Name: ___________________________________ USN: ___________________

Branch -------------Section: _____ Batch :_______ Roll No.: _________________

INDEX				
Sl. No.	**Date**	**Title of the experiment**	**Signature of the staff**	**Remarks**
1		Wavelength of LASER using Grating		
2		Numerical aperture using Optical Fiber		
3		Four Probe method		
4		Transistor Characteristics		
5		Charging and Discharging of a capacitor		
6		Photo - Diode Characteristics		
7		Series and Parallel LCR		
8		Magnetic field at any point along the axis of a circular coil current carrying		
9		Plank’s constant using LEDs		
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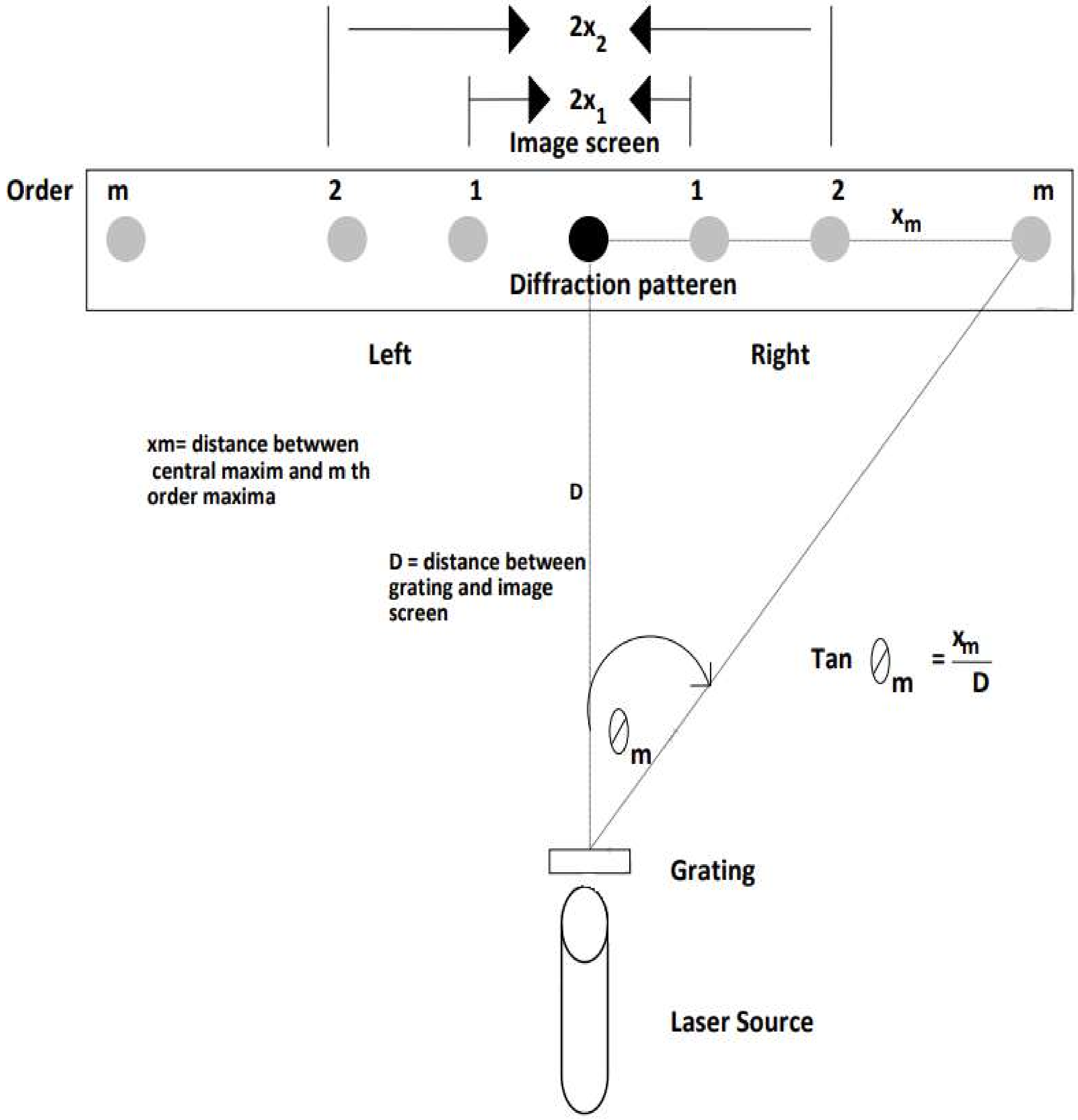
12				

RAY-DIAGRAM



2x2
2x1
Image screen
Order
m
2
1
1
2
m
xm
Diffraction patteren
Left
Right
xm= distance betwwen central maxim and m th order maxima
D
D = distance between grating and image screen
Tan Ø m = xm / D
Ø m
Grating
Laser Source

DIFFRACTION GRATING

EXPT.NO: 1 **DATE:**

AIM: To determine the wavelength of LASER source using diffraction grating.

APPARATUS: 625nm diode laser, Indian assembled 100LPI (lines per inch), 250LPI, 500LPI gratings, image screen.

PROCEDURE:

Semiconductor laser, grating stand and screen is kept horizontally on a table and the laser source is switched on. The grating is kept on a grating stand it is adjusted such that it is normal to the incident laser beam. After adjusting for normal incidence, the laser light is exposed to the grating and it is diffracted by it. The diffracted laser spots are seen on the screen which is kept behind the other side of the grating, The distances of spots of different orders from the centre spot (x_m) are measured.

The wavelength of the laser light is calculated using the formula

$$m\lambda = d\sin\theta$$

In the above equation all the parameters are known except θ. The angle θ can be found experimentally by measuring accurate distance D between grating and screen and distance between the consecutive maxima (which is nothing but the distance of m^{th} order diffraction pattern from the centre 0^{th}order). Different order of diffraction is the result of different incident angle θ .Hence to specify 'θ' for particular order it has been rewritten as θ_m, which indicate the diffraction angle for m^{th} order. Therefore, the m^{th}order diffraction angle is given by

$$\theta_m = \tan^{-1}\left(\frac{x_m}{D}\right)$$

Number of lines on grating =500 lines per inch.

Number of lines per cm (d) =2.54/500 =5.08x10^{-3} lines per cm (1 inch=2.54cm)

TABULAR COLUMN

Distance between grating element and the screen **(D) =55 cm**

Sl. No	Order of diffraction (m)	Readings of the diffracted patterns				Mean θ_m	λ=dsinθ / m in λ
		Left side		Right side			
		Distance from central spot x_m	$\theta_m = \tan^{-1}\frac{x_m}{D}$	Distance From Central spot x_m	$\theta_m = \tan^{-1}\frac{x_m}{D}$		
1	1						
2	2						
3	3						
4	4						
5	5						
6	6						
						Mean λ	

RESULT:

The wave length of the semiconductor laser source calculated using diffraction grating and

λ =_______________________ A^0

Observations

Diagrams

Figure-2 shows the complete experimental setup. A fixed screen is graduated in millimeter with 2mm pitch, i.e. the distance between two vertical lines on the screen is 2mm. Figure-2 shows the complete experimental set-up.

The X-Y bed consisting of a scale is fitted along the X-axis with zero coinciding with the screen. On this X axis a needle fixed above the scale which moves along with the chuck indicates the distance 'f' between the fixed screen and chuck holding the OFC. The Y motion is used to adjust the spot at the center of the graduated screen. Figure-3 shows the X-Y bed and Figure-4 shows the OFC cable used.
Figure-1 shows the NA and the angle θ.

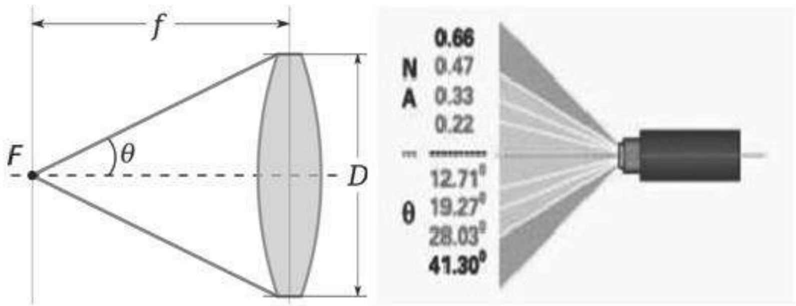


Figure-1: Laser light emerging from the cable and forming a divergent cone of rays

Distance between the chuck and the fixed graduated scale f = cm = m

Diameter of the circular spot =D= -------------------- m

$\tan\theta = D/2f$

The value of **'θ'** is calculated and presented in Table-1. NA can be calculated as follows. $\theta =$

$\tan^{-1}(D/2f)$

N.A. = $\sin\theta$

NUMERICAL APERTURE OF AN OPTICAL CABLE

EXPT.NO: **DATE:**

AIM: Determination of angle of acceptance and numerical aperture of an optical fiber.

APPARATUS: Optical Fiber Cable (OFC) of length1.5m (IEEE 1394 fire wire cable), semiconductor diode laser- red 625nm, X-Y bed carrying a screen and a movable chuck

PRINCIPLE: - Numerical aperture of a cable is defined as sine of the half angle of the cone generated due to the divergence of signal rays, as shown in Figure 1.

N.A. = Sinθ

In Figure-1, light coming out of an OFC falls on a screen, kept at a *distance 'L'* from it, on which an image of the laser spot is seen. This spot and the emerging light form a cone. If 'D' is the diameter of the circular spot and 'f' is distance between the screen and the OFC then

$$tan\theta = \frac{D/_2}{f} = \frac{D}{2f}$$

By measuring D and f, the value of tan θ can be determined; hence the numerical aperture can be calculated from the equation

NA = Sin θ = $\tan^{-1}$(D/2f).

Experimental procedure

- The optical cable is coupled to the laser and it is ensured that the laser light comes out of the other end of the cable. The other end of the cable is tied to the chuck fixed on the X-Y bed.

- The chuck carrying the OFC is brought close to the graduated screen and the laser spot is seen on the graduated screen. By adjusting the fine motion screw of the microscopic bench, the spot size is reduced to 8mm. Spot size = D= 8mm

- The distance between the fixed screen and chuck carrying the OFC is noted on the graduated scale fixed along the X-axis.

- The experiment is repeated by increasing the size of the spot to 10mm, 12mm, 14mm, 16mm, 18mm, 20mm, 22mm, 24mm, 26mm, and the corresponding value of 'f' is noted. This is done until the spot become sufficiently bright and clear. The readings obtained are tabulated inTable1.

- The experiment is repeated with another cable of 1m length and the readings obtained are tabulated in Table 1. A graph is plotted D versus f and the variation is a straight line given inFigure-2.

Table-1: Variation of D and f

Sl. No	f in cm	f in mm	D in mm	$\theta^0 = \tan^{-1}(D/2f)$	N.A= Sin θ
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
				Avg. Value of θ = ______	**Avg. Value of N.A = ______**

Note: - Numerical Aperture is constant for a given OFC. It is a fundamental parameter which is required for any communication system employing an OFC. An X-Y bed with heavy bed was found to be ideally suitable for this measurement and we have obtained quite consistent results for the two fibers used.

Cable-1,which has smaller value of NA, is of better quality.Cable-2,with almost double the NA, is of inferior quality. As expected, higher attenuation of sound was found in the case of the second cable (with higher value of NA) compared to the first cable.

Results:-

1. Numerical aperture of the fiber optic cable NA=_________

2. Acceptance angle for cable-1 θº =_________

CIRCUIT DIAGRAM

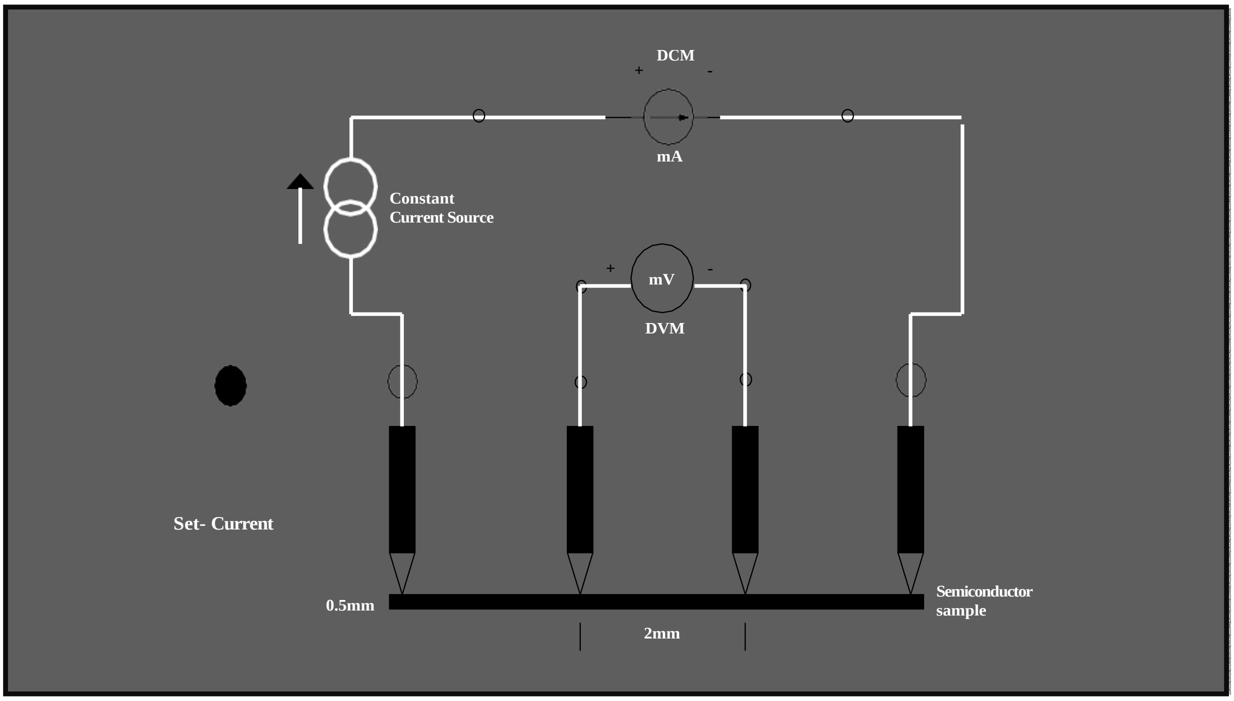


Figure: Four probe circuit connections

Table: Keep, Current (I) = 2mA.

SN	T	T=t+273	V	R=V/I	ρ_0 = (V/I)(2ΠS)	ρ= [ρ_0/f(w/s)]	ρ	1000/T	$\log_{10}$ (ρ)
Unit	°C	°K	mV	Ω	Ω -m	Ω -m	Ω -cm	K^{-1}	
1	35	308							
2	40	313							
3	45	318							
4	50	323							
5	55	328							
6	60	333							
7	65	338							
8	70	343							
9	75	348							
10	80	353							
11	85	358							
12	90	363							
13	95	368							
14	100	373							

RESISTIVITY OF A SEMICONDUCTOR BY THE FOUR-PROBE METHOD

EXPT.NO:

Aim*:* To determine the temperature dependent resistivity of semiconductor by four probe method.

Apparatus: four probe arrangement experimental setup, oven provided with heater to heat the sample, semiconductor sample, connecting wires etc.,

Experimental Procedure:

1. The four probe arrangement is placed on the sample as shown in figure. Care is taken to see that all the four probe touch the sample surface and make contact with the sample. A constant current is passed through the outer probes connecting it to the constant current source of the set-up.
2. The current is set to 2 mA. The voltage developed across the middle two probes is measured using a digital milli-voltmeter. A thermometer is pre fixed on the surface where crystal is mounted, this reads the same temperature as the semiconductor sample is experiencing.
3. Before switching on the heater, Note the voltage and temperature.
4. Now switch on "ON" the heater and note the voltage in mV at an interval of 5^0C upto 100^0C.
5. The distance between the probes and thickness of the crystal (W) are noted as 2mm and 0.5mm respectively ρ_0 is calculated for different values of V. The values of (W/S) are calculated and the value of the *f(W/S)* is calculated using the formula and is equal to 5.54 using these values, ρ is calculated for varies temperatures. For a germanium crystal the (W/S) and corresponding values can be obtained by using the below mentioned equation.
6. The values of (1000/T) and the corresponding values of logρ are plotted. Corresponding values of log ρ plotted on the graph and is found to be a straight line.
7. You may note that the graph may be in I quadrant or in I and II quadrants or only in II quadrant depending on the crystal.

$$f(W/S) = \frac{2S}{W} \log_e 2$$

Nature of Graph:

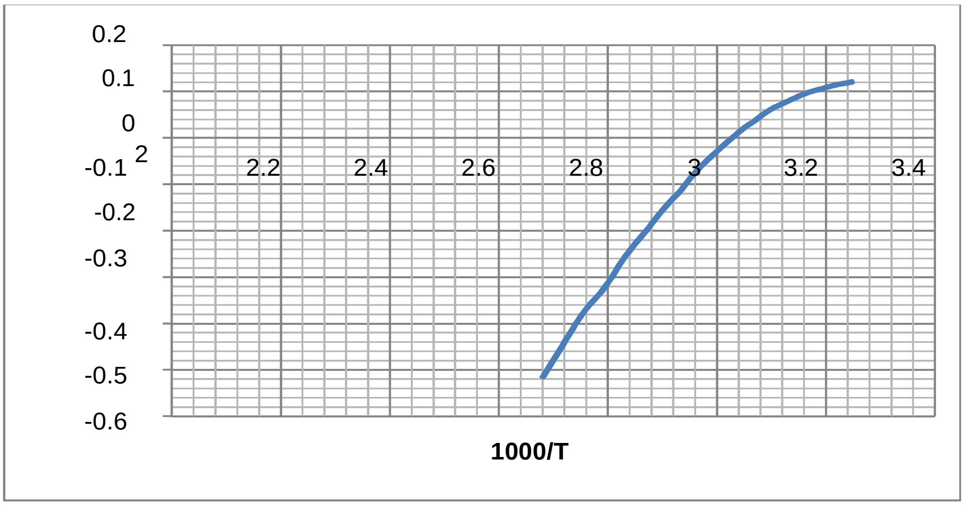
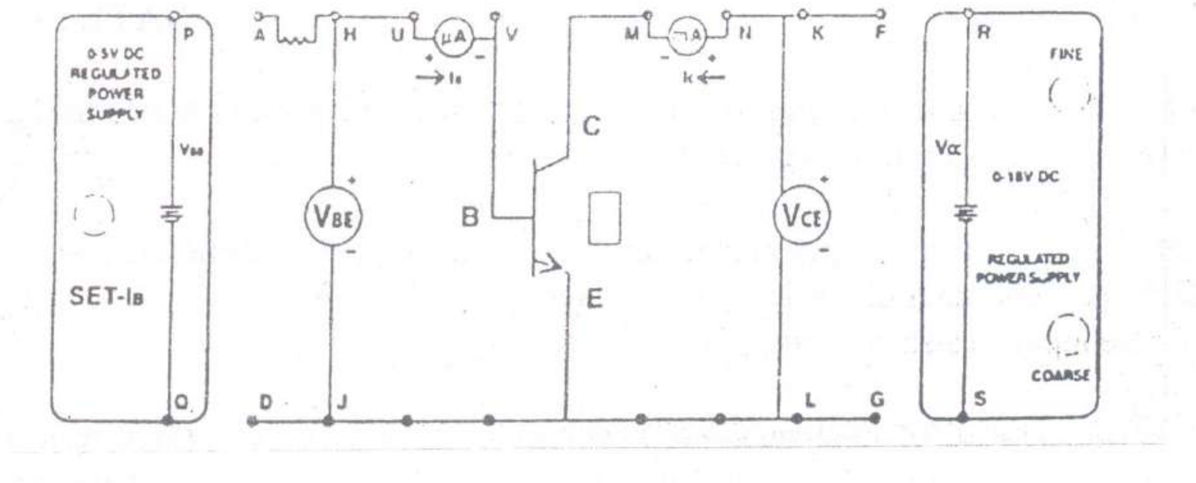


Figure: Variation of ρ with temperature

Result: The temperature dependence of the resistivity of semiconductor (germanium) sample is as shown in the table. The dependence of resistivity is exponential with temperature.

CIRCUIT DIAGRAM



TABULAR COLUMN

1) INPUT CHARACTERSTICS 2) TRANSFER CHARACTERSTICS 3) OUTPUT CHARACTERSTICS

V_{BE} –I_B for constant V_{CE} I_B – I_C for constant V_{CE} V_{CE}- I_C for constant I_B

(Keeping V_{CE}=1volt) (Keeping V_{CE}=1volt) (Keeping I_B= 50 μA)

Sl. No.	V_{BE} (volts)	I_B (μA)	Sl. No.	I_B (μA)	I_C (mA)	Sl. No.	V_{CE} (V)	I_C (mA)
1	0.10		1	10		1	0.1	
2	0.20		2	20		2	0.2	
3	0.30		3	30		3	0.3	
4	0.40		4	40		4	0.4	
5	0.50		5	50		5	0.5	
6	0.55		6	60		6	0.6	
7	0.60		7	70		7	0.7	
8	0.65		8	80		8	0.8	
9	0.70		9	90		9	0.9	
10	0.75		10	100		10	1.0	
11	0.80		11	110		11		

TRANSISTOR CHARACTERISTICS

AIM: To plot the characteristics curves of the given transistor and hence to determine

The input resistance, output resistance and the amplification factor

APPARATUS: Transistor regulated variable power supply, voltmeter, milli &micro Ammeters, etc.

THEORY: A transistor is a three terminal semiconductor device. The three terminals are the emitter, base & collector. There are two types: - 1) npn transistor 2) pnp transistor. One type of semiconductor is sandwiched between the two types of same semiconductor. The emitter is always heavily doped in order to provide a large supply of electrons. The base is lightly doped to minimize the recombination that occurs in it between the electrons and the holes. The collector will be having a large area in order to efficiently gather the charge carriers. The number of electrons that leave the emitter is a function of purely of the base-emitter voltage. It is the collector which receives almost all of them.

PROCEDURE: The circuit for transistor characteristics is rigged as follows:

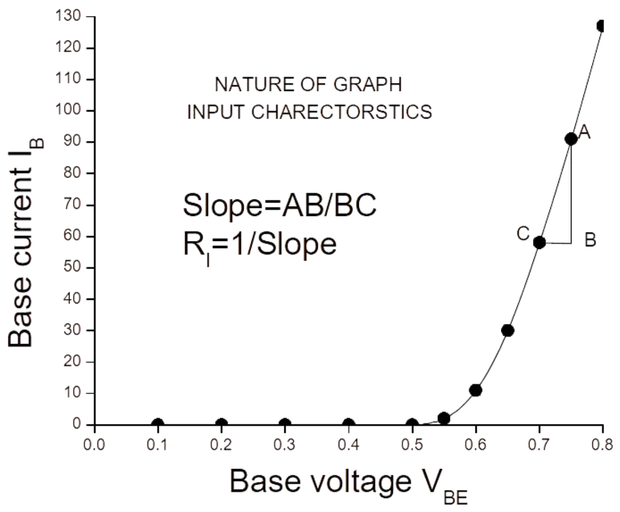
1. Connect the sockets, P is connected to A, Q is connected to D, T is connected to F & S is connected to G.
2. Across the terminals U & V micrometer is connected with proper polarity.
3. Across the terminals M & N millimeter is connected with proper polarity.
4. The transistor is mounted on the socket.

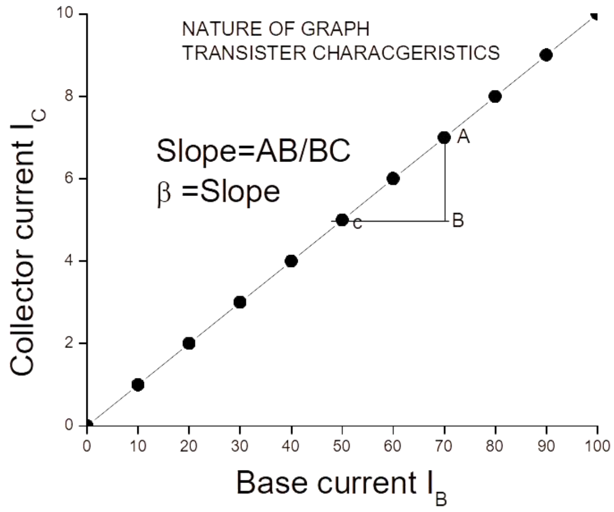
I. INPUT CHARACTERISTICS:

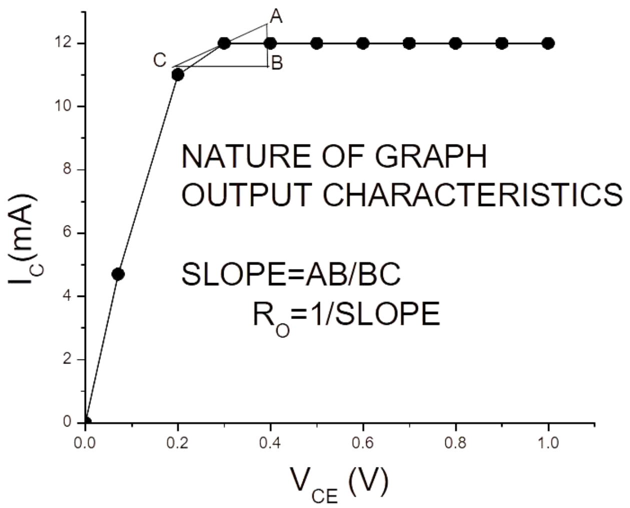
1. The circuit connections are made as described above.
2. The voltmeter is connected across the terminal K & L to set collector emitter voltage V_{CE} = 1 volt. The voltage can be set by the knobs coarse and fine.
3. Now the terminal is disconnected from K-L terminals and connected across J-H terminal to measure base emitter voltage $V_{BE.}$
4. By varying V_{BE} like 0.1, 0.2, 0.3 -----up to 0.8. by adjusting SET – I_B knob. The corresponding base current I_B is noted and tabulated in the table.
5. A graph is drawn by taking V_{BE} along X- axis & I_B along Y- axis. This is the input characteristics curve. From this curve find input resistance.

II OUTPUT CHARACTERISTICS:

1. The voltmeter is connected across the terminals K and L.
2. The base is now set to 50µA, by adjusting set -I_B knob.
3. By varying V_{CE} 0.1,0.2, …. up to 1Volt and the corresponding collector current on the milli ammeter is noted and tabulated in table 3
4. A graph is drawn by taking V_{CE} along x-axis and I_C along y-axis. This is the output characteristic curve. From this curve find output resistance.


NATURE OF GRAPH
INPUT CHARECTORSTICS
Slope=AB/BC
R_I=1/Slope
Base current I_B
Base voltage V_{BE}
A
B
C


NATURE OF GRAPH
TRANSISTER CHARACGERISTICS
Slope=AB/BC
β =Slope
Collector current I_C
Base current I_B
A
B
c


NATURE OF GRAPH
OUTPUT CHARACTERISTICS
SLOPE=AB/BC
R_O=1/SLOPE
I_C(mA)
V_{CE} (V)
A
B
C

III. TRANSFER CHARACTERISTICS

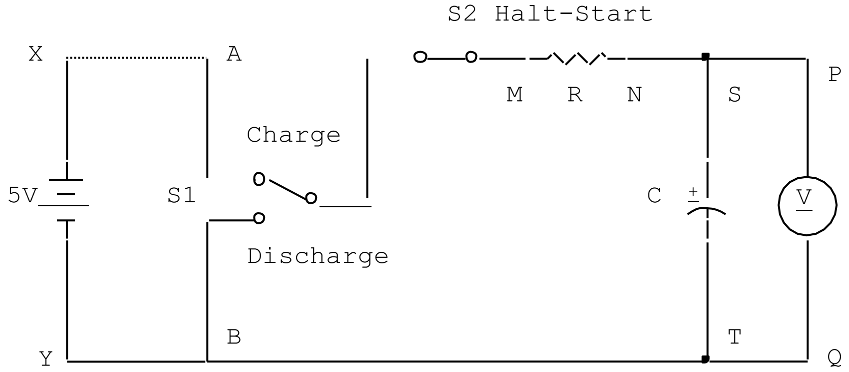
1. With V_{CE} = 1 volt, I_B is set to 0, 10, 20, ----- up to 100 μA& record I_C& tabulate in Table.

2. A graph is drawn taking I_B along X-axis & I_C Y-axis. Find amplification factor.

RESULTS:-

1. Input resistance of a given transistor R_I = ------------------------------ Ω.
2. Amplification factor of a given transistor β = ---------------------------
3. Output resistance of a given transistor R_0 = ------------------------------ Ω.

CIRCUIT DIAGRAM



TABULAR COLUMN

Keeping Voltage = 10V

Sl. No.	**Time "t" in sec**	**For Capacitor C1 R= ____kΩ Voltmeter readings**		**For Capacitor C2 R=______kΩ Voltmeter readings**		**For Capacitor C3 R=_____kΩ Voltmeter readings**	
		Charging	Discharging	Charging	Discharging	Charging	Discharging
1	0						
2	15						
3	30						
4	45						
5	60						
6	75						
7	90						
8	105						
9	120						
10	135						
11	150						
12	165						
13	180						
14	195						
15	210						
16	225						

DIELECTRIC CONSTANT BY USING CHARGING AND DISCHARGING

EXPT.NO: **DATE:**

AIM: To determine dielectric constant by using a DC charging and discharging circuit.

APPARATUS: Digital stop clock 0.1s resolution, digital dc voltmeter 0-20 V set of resistors and set of capacitors of known dimensions, dc power supply 5V

THEORY: A parallel plate condenser 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 within the plates the capacitance can be increased. The resulting capacitance of the parallel plate condenser is given by

$$C = K\frac{\varepsilon_0}{d}A$$

Where, C is the capacitance in Farad, K is dielectric constant
ε_0 is the permittivity 8.85×10^{-12} Fm^{-1}, A is the area of the plate
d is the distance between the plates or thickness of the dielectric material.

Charging and Discharging of a Capacitor

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

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

Figure -1 shows charging-discharge circuit arrangements using DC voltage source. When the switch is thrown to the discharge position the capacitor loses its charge hence it discharges through R. Therefore, the voltage across capacitor starts decreasing until it becomes zero. The instantaneous voltage across the capacitor during discharge is given by

$$V_{discharge} = V_o\,(e^{-t/RC})$$

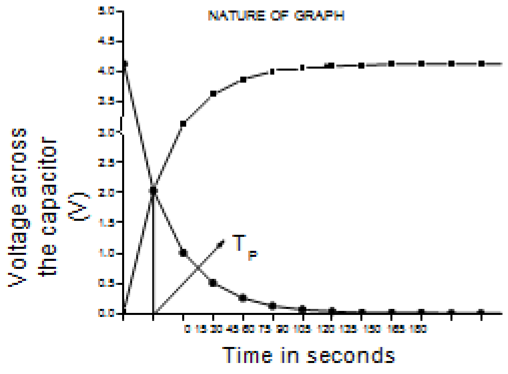
Where R is resistance in ohms C is capacitance in Farad
t is the instantaneous time
V_o is the maximum voltage to which capacitor is charged

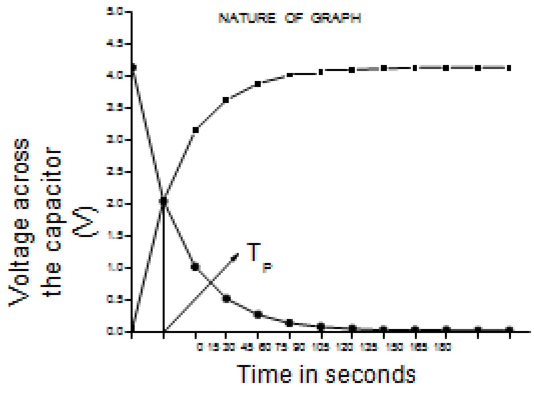
Figure-2 shows the charge-discharge curve. The charge-discharge curve intersects at a point P. At this instant of time T_p the voltage across the condenser is the same during charge and discharge process. Therefore, we have

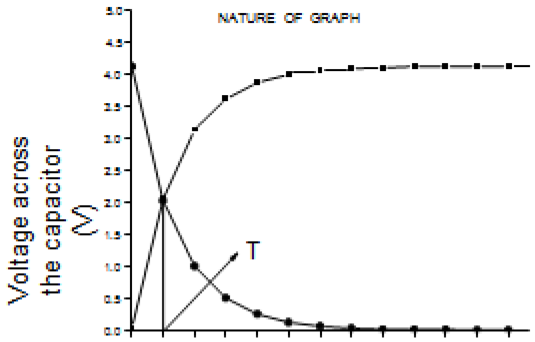
$$V_{Charge} = V_{discharge}$$

$$(1-e^{-Tp/RC}) = (e^{-Tp/RC})$$

Nature of Graph







Dimensions of capacitors

Capacitor	C1	C2	C3
Length(mm) L	114	183	251
Breadth (mm) B	5	6	6
Separation (mm) d	75	75	75

The capacitor dimensions are mentioned in mm in general.

i.e. $\frac{1}{2} = e^{-tp/RC}$

$\ln(\frac{1}{2}) = {}^{-T}{}_{P}/RC$

$RC = -T_P \ln 0.5$

$$C = \frac{0.693T_P}{R}$$ …. 4

By physically measuring the dimensions of the capacitor dielectric constant can be determined.

$$K = \frac{T_p d}{0.693\varepsilon_0 AR} = \frac{1.44T_p d}{\varepsilon_0 AR}$$ …5

Experimental Procedure

- The circuit connections are made as shown in Figure. R selected as 47kΩ and Capacitor C1is selected and connected to the circuit using patch cords.
- The digital stop clock is reset by pressing reset button. The display indicates00.0.
- Switch ON the instrument, volt meter moves from zero to maximum charging voltage. Note down the maximum voltage and time i.e. charging time.
- Now Switch OFF the instrument volt meter moves from maximum to zero. Note down the minimum voltage and time i.e. discharging time.
- Experiment is repeated for different capacitance values. And the corresponding readings are noted in Table.
- 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. The time at which voltage across the capacitor during charging and discharging is noted.
- The Dielectric constant is determined using above equation

For each capacitor calculate

Area = length x breadth = ----------m^2 for a given length and breadth

Given R =220KΩ Thickness = d=-------m, ε_0 = 8.85x10^{-12} F/m

T_P=-----------------seconds (can be obtained from the graph).

Hence the dielectric constant of material can be calculated by using the following formula

$$K = \frac{1.44 T_p x\ d\ x 10^{-6}}{\varepsilon_0 A R}$$

Calculations

K1 = ___________________

K2 = ___________________

K3 = ___________________

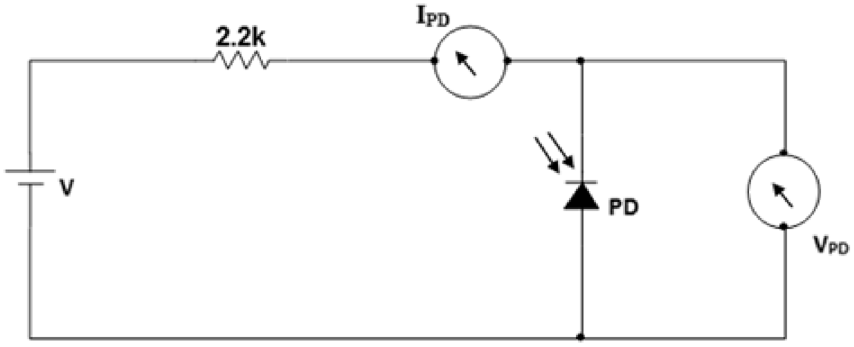
Result:

The dielectric constant of capacitor C_1 is = K_1____________

The dielectric constant of capacitor C_2 is = K_2____________

The dielectric constant of capacitor C_3 is = K_3____________

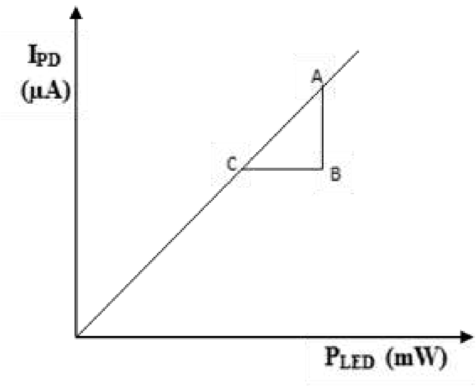
Circuit diagram:



V_{pp}= -1Volt

P_{LED}(mw)	I_{PD}(µA)
10	
11	
12	
13	
14	
15	
18	
21	
24	
30	
38	
50	

Nature Graph



Responsivity of photodiode Slope = $R_\lambda = \frac{AB}{BC}$= _______ A/w

PHOTO DIODE CHARACTERSTICS

EXPT.NO: **DATE:**

Aim: To study the I-V characteristics of photo diode in reverse bias and variations of photocurrent as a function of reverse voltage &intensity.

Apparatus: Photodiode expt .Setup consisting of 0-3v regulated power supply
0-2m A digital dc current meter, 0-2v digital dc voltmeter, site light LEC module, Photo Diode, LED etc.

Theory off the experiment

Introduction: Photodiodes are semi-conductor devices that respond to high energy particles and photons. Radiation-sensitive Junction is formed in a semi-conductor material whole resistivity changes when illuminated by light photons. The junction can be made to respond to the entire electromagnetic spectrum.

Responsivity (R_λ): The degree of response of a silicon photo diode to light is a measure of its sensitivity, and it is defined as the ratio of the photo current IPD to the incident light power "P" at a given wavelength

$R_\lambda = \frac{I_{PD}}{P}$ Where I_{PD} is photo diode current P is the light input power. In other words, it is a measure of the effectiveness of the conversion of the light power into electrical current.

I-V CHARACTERISTICS:

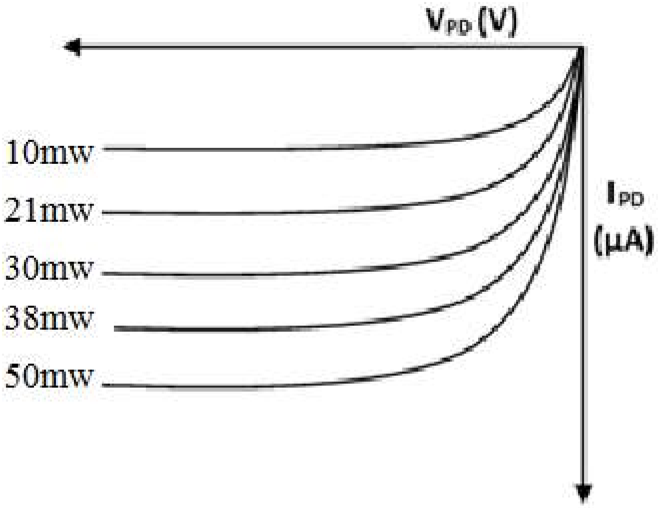
The current – voltage (I-V) characteristics of a photo diode when it is forward biased; there is an exponential increase in the current similar to rectifier diode. When a reverse bias voltage is applied, a small reverse saturation current appears.

NOTE:-*As the applied reverse bias voltage increases there is a sharp increase in the photocurrent and the device will be damaged permanently. This voltage is called break down voltage. For this diode magnitude of break down voltage voltages lies in the range 5-100v. Hence one should not apply too much reverse bias.*

Variation of PD voltage with current

V_{PD} (v)	I_{PD}(µA)				
	P_{LED}=10mw	P_{LED}=21mw	P_{LED}=30mw	P_{LED}=38mw	P_{LED}=50mw
0					
-0.1					
-0.2					
-0.3					
-0.4					
-0.5					
-1.0					

Nature of Graph: 2



Experimental Procedure: The experiment consists of two parts Part A: Determination of Responsivity.

Part A: Determination of Responsibility:

The circuit connections are given as shown in the circuit diagram. The reverse bias connection of photo diode means the positive terminal of the PD (p) is connected to the negative terminal of the power supply and negative of the PD is connected to positive terminal of the power supply.

- The white light LED &PD are placed face to face 10cm apart. This is the industry standard for any LED measurements. And the light arrangement is switched on. LED power is set to 10 mw by turning the knobs to its minimum position .After ensuring that the LED is glowing and while noting the PD current in the meter, the cover is placed so that any external light will not affect the readings.
- The voltages across PD is set to -1v by varying 0-3v power supply. The PD current $I_{PD}$is noted V_{PD}= -1v, I_{PD}=393μA.
- 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.
- The trial is repeated by varying the input power to 12mw, 13mw etc, readings up to 50mw, in each case V_{PD} as set to -1v and I_{PD} is noted inTable-1.
- A graph showing the variation of LED power on x-axis and PD current is drawn as shown in figure. A straight line graph is obtained, slope of which gives the value of responsivity.

Note: *The external conversion efficiency of white LED is 0.66, hence by dividing responsivity by 0.66 gives the exact responsivity of PD*

The quantum efficiency (QE) of photo Diode is 8.8%. The small QE value indicates that only 8.8% of the photons fall on the photodiode sand contributes to the photo current. This is because the light coming out of the LED is highly directional, forming a cone with solid angle only portion of light falls on Photo Diode.

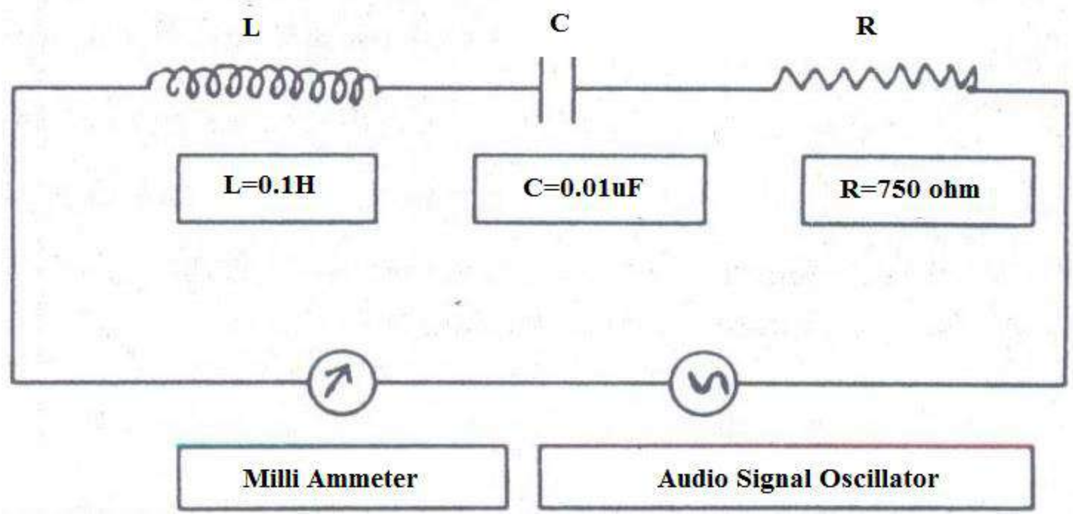
PART B: DETERMINATION OF V-I CHARACTERISTICS OF PD

- The LED power is set to 10-mw on the dial and V_{PD} is set to -0.10v and the corresponding I_{PD} is noted.
- The trail is repeated by increasing V_{PD} in the suitable steps up to a maximum of-2v.
- The corresponding I_{PD} values are noted in table-2

Result:

The I-V characteristics of a given photo diode is studied and found Responsivity (R_λ) at375nm= ______________________A/W

CIRCUIT DIAGRAM



Given: L=0.1H, C= 0.01 μF, R=750Ω

The resonant frequency is also calculated using the equation

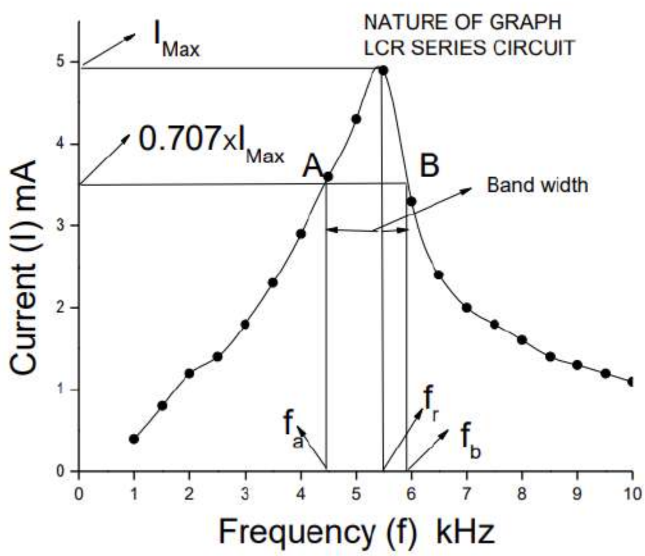
$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

fr =.........................Hz

TABULAR COLUMN

Sl.No.	Frequency (f) in kHz	Current in mA.
1	1.0	
2	1.5	
3	2.0	
4	2.5	
5	3.0	
6	3.5	
7	4.0	
8	4.5	
9	5.0	
10	5.5	
11	6.0	
12	6.5	
13	7.0	
14	7.5	
15	8.0	
16	8.5	
17	9.0	
18	9.5	
19	10	

Nature of the graph



SERIESAND PARALLEL RESONANCE "LCR" CIRCUITS

EXPT.NO: **DATE:**

AIM: To draw frequency response curve of a series and parallel LCR circuits, hence to calculate resonant frequency, Band width and Quality factor.

APPARATUS: An audio signal oscillator, a resistance box, an inductor coil, capacitor, ammeter & connecting wires etc.

PRINCIPLE:

The inductive reactance $X_L=2\pi fL$ and capacitive reactance $X_C=1/(2\pi fC)$varies with the applied frequency of the supply voltage in the circuit. At a particular frequency f_r, the inductive reactance become equal to capacitive reactance in the circuit. The frequency corresponds to this situation is referred to as resonant frequency (f_r). The total impedance of the circuit becomes equal to the resistance i.e Z=R in the circuit, which is minimum. Hence, the maximum current flows through the circuit at resonance due to this reason the series LCR resonance circuit is referred as Acceptor circuit. The resonant frequency is given by the equation $X_L = X_C$.

PROCEDURE:

When LCR connected end to end with AC source they are said to be in series

- The circuit connection is made as shown in the circuit diagram.
- The frequency of audio signal oscillator is set to 1kHz & the corresponding reading in the milli ammeter is noted.
- The frequency of the audio signal oscillator is increased in steps of 0.5 kHz up to 9.5 kHz & the corresponding milli ammeter readings are recorded.
- A graph is drawn between current (along Y-axis) & frequency (X-axis). From the graph the resonant frequency (f_r) is measured.

The resonant frequency is also calculated using the equation

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Given L=0.1 H, C= 0.01 µF.

QUALITY FACTOR:

The readings including f_r and I_{max} are plotted in a graph with frequency in KHz along X-axis, and the current in Ma along the Y- axis. A resonance curve as shown in graph will be obtained in which f_r and I_{max} are marked The line is drawn along x-axis at(I_{max} x 0.707).

From the above graph find f_a and f_b and calculate band width ($\Delta f = f_b - f_a$)

Now calculate quality factor using the following equation from graph

Δf = (fb-fa).

Qgraphical **= fr/Δf,**
For Given L = 0.1 H, C = 0.01 μF& R = 750 Ω.

Theoretically quality factor is calculated using the relation

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

Q_{Theory}= ______________

Given **L = 0.1 H, C = 0.01 μF& R = 750 Ω**

The resonant frequency can calculated using the equation for parallel resonant circuit as follows

$$f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

f_r = _______________KHz

Find fa and fb and calculate band width (Δf =fb-fa), Now calculate quality factor using the following equation from graph
Qgraphical= fr/Δf , where Δf=(fb-fa).

Verify this theoretically using the relation

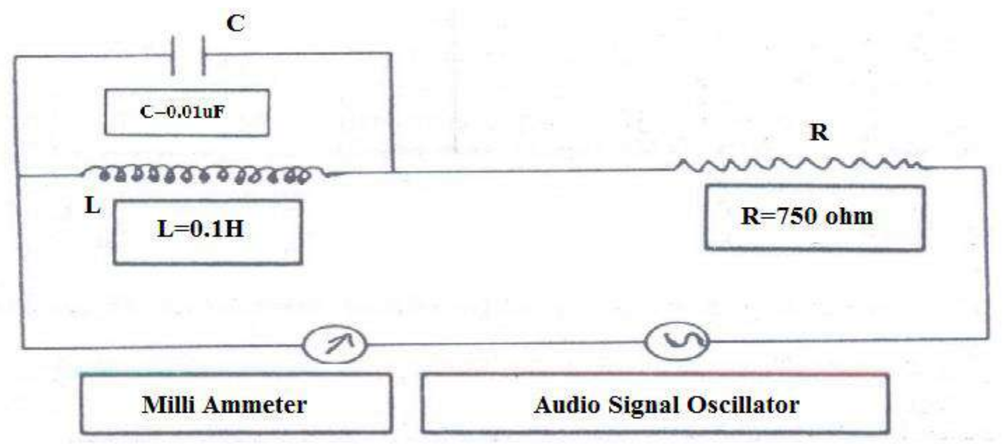
$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Given L = 0.1 H, C = 0.01 μF & R = 750Ω.

RESULTS:

1. Resonant frequency f_r = _______________kHz (from graph)
2. Resonant frequency f_r=________________kHz (from calculation)
3. Band width of the circuit Δf= ____________(from graph)
4. Quality factor of the circuit Q= ____________(from graph)
5. Quality factor of the circuit Q=_____________(from calculation)

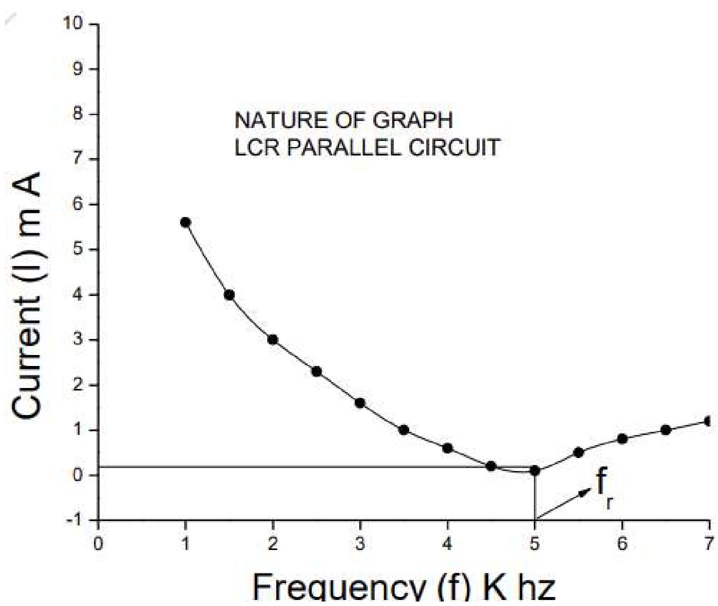
CIRCUIT DIAGRAM



Tabular Column

Sl.No.	Frequency (f) in kHz	Current in mA.
1	1.0	
2	1.5	
3	2.0	
4	2.5	
5	3.0	
6	3.5	
7	4.0	
8	4.5	
9	5.0	
10	5.5	
11	6.0	
12	6.5	
13	7.0	
14	7.5	
15	8.0	
16	8.5	
17	9.0	
18	9.5	
19	10	

Nature of Graph



PARALLEL LCR CIRCUIT

PRINCIPLE:

The inductive reactance & capacitive reactance connected in parallel at resonant frequency the inductive reactance exceeds the capacitive reactance. Hence $X_L > X_C$. Thus, the resultant impedance of the circuit becomes maximum hence the current in the parallel circuit becomes minimum. Due to the above reason the parallel LCR circuit is referred to be rejected circuit.

PROCEDURE:

When L & C are connected in parallel with series resistance & an AC source they are said to be in parallel

- The circuit connections are made as shown in the circuit diagram.
- Thefrequencyofaudiosignaloscillatorissetto1 kHz & the corresponding reading in the milli ammeter is noted.
- The frequency of the audio signal oscillator is increased in steps of 0.5 kHz up to 9.5 kHz & the corresponding milli ammeter readings are recorded.
- A graph is drawn between current (along Y- axis) & frequency (along X-axis). From the graph the resonant frequency f_r is measured.

The resonant frequency is also calculated using the equation

$$f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

Given L=0.1 H, C= 0.01uF & R=750 Ω

f_r = ________________ KHz

\

RESULTS:

1. Resonant frequency f_r = _______________kHz (from graph)
2. Resonant frequency f_r=________________kHz (from calculation)

Diagram

Magnetic field along the axis of the current carrying circular coil

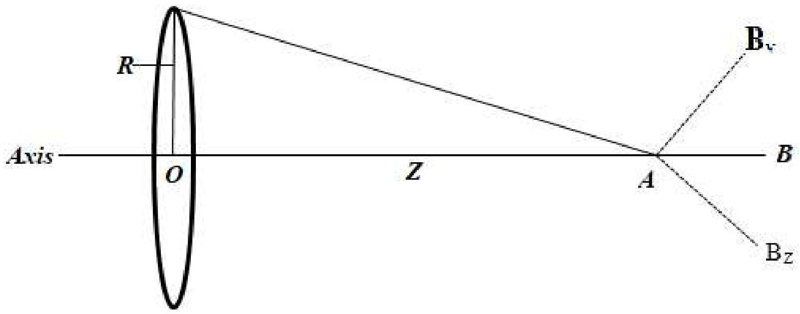
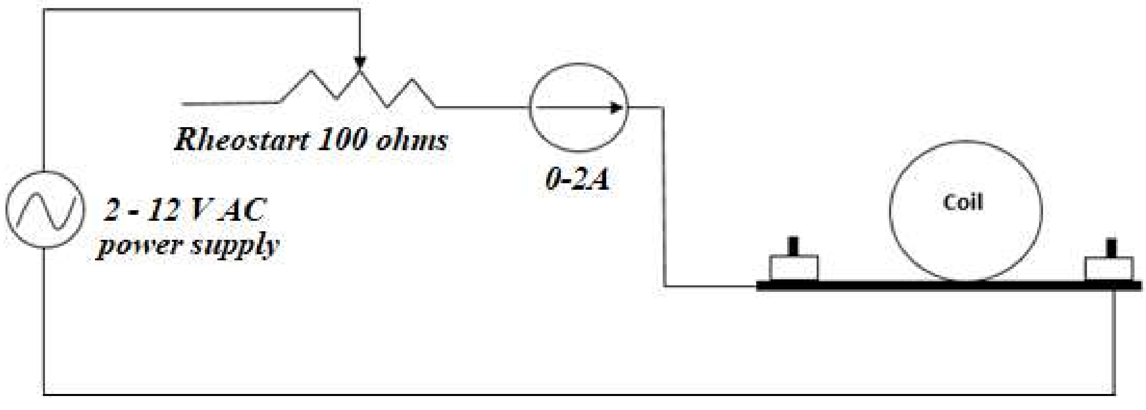


Figure-: Stewart - Gee apparatus with the search coil

Circuit Diagram



MEASUREMENT OF MAGNETIC FIELD ALONG THE AXIS OF A CIRCULAR CURRENT CARRYING COIL

EXPT.NO: **DATE:**

Aim: - To determine the magnetic field along the axis of the circular current carrying coil.

Apparatus: - Digital Stewart-Gee apparatus, AC power supply 2-12V, AC ammeter 0-2A, Rheostat 100Ω, digital Vernier, and LCR meter.

Theory

Experimental procedure

- The experimental setup is as shown in fig. Using Stewart-Gee apparatus, AC power supply, digital AC current meter and rheostat are connected series as shown in circuit diagram (There is no need to align the instrument along the magnetic meridian).
- The search coil cable is connected to the digital AC current meter along the axis of the instrument and it is switched on.
- Thecurrentinthefieldcoilisnowadjustedto1Aandvoltageissetto12V.Thefieldatthecenter of the coil is recorded from the LCD displays,

  At the center x= 0, Bpp= --------------------------gauss.
- The search coil is now moved to the left of the center by 1cm and the flux, induced e.m.f are noted as

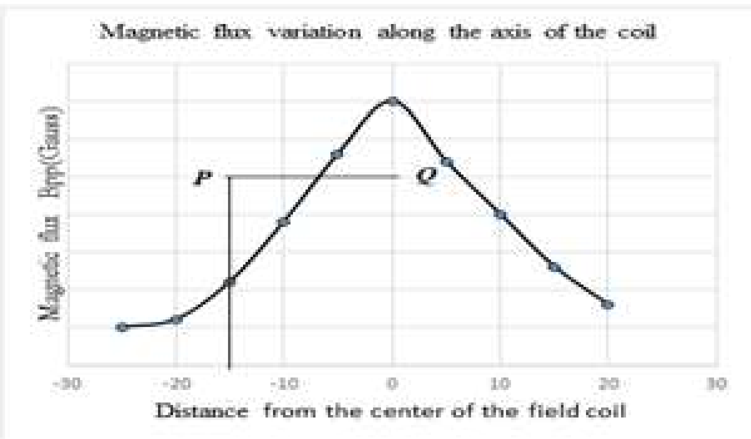
  At the center x = 1 cm, Bpp= -------------------------- gauss.
- The experiment is repeated by moving the search coil in steps of 1 cm, recording the e.m.f. and the flux each time. The readings obtained are recorded in the table.
- A graph is plotted by taking distance along X-axis and magnetic flux along Y-axis as shown in nature of the graph.

Note: - The curve is no exactly symmetrical about the vertical axis. This may be due to these light re alignment of the search coil.

Tabular column

Distance from the center of the coil 'a' in cm	Magnetic field Bpp in Gauss	Distance from the center of the coil 'a' in cm	Magnetic field Bpp in Gauss
	Left hand side		**Right hand side**
0		0	
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
18		18	
19		19	
20		20	

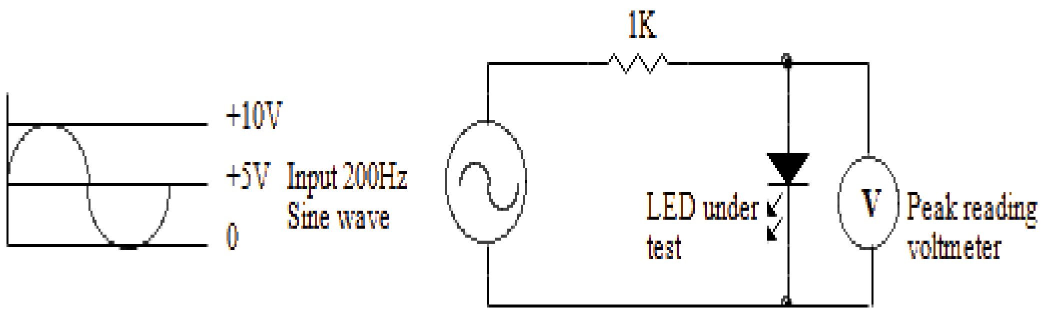
Nature of Graph



Result:

The variation of magnetic field intensity along the axis of current carrying circular coil has been studied and the nature of graph plotted.

CIRCUIT DIAGRAM



TABULAR COLUMN

Color	Wavelength (nm)	Knee Voltage (V)	$\lambda V x 10^{-9}$
Yellow	576		
Green	548		
Blue	350		
Red	620		
Average λV =			

PROCEDURE:

1. The circuit is rigged as shown in Figure. The input to the LED is an ac signal. The rectified output appears across the LED is a unidirectional pulsating. Hence, a peak reading meter is used to read voltage across the LED.
2. Using a digital peak reading voltmeter the voltage across the LED is measured and recorded in Table for given color LED light.
3. Trial is repeated by changing the LED and the corresponding knee voltage is noted in Table.
4. The product of wavelength and knee voltage is determined and its average value is calculated.
5. Planck's constant is calculated using equation.

where $e = 1.6 \times 10^{-19}$ C, $c = 3 \times 10^{8}$ m/s

PLANCK'S CONSTANT

EXPT. NO: **DATE:**

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

APPARATUS: Planck's constant experimental setup consisting of 0-10V peak to peak sine wave generator, digital peak reading voltmeter, six different know wavelength LED lights

THEORY: Max Planck in his paper published in 1900 announced his derivations based on his revolutionary idea. ***"The energy emitted by a resonator (black body radiator) is in discrete values or in quanta***" The packet of energy is given by Where "h" is a universal constant now called as Planck's constant in honor of the inventor. For Planck it was a "lucky guess" rather than a firm conclusion. He theoretically calculated the value of the constant appearing in his equation and obtained h = 6.55×10^{-34} Joules Second (Js).

Light Emitting Diode (LED)

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-1., Where 'c' is the velocity of the light 'λ' is the wavelength of the light emitted and '1/λ' is the wave number '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, Where 'e' is electronic charge

LEDs are very high efficiency diodes and hence this entire electrical energy is converted into light energy,…4

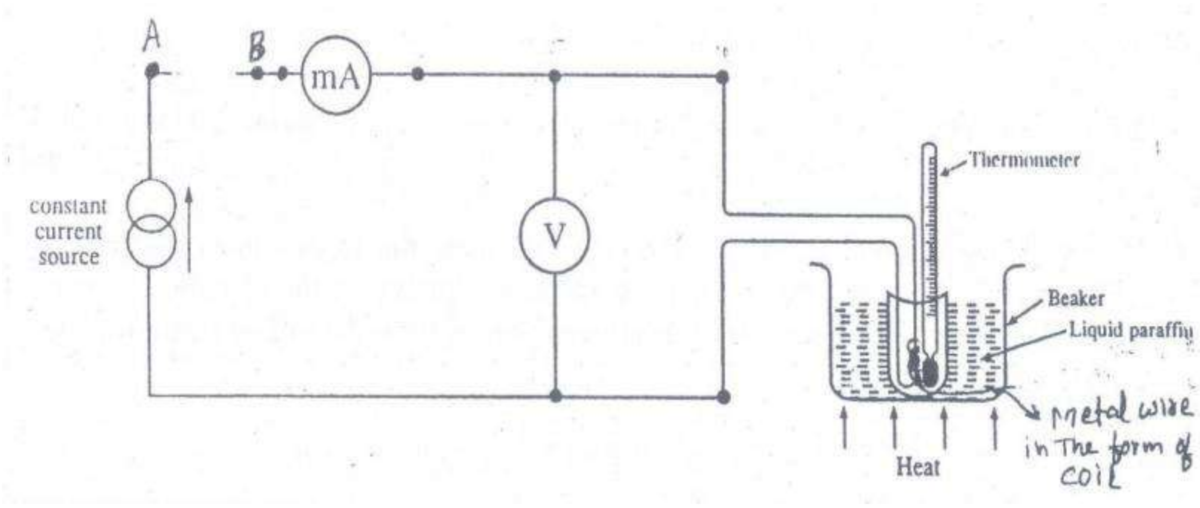
From which Planck's constant is given by

$$h = \frac{eV\lambda}{c}$$

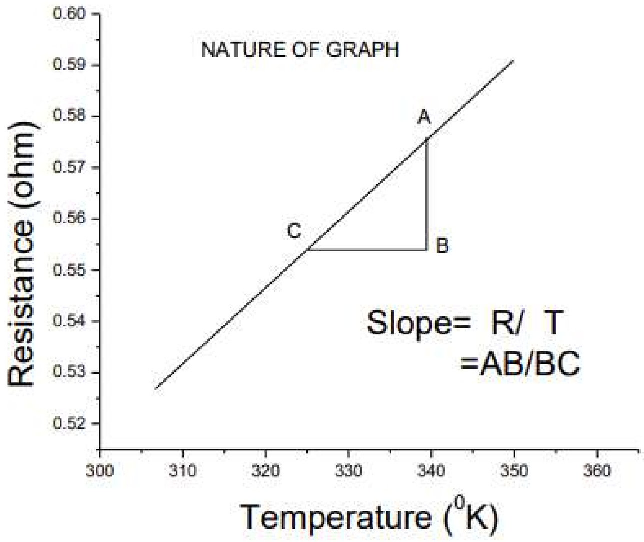
where e = 1.6×10^{-19} C, c = 3×10^{8} m/s

RESULTS: Planck's constant value obtained using LEDs h = ________________ J-s

CIRCUIT DIAGRAM



Sl. No.	Temperature 't' in ^{0}C	Temperature in ^{0}K T=(t+273)	Voltage (V) in mV	Current (I) in mA	Resistance$(R = \frac{V}{I})$ in Ω
1	85	358			
2	80	353			
3	75	348			
4	70	343			
5	65	338			
6	60	333			
7	55	328			
8	50	323			
9	45	318			
10	40	313			
11	35	308			



= ______________ ΩK^{-1}

$\frac{\Delta R}{\Delta T}$is the slope of the straight line obtained by plotting resistance of the metal against absolutetemperature of the metal.

Calculations

$$\text{Fermi energy } E_F = \left[\frac{ne^2\pi Ar^2}{L)(2m)}\right]^2 x\left(\frac{\Delta R}{\Delta T}\right)^2 \text{ J or eV}$$

Where n, A, πr^2, L are constants given below

n= 8.464 x 10^{28}/kg mol, A= 7.4 x 10^{-6}, πr^2 = 0.212 x 10^{-6} m^2, L = 3.58 m,
m = 9.1 x10^{-31}kg,
e = 1.602 x 10^{-19} C

$$\mathbf{E_F = 4.99 \times 10^{-13} \times (slope)^2\ J}$$

$$E_F = \frac{4.99X10^{-13}\,X(slope)^2}{1.602X10^{-19}}$$

E_F = ____________________eV

BLACK BOX

AIM: To identify the circuit elements like inductor, capacitor and resistor contained in a box and hence to evaluate their values.

APPARATUS: Black box, Digital voltmeter, Sine wave Oscillator, Load resistor.

PROCEDURE:

1. The circuit is rigged as shown in fig. oscillator is connected to input and its amplitude is set to 1V and frequency is set to 1000 Hz. Amplitude (i.e. I/P voltage) once set should not be allowed through out the experiment.

2. Any one element say Z_1, is selected and O/P voltage is measured, using digital AC voltmeter.

3. Experiment is repeated by connecting Z_2& Z_3 since I/P voltage is set to 1V, gain is directly given by O/P voltage.

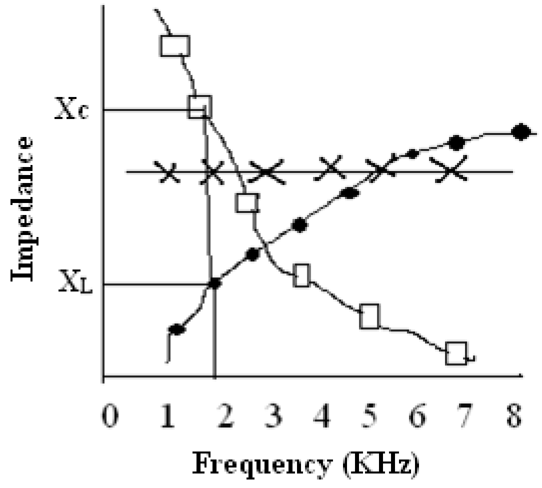
RESULT: 1) Circuit element L, C & R are identified

2) Their values are found to be

R = ………………… Ω C = ……………….. F L = …………..…. Henry

TABULOUR CALUMN:

Freq. KHz	Z_1		Z_2		Z_3	
	Gain	Impedance	Gain	Impedance	Gain	Impedance
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						



NATURE OF GRAGH :

X - Resistor

- Capacitor

●- Inductance

X_L - Inductive reactance at 2KHz

X_C - Capacitive reactance at 2KHz

VIVA QUESTIONS ON DIFFRACTION GRATING

1. **What do you mean by diffraction of light?**

Ans A beam of a light bends round the corner of the obstacles (edges of opaque lines of the grating) enters into the geometrical shadow. This phenomenon is called diffraction.

2. **What are the differences between the interference &diffraction?**

Ans a) Interference is the result of interaction of light coming from two different wave front originating from the same source whereas diffraction is the result of interaction of light coming from different parts of the same wave front. b) The width of the fringes in interference are always equal where as in diffraction they never be equal.

3. **How many types of diffraction are there? Name them how they are obtained.**

Ans a) Fresnel's diffraction:- Fresnel's diffraction is obtained by placing the source & the screen at finite from the aperture of obstacle having sharp edges. b)Fruanhoffer diffraction:- It is obtained by placing source and screen at infinity.

4. **What is meant by grating constant?**

Ans The distance between any two successive slits is called grating constant.

5. **Mention one of the applications of diffraction grating.**

Ans It is used to measure wavelength of different colour.

6. **Whether mercury source is monochromatic?**

Ans No, it is not a mono chromatic source.

7. **Whether intensity of diffraction pattern varies? Explain**.

Ans Intensity varies from maximum to minimum. As the order of the spectrum increases the intensity decreases.

8. **What is the condition to have diffraction by grating?**

Ans The width of lines drawn on glass plates should be equal to wave length of used light.

9. **What happens when the number of lines N per inch increased or decreased?**

Ans If N increased we get few order number of bands separated by large angle. If N decreased we get several order number of bands separated by small angle.

10. **What do you mean by diffraction of light?**

Ans When light passes by the edge of an opaque obstacle it bends slightly in to geometrical shadow. This property of light waves of bending aground corners is called diffraction of light.

VIVA QUESTIONS ON NUMERICAL APERTURE OF AN OPTICAL CABLE

1 **What is optical fiber?**

Ans: Optical fiber is a transparent dielectric media which can able to guide visible or IR light through long distance.

2. On which principle optical fiber works?

Ans: It works on the principle of Total internal reflection.

3. Define critical angle.

Ans: It is the angle of incident for which angle of refraction is equal to 90^o

4. State Snell 'slaw.

Ans: The ratio of angle of incident to angle of refraction is constant and is equal to refractive index

5. What is angle of acceptance?

Ans: It is the maximum angle of a ray surrounding the axis of optical after refraction into the core of an optical fiber under goes total internal reflection.

6. What is acceptance cone in optical fiber?

Ans: Acceptance cone is derived by rotating the ray of light around the axis of optical fiber by keeping angle of acceptance constant. Any signal light ray enters into core of an optical fiber undergoes TIR, and any signal light ray which enters into the core of an optical fiber out the cone of acceptance does not undergoes TIR.

7. What is numerical aperture of an optical Fiber?

Ans: The Numerical Aperture (NA) is a measure of light gathering capability of an optical fiber. The NA is related to the acceptance angle θ_o

N.A. = $\sin\theta_o$ Which indicates the size of a cone of light that can be accepted by the fiber.

8. What are the types of optical fiber?

Ans: There are three types of fiber optical cable viz (1) single mode (2) multimode and (3) graded index multimode optical fiber

9. What if fractional index change?

Ans: It is the ratio of difference of the refractive indices of the core and cladding to the refractive index of core of an optical fiber.

10. What is V number in fiber optics?

Ans: The V number is a dimensionless parameter which is often used to calculate the number of modes of an optical fiber.

11. What is refractive index profile?

Ans: It is the curve which indicates the variation of refractive index of an optical fiber with respect to the radial distance.

12. What is the difference between single and multi-mode optical fiber? The dimensions (Geometry) and ray diagram,

Ans: Only in case of graded index multi-mode optical fiber all the parameters i.e. geometry, refractive Index profile and ray diagram also changes.

13. What is attenuation?

Ans: The loss in the strength of signal light when it is propagating through core of an optical fiber over a long distance in the homogenous medium is known as attenuation.

14. What are the factors which effects the attenuation of an optical?

Ans: The attenuation of an optical fiber is due to: - absorption of signal light due to Impurities (presence of TM Ions such as iron cobalt copper etc in the fiber material), hydroxyl ions , intrinsic absorption, Rayleigh scattering, un burnt starting material, micro crystallites, presence of air bubbles, microscopic and macroscopic radiation.

15. What are the applications of the optical fibers?

Ans: In data link cables, local area network, submarine cables, sensing device etc

16. What are advantages of optical fiber cable over metallic cables?

Metallic cables	**Optical fiber cable**
Diameter = 76mm	Diameter = 13 mm
Twisted copper wires = 900	Fiber strands = 12
Transmission = 21000 channels	Transmission = 3 lakh channels
Weight of 1 m cable = 7 kg/m	Weight of 1 m cable = 0.06 kg/m

VIVA QUESTIONS ON TRANSISTOR

1. **What is semiconductor? Explain with types.**

Ans Semiconductor is a substance whose resistivity lies in between conductors and insulators. A semiconductor is divided in to two types: 1. Intrinsic semiconductor (It is a s.c. in its pure form) 2. Extrinsic semiconductor (It is doped semiconductor) Depending upon impurity added extrinsic s.c. is divided in to two types. 1. p-type s.c.(When a small amount of trivalent impurity(ex: indium) is added to pure s.c. then it is p-type s.c.) 2. n-type s.c.(When a small amount of heptavalent impurity(ex: Arsenic) is added then it is n-type s.c.

2. **What is doping? Why it is needed?**

Ans The process of adding impurity to s.c. to achieve desired characteristic is doping. It is needed to normally to increase conductivity of s.c. generally for 10^8 atoms of s.c. impurity is added.

3. **What do you mean by transistor ? Why it is called so?**

Ans A transistor is a three terminal s.c. device. It consists of either thin layer of p-type s.c. sandwiched between two n-type s.c. or a thin layer of n-type s.c. sandwiched between two p-type s.c. There are three layer – middle layer is base and two outer layers are called emitter and collector. Transistor transfers signal current from low resistance to high resistance circuit. Since it transfers signal across resistor it is called transistor. The word transistor is TRANSfer resistor.

4. **What does an arrow in a transistor symbol indicates?**

Ans The emitter which is shown by an arrow indicates the direction of conventional current. In PNP transistor electrons flow out of the emitter towards +ve battery terminal, consequently the conventional current flows into the emitter as indicated an inward arrow. Here majority charge carriers are holes. In NPN transistor electrons flow out of the emitter as indicated an out going arrow. Here majority charge carriers are electrons.

5. **What are emitter, base & collector?**

Ans Emitter:- It’s main function is to supply majority charge(electrons or holes) to base. Base:- It separates the input circuit of emitter from output circuit of the collector and thus forms two PN junctions between emitter and collector. Collector:- It’s main function is only to collect majority carriers from emitter.

6. **Define current gain in transistor?**

Ans The current gain is the ratio of output current to input current. In common emitter configuration it is the ratio of change in collector current to change in base current is called current gain or current amplification factor.

7. **How many types of configurations or modes are there in transistor?**

Ans There are three modes or configuration. They are I) Common base mode(CB mode), II) Common collector mode(CC mode) & III) Common emitter mode(CE mode).

8. **Why CE mode is used more often in transistor?**

Ans Owing to high input impedance and high current gain and power gain, the common emitter circuits are more commonly used.

9. **Mention some of the applications of transistor?**

Ans Transistors can amplify electronic signals and can also be used as an oscillator. They are widely used in radio and T.V. receivers.

10. **What is biasing?**

Ans Applying voltage or current to either transistor or diode is called biasing.

VIVA QUESTIONS ONDIELECTRIC CONSTANT

1. **What do you mean by dielectric material?**

Ans Dielectric material is a non-conducting material which serves as a charge storage aid under certain circumstances.

2. **How many types of dielectric materials are there?**

Ans There are two types of dielectric materials. They are Polar dielectric and Non-polar dielectric.

3. What are polar and non-polar dielectric materials?

Ans Polar dielectrics: - Dielectrics in which permanent dipoles are present.
Non-polar dielectrics: - in which dipoles are formed due to applied electric field.

4. What do you mean by dielectric constant?

Ans The ratio of capacitance of the material in air to the capacitance of capacitor in vacum.

5. What is a capacitor?

Ans Capacitor is a device to store charges.

6. Name the types of capacitors.

Ans Types of capacitors:- Paper capacitors, Mica capacitors, Electrolytic capacitors.

7. How the charge storage capacity of the capacitor increased?

Ans The capacitance of a capacitor is larger when there is dielectric material is between the plates.

8. Name the types of the polarization mechanisms.

Ans Types of Polarization mechanisms are – Electronic polarization, Ionic polarization, Orientation polarization, Space-charge polarization.

9. Define half charging time.

Ans In graph the charging & discharging curves meet at a point & that point is known as half charging point & the time is half charging time.

10. On what factors dielectric constant depends?

Ans Dielectric constant depends on capacitance of material & capacitance of vacuum.

11. Define resistance.

Ans The property of a material which opposes the flow of current.

12. Define time constant of RC circuits.

Ans The product RC is called the time constant.

13. What is the effect of applied electric field on polar and non-polar dielectrics?

Ans all the dipoles will be aligned in the field direction.

VIVA QUESTIONS ON PHOTO DIODE

1. What is photodiode?

Ans: 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. What is meant by responsivity?

Ans: The responsivity (or radiant sensitivity) of a photodiode is the ratio of generated photocurrent and incident optical power (neglecting noise influences), determined in the linear region of response.

3. What is quantum efficiency?

Ans: The "quantum efficiency" (Q.E.) is the ratio of the number of carriers collected by the Photo diode to the number of photons of a given energy incident on the Photo diode. The Quantum efficiency may be given either as a function of wavelength or as energy.

4. In photo diode experiment the reverse current depends on intensity of light or reverse voltage?

Ans: Intensity of light.

5. How reverse resistance changed with respect to intensity of light?

Ans: Decreases with increase of intensity of light

6. What is the result of the current voltage characteristics of photo diode?

Ans: The photo current depends on intensity of light not on the reverse voltage.

VIVA QUESTIONS ON:SERIES AND PARALLEL "LCR" CIRCUITS

1. What is capacitor? Define capacitance.

Ans Capacitor or condenser:- An electric condenser which can store a charge.
Capacitance:- A capacitance of a conductor is defined as a ratio of charge per volt .i.e. C=Q/V

2. What is an inductor?

Ans The e.m.f. induced in a circuit due to a changing electric current in thecircuit.

3. What do you mean by resonance?

Ans It is the phenomenon of making a particle to vibrate with its natural frequency under the influence of another vibrating particle with the same frequency is calledresonance.

4. What do you mean by sharpness of resonance?

Ans The sharpness of resonance is a measure of fall of current amplitude from its maximum value at resonant frequency on either side ofit.

5. What is meant by Henry, Ohm &Faraday?

Ans Henry:- It is the S.I. unit of self and mutual inductance, 1 Henry = 1 Weber/Ampere. Ohm:- Itisdefinedastheresistanceofacolumnofmercury106.3cmlonghavingamass144452 Gram&auniformcrosssectionalareaat0^0c.Aresistancehavingap.d.of1voltwhenone ampere of current is passed through it is unit of electrical resistance. Faraday:-It is the quantity of electricity required to liberate or deposit 1 gram equivalent of anion.

6. What is meant by resonance frequency?

Ans The frequency at which both reactance's X_L & X_C becomes equal is called resonant frequency

7. What is Q –factor?

Ans The ratio of V_L or V_C with applied voltage at resonant frequency is called voltage Magnification and denoted by Q – factor, Q=V_L/v = 1/R x √LC

8. What is bandwidth?

Ans Bandwidth = f2 –f1.

9. How do you obtain cut off frequency in series and parallel?

Ans In series cut off frequency = I_{max} / √2. In parallel cut off frequency = I_{max} x √2

10. **Explain the variation of current in two circuits**.

Ans In series:- total impedance of a circuit is equal to resistance Z=R which is minimum, hence maximum current flows through the circuit at resonance.

In parallel:- $X_L > X_C$, so impedance maximum & current minimum.

11. What is impedance?

Ans It is a measure of the resistance offered by a circuit to an a.c.

12. How do you identify the resonance in a circuit?

Ans The current is maximum at resonant frequency in a series circuit. The Current will be minimum at resonant frequency in parallel circuit.

VIVA QUESTIONS ON MEASUREMENT OF MAGNETIC FIELD ALONG THE AXIS OF A CIRCULAR CURRENT CARRYING COIL

1. What is magnet?

Ans: Magnet either natural or artificial is one which exhibits two properties one is attractive properties i.e. which attracts magnetic materials second directive property i.e. when it suspended freely in horizontal plane always comes to rest in north and south direction.

2. What are the laws of magneto statics?

Ans: Like poles repeals and unlike poles attracts.

The force of attraction or repulsion between two isolated magnetic poles is directly proportional to the pole strengths and inversely proportional to square of the distance between the poles.

3. What is pole strength?

Ans: pole strength of a magnetic pole is numerically equal to 10^7 times the force in newton that it exerts on a unit North Pole (North Pole of 1 Am) placed at a distance of 1 m from it in air or vacuum.

4. What is SI unit of pole strength?

Ans: Ampere-meter =A-m.

5. What is magnetic field?

Ans: Magnetic field is region within which a magnetic pole experienced a force. Even any moving charged particle also experienced by force.

6. What is null point?

Ans: In a combined magnetic field the null point is that point at which the magnetic field is zero.

7. What is a line of force in magnetic field?

Ans: line of force in magnetic field is the path along which an isolated north pole moves or tends to move.

8. Define magnetic flux density.

Ans: The number of lines of force passing normally through unit area of cross section around a point is called Magnetic flux density at that point. The SI unit is Wb/m^2 = Tesla. Magnetic flux density is a measure of magnetic field.

9. Define magnetic field or magnetic flux density.

Ans: Magnetic flux density or magnetic field B at a point is defined as the force in Newton acting on a north pole of strength 1 Am kept at that point.

10. What is magnetic moment?

Ans: The magnetic moment is a quantity that represents the magnetic strength and orientation of a magnet that produces a magnetic field.

11. Define intensity of magnetic field.

Ans: The intensity of magnetic field or magnetic field strength at any point is defined by the relation $H = \frac{B}{\mu_0}$

12. What is the magnetic effect of electric current?

Ans: Current carrying conductor produces magnetic field in the surrounding region is known as magnetic effect of electric current.

13. **How direction of magnetic field due to electric current defined?**

Ans : By Amperes swimming rule and Maxwell's right hand screw rule

14. State Biot-Savarts's law.

Ans: The magnetic intensity dH at a point A due to current I flowing through a small element dl is Directly proportional to current (I), Directly proportional to the length of the element (dl), Directly proportional to the sine of angle θ between the direction of current and the line joining the element dl from point A., Inversely proportional to the square of the distance (x) of point A from the element dl.

$$dH = \frac{\mu_0 \mu_r}{4\pi} xIdl \sin\theta / x^2$$

$$dH = kxIdl \sin\theta / x^2$$

$dH \alpha Idl \, ^{\sin\theta}/_{x^2}$

Where k is constant and depends on the magnetic properties of the medium.

K=$\mu_0\mu_r$/4Π

μ0 = absolute permeability of air or vacuum and its value is 4 x 10^{-7} Wb/A-m

μr= relative permeability of the medium.

15. What is the expression for magnetic field at the center of a circular coil carrying a current?

Ans: The magnetic field at the center of the current carrying circular coil is given by

$B = \frac{\mu_0}{4\pi} x 2\pi nI$ Tesla or Wb/m

16. How the magnetic field varies along the axis of the current carrying circular coil carrying current?

Ans: The field at the center of the coil is maximum and decreases with of distance on either side of the coil along the axis of the coil.

17. What is the relationship between Gauss and Tesla?

1 Gauss = 10^{-4} Tesla

VIVA QUESTIONS ONFERMI ENERGY

1. Define Fermi energy.

Ans The energy of the highest occupied level at zero degree absolute temperature.

2. Define mean free path.

Ans It is the average distance traveled by the conduction electrons between any two successive collisions with the Lattice ions.

3. On what factors the Fermi energy depends.

Ans Fermi energy depends on electron concentration.

4. Define Fermi temperature.

Ans The temperature at which the average thermal energy of the free electron in a solid becomes equal to the Fermi energy at0^0K.

5. Define density of states.

Ans The number of available states per unit volume per unit energy centered at given E in valence band.

6. What are valence electrons?

Ans The electrons in the outermost orbit of any atom of any element are called valence electrons.

7. Explain the variation of resistivity with temperature.

Ans In case of metal as the temperature increases the resistivity of the metal also increases.

8. What is Fermi factor?

Ans The Fermi function f(E) gives the probability that a given available electron energy state will be occupied at a given temperature.

9. Write the difference between classical and quantum theories.

	Classical free electron theory	Quantum free electron theory
1.	The energy values of free electrons are not quantized and are continuous.	The energy values of the free electrons are quantized and are discreet values.
2.	Classical free electrons obey Maxwell's – Boltzmann Statistics.	Quantum free electrons obey Fermi-Dirac statistics.