"Jai Sri Gurudev"

Sri Adhichunchanagiri Shikshana Trust ®

B.G.S.INSTITUTE OF TECHNOLOGY

B.G NAGARA - 5 71448

MANDYA

ENGINEERING PHYSICS LABORATORY MANUAL

I/II SEMESTER B.E.

PREPARED BY :

FACULTY, DEPARTMENT OF PHYSICS

C O N TE N T S

GENERAL INSTRUCTIONS

1. All the observations made during an experiment must be entered neatly in a separate note book.
2. Before coming to the laboratory write the Aim, apparatus required, figure, formula and necessary tabular column.
3. Proper units must be mentioned wherever necessary.
4. All entries must be shown with pen only.
5. Avoid overwriting in the observation book and in the laboratory record.
6. After completing of an experiment, write the correct values in the physics manual and take signature from lab in charge without fail.
7. Students should submit the record of the previous experiments when they come for next practical class.
8. Don't make noise unnecessarily during an experiment conduct in the laboratory.

INSTRUCTIONS FOR RECORD WRITING

Right Hand Page:

a) Write the Expt. No. and Date within the margin at the top OR space provided for same.
b) Name of the experiment (Block Letters)
c) Aim
d) Apparatus required
e) Procedure
f) Result with unit
g) Graph Sheets to be attached at the margin of the procedure

Left Hand Page:

a) Neat diagram
b) Formula and explanation of symbols with unit
c) Observation and calculations.

TRANSISTOR CHARACTERISTICS

AIM: To draw the input and output characteristics of the given NPN transistor, and hence to determine its ά and β and also the knee voltage for silicon.

APPARATUS: Given transistor → SL100, Variable DC power supply in the ranges 0-5V and 0-20V, DC micrometer (0-1000μA), DC milliameter (0-100mA), Digital voltmeter (DVM), circuit unit with a base resistor of 5.1KΩ and patch cords.

PROCEDURE: The circuit for studying the transistor characteristics for an NPN transistor is as shown in fig.1. Identify the base, the collector and the emitter leads of the given NPN transistor (SL 100) and then insert it into the relemate connector (i.e, the transistor socket), in the circuit. Through the relemate connector, the emitter, the base and the collector get connected to the points E, B and C respectively. The biasing voltages V_{BB} & V_{CC} are applied to the circuit by connecting P to A and Q to D, in the input side, and by connecting T to F and S to G on the output side. The micrometer (μA) is connected between U and V, and the milliammeter is connected between M and N.

INPUT CHARACTERISTICS STUDY:

SUB PROCEDURE: All the power supply knobs are turned to the minimum position, and all the power supply points are switched on. The voltmeter (DVM) is connected between K and L. The collector emitter voltage V_{CE} is set 2 volt, by varying V_{CC}. The voltmeter is disconnected and then connected between H and J. The base emitter voltage V_{BE} is increased from zero volt, insteps of 0.1V upto to 0.6V, and then in steps of 0.05V upto a maximum of 0.75V,and corresponding values of the base current I_B are noted from microammeter, and entered in the tabular column-I

EVALUATION OF THE CONSTANTS:

The readings are plotted, V_{BE} along X –axis, I_B along Y-axis(fig.2). The portion of the curve which could be approximated to a straight line, is extrapolated downward to meet X-axis at K and the value of V_{BE} at K, known as the knee voltage V_T is noted.

OUTPUT CHARACTERISTICS STUDY:

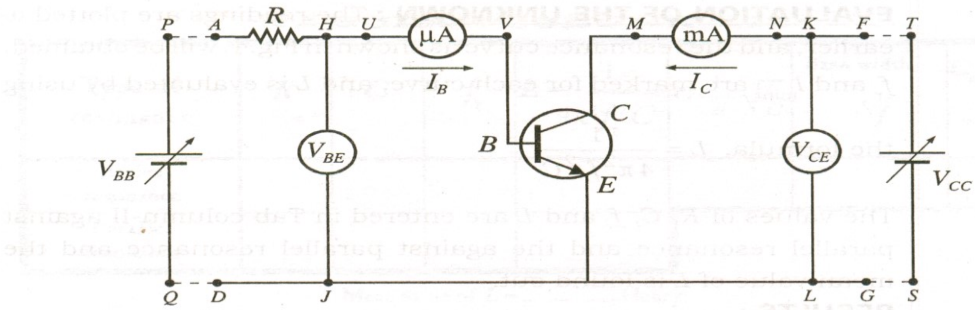
SUB PROCEDURE: I_B is set to 50 μA by varying V_{BB}. The voltmeter is connected between K and L.V_{CE} is varied (a) in steps of 0.05V, starting from 0V, upto 0.3V and ,(b) in steps of 2 volt upto a maximum value of 12V, by varying V_{CC}. The corresponding readings of collector current I_C are recorded from the milliameter in each step and entered under trial -I of tabular column-II. The same is repeated by setting I_B=100μA for trial -II, and I_B=150μA for trial-III to begin with, and corresponding readings of I_C are entered in the corresponding tabular column.

EVALUATION OF THE CONSTANTS:

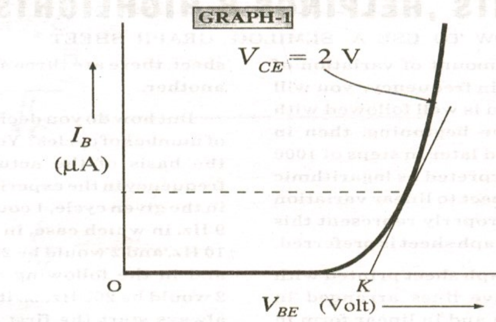
The readings under all the 3 trials are plotted in the same graph, with V_{CE} along X-axis, and I_C along Y-axis (fig-3). The values of I_C at points I_{C1}, I_{C2} and I_{C3} at which I_C becomes essentially independent of V_{CE} for the 3-curves are noted. The current gain β in general is given by, β= ($\Delta I_C/\Delta I_B$). β is evaluated for different combinations of curves, (for example, for the lower curve pair β = I_{C2}- I_{C1}/I_{B2}-I_{B1}), and the average value of β is found out. The value of α is calculated by using the equation,

$$\alpha = \beta/(1+\beta)$$

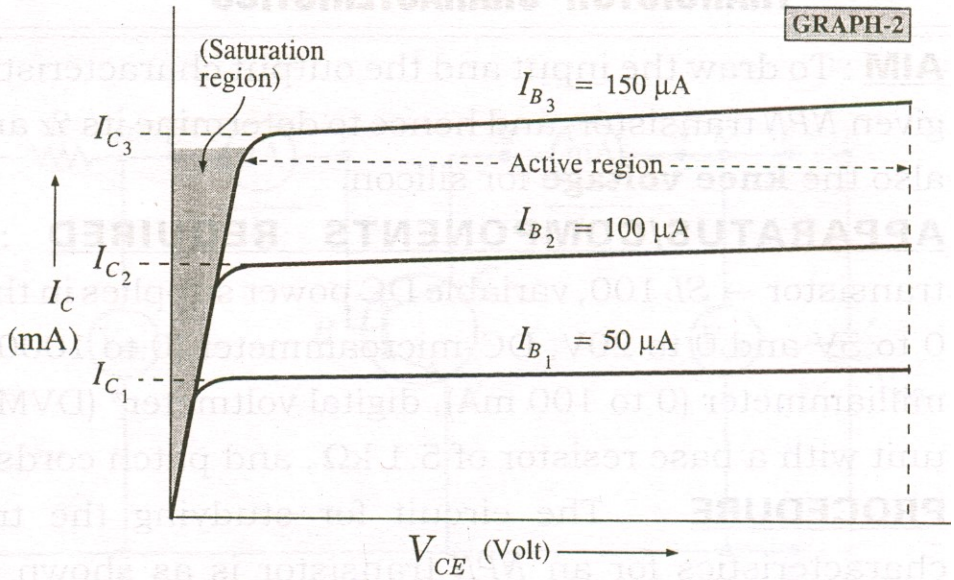
I FIGURES :



CIRCUIT DIAGRAM - *TRANSISTOR CHARACTERISTICS*
Fig. 1



INPUT CHARACTERISTICS
Fig. 2



OUTPUT CHARACTERISTICS

Fig. 3

II FORMULAS USED :

1. $\beta = \dfrac{\Delta I_C}{\Delta I_B} = \dfrac{I_{C_2} - I_{C_1}}{I_{B_2} - I_{B_1}}$

where, β, is the current amplification factor,

$\Delta I_B = I_{B_2} - I_{B_1}$, is the change in base current,

$\Delta I_C = I_{C_2} - I_{C_1}$, is the corresponding change in collector current.

2. $\alpha = \dfrac{\beta}{1+\beta}$

III **RESULTS**: for the given transistor

(i) The input, and output characteristics are obtained,

(ii) The knee voltage V_T is found to be=…………………..V

(iii) The value of β=………………….

(iv) The value of α =………………….

IV OBSERVATIONS:

a) Input Characteristics

TABULAR COLUMN – I

Dependence of I_B on V_{BE} for constant V_{CE}

V_{BE} (volts)	V_{CE} =2V I_B (µA)
0.00	
0.10	
0.20	
0.30	
0.40	
0.50	
0.55	
0.60	
0.65	
0.70	
0.75	
0.80	
0.85	

For Graph – 1

b) Output Characteristics

TABULAR COLUMN – II

Dependence of I_C on V_{CE} for constant I_B

V_{CE} (volts)	TRIAL-1	TRIAL-2	TRIAL-3
	I_{B1}=20µA	I_{B2}=40µA	I_{B3}=60µA
	I_{C1}(mA)	I_{C2}(mA)	I_{C3}(mA)
0.00			
0.05			
0.10			
0.15			
0.20			
0.25			
0.30			
1.00			
2.00			
4.00			
6.00			
8.00			
10.00			

For Graph - 2

The knee voltage is found to be = ---------------V

V CALCULATIONS :

Evaluation of current amplification factor β :

From graph - 2, I_{C_1} =........mA, I_{C_2} =........mA, I_{C_3} =........mA,

and, I_{B_1} =........μA, I_{B_2} =........μA, I_{B_3} =........μA.

$$\beta_1 = \frac{I_{C_2} - I_{C_1}}{I_{B_2} - I_{B_1}} = \ldots\ldots$$

$$\beta_2 = \frac{I_{C_3} - I_{C_2}}{I_{B_3} - I_{B_2}} = \ldots\ldots$$

$$\text{and, } \beta_3 = \frac{I_{C_3} - I_{C_1}}{I_{B_3} - I_{B_1}} = \ldots\ldots$$

$$\text{The average value of } \beta = \frac{\beta_1 + \beta_2 + \beta_3}{3} = \ldots\ldots$$

$$= \ldots\ldots$$

(iii) **Evaluation of α :**

$$\alpha = \frac{\beta}{1+\beta} = \ldots\ldots$$

$$= \ldots\ldots$$

VI RESULTS :

For the given transistor,

(i) The knee voltage V_T is found to be =........

(ii) The value of β =........

(iii) The value of α =........

EXPERIMENT – 02

ZENER CHARACTERISTICS

AIM: To draw the I-V characteristics of a Zener diode, and determine the knee voltage and Zener voltage.

APPARATUS: Zener diode, 0 to 20V DC power supply, digital voltmeter (DVM), digital DC milliameter (DCM), resistor, circuit unit, patch cords.

PROCEDURE: The circuit for studying the forward bias characteristics of a zener diode is as shown in Fig.1. The biasing voltage is applied to the circuit, by connecting P to A, and Q to D. The milliammeter (DCM) is connected between U and V, and the voltmeter (DVM) is connected between H and J.

For the Zener diode, the n-section, and the p-section are identified with the help of an ohm meter.

FORWARD BIAS STUDY: The p-section lead of the zener diode is connected to E and its n-section lead is connected to F (Fig. 1). The power supply knob is turned to the minimum position, and the power supply point is switched on. The applied voltage V_F is increased from zero volt in steps of 0.1V (using adjustment knob), upto 0.6 V (at which a rapid rise in current begins), and then in steps of 0.05V (using fine adjustment knob), upto a maximum of 0.8V, and the corresponding current is noted at each step, and recorded in Tab.column-I.

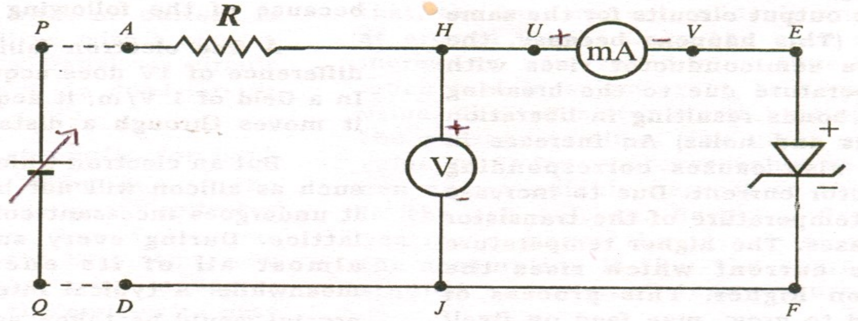
REVERSE BIAS STUDY: The Power supply knob is turned to minimum. Now, the zener diode is subjected to a reverse bias by connecting the p-section and n-section leads to F and E respectively (Fig. 2). The applied voltage V_R is varied in steps of 1 volt, until there is a sign of increase in the current I_R from zero value. (For a 7.5 volt zener diode, it starts around 7.4 V). Once a small increase in current is observed, the voltage is increased in steps of 0.02 V upto a maximum of 7.64 V, during which there will be a steep rise in the reverse current. The readings are recorded at each step in Tab. Column-II.

GRAPHICAL: In a suitable graph sheet, the origin 'O' is chosen at the center (Fig.3). The readings from the Tab. Column-I are plotted in it, with the voltage V_F (forward voltages) along the positive X-axis, and the current I_F (forward current) along the positive Y-axis. The curve obtained lies in the first quadrant, and is called the forward bias characteristics for the Zener diode (Fig.3). After the rapid rise in the current, the portion of the curve which could be approximated to a straight line is extrapolated downward to meet X-axis at K, and the value of V_F at K, known as the knee voltage, V_K is noted.

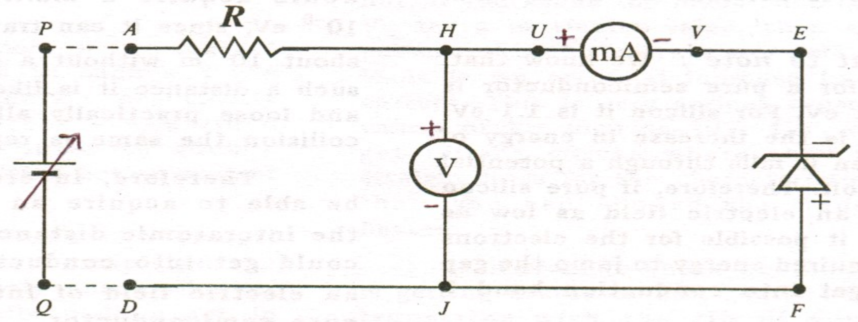
The readings from the Tab. Column-II are plotted in the same graph sheet, with the voltage V_R (reverse voltage) along the negative Y-axis. The curve obtained lies in the third quadrant, and is called the reverse bias characteristics for the zener diode (Fig. 3).

In the curve, after the stage where steep rise in the current occurs, the portion of the curve which forms a straight line is extrapolated upward to meet the X-axis at L, and the value of V_R at L known as the breakdown voltage, or zener voltage V_Z (which depends on the particular zener diode) is noted.

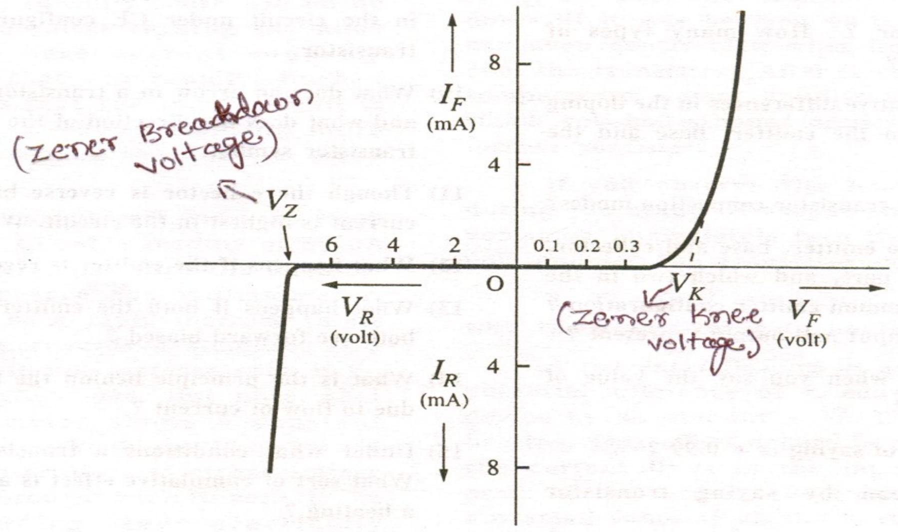
I FIGURES :



FORWARD BIAS SET-UP
Fig. 1



REVERSE BIAS SET-UP
Fig. 2



ZENER DIODE CHARACTERISTICS
Fig. 3

II. OBSERVATIONS

a) Forward bias characteristics

TABULAR COLUMN – I

V_F (volt)	I_F (mA)
0.10	
0.20	
0.30	
0.40	
0.50	
0.60	
0.65	
0.70	
0.75	
0.80	
0.85	
0.90	
0.95	
1.00	

From Graph,

The value of knee voltage,
V_K = ... V

b) Reverse bias characteristics

TABULAR COLUMN - II

V_R (volt)	I_R (mA)
0.00	
2.00	
4.00	
6.00	
8.00	
10.00	
11.00	
11.50	
11.55	
11.60	
11.65	
11.70	
11.75	
11.80	
11.85	
11.90	
11.95	
12.00	
12.05	
12.10	

From Graph,
The value of Zener voltage,
V_Z = ... V

III RESULTS :

1) The value of zener voltage for the given zener diode is found as, V_Z = ... V
2) The value of knee voltage for silicon is found as, V_K = ... V

DIELECTRIC CONSTANT BY RC CHARGING AND DISCHARGING

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

APPARATUS: 5V DC power supply, digital voltmeter, timer, standard resistors, capacitors of known dimensions and patch cords.

PROCEDURE: The required circuit is shown in fig.1. The supply points are switched on. The 5V power supply is connected to the points A and B. The given resistor is connected between the points M and N. The given capacitor is connected between the points S and T. to begin with, the toggle in the switch S is set to halt position. The timer is set to zero by pressing the reset button. The digital voltmeter is connected between the points P and Q in the circuit at which time it should read zero.

CHARGE MODE STUDIES: To start with the toggle of the switch S is set to charge mode. Next the toggle in switch S is flicked to start position, at which instant the capacitor begins to get charged to higher voltage and the timer starts counting simultaneously.
Immediately starts noting down the voltage readings V in the voltmeter at every 5 seconds interval from zeroth second, until V becomes practically constant (i.e say, when two consecutive readings remain same). The readings for V are entered in the tabular column, under charge mode (the readings must be V=0 for T=0).

DISCHARGE MODE STUDIES: The following 4 operations must be performed in quick succession.

- (i) The toggle of the switch S is changed to halt position,
- (ii) the timer is reset to read zero,
- (iii) the toggle in switch S is changed to discharge mode, and simultaneously,
- (iv) the toggle in switch S is flicked to start position.

Immediately start noting down the readings for V at every 5 seconds interval till V becomes practically constant i.e, constant over two consecutive observations. The readings for V are tabulated under discharge mode (for T=0, the entry for V must be same as the maximum voltage value attained during charge mode studies.)

EVALUATION OF UNKNOWN: From the tabular column readings a graph is plotted with time T in seconds taken along X-axis, and the voltage V is volts along Y-axis. The charge mode curve and the discharge mode curve intersect at the point P (fig2).

By referring the position of P to the time axis, the value of its abscissa T in seconds is found out. The value of the dielectric constant K is given by,

K ={ **EMBED Equation.3** }

Where, d and A, are the thickness and area of the dielectric material (in S.I units)

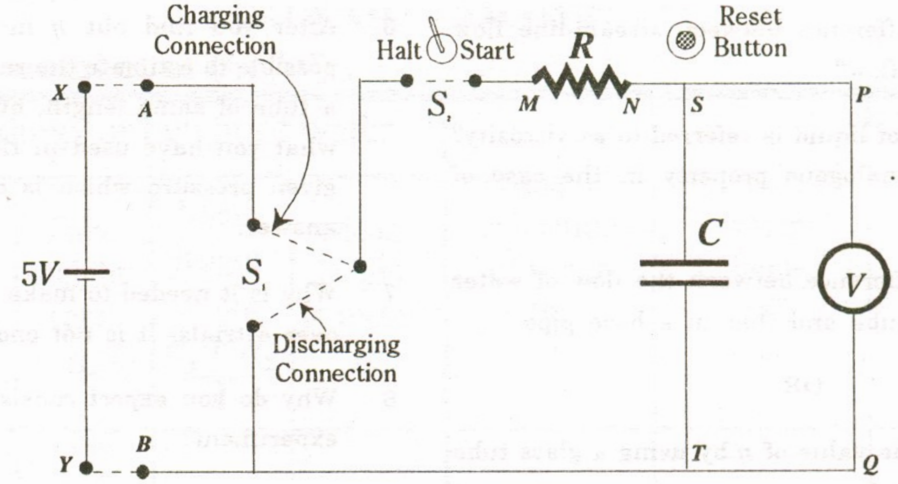
$\sum_o$, is the permittivity of free space,

R, is the resistance in the circuit.

RESULT: The value of dielectric constant of the material in the capacitor is found to be,

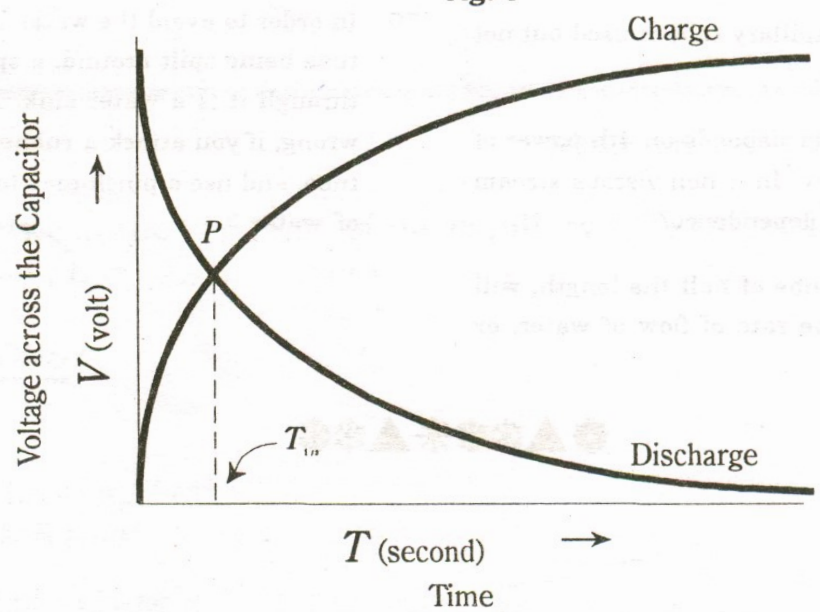
K=………………

I FIGURES :



CIRCUIT DIAGRAM

Fig. 1



CHARGE DISCHARGE CURVES

Fig. 2

II FORMULA USED :

K = { EMBED Equation.3 }

Where, K is the dielectric constant of the material with in the capacitor,

d and A, are the thickness and area of the dielectric material (in S.I units)

$T_{1/2}$, is the time in seconds required to get charged / discharged to 50% of the capacitance value, (Sec)

R, is the resistance in the circuit, (Ω)

$\sum_o$ = 8.854×10^{-12} F/m is the permittivity of free space.

III OBSERVATIONS:

TABULAR COLUMN

GE }

Dependence of capacitor's Voltage on time:

Time in seconds T	R=……..Ω Voltage across C in volts	
	Charge mode	Discharge mode
0		
5		
10		
15		
20		
25		
30		
35		
40		
45		
50		
55		
60		
65		
70		
75		
80		
85		
90		

IV CALCULATIONS:

Measured Values :

R = …. . . . . Ω

$T_{½}$ =………………Sec

∑o = 8.854x10^{-12} F/m

Data on the dielectric material in the capacitor:

Length, l = ………..mm = …………x10^{-3}m

Breadth, b = ……… mm = …………x10^{-3}m

Thickness, d =………mm = ……….x10^{-3}m

Area of the dielectric material,

A = l x b = …………m^2

Dielectric constant of the dielectric material is,

K = { EMBED Equation.3 }=

= ………………………

RESULT: The value of dielectric constant of the material in the capacitor is found to be,

K=………………

OPTICAL FIBER

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

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

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: **The Acceptance angle,**

$$\theta_0 = \tan^{-1}\left(\frac{D}{2L}\right)$$

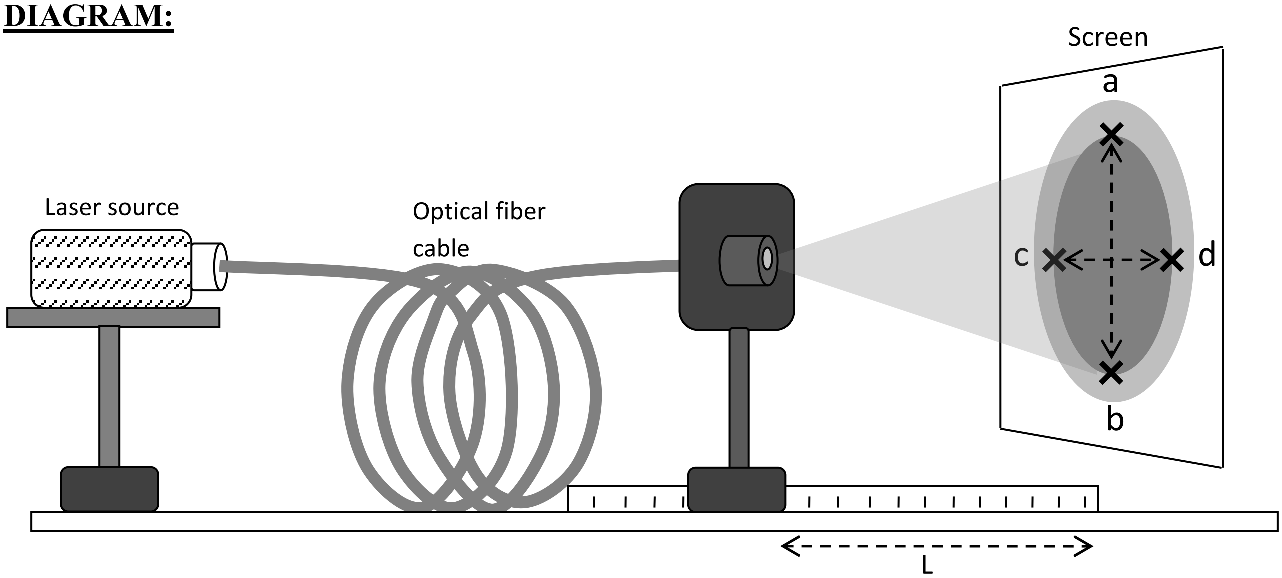
Where D – the diameter of the bright circle formed on screen,

L – the distance between the optical fiber end and screen.

Numerical Aperture,

$$NA = \sin\theta_0$$

DIAGRAM:



PROCEDURE:

- Switch on the laser source and adjust the distance between output end of the optical fiber and the screen ‘L’ (say 2 cm).
- Place a graph sheet on the screen and observe the circle formed on the graph sheet.
- 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.
- Repeat the above steps for different values of L (for 4cm, 6cm, …).
- Find the Acceptance angle from the tabular column and hence the Numerical aperture.

Tabular column:

Trail No.	**L** (in cm)	**Horizontal diameter D_1** (in cm)	**Vertical diameter D_2** (in cm)	**Mean Diameter D** (in cm)	**Acceptance angle** $\theta_0 = \tan^{-1}\left(\frac{D}{2L}\right)$	**Numerical aperture NA** $NA = \sin\theta_0$
1	2					
2	4					
3	6					
4	8					
5	10					

$(\theta_0)_{mean}$ = ………… $(NA)_{mean}$ = ……………

RESULT: The Angle of acceptance and Numerical aperture of the given optical fiber are found to be

θ_0 = ...

NA = ...

Note:

- The values shown here are for the setup used for testing purpose. There may be slight variation with the readings.
- The **source of error** in this experiment is, **marking of the dark circle**. The diameter markings should be done only on the inner dark circle, not for the outer circle. Refer the diagram given above for correct markings. Error in this part would be more as it depends on the eye sensitivity of the observer also.
- Avoid staring at the light spot for longer times, as it will strain the eye quickly.
- Do not view the laser light directly from source as it may damage eye permanently
- Do not bend the fiber with sharp bending curvatures as it may damage the fiber permanently.
- Do not touch the fiber end points with bare hands as it may contaminate the fiber open end surface and it may degrade the output quality.

Experiment – 05

LASER

AIM: To determine the wavelength of a given laser using diffraction grating.

APPARATUS: 625nm Diode laser, Indian assembled 500LPI (lines per inch) diffraction grating plate, Image screen. The complete experimental setup is shown in fig. 2

THEORY: Laser is one of the most significant inventions made in the 20^{th} century. It stands for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. In this experiment we are using semiconductor laser.

Semiconductor Laser (Injection Laser):-

Light emitting diodes are basically semiconductor lasers. A widely used semiconductor laser is Ga As Laser (Gallium Arsenide).

Construction: The fig.1 shows a typical Semiconductor laser. It consists of a heavily doped PN junction with a depletion layer of thickness 0.1 micrometer. Diode used as a cube with each edge 0.4mm long with the junction lying horizontal as shown in the figure. The doping concentration is very high, it is of the order of 10^{17} to 10^{19} atoms per cm^3.The current is passed through the ohmic contacts provided to the top and bottom faces. The front and back faces are polished and made highly parallel to each other to have a laser cavity. The other two faces are roughed.

Working: The Diode is forward biased using an external source. Therefore electrons and holes flow across junction. Hence the current flows through the diode. When a hole meets an electron it recombines with electron emitting a photon. This could be considered as the transition of electron from conduction band to valance band. When the current is low, spontaneous emission is predominant. If the current is sufficiently high, population inversion is achieved. The photons liberated initially due to spontaneous emissions induce further stimulated emissions. The laser cavity helps in the amplification of light. Finally this results in an avalanche of photons and hence the laser action is achieved. If the Ga As semiconductor is used, then the wavelength of the laser emitted is 840nm.

PROCEDURE:

1. The distance between the Grating & the screen has to be adjusted more than 1 meter.
2. Laser is placed on a table and switched ON, the leveling screw of the laser stand are adjusted such that laser beam exactly falls on center of graph sheet placed on the screen, which is placed more than 1m from the laser source.
3. The grating element (500 LPI) is now mounted on the grating stand close to the laser source.
4. Then the diffracted laser spots can be seen on both the sides of central maximum.
5. The centers of various spots of diffraction pattern are marked on the graph sheet using a pencil. Then the graph sheet is removed from the screen.
6. Distance between (X_1) first orders about central maximum, (X_2) second orders, (X_3) third orders …….. So on are measured and tabulated.
7. Diffraction angles for various orders of diffraction can be calculated using formula.

$$\theta_n = \tan^{-1}\left(\frac{X_n}{D}\right) \text{ in degree.}$$

Where D – distances between the grating plate & screen in meter.

8. Hence the wavelength of laser for various orders of diffraction can be calculated using the formula.

$$\lambda_n = \frac{d \sin\theta_n}{n}$$

RESULT :

The wavelength of given laser by diffraction method using grating is λ= …………meter.

OBSERVATION:

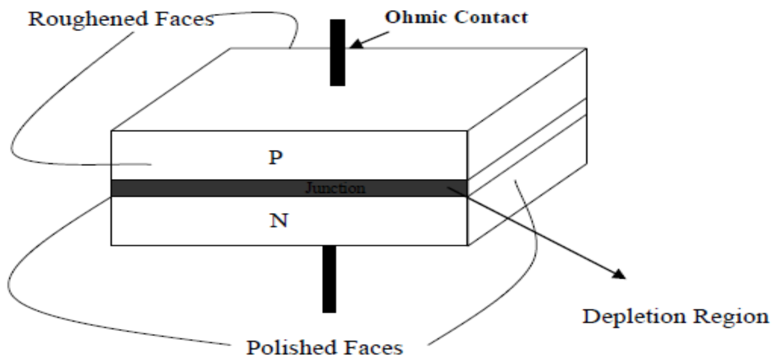


Fig.1:

EXPERIMENTAL ARRANGEMENT OF LASER

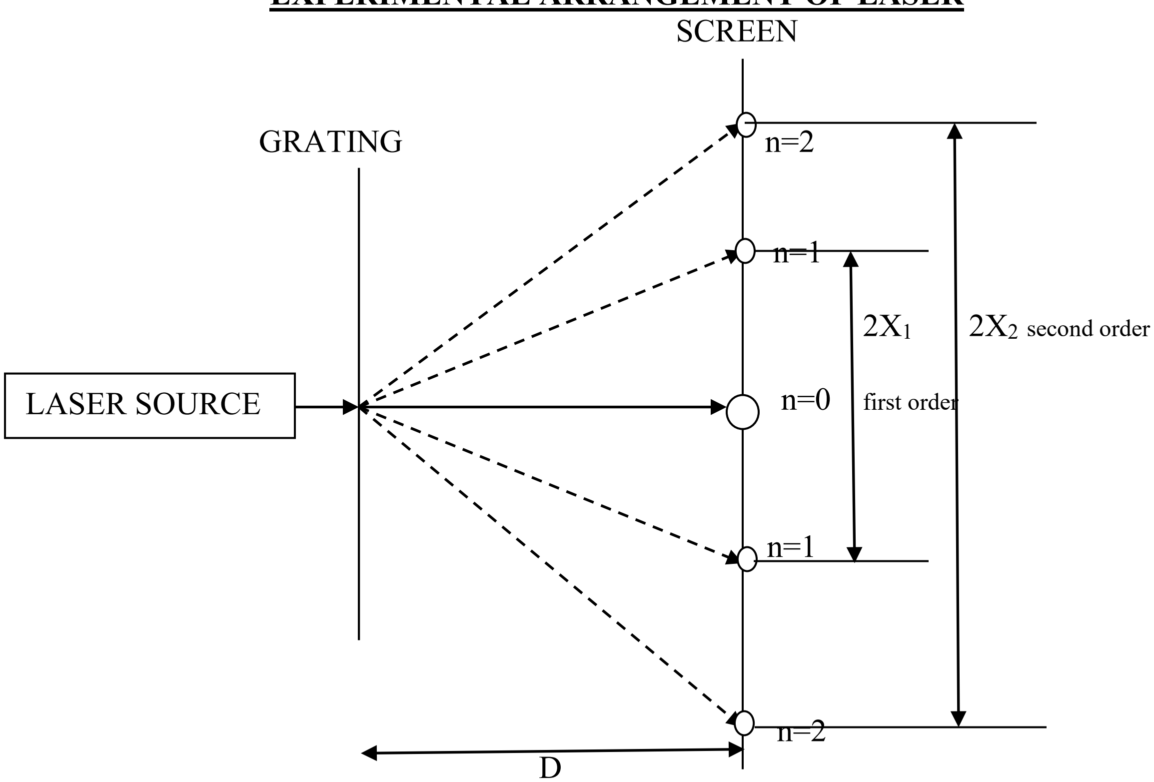


Fig.2

Distance between grating and screen is D = ... cm

To calculate grating constant (d):

Width of 500 lines on grating = 1 inch

Therefore Width of 1 line on grating is $= \frac{1 \text{ inch}}{500}$

$= \frac{2.54\ cm}{500}$

Hence the distance between 2 consecutive rulings on grating d = 5.08 X 10^{-5}m

TABULAR COLUMN:

Sl.No.	Order of diffraction pattern n	Distance between various orders of diffraction about central maximum X_n in cm	$\theta_n = \tan^{-1}\left(\frac{X_n}{D}\right)$ in deg	$\lambda_n = \frac{d \sin\theta_n}{n}$ in nm

<u>CALCULATION PART</u>:

Formula Used:

To calculate wavelength of LASER for n^{th} order.

$$\lambda_n = \frac{d \sin \theta_n}{n} \text{ in meter}$$

Where d is grating constant or the distance between two consecutive rulings

θ_n is the angle of diffraction for n^{th} order of the diffraction

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

λ_n is the wavelength of the light used for n^{th} order.

FOR 1^{ST} ORDER

$$\lambda_1 = \frac{d \sin \theta_1}{1} \text{ in meter}$$

Where d – grating constant =……… m

θ_1 – diffraction angle for 1^{st} order =……..in degree

λ_1=

=

= …………………………… meter

EXPERIMENT-06

YOUNG'S MODULUS BY SINGLE CANTILEVER

AIM: - To determine the young's modulus of the material of the given beam by the method of single cantilever.

APPARATUS: - Single cantilever setup, slotted weights, travelling microscope, reading lens and lamp.

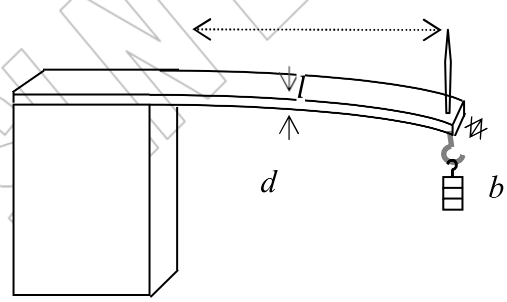
FORMULA:

$$\boxed{\frac{4Mgl^3}{bd^3y}}$$

{ SHAPE * MERGEFORMAT } MERGEFORMAT } { SHAPE * MERGEFORMAT } { SHAPE *

Where, M-mass producing the Elevation (in kg).
g-acceleration due to gravity (= 9.8 ms^{-2}).
l-distance between the needle and fixed end (in m).
b&d -breadth and thickness of the wooden scale (in m).
y-mean elevation produced (in m).

DIAGRAM:



PROCEDURE:-

- The tip of the needle (inverted image) on the single cantilever is made to coincide with the intersection of the cross wire of the travelling microscope (with no load in the hook).
- Note down the readings of the travelling microscope in the tabular column as the no load reading.
- Now add some weight to the hook (say 50gm). Again coincide the tip of the needle to the intersection of the cross wire and corresponding readings are noted in the tabular column.
- This is repeated up to 250gm in steps of 50 gm every time and corresponding readings are noted in the tabular column.
- The experiment is repeated by decreasing the load in the weight hanger in steps of 50g and the corresponding readings are taken and are tabulated.
- The elevation or deflection of the cantilever beam 'y', for load 'M' in kg is found out from the tabular column.

- By using the breadth (b) and thickness (d) of the bar, the young's modulus of the material of the beam is calculated.

$$LC = \frac{Value of\ 1 M\,S\,D}{Total\ no.of\ V\,S\,D} = \ldots\ldots\ldots\ldots\ldots\ldots$$

TR= MSR+ (CVD x LC)

Tabular column to find elevation

Load in hanger (g)	Load increasing			Load decreasing			Mean R_1 (cm)	Load in hanger (g)	Load increasing			Load decreasing			Mean R_2 (cm)	Elevation $y= R_1 \sim R_2$ (cm)
	MSR (cm)	CVD	Total (cm)	MSR (cm)	CVD	Total reading (cm)			MSR (cm)	CVD	Total reading (cm)	MSR (cm)	CVD	Total reading (cm)		
0								150								
50								200								
100								250								

Mean elevation, y =………………….... m

CALCULATION:

$$q = \frac{4\,M\,g\,l^3}{b\,d^3 y}$$

RESULT:-Young's modulus of the material of the beam is found to be q= ----------------N/m^2

VERIFICATION OF SERIES AND PARALLEL RESONANCE USING LCR CIRCUIT

AIM: To study the frequency response of series and parallel resonance circuit and hence determine the inducted values (for fixed capacitance) of given a inductor and also determine the bandwidth and quality factor of the circuit in series resonance.

Apparatus: Audio frequency oscillator, A.C Millimeter, standard inductor coil, resistor and capacitor, patch cards etc.

Theory:

Resonance: It is a phenomenon at which the natural frequency of circuit is equal to frequency of the applied source. At resonance the impedance of circuit may be maximum or minimum depending on how L, C & R are arranged. There are two types of resonance circuits.

1. Series Resonance (L, C, R are in series with source)
2. Parallel Resonance (L & R in series and C is parallel to L & R with the source)

{ EMBED Equation.3 }

Quality Factor:

It gives the sharpness of resonance. It is defined as Q={ EMBED Equation.3 } and Q={ EMBED Equation.3 }{ EMBED Equation.3 }

Q factor also gives voltage magnification in series circuit. Physical significance of Q factor indicates high voltage magnification and high selectivity of tuning coil.

The ability of a reactive circuit to store energy it also expressed in terms of quality factor. It is figure of merit which enables one to compare difference coil.

Band Width: Use full frequency range, the circuit can be use. It also decides and measures the sharpness of frequency curve.

$$\Delta f = f_b - f_a$$

In parallel resonance circuit impedance and current is minimum at resonance. Hence the circuit is called rejecter circuit. In this case Q factor gives current magnification and Q factor does not exist.

1. SERIES RESONANCE STUDIES

PROCEDURE: The required circuit is as shown in Fig.1. The ac milliameter is connected between M and N, and the oscillator is connected between X and Y. the given inductor 'L' (of unknown value) is connected between A and B. A capacitor C, a resistor R of known values are connected between D and E, and F and G respectively, and their values entered in tabular column-1

The supply points are switched on, and the output of the oscillator is adjusted to approximately 20V, which is kept constant throughout the experiment. The frequency 'f' is increased from 1KHz to 10KHz in appropriate steps and the corresponding readings of the current I in mA read from the milliameter are entered in Tab. Column-1 under series resonance. However during this variation of f, the frequency f_r for which current reaches its maximum value (I_{max}), called resonance frequency, must be measured with maximum accuracy. Both f_r and I_{max} readings are entered at the end of the tab.column-1

.

EVALUATION OF THE UNKNOWN:

The readings including f_r and I_{max} are plotted in a graph with frequency in Hz along X-axis, and the current in mA along the Y-axis. A resonance curve as shown in fig.2 will be obtained in which f_r and I_{max} are marked. The values of R,C and f_r are entered in tab. Column-2 against series resonance. The value of inductance 'L' in henry is evaluated using the equation.

L={ EMBED Equation.3 }

The quality factor Q of the circuit is evaluated by using the equation,

Q={ EMBED Equation.3 }X{ EMBED Equation.3 }

A straight line is drawn parallel to frequency axis at the point I_{max}/{ EMBED Equation.3 }(=0.707 I_{max} approximately), on Y-axis, which cuts the curve at the points A and B, (Fig.2), which corresponds to frequencies f_a and f_b respectively. The quality factor graphical $Q_{graphical}$ is evaluated by using the equation, $Q_{graphical}=(f_r/\Delta f)$, where $\Delta f=(f_b-f_a)$ is the band width, the values of Δf and $Q_{graphical}$ are entered into tab. Column-2. Values of Q obtained by both methods are expected to be in agreement.

2. PARALLEL RESONANCE STUDIES:

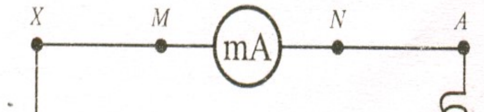
PROCEDURE: The required circuit is shown in Fig.3. the points D and E are shorted and the capacitor C is now connected between J and K, all other connections are retained as such . The frequency f is varied and the corresponding circuit currents are noted as earlier. The readings are in tab. column-I under parallel resonance. In this case the resonance frequency f_r corresponds to the minimum value of current (I_{min}) in the circuit. The values of f_r and I_{min} are measured accurately and in the respective columns for the resonance conditions.

EVALUATION OF THE UNKNOWN: The readings are plotted as earlier, and the resonance curve as shown in Fig.4 will be obtained f_r and I_{min} are marked for each curve, and L is evaluated by using the formula.

L={ EMBED Equation.3 }

The values of R, C, f_r and L are entered in tab. Column-2 against parallel resonance and the mean value of L is found out.

I. FIGURES :



II. <u>OBSERVATION:</u>

1. TABULAR COLUMN:

Frequency (KHz)	Series resonance output current (mA)	Parallel resonance output current (mA)
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		
6.0		
6.5		
7.0		
7.5		
8.0		
8.5		
9.0		
10.0		

2. TABULAR COLUMN:

Type of resonance	R (KΩ)	C (µF)	f_r (KHz)	L={ EMBED Equation.3 } In Henry	Q ={ EMBED Equation.3 }	Band width (KHz)
Series Resonance						

Specimen Calculations for Series Resonance:

R = ………..Ω, C = …….. μF, f_r = ……… KHz, Δf = ……… KHz

L = { EMBED Equation.3 }
L is the inductance of the given inductor in henry
f_r is the resonant frequency in Hz
C is the capacitance of the given capacitor in Farad

= …………………..H

Q = { EMBED Equation.3 }X{ EMBED Equation.3 } = ……………………..

= …………….

$Q_{graphical}$= (f_r/Δf) = …………….

RESULT:

(a) The inductance value of the given inductor is found to be, L= ………….Henry.

(b)The band width and quality factor of the circuit are found and entered in tab. Column-2

FERMI ENERGY

AIM: To determine the Fermi Energy and Fermi Temperature for the given metal.

Apparatus Used

DC regulated power supply, Digital milliameter, Digital millivoltmeter (DMM), Heating arrangements, Thermometer 0-160 degree, and Wire of copper. The complete experimental setup is shown in Figure-1.

THEORY:

"Fermi level" is the term used to describe the top of the collection of electronic energy levels at absolute zero temperature. This concept comes from Fermi – Dirac statistics.
The energy corresponding to the highest occupied level at zero degree absolute is called the Fermi Energy, and the corresponding energy level is referred to as Fermi level.
In metals, Fermi energy gives us information about the velocities of the electrons which participate in ordinary electrical conduction and Fermi temperature. The Fermi velocity V_F of these conduction electrons and Fermi temperature T_F can be calculated from the Fermi energy E_F using the relation,

{ EMBED Equation.3 }
…1

Where m = 9.1 x 10^{-31} kg is the mass of electron.
E_F is Fermi Energy
V_F is Fermi Velocity

And

$E_F = kT_F$

Where k = 1.38 x 10^{-23} J K^{-1} is Boltzmann constant.

The number of free electrons in metal per unit volume is given by,

{ EMBED Equation.3 }
…(2)

Where N = 6.023 x 10^{26} per k m^3 is Avogadro number
ρ = density of the metal
M = Mass number of the metal

The electrical conductivity of the metal,

{ EMBED Equation.3 }
…4

Where L is the length of the metal wire
R is its resistance at a reference temperature
a is the area of cross-section of the wire.

The relaxation time is given by,

{ EMBED Equation.3 }
…5

Where e = 1.602 x 10^{-19} C is electron charge.

If V_F is Fermi velocity, then mean free path of electrons,

$\lambda_F = V_F\tau$ then V_F = { EMBED Equation.3 }

Hence the Fermi energy,

E_F ={ EMBED Equation.3 }m V^2_F
={ EMBED Equation.3 } m{ EMBED Equation.3 }

={ EMBED Equation.3 }m{ EMBED Equation.3 }X}}EMBED Equation.3 {(

={ EMBED Equation.3 }X{ EMBED Equation.3 } λ^2_F T^2X({ EMBED Equation.3 })

Where a=π r^2 = Area of cross section of the wire.
r = Radius of the wire.

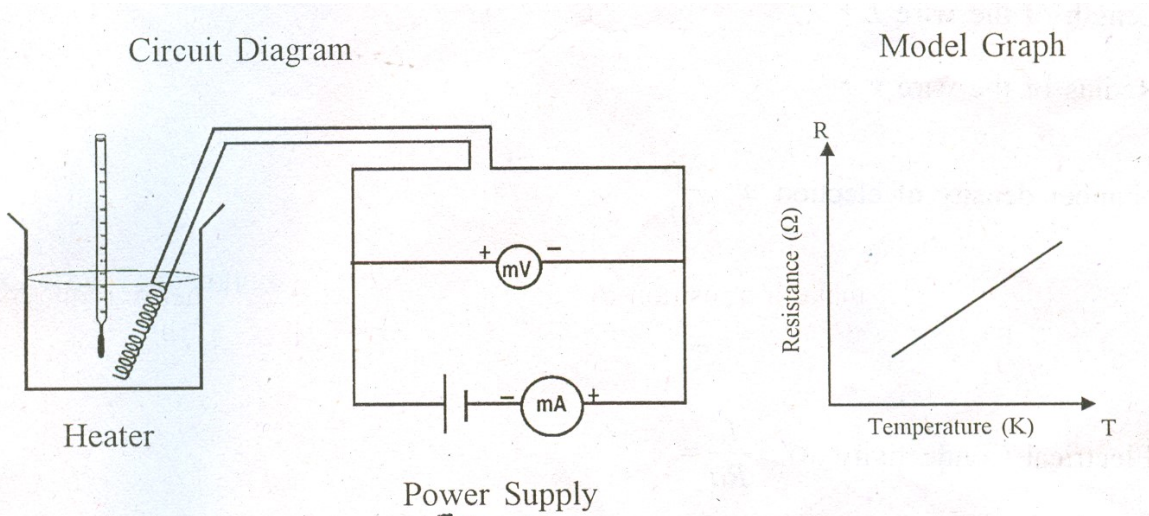
Now Fermi energy,
{ EMBED Equation.3 } …7

Where the constant A = λ_F x T
T is the reference temperature of the wire in Kelvin,
r is the radius of the wire
{ EMBED Equation.3 } is the slope of the straight line obtained by plotting resistance of the metal against absolute temperature of the metal.

Once the Fermi energy is found, Fermi temperature can be calculated using the equation.

PROCEDURE: About two meter length of the given wire is taken and its radius and length are measured. Its mass number and density is taken from the physical and mathematical tables. The wire is wound over an insulating tube to form a coil, and then immersed in pre-heated liquid paraffin. The two ends of the coiled wire are connected to power supply through a milliammeter in series and millivoltmeter across the coil as shown in the circuit. A thermometer is immersed into the oil bath to measure the steady temperature of the coil. When the temperature of the oil bath is steady at 100^0C, the circuit is switched on, and the voltage and current readings are noted. The power supply is then switched off. The coil is allowed to cool in the bath, and the above procedure is repeated in intervals of 5^0C, until the temperature falls close to room temperature. The results are tabulated and a graph of resistance Vs temperature T on the Kelvin scale is plotted. The slope of the straight line obtained is calculated.

I. FIGURE



[Fig.1]

II. OBSERVATION:

TABULAR COLUMN:

Sl. No.	Temerature oC	Temperature K	Voltage V (m V)	Current I (mA)	Resistance R=V/I (Ω)

III. CALCULATION:

Length of the wire L =…………..m

Radius of the wire r =…………....m

Number density of the electron for cooper (n) = ………………/m^3

Charge of an electron (e) = ………………..C

Mass of an electron (m) = ……………..Kg

Constant A = λ_F T=…………..

ΔR = Change in resistance

ΔT = Change in temperature

Slope of the R-T Graph, { EMBED Equation.3 } =

Fermi Energy is given by,

{ EMBED Equation.3 }

IV. **RESULT:**

The experimental value of Fermi Energy for the given copper wire=E_F =……….eV

The standard value of Fermi Energy for the given copper wire=E_F =……….eV

Experiment-09

SPRING CONSTANT

AIM:- To determine the spring constants in Series and Parallel combination.

APPARATUS: Springs, Scale, Rigid stand, Slotted weights, etc.

FORMULA:- 1) Spring constant,

$$k = \frac{F}{x} \quad in\ Nm^{-1}$$

Where, F – Force applied (= mg) in N.

x – Displacement produced in the spring in m.

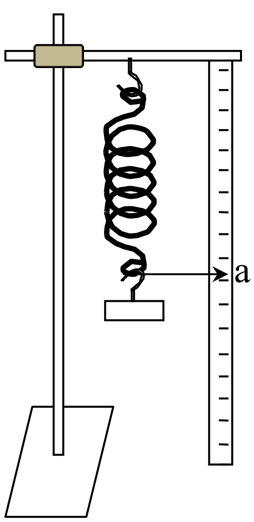
2) Spring constant for Series combination of springs,

$$k_{Series} = \frac{k_1 k_2}{k_1 + k_2} \quad in\ Nm^{-1}$$

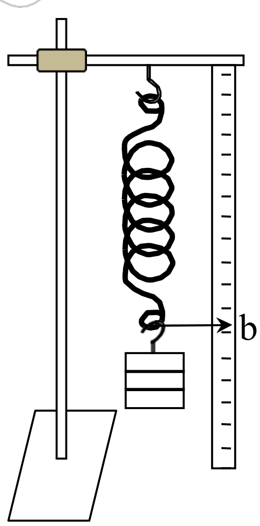
3) Spring constant for Parallel combination of springs,

$$k_{Parallel} = k_1 + k_2 \quad in\ Nm^{-1}$$

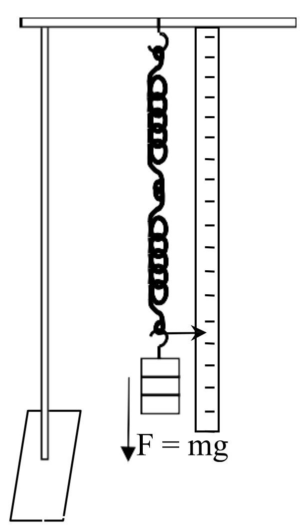
DIAGRAM:-



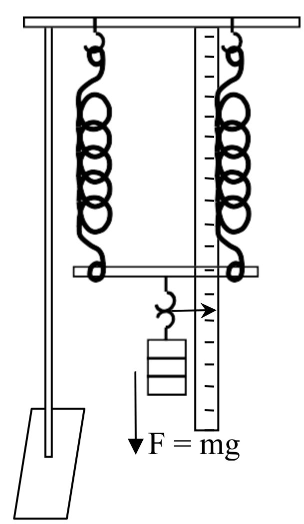
With initial load



With load



Series combination



Parallel combination

PROCEDURE:-

- Hang the spring1 to the given rigid stand with dead load and note down the position 'a' of the pointer on the scale with initial load.
- Add some more load into the weight hanger (say 50gm) and note down the position 'b' of the pointer on the scale with final load.
- Repeat the same for some more loads in steps of 50gm and tabulate the readings in the tabular column.
- Find out the average spring constant 'k_1'.
- Repeat the above steps for the spring 2 and find out 'k_2'.

To verify Series combination law of springs:

- Hang the springs in series combination as shown in the diagram. With the initial load, note down the position 'a' of the pointer on the scale.
- Add some more load into the weight hanger (say 50gm) and note down the position 'b' of the pointer on the scale with final load.
- Repeat the same for some more loads in steps of 50gm and tabulate the readings in the tabular column.
- Find out the average spring constant 'K_{series}'.

To verify Parallel combination law of springs:

- Hang the springs in parallel combination as shown in the diagram. With the initial load, note down the position 'a' of the pointer on the scale.
- Add some more load into the weight hanger (say 50gm) and note down the position 'b' of the pointer on the scale with final load.
- Repeat the same for some more loads in steps of 50gm and tabulate the readings in the tabular column.
- Find out the average spring constant '$K_{parallel}$'.

Calculate the theoretical values of K_{series} and $K_{parallel}$ and compare the values with experimental values.

TABULAR COLUMN:-

To find k_1

Pointer reading with initial load(w), a =..................cm

Trial No.	**Load in gm**	**Pointer reading 'b' in cm**	**Spring stretch ($x = b - a$) in cm**	**Force, F ($F = mg$) in N**	**Spring constant $k_1 = F/x$ in N/m**
1	W + 50				
2	W + 100				
3	W + 150				

Average k_1 = ...N/m

To find k_2

Pointer reading with initial load(w), a =.................cm

Trial No.	Load in gm	Pointer reading 'b' in cm	Spring stretch (x = b - a) in cm	Force, F (F = mg) in N	Spring constant k_2 = F/x in N/m
1	W + 50				
2	W + 100				
3	W + 150				

Average k_2 = ...N/m

To verify series combination of springs

Pointer reading with initial load(**w**), a =.................cm

Trial No.	Load in gm	Pointer reading 'b' in cm	Spring stretch (x = b - a) in cm	Force, F (F = mg) in N	Spring constant K_{series} = F/x in N/m
1	W + 50				
2	W + 100				
3	W + 150				

Average K_{series} =...................... N/m

Theoretical calculation, K $= \dfrac{k_1 k_2}{k_1 + k_2}$ = ……………………...$in\ Nm^{-1}$

To verify parallel combination of springs

Pointer reading with initial load(**w**), a =.................cm

Trial No.	Load 'm' in gm	Pointer reading 'b' in cm	Spring stretch (x = b - a) in cm	Force, F (F = mg) in N	Spring constant $K_{parallel}$ = F/x in N/m
1	W + 50				
2	W + 100				
3	W + 150				

Average $K_{parallel}$ = ...N/m

Theoretical calculation, $k_{Parallel} = k_1 + k_2$ = …………………………….$in\ Nm^{-1}$

RESULT:-

The spring constants for the springs are found to be, k_1 =......................N/m

k_2 = ...N/m

The spring constants for the combination of springs are found to be,

Combination	**Theoretical**	**Experimental**
Series	K_{series} =	K_{series} =
Parallel	$K_{parallel}$ =	$K_{parallel}$ =

EXPERIMENT – 10

TORSIONAL PENDULUM

Aim: To determine the moment of inertia of the given regular body and also to determine the rigidity modulus of the material of the given suspension wire, by setting up a torsional pendulum.

Apparatus required: Rectangular plate, circular plate, irregular body, stand with clamp, steel wire fixed between chuck nuts, stop clock.

Procedure: The masses M_1 & M_2 of the rectangular and circular plates respectively, are found by weighing then each in a rough balance up to an accuracy of ±1gm. The length L, the breadth B of the rectangular plate, and also the circumference C of the circular plate, are found by using a meter scale, to an accuracy of ±1mm. The moments of inertia values of the two bodies about the respective axes are evaluated by using the corresponding equation listed in tabular column.

The experimental wire, whose both ends are tightly fastened to two chuck nut (Figure), is taken. One of the chuck nuts is firmly clamped to the stand. The rectangular plate is screwed on to the other chuck nut, without permitting the wire to undergo any twisting while the body is fixed to it.

A convenient reference mark at the edge of the body is identified. The reference stick is placed just next to it. The body is given a gentle rotation, so that it oscillates in small amplitude, with the wire as its axis, without any wobbling motion. At the moment when the body reference mark crosses the reference stick, a stop clock is started. The oscillation is counted as when the body reference mark crosses the reference stick again in the same direction. Time taken'?t' for complete 20 oscillations is found under two trials. The body is then gently removed from the chuck nut.

The same procedure is repeated for all the axes of oscillations of the rectangular and circular plates, listed in Tabular column, mean value of 't' is found from which the period T, and hence T^2 are determined. The value of $(\frac{I}{T^2})$ is found out.

Determination of moment of Inertia of the Rectangular body:

The given regular body is suspended by the experimental wire. The time taken to execute 20 oscillations about an axis perpendicular to the plane and passing through centre of gravity is found out. The moment of inertia I of the body about the same axis is found by evaluating $\left(\frac{I}{T^2}\right)_{mean}$.

Determination of the rigidity modulus 'n' of the material of the suspension wire:

The diameter of the wire is found at 3 different points along its length, by using a screw gauge, from which the radius 'r' is evaluated. Length 'L' of the wire exposed between chuck nut to chuck nut is also found out. The rigidity modulus 'n' is evaluated by using the formula,

$$\eta = \frac{8\pi l}{r^4}\left(\frac{I}{T^2}\right)_{mean} \text{ N/m}^2$$

Results:

1. The moment of inertia of the given regular body about an axis passing through centre of gravity is calculated by using given data.
2. The value of rigidity modulus of the material of the given suspension wire is found to be η= …………………………………….. N/m^2

Observations and calculations:

Formula:

$$\eta = \frac{8\pi l}{r^4}\left(\frac{I}{T^2}\right)_{mean} \text{ N/m}^2$$

Where,

'η', is the rigidity modulus of the material of the wire N/m^2.

'l', is the length of the suspension wire in m.

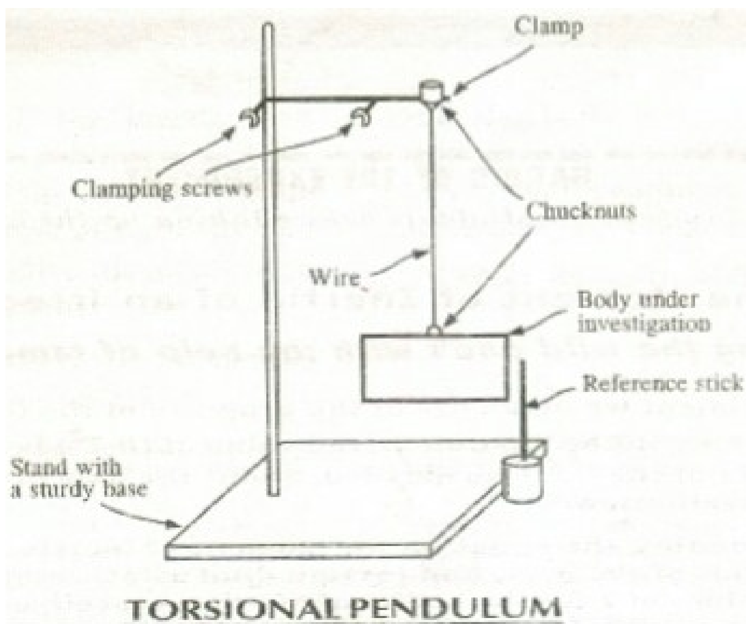
'r', is the radius of the material of the wire in m.

$\left(\frac{I}{T^2}\right)_{mean}$ Is the mean value of the ratio of the moment of inertia, to square of period for regular bodies (Kgm^2/s^2)

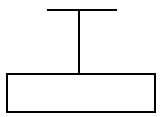
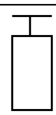
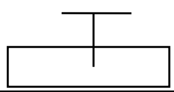
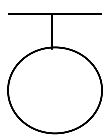
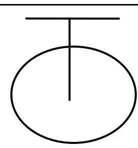
Measurement of dimensions for evaluation of Moment of inertia

- Mass of the rectangular plate, M_1 = …………… Kg
- Length of the rectangular plate, L = ……………. cm = ……………$\times 10^{-2}$m
- Breadth of the rectangular plate, B = ……………. cm = ………… $\times 10^{-2}$m
- Mass of the circular plate, M_2 = ……………Kg
- Radius of the circular plate, R = ……………. cm = …………….$\times 10^{-2}$m
- Length of the suspension wire , l = ……………..cm = ………… $\times 10^{-2}$m
- Radius of the suspension wire, r = ……………...cm = ……………$\times 10^{-2}$m

Figure.



Tabular column

Body	Axis through centre of gravity	Symbolic Representation	Moment of Inertia I		Time for 20 oscillations t(sec)		Mean 't' (sec)	Period T=(t/20) (sec)	T^2 sec^2	$\left(\frac{I}{T^2}\right)$ Kgm^2/s^2
			Concerned equation	Value Kgm^2	Trial 1	Trial 2				
Rectangular body	Perpendicular to the length		$\frac{M_1 L^2}{12}$							
	Perpendicular to the breadth		$\frac{M_1 B^2}{12}$							
	Perpendicular to the plane		$\frac{M_1 (L^2 + B^2)}{12}$							
Circular body	Perpendicular to the diameter		$\frac{M_2 R^2}{4}$							
	Perpendicular to the plane		$\frac{M_2 R^2}{2}$							

Mean value of $\left(\frac{I}{T^2}\right)$= .... Kgm^2/s^2

EXPERIMENT-11

PHOTO DIODE CHARACTERISTICS

AIM: To study the I-V characteristics of photo diode in reverse bias, study the variation of photo diode current with LED power and determine Responsivity.

APPARATUS: Photo diode, Light Emitting Diode, micro ammeter, battery, etc.

DISCRIPTION: A photo diode is semiconductor device that respond to high energy particles and photons. Radiation sensitive junction is formed in a semiconductor material whose resistivity changes when illuminated by light photons. The junction can be to respond to the entire electromagnetic spectrum. When a p-n junction is reversed biased a small reverse saturation current flow due to thermally generated charge carriers. Increasing the junction temperature generates more hole electron pairs, and so the minority carrier (reverse) current is increased. The same effect occurs if the junction is illuminated. Hole and electron pairs are generated by the incident light energy; minority charge carriers are swept across the junction to produce a reverse current flow. Increasing the junction illumination increases the number of charge carriers generated. And thus increases the level of reverse current.

PROCEDURE:

PART A: To Study the I-V Characteristics of photo diode:

Connections are made as shown in the figure. Adjust the illumination (LED power) for 10 mW on the dial and V_{PD} is set to -0.1 V and the corresponding I_{PD} is noted. The V_{PD} is increased in suitable steps (shown in tabular column) up to a maximum of -1.5 V the corresponding I_{PD} values are noted in the tabular column 1. The experiment is repeated by increasing the LED power to 21 mW, 30 mW, 38 mW and 50 mW in steps. In each case V_{PD} is varied from 0 to -2.0V and the corresponding I_{PD} are noted.

Now plot a graph by taking V_{PD} along X-axis and I_{PD} along Y-axis as shown in the sample graph1. The graph shows the I-V characteristics of the photo diode.

PART B: To study the variation of photo diode current with LED power and determine Responsivity:

The LED power is set to 10 mW, adjust the voltage across photo diode is V_{PD} = -1.0 V by varying power supply and the photo diode current I_{PD} (μA) is noted. Further the LED power is increased to 11 mW by keeping V_{PD} = -1.0 V and the corresponding I_{PD} is noted. The experiment is repeated by varying the LED power as shown in tabular column2 (by keeping V_{PD} to -1.0 V) and corresponding I_{PD} is noted.

Now plot the graph of I_{PD} along Y-axis and P_{LED} along X-axis. A straight line graph is obtained as shown in the sample graph 2.

Responsivity : The responsivity of a silicon photodiode is a measure of the sensitivity to light, and it is defined as the ratio of the photocurrent I_P to the incident light power P at a given wavelength. $R_\lambda = \frac{I_P}{P}$

In other words, it is a measure of the effectiveness of the conversion of the light power into electrical current. It varies with the wavelength of the incident light as well as applied reverse bias and temperature.

RESULT: 1. The I-V characteristic of a Photo diode is obtained.

2. The variation of Photo diode current with LED power is obtained.

3. The Responsivity of Photo diode is ………….

CIRCUIT:

{ EMBED PBrush }

Graph 1

OBSERVATION:

Tabular Column: 1

V_{PD} Volts	Reverse current (I_{PD}) µA				
	10 mW	21 mW	30 mW	38 mW	50 mW
-0.1					
-0.2					
-0.3					
-0.4					
-0.5					
-1.0					
-1.5					

Tabular Column: 2

P_{LED} (mW)	**I_{PD} (µA)**
	V_{PD}=-1.0V
10	
11	
12	
13	
14	
15	
18	
21	
24	
30	
50	

{ EMBED PBrush }

Graph 2

Experiment No-12

NEWTON'S RINGS

AIM: To determine the radius of curvature of the given Plano convex lens by forming Newton's rings.

FORMULA:

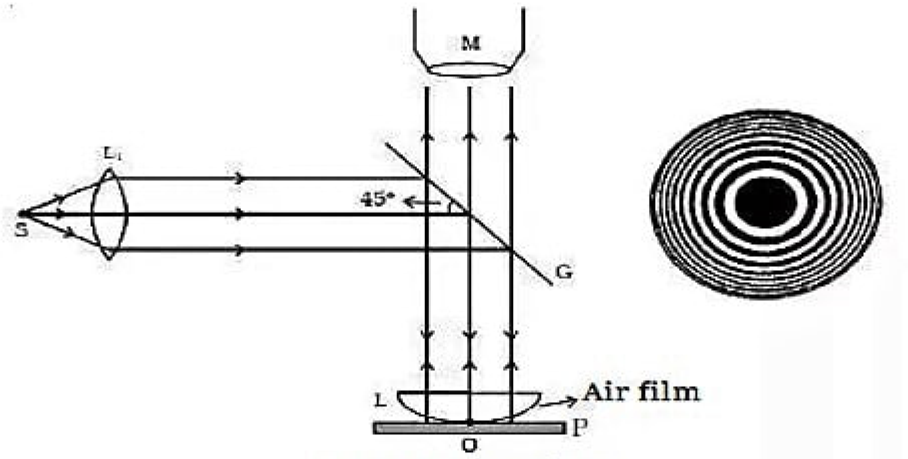
$$R = \frac{D_m^2 - D_n^2}{4[m-n]\lambda} \text{ meter}$$

Where R= Radius of curvature of the Plano convex lens in meter.

D_m= Diameter of the m^{th} ring in meter.

D_n = Diameter of the n^{th} ring in meter.

λ = Wavelength of the sodium light i.e., 5896 Å



Newton's Rings

PROCEDURE:

Sodium vapour lamp is illuminated and is allowed for maximum brightness. A travelling microscope with a turnable inclined glass plate system is brought in the field of view by keeping a reflecting mirror; the inclined glass plate is adjusted to 45^0 inclination by conforming maximum brightness in the telescope. Now the Plano convex lens whole radius of curvature is to be determined is placed over a plane glass plate so as to form a thin symmetrically varying air film in between. This setup is placed under inclined glass plate normal to the telescope. Viewing through the telescope, the telescope is adjusted till the clear dark and light rings are obtained. The cross wires are coincided exactly at the centre of the dark ring. Taking this centre dark ring as the zeroth dark ring the vertical cross wire is coincided for 12^{th} dark ring on left side, the corresponding in the travelling microscope is noted and is entered in the tabular column. Similarly the readings for 10th,8th,6th,4th and 2nd dark ring on the left side are noted. Then the travelling microscope is moved towards the right side and the readings of 2nd, 4th, 6th, 8th, 10th and 12th are noted in a similar manner. Now the diameter of dark rings is determined by using the different method as shown in the tabular column. The mean value of $(D_m^2 - D_n^2)$ is taken and the radius of curvature of the plano convex lens 'R' is calculated from the formula given above.

OBSERVATION AND CALCULATIONS:

Least count of the Travelling Microscope:

1cm = ________________MSD

Total no. Of VSD =......................

Least count of Travelling Microscope = Value of 1Msd / Total no. Of VSD

= ______________cm

TABULAR COLUMN:

Ring No 'm'	TM reading in mm		Diameter D_m $(L_m \sim R_m)$	D_m^2 in mm^2	Ring No 'n'	TM reading in mm		Diameter D_n $(L_n \sim R_n)$	D_n^2 in mm^2	$(D_m^2 - D_n^2)$ mm^2
	Left L_m	Righ R_m				Left L_n	Right R_n			
12					06					
10					04					
08					02					

Mean $(D_m^2 - D_n^2)$ = ____________mm^2

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

CALCULATIONS:

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

RESULT:

The radius of curvature of the Plano convex lens is ....meter.

Some viva questions and answers for practical examination

1. What is least count of an ordinary scale, wrist watch, and protractor?
1 mm, 1 sec, 1 degree or 0.5 degre

2. What is the meaning of pitch ?
Pitch is the distance between any two successive crest or trough in screw region.

3. Why the screw gauge is used to measure the diameter of wire or thickness of plate?
Screw gauge gives the accurate measurement of dimensions (i.e, diameter or thickness or length) of the body.

4. What is the least count of screw gauge?
0.01 mm or 0.005 mm (depending on the type of screw gauge)

5. What is the formula to measure the pitch?
Least count = pitch/total no of head scale divisions

6. What is resonance?
When the frequency of generator is varied from a low value to a high value of certain frequencies, the current become maximum.

7. How can you define resonant frequency in series LCR circuit?
In series LCR circuit, the resonant frequency is that frequency at which the current in the circuit is maximum.

8. When the current will be maximum in series LCR circuit?
When the impedance is minimum.

9. Give an expression for resonant frequency in LCR series circuit?
$F_0 = 1/2\Pi(LC)^{1/2}$ Hz

10. Can you define resonant frequency in parallel LCR circuit?
In parallel LCR circuit, the resonant frequency is that frequency at which the current is minimum.

11. Why LCR series circuit is called an acceptor circuit?
LCR series circuit accepts (or give more current), the resonant frequency to which it resonates.

12. Why LCR parallel circuit is called rejecter circuit?
LCR parallel circuit rejects (or takes minimum current), the resonant frequency to which it resonates.

13. Define Quality factor?
It is defined as the ratio of the energy stored in the coil to the energy dissipated in the circuit across the resistance. i.e. **{** **}**
EMBED Equation.3

or

It is defined as the ratio of resonant frequency to the bandwidth. i.e. $Q = f_0 / f_2 - f_1$

14. What are wattles current?
The current through a pure inductive or capacitive circuit.

15. What is an Inductance?
Inductance is the ability of the conductor to produce induced emf, when the current varies.

16. What is the unit of Inductance?
Henry

17. What is Zener diode?
A Zener diode is like an ordinary diode except that it is properly doped so as to have a sharp breakdown voltage.

18. What is the difference between an ordinary diode and Zener diode?

An ordinary diode utilizes forward characteristics, whereas Zener diode utilities reverse characteristics.

Ordinary diode used as rectifier. Zener diode used as voltage regulator.

19. What is Zener voltage?

The breakdown voltage of a Zener diode.

20. What is forward bias and reverse bias?

In a circuit if positive terminal of the battery is connected to p side and negative terminal to the n side it is called forward bias and vice versa.

21. In which case the current flows in the circuit is low?

Reversed biased

22. What is transistor?

Transistor is a three terminal and two junction semiconductor devices.

23. What is the function of the transistor?

Transistor function is to amplify the current.

24. What are the terminals in a transistor?

Emitter base and collector

25. What is emitter?

The emitter is highly doped and emits majority charge carriers through the base.

26. What is collector?

The collector is used collect the majority charge carriers and the doping lies between emitter and base.

27. What is base?

The middle region of the transistor is called base. Its thickness is small and is lightly doped and modifies the emitter current.

28. How many types of transistor are there?

Two types: NPN and PNP transistors.

29. What is photo diode?

A diode which is sensitive to light is called photo diode.

30. How diode conducts current when it is reversed biased?

Current conducts due to minority charge carriers.

31. How reverse current varies with illumination of light in photo diode?

Reverse current varies linearly with increase of illumination.

32. Why reverse current increases in photo diode when it is illuminated?

When junction is illuminated electron hole pairs are generated by the incident light energy and minority charge carriers are swept across the junction to produce reverse current flow.

33. What are the types of photo diode?

- P-N junction photo diode
- PIN photo diode
- Avalanche photo diode

34. In present experiment which type of photo diode is used?

P-N junction photo diode.

35. What are the applications of photo diodes?

They are used in compact disc players, smoke detectors, and remote control in TV, camera light meters, clock radios and street lights.

36. What are the differences between LED and Photo diodes?
LED emits light during forward bias whereas photo diode conducts current when light is incident on it.

37. What you mean by junction?
A junction is the boundary separating the two regions of the p-type and n-type semiconductors when they are joined together.

38. What are the majority charge carriers in the p-type semiconductor?
Holes (positive charge)

39. What are the majority charge carriers in the n-type semiconductor?
Electrons (negative charge)

40. Whether holes are particles or charges?
Charges.

41. What are Ultrasonic waves?
The waves whose frequency greater than 20 kHz.

42. What are infrasonic waves? Give Example.
The waves whose frequency less than 20 Hz. Example Seismic waves

43. What is the frequency range of audible sound?
Between 20 Hz to 20 kHz.

44. What is the principal used in Ultrasonic Interferometer?
Standing waves are produced using aqua grating and the wavelength is measured.

45. In which medium sound waves travels faster?
Solid medium

46. What is standing wave?
If two similar waves travelling in opposite direction superposing giving rise to standing waves.

47. Which type crystal is used in Ultrasonic Interferometer Experiment?
Quartz crystal.

48. What is the role Quartz crystal in Ultrasonic Interferometer Experiment?
Quartz crystal vibrates giving rise to standing waves.

49. What you mean by aqua grating?
The Ultrasonic waves produced by Quartz crystal get reflected from the walls of the glass producing nodes and anti-nodes in liquid. Nodes are transparent to light and anti-nodes are opaque. This acts as aqua grating.

50. What is capacitor?
The device used to store charges.

51. What is capacitance of a capacitor?
The ability of a capacitor to store charges.
i.e. C = Q/V

52. What is charging of the capacitor?
Storing of energy in the form of electrostatic field.

53. What is discharging of the capacitor?
Removal of charges from the capacitor.

54. Define Dielectric constant?
The ratio of the capacitance of a capacitor with the given material to capacitance of the same capacitor with vacuum. i.e. { EMBED Equation.3 }

55. What is dielectric medium?

A medium in which an applied electric field causes displacement of charges.

56. Define relative permeability?

It is defined as the ratio of absolute permittivity of the medium to the absolute permittivity of free space.

57. Give an expression for the capacitance of parallel plate capacitor?

C = { EMBED Equation.3 }

58. What is the effective capacitance of capacitor when connected in series?

$1/C_s=1/C_1+1/C_2+1/C_3+$ ………………

59. What is the effective capacitance of capacitor when connected in parallel?

$C_P=C_1+C_2+C_3+$……………

60. What happens to the capacitance of a capacitor with the introduction of dielectric in between the two plates?

Capacitance increases.

61. What happens to the charge on a parallel plate capacitor when the potential difference between its plates is doubled?

Charges get doubled.

62. What is the difference between insulator and dielectrics?

If the main of the material is to provide just insulation then it is referred as insulator. If it is employed for charge storage then its named dielectric remains.

63. What is diffraction?

The bending of light around the corners of an obstacle situated in the linear path is called diffraction.

64. What is diffraction grating?

It is a glass plate with a very large number of closed equally spaced parallel lines drawn on it using special technique.

65. What is grating constant?

The distance between any two successive lines in grating.

66. Which source of light is used in grating experiment?

Mercury source.

67. What is spectrometer?

It is an instrument used to measure the deviation of light from the direct light.

68. What is the difference between Fresnel and Fraunhoffer diffraction?

The distance between the source and the screen are at finite distance in Fresnel whereas in Fraunhoffer it is at infinite distances.

69. What you mean by angle of minimum deviation?

The position in which the incident angle and the refracted angle of light will be same.

70. Which color of light travels faster in air?

All colors will have same speed.

71. What is the difference between monochromatic light and composite light?

Monochromatic light will having single wavelength (color), whereas composite light consisting of different wavelengths (different colors).

72. What is the difference between interference and diffraction?

Interference is the modification of light intensity due to superposition of two or more light waves which are travelling with same phase (coherent), where as diffraction is the bending of light around the edge of an obstacle (the dimension of obstacle will be comparable with the wavelength of light).

73. What is photo electric effect?

Photo electric is the emission of electrons from a material when a light of suitable frequency is incident on it.

74. Who discovered Photo electric effect?
Hertz.

75. Who explained Photo electric effect?
Einstein.

76. Which nature of light can be explained using Photo electric effect?
Particle nature.

77. What is threshold frequency?
The minimum frequency of the incident light below which Photo electric emission does not takes place.

78. How the kinetic energy of photo electrons varies with frequency?
The kinetic energy of photo electrons varies directly with the frequency of the incident light and is independent if intensity.

79. How Photo electric effect varies with frequency and intensity of light?
Photo electric effect is directly proportional to the intensity of incident light provided the frequency grater than the threshold frequency.

80. What is knee voltage?
It is the minimum voltage at which the device would conduct in the forward bias mode.

81. How LEDs emits different colour?
Different colours are due to the energy gap between the conduction band and the valence band. We know that, $E_g = hc/\lambda$, hence $\lambda = hc/E_g$. So if E_g is in the range of 1.72eV to 2.4 eV then λ is in visible range.

82. What is a black body?
A black body is one in which it absorbs all the radiations incident on it.

83. What is emissive power and absorptive power?
Emissive power of a black body is the amount of radiation emitted by a black body per unit area per second.
The absorptive is the total radiation absorbed by a black body to the total radiation incident on it.
For pure black body emissive power and absorptive power = 1.

84. State Kirchhoff's law?
At a given temperature, the ratio of emissive power to the absorptive for all bodies is constant and is equal to emissive power of a perfect black body.
$e/a = E$; ($E = 1$ for a perfect black body) Therefore $e/a = 1$.
i.e. $e = a$. (Which signifies that good emitters are good absorbers)

85. State Stefan's law?
The rate of emission (energy) of a black body is directly proportional to fourth power of its absolute temperature. i.e. $E \alpha T^4$

86. State Wien's displacement law?
The wavelength corresponds to maximum intensity is inversely proportional to the absolute temperature. i.e. $\lambda_m \alpha 1/T$

87. Define Fermi energy?
The energy corresponding to the highest occupied level at zero degree absolute is called Fermi energy.

88. If length or radius of the copper wire increased or decreased what happens the Fermi energy of copper?
No change.

89. Instead of copper if we use other conductor what happens the Fermi energy?

Fermi energy depending upon the conductor used

90. What is Fermi level?

The energy level of electron corresponding to Fermi energy is called Fermi level.

91. What is Fermi factor?

Fermi factor is the probability of occupation of a given energy state for a material in thermal equilibrium.

92. What is Fermi velocity?

The velocity of electrons which occupy the Fermi level is called the Fermi velocity.

93. What is Fermi temperature?

It is the temperature at which the average thermal energy of the free electron in a sold becomes equal to Fermi energy at zero Kelvin.

94. Define Fermi function?

It is the distribution function, which gives the probability of occupation of a given state for a material ion thermal equilibrium in terms of Fermi energy, Boltzmann constant and temperature in K.

i.e. { }

EMBED Equation.3

95. Define drift velocity?

The average velocity with which the electrons move inside the metal with the application of an electric field.

96. What is mobility?

It is the drift velocity acquired by the electrons per unit applied electric field.

97. Define relaxation time?

The time required to reduce the average velocity to 1/e times when the electric field is turned off.

98. What is mean collision time?

The average time between two consecutive collisions of a electrons with the lattice points.

99. Define mean free path?

The average distance travelled by the electrons between successive collisions.

100. What is Elastic body?

A body that regains its original shape after the removal of applied forces on it is called Elastic body.

101. What is plastic body?

A body that does not regains its original shape after the removal of applied forces on it is called plastic body.

102. **D**efine Stress?

The restoring force per unit area is called stress.

$$\text{Stress} = \frac{Restoring\ force}{Unit\ area}$$

103. Define strain?

It is the ratio of change in dimension to the original dimension.

$$\text{Strain} = \frac{Change\ in\ dimension}{Original\ dimension}, \qquad \text{Linear Strain} = \frac{Change\ in\ length}{Original\ length}$$

104. Define Hooke's law?

The stress is directly proportional to the strain within elastic limit.

105. Define Poisson's ratio?

It is the ratio of lateral strain to the longitudinal strain.

106. Define longitudinal strain or tensile strain?

When the forces act along the length of the body, a change in length is produced. The ratio of change in length to the original length is called longitudinal strain.

107. Define Shear or Shearing strain?

It is defined as the ratio of the relative displacement between two layers under the action of a tangential force to the distance them. The distance measured at right angles to the direction of stress.

108. Define Volume strain?

IWhen the forces are applied normal to the surface of a body in all directions, it undergoes a change in the volume. The ratio of change in the volume to the original volume is called volume strain.

109. List out the different types of modulus.

- Young's modulus.
- Bulk modulus.
- Rigidity modulus.

110. **D**efine Young's modulus?

The restoring force per unit area is called normal strain.

$$Y = \frac{\boldsymbol{Stress}}{\boldsymbol{Strain}}$$

111. Define Rigidity Modulus?

It is the ratio of tangential stress to the shearing strain is called Rigidity modulus and is denoted by n.

Rigidity modulus $n = \frac{tangential\ stress}{shearing\ strain}$

112. Define Bulk modulus?

The ratio of normal stress to volume strain is called bulk modulus of Elasticity and denoted by K.

Bulk Modulus (K) $= \frac{Normal\ Stess}{Volume\ strain}$

113. Define moment of inertia, mention its unit.

Moment of inertia is the inertia of a body executing rotational motion. It is given by the sum of the products of the masses of different particles of the body and the square of their respective distances from axis of rotation. Its unit is kg m^2.

114. Distinguish between inertia and moment of inertia.

Inertia and momentum of inertia are analogous quantities. In other words, moment of inertia plays the same role in rotational motion as mass does in linear motion.

115. Why the moment of inertia of a body is different for different axes of rotation?

The moment of inertia of the body is different for different axes of rotation because the mass distribution is different for different axes of rotation.

116. What is torsion?

A twisting deformation produced by a torque or a couple is known as torsion. Torsion can be generated in a body by applying a torque to one end by keeping the other end fixed.

117. What is a torsional pendulum?

A set up in which, a rigid body suspended by a wire clamped to a support executes to and fro turning motion with the wire as the axis of rotation, is called a torsional pendulum.

118. State one fundamental difference between a simple pendulum and torsional pendulum.

Simple pendulum executes simple harmonic oscillations about a vertical plane. The torsional pendulum on other hand executes simple harmonic oscillations about a horizontal plane.

119. Define rigidity modulus.

The ratio of shear stress to shear strain within the elastic limit is known as rigidity modulus.

120. Define mass and weight with units.

The amount of matter contained in a body is known as mass of a body. Its unit is kg. The force with which a body is attracted towards the centre of earth is known as weight of a body. Its unit is Newton.

121. Define period and frequency of oscillation.

The time taken by a vibrating body to execute one complete oscillation is known as period of oscillation (T).

The number of vibrations executed by a body in one second is known as frequency (f). ($f=1/T$).

122. What is regular body?

Bodies whose area or volume could be expressed in terms of equations of geometry is known as regular body. Or bodies having well defined geometrical dimensions such as length, breadth, thickness, radius, etc., are known as regular bodies.

123. Why $\frac{I}{T^2}$ is a constant in the experiment?

Irrespective of the shape and the axis of rotation of the body, the entire assembly constitutes a torsional pendulum. The period of oscillation of a torsional pendulum is given by

$T=2\pi\sqrt{I}/C$ or $T^2=4\pi^2\left(\frac{I}{C}\right)$ or $\left(\frac{I}{T^2}\right)=\left(\frac{C}{4\pi^2}\right)$=constant

Where, I, T and C respectively are the moment of inertia of the body, period of oscillation and restoring couple per unit twist generated in the wire. For a wire of given length, diameter and material 'C' is constant. Therefore, $\frac{C}{4\pi^2}$ will always be a constant and hence $\frac{I}{T^2}$ is a constant.

124. About what axis will the moment of inertia of a body is maximum?

The moment of inertia of a body will be maximum about an axis normal to the plane of a body.

125. Why the amplitude of oscillation should be small?

The equation for period of oscillation of torsional pendulum given by $T=2\pi\sqrt{\frac{I}{C}}$ holds good only for oscillations of small amplitudes.

|| Jai Sri Gurudev ||

Adichunchanagiri Shikshana Trust (R)

BGS INSTITUTE OF TECHNOLOGY

Department of Engineering Physics

LABORATORY RUBRICS

Programme	Course Code	Subject	Credits	L-T-P-TL	Assessment		Exam Duration
					SEE	CIA	
B.E	18PHYL16/26	Engineering Physics Lab	02	0-0-3-3	60	40	3Hrs

Maximum Marks: 40

Continuous Internal Evaluation	Excellent (80%-100%)	Good (80%-60%)	Average (40%-50%)
a. Observation write up and punctuality (05)	Students should write the experiments in the Observation book neatly and attend the labs regularly	Students should write the experiments in the Observation book and attend the labs.	Improper maintenance of observation books and being irregular to the labs.
b. Conduction of experiment and output (10)	Students should conduct the experiments following the given procedure, plot the graph, perform calculation and show the accurate results with S.I unit.	Students should conduct the experiments following the given procedure, plot the graph and perform calculation with average results.	Improper conduction of experiments, graph plotting and results without S.I. unit.
c. Viva voce (05)	They should answer all the questions.	If they answer some of the questions.	If they doesn't answer the questions.
d. Record write up (10)	They should write records neatly, legibly and with suitable circuit diagrams.	They should write records with suitable circuit diagrams.	Improper/poor maintenance of record.
e. Internal Test (10)	Students should write the given experiments containing Formula, Tabular column, Nature of the graph, conduct the experiment and show the results with S.I. unit.	Students must write the given experiments, conduct the experiment and show the results.	If the student write the experiment but fails to conduct it.