	15 marks
Lab Internal Test	10 marks

Objectives and Course Outcomes

Course: Applied Physics Laboratory   Course Code: BPHYS102/202

Course Objectives:

- To realize experimentally, the mechanical, electrical and thermal properties of materials, concept of waves and oscillations.
- Build simple circuits and hence study the characteristics of semiconductor devices.

Course Outcomes:

After the completion of Applied Physics Lab course, students will be able to

Apply the fundamental concepts of optics and semiconductor physics to understand the characteristics, properties and applications of devices and materials.
Apply the knowledge of properties of materials in various applications.

Note:

- Students are required to read and come well prepared to conduct the experiments. However, a brief instruction, to conduct an experiment will be given.
- Go to the respective apparatus and build/setup the circuit/experiment.
- Show the setup to the in charge/instructor and then switch on the circuit/or start doing the experiment.
- Note down all the readings in the observation book.
- Once the experiment is done switch off the circuit, disconnect the apparatus and leave the apparatus to its initial state.
- Same to be repeated for second experiment.
- Do the calculations and obtain the results for both the experiments.
- Show the results in the observation book and get it corrected.
- Transfer the readings and the results into the lab manual and get it corrected within next day upon the conduction of experiment after which students will lose marks for late correction.

CONTENTS

SUMMARY OF WORK DONE

Sl. No.	DATE	EXPERIMENT TITLE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Signature of the Teacher

OBSERVATION: **Expt. 1**

RAY DIAGRAM:

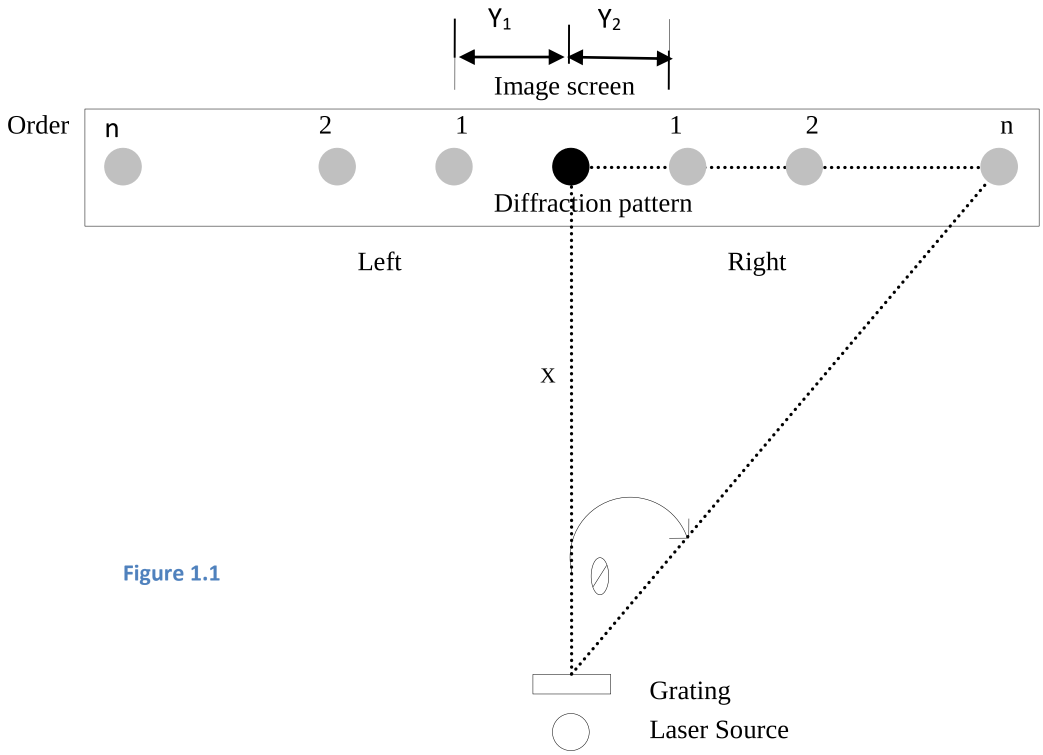


Figure 1.1

Number of lines per meter on the grating, N= 2×10^4 lines/m.

Distance between the grating and the screen, X = 100 cm.

TABULAR COLUMN:

Order of diffraction n	Distance between central maximum of the n^{th} order maximum		Average $Y = \frac{Y_1+Y_2}{2}$ (cm)	Deviation $\theta = \tan^{-1}\left(\frac{Y}{X}\right)$ (deg)	$\lambda = \frac{\sin\theta}{nN}$ (m)
	Left Y_1 (cm)	Right Y_2 (cm)			
1					
2					
3					
4					

Mean λ: ___________________m

EXPERIMENT 1

LASER DIFFRACTION

AIM: To determine the wavelength of semiconductor laser using laser diffraction.

APPARATUS: Diffraction grating, grating holder, diode laser, screen fixed with graph sheet and meter scale.

PRINCIPLE: The ability of a diffraction grating is to physically separate the different wavelengths. If the incoming light is multicolored or consists of more than one wavelength, then the angle of diffraction differs from color to color, resulting in multiple image of the slit opening with different colors. If the incoming light is single colour then different orders of slit images are seen with varying intensities.

A plane diffraction grating consists of a number of equidistant parallel slits or lines, all of same width. Diffraction occurs when the size or dimension of the obstacle is comparable with the wavelength of the source. When a parallel beam of light is incident on the grating, **Fraunhoffer diffraction** takes place. Maxima of different wavelengths occur on either side of the central maximum.

FORMULA: A laser consists of single wavelength falling on a grating will produce diffraction pattern. The principal maximum intensity of the diffracted light is given by,

$$d \sin\theta = n\lambda$$

where, d is grating constant or the distance between two consecutive rulings, $d = \frac{1}{N}$

N is number of lines per meter on the grating (m)

θ is the angle of diffraction (deg),

n = 1, 2, 3… n is called order of diffraction,

λ is the wavelength of the light used (m).

Thus the wavelength of laser is determined using the formula,

$$\lambda = \frac{\text{Sin}\,\theta}{\text{nN}} \quad in \quad m$$

CALCULATIONS:

PROCEDURE:

1. The grating is placed on grating stand and the LASER is aligned such that the beam is incident on the grating. Distance between the grating and the screen is adjusted for 1 meter (X) or 100 cm.
2. The laser beam is incident normally on the grating. Diffraction pattern is obtained on the screen as in Fig 1.1.
3. The screen is adjusted such that the central bright maximum coincides with the zero of the scale fixed on the screen. The separation between central bright maximum and first order maximum to the left of diffraction pattern (say Y_1) is measured. Same is repeated for Y_2 also.
4. Procedure is repeated to take the readings up to fourth order. Angle of deviation (θ) for each order is calculated.
5. The average wavelength is determined.

APPLICATIONS:

Lasers find wide range of applications in the following fields:

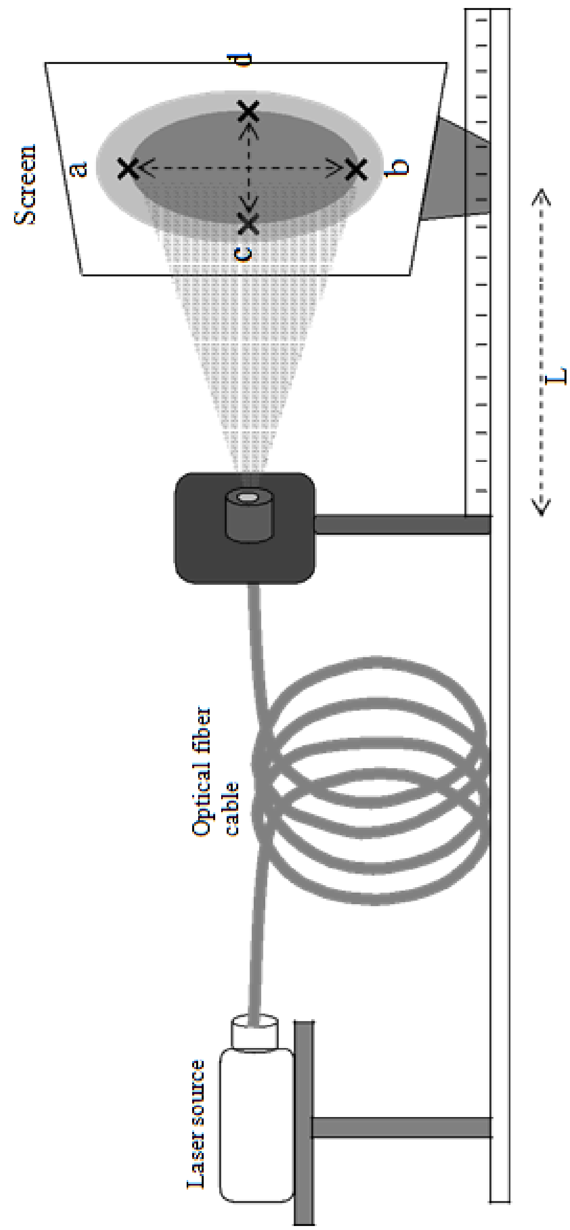
- **Medicine**: Bloodless surgery, laser healing, surgical treatment, kidney stone treatment, eye treatment, dentistry.
- **Industry**: Cutting, welding, material heat treatment, marking parts, non-contact measurement of parts.
- **Military**: Marking targets, guiding munitions, missile defense, electro-optical countermeasures (EOCM), alternative to radar, blinding troops.
- **Law enforcement**: used for latent fingerprint detection in the forensic identification field.
- **Research**: Spectroscopy, laser ablation, laser annealing, laser scattering, laser interferometry, LIDAR, laser capture micro dissection, fluorescence microscopy.
- **Semiconductor lasers find important use in optical communications, also used as reading devices for CD players**.

RESULT:

The wavelength of LASER beam is given by λ = _________________m

OBSERVATION: **Expt. 2**

DIAGRAM:



EXPERIMENT 2

OPTICAL FIBER

AIM: To determine the Acceptance angle and Numerical aperture of the given optical fiber.

APPARATUS: Laser source, Optical fiber, Screen, Scale, Lamp.

PRINCIPLE: The sine of the acceptance angle of an optical fiber is known as the numerical aperture of the fiber. The acceptance angle can also be measured as the angle spread by the light signal at the emerging end of the optical fiber. Therefore, by measuring the diameter of the light spot on a screen and by knowing the distance from the fiber end to the screen, we can measure the acceptance angle and there by the numerical aperture of the fiber.

FORMULA:

Acceptance angle,

$$\theta_o = tan^{-1}\frac{D}{2L} \qquad (deg)$$

where, θ_o is the acceptance angle (deg)

D is the diameter of the bright circle formed on screen (m)

L is the distance between the optical fiber end and screen (m)

Numerical aperture,

$$NA = sin\theta_o$$

PROCEDURE:

1. Switch on the laser source and adjust the distance between output end of the optical fiber and the screen ‘L’ (say 5 cm).
2. Place a graph sheet on the screen and observe the circle formed on the graph sheet.
3. Mark the points ‘a’, ‘b’, ‘c’ &‘d’ on the inner bright circle as shown in the diagram. Note down the horizontal diameter D_1 and vertical diameter D_2 of the inner bright circle in the tabular column.
4. Repeat the above steps for different values of L (for 4cm, 3cm …).
5. Find the Acceptance angle from the tabular column and hence the Numerical aperture.

TABULAR COLUMN:

Trial No.	L (cm)	Horizontal diameter D_1 (cm)	Vertical diameter D_2 (cm)	Mean diameter D (cm)	Acceptance angle $\theta_o = tan^{-1}\frac{D}{2L}$ (deg)	Numerical Aperture $NA = sin\theta_o$
1	2					
2	3					
3	4					
4	5					

$(\theta_o)_{mean}$=……………………deg

$(NA)_{mean}$=……………………

APPLICATIONS:

The application and uses of optical fiber can be seen in:

1) Medical Industry
2) Communication
3) Defense
4) Industries
5) Broadcasting
6) Lighting and Decorations
7) Mechanical Inspections

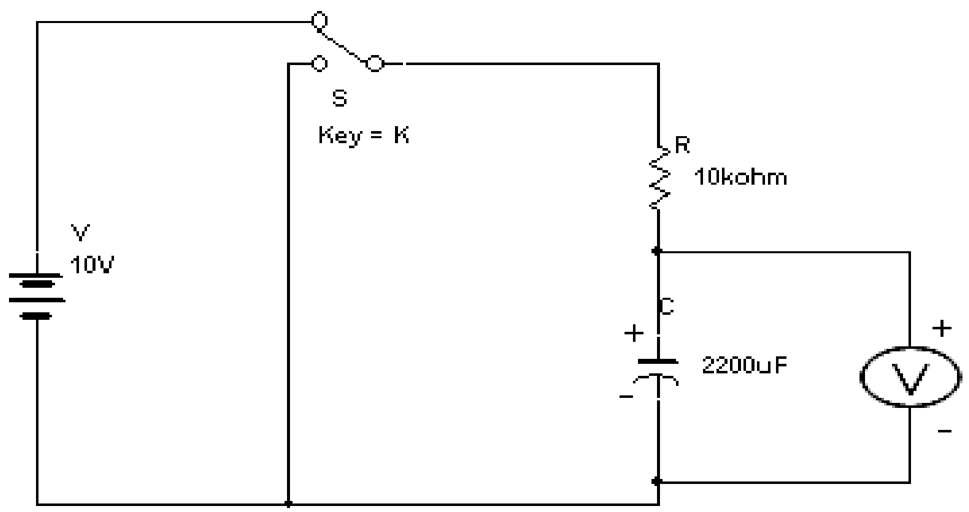
RESULT:

1. The Angle of acceptance of the given optical fiber is θ_o = …………… deg
2. Numerical aperture of the given optical fiber is NA = ……………….

OBSERVATION:

Expt. 3

CIRCUIT DIAGRAM:



V = Voltmeter

C = Capacitor

R = Resistor

Figure 3.1

EXPECTED GRAPH:

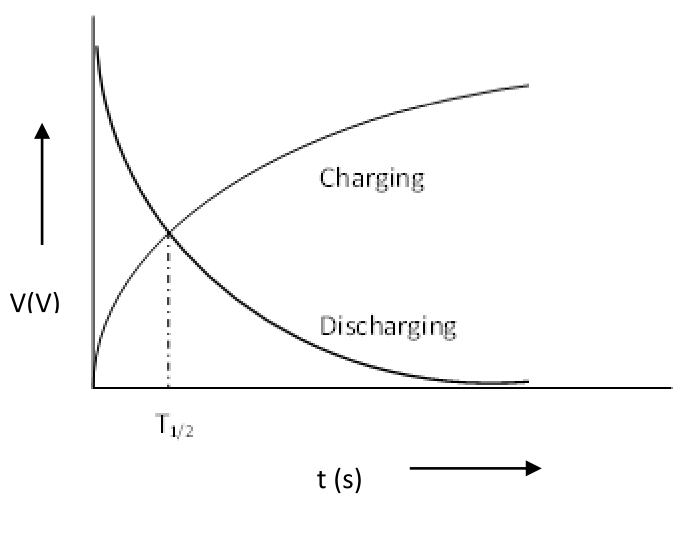


Figure 3.2

CALCULATIONS:

From Graph $T_{1/2}$ = …….......... s

EXPERIMENT 3

DIELECTRIC CONSTANT BY RC CHARGING AND DISCHARGING

AIM: To determine the dielectric constant of the material of the capacitor by the method of charging and discharging.

APPARATUS: DC regulated power supply, toggle switch, electrolytic capacitor, resistor and voltmeter.

THEORY: A parallel plate capacitor is formed by keeping two metallic plates parallel to each other. By applying a potential across the two plates an electric field is produced inside the space between the two plates. By placing an electrically insulated material (dielectric) within the plates the capacitance of the capacitor can be increased. A capacitor can be charged using a resistor and a DC source. The capacitor will charge exponentially. The instantaneous voltage across the capacitor during charging is given by

$$V_{charge} = V_0 (1-e^{-t/RC})$$

When the switch is turned to the discharge mode, the capacitor loses its charge and discharges through R. Therefore, the voltage across the capacitor starts decreasing until it becomes zero. The instantaneous voltage across the capacitor during discharge is given by

$$V_{discharge} = V_0 (e^{-t/RC})$$

where R is resistance in ohms, C is capacitance in Farad, t is the instantaneous time, V_0 is the maximum voltage to which capacitor is charged.

FORMULA:

The dielectric constant of the material of the capacitor is determined using the formula

$$\varepsilon_r = \frac{T_{1/2}\ d \times 10^{-6}}{0.693\ \varepsilon_o\ R\ A}$$

where, ε_o is permittivity of free space = 8.854×10^{-12} *F/m*

R is the resistance = 10 $k\Omega$,

A is area of the plates of the capacitor = 73.6×10^{-4} m^2,

d is the thickness of the dielectric material between the plates of the capacitor, d = 0.11×10^{-3} m

TABULAR COLUMN:

Time (s)	Charging Voltage (V)	Discharging Voltage (V)
0		
10		
20		
30		
40		
50		
60		
70		
80		
90		
100		
110		
120		

PROCEDURE:

1. The connections are made as shown in the circuit diagram (Fig. 3.1). The charge is removed from the capacitor by shorting its terminals.
2. It is ensured that the toggle switch is at the center. The toggle switch is turned-on for charging mode and simultaneously a stop clock is started.
3. The potential difference across the capacitor is noted for every 10 seconds until the saturation is achieved (i.e., the voltage across the capacitor remains constant).
4. After the saturation is achieved the toggle switch is turned to center position. The stop clock is reset to zero.
5. The toggle switch is turned on for discharging mode. The voltage across the capacitor is noted for every 10 seconds until the capacitor discharges completely.
6. A graph of voltage versus time is plotted on the same graph for both charging and discharging of a capacitor (Fig 3.2). In graph the meeting point of two curves is noted as time $T_{1/2}$.

APPLICATIONS:

A capacitor can store electric energy when disconnected from its Charging circuit, so it can be used like a temporary battery. Capacitors are commonly used in electronic devices to maintain power supply while batteries are being changed. In car audio systems, large capacitors to store energy for the amplifier are on demand. Capacitors are widely used in electronic circuits to perform variety of tasks, such as smoothing, filtering, bypassing etc.

RESULT:

The dielectric constant of the dielectric material of parallel plate capacitor is

ε_r =_______________

OBSERVATION: **Expt. 4**

CIRCUIT DIAGRAM:

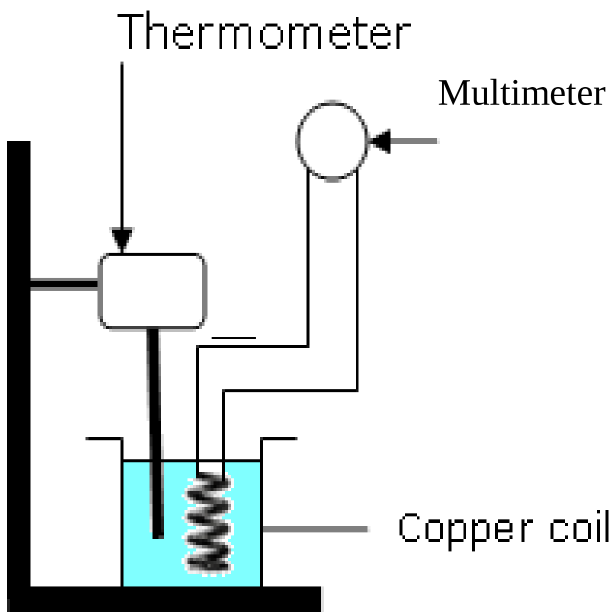


Figure 4.1

EXPECTED GRAPH:

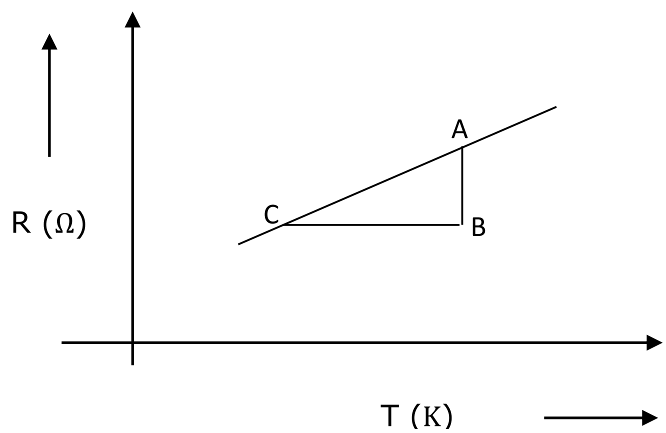


Figure 4.2

EXPERIMENT 4

FERMI ENERGY OF COPPER

AIM: To determine the Fermi energy of copper by studying the variation of resistance with temperature.

APPARATUS: Copper coil, Thermometer, Multimeter, Beaker.

PRINCIPLE: The energy of the highest occupied level at zero-degree absolute is called the Fermi energy (E_F) and the energy level is referred to as the Fermi level. Fermi energy gives us information about the velocities of the electrons which participate in the electrical conduction. Fermi temperature (T_F) is the temperature at which the average thermal energy of free electrons becomes equal to Fermi energy.

Pauli's exclusion principle "it states that no two electrons can have the same four quantum numbers". That is, if n, l, and ml are the same, m_s must be different such that the electrons have opposite spins.

FORMULA:

(1) The Fermi energy of copper is calculated using the formula,

$$E_F = 1.37 \times 10^{-15} \sqrt{\frac{DAS}{l}} \quad \text{J}$$

where, D is Density of copper = 8.96×10^3 kg/m^3,

l is the Length of the copper wire = 11 m,

A is the area of cross-section of the wire which is found using the formula,

$$A = \frac{\pi d^2}{4} \ (m^2),$$

d is the diameter of the Copper wire = 0.25×10^{-3} m,

S is the slope in Ω/K.

TABULAR COLUMN:

Sl. No.	Temperature T (^{0}C)	Temperature T (K)	Resistance R (Ω)
1			
2			
3			
4			
5			
6			

PROCEDURE:

1. The circuit connections are made as shown in Fig 4.1. The copper coil is immersed into the beaker and the beaker is filled with boiling water & a thermometer is introduced into water.
2. Starting with the temperature of 85°C, the resistance (R) of the copper coil is measured using multimeter and the temperature of the water is measured using a Digital thermometer.
3. The resistance of the copper coil is measured for every 5°C fall in temperature (T) of water up to 60°C. A graph of Resistance (R) Versus Temperature (T) is plotted (as in Fig 4.2). The slope (S) is determined and hence Fermi energy of E_F of copper is calculated.

APPLICATION:

It is used, for example, to describe metals, insulators, and semiconductors. It is a very important quantity in the physics of superconductors.

The concept of Fermi energy is crucially important concept for the understanding of the electrical and thermal properties of solids.

RESULT:

The Fermi energy of Copper is given by E_F =__________eV

OBSERVATION: **Expt. 5**

CIRCUIT DIAGRAM:

SERIES RESONANCE CIRCUIT:

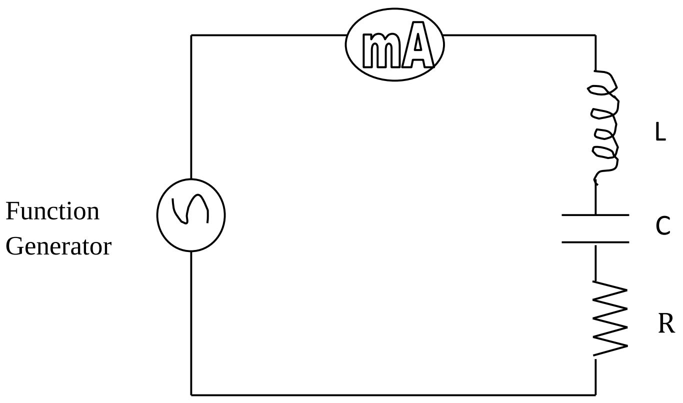


Figure 5.1

EXPECTED GRAPH:

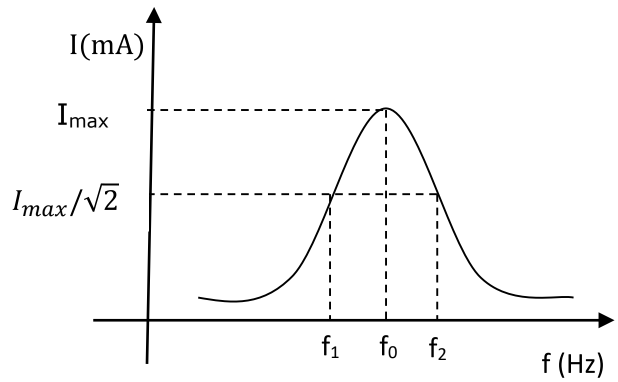


Figure 5.2

PARALLEL RESONANCE CIRCUIT:

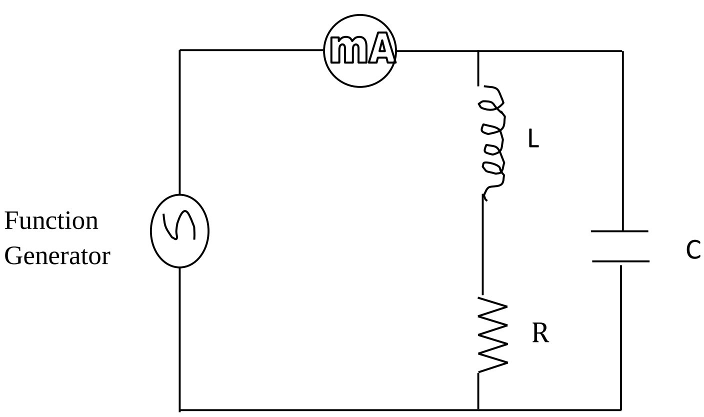


Figure 5.3

EXPECTED GRAPH:

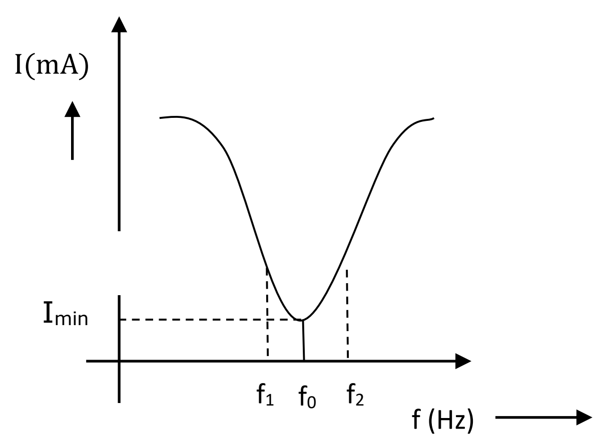


Figure 5.4

EXPERIMENT 5

SERIES AND PARALLEL RESONANCE CIRCUITS

AIM: To study the series and parallel LCR resonance and hence to calculate the self-inductance value of the given inductor **L**, Bandwidth **BW** and Quality factor **Q** using series LCR resonance.

APPARATUS: Resistor, inductor, capacitor, function generator and AC milli-ammeter.

PRINCIPLE:

In a series resonance circuit, the current depends on the frequency of the input voltage. With the increase in frequency, the inductive reactance (X_L) increases and capacitive reactance (X_C) decreases. At resonance ($X_L = X_C$), the output voltage and current are in phase and have maximum value. Knowing the capacitance and the resonant frequency, the inductance, bandwidth and quality factor are calculated. But in a parallel resonant circuit, at resonance with resistance in the inductance arm, the current in the inductance arm is equal to the current in the capacitance arm ($I_L = I_C$). The impedance is maximum and hence the current is minimum. The output voltage and current are out of phase.

FORMULA:

(1) The Self Inductance of inductor is found using the formula,

$$L = \frac{1}{4\pi^2 {f_0}^2 C} \quad \text{H}$$

where, f_0 is the resonant frequency (Hz)
C is the value of capacitance (F)

(2) The Band Width is found using the formula,

$$\Delta f = (f_2 - f_1) \quad \text{Hz}$$

where, f_1 is the lower cut off frequency (Hz),
f_2 is the upper cut off frequency (Hz)

(3) The Quality factor is found using the formula,

$$Q = f_o/(f_2 - f_1)$$

where, f_o is the resonant frequency (Hz)

TABULAR COLUMN:

Capacitance of the given capacitor = 47 nF

Frequency (Hz)	Series Current (mA)	Parallel Current (mA)
1000		
1200		
1400		
1600		
1800		
2000		
2200		
2400		
2600		
2800		
3000		
3200		
3400		
3600		
3800		
4000		

PROCEDURE:

SERIES CIRCUIT:

1. The circuit connections are made as shown in Fig. 5.1.
2. The frequency is increased from 1000 to 4000 Hz in steps of 200Hz and corresponding values of current are recorded.
3. A graph of current versus frequency is plotted. The curve obtained is as shown in Fig. 5.2.
4. The resonant frequency, bandwidth, quality factor are determined with the help of the graph.
5. Using resonant frequency and capacitance value, calculate inductance of the given inductor.

PARALLEL CIRCUIT:

6. The circuit connections are made as shown in Fig. 5.3.
7. The experiment is repeated as in the case of series.
8. A graph of current versus frequency is plotted. The curve obtained is as shown in the Fig. 5.4.
9. The resonant frequency is determined with the help of the graph.
10. Using resonant frequency and capacitance value, calculate inductance of the given inductor.

APPLICATIONS:

They are used in many different types of oscillator circuits. Another important application is for tuning, such as in radio receivers or television sets, where they are used to select a narrow range of frequencies from the ambient radio waves.

One use for resonance is to establish a condition of stable frequency in circuits designed to produce AC signals.

RESULT:

Series LCR

(a) Resonant frequency, f_o = ……………… Hz

(b) Self-inductance of the inductor, L = ………………...H

(c) Band-width, Δf = ………………. Hz

(d) Quality factor, Q = ………………

Parallel LCR

(a) Resonant frequency, f_o = ……………… Hz

(b) Self-inductance of the inductor, L = ………………...H

CIRCUIT DIAGRAM: Expt.6

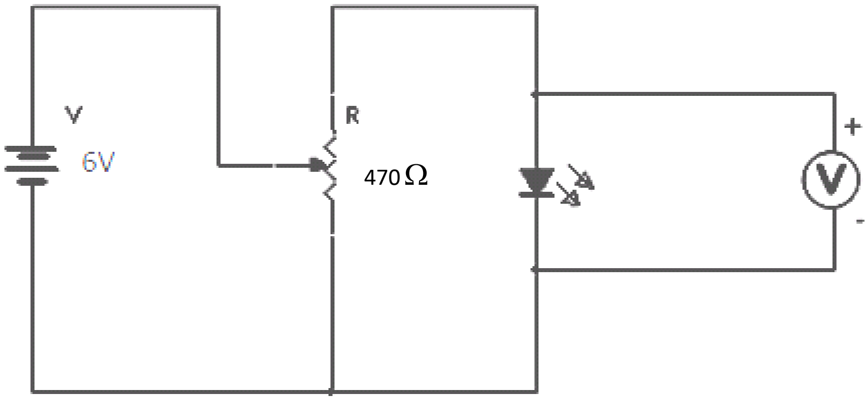


Figure 6.1

R = Resistor, V = Voltmeter

TABULAR COLUMN:

Serial no.	L E D	Wavelength λ (nm)	Turn-on voltage V_0 (V)	Energy of the photon $E = eV_0$ (J)	Frequency $\nu = c/\lambda$ (s^{-1})
1	Blue	**440**			
2	Green	**570**			
3	Yellow	**600**			
4	Orange	**620**			
5	Red	**640**			

EXPERIMENT 6

PLANCK'S CONSTANT USING LED

AIM: To determine the value of Planck's constant using Light Emitting Diode (LED).

APPARATUS: LED (Red, Orange, Yellow, Green, Blue), battery eliminator 6V, potentiometer, voltmeter.

PRINCIPLE:

Planck's law states that "a law that is the basis of quantum theory, which states that the energy of electromagnetic radiation is confined to indivisible packets (quanta), each of which has an energy equal to the product of the Planck constantand the frequency of the radiation".

FORMULA:

(1) The energy E is calculated using the formula,

$$\mathbf{E = eV_0} \qquad \mathbf{J}$$

where, e = charge on electron = **1.6** x **10^-19^ C**,

V_0 = turn on voltage in **V**.

(2) The frequency (ν) of the radiation is calculated using the formula,

$$\boldsymbol{\nu = \frac{c}{\lambda}} \qquad \text{in } s^{-1}$$

Where, *c* is the velocity of light=$\mathbf{3 \times 10^8}$ $\boldsymbol{ms^{-1}}$,

ν is wavelength of light in **m**.

(3) Planck's constant is found using the formula,

$$\boldsymbol{h = \frac{E}{\nu}} \quad \mathbf{Js}$$

where, E is the energy of the photon in **J,**

ν is the frequency of radiation in s^{-1}.

EXPECTED GRAPH:

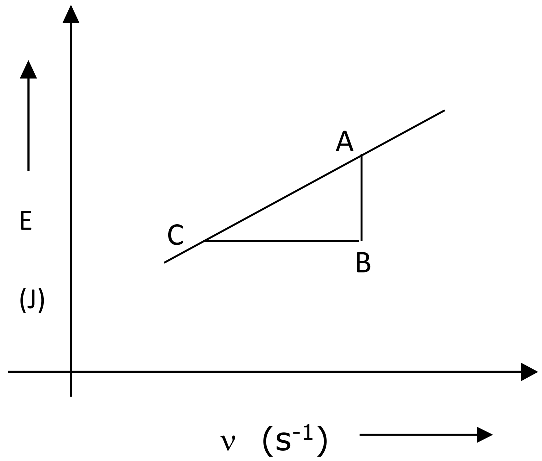


Figure 6.2

APPLICATION:

LED's are used in,

Household appliances, VCR/ DVD/ Stereo/Audio/Video devices, Toys/Games Instrumentation, Security Equipment, Switches, as indicator lamps in many devices, street lights and in other architectural lighting where color changing is used.

Aviation lighting: LEDs are also

being used now in airport and heliport lighting. Cameras on mobile phones, where space is at a premium and bulky voltage-raisingcircuitry is undesirable.

PROCEDURE

1. The connections are made as shown in fig 6.1. The voltmeter is connected acrossthe red LED.

2. The voltage is applied across the diode using the source and is increased by operating the potentiometer until the LED just starts to glow (minimum intensity).

3. The turn on voltage (V_0) of the red LED is noted down. The voltage across the diode is reduced to zero.

4. The source and the voltmeter are connected across the orange LED. The turn-on voltage for orange LED is noted. The same is repeated for other LEDs.

5. The energy (E) corresponding to turn on voltage (V_0) and hence the frequency(ν) of the radiation is calculated.

6. A graph of energy (E) versus frequency (ν) is plotted (as in fig 6.2). The slope (S) of straight line is obtained which gives the value of Planck's constant.

RESULT: The value Planck's constant is h=_________________**J s**.

OBSERVATION:

CIRCUIT DIAGRAM: Expt. 7

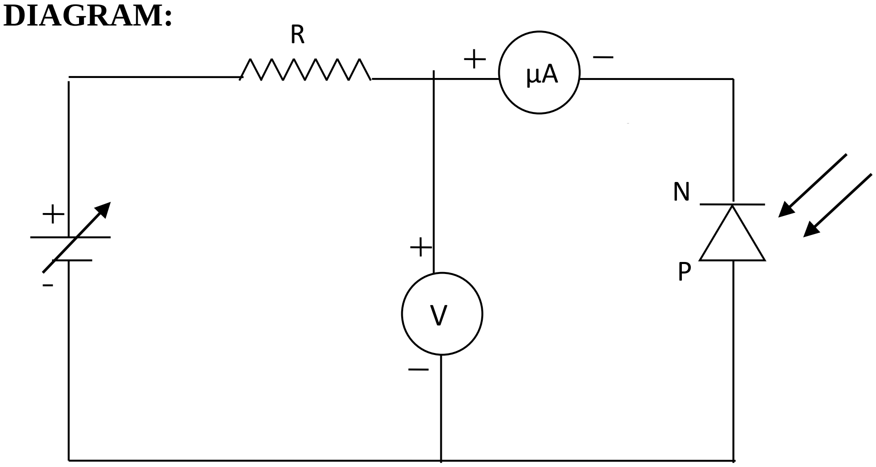


Figure-7.1

EXPECTED GRAPHS:

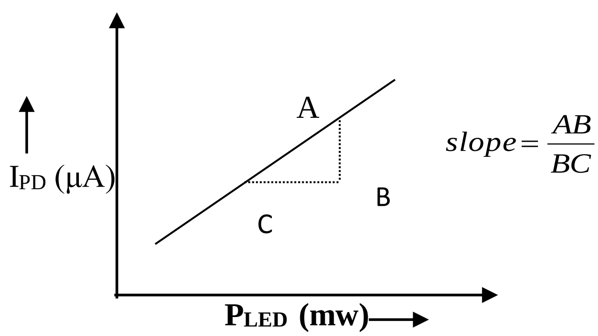


Figure 7.2-Variation of photodiode current with LED power (V_{PD} = -1 V)

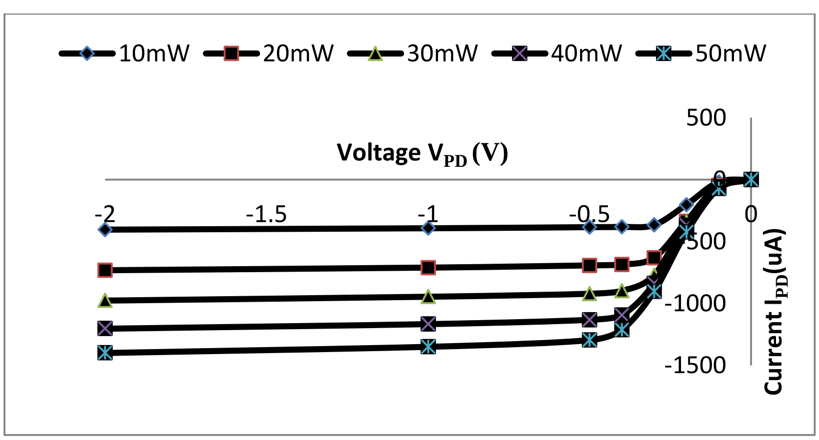


Figure 7.3-Variation of photodiode voltage with current

EXPERIMENT 7

PHOTODIODE CHARACTERISTICS

AIM: To study the I-V characteristics of a photodiode and to determine the responsivity from the variation of photocurrent with the intensity of illumination.

APPARATUS: Regulated power supply, digital DC current meter, digital DC volt meter, white light LED and photo diode LED type.

THEORY: A photodiode is a semiconductor device that converts light energy into electrical energy. Radiation sensitive junction is formed in a semiconductor material whose resistivity changes when illuminated by light. PN junction photodiodes comprise a two-electrode, radiation sensitive junction formed in a semiconductor material, in which the reverse current varies with the amount of illumination. The photo diode behaves as a constant current source when operated with reverse bias. The Photodiodes are optimized to conduct in reverse bias by controlling the level of doping. When there is no light falling on the Photodiode it does not conduct in the reverse bias, hence light is must for conduction in Photodiode.

FORMULA: The degree of response of a silicon photodiode to light is a measure of its sensitivity, and it is defined as the ratio of the photocurrent I_{PD} to the incident light power P_{LED} at a given wavelength Rλ. Responsivity is given by

$$R_{\lambda} = \frac{I_{PD}}{P_{LED}} \text{ in A/W}$$

where, I_{PD} is the photodiode current and P_{LED} is the light input power.

PROCEDURE:

A. Determination of Responsivity:

1. The LED (white light) and PD are placed face to face as shown in Fig. 7.1, and the light arrangement is switched on. LED power is set to 10mW by turning the knob to its minimum position. While noting the photodiode current in the meter, the cover is placed so that any external light will not affect the readings. Photodiode is reverse biased by connecting the power supply and negative terminal of the diode to the positive terminal of the power supply.

TABULAR COLUMN:

a) Variation of photodiode current with LED power (V_{PD} = -1V)

P_{LED} (mW)	I_{PD} (μA)
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Table 7.1

b) Variation of photodiode voltage with current

V_{PD}(V)	I_{PD}(μA)		
	P_{LED} = 10mW	P_{LED} = 21mW	P_{LED} = 30mW
0			
0.1			
0.2			
0.3			
0.4			
0.5			
1.0			
2.0			

Table 7.2

2. The LED power is increased insteps of 1mW upto 20mW. In each case V_{PD} is set to -1V and I_{PD} is noted in Table-7.1
3. A graph showing the variation of P_{LED} on X-axis and I_{PD} on Y axis is drawn as shown in Figure-1.2. A straight line graph is obtained and the slope gives the value of responsivity.

B. I-V Characteristics of PD:

1. The LED power is set to 10mW on the dial and V_{PD} is set to -0.1V 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 7.2.
3. Experiment is repeated by increasing the LED power to 10, 21 and 30mW. In each case variation in V_{PD} and corresponding I_{PD} are noted in Table 7.2.
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.

APPLICATIONS:

Photodiodes have wide range of applications. Photodiodes are used in camera for auto-focus and photographic flash control, in medical field as blood particle analyzers, in safety equipment as smoke detectors and flame monitors, in automotive industry as sunlight detectors, in optical fiber communication systems and in industries like bar code scanners, position sensors, light pens etc.

RESULTS:

1. The responsivity of the photodiode = …………….. A/W
2. IV characteristics are drawn for the photo diode and the linearity of photocurrent with light intensity is observed.

OBSERVATION **Expt. 8**

DIAGRAM:

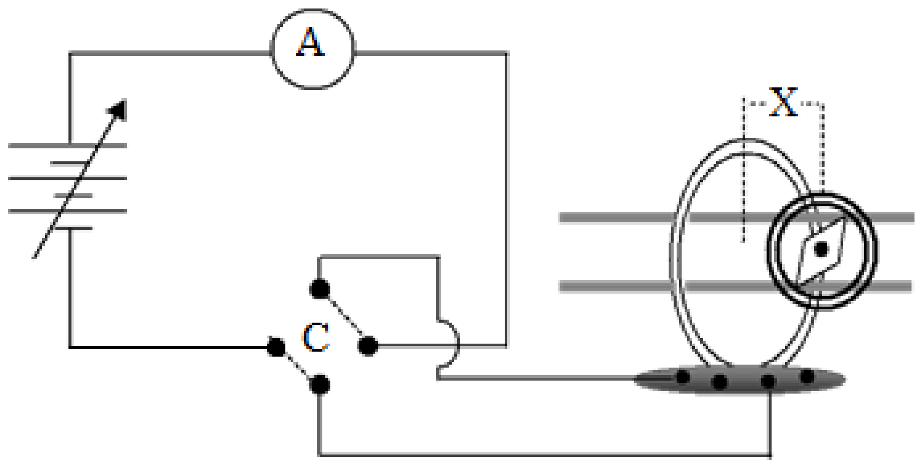


Figure 8.1

EXPERIMENT 8

MAGNETIC FIELD ALONG THE AXIS OF A COIL

AIM: To determine the magnetic field intensity along the axis of a circular coil carrying current and earth's horizontal magnetic field by deflection method.

APPARATUS: Deflection magnetometer, sprit level, commutator, ammeter, variable power supply and connecting wires.

PRINCIPLE: For a circular coil of a n turns, carrying a current I, the magnetic field at a distance x from the coil and along the axis of the coil is given by

$$B = \frac{\mu_0 nI}{2} \frac{R^2}{(R^2 + x^2)^{\frac{3}{2}}}$$

In this experiment, the coil is oriented such that the plane of the coil is vertical and parallel to the north-south direction. The axis of the coil is parallel to the east-west direction. The net field at any point x along the axis, is the vector sum of the fields due to the coil B(x) and earth' s magnetic field B_H.

FORMULA:

$$B = \frac{\mu_0 nI}{2} \frac{R^2}{(R^2 + x^2)^{\frac{3}{2}}} \text{ in Tesla}$$

where, B – the magnetic field intensity at the center of a circular coil (T)

n – Number of turns in the TG coil

R – Radius of the coil (m)

x – Distance between the center of the coil and pointer in the compass box (m)

μ_o - Permeability of free space = $4\pi x10^{-7}$ Hm^{-1}

I – the current through the coil (A)

$$B_H = \frac{B}{\tan\theta}$$

where, B – the magnetic field intensity at the center of a circular coil (T)

B_H – horizontal component of earth's magnetic field (T)

θ – Mean deflection in TG (degree)

TABULAR COLUMN:

Sl. No.	Current I (A)	X (m)	Deflection (deg)				Average θ (deg)	B (T)	$B_H = \frac{B}{\tan\theta}$ (T)
			θ_1	θ_2	θ_3	θ_4			
1	0.1	0							
2		0.05							
3		0.1							
4	0.2	0							
5		0.05							
6		0.1							

CALCULATIONS:

PROCEDURE:

1. The connections are made as shown in the circuit diagram.
2. Arrange the deflection of the magnetometer in the magnetic meridian of the earth.
3. Now align the plane of the coil with respect to 90°-90° line of the magnetometer.
4. Keep the magnetometer exactly at the center of the coil (for this case x = 0).
5. Pass a current I (say 0.5A) to flow through the coil and the corresponding magnetometer deflections θ_1 and θ_2 are noted.
6. The direction of the current is reversed by using the commutator C and the corresponding magnetometer deflections θ_3 and θ_4 are noted.
7. Average deflection θ is calculated.
8. Calculate the magnetic field B at the center of the coil by using the given formula.
9. Repeat the experiment for different values of x (say 5cm, 10cm…) by sliding the magnetometer along the axis.
10. Find the average of both B and B_H.

RESULT:

The magnetic field intensity along the axis of the given circular coil is calculated and is as shown in the tabular column.

At the center (x = 0) it is found to be B = ……………..T and the Earth's horizontal magnetic field intensity is found to be B_H =………………T

OBSERVATION: **Expt. 9**

CIRCUIT DIAGRAM:

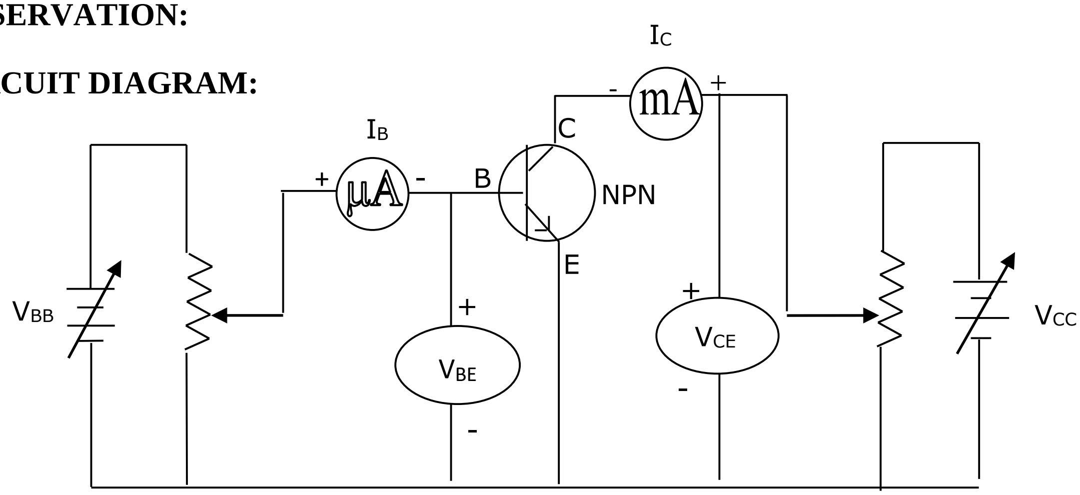


Figure 9.1

EXPECTED GRAPH:

INPUT CHARACTERISTICS:

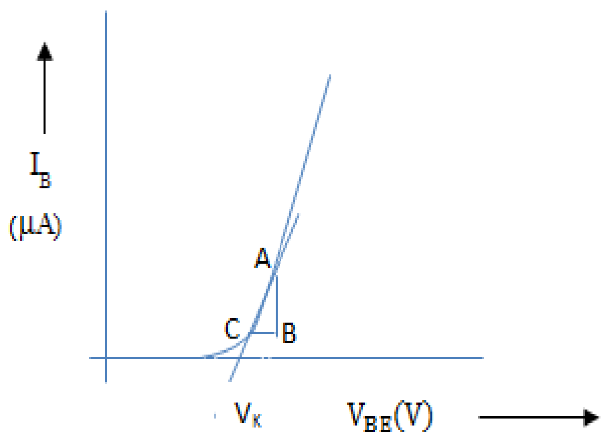


Figure 9.2

OUTPUT CHARACTERISTICS:

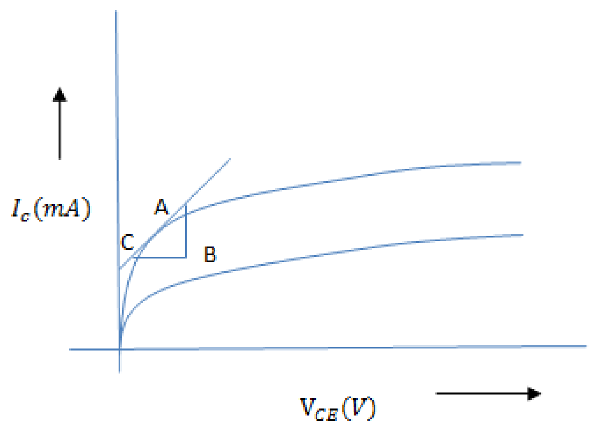


Figure 9.3

EXPERIMENT 9

TRANSISITOR CHARACTERISTICS

AIM: To study the input and output characteristic of the given Transistor in C-E mode and to find Input resistance, Output resistance and Amplification factor.

APPARATUS: Transistor, DC Regulated power supplies, DC Micro ammeter, DC milli ammeter, DC Voltmeter.

PRINCIPLE: A bipolar junction NPN transistor consists of two back-to-back p-n junctions, which share a thin common region with width, w. Contacts are made to all three regions, the two outer regions called the **emitter** and **collector** and the middle region called the **base**. The device is called "bipolar" since its operation involves both types of mobile carriers, electrons and holes.

FORMULA:

(1) The input resistance $\boldsymbol{R_i}$ is determined using slope.

$$\frac{1}{slope} = R_i = \frac{\Delta V_{BE}}{\Delta I_B} \quad \text{in } \Omega$$

(2) The output resistance is determined using slope

$$\frac{1}{slope} = R_o = \frac{\Delta V_{CE}}{\Delta I_C} \quad \text{in } \Omega$$

where, V_{BE} = base-emitter voltage in V,

V_{CE} = collector-emitter voltage in V,

I_B = Base current in μ A,

I_C = Collector current in mA.

(3) The current amplification factor $\boldsymbol{\beta}$ is determined using the formula,

$$\beta = \frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}}$$

where, I_C is collector Current in *mA*, I_B is base Current in μ A.

TABULAR COLUMN:

INPUT CHARACTERISTICS

V_{CE} = 2V	
V_{BE} (V)	I_B (µA)
0	
0.1	
0.2	
0.3	
0.4	
0.5	
0.55	
0.6	
0.65	
0.7	
0.75	
0.8	

OUTPUT CHARACTERISTICS

V_{CE} (V)	I_{B1} =50µA	I_{B2} =75µA
	I_{C1} (mA)	I_{C2} (mA)
0		
0.2		
0.4		
0.6		
0.8		
1		
2		
3		
4		
5		

PROCEDURE:

1. The electrical connections are made as shown in the Fig. 9.1.
2. The voltmeter is connected across collector-emitter junction and V_{CE} is adjusted for 2V.
3. The voltmeter is now connected across emitter-base junction and V_{BE} is increased from 0 to 0.8 V in steps of 0.1 V and corresponding value of base current I_B are recorded.
4. A graph of base emitter voltage V_{BE} V/s base current I_B, for constant V_{CE} is plotted (as in Fig. 9.2). A tangent is drawn to the increasing portion of the curve and that value of x-axis is taken as **Knee Voltage** $V_{K.}$
5. The voltmeter is connected across collector-emitter junction. The base current I_B is adjusted for 50μA. The collector-emitter voltage V_{CE} is initially varied in steps of 0.1V starting from 0.1V till 0.3V then in steps of 1V till 8V and the corresponding values of collector current I_C are recorded. The experiment is repeated by adjusting I_B for 75 μA.
6. The graph of V_{CE} v/s I_C is plotted for both the values of I_B (as in Fig 9.3). Slope is found at the increasing portion of any one curve.

APPLICATIONS:

The design of a transistor allows it to function as an amplifier or a switch. From mobile phones to televisions, vast numbers of products include amplifiers for sound reproduction, radio transmission, and signal processing.

RESULT:

1. The input resistance of transistor $\boldsymbol{R_i}$ = ---------------Ω
2. The output resistance of transistor $\boldsymbol{R_o}$ = ------------- Ω
3. The β of the transistor is found to be **β** = ------------

VIVA VOCE

QUESTIONS

QUESTIONS

LASER DIFFRACTION

1. **Define wavelength and frequency?**
   Wavelength is the distance between two consecutive crust or trough.
   Frequency is the number of cycles completed in one second.

2. **What is diffraction of light?**
   The bending of light around the corners of small obstacle is called diffraction.

3. **Which is the obstacle in the experiment?**
   Grating.

4. **What is a grating?**
   It's a plane glass plate having large number of parallel lines.

5. **What is grating constant?**
   It is the distance between two consecutive lines.

6. **What is the condition for diffraction?**
   The size of the obstacle must be comparable to the wavelength of the light used.

7. **Name the 2 types of diffraction?**
   Fresnel diffraction and Fraunhoffer diffraction.

8. **Distinguish between Fresnel and Fraunhoffer diffraction?**
   Fresnel diffraction:
   - Spherical or cylindrical wave fronts are used.
   - Lenses are not used.
   - Source and screen are kept at finite distance.

   Fraunhoffer diffraction:
   - Plane wave fronts are used.
   - Lenses are used.
   - Source and screen are kept at infinite distance.

9. **What is LASER?**
   The term LASER stands for Light Amplification by Stimulated Emission of Radiation.
   It is a device which produces a powerful, monochromatic collimated beam of light in which the waves are coherent.

10. **What is semiconductor diode laser?**
    Semiconductor diode laser is a specially fabricated p-n junction diode. It emits laser light when it is forward biased.

11. **What are the characteristic of laser radiation?**
    Laser radiations have high intensity, high coherence, high monochromaticity and high directionality with less divergence.

12. **Distinguish between monochromatic and polychromatic light with an example?**
    The light with single wavelength is called monochromatic.
    Ex: Sodium vapour lamp.
    The light with different wavelengths is called polychromatic.
    Ex: Mercury vapour lamp.

13. **Distinguish between interference and diffraction?**
    Interference: It is the modification in the intensity of light due to superposition of two or more waves. For interference 2 sources must be coherent. All fringes are equally spaced. Intensity of all bright fringes are same.
    Diffraction: It is the bending of light around the corners of small obstacle. For diffraction size of the obstacle must be comparable with the wavelengths of light. Fringes are not equally spaced. Intensity of all bright fringes are not same.

14. **Is the conducting experiment Fraunhoffer type or Fresnel type?**
    Fraunhoffer diffraction.

15. **Are the intensities of light same in all the orders of the spectrum?**
    NO.

16. **What is a wave front?**
    It is the locus of all the particles which are in the same state of vibration.

17. **What is the basic principle involved in LASER action?**
    An emission that is caused by an external stimulus known as ’Stimulated emission’ is the basic principle in LASER action.

18. **What is Stimulated emission?**
    Stimulated emission is the emission of a photon by a system, under the influence of a passing photon of suitable energy, due to which the system transits from a higher energy state to a lower energy state. The photon thus emitted is called stimulated photon and will have same phase, energy and direction of movement as that of the passing photon is called stimulating photon.

19. **What are the requirements of LASER system?**
    (I) The excitation source for pumping action.
    (II) An active medium which supports population inversion,
    (III) A laser cavity.

20. What are the conditions required for the LASER action?
Population invention and metastable state.

21. What is population inversion?
It is a stage at which number of atoms in the excited state exceeds the number of atoms in the ground state (N_2>N_1).

22. How are gratings are prepared?
Gratings are prepared by ruling parallel and equidistant lines on a well-polished glass plate using sharp diamond edge.

23. What happens to diffraction pattern when laser light is replaced by white light?
The diffraction pattern will be band of seven colours with white spot at the center. The violet colour is nearer to white spot and red at the extreme end (because θ αλ).

24. What is a spectrum?
It is an orderly arranged wavelength.

25. Distinguish between pure spectrum and impure spectrum with an example?
Pure spectrum is one in which constituent colours do not overlap. Ex: Prism spectrum.
Impure spectrum is one in which constituent colours overlap. Ex: Rainbow.

OPTICAL FIBER

1. What is the basic principle of an optical fiber?
Optical fiber works based on the principle of total internal reflection [TIR]

2. What is an optical fiber?
An optical fiber is a wave guide system through which light signals are carried over longer distances without loss of energy.

3. What is Numerical aperture (NA)?
The light gathering capacity of an optical fiber is called Numerical Aperture.

4. Why optical fibers do not pick up electricity?
Optical fibers are made by pure non-metallic materials hence they won't allow electricity.

5. What is Total Internal Reflection (TIR)?
Total internal reflection is the phenomenon in which complete reflection of a light ray occurs into the same medium, when a propagated wave strikes a medium boundary at an angle larger than a critical angle with respect to the normal to the surface.

6. **What is the condition for Total Internal Reflection?**
   1. A ray must travel from Denser medium to Rarer medium.
   2. The angle of incidence must be greater than the critical angle.

7. **What is an acceptance angle?**
   The angle θ_0 is called the wave guide acceptance angle or the acceptance cone half-angle which is the maximum angle from the axis of optical fiber at which light ray may enter the fiber so that it will propagate in core by total internal reflection.

8. **What is attenuation in optical fiber?**
   The total power loss offered by the total length of the fiber in the transmission of light is called attenuation.

9. **What are the different types of optical fiber?**
   The optical fibers are classified under three categories.
   They are
   1) Single Mode Step Index Fiber,
   2) Step Index Multi Mode Fiber and
   3) Graded index Multi Mode Fiber

10. **What is Optical fiber made up of?**
    Dielectric materials such as glass or plastic.

FERMI ENERGY

1. **Define Fermi energy?**
   Fermi energy is the highest occupied energy level at absolute zero Kelvin.

2. **What is the unit of Fermi energy?**
   S.I unit is joule and practical unit is eV.

3. **Give the relation between eV and joule?**
   $1eV=1.602\times10^{-19}$ J

4. **What is meant by Fermi factor?**
   It is the probability of occupation of a given energy state for a material in thermal equilibrium.

5. **Define Fermi velocity?**
   It is the velocity of electrons which occupy the Fermi level.

6. **What are the factors on which Fermi energy depends?**
   Temperature and the nature of the material.

7. **In this experiment, Fermi energy depends on length (L) of the copper wire?**

No.

8. **How many electrons are there in each energy level?**
   Two

9. **State Pauli's exclusion principle?**
   No two electrons can have four quantum numbers.

10. **What is Fermi level?**
    It is the highest energy state occupied by an electron at absolute zero temperature.

11. **If the dimension of the wire is changed, will it affect the value of E_F?**
    No. E_F depends on the material and the temperature but not on the dimension.

12. **Mention the materials belonging to conductors of metals.**

Metals as good conductors include iron, copper, aluminium nickel, gold silver etc.

13. **What is meant by Fermi energy of a metal?**

At 0K there is an energy level above which all levels are empty and below which all levels are completely occupied and is called Fermi energy of a metal.

14. **What is the effect of temperature on E_F?**

At 0K, Fermi level will be at the center of the energy gap, but as the temperature increases E_F moves towards the condition band.

15. **Are the energy levels lying above E_F are empty at 0K?**

Yes, they are empty but below E_F are filled.

16. **From where does the Fermi level concept comes from?**

It comes from fermi-Dirac statistics.

17. **What are fermions?**

Photons, electrons, pions etc, which have ½ spin are called fermions.
They obey Pauli's exclusion principle.

18. **How Fermi energy does vary in semiconductors?**

Fermi energy is at lower level in case of impurity semiconductor and is at higher level in intrinsic semiconductor.

19. **What is the importance of Fermi Energy?**

It helps to understand electrical and thermal properties of solids. It explains why electrons do not contribute significantly to the specific heat of solids at room temperature T. It gives information about the velocity of electrons which participate in ordinary electrical conduction.

DIELECTRIC CONSTANT

1. **What are dielectrics?**
   Dielectrics are the insulators and they do not conduct electricity. Dielectrics are used to increase the capacitance.

2. **Name some dielectrics?**
   Paper, mica, wood, water.

3. **Define dielectric constant?**
   It is the ratio of the capacitance of the capacitor with dielectric medium to the capacitance with air.

4. **What is the other name of dielectric constant?**
   Relative permittivity.

5. **What are the uses of dielectrics?**
   To increase capacitance.

6. **What is a capacitor?**
   Device used to store electric charges.

7. **What is meant by capacitance or capacity?**
   The ability to store electric charges.

8. **Define one farad?**
   Capacitance is one farad when the addition of 1C charge raises the potential by 1volt.

9. **Give the relation between Q , C , V ?**
   Q=CV

10. **What is the effect of dielectric on capacitance of a capacitor ?**
    Increases

11. **What is the effect of dielectric on the force between two plates of a capacitor?**
    Force decreases.

12. **Name the methods of charging a body?**
    Charging by friction, conduction and induction.

13. **Name the properties of charges?**
    Charge is scalar. Charge is conserved. Charge is not affected by its motion.

14. **What is meant by electric polarization?**
    It is the process of producing induced dipoles by applying external electric field.

15. **Name the different types of polarization mechanisms?**
    Electronic Polarization
    Orientation Polarization
    Ionic Polarization

16. **Classify Dielectrics?**
It is classified into Polar and Non-polar dielectrics.

17. **Define time constant?**
It is the time taken by the capacitor to charge 63.7% of its maximum charge.

18. **If area or thickness of dielectric is varied, will it affect the value of dielectric constant?**
NO.

19. **What is the effect of C and R on time constant?**
Time constant is directly proportional to C and R

20. **What is the function of the capacitor for DC and AC?**
Blocks DC and allows AC to pass or for ac short circuit and for dc open circuit.

21. **What are passive elements?**
The circuit elements which cannot deliver any electrical power and do not perform the operations like amplification, rectification etc are called passive elements.

22. **What are active elements?**
The circuit elements which can deliver electrical power to the system and can perform the operations like amplification, rectification etc are called active elements.

23. **How can the capacitance of a capacitor be increased?**
Capacitance of a capacitor can be increased by introducing a dielectric material between the two parallel plates of the capacitor.

24. What is the charge on the capacitor when the voltage across it is V?
Q=CV Coulomb, when C is expressed in farad and Vin volt.

25. **Are the time constants for charging and discharging of a capacitor the same in your experiment?**
No, the time constant for discharging the capacitor is longer than for is charging.

26. **What is the unit of Dielectric constant?**
Dielectric constant is a dimension less constant, hence t has no unit.

27. **What is dielectric strength?**
The limiting electric electric field above which the dielectric breakdown occurs is called dielectric strength.

28. **Give applications of dielectrics?**
Dielectric can be used as a dielectric medium in capacitors, as an insulator in power transmission, as a heating material in microwave oven.

29. The dielectric constant depends on what factors?
It depends on frequency, material and temperature.

30. What is charging and discharging?
Charging is the process of storing the energy in the capacitor.
Discharging is the process of releasing the energy from the capacitor.

SERIES AND PARALLEL RESONANCE

1. What are passive and active components?
Passive components: They do not give their own energy. Ex: L, C and R.
Active Components: They give their own energy: Ex: Power supply and IC.

2. What is resonance?
It is the phenomenon that occurs when the applied frequency becomes equal to then natural frequency of the body.

3. State the condition for resonance in LCR circuits?
Inductive reactance must be equal to the capacitive reactance (X_L=X_C).

4. Define reactance and impedance?
The effective opposition offered by the capacitor or inductor to the flow of AC is known as reactance.
(The reactance depends on frequency)
The opposition offered by the combination of L, C and R to the flow of AC is known as impedance.
The opposition offered by the Resistor to the flow of current is known as resistance.
(Resistance is independent of frequency).

5. Define Inductive reactance (X_L) and capacitive reactance (X_C)?
The effective opposition offered by the inductor to the flow of AC is known as $X_{L.}$
The effective opposition offered by the capacitor to the flow of AC is known as $X_{C.}$

6. What is resonant frequency?
The frequency at which resonance takes place is called as resonant frequency.

7. Name the factors on which resonant frequency depends?
Inductance and capacitance.

8. Define self-induction and mutual induction?
The phenomenon in which change in current in a coil induces emf in the same coil is known as self-induction.
The phenomenon in which change in current in a coil induces emf in the other coil is known as mutual induction.

9. Define choke and hence 1 henry?

Choke: It is a device used to control currents in AC circuits.
1 henry: Self-inductance of a coil is said to be 1 henry if 1 volt emf is induced in the coil when the rate of change of current is 1A/sec.

10. **What are cut off frequencies?**
These are the frequencies at which current falls to $(1/\sqrt{2})$ times the maximum current.

11. **Define band width and quality factor?**
Band width is the difference between two cut off frequencies.
Quality factor is the ratio of resonant frequency to the band width.

12. **Name the factors on which sharpness of resonance depends?**
Resistance(R).

13. **How does the capacitance reactance vary with frequency?**
Inversely proportional ($X_C=1/2\pi fC$)

14. **How does the inductance reactance vary with frequency?**
Directly proportional ($X_L=2\pi fL$)

15. **What are the salient features of series resonance at resonance?**
Impedance is minimum, current is maximum, voltage and current are in same phase.

16. **What are the salient features of parallel resonance at resonance?**
Impedance is maximum and current is minimum.

17. **Why current is maximum in series LCR circuit at resonance?**
Because impedance is minimum.

18. **Why current is minimum in parallel LCR circuit at resonance?**
Because impedance is maximum

19. **Why series resonance is called acceptor circuit and parallel resonance is called rejector circuit?**
In series at resonance impedance is minimum. Hence it is a acceptor circuit.
In parallel at resonance impedance is maximum. Hence it is a rejecter circuit.

20. **Mention the uses of electrical resonance?**
Used in radio and TV receivers, used to find unknown frequency of the given source.

21. **What happens to the resonant frequency if R is changed?**
Remains constant, because resonant frequency depends only on L and C

22. **What is the power dissipation in a pure inductive/pure capacitive circuit?**
Zero

23. **What is the phase relationship between voltage and current in a pure resistor, inductor and capacitor?**
In resistor voltage and current are in phase. Whereas in inductor and capacitor voltage and current are 90° out of phase.

24. **What is the role of capacitor for AC and DC?**
It blocks DC and allows AC to pass.

25. **How do you increase the sharpness of resonance?**
By decreasing R.

PLANCK'S CONSTANT

1. **How LED works?**
When forward bias gives to the light emitting diode (LED), immediately LED doesn't glow and takes some time. The minimum potential at which LED starts to glow is known as the stopping potential. The light from LED is the result of electron and hole recombination in the depletion region.

2. **Why Minimum potential is required to glow the LED?**
There is a potential barrier for the charge carrier to cross the junction, to overcome it they required this amount of potential energy. And then after with small change in potential, they cross the junction, and current flows through the LED.

3. **In the photoelectric effect, a suitable frequency of photon falls on an electron in an atom and ejects the electron. In LED when electron-hole recombination takes place a photon emits. How do you see these two phenomena?**
Both phenomena are different, in the case of the "photoelectric effect" to emit the electron, from the surface of a material, a minimum energy of threshold frequency is required. While on the other hand, in a light-emitting diode (LED) photon emits when electron-hole recombination takes place above the threshold value of the voltage; known as stopping potential.

4. **Which material do we use in the LED?**
Gallium Arsenide which is of a semiconductor nature.

5. **How are photons emitted from the LED and from which section of the LED?**
When electron-hole recombine photons emit, these emit from the depletion region.

6. **What happens when you provide the forward bias to the LED in terms of the conduction band & valence band in the depletion region?**
Conduction band and valence band drift in the depletion region.

7. **Why does not LED starts to glow immediately when you provide the forwarding bias to that?**
Because of the potential barrier at the junction for the charge carriers.

8. **Why does Blue color LED stopping potential greater than the Red color LED?**
from the relation $eV_0=h\nu$
further $\nu = c/\lambda$ so $eV_0=h\nu$
$eV_0=hc/\lambda$ in this relation e, h, and c are constants, so you can see $V_0 \propto 1/\lambda$

for small wavelength, stopping potential is higher than the larger wavelength. As you can see in Table. 1 the blue color wavelength is 475 nm while for the red it is 650 nm.

PHOTODIODE CHARACTERISTICS

1. **What is a Photodiode?**
A *photodiode* is a semiconductor device that converts light into an electrical current. The current is generated when photons are absorbed in the *photodiode*.

2. **Explain the working principle the photodiode?**
When photons of energy greater than 1.1 eV hit the diode, electron-hole pairs are created. The intensity of photon absorption depends on the energy of photons – the lower the energy of photons, the deeper the absorption is. This process is known as the inner photoelectric effect.
If the absorption occurs in the depletion region of the p-n junction, these electron-hole pairs are swept from the junction - due to the built-in electric field of the depletion region. As a result, the holes move toward the anode and the electrons move toward the cathode, thereby producing photocurrent. The sum of photocurrents and dark currents, which flow with or without light, is the total current passing through the photodiode. The sensitivity of the device can be increased by minimizing the dark current.

3. **How photodiode is different from LED?**

PHOTO DIODE	LED
1. Light detector.	1. Light emitter.
2. Works in reverse bias.	2. Works in forward bias.
3. used as optical sensors.	3. used for displays.

4. **What are the applications of photo diode?**
Smoke detectors, Flame monitors, Security inspection Equipment-Airport X-ray, Bar Code scanners, Fiber Optic Links etc.

5. **Explain photoconductivity?**
Photoconductivity is an optical and electrical phenomenon in which a material becomes more electrically conductive due to the absorption of electromagnetic radiation such as visible light, ultraviolet light, infrared light or gamma radiation.

6. **Define dark current?**
Dark current is the relatively small electric current that flows through photosensitive devices such as a photomultiplier tube, photodiode, or charge-coupled device even when no photons are entering the device.

7. **In what sense does the photo diode differ from a rectifier diode?**

A photo diode differs from rectifier diode in the sense that its reverse current increases with the increase in light intensity at the p-n junction.

8. **Why photo diode works in reverse bias condition only?**
   It's because when reverse biased, the depletion region becomes wider. Only electron-hole pairs that are generated in the depletion region (or within a diffusion length of the depletion region) will be swept across the junction and contribute to reverse current. So having a large depletion region is beneficial. You can also operate the PD with no bias but it will not be efficient.

9. **What are the materials used for the fabrication of diode?**
   Silicon, germanium and gallium arsenide as well as organic semiconductors.

10. **What is dark resistance in photodiode?**
    The resistance of photo diode with no incident light is called dark resistance (Rr).

11. **Does photo diode work in forward bias condition?**
    Yes, it will work as a normal diode.

12. **Can we replace photodiode with ordinary diode?**
    No, because ordinary diode doesn't work in reverse bias.

MAGNETIC FIELD INTENSITY

1. **Name the law to derive magnitude of magnetic field along axis of a circular coil carrying current.**
   Biot - Savart law.

2. **What is Magnetic field?**
   The magnetic field is the area around a magnetic which there is magnetic force.

3. **What is Magnetic flux?**
   The total number of magnetic field lines penetrating an area is called the Magnetic flux.

4. **What will be the magnetic field value at the centre of a current carrying coil?**
   At the centre of a current carrying coil, the magnetic field intensity is directly proportional to the current and inversely propotional to the radius of the coil. So, if the current is doubled and radius is halved, then the value of B increase by 4 times the initial value.

5. **What is the unit of Magnetic field intensity?**
   The S.I unit of Magnetic field intensity is Tesla.

6. **When does a current carrying conductors placed in a magnetic field experiences a maximum force?**
   It experiences maximum force when it is placed perpendicular to the direction of magnetic field.

7. **What is deflection method?**
   The method of electrical measurements in which the deflection of the index of the measuring instrument is used as the measure of the current or other element under examination.

TRANSISTOR CHARACTERISTICS

1. **What is a transistor?**
   It is a 3 terminal and 2 junction semiconductor devices.

2. **Name the terminals of a transistor in the ascending order of doping?**
   Base, collector and emitter.

3. **Name the two junction of a transistor?**
   Emitter-base junction and Collector-base junction.

4. **What is the normal operating condition of a transistor?**
   Emitter-base junction is forward biased and Collector- base junction is reverse biased.

5. **Why the name transistor?**
   Because it transfers current from low resistance path to the high resistance path. (Transistor stands for transfer + resistor).

6. **Explain the functions of emitter, base and collector.**
   Emitter emits charge carriers. Collector collects the charge carriers. Base allows the charge carriers to pass through it.

7. **Why emitter is heavily doped?**
   To emit large number of charge carriers.

8. **What is an amplifier?**
   It is a device used to increase the strength of the weak signal .

9. **Name the applications of transistors.**
   Used in amplifiers, electronic switches, oscillators.

10. **Name the different modes of transistor?**
    Common-emitter mode, common-base mode, common-collector mode.

11. **C-E mode is most commonly used. Why?**
    Because of high voltage gain and high power gain.

12. **Define current amplification factor or current gain?**
    It is the ratio of output current to the input current.

13. **Define α and β?**
    α is the ratio of change in collector current to the change in emitter current. (It gives current gain for common-base mode). β is the ratio of change in collector current to the change in base current.

14. **Give the relation between α and β?**
    $\alpha = \beta/(1+\beta)$

15. **Name the advantages of transistors over vacuum tubes?**
    Cost is low, low power dissipation, compact in size, high efficiency.

16. **What arrow indicates in the symbol of a transistor?**
    Direction of conventional flow of current.

17. **What is an oscillator?**
    It is a device that converts DC into AC.

18. **Is α greater than unity?**
    NO

19. **Why the word is 'common' also called grounded?**
    Because all voltages are measured with respect to the common terminal.

20. **Who invented transistor?**
    William Shockley, A John Bardeen and Walter Brattain

21. **What is meant by biasing?**
    The process of giving external voltage to the p-n junction is known as biasing.

22. **What is a p-n junction?**
    When a p-type semiconductor is suitably joined with n-type semiconductor, the contact surface is called p-n junction and the resulting device is called as p-n junction diode.

23. **What is a diode?**
    It is a 2 terminal semiconductor device.

24. **What are semiconductors?**
    Semiconductors are those whose electrical properties lie between that of conductors and insulators.

25. **Name the types of semiconductors?**
    Intrinsic semiconductors (pure semiconductors) and extrinsic semiconductors (impure semiconductors).

26. **How do you obtain p-type and n-type semiconductors?**

p-type semiconductor is obtained by adding trivalent impurity (such as Ga, Boron, Indium) to a pure semiconductor. n-type semiconductor is obtained by adding pentavalent impurity (such as As, antimony, bismith) to a pure semiconductor.

27. What is doping?
The process of adding impurities to a pure semiconductor is known as doping.

28. What is the need of doping?
To increase conductivity.

29. Explain ohmic and non ohmic devices with examples?
Devices which obey ohm’s law are called ohmic devices.
Ex: voltmeter, ammeter, galvanometer, resistor.
Devices which do not obey ohm’s law are called non ohmic devices.
Ex: transistor, thermistor.