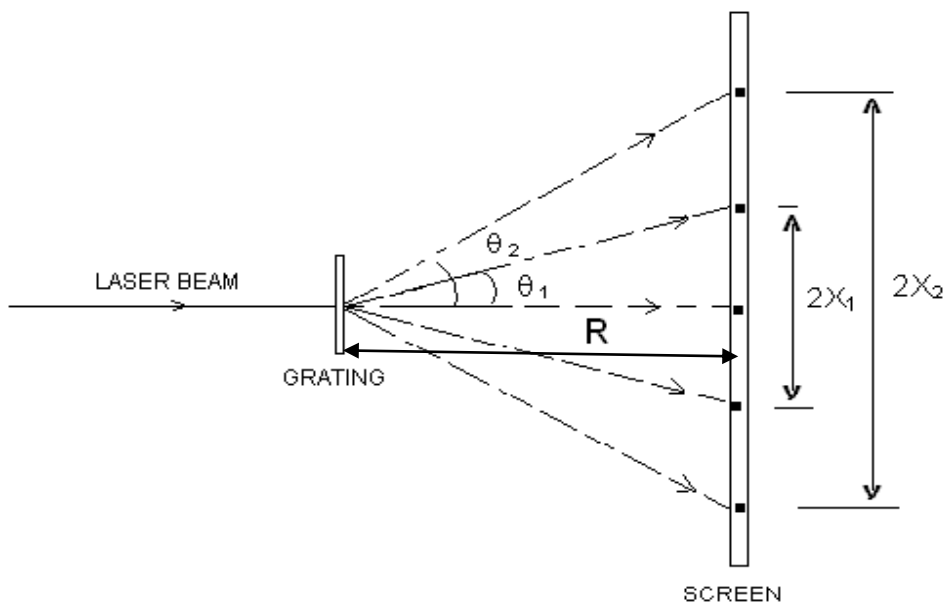**Diagram:**

Observations:

Diffraction Order m	Distance 2X_m in m	X_m in m	Diffraction angle $\theta_m = \tan^{-1}\left(\dfrac{x_m}{R}\right)$ in degree	Wavelength $\lambda = \dfrac{d \sin \theta_m}{m}$ in m
1	2X_1= x10^{-2}	X_1= x10^{-2}	θ_1 =	λ_1 = x10^{-7}
2	2X_2 = x10^{-2}	X_2 = x10^{-2}	θ_2 =	λ_2 = x10^{-7}
3	2X_3 = x10^{-2}	X_3 = x10^{-2}	θ_3 =	λ_3 = x10^{-7}
4	2X_4 = x10^{-2}	X_4 = x10^{-2}	θ_4 =	λ_4 = x10^{-7}

Calculations:

λ_{av} = ……….x10^{-7}

2X_1 =……… x10^{-2} m λ_{av} =……….

x10^{-10}

$X_1 =$.......... $\times 10^{-2}$ m

$\lambda_{av} =$...............$\overset{\circ}{A}$

$\theta_1 = \tan^{-1}(X_1 / R)$

$\theta_1 = \tan^{-1}($ / $)$

$\theta_1 =$

$\lambda_1 = (d \; \text{Sin} \; \theta_1)/1$

$\lambda_1 = (10^{-5} \times \text{Sin}$ $)/1$

$\lambda_1 =$................ $\times 10^{-7}$

Experiment No. : 1　　　　　　　　# Diffraction

Aim: **To determine Wavelength of semiconductor laser using diffraction by calculating grating constant.**

Apparatus: Diode laser source, grating (2500 LPI) with holder, scale, screen and thread.

Principle: Diffraction of light occurs when the width of the obstacle is comparable to the wavelength of the source. The light from the laser source is allowed to fall normally on the grating, by measuring the distance between the diffracted spots, the wavelength of laser light is determined.

Formula:

Wavelength of the laser source,　　$\lambda = \dfrac{d \sin \theta_m}{m}$　　in Å

Where　　　θ_m is the angle of diffraction corresponding to mth order principal maximum.

　　　　m = 1, 2, 3… is called order of diffraction, **d** is the grating constant

　　　　For 2500 lines per inch of a grating; '**d**' can be calculated as below

$$d = \frac{1}{\text{Number of lines / inch}} = \frac{1}{2500 \ /\text{inch}} = \frac{1}{2500 \ /0.0254\text{m}} = \frac{1}{98425.19/\text{m}} = 1.01 \text{X} 10^{-5}\text{m} = 10^{-5}\text{m}$$

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

　　　Where **X$_m$** is the distance of mth order diffraction maximum from the central maximum measured in m, **R**=distance between screen and grating = **1m**

Conduction:

1. Place the grating in its holder and the screen is placed at a distance of 1m

2. The laser beam after passing through the grating undergoes diffraction. The diffraction spots are observed on the screen.

3. The distances $2X_m$ between the symmetrical spots on either side of 0th order are measured and entered in the tabular column.

4. The angle of diffraction θ_m is calculated using $\theta_m = \tan^{-1}\left(\dfrac{x_m}{R}\right)$.

5. λ is calculated using the formula $\lambda = \dfrac{d \sin \theta_m}{m}$

Result:

The wavelength of semiconductor Laser λ = ……….…. Å.

Circuit Diagram:
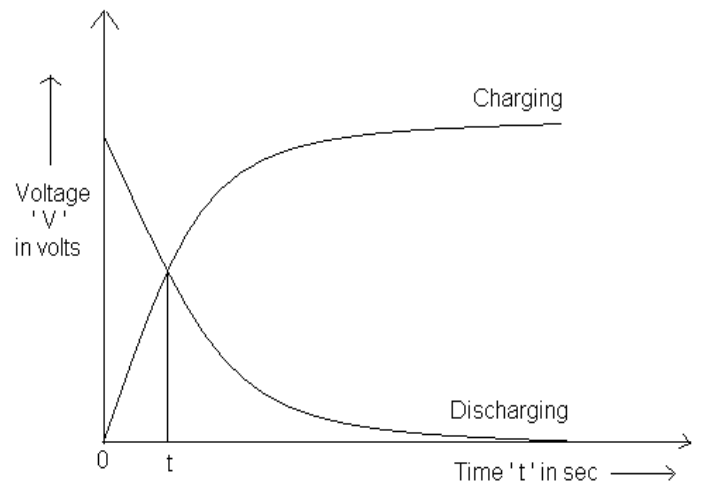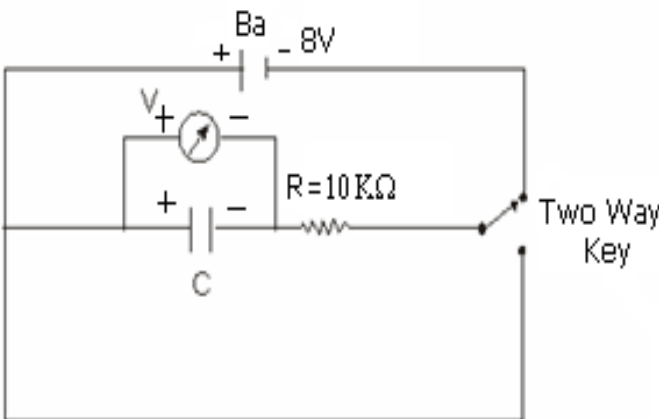
Observations:

Time t in sec	Voltage 'V' across the capacitor in volts	
	During Charging	During Discharging

Nature of graph

0	0.00	
10		
20		
30		
40		
50		
60		
70		
80		
90		
100		
110		
120		

Capacity of a capacitor **C** = $\dfrac{t}{0.693\,R}$ farads

Dielectric constant of a $\varepsilon_r = \dfrac{t \times d}{0.693\,\varepsilon_0\,(L \times B) \times R}$. capacitor

Calculations:

C=

$\epsilon_r=$

C=

$\epsilon_r=$

Experiment No. : 2   **Dielectric Constant**

Aim: Calculation of Dielectric constant by charging and Discharging of a Capacitor.

Apparatus: Electrolytic capacitor, Voltmeter (multimeter), a resistor (10 KΩ), two-way key, D.C. power supply (20/30V), Stop clock and connecting wires.

Formula:

$$C = \frac{t}{R\log_e 2} = \frac{t}{0.693R} \text{ farads}$$

Where **t** = time corresponding to intersection of the two curves

Dielectric constant of a capacitor = $\varepsilon_r = \dfrac{t\,d}{0.693\,\varepsilon_0\,(L \times B) \times R}$

Where ε_o = **8.854x10^{-12}** F/m, **L**: length of capacitor strip =**0.55**m, **d**: distance of separation of capacitor strips=**100x10^{-12}**m, **R**: Resistance=10 K Ω =**10x10^3**Ω. **B** : Breadth of capacitor strip=**1.5x10^{-2}** m.

Conduction:

1. Electrical connections are made as shown in the circuit diagram and the voltage in power supply is set to **8V.**

2. A stop clock is started and circuit is closed (by closing the plug key K_1) simultaneously.

3. The potential difference **V** across the terminals of capacitor is noted at every 10 seconds interval, till 120 seconds during the charging of capacitor and readings are entered in the tabular column.

4. The stop clock is stopped and reset, the plug key is removed.

5. The plug key is transferred from K_1 to K_2 and stop clock is started simultaneously.

6. The potential difference **V** across the terminals of capacitor is noted at every 10 seconds interval, till 120 seconds during the discharging of capacitor and reading are entered in the tabular column.

7. A graph of time **V** versus potential difference **t** is plotted for both charging and discharging of the capacitor.

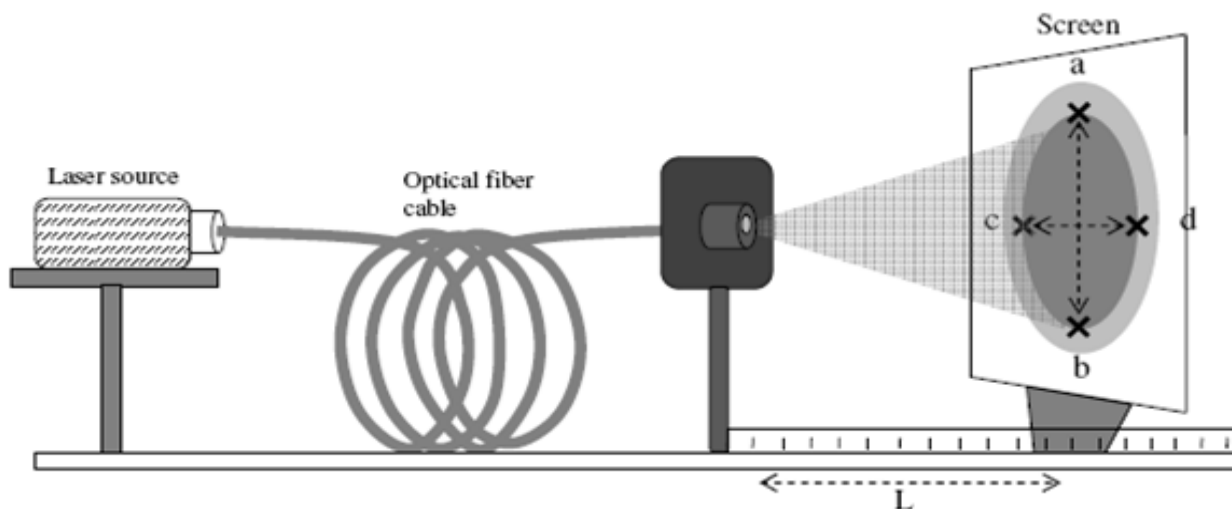8. The time **t** corresponding to the intersection of the curves is determined.

Result:

Capacitance of a capacitor C = …………farads

$$C = …………..μf$$

Dielectric constant of a capacitor ϵ_r =……………………

Diagram:

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 $\theta_0 = \tan^{-1}(D/2L)$	Numerical Aperture NA = $\sin\theta_0$
1	2					
2	4					
3	6					
4	8					

Mean θ_0 =…………..   Mean **NA**= ………….

Experiment No. : 3   **Acceptance angle and Numerical Aperture**

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 angular spread of 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 $\theta_0 = \tan^{-1}(D/2L)$

Where D = the diameter of the bright circle formed on screen in cm

L = the distance between the optical fiber end and screen in cm

And the Numerical Aperture,   **NA = $\sin\theta_0$**
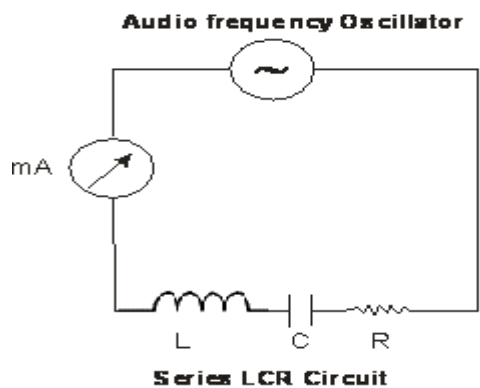
Conduction:

1. Switch on the laser source and adjust the distance between output end of the optical fiber and the screen '**L**' (say 2 cm).

2. Place a graph sheet on the screen and observe the circle formed on the graph sheet.

3. Mark the points 'a','b','c' & 'd' on the inner bright circle as shown in the diagram. Note down the horizontal diameter D_1 and vertical diameter D_2 of the inner bright circle in the tabular column.

4. Repeat the above steps for different values of **L** (for 4cm, 6cm and 8cm).

5. Find the Acceptance angle from the tabular column and hence the Numerical aperture.

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

$$\theta_0 = \text{..............}$$
$$NA = \text{.............}$$

Circuit diagram:

Observations:

C = 1 μF, R = 100 Ω, L =? H

Audio frequency Oscillator

mA

L   C   R

Series LCR Circuit

Frequency 'f' in H_z	Ammeter reading 'I' in mA
40	
80	
120	
160	
200	
240	
280	
320	
360	
400	

$$L = \frac{1}{4\pi^2 f_r^2 C}$$

Nature of

I_{max}

$\dfrac{I_{max}}{\sqrt{2}}$

I in ma

f_1 f_r f_2 f in Hz

Series Resonance circuit:

The series resonance frequency f_r=..........H_z

Bandwidth =..........H_z

Quality factor **Q** = ...

Inductance **L=.............H**

Experiment No. : 4   **Series and Parallel LCR Circuits**

Aim: To study the frequency response characteristics of a series and parallel resonance circuits and hence to determine the Inductance (L), bandwidth and the quality factor of the circuits.

Apparatus: Audio frequency oscillator, Copper ballast /choke (Inductor)**,** Capacitor **C=1μF**, Resistance box **R = 100 Ω**, AC milliammeter and connecting wires.

Formula: **Inductance,** $$L = \frac{1}{4\pi^2 f_r^2 C}$$ in Henry

Bandwidth = **(f$_2$ - f$_1$)** in H$_z$

Where f$_2$ = Upper cut-off frequency in H$_z$.

f$_1$ = Lower cut-off frequency in H$_z$.

f$_r$ = Resonance frequency in H$_z$

The quality factor of the circuit is given by

$$Q = \frac{f_r}{f_2 - f_1}$$

Common procedure for both series and parallel:

1.   The electrical connections are made as shown in the circuit diagram.

2. The frequency generator is switched on and frequency is set at 40 Hz, the milliammeter

   reading is noted.

3. The frequency is increased in steps of 40Hz up to 400Hz and in each time

   corresponding milliammeter reading is noted.

a. Series resonance circuit:

1. A graph is plotted by taking frequency along the X-axis and current along the Y- axis.

2. The frequency corresponding to the maximum value of current (I_{max}) which is called resonance frequency (f_r) is noted from the graph.

3. The maximum value of current (I_{max}) of a resonance curve for a particular value is noted.

4. A straight line parallel to X - axis corresponding to the value of (I_{max} / $\sqrt{2}$) is drawn on the curve such that the line cuts the curve at two points on either side of the resonance frequency.

5. The frequencies f_1 and f_2 corresponding to these points are noted from the graph and the band width (f_2 - f_1) H_z is calculated.

6. The quality factor of the circuit is then calculated using the relation.
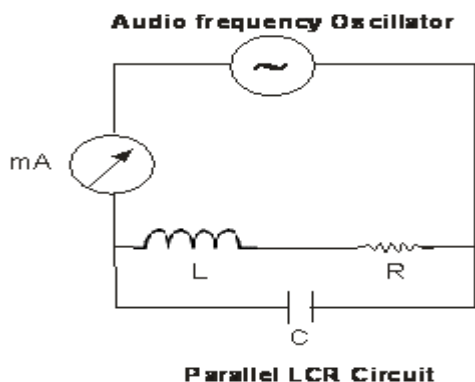
$$Q = \frac{f_r}{f_2 - f_1}$$

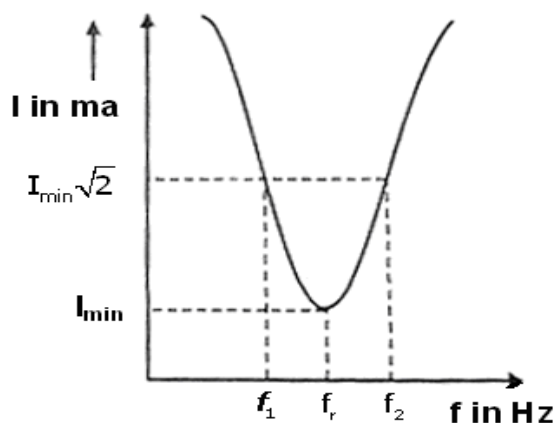**Circuit   diagram:**

Observations:

Frequency 'f' in H_z	Ammeter reading 'I' in mA
40	

C =1 µF, R =100 Ω ,   L = 1H

Audio frequency Oscillator

mA

L   R

C

Parallel LCR Circuit

80	
120	
160	
200	
240	
280	
320	
360	
400	

Nature of Graph:

I in ma

$I_{min}\sqrt{2}$

I_{min}

f_1 f_r f_2 f in Hz

Parallel Resonance Circuit:

The parallel resonance frequency f_r=..........H_z

Bandwidth =..........H_z

Quality factor **Q** = ...

b. Parallel Resonance Circuit:

1. A graph is plotted by taking frequency along the X- axis and current along the Y- axis.

2. In this case the resonance occurs when the current in the circuit is minimum.

3. Hence the frequency corresponding to I_{min} gives the resonance frequency f_r of the circuit.

4. A straight line parallel to X- axis corresponding to the value of (I_{min} X $\sqrt{2}$) is drawn on the curve such that the line cuts the curve at two points on both side of resonance frequency.

5. The frequencies f_1 and f_2 are noted from the graph and the band width (f_2 - f_1) H_z is calculated.

6. The quality factor of circuit is calculated using the relation

$$Q = \frac{f_r}{f_2 - f_1}$$

Result:

Series Resonance circuit:

      The series resonance frequency f_r=……….H_z

      Bandwidth =……….H_z

Quality factor Q = …….

Inductance L = …….. Henry

Parallel Resonance Circuit:

The parallel resonance frequency f_r=……….H_z

Bandwidth =……….H_z

Quality factor Q = …….

Observations:

Sl. No.	Object	Axis of suspension	Moment of Inertia I in Kgm^2	Time for 10 Oscillations in sec			Period T $T = t$ /10 in sec	$\dfrac{I}{T^2}$ Kgm^2s^{-2}
				t_1	t_2	Avg t		
1	Rectangular body	Passes through the centre perpendicular to the plane	$I_1 = \dfrac{M(L^2+B^2)}{12}$ $I_1 =$				$T_1 =$	$\dfrac{I_1}{T_1{}^2} =$ $=$
2	Circular body	Passes through the centre and perpendicular to the plane	$I_2 = \dfrac{MR^2}{2}$ $I_2 =$				$T_2 =$	$\dfrac{I_2}{T_2{}^2} =$ $=$
							$(I/T^2)_{mean}= [I_1 /T_1^2 + I_2 /T_2^2] / 2$	$=$

3	Irregular body	Passes through the centre	I_0 =				T_0 =	

Mass of the Rectangular body $M = 770 \times 10^{-3} Kg$

Length of the Rectangular body $L = 15.2 \times 10^{-2} m$

Breadth of the Rectangular body $B = 10 \times 10^{-2} m$

Mass of the Circular body $M = 880 \times 10^{-3} Kg$

Circumference of the Circular body $C = 49.5$ cm; Radius $R = C/2\pi = 7.88 \times 10^{-2} m$

Length of the Wire $l = \ldots\ldots\ldots \times 10^{-2} m$ Radius of the Wire $r = 0.238 \times 10^{-3} m$

Calculations:

$$I_0 = T_0^2 \left(\frac{I}{T^2} \right)_{mean} =$$

$I_0 = ($ $)^2 \times ($ $)$

$I_0 = \ldots\ldots\ldots\ldots\ldots Kgm^2$

$$n = \frac{8\pi l}{r^4} \left[\frac{I}{T^2} \right]_{Mean}$$

$n=$

$n = \ldots\ldots\ldots\ldots\ldots N/m^2$

Experiment No. : 5   **Torsional Pendulum**

Aim: Determination of moment of inertia of irregular body and rigidity modulus of the material of the suspension wire (steel) using Torsional pendulum.

Apparatus: Two regular bodies (rectangular body and circular body), Irregular body, Suspension experimental wire, Chuck nuts, Stop-clock, Iron Stand and Metre scale.

Formula: Moment of Inertia of irregular body, $I_0 = T_0^2 \left(\dfrac{I}{T^2} \right)_{mean}$ in kgm²

Rigidity modulus of the wire $n = \dfrac{8\pi l}{r^4} \left(\dfrac{I}{T^2} \right)_{mean}$ in N/m²

Conduction:

1. The masses of the regular bodies (rectangular plate and circular disc) are found. Length and breadth of the rectangular body and radius of circular disc are measured.

2. Moments of inertia about the axes passing through center and prpendicular to plane is calculated for both rectangular plate and circular disc.

3. The rectangular plate is suspended by means of the experimental wire (steel) using a pair of chuck nuts.

4. The plate is given a small angular twist and released.

5. Time taken for 10 torsional oscillations is determined as a mean of two trials.

6. The period **T** and the ratio $\dfrac{I}{T^2}$ are computed.

7. Then the given irregular body is suspended about an arbitrary axis and its period T_0 of torsional oscillations is accurately determined.

8. Moment of inertial I_0 of the irregular body can be determined using the formula.

9. Rigidity modulus of the material of the wire (steel) is calculated using the formula.

Result:

1. **Moment of inertia of irregular body $I_0 =$** …………….. **Kgm²**

2. **Rigidity modulus of the wire**   **n   =** ……………. **N/m²**
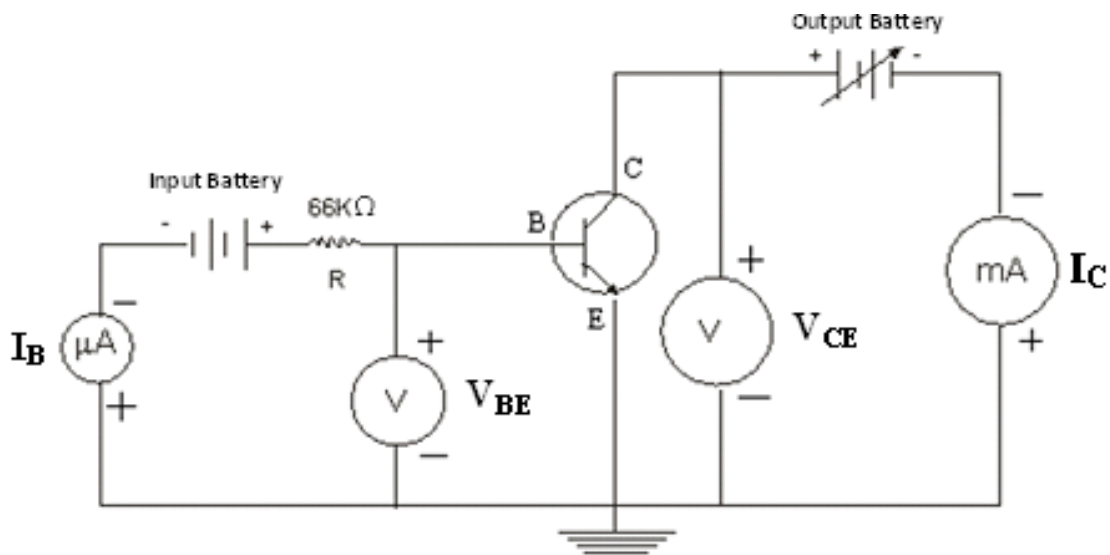
Circuit diagram:

Observations:

For input characteristics: **Nature of Graph:**

V_{CE} = 4V	
V_{BE} in volts	I_B in μA
0.00	
0.10	
0.20	
0.30	
0.40	
0.50	

Input Resistance R_i = BC/AB

Experiment No. : 6   **Characteristics of Transistor**

Aim: To study of   Input and Output Characteristics of a given NPN Transistor in common emitter (CE) mode configuration and hence to determine the Input resistance (R_i), Amplification factor (β), Current gain(α) of the transistor.

Apparatus: Transistor (NPN), DC milli ammeter, DC micro ammeter, DC voltmeter, resistor (66KΩ), dual regulated DC power supply and connecting wires.

Formula: The amplification factor β in Common Emitter (CE) mode is given by

$$\beta = \frac{(I_{C2} - I_{C1})}{(I_{B2} - I_{B1})}$$
$$\alpha = \frac{\beta}{1+\beta}$$

and   Current Gain

**Conduction:**

Input characteristics:

1. The electrical connections are made as shown in the circuit diagram.

2. The voltage between the collector-emitter V_{CE} = 4V is set constant, by varying the voltage knob of the output battery.

3. The voltage between Base-Emitter V_{BE} is varied in the input battery, in the interval of 0.1V, till the micro ammeter starts showing 1 μA.

4. Thereafter V_{BE} is varied in the interval 0.02 V till micro ammeter reads about 20μA, at each stage base current I_B is recorded.

5. The graph is drawn by taking V_{BE} along X-axis and I_B along Y-axis, which gives the input characteristics.

6. The input resistance of the transistor is calculated using the formula **R_i = BC/AB** in Ω

For output characteristics:

I_{B1}= 40μA	I_{B2} = 80μA

V_{CE} in volts	I_{C1} in mA	V_{CE} in volts	I_{C2} in mA
0		0	
1		1	
2		2	
3		3	
4		4	

Nature of graph:

I_C in mA

V_{CE} in volts

$I_{B2} = 80\mu A$
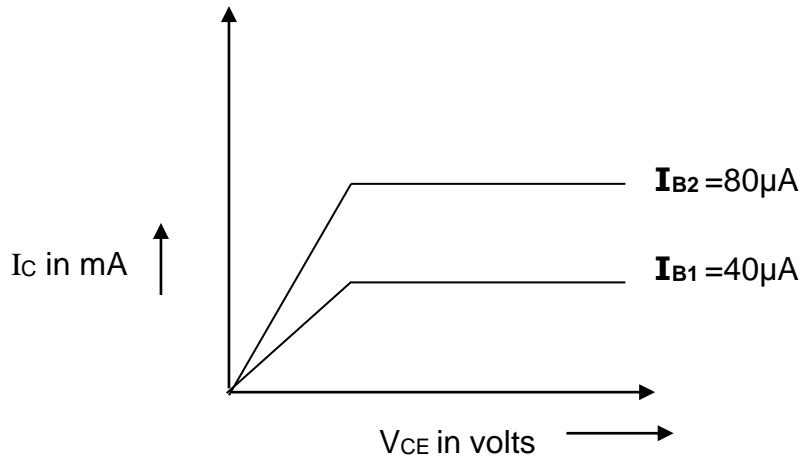
$I_{B1} = 40\mu A$

Output characteristics:

For Output characteristics place the voltmeter positive probe at collector

1. The base current I_{B1} = **40 μA** is set constant by varying the input battery voltage knob.

2. The Collector-Emitter voltage V_{CE} is varied as 0V, 1V, 2V, 3V and 4V (by varying the output battery) at each stage the Collector current I_C is noted.

3. The experiment is repeated by keeping I_{B2} = **80μA**

4. The graph is plotted by taking V_{CE} along X-axis and I_C along Y-axis which gives the output characteristics.

5. The amplification factor is calculated using the formula

$$\beta = \frac{\left(I_{C2} - I_{C1}\right)}{\left(I_{B2} - I_{B1}\right)} \qquad \text{and} \quad \text{Current gain is} \quad \alpha = \frac{\beta}{1+\beta}$$

Results:

The input, output characteristics of the given transistor are drawn.

The input resistance of the transistor R_i= ....Ω

The amplification factor of a transistor in CE mode β = ...

The current gain α= ....

Diagram:
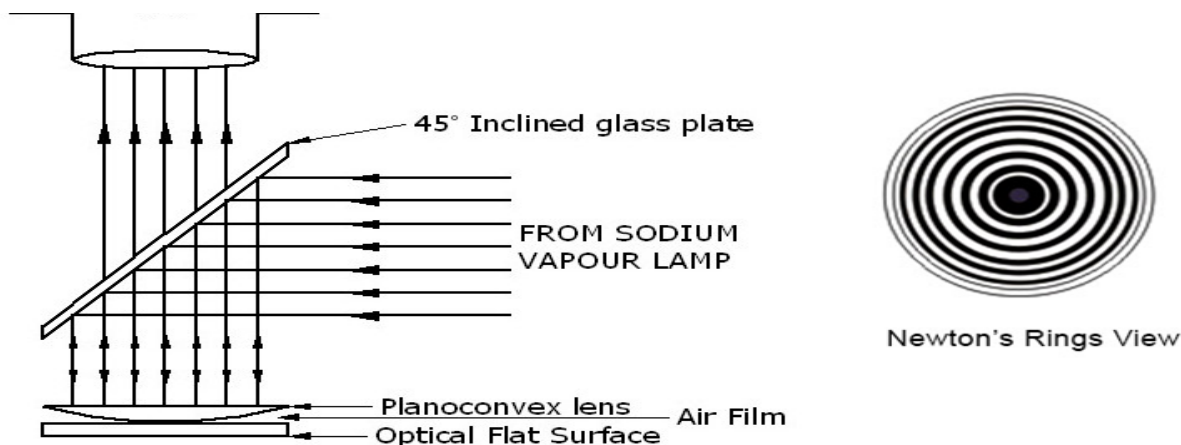
Newtons rings apparatus setup

Observations:

$$\text{Least count of Travelling Microscope} = \frac{\text{Value of 1 MSD}}{\text{Total Divisions in V.S}} = \frac{1/20}{50} = 0.001\,\text{cm}$$

Tabular column for recording MSR and CVD readings

Ring No.	Left side readings			Right side readings		
	MSR in cm	CVD	TR in cm	MSR in cm	CVD	TR in cm
10						
08						
06						
04						

Ring No.	Travelling Microscope reading		Diameter (L ~ R) D_m in cm	D_m^2 in cm^2	Ring No.	Travelling Microscope reading		Diameter (L ~ R) D_n in cm	D_n^2 in cm^2	$D_m^2 \sim D_n^2$ in cm^2
	Left side (L) in cm	Right side (R) in cm				Left side (L) in cm	Right side (R) in cm			
10					06					
08					04					

$$(D_m^2 \sim D_n^2)_{\text{Mean}} = \ldots\ldots\ldots\ldots \text{cm}^2$$

$$(D_m^2 \sim D_n^2) = \ldots\ldots\ldots\ldots \times 10^{-4}\,\text{m}^2$$

Calculations: $R = \dfrac{\left(D_m^2 \sim D_n^2\right)_{mean}}{4\lambda(m-n)}$

R=

R =……………..m

Experiment No. :07   **Newton's Rings**

Aim: To determine the radius of curvature of planoconvex lens surface by forming

        Newton's rings with it.

Apparatus: Travelling microscope, sodium vapor lamp, convex lens and reading lens.

Formula:

$$\text{Radius of curvature of the lens } \mathbf{R} = \frac{D_m^2 \sim D_n^2}{4\lambda(m-n)} \text{ m}$$

Where λ is the wavelength of the monochromatic light, = 5893Å. λ = 5893 × 10^{-10}m;
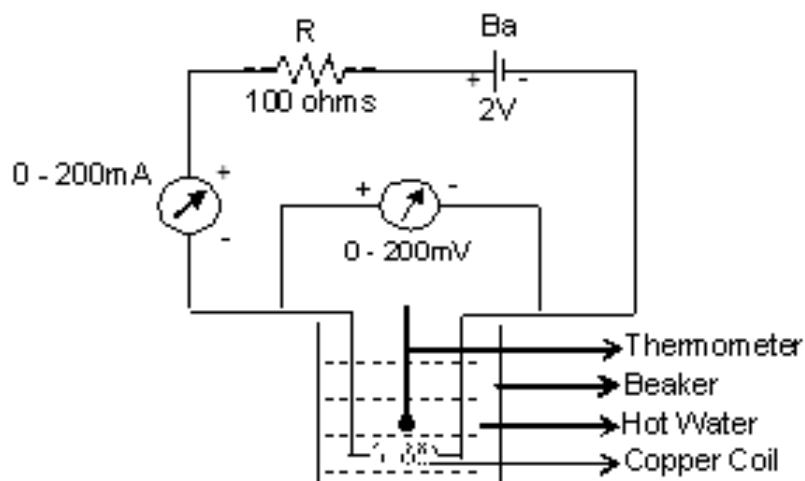
D_m and D_n are the diameters of mth and n^{th} order dark rings (m-n) = 4

Conduction:

1. Place the Plano covex lens on the circular glass plate. Keep the arrangement infront of Sodium lamp.
2. Adjust the position of the travelling microscope till the point of intersection of cross wires coincides with the centre of the ring system.
3. Slide the microscope to the left till the cross wire lies tangentially at the centre of 10th dark ring.
4. Note down MSR and CVD readings and TR is calculated using the formula TR=MSR+(CVDXLC) and enter the same in the tabular column.
5. Slide the microscope backward with the help of slow motion screw and note the readings for 8th, 6th and 4th rings repectively.
6. Slide the microscope to the right and note the readings for 4th, 6th,8th and 10th dark rings repectively.

Result: The radius of curvature of given Plano convex lens surface is   R =
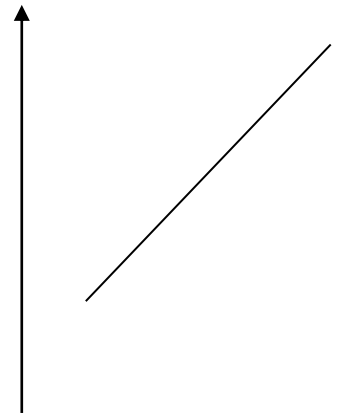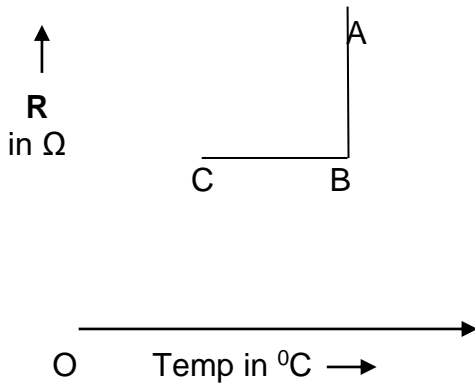
………..m.

Circuit diagram:

Observations:

Nature of graph:

Temperature in ⁰C	V in mV	I in mA	R=V/I in Ω
85°			
80°			
75°			
70°			
65°			
60°			

55°			
50°			

R
in Ω

A

C   B

O   Temp in °C →

Slope =AB/BC

Calculations:

A= $\pi\, r^2$ = 3.142 X (0.213 X10^{-3})^2 =   …………………m^2

E$_F$= $\dfrac{1.437\times10^{-15}}{1.6\times10^{-19}}\times$.

Experiment No. :08   **Fermi Energy**

Aim: To determine the Fermi energy of copper wire (metal).

Apparatus: A copper wire coil, battery, milliammeter, millivoltmeter (multimeter), beaker with hot water, thermometer, screw gauge, connecting wires.

Formula:

$$E_F = \frac{1.437 \times 10^{-15}}{1.6 \times 10^{-19}} \times \sqrt{\frac{A\rho S}{L}} \; eV$$

Where A is area of cross section of copper wire A = π r^2 in m^2

r is the radius in m (Determine ' r ' using Screw gauge page no.22)

ρ is the density of copper wire = 8.94 x 10^3 Kg/m^3

S is the slope (From the Graph)

L is Length of the copper wire (L=20m)

Conduction:

1. The circuit connection is made as shown in the circuit diagram

2. The coil is immersed in cold water, a thermometer is immersed, battery is switched ON; the voltage is set for **2V** in power supply.

3. Now the copper wire immersed in hot water, at about 85°C the voltage **V** in millivolt and the current **I** in milliamps are noted.

4. The experiment is repeated for every 5°C fall in temperature till 50 °C

5. The Resistance R=V/I in Ω of the coil for each temperature is calculated.

6. The graph is plotted by taking R along Y-axis and temperature along X-axis

Slope S = AB/BC = ...in Ω/ ^{0}C is calculated.

Result:

Fermi energy of copper wire (metal)   E$_F$= ……..…eV

Screw Gauge

1. To find radius of the wire for Fermi energy experiment:

Observations:

No. of rotations given to the screw head =1

No of divisions uncovered on the pitch scale = 1mm

$$\text{Pitch} = \frac{\text{No of divisions uncovered on the pitch scale}}{\text{No. of complete rotations given to the head scale}} = 1/1 = 1 \text{ mm}$$

$$\text{Least Count (L.C)} = \frac{\text{Pitch}}{\text{Total no. of head scale divisions}} \text{ mm} \quad = 1/100 = 0.01 \text{mm}$$

Tabular Column:

Zero error = + 3 divisions.   Zero correction = - 3   divisions

Trial No.	PSR in mm	HSD	Corrected HSD CHSD = HSD + ZC	Diameter 'd' in mm d = PSR + (CHSD X LC)
1	0	45	42	0.42
2	0	46	43	0.43
3	0	46	43	0.43

Mean diameter **d** = 0.426 mm

Radius **r** = **d/2** = 0.213 X10^{-3}m

2. To find thickness ' d ' of the beam for Young's Modulus experiment:

Observations:

No. of rotations given to the screw head =1

No of divisions uncovered on the pitch scale = 1mm

$$\text{Pitch} = \frac{\text{No of divisions uncovered on the pitch scale}}{\text{No. of complete rotations given to the head scale}} = 1/1 = 1 \text{ mm}$$

$$\text{Least Count (L.C)} = \frac{\text{Pitch}}{\text{Total no. of head scale divisions}} \text{ mm} \quad = 1/100 = 0.01 \text{mm}$$

Tabular Column:

Zero error = - 2 divisions.   Zero correction = + 2 divisions

Trial No.	PSR in mm	HSD	Corrected HSD CHSD = HSD + ZC	Thickness 'd' in mm d = PSR + (CHSD X LC)
1	01	71	73	1.73
2	01	72	74	1.74
3	01	71	73	1.73

Mean Thickness **d** = 1.733 mm

Thickness **d** = 1.733X10^{-3}m

3. To find radius ' r ' of the wire for Torsional Pendulum experiment:

Observations:

No. of rotations given to the screw head =1

No of divisions uncovered on the pitch scale = 1mm

$$\text{Pitch} = \frac{\text{No of divisions uncovered on the pitch scale}}{\text{No. of complete rotations given to the head scale}} = 1/1 = 1 \text{ mm}$$

$$\text{Least Count (L.C)} = \frac{\text{Pitch}}{\text{Total no. of head scale divisions}} \text{mm} \quad = 1/100 = 0.01 \text{mm}$$

Tabular Column:

Zero error = - 4 divisions.   Zero correction = + 4 divisions

Trial No.	PSR in mm	HSD	Corrected HSD CHSD = HSD + ZC	Diameter 'd' in mm d = PSR + (CHSD X LC)
1	0	44	48	0.48
2	0	43	47	0.47
3	0	44	48	0.48

Mean Diameter **d** = 0.476 mm

Radius **r** = **d/2** = 0.238 X 10⁻

³m

Vernier Calipers

To find breadth 'b' of the specimen material for Young's modulus experiment:

Observations:

$$\text{Least count} = \frac{\text{Value of 1 Main Scale reading}}{\text{Total number of divisions in the vernier scale}} = \frac{\left(\frac{1}{10}\right)cm}{10} = \frac{0.1cm}{10} = 0.01cm$$

Trial No.	MSR in cm	CVD	b = MSR + (CVD X LC) in cm
1	2.40	03	2.43
2	2.40	04	2.44
3	2.40	03	2.43

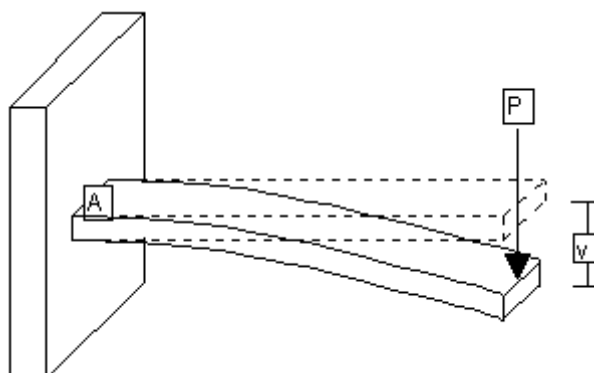Mean **b** = 2.433cm

b = 2.433x 10⁻

²m

Diagram:

Fig : Cantilever beam deflection under load at fixed end.

Observations:

$$\text{Least count of Travelling Microscope} = \frac{\text{Value of 1 MSD}}{\text{Total Divisions in V.S}} = \frac{1/20}{50} = 0.001 \text{cm}$$

Tabular column for recording MSR and CVD readings

Load on the hanger in gm	Load increasing (LI)			Load decreasing(LD)		
	MSR in cm	CVD	TR in cm	MSR in cm	CVD	TR in cm
0						
10						
20						
30						
40						
50						

Load in the weight hanger in gm	Travelling Microscope reading		Mean $\left(\frac{(LI+LD)}{2}\right)$ in cm	Load in the weight hanger in gm	Travelling Microscope reading		Mean $\left(\frac{(LI+LD)}{2}\right)$ in cm	Elevation δ for 30 gm in cm
	Load increasing (LI) in cm	Load decreasing (LD) in cm			Load increasing (LI) in cm	Load decreasing (LD) in cm		
0				30				
10				40				
20				50				

Mean Elevation (δ_{mean}) =…….…….cm

=…………..X10^{-2}m

Young's modulus $\qquad Y = \dfrac{4mgL^3}{bd^3\delta}$ in N/m^2

Calculations:

m = 30gm=30x10^{-3}Kg, **g**=9.8 m/s^2, **L=**   x10^{-2}m, **b** = 2.433x 10^{-2}m, **d** = 1.733X10^{-3}m

Experiment No. : 9   **Single Cantilever Experiment**

Aim: To determine the young's modulus of a beam by Single cantilever experiment.

Apparatus: A thin bar of material whose young's modulus is to be determined, travelling microscope and set of 10gm slotted weights.

Formula:

$$Y = \frac{4mgL^3}{bd^3\delta} \text{ in N/m}^2$$

Where '**Y**' is young's modulus for the material, '**L**' is the distance between the needle and fixed end in m, '**b**' and '**d**' is the breadth and thickness of the cantilver beam in m, '**g**' is the acceleration due to gravity =9.8 m/s^2 and 'δ' is the elevation produced in m. **m** is mass producing the dipression m = 30gm = 30x10^{-3}Kg**.**

Conduction:

1. The thickness'**d**' is measured using screw gauge (see page no.22), The breadth '**b**' is measured using slide calipers (see page no.23)and the length **L** is measured using scale.

2. 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 dead load in the hook).

3. Note down the readings of MSR and CVD using the travelling microscope and TR is calculated using the formula TR=MSR+(CVDXLC) and enter the same in the tabular column.

4. This is repeated up to 50gm in steps of 10 gm every time and corresponding readings are noted in the tabular column.

5. The dipression of the scale for 30 gm and mean depression δ is calculated.

6. The young's modulus of the material of the scale is calculated using the given formula.

Result: - The Young's modulus of a beam is Y=……………N/m^2.

Daigram:

| With initial load | With load | Series combination | Parallel combination |
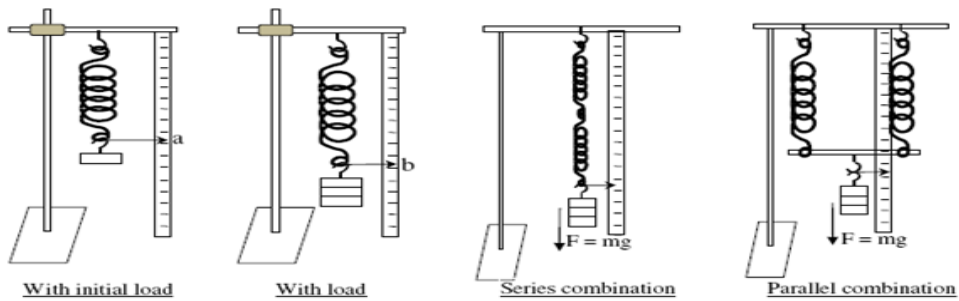
Tabular Column :

To find k$_1$:   Pointer reading with initial load =100x10^{-3}Kg   **a** = ……x 10^{-2}m

Trial No.	Load 'm' in Kg	Pointer Reading 'b' in m	Spring stretch (x=b-a) in m	Force F (F=mg) in N	Spring Constant $k_1 = F/x$ in N/m
1	50 $\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{-2}$		
2	100 $\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{-2}$		
3	150 $\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{-2}$		

Average k_1 = ... N/m

To find k_2:   Pointer reading with initial load $=100 \times 10^{-3}$Kg   **a** = ...x 10^{-2}m

Trial No.	Load 'm' in Kg	Pointer Reading 'b' in m	Spring stretch (x=b-a) in m	Force F (F=mg) in N	Spring Constant $k_2 = F/x$ in N/m
1	50 $\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{-2}$		
2	100 $\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{-2}$		
3	150 $\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{-2}$		

Average k_2 =.................... N/m

To verify series combination of springs

Pointer reading with initial load $=100 \times 10^{-3}$Kg   **a** = ...x 10^{-2}m

Trial No.	Load 'm' in Kg	Pointer Reading 'b' in m	Spring stretch (x=b-a) in m	Force F (F=mg) in N	Spring Constant k_{Series} = F/x in N/m
1	50 $\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{-2}$		
2	100 $\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{-2}$		
3	150 $\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{-2}$		

Average K_{series} = ……………. N/m

Theoretical calculation $k_{series} = \dfrac{k_1 k_2}{k_1 + k_2}$ N/m

Experiment No. :10   **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 $k = \dfrac{F}{x}$ in N/m where F = Force applied (=mg) in N

   x = displacement produced in the spring in m

2. Spring constant for series combination of springs

   $$k_{series} = \frac{k_1 k_2}{k_1 + k_2} \quad \text{in N/m}$$

3. Spring constant for parallel combination of springs $k_{parallel} = k_1 + k_2$ in N/m

Conduction:

1. Hang the spring1 to the given rigid stand with dead load of 100gm and note down the position 'a' of the pointer on the scale with initial load.
2. 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.
3. 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$_1$'.
4. Repeat the above steps for the spring 2 and find out 'k$_2$'.

To verify Series combination law of springs:

1. Hang the springs in series combination as shown in the diagram. With the initial load of 100gm, note down the position 'a' of the pointer on the scale.
2. 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.
3. 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:

1. Hang the springs in parallel combination as shown in the diagram. With the initial load of 200gm, note down the position 'a' of the pointer on the scale.

2. Add some more load into the weight hangers (say 50gm each) and note down the position 'b' of the pointer on the scale with final load.
3. Repeat the same for some more loads in steps of 100gm 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.

Result: The spring constants for the springs are found to be,

$k_1 =$ ....N/m $k_2 =$ .... N/m

Combination	Theoretical in N/m	Practical in N/m
Series	$K_{series} =$	$K_{series} =$
Parallel	$k_{Parallel} =$	$k_{Parallel} =$

To verify parallel combination law of springs
              Pointer reading with initial load (W=200gm)   a = ... x 10^{-2}m

Trial No.	Load 'm' in Kg	Pointer Reading 'b' in m	Spring stretch (x=b-a) in m	Force F (F=mg) in N	Spring Constant k parallel = F/x in N/m
1	100 x10^{-3}	x10^{-2}	x10^{-2}		
2	200 x10^{-3}	x10^{-2}	x10^{-2}		
3	300 x10^{-3}	x10^{-2}	x10^{-2}		

Average $k_{Parallel} =$ ....
N/m

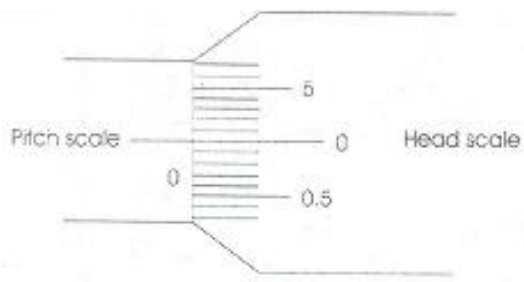Theoretical calculation $k_{parallel} = k_1 + k_2$ in N/m
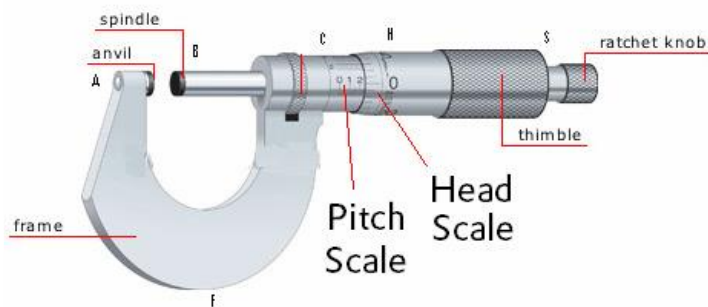
Screw Gauge

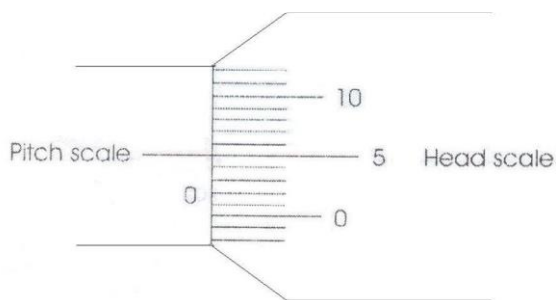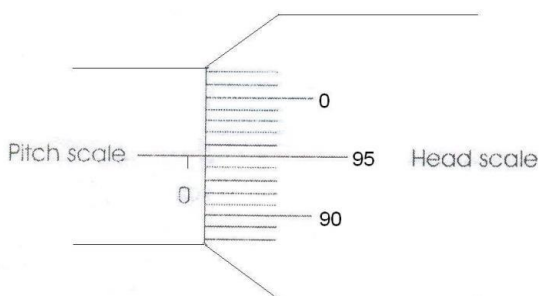Fig a. Zero Error
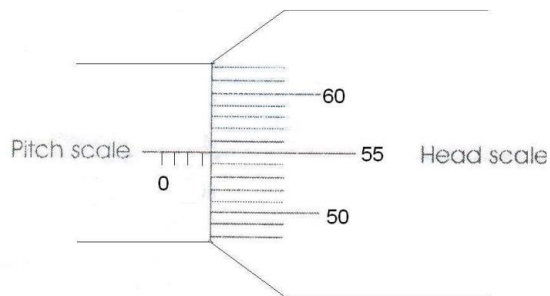

Fig b. Positive Zero Error

Fig c. Negative Zero Error   Fig d. To find PSR and HSD: PSR= **3** and HSD = **55**
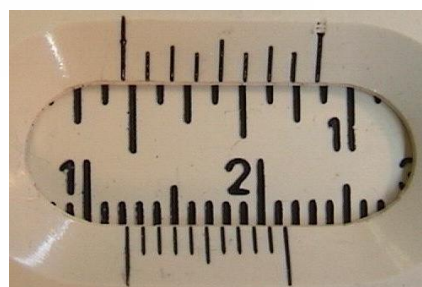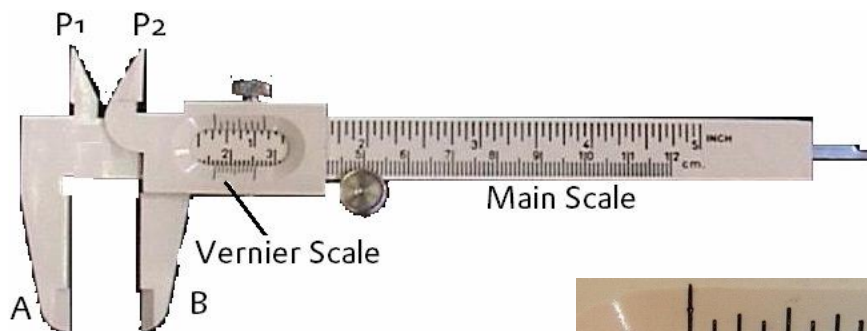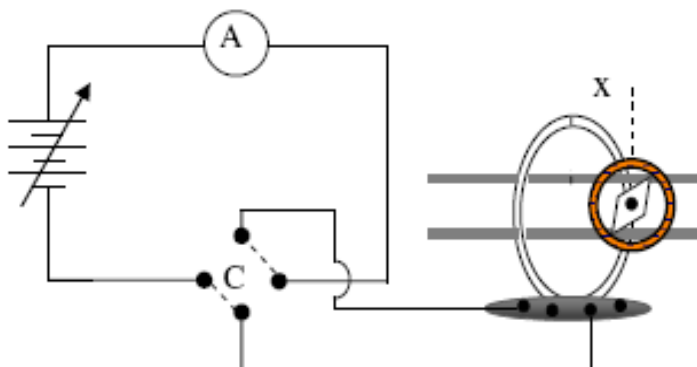
Vernier Calipers:

Fig e: To find MSR and CVD: MSR = **1.2** and CVD = **3**

Circuit Diagram:

Tabular Column:

Sl. No.	Current I in A	Deflections in degrees				Average θ in degrees	$B_{Theoritical}$ in 10^{-5} T	$B_{Experimental}$ in 10^{-5} T
		θ_1	θ_2	θ_3	θ_4			
1	0.10							
2	0.15							
3	0.20							

Calculation:

Experiment No. :11   **Magnetic Field along the axis of a coil**

Aim: To determine the magnetic field intensity at the center of a circular coil

carrying current and earth's horizontal magnetic field using deflection

magnetometer method.

Apparatus: Deflection magnetometer, commutator, ammeter, variable power supply

and connecting wires.

Formula:

$$B_{theoritical} = \frac{\mu_0 n I}{2a}$$ and $B_{experimental} = B_H \tan\theta$

Where '**B**' is the magnetic field intensity at the centre of a circular coil, '**μ_0**' is the permeability of free space = **$4\pi \times 10^{-7}$ Hm^{-1}** ,'**n**' is the number of turns in the TG coil **n=50**, '**I**'is the current through the coil in Ampere '**a**' is the radius of the coil, '**x**' is the distance between the centre of the coil and pointer in the compass box i.e.**x=0**,circumference of the coil **C=2πa=55cm, B$_H$=3.5x10^{-5}T**

Where **B$_H$** is the horizontal component of earth's magnetic field and **θ** is the mean

deflection in Tangent Galvenometer.

Conduction:
1. The connections are made as shown in the circuit diagram.

2. Set the plane of the coil in the magnetic maridian and   adjust the aluminium pointer to   read 0°-0° on the circular scale of the deflection magnetometer.

3. Keep the magnetometer exactly at the centre of the coil (for this case **x = 0**).

4. Pass a current **I** (say 0.10A,0.15A and 0.20A) to flow through the coil and note down the corresponding magnetometer deflections θ_1 and θ_2 are noted.

5. The direction of the current is reversed by using the commutator C and the corresponding magnetometer deflections θ_3 and θ_4 are noted.

6. Average deflection θ is calculated. And magnetic field at the centre of the coil 'B Experimental is calculated

7. Compare the theoratical and experimental values B at the centre of coil for different currents.

Result: It was found from the experiment that the theoratical and experimental values of B at the centre of coil for different currents match each other within the experimental errors.

Circuit diagram:
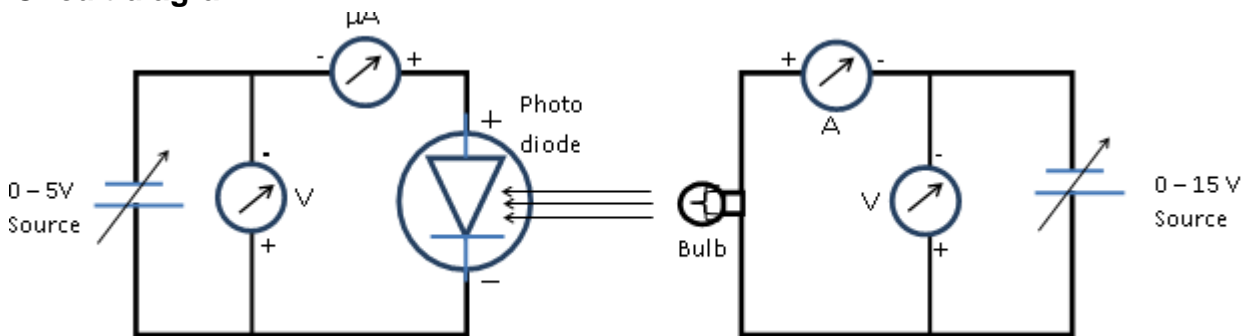
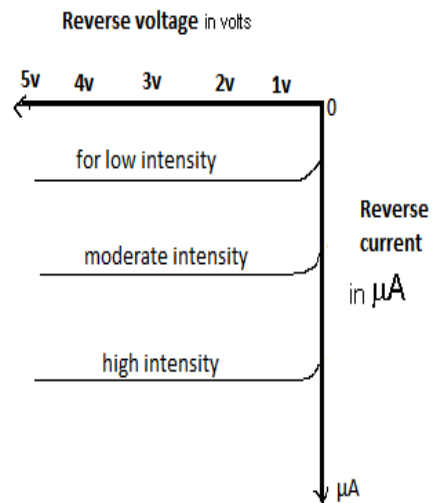**Observations:**
Nature of graph:
To study the reverse bias characteristics of the photodiode:

Sl. No.	Low intensity of bulb (For I=4µA)		Moderate intensity of bulb (For I=8µA)		High intensity of bulb (For I= 12µA)	
	Biasing voltage in volts	Current in µA	Biasing voltage in volts	Current in µA	Biasing voltage in volts	Current in µA

1	0		0		0	
2	1		1		1	
3	2		2		2	
4	3		3		3	
5	4		4		4	

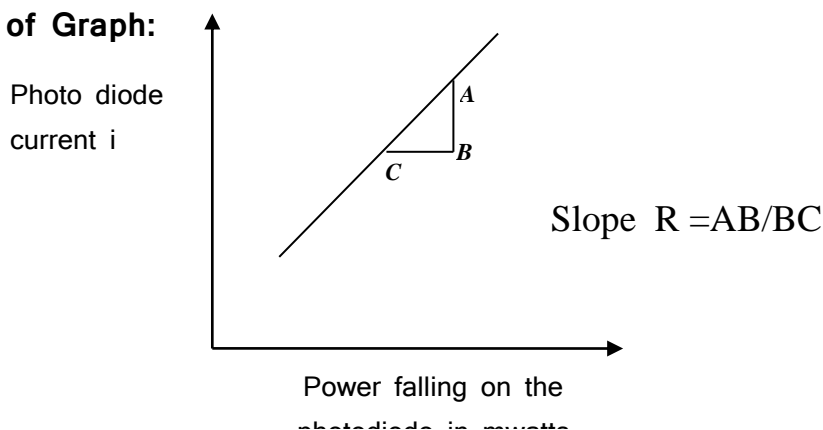**To find the responsivity of the photo diode:**

Radius of the photodiode, r = 2mm,

Distance from filament of the bulb to the photodiode, d = 1cm

Sl. No.	Across the bulb			Power falling on photodiode $P = \dfrac{P_o \times r^2}{4d^2}$ in mWatts	Photodiode Current in μA
	V in V	I in A	$P_o = V \times I$ in Watts		
1	5.0				
2	6.0				
3	7.0				
4	8.0				
5	9.0				
6	10.0				

Nature of Graph:

Photo diode
current i

Slope R =AB/BC

Power falling on the
~~photodiode in mwatts~~

Experiment No. : 12   **Photodiode Characteristics**

Aim: To study the reverse bias characteristics of the photodiode and hence to find its Photo Responsivity.

Apparatus: Photodiode, Bulb, power supplies for LED/Bulb and Photo diode.

Formula: Responsivity of the Photo diode, R = slope of the graph   in mA/watt

Principle:

Photodiode is a two terminal junction diode in which the reverse saturation current changes when it's reverse biased junction is illuminated by suitable wavelength of light.

When a p-n junction is reverse biased, a small amount of reverse saturation current is produced due to thermally generated electron-hole pairs. The number of these minority charge carriers depends on the intensity of light incident on the junction. When the diode is in a glass package, light can reach the junction and thus changes the reverse current.

Conduction:

To study the reverse bias characteristics of the photodiode.
1. The electrical connections are made as shown in the circuit diagram
2. The Power supplies are switched ON and the voltage across the bulb is increased till the microammeter reads photocurrent of **4μA**.
3. For this fixed intensity of the bulb the reverse bias voltage across the photodiode varied as 0, 1, 2, 3 and 4 volts and the corresponding micro ammeter reading is recorded in the tabular column.
4. The experiment is repeated by varying the intensity of the bulb for **8μA** and **12μA** of photo currents.
5. The graph is plotted between current versus voltage for different intensity of the bulb in the third quadrant of the graph, because the current and voltages are for the reverse bias.
6. The characteristics of photodiode in reverse bias condition are obtained as shown in the specimen graph.

To find the responsivity of the photo diode

1. With the same electrical connections the voltage across the bulb is adjusted to say 5V and the corresponding current through the bulb and the diode is noted in the second tabular column.

2. The voltage is increased in steps of 1V up to around 10V (5V, 6V, 7V, 8V, 9V and 10V) and the corresponding currents are tabulated.

3. A graph of photo diode current across the diode vs power falling on the photodiode is plotted and the responsivity is calculated using the formula.

Result: The reerse bias characteristics of the given photodiode for different intensity of light is as represented in the graph.

The Power Responsivity of the given photodiode is found to be, R =…………mA/Watts

Definitions and Viva-Voce Questions with Answers

1. Diffraction

1. Diffraction of light: The phenomenon of bending of light around the corners of small obstacles and hence its encroachment into the region of geometrical shadow.

2. Grating: A grating is a device consisting of a large number of parallel slits of the same width separated by equal opaque spaces. A grating is made by ruling equidistant fine and parallel lines on an optically flat glass plate by using a diamond point.

3. Grating element or grating constant: The space between any two lines on the grating.

4. LASER: Light amplification by stimulated emission of radiation. It is a source of a highly coherent, highly monochromatic and perfectly parallel beam of radiation.

5. Induced absorption: Induced absorption is the absorption of an incident photon by a system as a result of which the system is elevated from a lower energy state to an higher state.

6. Spontaneous emission: Spontaneous emission is the emission of a photon, when a system transits from a higher energy state to a lower energy state without the aid of any external agency

7. Stimulated emission: Stimulated emission is the emission of a photon by a system, under the influence of a passing photon of just the right energy, due to which the system transits from a higher energy state to a lower energy state

8. Population inversion: Population inversion is the state of a system at which the population of a particular higher energy state is more than that of a specified lower energy state. Population inversion is achieved by pumping mechanism.

9. Metastable state: A higher energy state which is present between ground and excited states is called a meta stable state.

12. Applications of Laser: Laser is used in Industries (viz., welding, cutting, drilling,) Medicine, Material processing, Communications, energy resourcse, 3-D photography, Laser range finder in Defense and in compact disc drives.

2. Dielectric Constant of a Capacitor

1. Dielectrics: Dielectrics are insulators, they do not have free electrons, and they do not conduct electricity. They enhance the charge storing capacity of a capacitor.Ex: air, glass, plastic, water etc

2. Polar dielectrics: The molecules of a dielectric which possess a permanent dipole moment.

3. Non polar dielectrics: The molecules of a dielectric which do not possess a permanent dipole moment.

4. Give two examples each for polar and non polar molecules?
Water (H_2O) & carbon monoxide (CO) are polar molecules and Oxygen (O_2) & carbon dioxide (CO_2) non polar molecules.

5. Polarization: An electric field is applied to dielectric material, there is displacement of charges leading to formation of dipoles. This phenomenon is called polarization.

6. Dipole: Two equal and unlike charges separated by a finite distance constitute a dipole.

7. Dielectric constant: It is the ratio of permittivity of any medium to the permittivity of vacuum.

8. Dielectric strength of a dielectric: The maximum value of applied electric field above which dielectric break down occurs is called the dielectric strength of a dielectric.

9. Capacitor: A capacitor is device which can store electric energy by storing electric charges.

10. Capacitance: It represents the charge storing ability of the capacitor.

11. Dipole moment: Product of magnitude of either charge and the distance between the charges.

12. Charging of a capacitor: When a capacitor is in a closed circuit with a dc source and a resistor, the charge in the capacitor increases with time and reaches saturation.

13. Discharging of a capacitor: When a charged capacitor is in a closed circuit with a resistor, the charges on the capacitor leak through its dielectric and the resistor. The charge on capacitor decreases with time and reaches zero. This process is called discharging.

14. Define 1 Farad: It is the capacitance of a capacitor which holds 1Coulomb of charge under a potential difference of 1Volt.

15. Dielectric break down: The phenomenon due to which dielectric loses its insulating property and behaves like a conductor is called dielectric break down.

3. Photodiode Characteristics

1. Photodiode: Photodiode is a two terminal junction diode in which the reverse saturation current changes when its reverse biased junction is illuminated by suitable wavelength of light.

2. Working principle the photodiode: When a p-n junction is reverse biased, a small amount of reverse saturation current is produced due to thermally generated electron-hole pairs. The number of these minority charge carriers, depends on the intensity of light incident on the junction.

3.Responsivity: It is defined as the ratio of the photocurrent to the incident light power at a given wavelength.

4. Factors we must consider while selecting photodiode: Wavelength of light to which it is sensitive, Operating voltage, switching time and mounting.

5. Applications: Photodiodes are used in signal detection, demodulation, switching, logic circuits, character recognition, optical communication equipments, encoders etc.

6. Optoelectronics: It is the technology that makes use of the principles of optics and electronics.

7. Optoelectronic devices: A light emitting diode and photo diode.

8. Biasing: Supplying external DC voltage to a diode or a transitor is called biasing.

9. **Forward bias:** When p-side of the junction (or diode) is connected to the positive terminal of an external source and n-side to the negative of an external source. **Reverse bias:** When p-side of the junction is connected to the negative terminal of an external source and n-side to the positive of an external source.

10. Differnce between photodiode and LED: In *Photodiode* the illuminated light produce a reverse saturation current but in *LED's* a suitable biasing current produce a photons of suitable frequency.

4. Series and Parallel Resonance Circuit

1. Series resonance circuit: A circuit containing an inductor, a capacitor and a resistor in series with an AC source.

2. Audio Frequency oscillator: An Audio Frequency oscillator is a device which can produce sinusoidal waveforms of any desired frequency ranging from 20Hz to 20 KHz.

3. Resonance in an LCR circuit: The condition in which frequency of the applied current from the AC source matches the natural frequency of the LCR circuit. When the inductive reactance matches with the capacitive reactance the resonance occur.

4. Resonance frequency: The frequency at which the resonance occurs is called Resonant frequency.

5. Bandwidth: The range of frequencies between the lower and upper cutoff frequencies is called bandwidth.

6. Quality factor: The ratio of a resonant frequency of a circuit to its bandwidth is called Quality factor

7. Series circuit called as acceptor circuit : Because it accepts one frequency component out of the input signals having different frequencies. The accepted frequency is equal to its own resonance frequency.

8. Parallel resonance circuit is called a rejecter circuit: Because it rejects the signal having same frequency as its own frequency.

9. **Significance of Quality factor:** It measures the sharpness of resonance.

10. Alternating current: The current which varies periodically with time

11. Why do you need a frequency generator (AC) in this experiment? Why cannot you use DC? The very aim is to study how the LCR circuit allows / stops the current of a particular frequency stopping / allowing currents of other frequencies. Hence there is a need for the variable frequency AC source. Here DC is of no use as it has no frequency.

12. Define frequency and period of AC?
Number of cycles generated per second is called frequency and Time taken to generate one complete cycle is called period.

13. Uses of LCR circuits: For high frequency radio communications, in frequency filter circuits like high pass filter, low pass filter and band pass filter, in radio & TV receivers to select a particular station (frequency), in communication devices like RADARs

14. Define 1 Henry: It is the self inductance of a coil if a potential difference of 1V is induced in the coil when the current through it varies at the rate of 1ampere per second.

15. Choke: It is an inductance coil used in AC circuits to bring down the value of current without appreciable power loss.

16. RMS value of AC: It is the Square root of the sum of the squares of the instantaneous values of current taken over a complete cycle.

5. Input and Output Transistor Characteristics

1. Transistor: A transistor is a semiconductor device consisting of two P-N junctions back to back. It has 3 doped regions and its main function is amplification.

2. Transistor is so named: Transistor term is derived from the combination of two words "**transfer**" and "**resistor**". When transistors are used in circuits the variations in the low resistance input circuit are transferred to high resistance output circuit.

3. Name the three regions in a transistor. They are emitter, base and collector.

4. What is the role of emitter, base and collector of a transistor? Emitter supplies a large number of majority charge carriers of current through the device. **Base** controls the flow of charges through the device. **Collector** collects the majority charge carriers supplied by the emitter.

5. What is the significance of arrow mark in the symbol of a transistor?
The arrow mark in the transistor symbol signifies the direction of conventional current.

6. What is the relation between transistor currents?
The emitter current (I_E) is always equal to the sum of base current (I_B) and collector current (Ic).

7. Transistor is current control device: By controlling the base current, the outgoing collector current can be controlled for the given emitter current. Hence a transistor is current control device.

8. Applications of the transistor: In amplification of ac signals and switching (gates) devices of radio, TV and other communication systems**.**

9. Amplification: The process of increasing the amplitude of weak AC signal (voltage or current) Without altering the other characteristics (like frequency) of the signal.

10. Mention the three modes in which transistor is operated.
Common base mode, Common collector mode and Common Emitter mode

11. Why CE mode is more often used in the transistor circuit?: CE mode is used more often because of high input impedance, high voltage gain, high current gain, and power gain.

12. Explain the input and output characteristics.
Input characteristics relate the input voltage with input current at a constant output voltage.
They are the curves obtained by plotting I_B verses V_{BE} at constant V_{CE}.
Output characteristics relate the output voltage with output current at a constant input current.
They are the curves obtained by plotting I_C verses V_{CE} at constant I_B.

13. What are the three regions of output characteristics curve?
   a.   Cut off region: It is the region below the curve when the base current is zero.
   b.   Saturation region: It is a region till the collector current increases sharply.
   c.   Active region: It is the region where the collector current remains steady.

14. In which region the transistor is operating? Ans: Active region

6. Young's Modulus by Single Cantilever method

1. Stress: The magnitude of applied force per unit area is called stress. It is measured in N/m^2.
Strain: The change in dimension to the original dimension of a body. Strain has no unit.
2. Hooke's law: The stress is directly proportional to the strain within the elastic limits.
3. Modulus of Elasticity: The ratio of stress to the strain is called modulus of elasticity. It is measured in N/m^2. There are three moduli of elasticity.
Young's modulus: The ratio of longitudinal stress to longitudinal strain within the elastic limits.
Bulk modulus: The ratio of Volume stress to the volume strain within the elastic limits.
Rigidity modulus: It is the ratio of shear stress to the shear strain within the elastic limits.
4. Poisson's ratio: Within elastic limits the ratio of lateral strain to the longitudinal strain is called Poisson's ratio. It has no unit.
5. Cantilever: When one end of a horizontal beam is fixed and the other end is free, is called a cantilever.
6. Elasticity: The property of material bodies by virtue of which they regain their original shape and size after the deforming force is removed. **Plasticity:** The property of material bodies by virtue of which they do not regain their original shape and size after the deforming force is removed.
7. Elastic limit: It is the upper limit of the deforming force up to which the body regains its original shape and size, and beyond which the body becomes permanently deformed.
8. Beam: When the lengths of the rod of uniform cross section is very large compared to its breadth such a rod is called beam.
9. Deformation: Change in length, shape or size in a rigid body due to an external force.
10. Deforming force: An external force which produces a change in length, shape or volume in a rigid body.
11. **Perfectly elastic body:** A body which completely regains the original shape and size after the removal of the deforming force. Eg. Quartz, phosphor bronze, etc.
12. Perfectly plastic body: A body which does not recover its original state and retains the deformed state on removal the external force. Eg. A ball of clay, paraffin wax, etc.

13. Annealing: Annealing operation involves heating and gradual cooling. This causes decrease in elastic properties. Operations like hammering and rolling break up the crystal grains resulting in increase of elastic properties.

14. Strain softening: Strain softening is defined as a phenomenon in which the stress in the material is decreasing with an increase in strain.

15. Strain hardening: When a material is strained beyond the yield point, more stress is required to produce additional plastic deformation and the material becomes stronger and more difficult to deform. This is known as *strain hardening*.

7. Newton's Rings

1. Interference of light: The modification in the distribution of light energy due to the superposition of two or more waves of light is called interference of light.

2. Conditions for sustained interference: The light waves superposing at a point must have the same wavelength or same frequency. The amplitude of superposing light waves should be equal or almost equal. The waves superposing should either have the same phase or constant phase difference. Light sources must be very narrow and very close to each other.

3. Coherent sources: Any two sources of light continuously emitting light waves having zero or constant phase difference are called coherent sources.

4. Newton's rings: When a monochromatic light falls normally on Plano convex lens and glass plate set, the light reflected by the lower surface of the lens and upper surface of the glass plate superpose to produce Interference pattern. This circular interference pattern is called Newton's rings.

5. Why the central ring is dark? The central ring is dark because the two interfering rays have a path difference (λ/2) in spite of the fact that the thickness is zero.

6. How to obtain central bright spot in Newton's rings? By interpose a film of refractive index less than that of the material of the lens and greater than that of the material of the plate. Then the path difference between the two rays becomes λ produces central bright spot.

7. On what factors does the diameter of a ring depend?
It depends on the wavelength of the light and the radius of curvature of the plano-convex lens.

8. What are the applications of Newton's rings?
It is used to determine wavelength of unknown light source and radius of curvature of given lens.

9. Why Newton's are rings circular?
The reason is that the thickness of air film remains constant over a circle. At all points over a circle, the same path difference is introduced between rays reflected at the upper surface and at the lower surface. So, the same condition of interference (constructive or destructive) is satisfied at all these points. Hence the fringes are circular.

8. Fermi Energy

1. Fermi level: The highest energy level in the valence band occupied by electrons in a crystal at absolute zero temperature is called Fermi level.

2. **Fermi energy:** The energy corresponding to the Fermi level is called Fermi energy.

3. Importance of Fermi energy: Electrical conduction takes place only when electrons acquire energy above the Fermi energy. It helps to understand electrical & thermal properties of solids. It explains why electrons do not contribute significantly to the specific heat of solids at room temperature T.

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

5. Fermi Temperature (T_F): It is the temperature at which the average thermal energy of the free electrons in a solid becomes equal to the Fermi energy at 0^0K. $T_F = E_F/K$

6. Fermi velocity: The velocity of the electrons which occupy the Fermi level is called the Fermi velocity V_F. It is measured by $V_F = \sqrt{2E_F/m}$

7. **What is the unit for Fermi energy?**
Its unit is eV. 1eV is the energy possessed by electron when unit charge is accelerated through a potential difference of 1Volts. $1eV = 1.6 \times 10^{-19} C \times 1V = 1.6 \times 10^{-19} J$.

8. Factors on which E_F depends: E_F depends on the material and the temperature.

9. How many electrons are there in each energy level? According to Pauli's exclusion principle, there are 2 electrons are there in each energy level.

10. Pauli's exclusion principle: It states that no two electrons having same set of quantum numbers can occupy the same energy level.

9. Torsional Pendulum

1. Moment of inertia: It is the product of the rotating mass and square of its distance from the axis of rotation. unit of moment of inertia is Kgm^2

2. **Torque:** A force F acting at a distance r from the axis of a body has a rotational effect on the body. This rotational effect of a force is called moment of the force or torque

3. **Torsional oscillations:** One end of wire is fixed to a rigid support other end carrying an object is twisted and released. It executes torsional oscillations.

4. Inertia: Inertia is the tendency of a body to remain at rest or to remain in the state of motion unless it is compelled by an external force. Inertia depends on the mass of the body.

5. Rigid body: A rigid body is one in which the particles of the body remain at fixed distance from one another. Therefore, the size and shape is not altered by the application of external forces.

6. Translational motion: The motion of a body along a straight or curved path is translational motion. In translational motion, each particle of the body covers the same distance in a given time.

7. Rotational motion: During the motion of the body if a line of points of the body remain at rest, the motion is called rotational motion. Example: spinning top, motion of earth about its own axis,etc.

8. Factors on which the moment inertia of a body depends: Axis of rotation, distribution of the mass of the body, shape and size.

9. Torsion of a body: A body is said to be under torsion if it is fixed at one end and is twisted at the other end about its axis by means of a torque (couple).

10. **Torsional pendulum:** A rigid body attached to one end of the wire whose other end is fixed to a support is capable of oscillating when the rigid body is given torque or rotating effect. This arrangement is called a torsional pendulum.

10. Spring Constant

1. **What is a spring?** Ans: A spring is a cylindrical metal coil which possesses elasticity

2. **How do you say the spring possesses elasticity?**
A compressed or stretched string tends to regain its original length, following Hook's law.

3. **Simple Harmonic Motion (SHM):** It is a motion in which the acceleration of the body is directly proportional to its displacement from a fixed point and is always directed towards the fixed point.

4. Spring constant or force constant: It is the magnitude of the applied force that produce unit extension in the spring while it is loaded within the elastic limit. Its unit is N/m.

5. **Physical significance of force constant:** Force constant is a measure of stiffness. In the case of springs, it represents how much force it takes to stretch the spring over a unit length.Thus springs with larger value for force constant will be stiffer.

6. State Hooke's law. Within the elastic limit, stress is directly proportional to strain.

7. **How does the thickness of the wire affect spring constant?**
Thicker wire has a larger spring constant.

8. **Effect of length of the spring on spring constant:** Spring constant decreases with increasing in length of the spring.

9.Forced Oscillations: It can be defined as the vibrations in which the body vibrates with a frequency other than its natural frequency under the action of an external periodic force.

10.**Conditions of an ideal spring** i. Spring is assumed to be light. ii. No dissipative forces which tend to decrese the motion of a spring. Iii. Restoring force of the spring is directly prportional to its extension.

11. Free Oscillations: It is the oscillations in which the body oscillates with its own natural frequency when left free to itself

12. Natural frequency: The frequency with which a body vibrates freely at its own.

13. Damped Oscillations: The oscillations in which the amplitude continuesly decreses with time are called damped oscillations.

11. Magnetic Field along the axis of a Coil

1. What is magnetic field? The region in which a unit magnetic pole experiences a force. SI unit of magnetic field is Tesla.

Tesla: It is that magnetic field in which a particle, carrying a charge of one coulomb, and moving perpendicularly through a magnetic field, at a speed of one metre per second, experiences a force with magnitude one newton.

2. Magnetic flux lines: Curved lines (imaginary lines) used to represent a magnetic field, drawn such that the number of lines represents the strength of the magnetic field and the tangent to any curve at a point gives the direction of magnetic field at the point.

3. Weber. One weber is that change in magnetic flux per second, which induces an emf of one volt across two open circuited terminals.

4. What is magnetic flux density B?
The number of magnetic lines of force per unit normal area. $\mathbf{B = \Phi / A}$ weber m^{-2} or Tesla.

5.M**agnetic field intensity H:** Force experienced by a unit north pole placed at the given point. N web^{-1} Or A m^{-1}.

6. Magnetic substance: The substances which are susceptible to magnetic influence.

7. Magnetic moment: It is the product pole strength and the distance between the poles. Am^2.

8. Magnetization M :** Magnetic moment per unit volume of the magnetic material or magnet.

9. Magnetometer: It a devise used to measure magnetic field at a given point. It works on the principle of tangent law.

10. State tangent law of magnetism: If a magnetic field B is applied at right angles to the horizontal component of the earth's field B$_H$, The magnetic needle comes to equilibrium at an angle θ to the magnetic meridian such that $\mathbf{B = B_H \tan \theta}$.

11. Magnetic axis: It is the line passing through the two poles of a magnet.

12. **Magnetic meridian:** The vertical plane at the place passing through the magnetic axis of the earth.

12. Numerical Aperture and Acceptance Angle

1. Numerical aperture. Numerical aperture is defined as the light gathering capability of an optical fiber. It is the sine of the acceptance angle. **NA=sin Θ_0**

2. Principle used in fiber optic communication system: Total internal reflection (TIR).

3. What is the condition for propagation of light in an Optical fiber?
    Sin Θ_i < Sin Θ_0, where Θ_i is the angle of incidence of a ray.

4. Acceptance angle: The maximum value of the angle of incidence (θ_0) for a ray to propagate through an optical fiber.

5. What is the expression for Acceptance angle? Ans: $\Theta_0 = \sin^{-1} [\sqrt{(n_1^2 - n_2^2)}/n_0]$

6. Optical fiber: It is a device which transmits optical signals over long distances by means of TIR

7. Types of optical fibers: There are three types of optical fiber, i. Single mode fiber, ii. Step-index multimode fiber & iii. Graded-index multimode fiber.

8. TIR: When light travels from a denser medium to a rarer medium, if the angle of incidence is greater than the critical angle, it undergoes reflection back into the denser medium.

9. What are the sources used in optical communication? LEDs and LASER diodes

10. Applications of optical fiber: To transmit the information which are in the form of coded signals of the telephone communication, Computer data, & to transmit the optical images (eg: endoscopy)

11.Attenuation: The loss of signal power suffered by an optical signal as it propagates through an optical fiber.