A LABORATORY MANUAL OF ENGINEERING PHYSICS

(1/11 Semester B.E.)

(Common to all Branches)

SUBJECT CODE: 18PHYL 16/26

2019-2020

-: OUR MISSION:-

Disciplined and Integrated Development of Personality Through Academic Excellence, Sports and Cultural Activities

Name: ....

USN/Roll No : .... **Group:** ....

Section : ....

Branch : ....

DEPARTMENT OF PHYSICS

SIR M. VISVESVARAYA INSTITUTE OF TECHNOLOGY

(Affiliated to VTU, Recognised by AICTE and Accredited by NAAC

Bangalore - 562 157

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TABLE OF CONTENTS

Sl. No.	TITLE OF THE EXPERIMENT	PAGE NO.
1.	DIELECTRIC CONSTANT	1-11
2.	FERMI ENERGY	12-21
3.	LCR RESONANCE CIRCUITS	22-31
4.	NEWTON'S RINGS	32-41
5.	SPRING CONSTANT	42-51
6.	TORSION PENDULUM	52-63
7.	TRANSISTOR CHARACTERISTICS	64-77
8.	MAGNETIC FIELD ALONG THE AXIS OF A COIL	78-86
9.	SINGLE CANTILEVER	87-97
10.	LASER DIFFRACTION	98-104
11.	PHOTO DIODE CHARACTERISTICS	105-112
12.	OPTICAL FIBER	113-118
13.	APPENDIX-I	119
14.	APPENDIX-II	120

Suggested Experiments in Engg. Physics Lab.

(Common to all Branches)

(Effective from the academic year 2018-19)

Course Code : 18PHY16/26 | **IA Marks: 40**

Contact Hours/Week: 03 | **Exam. Marks: 100**

Credits: 1.5 | **Exams. Hours: 03**

Course Learning Objectives: This course **(18PHY16/26)** will enable students

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

SI. No	Title of the Experiment	To which Module it belongs
1	Determination of spring constants in Series and Parallel combination	I
2	Determination of Magnetic field intensity at the center of a circular coil carrying current bv deflection method)	III
3	n & I by Torsional pendulum (radius of the wire, mass and dimensions of the regular bodies to be given). (In the examination either n or I to be asked)	II
4	Young's modulus of a beam by Single Cantilever experiment (breadth and thickness of the beam to be given)	II
5	Radius of curvature of piano convex lens using Newton's rings (wavelength of light to be given)	III
6	Study Series and parallel LCR resonance and hence calculate inductance, band width and quality factor using series LCR Resonance	I/III
7	Determine Acceptance angle and Numerical aperture of an optical fiber	III
8	Determine Wavelength of semiconductor laser using Laser diffraction by calculating grating constant.	IV
9	Estimation of Fermi Enernv of Copper	V
10	Study of input and output Transistor characteristics and hence calculate input resistance, a and B	V
11	Draw photodiode characteristics and calculate power responsivity	V
12	Calculation of Dielectric constant by RC charging and Discharging	V

Note:

1. In addition to above experiments, Reddy shock tube must be introduced as compulsorydemo experiment
2. All 12 experiments are mandatory. Student has to perform 2 experiments in the semester end examination

Course Outcomes:

Upon completion of this course, students will be able to

1. Apprehend the concepts of interference of light, diffraction of light, Fermi energy and magnetic effect of current

EVALUATION SCHEME

ENGINEERING PHYSICS LAB **18PHYL 16/26**

		EX	IN
❖	**PROCEDURE**		
	A) FORMULA WITH EXPLANATION B) FIGURE / CIRCUIT DIAGRAM C) TABULAR COLUMN	08	10
❖	**CONDUCTION**		
	A) SET UP AND MEASUREMENT B) CONDUCTING EXPERIMENT	25	20
❖	**CALCULATION**		
	A) SUBSTITUTION / SIMPLIFICATION B) GRAPH / ACCURACY / RESULT & REPORT	10	10
VIVA-VOCE		07	10
TOTAL MARKS		**50**	**50**

Note:
The candidate has to perform two experiments in external examination. Each experiment 50 marks.

The INTERNALS will be conducted for 50 marks and reduced to 10 marks. 30 marks are awarded for the record and for performance in the lab during semester.

Important Note: Work done in the lab and the practical record are continuously assessed. Candidate must score a minimum of 20 out of 40 sessional marks. If candidate fails to get the minimum prescribed, he/ she will not be allowed to sit for the Lab examination as per VTU regulations.

SUMMARY OF WORK DONE

INCHARGE FACULTY : ____

NAME:_____________________________________ USN : _________________________

BRANCH : ______SEC:________SEM:________ BATCH:________ YEAR:_____________

SL. NO.	DATE	TITLE OF THE EXPERIMENT	MARKS OBTAINED		FACULTY SIGNATURE
			MANUAL	RECORD	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
AVERAGE MARKS OBTAINED					

SIGNATURE		
STUDENT	INCHARGE FACULTY	HEAD OF THE DEPARTMENT

Exp No. : Date :

DIELECTRIC CONSTANT

AIM : To determine the capacitance value of the given capacitors, RC time constant values and dielectric constant values using a DC charging and discharging circuit.

APPARATUS : 5V DC power supply, digital voltmeter, timer, resistors of known values, and capacitors of unknown values, circuit unit and patch cords

FORMULAE :

1. $$C = \frac{T_{1/2}}{0.693 \times R}$$ Farad,

Where,
- C is capacitance, (F).
- $T_{1/2}$ is the time in second required to get charged/discharged to 50% of the capacitance value, (s).
- R_1 is the resistance (Ω).

2. $$T = RC$$ Second,

Where, T is the time constant (capacitative time constant), (s)

3. $$K = \frac{(1.44 \times 10^{-6})\, T_{1/2}\, d}{\varepsilon_0 \, A \, R}$$

Where,
- K = dielectric constant
- $T_{1/2}$ = time in second required by the capacitor to get charged/discharged to 50% of capacitance value (from graph (s))
- d = separation between capacitor plates (m)
- A = area of capacitor plates (m^2)
- R = resistance used in circuit (Ω).
- ε_0 = 8.854×10^{-12} F/m

DIAGRAM :

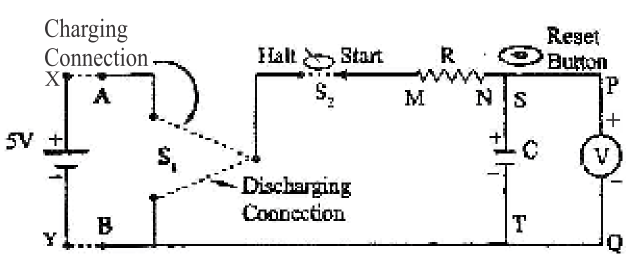


Fig. 1

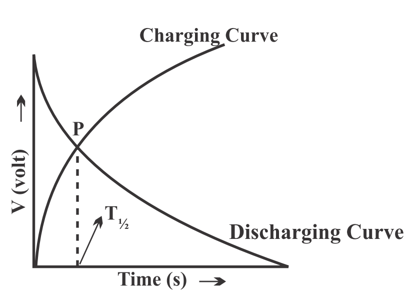


Fig. 2

CAPACITOR DIMENSIONS

Capacitor Dimensions	Length (mm)	Breadth (mm)	Separation (mm)
C_1	47	5	0.075
C_2	114	5	0.075
C_3	183	6	0.075

PROCEDURE:

- ❖ Circuit connections are made as shown in diagram for a set RC combination (Taking R_1 = 100k, C = C_1).
- ❖ The digital stop clock is reset by pressing reset button.
- ❖ Set the voltmeter reading to zero by shorting the two terminals of capacitor.
- ❖ The toggle switch S_1 is thrown to the charge position. The toggle switch S_2 is thrown to the start position.
- ❖ Time from the digital clock and voltage from the voltmeter are noted starting from 0 seconds to at an interval of 5 seconds.
- ❖ Once the clock shows 90 seconds reading immediately the clock is reset and switch S_1 is thrown to discharge position (D) simultaneously.
- ❖ Continue noting down time and voltage starting from 0 seconds to 90 seconds at an interval of 5 seconds.
- ❖ Repeat the procedure for R_1=100k, C = C_2
- ❖ A graph is drawn taking time in seconds along X-axis and voltage in volts along Y- axis for each RC combination.
- ❖ The Value of time ($T_{1/2}$) where the charging and discharaing curve intersect is determined.
- ❖ For each RC combination the value of capacitance C, time constant T and dielectric constant K is calculated usinp the formula 1, 2 & 3 respectively,

RESULTS :

1. The capacitance values are found to be,

   (A) C_1 = ... Farad

   (B) C_2 = ... Farad

2. The time constant values are found to be,

   (A) T_1 = ... Second.

   (B) T_2 = ... Second.

and

3. The dielectric constant values are found to be

   (A) K_1 = ...

   (B) K_2 = ...

Signature of the Teacher :

Marks Obtained : | | |

Date :

OBSERVATIONS AND CALCULATIONS :

TABULAR COLUMN

Dependence of Capacitors voltage on time

Time in seconds	RC Combination – 1		RC Combination – 2	
	Voltage across C_1 in volts $R_1 = 100\ k\Omega$		Voltage across C_2 in volts $R_1 = 100\ k\Omega$	
	Charge mode	Discharge mode	Charge mode	Discharge mode
0				
5				
10				
15				
20				
25				
30				
35				
40				
45				
50				
55				
60				
65				
70				
75				
80				
85				
90				
95				
100				

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

DIELECTRIC CONSTANT

VIVA - VOCE

1. What are dielectrics?
2. What is forbidden gap?
3. Why do we use dielectric material in capacitor?
4. What is the dielectric constant for air/vacuum?
5. Define capacitance & Dielectric Constant?
6. How can the capacitance value of the capacitor be increased?

– 0 – 0 – 0 –

Exp No. : Date :

FERMI ENERGY

AIM : To determine the Fermi energy and Fermi temperature of the given metal by studying resistance variation at different temperatures.

APPARATUS : DC regulated power supply, digital milliammeter, digital millivoltmeter, heating arrangements, thermometer, metal coil, circuit unit and patch cords.

PRINCIPLE : Fermi energy is the energy corresponding to the highest occupied level at zero degree absolute kelvin and the energy level is referred to as the Fermi level.

Fermi energy plays an important role in the application of Fermi-Dirac statistics. The Fermi-Dirac distribution function for electrons is given

$$F(E) = \frac{1}{e^{\left(\frac{E - E_F}{kT}\right)} + 1} \quad \text{where } E_F \text{ is Fermi energy}$$

At $T = 0$ K, $f(E) = 1$ for $E < E_F$ and $f(E) = 0$ for $E > E_F$. Thus at absolute zero, E has the significance of a cut off energy because all states with energy less than E are completely filled and all the states with energy greater than E are vacant at T = 0 K.

FORMULA :

1. **Electron density :** $n = \frac{N\rho}{M}$ m^{-3}

where, N = 6.023×10^{26} per kg mol is Avogadro number.
ρ = density of the metal = 8930 kg m^{-3}.
M = mass number of the metal = 63.54.

2. **Fermi energy :**

$$E_F = \left[\frac{n\, e^2 \pi A\, r^2}{L\sqrt{2m}}\right]^2 \times \left[\frac{\Delta R}{\Delta T}\right]^2 \quad J = \text{..................} eV$$

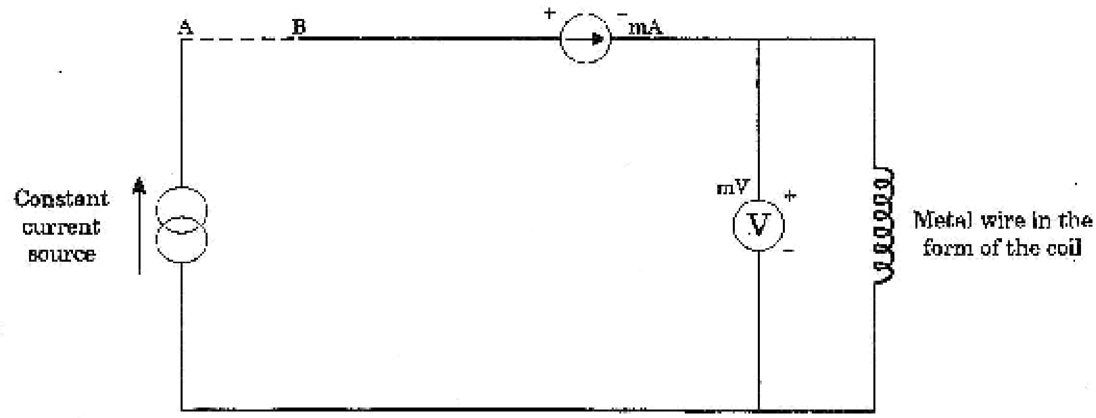
where, n = electron density per m^3.
e = electron charge = 1.602×10^{-19} C.
A = constant = 7.6×10^{-6}.
r = radius of the copper wire = 0.26×10^{-3} m.
L = length of copper wire = 3.58 m.
m = mass of the electron = 9.1×10^{-31} kg.
$\frac{\Delta R}{\Delta T}$ = slope of the straight line obtained by plotting resistance of the material against absolute temperature of the metal.

3. **Fermi temperature :**

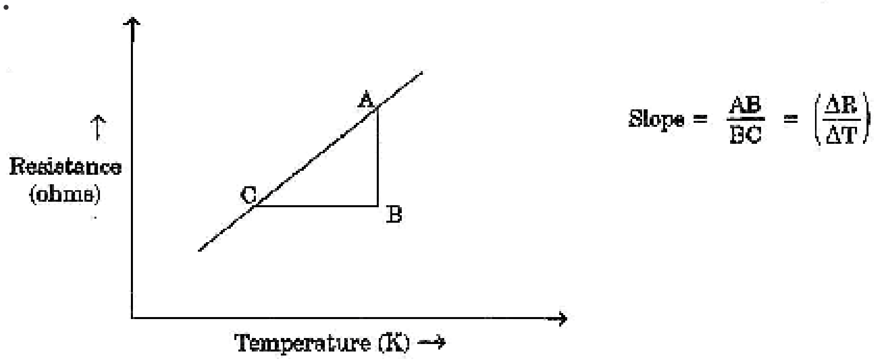
$$T_F = \frac{E_F}{k} \quad K$$

where k = Boltzmann's constant = 1.381×10^{-23} J/K.
E_F = Fermi Energy in J.

DIAGRAM :



GRAPH :



PROCEDURE :

- ❖ The experimental setup is as shown in the figure. The two ends of the coiled wire is connected to a power supply through a milliammeter and millivoltmeter is connected across the coil.
- ❖ A thermometer is immersed in the beaker containing hot water and coil.
- ❖ The power supply is switched on and voltage and currents are noted in table. The water is allowed to cool and temperature is noted down in regular intervals.
- ❖ Trial is repeated taking reading in the interval of 5 degree and till the temperature reaches 45^0. At each temperature, the voltages and currents are measured and hence from ohm's law, resistance is found [R=V/IΩ].
- ❖ A graph is drawn taking temperatures in degree K along X-axis and resistance on Y-axis as shown in figure. The slope of straight line is calculated.
- ❖ Finally Fermi energy is calculated. Once the Fermi energy is found, Fermi temperature can be calculated.

RESULTS :

1. Electron density is found to be n = ... $/m^3$.
2. Fermi energy is found to be E_F = ... eV.
3. Fermi temperature is found to be T_F = ... K.

Signature of the Teacher : Marks Obtained :

Date :

OBSERVATIONS AND CALCULATIONS :

TABULAR COLUMN TO FIND R

Temperature		Voltage (mV)	Current (mA)	Resistance (Ω) R = V/I
^{0}C	^{0}K			

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

FERMI ENERGY

VIVA - VOCE

1. Define Fermi energy and Fermi level.

2. Define Fermi - dirac statistics.

3. What is Fermi factor and Fermi temperature.

4. What are fermions and bosons?

5. State Pauli's Exclusion principle.

– 0 – 0 – 0 –

Exp No. : Date :

LCR CIRCUITS

AIM : To study the current (I) vs frequency (f) response curve of a LCR circuit both in series and parallel and hence to determine the value of resonant frequency (f), inductance of the given coil (L), bandwidth BW and quality factor (Q).

APPARATUS : Inductor(L), Capacitor(C), Resistance(R), AC Voltmeter, AC ammeter, Audio Frequency oscillator, connectiong wires etc.

PRINCIPLE : If a resistor having a resistance R, an Inductor having inductance L and a capacitor having capacitance C are connected in series across an AC source of an output voltage V_{rms}, the impedance of the circuit is

$$Z = \sqrt{[R^2 + (X_L \sim X_C)^2]}$$

where, X_L = Inductive reactance = L = 2 fL

$$X_C = \text{Capacitive reactance} = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

The current in the circuit is $I = \frac{V}{Z}$. X_L varies directly with frequency and X_C varies inversely with frequency and R is independent of frequency. At the Frequency f_r, called resonance frequency, the impedance of the circuit is minimum, and the corresponding current is maximum, this condition is known as resonance. At resonance $X_L = X_C$. When an inductor of negligible resistance and the capacitor are connected in parallel to an audio oscillator then voltage across R is maximum and hence current is minimum. By knowing the values of C, and measuring f_r from graph of I versus f, Values of L, Q and BW is determined.

FORMULA : 1. The inductance of the coil (L) is given by

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

where,

L = The inductance of the given coil in H.

f_r = The resonance frequency in Hz.

C = capacitance of the capacitor in F.

2. The Quality factor (Q) of the coil is given by

$$Q = \frac{2\pi f_r L}{R} = \frac{1}{2\pi f_r CR}$$

3. The Bandwidth (BW) of the circuit is given by

$$BW = f_2 - f_1 \quad Hz$$

Where

f_2 = Upper cutoff frequency in Hz.

f_1 = Lower cutoff frequency in Hz.

DIAGRAM :

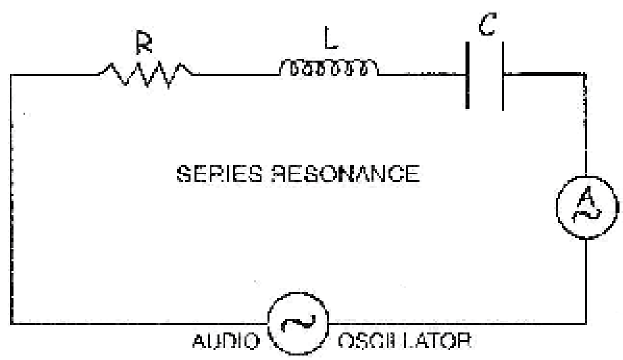
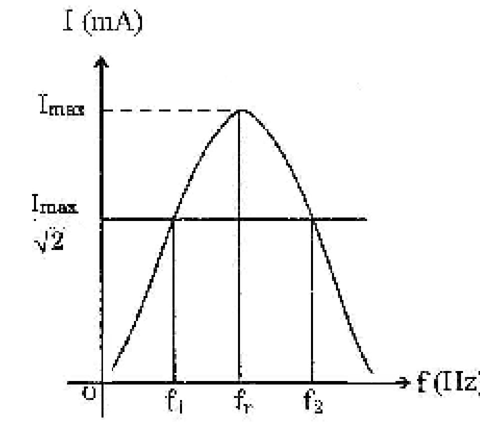


Fig. 1



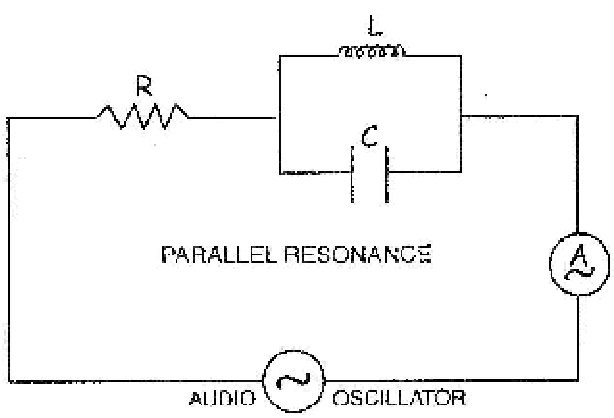
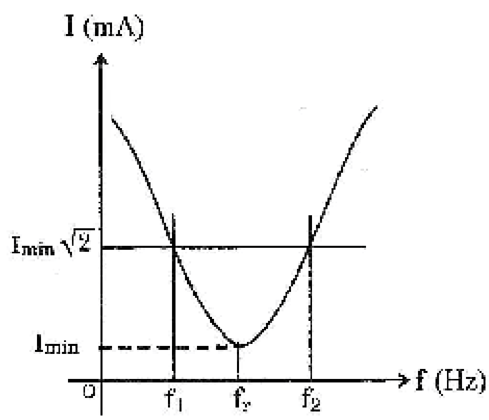


Fig. 2



PROCEDURE:

- ❖ Circuit connections for series resonance are made as shown in Fig 1.
- ❖ Keeping input voltage constant (say 4V) the frequency is varied in steps (say 200 Hz) and the corresponding current is noted in each case.
- ❖ As we increase the frequency, the current increases up to resonance frequency; further increase in frequency leads to decrease in current.
- ❖ A graph is plotted taking current readings along Y-axis and frequency readings along X-axis.
- ❖ From the graph, the resonance frequency, lower cut off frequency and upper cut off frequency are determined.
- ❖ The inductance of the coil, quality factor, and band width are calculated using the formulae 1, 2, and 3 respectively.
- ❖ Circuit connections for parallel resonance are made as shown in Fig. 2
- ❖ Repeat the above procedure for parallel resonance. Determine the value of resonance frequency and then calculate the values of L, Q, and BW.

RESULTS:

Series Resonance Circuit:

1. Resonant frequency is found to be, f_r = ____________________ Hz.
2. Inductance of the coil is found to be, L = ____________________ H.
3. Quality Factor is found to be, Q = ____________________ .
4. Band width is found to be, BW = ____________________ Hz.

Parallel Resonance Circuit:

1. Resonant frequency is found to be, f_r = ____________________ Hz.
2. Inductance of the coil is found to be, L = ____________________ H.
3. Quality Factor is found to be, Q = ____________________ .
4. Band width is found to be, BW = ____________________ Hz.

Signature of the Teacher :

Marks Obtained :

Date :

OBSERVATIONS AND CALCULATIONS :

TABULAR COLUMN TO FIND RESONANCE FREQUENCY

R = ________________ Ω **C = ________________ F**

SERIES RESONANCE		PARALLEL RESONANCE	
Frequency in Hz.	Current in mA	Frequency in Hz.	Current in mA
200		200	
400		400	
600		600	
800		800	
1000		1000	
1500		1500	
2000		2000	
2500		2500	
3000		3000	
3500		3500	
4000		4000	
4500		4500	
5000		5000	
5500		5500	
6000		6000	
6500		6500	
7000		7000	
7500		7500	
8000		8000	

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

NOTE :

- ❖ Circuit connections should be made properly without any discrepancies then the supply is switched on.
- ❖ Care should be taken to keep the input voltage always a constant.
- ❖ Current readings for series should start and end with the same readings. (Suppose if your first reading for series is about 1 mA then you are supposed to take readings until you reach 1 mA or at least very close to 1 mA say 3 mA)
- ❖ Above is applicable for parallel also (Suppose, your first reading for parallel is about 40 mA then you are supposed to take readings until you reach 40 mA or at least very close to 40 mA say 37 mA)
- ❖ Calculations for both series and parallel should be shown separately.

VIVA - VOCE

1. What is an Oscillator? Which is the circuit that acts exactly opposite to the Oscillator?
2. What is the action of L, C and R?
3. What is the other name for series and parallel resonance circuit? Why is it called so?
4. What happens if you connect series and parallel resonance circuit in series with each other?
5. Where is the above circuit used?
6. Why should ammeter be connected in series with the circuit?
7. Why should voltmeter be connected in parallel with the circuit?
8. What is the principle behind this experiment?
9. What do you mean by resonance?
10. What do you mean by an impedance of the circuit?

— 0 — 0 — 0 —

Exp No. : Date :

NEWTON'S RINGS

AIM : Determination of the radius of curvature of the surface of a convex lens by measuring the diameters of the Newton's rings.

APPARATUS : Plano-convex lens, optical plane glass plate, turnable glass plate, travelling miscroscope, reading lens, sodium vapor lamp, micrometer or travelling micrometer.

PRINCIPLE : When a Plano-convex lens is placed on an optically flat glass plate, a thin airfilm of varrying thickness is formed between the lens and the plate. When a monochromatic light is incident normally on the system, reflected waves interfere producing an interference pattern. The point of observation will be dark or bright depending upon the thickness of the film. The loci of all the points having the same thickness is a circle due to radial symmetry. Thus, we have to observe a set of concentric bright and dark circles around the point of contact between the lens and plate. The point of contact will be dark due to destructive interference.

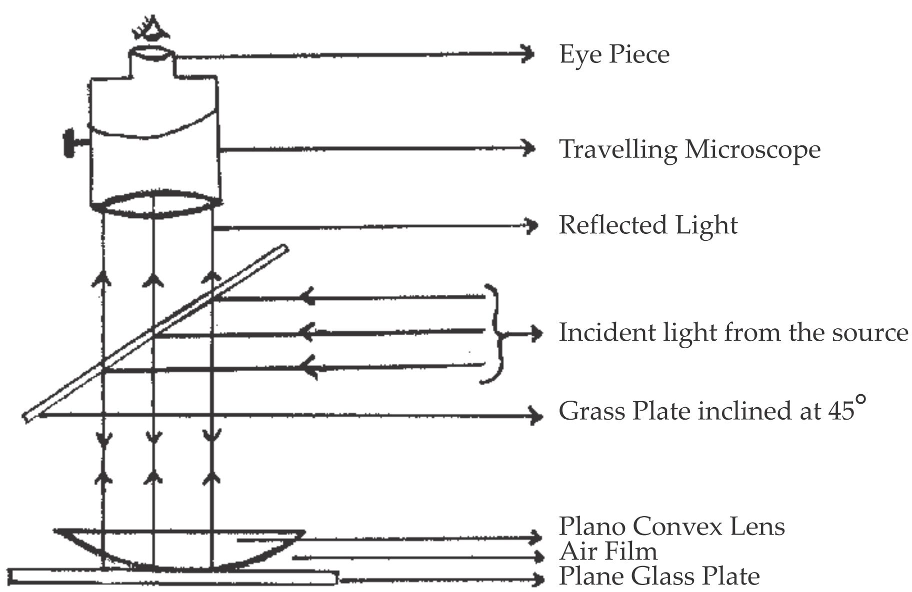
FORMULA : Radius of curvature of the surface of the lens.

$$R = \frac{(D^2_m - D^2_n)_{mean}}{4 \lambda (m-n)} \quad m$$

where, λ = Wave length of sodium light = 5893×10^{-10} m

Dm, Dn = Diameter of m^{th} and n^{th} dark ring respectively.

DIAGRAM:



PROCEDURE :

- ❖ A plano convex lens and the glass plates P & Q are thoroughly cleaned. The plano convex lens 'L' is placed over the glass plate 'P' the apparatus is set up as shown in Figure.
- ❖ Light from the monochromatic source is made to fall on the glass plate 'Q' which is inclined at an angle 45^0. The beam is reflected vertically downwards. It is then incident normally on the plano convex lens, the beam gets reflected from the top and bottom surfaces of the air film introduced between the surfaces of the convex lens 'L' and the glass plate 'P'. Due to interference between these two rays alternative bright and dark rings are formed.
- ❖ A travelling microscope is kept vertically above the ring system, the microscope is focussed on the ring system. It's position is adjusted such that the point of intersection of the cross wire is at the centre of the ring system. The microscope is moved by means of the tangential screw from the central dark spot to the left hand side counting the number of dark rings.
- ❖ One of the cross wires is made tangential to the 12^{th} dark ring. The readings of the pitch scale and circular scale are recorded by means of the tangential screw. The microscope is moved towards the right hand side, the cross wire is made tangential to the 12^{th}, 10^{th}, 8^{th}, 6^{th} and 4^{th} dark rings and the corresponding readings are recorded on LHS.
- ❖ After reading the centre of the ring system the microscope is moved towards the right hand side of the centre dark spot by means of the tangential screw, the cross wire is made tangential to the 4^{th}, 6^{th} .... 12^{th} dark ring. The microscope is always moved in the same direction to avoid the error due to back lash. The difference between the left hand side and right hand side readings gives the diameter of a particular dark ring.
- ❖ Let the diameter of the m^{th} dark ring be D_m and the diameter of the n^{th} dark ring be D_n, the mean value of $(D^2_m - D^2_n)$ is found out then the radius of curvature of the surface of the lens is determined by using the formula.

RESULTS :

The radius of curvature of the given converging lens is found to be ....

Signature of the Teacher : Marks Obtained : | | |

Date :

OBSERVATIONS AND CALCULATIONS :

Least count of the travelling Microscope :

$$LC = \frac{\text{Pitch}}{\text{Total number of divisions on head scale}} = \_\_\_\_\_\_\_\_\_\_ \text{ mm}$$

$$\text{Pitch} = \frac{\text{Distance moved}}{\text{Number of rotations given head scale}} = \_\_\_\_\_\_\_\_\_\_ \text{ mm}$$

DETERMINATION OF THE DIAMETER OF THE RING

Ring No. **m**	RHS			LHS			Diameter $D_m=R_1 \sim R_2$ mm	D^2_m mm^2	Ring No. **n**	RHS			LHS			Diameter $D_n=R_1 \sim R_2$ mm	D^2_n mm^2	$D^2_m \sim D^2_n$ mm^2
	PSR mm	CSR	Total readings R_1 mm	PSR mm	CSR	Total readings R_2 mm				PSR mm	CSR	Total readings R_1 mm	PSR mm	CSR	Total readings R_2 mm			
12									**06**									
10									**04**									
08									**02**									

Mean value of $D^2_m - D^2_n$ = ... mm^2 = ... $X 10^{-6} m^2$

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

NOTE :

- ❖ The upper surface of the plane glass plate should be thoroughly cleaned.
- ❖ The lens used must have a larger radius R.
- ❖ Care should be taken to keep the glass plate exactly inclined at **45^0** with the plane of lens.
- ❖ Beware of the **Backlash** error.
- ❖ Discard the **first three rings** and then consider the fourth ring as you first experimental ring.
- ❖ The fringes must be focused on the cross wire by the no-parallax method.

VIVA - VOCE :

1. What is the interference phenomenon?
2. Can two Independent sources produce Interference phenomenon?
3. What are coherent sources?
4. Give the conditions for getting interference phenomenon?
5. What are the different types of interference phenomenon?
6. What are Newton's Rings?
7. How are these rings formed?
8. Why are these rings circular?
9. If the fringes are not exactly circular what do you infer?
10. Why do we use the plano-convex lens of large focal length?
11. Why do the rings get closer as the order of the rings increases?
12. Why is the 45^0 plate employed?
13. How this system produces bright centre?
14. What will happen if the film is illuminated by white light instead of yellow (sodium) light?
15. In that case, which colour will you come across first near the centre?

— 0 — 0 — 0 —

Exp. No. .... Date: ....

Spring Constant

Aim: To determine the Spring Constant in Series and Parallel combination.

Apparatus: Spring, Scale, Rigid Stand, Slotted Weights etc..

Principle: The

Formula:

1. Spring Constant $k = \frac{F}{x}$ in Nm^{-1}

   Where, F = Force Applied (= mg) in N.

   x = Displacement Produced in spring in m.

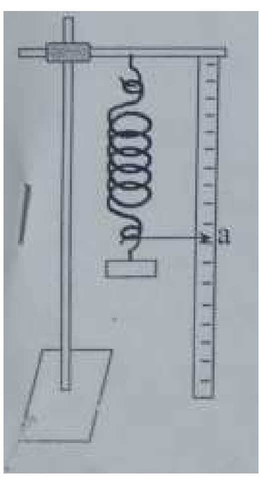
2. Spring Constant for Series combination of Springs

$$k_{series} = \frac{k_1 k_2}{k_1 + k_2} \text{ in } Nm^{-1}$$

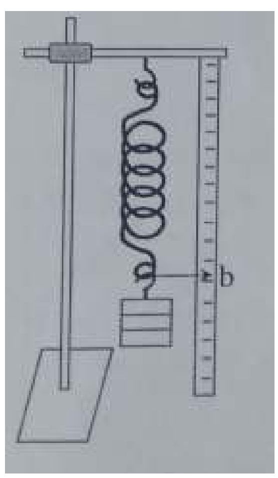
3. Spring Constant for Parallel combination of Springs

$$k_{parallel} = k_1 + k_2 \text{ in } Nm^{-1}$$

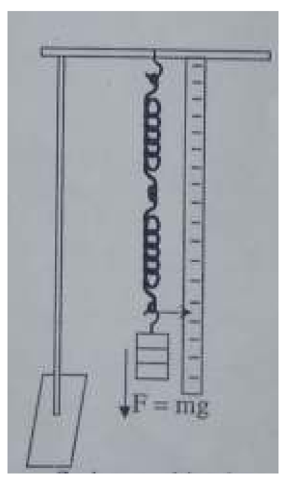
Diagram:



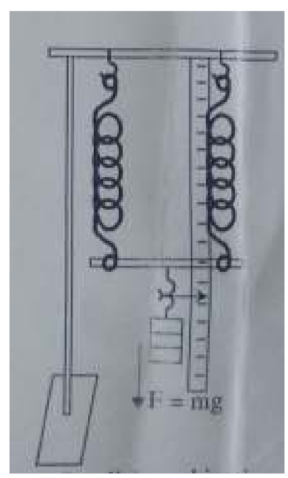
With initial load



With load



Series combination



Parallel combination

Procedure

- Hang the spring 1 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 the 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 value 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	Load in gm (W+m)	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 (W+m)	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 (W+m)	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, $k_{series} = \frac{k_1 k_2}{k_1 + k_2}$ in Nm^{-1}

To verify Parallel combination of springs

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

Trial No.	Load in gm (W+m)	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	$k_{Parallel}$ =	$k_{Parallel}$ =

Signature of the Teacher　　　　Marks Obtained:…….

Date:

CALCULATION :

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Exp. No. Date:

TORSIONAL PENDULUM

AIM: To determine the rigidity modulus of the material of the given wire and moment of inertia of an irregular bodies about an axis perpendicular / parallel (along) to its plane using torsion pendulum

APPARATUS: Regular bodies (consider circular & rectangular plates) chuck-nut arrangements to clamp the wire, stop dock, pointer and an irregular body (consider triangle / pentagon plates), thread, meter scale

PRINCIPLE: A rigid body suspended from one end of a wire whose other end is fixed to the rigid support is called a torsional pendulum The rigid body (rod or disc) is turned in its own plane to twist the wire, so that, on being released, it executes torsional oscillation about the wire as axis The angular acceleration of the disc is proportional to its angular displacement, and, therefore, its motion is simple harmonic.

Hence its time period is given by, $T = 2\pi\sqrt{\frac{I}{C}}$

therefore, $$C = 4\pi^2\left(\frac{I}{T^2}\right)_{mean}$$

where, C is the couple per unit twist given by $c = \frac{\pi\eta(r^4)}{2l}$ for wire.

FORMULA:

Rigidity modulus of the material of the wire is given by,

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

Where, 'η' is the rigidity modulus of the material in N/m^2,

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

l is the length of the pendulum in m,

I is the moment of inertia in Kgm^2,

T is the time period of oscillation in s,

$\left(\frac{I}{T^2}\right)_{mean}$ is the average value of regular bodies.

Moment of Inertia of the irregular body about an axis perpendicular to its plane is given by,

2 $$I_1 = T_1^2\left(\frac{I}{T^2}\right)_{mean} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \text{ Kgm}^2$$

Where,

I_1 is the moment of Inertia of the irregular body m Kgm^2,

T_1 is the time period of oscillation in s.

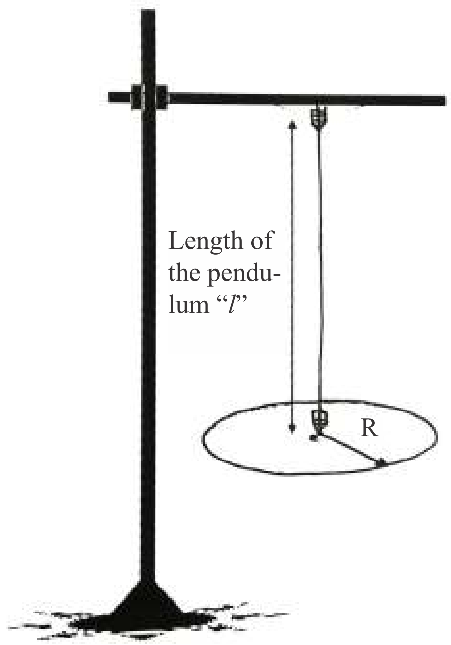
Moment of Inertia of the irregular body about an axis parallel to its plane is given by,

3. $$I_2 = T_2^2\left(\frac{I}{T^2}\right)_{mean} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \text{ Kgm}^2$$

I_2 is the moment of Inertia of the irregular body in Kgm^2

T_2 is the time period of oscillation in s.

DIAGRAM



TORSIONAL PENDULUM

PROCEDURE:

- ❖ The length of the torsion pendulum wire (!) is measured and the radius (r) of the given wire is noted.
- ❖ Mass (M) and Radius (R) of circular plate as well as Mags (M), (L) & (B) of the rectangular plate are measured in SI units and tabulated.
- ❖ Regular body (say circular) is fixed to the pendulum using the chuck-nut arrangement.
- ❖ A pointer is mounted vertically in front of the reference line when the plate is at rest.
- ❖ The circular plate is slightly rotated in the horizontal plane and let free to execute torsional oscillations.

- Time for 10 oscillations is determined for two trails and period T is calculated.
- The procedure is repeated for different axis of rotations for all the bodies. (circular/rectangular/irregular plates) and period T is tabulated for each case
- Calculate the moment of inertia corresponding to foe axis of rotation of regular bodies.
- Determine the $\left(\frac{I}{T^2}\right)_{mean}$ of the regular bodies.
- Calculate rigidity modulus of the given material (η) using formula 1.
- Calculate moment of inertia of the irregular body (I_1 and I_2) using formula 2 and 3.

RESULT

1. Rigidity modulus of the material of the given wire is found to be

   η = ________________________________ N/m^2

2. Moment of Inertia of the irregular body about an axis perpendicular to its plane is found to be

   I_1= ________________________________ Kgm^2

3. Moment of Inertia of the irregular body about an axis parallel to its plane is found to be

   I_2= ________________________________ Kgm^2

Signature of the Teacher **Marks Obtained**

Date:

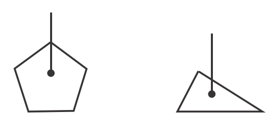
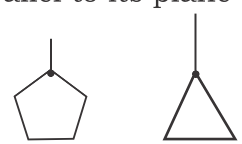
DETERMINATION OF (I/T^2) OF REGULAR BODIES

Regular Body	Axis of rotation / MI Formula	Time for 10 oscillations T_1 (s)	T_2 (s)	Mean 't' (s)	Period $T = t/10$ (s)	T^2 (s^2)	Moment of inertia I (Kgm^2)	$\left(\frac{I}{T^2}\right)$ (Kgm^2/s^2)
Rectangular Plane m= Kg	Perpendicular to its plane $\frac{M(L^2+B^2)}{12}$							
L = M B = m	Perpendicular to its length $\frac{ML^2}{12}$							
	Perpendicular to its breadth $\frac{MB^2}{12}$							
Circular plane M= Kg	Perpendicular to its plane $\frac{MR^2}{2}$							
R= m *(C = 2πR)	Parallel to plane $\frac{MR^2}{4}$							

Length of the wire, l =

$\left(\frac{I}{T^2}\right)_{mean}$ = ______________ Kgm^2/s^2

DETERMINATION OF (T^2) OF IRREGULAR BODIES

Irregular Body	Axis of rotation / MI Formula	Time for 10 oscillations			Period $T = t/10$ (s)	T^2 (s^2)
		T_1 (s)	T_2 (s)	Mean 't' (s)		
Triangular or Pentagon	Perpendicular to its plane 				T_1	T_1^2
	Parallel to its plane 				T_2	T_2^2

CALCULATION :

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NOTE :

- ❖ Determine the radius of the circular disc using **Circumference = 2πr.**
- ❖ Care should be taken while **winding or unwinding** the bodies. (It should be removed from the clamp and then wound or unwound).
- ❖ Use the **lower chuck** nut to give Oscillations.
- ❖ Determine the **radius** of the specimen wire carefully with accuracy upto third decimal place.
- ❖ Experimental wire should be fairly long, thin and uniform.
- ❖ Radius of the wire should be measured carefully, because any error in this may result uncorrect result as it occurs in fourth power.
- ❖ Do not twist the wire beyond its elastic limit.
- ❖ Support must be rigid, on which the wire the regular and irregular bodies are suspended.

VIVA - VOCE

1. How do you distinguish between translatory and rotatory motion?
2. What do mean by inertia of a body? On what factor does it depend?
3. What is moment of inertia of a body? What is its physical significance?
4. Why is it called moment of inertia? Upon what factors does this depend?
5. What do you mean by radius of gyration? On what factor does it depend?
6. When is the moment of inertia of a body minimum?
7. Is moment of inertia a vector or a scalar quantity?
8. Should the amplitude of Oscillation be small in this case also, as in the case of simple pendulum?
9. What is the expression for time period of Oscillation? Upon what factors does it depend?
10. What type of suspension wire will you chose for this experiment and why?
11. Explain what do you mean by elasticity and its limit.
12. Define rigidity modulus.
13. State Hooke's Law.

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Exp No. : Date :

TRANSISTOR CHARACTERISTICS

AIM : To draw the characteristics for a transistor in common emitter mode and hence to determine the input impedance R_i, output impedance R_0, current gain β, and hence α.

APPARATUS : Transistor (BC107, SL100), DC Dual power supply (0-10 volts), DC Milliammeter, DC Microammeter, DC Voltmeter, Resistor (33K), etc.

PRINCIPLE : In a transistor; the emitter - base junction of a transistor is forward biased, and the base - collector junction is reverse biased so that the collector collects the electrons emitted from the emitter and the base current controls the collector current. By measuring the change in collector current due to small change in base current at constant collector - emitter potential, the input impedance R_i, output impedance R_0, current gain β, and hence α can be calculated.

FORMULA : 1. The input impedance of the transistor is given by

$$\text{Slope} = \frac{AB}{BC}$$

$$R_i = \frac{V_i}{I_i} = \frac{\Delta V_{BE}}{\Delta I_B} = \frac{1}{\text{Slope}} \quad \Omega$$

where,

R_i = Input impedance in Ω

V_i = Input Voltage in V

I_i = Input current in A

ΔV_{BE} = Change in emitter to base voltage in V.

ΔI_B = Change in base current in A.

2. The output impedance of the transistor is given by

$$\text{Slope} = \frac{AB}{BC}$$

$$R_0 = \frac{V_0}{I_0} = \frac{\Delta V_{CE}}{\Delta I_C} = \frac{1}{\text{Slope}} \quad \Omega$$

where,

R_0 = Output impedance in Ω

V_0 = Output Voltage in V

I_0 = Output current in A

ΔV_{CE} = Change in emitter to collector voltage in V.

ΔI_C = Change in collector current in A.

3. The current gain in CE mode is β

$$\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$$

where,

$\Delta I_C = I_{C2} - I_{C1}$ in mA

$\Delta I_B = I_{B2} - I_{B1}$ in μA

4. The current gain in CB mode is α

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

where,

β = Current gain in CE mode.

α = Current gain in CB mode

DIAGRAM:

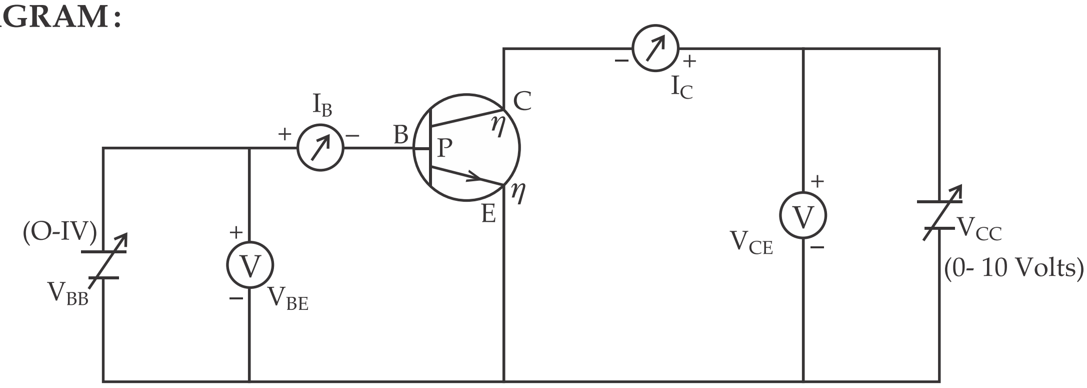


Fig. 1

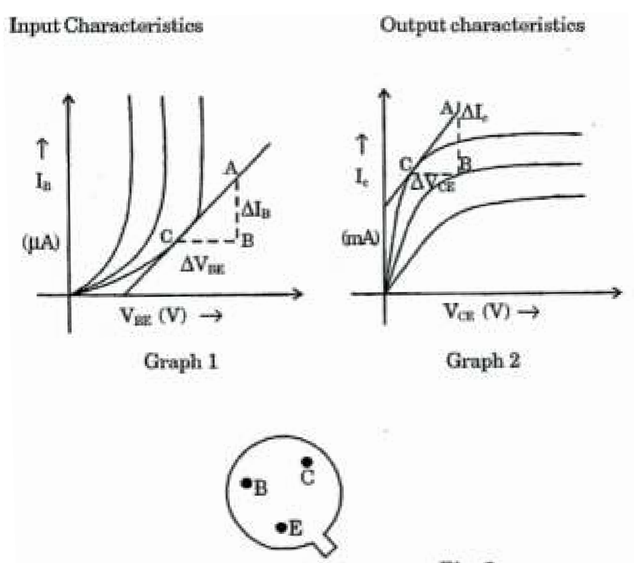
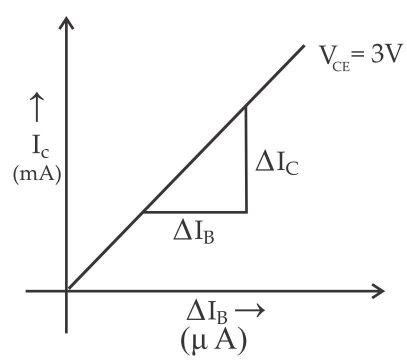


Fig. 2

Transfer Characteristics



Graph - 3

PROCEDURE :

- ❖ Circuit connections are made as shown in figure 1.
- ❖ V_{CE} is kept constant. (say 2V) and V_{BE} is varied in steps of 0.05 volt and I_B is noted. [The experiment can be repeated for different values of V_{CE} (5V, 10V)].
- ❖ A graph (1) is plotted taking I_B reading along Y axis and V_{BE} readings along X-axis.
- ❖ Input impedance R_i is determined by calculating the value of slope from graph (1).
- ❖ Keeping I_B a constant (Say 20 μA) V_{CE} is varied in steps of 0.5V and I_C is noted. [The experiment can be repeated for different values of I_B (repeat for 40 μA)].
- ❖ A graph (2) is plotted taking values of I_C along Y-axis and V_{CE} along X-axis.
- ❖ Output impedance R_0 is determined by calculating the value of slope, from graph (2).
- ❖ Current Gain β is determined by using the formula (3)
- ❖ α is calculated using the formula (4).
- ❖ For transfer characteristics, we keep V_{CE} at 3V and vary I_B in steps of 10μA and note the corresponding value of I_C. Make a plot of I_C Vs I_B as shown in Graph - 3. The current gain 'β' is found by calculating the slope of the straight line.
- ❖ Observations and results are tabulated.

RESULTS :

The input characteristics, output characteristics and transfer characteristics of transistor in common Emitter mode are drawn

The input impedance R_i in CE mode = ____________________ Ω.

The output impedance R_0 in CE mode = ____________________ Ω.

Current Gain β in CE mode = ____________________.

Current Gain α in CB mode = ____________________.

Signature of the Teacher :   Marks Obtained : | | |

Date :

OBSERVATIONS AND CALCULATIONS

INPUT CHARACTERISTICS

Trial No.	V_{CE} = ______________ V		V_{CE} = ______________ V	
	V_{BE} (V)	I_B (μA)	V_{BE} (V)	I_B (μA)
1.	0.00		0.00	
2.	0.05		0.05	
3.	0.10		0.10	
4.	0.15		0.15	
5.	0.20		0.20	
6.	0.25		0.25	
7.	0.30		0.30	
8.	0.35		0.35	
9.	0.40		0.40	
10.	0.45		0.45	
11.	0.50		0.50	
12.	0.55		0.55	
13.	0.60		0.60	
14.	0.65		0.65	
15.	0.70		0.70	
16.	0.75		0.75	
17.	0.80		0.80	
18.	0.85		0.85	

OUTPUT CHARACTERISTICS

Trial No.	I_B = ________________ μA		I_B = ________________ μA	
	V_{CE} (V)	I_C (mA)	V_{CE} (V)	I_C (mA)
1.	0.0			
2.	0.5			
3.	1.0			
4.	1.5			
5.	2.0			
6.	2.5			
7.	3.0			
8.	3.5			
9.	4.0			
10.	4.5			
11.	5.0			

TRANSFER CHARACTERISTICS

Trial No.	V_{CE} = 3V	
	I_B (μA)	I_C (mA)
1	0	
2	10	
3	20	
4	30	
5	40	
6	50	
7	60	
8	70	
9	80	
10	90	

CALCULATION :

CALCULATION :

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CALCULATION :

NOTE :

- ❖ Circuit connections are made properly.
- ❖ Care should be taken to keep the input current properly since it is of small magnitude.
- ❖ Current limiting resistor at base should be of high value.
- ❖ Identify the terminals of transistor carefully.
- ❖ Biasing should be done properly.
- ❖ Handle the leads of the devices with care.

VIVA - VOCE

1. What do you mean by biasing?
2. What is a transistor and how many types are there?
3. What are the three terminals of a transistor called and explain their function. How do you identify them?
4. What are the comparative differences in doping concentration between the emitter, base and the collector terminals of a transistor?
5. Define current amplification of a transistor.
6. What does the arrow in the transistor symbol represent?
7. What are three basic transistor connection modes?
8. Why should the base be very thin and very lightly doped?
9. What happens if both the transistor junctions are reverse biased?
10. State at least two fundamental differences between a diode and a transistor.
11. Why is CE mode preferred over any other mode?
12. What are the applications of a transistor?

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Experiment No. ....   Date: ....

Magnetic Field along the axis of a coil

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

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

Principle:

Formula:

$$B = \frac{\mu_0 n l}{2} \frac{a^2}{(a^2 + x^2)^{3/2}} = T$$

Where:

B = the magnetic field intensity at the centre of a circular coil in Telsa T.

n = number of turns in the TG coil.

a = radius of the coil in meter m.

x = distance between the centre of the coil and pointer in compass box in meter m.

I = the current through the coil in ampeare A.

μ_0 = Permeability of free space = $4\pi \times 10^{-7} Hm^{-1}$

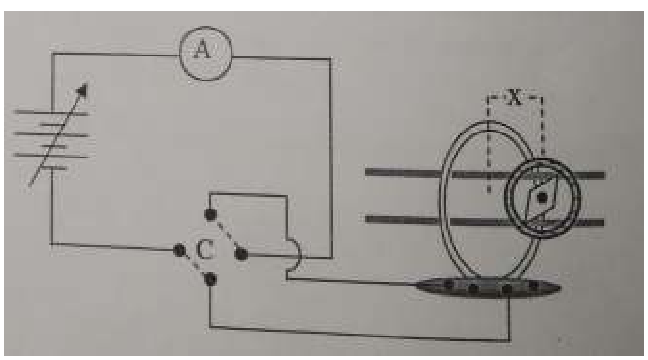
$$B_H = \frac{B}{\tan\theta} = T$$

Where:

B_H = horizontal component of earth's magnetic field

θ = mean deflection in TG.

Circuit Diagram



Procedure:

1. The connections are made as shown in the circuit diagram.
2. Arrange the deflection of the magnetometer in the magnetic meridian of the earth

3. Now align the plane of the coil with respect to 90°-90° line of the magnetometer.
4. Keep the magnetometer exactly at the centre of the coil (for this case x = 0).
5. Pass a current I (say 0.2A) to flow through the coil and the corresponding magnetometer deflections θ_1 and θ_2 are noted after the needle comes to stand still.
6. The direction of the current is reversed by using the commutator C and the corresponding magnetometer deflections θ_3 and θ_4 are noted.
7. Average deflection θ is calculated.
8. Calculate the magnetic field at the centre of the coil by using the given formula $B = \frac{\mu_0 n l}{2} \frac{a^2}{(a^2 + x^2)^{3/2}}$ and also B_H.
9. Repeat the experiment for different values of x (say 5cm, 10cm, ...) by sliding the magnetometer along the axis.
10. Find the average of both B and B_H.

Radius of the coil = a = 8.2 cm, n= 50 turns, I = 0.2 A

Tabular Column:

Sl. No.	Current I in A	X in cm	Deflections in degrees				Average θ in degree	B in $\times 10^{-5}$T	$B_H = \frac{B}{\tan\theta}$ ($\times 10^{-6}$ T)
			θ_1	θ_2	θ_3	θ_4			
1.	0.2	0							
2.		5							
3.		10							
4.		15							

Mean value of B_H = ………………

Result:

The Earth's horizontal magnetic field by deflection method is found to be

B_H = ……………… T

Signature of the Teacher Marks obtained: ……

Date:

CALCULATION :

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Experiment No. .... Date: ....

Single Cantilever

AIM: To determine the young's modulus of the material of the given bar (meter scale) by using a meter scale.

APPARATUS: Uniform meter scale (rectangular steel beam with pointer pin), clamp, scale K pan, weights, travelling microscope, lamp etc.

PRINCIPLE: A cantilever is a horizontal beam, one end of which is clamped rigidly and the other end is loaded. Under the action of the load at the free end and the reaction at the clamped end, a couple is developed which bends the beam. The internal bending moment is equal and opposite to the external couple and the restoring force is proportional to the depression at the loaded end. By measuring the depression for various loads the young's modulus is determined.

FORMULA:

Young's modulus (Y) of the material of the wire is given by,

$$Y = \frac{4mgl^3}{bd^3\delta} = \text{......................} \; N/m^2$$

Where,

Y is the young's modulus of the material in N/m^2,

m is the load in kg,

g is the acceleration due to gravity m/s^2

1 is the length of the cantilever in m,

b is the breadth of the cantilever in m,

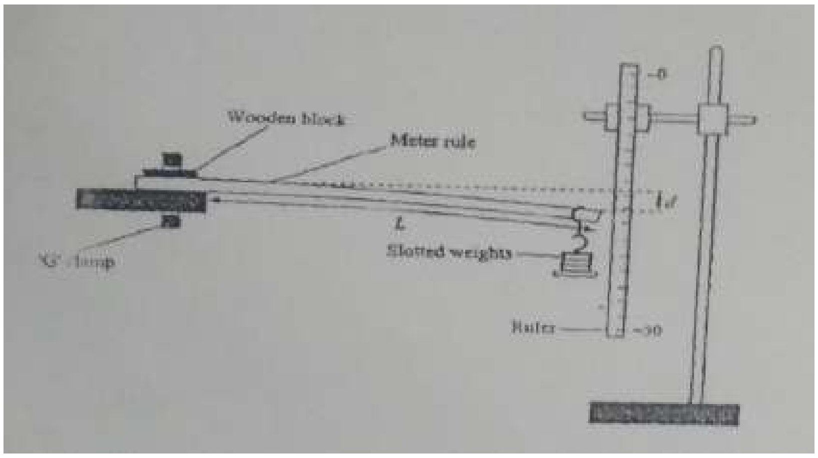
d is the thickness of the cantilever in m,

δ is the depression produced due to load in m

Least Count of travelling microscope:

$$LC = \frac{\text{Value of 1 MSD}}{\text{Total Number of VSD}} = \text{.................cm}$$

Diagram



PROCEDURE:

- ❖ The length of the cantilever is measured, breadth and thickness of the cantilever is noted,
- ❖ One end of the scale is clamped rigidly to table and the other end at the length '1' a pin is fixed vertically and weight hanger is fixed at this point.
- ❖ The travelling microscope is adjusted so that the tip of pin coincides with the crosswire.
- ❖ With no load in the hanger, the travelling microscope is focused on the pin and the reading is noted.
- ❖ Increase the load in hanger in steps of 20g (say W +0 g to W + 100 g) and note down the corresponding reading.
- ❖ Decrease the load in hanger in steps of 20 g (say W + 100 g to W + 0 g) and note down the corresponding reading.
- ❖ The mean depression 'δ' for a definite load 'm' is determined.
- ❖ Calculate the young's modulus 'Y' using formula 1.

RESULT:

Young's modulus 'Y' of the material of the given beam is found to be

Y =_______N/m^2

Signature of Teacher　　　　　　　　　　Marks Obtained ....

Date:

OBSERVATIONS AND CALCULATIONS:

Tabular Column to find Depression (δ)

Least Count of Travelling Microscope $LC = \frac{Value\ of\ 1\ MSD}{Total\ Number\ of\ VSD} = ...cm$

Load in Scale Pan gram	Load increasing			Load decreasing			Mean R_1 cm	Load in scale Pan gram	Load increasing			Load decreasing			Mean R_2 cm	Depression $R_1 \sim R_2$ cm
	MSR cm	CVD	TR cm	MSR cm	CVD	TR cm			MSR cm	CVD	TR cm	MSR cm	CVD	TR cm		
W + 0								W + 60								
W + 20								W + 80								
W + 40								W + 100								

Mean depression in 'δ' = ... m

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

NOTE :

- ❖ Once the setup is done you are not supposed to **disturb** the apparatus.
- ❖ Focussing the **pin tip** should be as clear as possible.
- ❖ At each **loading and unloading** of the beam, the weights must be added and removed gently to avoid Oscillations.
- ❖ **Breadth, length and thickness** should be measured accurately.

VIVA - VOCE

1. What do you understand by elasticity?
2. What do you mean by limit of elasticity?
3. What do you mean by stress and strain? What are their units and dimensions?
4. How many types of strains are there? How are they produced?
5. How many types of stress are there? How will you produce them?
6. What is the difference between stress and pressure?
7. What is modulus of elasticity?
8. Define different types of modulus of elasticity with their units.
9. What is the effect of temperature, drawing hammering, annealing and impurity on elastic moduli of a metal?
10. Give one example for material whose elasticity increases with decrease of temperature.
11. What is the practical use of the knowledge of elastic moduli?
12. What do you mean by neutral surface, neutral axis bending moment?
13. Do all the filaments other then those lying in the neutral surface suffer equal cha
14. Does the weight of the beam not contribute to the depression at the center? If yes, why have you not taken into account?
15. Instead of keeping the breadth of the beam horizontal can you keep it vertical? What is the practical use of this information?
16. Which of the quantities 'b' or'd' should be measured more accurately and why?
17. What type of beam will you select for your experiment and why?
18. Why do you load and unload the beam in small steps and gently?
19. How will you determine the rigidity of fluids?

- 0 - 0 - 0 -

CALCULATION :

Exp No. : Date :

LASER DIFFRACTION

AIM : To Determine the wavelength (λ) of the given laser source using diffraction grating.

APPARATUS : Laser source, grating, screen with graph paper, etc.

PRINCIPLE : Diffraction is the bending of light waves after they pass through small openings (or around the small obstacles). The diffraction of light wave is possible only when the size of the obstacle is of the order of wavelength of incident light i.e. $\lambda \approx d$. The diffraction pattern consists of variation of intensity of the image being formed.

FORMULA : The condition for maximum intensity is

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

i.e.,
$$\lambda = \frac{d \sin\theta}{n} \text{ m}$$

where n is order of spectrum.

λ is wavelength of laser light in metres

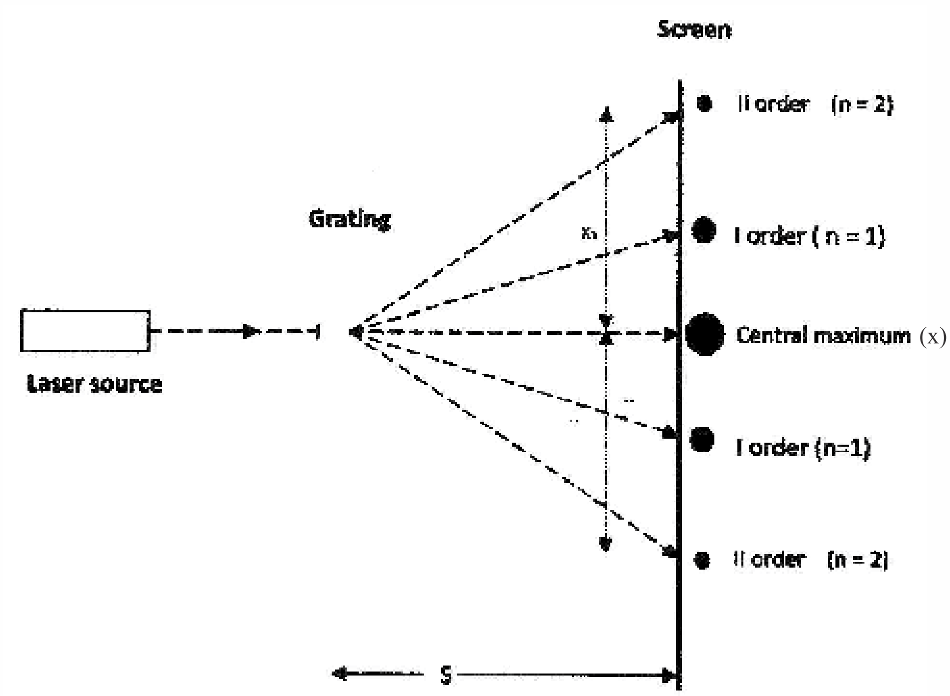
d = grating constant in m

θ = angle of diffraction in deg.

PROCEDURE :

1. Arrange the experiment set up as shown in the figure, such that the laser source, grating and screen are in the same line.
2. Keep the distance between the screen and grating as 50 cm (s).
3. Note the diffraction pattern obtained on the screen, in a graph sheet.
4. Mark the centre bright spot as X.
5. Measure the distance between the first pair of spots (n=1) from the centre spot and tabulate.
6. Similarly distance between the 2nd order, 3rd order, 4th order & 5th order spots are noted down.
7. λ is calculated using the formula.
8. Average value of λ is calculated and the result is obtained.

RAY DIAGRAM :



TABULAR COLUMN : d = $1X10^{-5}$ m; s = 50 cm

Order n	$2X_n$ in cm	X_n in cm	Sin $\theta_n = X_n$ / S
1			
2			
3			
4			
5			

$$\lambda n = \frac{d \sin\theta_n}{n} m$$

RESULTS :

The wavelength of the given laser source = ________________ m

Signature of the Teacher :

Marks Obtained :

Date :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

Exp No. : Date :

PHOTO DIODE CHARACTERISTICS

AIM : To study the V-I characteristics of a photo diode in reverse bias and the variation of the photo current as a function of reverse voltage and intensity.

APPARATUS : Photodiode, (0-20v) Power supply, voltmeter, ammeter, light source, resistance (1KΩ) and patch cards.

PRINCIPLE : A photodiode is a p-n junction diode, in which the reverse saturation current increases when it is illuminated with light. When a p-n junction is reversing biased, practically it does not conduct. However small current flows through the circuit due to the minority carriers in p and n regions. It is called dark current. When a light of suitable intensity is incident on the junction; the light photons bombard the junction and produce electron-hole pair. The current through the circuit increases. The strength of the current increases with the increase in the intensity of light.

FORMULA

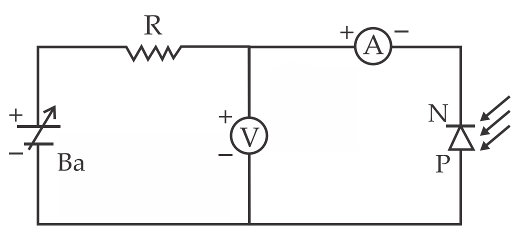
$$E_V = \frac{\phi_V}{d^2} = \_\_\_\_\_\_\_\_\_\_\_\_ \text{ lux}$$

E_V = Illumination in Lux (or lx)

ϕ_V= Luminious flux in Lumen (lm)

D = Distance between the light source and photo diode in meter (m)

CIRCUIT DIAGRAM



Where,

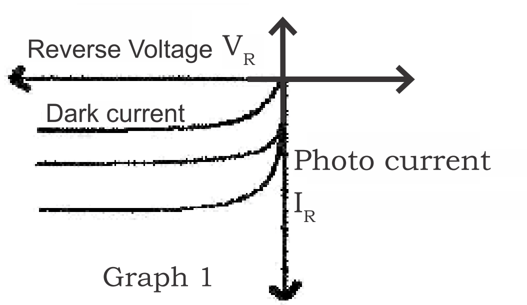
R is the Resistor

Ba is the DC Power supply

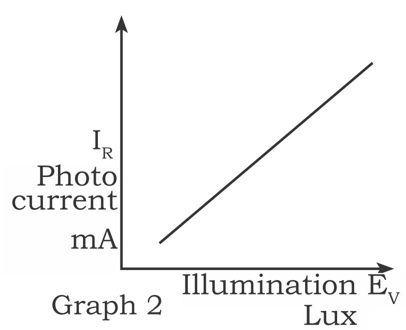
V is the Digital voltmeter and

A is the Digital current meter

GRAPH : V-I CHARACTERISTICS IN REVERSE BIAS



Graph 1



Graph 2

PROCEDURE :

1. The circuit connections are made as shown in the figure.
2. Increase the voltage (V_R) in terms of 0.5, till 4.5 V and note down the current reading (darkcurrent).
3. Now illuminate the junction diode by light from the source, maintaining at a constant intensity.
4. Vary the voltage in terms of 0.5 1V till 4.5 V and note down the current reading.
5. For constant intensities, vary the distance of the source from the diode and note down the current.
6. Plot a graph of voltage v/s current across the device as shown in the figure, and also plot the graph of E_V v/s I_R

OBSERVATIONS :

V-I Characteristics in Reverse Bias

Sl No.	Reverse Voltage V_R in (V)	Dark Current (without illumination) I_R (mA)	Photo Current (with illumination) I_R (mA)
1	0		
2	0.5		
3	1.0		
4	1.5		
5	2.0		
6	2.5		
7	3.0		
8	3.5		
9	4.0		
10	4.5		

VARIATION OF PHOTO CURRENT WITH ILLUMINANCE

$\phi_V \backsimeq$ 40 lumen for white LED, $V_R = 5V$

Sl. No.	Position	Distance d $\times 10^{-2}$m	Distance d^2 m^2	Illuminance E_V Lux	Photo current I_R (mA)
1.	First	2			
2.	Second	4			
3.	Third	6			
4.	Fourth	8			
5.	Fifth	10			
6.	Sixth	12			
7.	Seventh	14			
8.	Eight	16			
9.	Nineth	18			
10.	Tenth	20			

CALCULATION :

RESULT/INFERENCE

1. The V-I characteristics of Photo diode is studied.
2. It is observed that Photo current (I_R) is independent of reverse voltage (V_R)
3. It is observed that Photo current (I_R)is a function of Illuminane and $I_R \propto E_V$

Signature of the Teacher **Marks Obtained**

Date:

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

CALCULATION :

Experiment No. ....   Date: ....

Optical Fiber

AIM: To determine the angle of acceptance and the numerical aperture of the given optical fiber.

APPARATUS: One meter length Single strand plastic optical fiber (POF) of different core diameter, Laser source, Screen, Meter scale etc.

PRINCIPLE: Optical fibers are light guides used in optical communication as wave guides. They are made of transparent dielectric materials like glass or plastic. An optical fiber is made of two parts. One is the inner cylindrical material made of glass or plastic called core and the other is called cladding which envelopes the core. Cladding is made of same material as that of core but with lesser refractive index. The principle mainly involved in optical guide is total internal reflection. Numerical aperture represents the light gathering capacity of an optical fiber.

FORMULA:

Acceptance angle of the optical fiber is given by,

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

Where,

θ_0 is the acceptance angle of the optical fiber in degree

D is the diameter of the bright spot in cm

L is the distance from the optical fiber end to the screen in cm

Numerical Aperture of the optical fiber is given by,

2. NA = $n_0 \sin \theta_0$ = ...

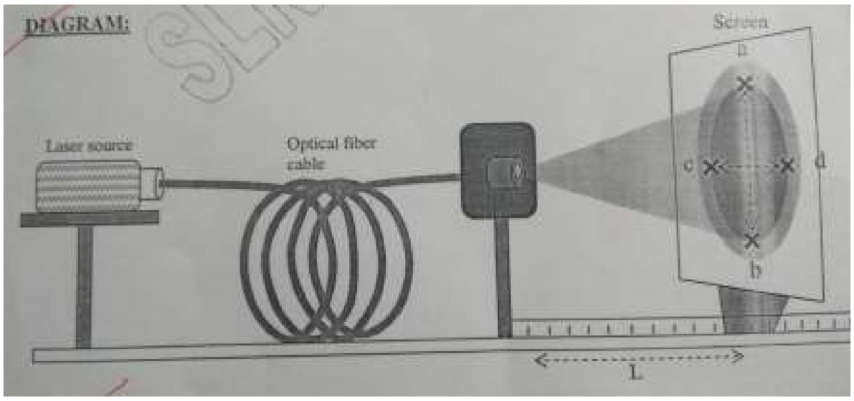
Where,

NA is the numerical aperture

n_0 is the refractive index of the medium from which light is entering (n_0 = 1 for air)

θ_0 is the acceptance angle of the optical fiber in degree

Diagram



Procedure:

- ❖ Switch on the laser source and adjust the distance between output end of the optical fiber and the screen L (say 5 cms).
- ❖ Place a graph sheet on the screen and observe the circle formed on the graph sheet.
- ❖ Mark the points 'a', 'b', 'c', and '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 (4 cms, 3 cms....)
- ❖ 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 θ_0
1.						
2.						
3.						
4						

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

Result:

The angle of acceptance and Numerical aperture of the given optical fiber are found to be

θ_0 = ... NA = ...

Signature of the teacher: Marks Obtained

Date

CALCULATION :

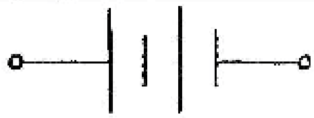
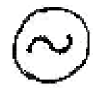
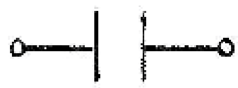
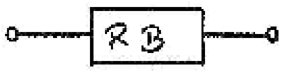
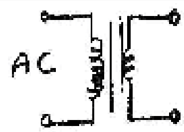
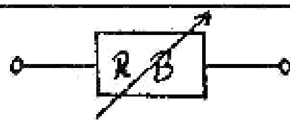
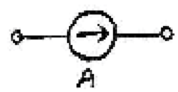
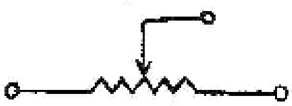
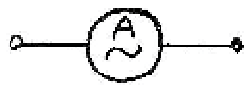
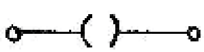
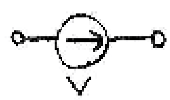
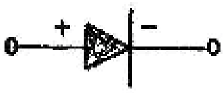
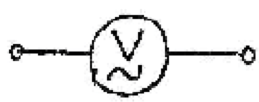
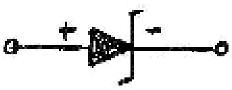
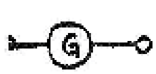
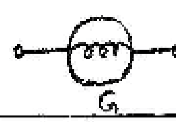
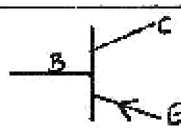
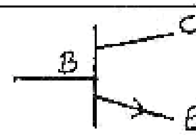
CALCULATION :

CALCULATION :

CALCULATION :

APPENDIX - I

SYMBOL FOR ELECTRICAL AND ELECTRONIC DEVICES

Name	Symbol of the Device	Name	Symbol of the Device
DC Battery		Oscillator	
Resistor		Inductor	
Variable Resistor		Capacitor	
Standard Resistance Box		Transformer	
Variable Resistance Box		Ammeter DC	 
Rheostat		Ammeter AC	
Plug Key	 Closed  Open	Voltmeter DC	 
Diode		Voltmeter AC	
Zener Diode		Galvanometer	 
Transistor (PNP)		Transistor (NPN)	

APPENDIX - II

Least Count Calculations

1) Diffraction Grating

$$\text{Least count of the spectrometer} = \frac{\text{Value of 1 MSD}}{\text{Total No. of VSD}}$$

$$= \frac{30'}{30} = 1 \text{ min}$$

2) Young's Modulus

a) $$\text{L.C. of Vernier caliper} = \frac{\text{Value of 1 MSD}}{\text{Total No. of VSD}} = \frac{0.1 \text{ cm}}{10} = 0.01 \text{ cm}$$

b) $$\text{L.C. of Screw gauge} = \frac{\text{Pitch}}{\text{Total No. of divisions on Head Scale}}$$

$$= \frac{1 \text{ mm}}{100} = 0.01 \text{ mm}$$

$$\text{Pitch} = \frac{\text{Distance moved on Pitch scale}}{\text{No. of rotations given}} = \frac{5 \text{ mm}}{5} = 1 \text{ mm}$$

c) $$\text{L.C. of Travelling Microscope} = \frac{\text{Value of 1 MSD}}{\text{Total No. of VSD}}$$

$$= \frac{0.05 \text{ cm}}{50} = 0.001 \text{ cm}$$

3) Newton's Rings

$$\text{L.C. of Travelling Microscope} = \frac{\text{Pitch}}{\text{Total No. of divisions on Head Scale}}$$

$$= \frac{1 \text{ mm}}{100} = 0.01 \text{ mm}$$

$$\text{Pitch} = \frac{\text{Distance moved on Pitch scale}}{\text{No. of rotations given}} = \frac{5 \text{ mm}}{5} = 1 \text{ mm}$$

NOTES :

NOTES :