PHYSICS LABORATORY MANUAL

FOR

ENGINEERS

FOR FIRST YEAR BE / B.TECH STUDENTS

(AS PER THE REVISED SYLLABUS OF THE ANNA UNIVERSITY EFFECTIVE FROM THE ACADEMIC YEAR 2008 – 2009)

A.IRUTHAYASEELAN, M.S.JAGADEESAN, D.KARUNANITHI, M.JANAKI

Kongunadu College of Engineering and Technology,

Tholurpatti, Thottiam – Tk,

Trichy -621 215

Phone: 04326 290333, 277571, 277572

First edition: July 2010

ENGINEERING PHYSICS LABORATORY

LIST OF EXPERIMENTS

SEMESTER - I

1. (a) Particle size determination using Diode Laser.
   (b) Determination of Laser parameters – Wavelength, and Angle of divergence.
   (c) Determination of Acceptance angle in an Optical Fiber.
2. Determination of thickness of a thin wire – Air wedge method.
3. Determination of velocity of sound and compressibility of liquid – Ultrasonic Interferometer.
4. Determination of wavelength of Mercury spectrum – Spectrometer grating.
5. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
6. Determination of Hysteresis loss in a Ferromagnetic material.

SEMESTER - II

1. Determination of Young's modulus of the material – Non uniform bending.
2. Determination of Band Gap of a semiconductor material.
3. Determination of Specific resistance of a given coil of wire – Carey Foster Bridge.
4. Determination of Viscosity of liquid – Poiseuille's method.
5. Spectrometer Dispersive power of a prism.
6. Determination of Young's modulus of the material – Uniform bending.
7. Torsional pendulum – Determination of Rigidity modulus.

P = 45 Periods

Physics Laboratory classes will be conducted on alternate weeks with 3 periods duration.

Preface

This book physics Laboratory manual for engineers is written as per the latest Anna University pattern syllabus.

The special feature of this book is the theory, formulae and procedural steps involved in all the 13 experiments have been explained in a simple and lucid manner with neat diagrams. This book also serves as an observation manual. The graph sheets, Worksheets are provided with adequate space for all the experiments. At the end the viva voce question are given. The data of physical constant, conversion factors, physical quantities and units are given in the appendices.

This book serves a valuable tool for the students

The author invites suggestions and criticisms on this book

AUTHORS

ACKNOLEDGEMENTS

First of all we wish to thank The Almighty and the authorities of **Kongunadu Educational and Charitable Trust** for their permission, support and encouragement in bringing out this book.

We express our heartful thanks to our honorable chairman, **Mr.R. Periasamy**, Founder and chairman, **Kongunadu Educational and Charitable Trust.**

We express Our sincere thanks to **Mr.K. Thangavelu** Secretary, **Mr.S. Thennarasu** Treasurer, **Mr.P. Arun kumar** Vice chairman, **Mr. P. Ashok kumar** Joint secretary for lending their support to publish this manual book.

We are also thankful to **Dr. D. Louis de'souza**. our college Principal, **Mr.M.S. Kumaravel** Academic Coordinator and **Mr. K. Balasubramanian** HOD S&H and department colleagues.

Our special thanks to **Dr. A Cyrac peter** and **Mr. M. Kumar** help for their consistent to prepare this manual book.

Finally we express our sincere thanks to publishers, printers for printing this book in time.

AUTHORS

List of Experiments

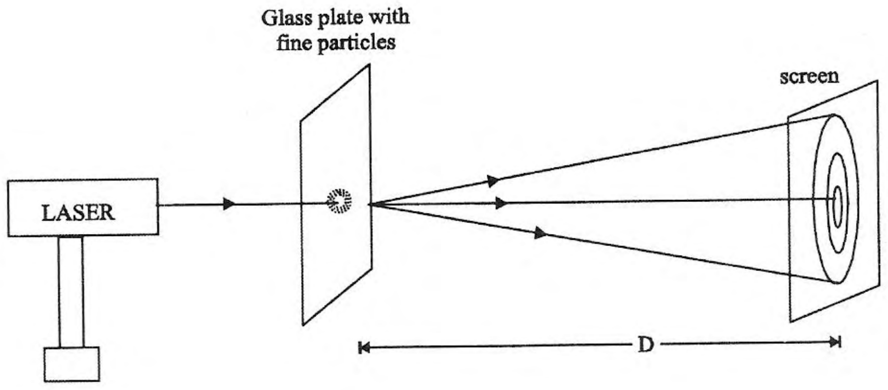
1. (a) Particle size determination using Diode Laser.

   (b) Determination of Laser parameters – Wavelength, and Angle of divergence.

   (c) Determination of Acceptance angle in an Optical Fiber.
2. Determination of thickness of a thin wire – Air wedge method.
3. Determination of velocity of sound and compressibility of liquid – Ultrasonic Interferometer.
4. Determination of wavelength of Mercury spectrum – Spectrometer grating.
5. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
6. Determination of Hysteresis loss in a Ferromagnetic material.
7. Determination of Young's modulus of the material – Non uniform bending.
8. Determination of Band Gap of a semiconductor material.
9. Determination of Specific resistance of a given coil of wire – Carey Foster Bridge.
10. Determination of Viscosity of liquid – Poiseuille's method.
11. Spectrometer Dispersive power of a prism.
12. Determination of Young's modulus of the material – Uniform bending.
13. Torsional pendulum – Determination of Rigidity modulus.

Appendix

1. Measuring Instruments
2. Viva Voce Questions
3. Model Question for Practical Examination
4. Data Physical Constant



Particle size determination by Laser

Determination of size of the particles

Sl.No	Distance between the screen and the glass plate (D)	Order of diffraction n.	Distance between the central bright point and n^{th} fringe (x_n)	Particle size $2d = \frac{n\lambda D}{x_n}$
Unit	cm		cm	cm
1		1		
		2		
		3		
		4		
2		1		
		2		
		3		
		4		

Mean = …………..x10^{-5}m

Exp.No: **Date:**

1. a) PARTICLE SIZE DETERMINATION BY LASER

Aim:

To determine the particle size of the given lycopodium powder using laser diffraction method.

Apparatus required

1.He-Ne laser or semiconductor laser 2.Lycopodium powder
3.Glass plate 4.Screen 5. Metre Scale

Formula

Grain size (diameter) '2d' of the grain

$$2d = \frac{n\lambda D}{x_n} \quad \text{metre}$$

Where

n → Order of diffraction

λ → Wavelength of laser light used in metre

D → Distance between glass plate and the screen in metre

x_n → Distance between central bright spot and the n^{th} fringe in metre

Procedure

The powder of few microns whose size is to be determined is spread over the glass plate. The glass plate is inserted vertically through the path of the laser beam. To get the contrast circular rings on the screen the glass plate is adjusted until clear image is formed. After the ring formation using white paper or trace sheet the circular patterns are marked carefully. The ratio of different order dark rings(x_n) are measured. The distance between the screen and the glass plate is D is measured. Knowing all, the size of particle can be calculated. Using the formula. The particle size can be found different D values.

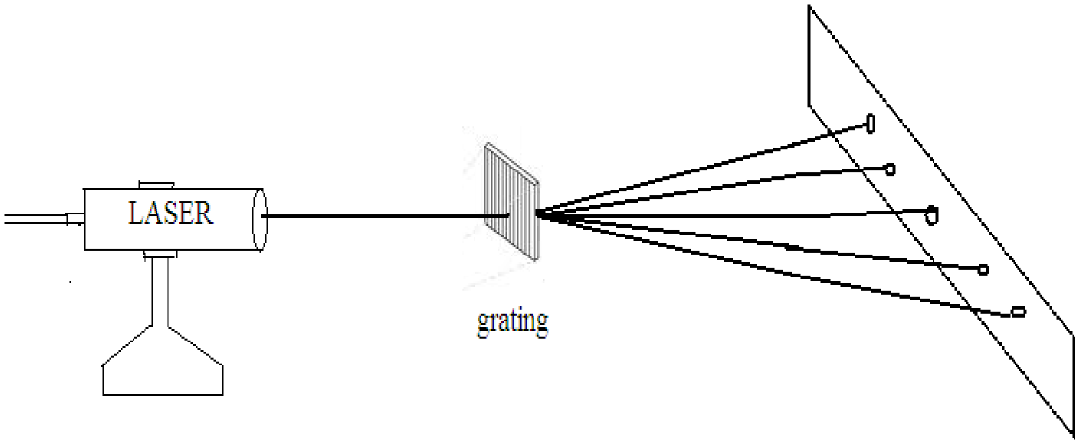
Calculation:

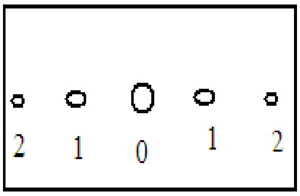
Grain size (diameter) ‘2d’ of the grain

$$2d = \frac{n\lambda D}{x_n} \quad \text{metre}$$

Result

Average size of the particle = …………….x10^{-5}m


LASER
grating


2 1 0 1 2

Exp.No: **Date:**

1. b) Laser – Grating

Aim:

To determine the wave length of the given laser source of light using grating

Apparatus Required;

He – Ne laser (or) Semi conductor, Grating, Screen, Paper& pencil

Formula:

Wave length of the given laser source of light

$$\lambda = \frac{\sin\theta}{Nn} metre$$

Where

θ → Angle of diffraction in degrees

n → Order of diffraction

N → Number of lines in the grating per metres

Procedure:

He-Ne laser or Semiconductor laser is kept horizontally and switched on. The grating is held normal to the laser beam. This is done by adjusting the grating in such way that the reflected laser beam coincides with beam coming out of the laser source.

After adjusting for normal incidence, the laser light is exposed to the grating and it is diffracted by it. On the other side of the grating on the screen, the diffracted laser spots are seen. The distances of different orders from the centre spot (X_n) are measured.

The distance between the grating and screen (D) is measured. Using the formula, 'θ' is calculated. The wave length of the laser light is calculated using the formula

Determination of wave length of laser light –Readings

Distance between grating and laser source (D) = ………………metres

Number of lines in the grating per metres = 15,000 lilnes per inch

(592885 lines per metres).

S. N.	Order of diffraction (n)	Readings for the diffracted image						Mean θ	$\lambda = \frac{\sin\theta}{Nn}$ nm
		Left side			Right side				
		Distance of diff. order from central spot	tanθ =X/D	θ = $\tan^{-1}$x/D	Distance of diff. order from central spot	Tanθ =X/D	θ = $\tan^{-1}$ x/D		
1	1	X_1 =			X_1 =				
2	2	X_2 =			X_2 =				
3	3	X_3 =			X_3 =				
4	4	X_4 =			X_4 =				
5	5	X_5 =			X_5 =				
6	6	X_6 =			X_6 =				

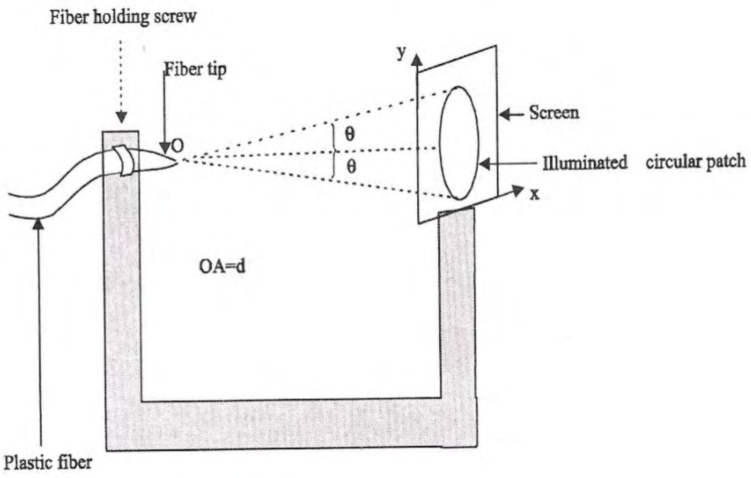
Mean wave length of the given laser light =…………..

Calculation:

$$\lambda = \frac{\sin\theta}{Nn}\,metre$$

Result:

Wave length of the laser the light source = -------------------- m



Numerical Aperture measurements fig

Find the Numerical aperture and acceptance angle

$n_0 =$ Refractive index of air =

S.No.	Distance from the fibre end to circular image 'd'	Radius of the circular image 'r'	Acceptance angle $\theta_a = r/d$	NA = $n_0 \sin\theta_a$
1.				
2.				
3.				
4.				
5.				
6.				

Calculation:

Exp.No: **Date:**

1. c) Determination of Numerical Aperture and Acceptance Angle of an optical fiber

Aim:

To determine the acceptance angle and numerical aperture of an optical fibre.

Apparatus required:

Laser light source, Laser power mater, Optical fibre cables of various length, Optical fibre connectors, Numerical aperture jig, Mandrel for optical fibre.

Formula;

Numerical aperture: $NA = n_0 \sin\theta_a$

Acceptance angle $\theta = r/d$

Where n_0 → Refractive index of air

θ_a → Acceptance angle in radian

r → Radius of the circular image in metre

d → Distance from the fibre end to circular image in metre

Procedure:

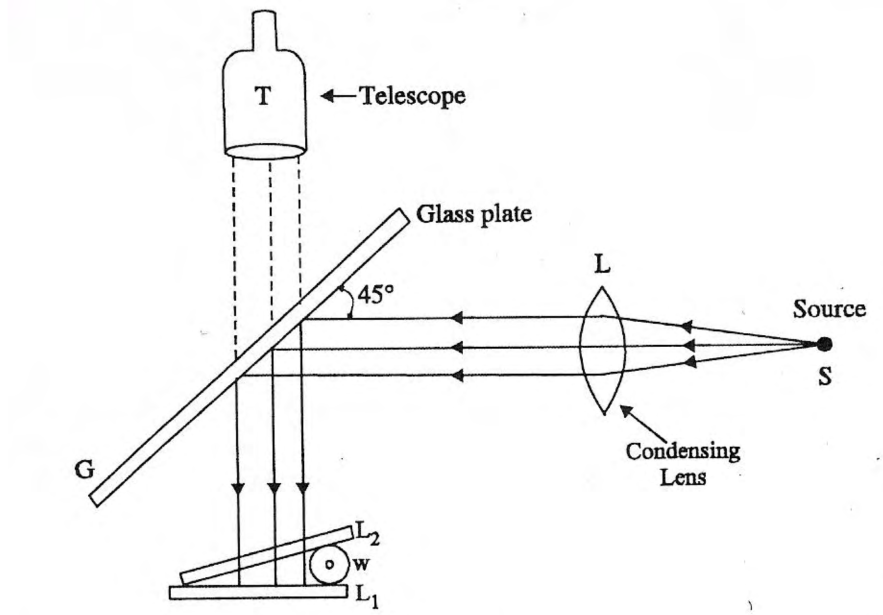
The given LASER source is connected to the optical fibre cable. The other end is exposed to the air medium in the dark place. The emerging light is exposed on a plain paper.

Now, we get illuminated circular patch on the screen. The distance from the fibre end to circular image (d) is measured using metre scale. Similarly the radius of the image is also measured. Thus acceptance angle and numerical aperture of cable is found by using the formula.

Result:

Numerical aperture of the optical fibre = ………

Acceptance angle of the optical fibre = ………



L_1, L_2 - Transparent plane glass plates w - Specimen (wire)

1) To find the distance (l) between the edge of contact and the given wire.

Position	Travelling Microscope readings				Distance $l = l_1 - l_2$ $\times 10^{-2}$m
	MSR $\times 10^{-2}$m	VSC div	VSR= (VSC X LC) $\times 10^{-2}$m	Total reading= MSR+VSR $\times 10^{-2}$m	
Edge of contact				l_1	
Wire				l_2	

Expt.No. **Date:**

2. Air wedge

Aim

To determine the thickness of the thin wire (or) sheet of paper by forming an interference fringe pattern using an air wedge setup.

Apparatus required

Travelling microscope, sodium vapour lamp, air wedge setup, convex lens, reading lens, a 45° inclined glass plate.

Formula:

The thickness of the given material

$$t = \frac{\lambda l}{2\beta} \text{ metre}$$

λ = wavelength of sodium light in metres.

β = mean width of one fringe in the interference pattern in metres.

L = distance of the wire from the edge of contact in metres.

Procedure

An air wedge is formed by placing two optically plane glass plate one over the other. One end of the glass plates are fastened by a rubber band. Near the other end thin wire is or paper is introduced between the glass plates so that it is perpendicular to the length of the glass plates. The light falling on this air wedge setup is rendered parallel by a convex lens placed near the sodium vapour lamp. These parallel rays are then incident on a glass plate inclined at 45 to the horizontal. Now this light is made to fall on the air wedge setup mounted on the pedestal of the traveling microscope. The light rays getting reflected from the upper and lower glass plates will interfere with each other and form an interference fringe pattern with alternate dark and bright bands.

2) To determine fringe width(β)

S.N.	Order of band n	Travelling Microscope readings $x10^{-2}$m				Width of 4 bands $x10^{-2}$m	Width of 1 band 'β' $x10^{-2}$m
		MSR $x10^{-2}$m	VSC div	VSR $x10^{-2}$m	TR=MSR+VSR $x10^{-2}$m		
1.	n						
2.	n+4						
3.	n+8						
4.	n+12						
5.	n+16						
6.	n+20						
7.	n+24						
8	n+28						
9.	n+32						
10.	n+36						
11.	n+40						

Calculation:

Thickness of given wire $t = \frac{\lambda l}{2\beta}$ **metre**

Wavelength of sodium light = 5893 $\times 10^{-10}$m

Mean width of one fringe in the interference pattern β = ……….10^{-2}m

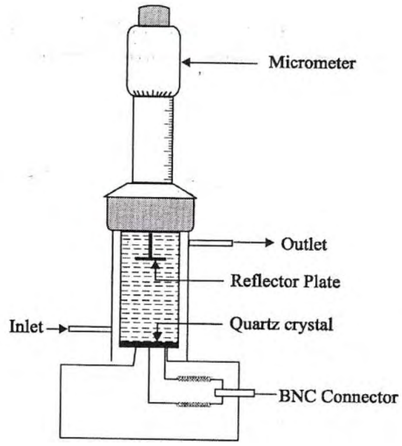
Distance of the wire from the edge of contact (l) =………$\times 10^{-2}$m

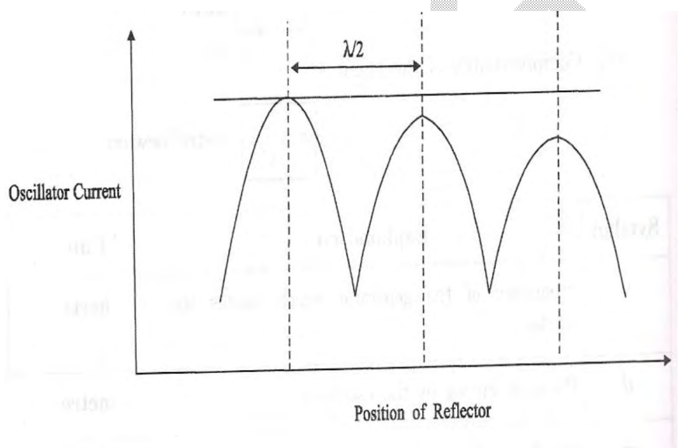
The traveling microscope is adjusted to catch the edge of contact (rubber band) of the glass plates. The readings in the horizontal scale is noted. The horizontal screw of the traveling microscope is rotated, the traveling microscope is rotated, the traveling microscope will traverse through the alternate dark and bright bands. Any dark band can be chosen as the n^{th} banc and the readings of the horizontal scale and be noted.

The horizontal screw is rotated and the readings for the (n+4), (n+8), (n+12), dark bands are noted. From these values, the mean width of one band β is calculated. The distance (l) between the edge of contact and the thin wire or paper is measured. The wavelength of the light source λ is known. Thus from the above values the thickness of the wire can be calculated.

Result:

The thickness of the given object :…………….metres.


Micrometer
Outlet
Reflector Plate
Inlet
Quartz crystal
BNC Connector


λ/2
Oscillator Current
Position of Reflector

Ex. No: **Date:**

3. Compressibility of liquids using ultrasonic waves

Aim :

To determine the velocity of the ultrasonic waves in the given liquid and its compressibility by using ultrasonic interferometer .

Apparatus required

Given liquid, ultrasonic interferometer liquids and quartz crystals.

Formula

Wave length of the ultrasonic wave in the liquid

$$\lambda = \frac{2d}{n}. \text{ m}$$

Velocity of ultrasonic wave in the liquid.

$$v_1 = \gamma\lambda \quad \text{m/sec}$$

Compressibility of liquid

$$k = \frac{1}{v_1^{\ 2}} \quad \text{m}^2/\text{N}.$$

Where

n = Number of maximum deflection in the micrometer

d = Distance traversed by micrometer for n maximum deflection in m.

λ = Wave length of stationary ultrasonic waves in the liquid in the measuring cell in m

f = Frequency of ultrasonic wave in Hz.

ρ = Density of the given liquid in Kg/m^3

Procedure

Ultrasonic interferometer is simple and direct device with a high degree of accuracy . It is a highly sensitive equipment and at most care should be taken in handling the apparatus.

The ultrasonic interferometer consists of the following parts:

a) The High Frequency Generator
b) The Measuring Cell

1) Reading for 'n ' Oscillations

Lc.=0. 01 mm

Order of deflection in micrometer	Micrometer reading for n maximum deflections			Distance traverse d in micro meter 'd'	$\lambda=2d/n$	$V=\gamma\ \lambda$ m/s
	PSR	HSC	Total reading =PSR+(HSCxLC)			
Unit	10^{-3}m	Div	10^{-3}m	10^{-3}m	10^{-3}m	m/s
n=5						
n=10						
n=15						
n=20						
n=25						
n=30						
n=35						
n=40						
n=45						
n=50						

a) High Frequency Generator is designed to excite the quartz crystal fixed at the bottom of the measuring cell at its resonant frequency to generate ultrasonic waves in the experimental liquid filled in the “Measuring Cell”. A micrometer to observe the changes in current and two controls for the purpose of sensitivity regulation and initial adjustment of the micrometer is provided on the panel of the High Frequency Generator.

b) The Measuring Cell is specially designed double walled cell for maintaining the temperature of the liquid constant during the experiment. A fine micrometer screw has been provided at the top, which can lower or raise the reflector plate in the liquid in the cell through a known distance. It has a quartz crystal fixed at its bottom.

Initial Adjustment

1. Insert the cell in the square base socket and clamp it with the help of a screw provided on one of its side.
2. Unscrew the knurled cap of cell and lift it away from the double walled construction of the cell. In the middle portion of it pour experimental liquid and screw the knurled cap.
3. Two chutes in double wall construction are provided for water circulation to maintain the desired temperature.
4. Connect the High Frequency Generator with cell by co-axial cable provided with the instrument.
5. In Multi frequency Ultrasonic Interferometer frequency selector knob should be positioned at desired frequency and cell should be used for the same frequency.

For Initial adjustment two knobs are provided on high frequency generator, one is marked with ‘Adj’ the position of the needle on the Ammeter is adjusted and the knob marked ‘Gain’ is used to increases the sensitivity of the instrument for greater deflection if desired.

The ammeter is used to notice the number of maximum deflections while micrometer is moved up and down in liquid.

Calculation

Given liquid :

Density of given liquid ρ : Kg/m^3

Frequency of the ultrasonic wave generated γ = …….. Hz

Least count = 0. 01 mm

Number of maximum deflections n = ……….

1) Distance traversed in micrometer for n maximum deflections d = ……m

i. Wavelength of ultrasonic wave in the given liquid

$$\lambda = \frac{2.d}{n} \quad \text{m}$$

$$v_1 = \lambda\gamma \quad = \quad \text{m/sec}$$

The measuring cell is connected to the output terminal of the high frequency generator through a shielded cable. The cell is filled with experimental liquid before switching on the generator. The ultrasonic waves move normal from the quartz crystal till they are reflected back from the moveable plate and the standing waves are formed in the liquid in between the reflector plate and the quartz crystal. The micrometer is slowly moved till anode current on the meter of the High frequency generator shows a maximum. A number of maxima readings of anode current are passed and their number 'n' are counted. The total distance (d) thus by the micrometer gives the value of the wavelength(λ) with the help of the following relations.

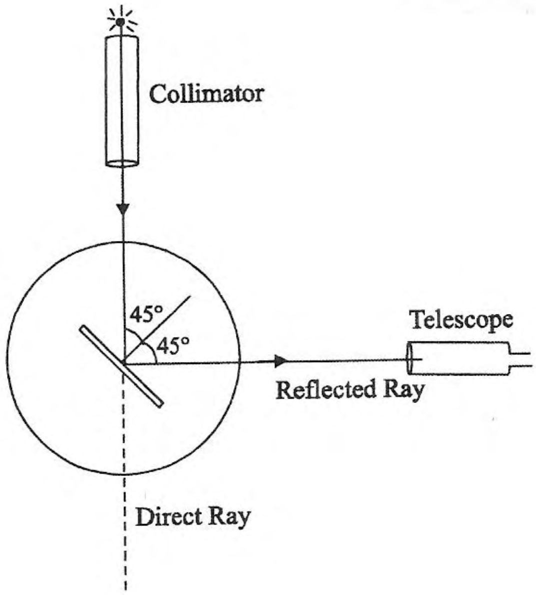
$$d = n\,\lambda/2 \quad \Rightarrow \lambda = 2d/n$$

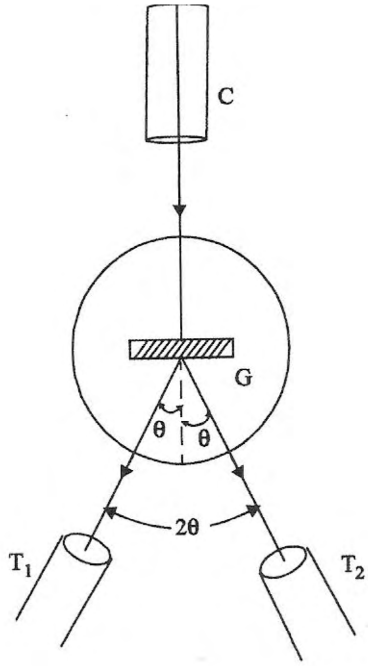
Once the wavelength (λ) is known the velocity (v) of ultrasonic wave in the liquid can be calculated from the formula given.

Result

Velocity of ultrasonic wave in the given liquid =………….m/s

Compressibility of the given liquid =………….m^2/N





Normal incident position **Spectrometer Grating**

Exp.No. **Date:**

4. SPECTROMETER-GRATING

Aim:

To determine the wave length of spectral lines, emitted by mercury light using plane transmission grating.

Apparatus required:

Spectrometer, diffraction grating, sodium vapour lamp and mercury vapour lamp.

Formula:

The wavelength of the spectral line is given by

$$\lambda = \frac{\sin\theta}{Nn} \quad \text{m}$$

Number of lines per meter of the grating

$$N = \frac{\sin\theta}{\lambda n}$$

Where

N → Order of the spectrum

N → Number of lines per Metre of the grating

Θ → angle of diffraction.

Procedure:

Adjustment of the grating for normal incidence

The preliminary adjustments of the telescope are made. The telescope is brought in front of the collimator and the direct image of the slit is viewed. The image is made to coincide with the vertical cross wire by adjusting the tangential screw of the telescope. The reading of any one of the vernier is taken. The vernier table is clamped and the telescope is rotated through 90º and fixed.

Now, the grating is mounted on the prism table vertically at the centre, with its ruled surface facing the collimator. The prism table is rotated slowly, till the reflected image of the slit coincides with the vertical cross wire, of the telescope. The reading of the vernier is noted and the vernier table is rotated through 45º towards the collimator. Now, the surface of the grating is normal to the parallel rays coming from the collimator.

Measurement of angle of diffraction of various colours

The slit is illuminated by a mercury light. After the adjustment of normal incidence, the telescope is released and brought to the position of direct image. The diffracted images of the first order are seen on either side of the telescope. The vertical cross wire of the telescope is carefully made to coincide with each spectral line successively and the readings of the circular scale and the vernier are taken. The readings are taken on both the sides. The difference between the readings or both sides gives twice the angle of diffraction.

Measurement of number of lines per unit length of the grating

The slit is illuminated by sodium light of known wavelength. After th adjustment of normal incidence, the telescope is released to catch the diffracted image of the first order on the left side of the central direct image. The readings are taken. The telescope is then turned towards the right side to catch the image of the first order. The readings are taken. The difference between the two readings gives 2θ where θ is angle of first order diffraction. The number of lines per meter of the grating is calculated using the formula.The experiment is also repeated for the second order and the readings are tabulated.

Calculation

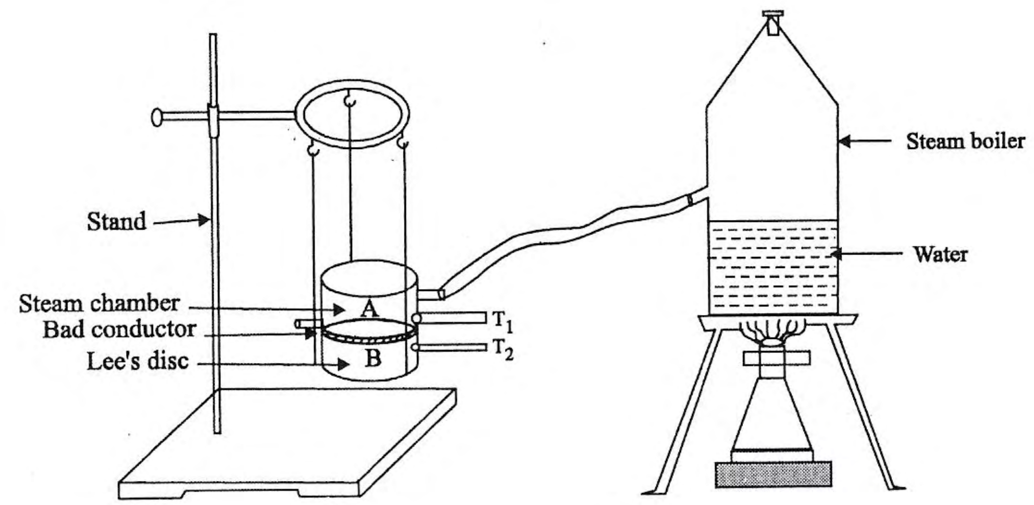
The wavelength of the spectral line is given by

$$\lambda = \frac{\sin\theta}{Nn} \quad \text{m}$$

Result:

1. The number of lines per meter of the grating (N) =
2. The wavelength of prominent lines of the mercury spectrum are:

   1
   2
   3
   4
   5
   6



Lee's disc apparatus

2) Thickness of the card board using Screw gauge:

LC=0.01 mm ZE = ………Div

ZC = ………x10^{-3} m

S.No.	Pitch scale Reading (PSR)	Head Scale Coincidence (HSC)	Head Scale Reading HSR=(HSC× LC)	Observed reading OR=PSR+HSR	Correct Reading = OR $\pm$ ZC
Unit	$\times 10^{-3}$m	Div	$\times 10^{-3}$m	$\times 10^{-3}$m	$\times 10^{-3}$m

Mean (d)= ……….x10^{-3}m

Exp.No: **Date:**

5. THERMAL CONDUCTIVITY OF BADCONDUCTOR LEE'S DISC.

Aim:

To determine the thermal conductivity of a given bad conductor by Lee's disc method.

Apparatus required:

Lees' Disc apparatus. Two thermometers, circular disc of the specimen of a bad conductor (ebonite or card board), stop watch steam boiler, vernier calipers, screw gauge.

Formula:

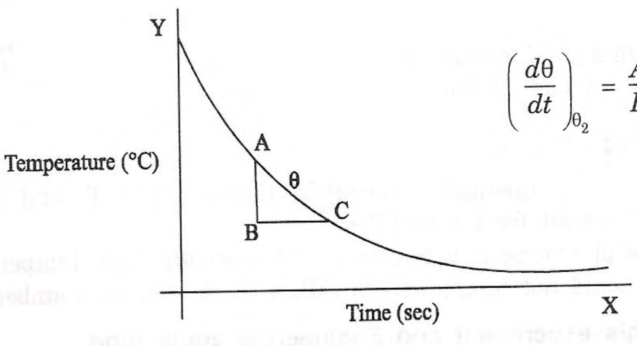
The thermal conductivity of bad conductivity

$$K = \frac{Msd\left(\frac{d\theta}{dt}\right)\left(\frac{r+2h}{2r+2h}\right)}{\pi r^2(\theta_1 - \theta_2)} wm^{-1}K^{-1}$$

M	→	Mass of the Lee's disc in Kg
h	→	Thickness of the disc in m
r	→	Radius of the disc in m
d	→	Thickness of the card board m
θ_1	→	Steady temperature of steam in ^{o} C
θ_2	→	Steady temperature of disc in ^{o} C
$\left(\frac{d\theta}{dt}\right)$ at θ_2	→	Rate of cooling at θ_2

1) Determination of the rate of cooling of disc at θ_2

S.No.	Temperature (° C)	Time (Seconds)	S.No.	Temperature (° C)	Time (Seconds)



$$\left(\frac{d\theta}{dt}\right)_{\theta_2} = \frac{AB}{BC}$$

Description:

The apparatus consists of a metal slab A of copper which is suspended by means of three strings from a stand. A hollow cylindrical vessel B with inlet and outlet for steam is placed above A. The cardboard of same diameter whose thermal conductivity is required is placed between A and B. The thermometers T_1 and T_2 are used to measure the temperatures of B and A respectively.

Procedure:

The experimental arrangement is shown fig. steam is allowed to pass through the inlet of the vessel B and it escapes out through the outlet. The temperatures θ_1 and θ_2 are noted when the thermometers T_1 and T_2 show steady and constant readings. Now the cardboard is removed and the vessel B is kept in direct contact with the metal slab A, till its temperature is about 5ºC above the steady temperature θ_2. A stop watch is started and time is noted for every 1ºC fall the temperature until the metallic disc attains 5ºC below θ_2. A graph between temperature and time is drawn. Rate of cooling $d\theta/dt$ at θ_2 is calculated from the graph.

Thickness and radius of metallic disc is measured using screw gauge and Vernier caliper respectively. The thickness of bad conductor is found using screw gauge. Substituting the all values in the given formula the thermal conductivity of bad conductor can be calculated.

2) Radius of the disc using vernier caliper:

LC=0.01 cm ZE = ………Div

ZC = ………x10^{-2} m

S.No	Main scale Reading (MSR)	Vernier Scale Coincidence (VSC)	Vernier Scale Reading VSR= (VSC x LC)	Observed reading OR=MSR+VSR	Correct Reading = OR$\pm$ZC
Unit	$\times10^{-2}$m	Div	$\times10^{-2}$m	$\times10^{-2}$m	$\times10^{-2}$m

Mean (2r)= ………x10^{-2}m

3)Thickness of the Lee's disc(Metallic disc) using Screw Gauge:

LC=0.01 mm ZE = ………Div

ZC = ………x10^{-3} m

S.No.	Pitch scale Reading (PSR)	Head Scale Coincidence (HSC)	Head Scale Reading HSR=(HSC x LC)	Observed reading OR=PSR+HSR	Correct Reading = OR$\pm$ZC
Unit	$\times10^{-3}$m	Div	$\times10^{-3}$m	$\times10^{-3}$m	$\times10^{-3}$m

Mean (h)= ………x10^{-3}m

Calculation:

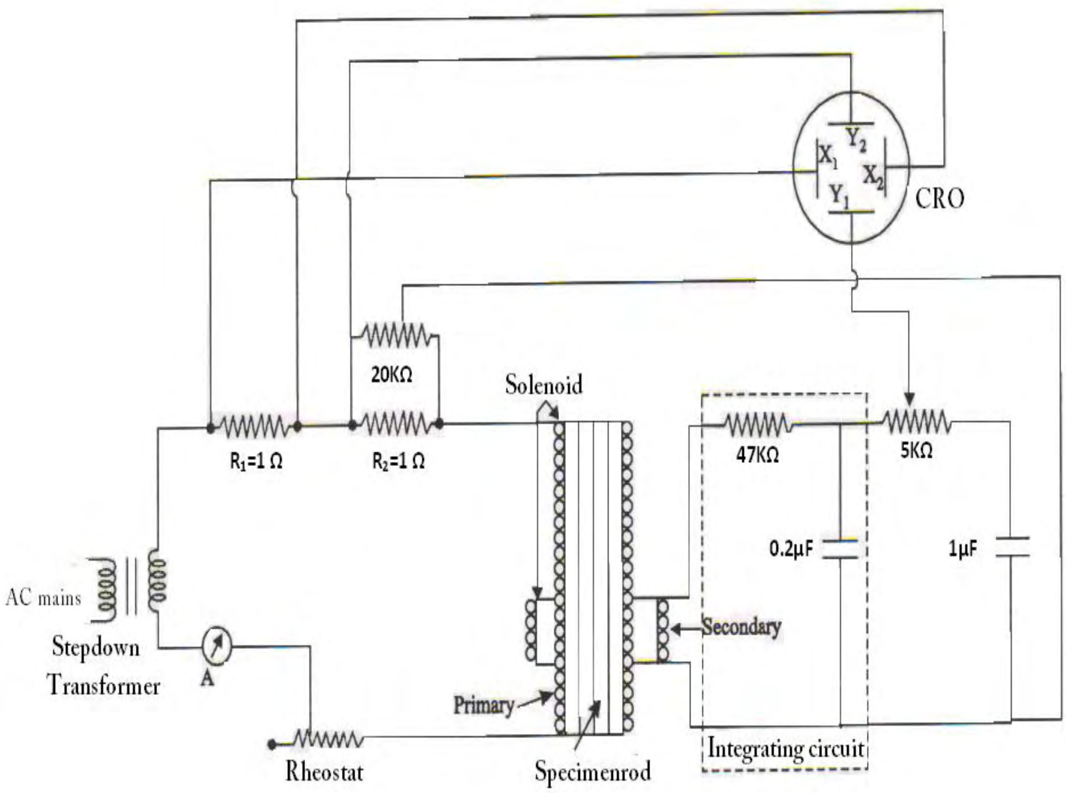
Mass of the Lee's disc	M	=……………Kg
Thickness of the disc	h	=……………$\times 10^{-3}$m
Radius of the disc	r	=……………$\times 10^{-2}$m
Thickness of the card board	d	=……………$\times 10^{-3}$m
Steady temperature of steam	θ_1	=……………° C
Steady temperature of disc	θ_2	=……………° C
Rate of cooling at $\left(\frac{d\theta}{dt}\right)$ at θ_2		=……………

Thermal conductivity of the card board

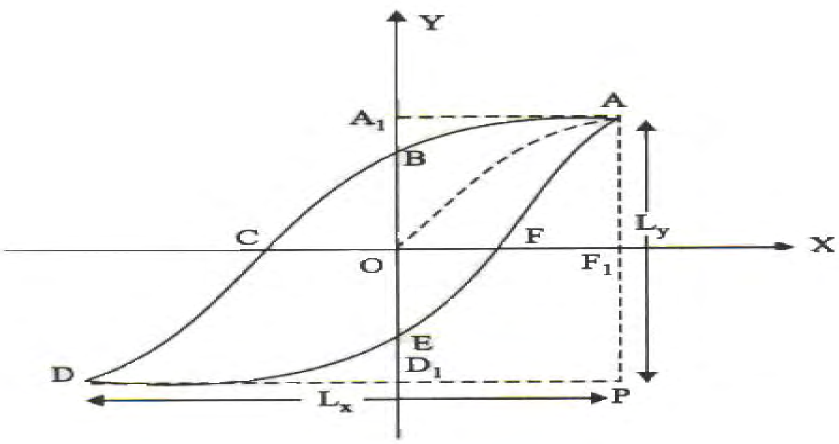
$$K = \frac{Msd\left(\frac{d\theta}{dt}\right)\left(\frac{r+2h}{2r+2h}\right)}{\pi r^2(\theta_1 - \theta_2)} wm^{-1}K^{-1}$$

Result:

The thermal conductivity of bad conductor = ………… $Wm^{-1} K^{-1}$



B-H CURVE APPARATUS



B-H CURVE

Exp.No: **Date:**

6. DETERMINATION OF HYSTERISIS LOSS IN A FERROMAGNETIC MATERIAL

AIM

To trace the B-H curve for a ferromagnetic material using CRO and to find the hysteresis loss of a ferromagnetic material.

REQUIRED APPARATUS

CRO, step down transformer, A.C ammeter, rheostat, resistant 1Ω -2nos, 47k Ω-1nos, 20 k Ω and 5 k Ω variable resistances two capacitors (1μf and 2μf), solenoid, specimen rod.

FORMULA

Hysterisis Loss = $\dfrac{N_p\sqrt{2}\left(\frac{V}{R}\right)X\left[2\sqrt{2}N_p\left(\frac{V}{R}\right)\Pi r^2\right]}{L_x\sqrt{\frac{L_y}{2}}}X$ (area of the loop in m^2) J/Cycle/Volume

Where,

N_p → is the number of turns in solenoid

V → is the voltage applied in B-H apparatus in volt

R → is the resistance in integrator circuit in ohm

L_x → is the maximum deflection of x- axis in meter

r → is the radius of the coil in meter and

L_y → is the length of the line along y- axis in meter.

CALCULATIONS

Number of turns in the solenoid N_p =…………………….turns

The voltage applied to B-H curve apparatus V = …………………………volts

Resistance in integrator circuit R = …………………………ohms

Radius of the coil r = ………………………………..m

Maximum deflection in x- axis L_x =……………………………….m

The length of the line along y – axis L_y =………………………………..m

$$\text{Hysterisis Loss} = \frac{N_p\sqrt{2}\left(\frac{V}{R}\right)X\left[2\sqrt{2}N_p\left(\frac{V}{R}\right)\Pi r^2\right]}{L_x\sqrt{\frac{L_y}{2}}}X$$

(area of the loop in m^2) J/Cycle/Volume

PROCEDURE

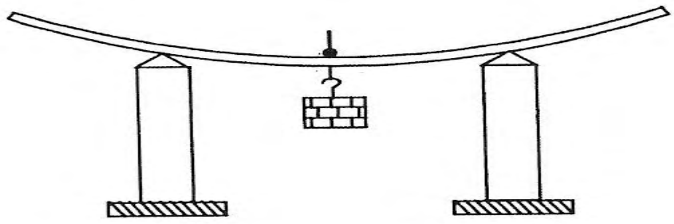
Draw a diagram showing the scheme of connections as shown in diagram and make all the connections properly. The specimen is taken in the form of ferromagnetic rods. A solenoid is wounded on a non-metallic frame. A centrally situated secondary of nearly 1000 turns is wound on a spool. The specimen rod is inserted into the solenoid completely. Switch On and A.C main and obtain maximum current in the primary circuit with the help of a rheostat R_H. Now adjust the X and Y amplifier and so that we get a pattern within the screen. The pattern obtain should be as shown in figure.After getting proper hysterisis pattern on the screen, place a tracing paper on screen and trace the B-H hysteresis loop and L_x and L_y are measured. Now, slowly move the specimen rod out of the solenoid until the length L_y of the vertical line is reduced to $L_y/2$.

Keeping the specimen rod in this position, adjust the y- amplifier gain to increase the length of the line to its original value L_y. This implies that Y- amplifier gain is now double of its original value.

All these values are substituted in the equation given the hysteresis loss can be calculated.

RESULT

Hysterisis loss = ……………………………………………….J/Cycle/Volume



Non- Uniform bending

1)To find depression 'y'

LC = 0.001cm. TR=MSR+(VSC X LC)

S. No.	Distance between knife edges(l)	Load (M)	Microscope Reading						Mean	Depression (y) for M Kg
			Increasing Load			Decreasing Load				
			MSR	VSC	TR	MSR	VSC	TR		
Unit	10^{-2} m	10^{-3}Kg	10^{-2}m	Div	10^{-2} m	10^{-2} m	Div	10^{-2} m	10^{-2} m	10^{-2} m

Mean (y) = ------------10^{-2} m

Expt.No. **Date:**

7. DETERMINATION OF YOUNG'S MODULUS BY NON- UNIFORM BENDING

Aim

To determine the young modulus of the given material of the beam by non uniform bending.

Apparatus required

A long uniform beam usually a metre scale, traveling microscope, pin, weight hanger with slotted weights, vernier calipers, screw gauge, knife edges etc.,

Formula

The Young's modulus of the given material of the beam

i) By calculation $Y = \frac{gl^3}{4bd^3} \cdot \frac{M}{y}$ **Nm^{-2}**

ii) By Graphical method $Y = \frac{gl^3}{4bd^3} \cdot \frac{1}{K}$ Nm^{-2}

Explanation of symbols

g → Acceleration due to gravity in ms^{-2}

l → Distance between the two knife edges in metre

b → Breadth of the beam in metre

d → Thickness of the beam in metre

y → Depression produced for 'M' kg of load in metre

M → Load applied in Kg.

K → Slope y/M from the graph mKg^{-1}

2) To find the thickness(d) of the beam using screw gauge.

LC=0.01 mm

ZE = ………Div

ZC = ………x10^{-3} m

S.No.	Pitch scale Reading (PSR)	Head Scale Coincidence (HSC)	Head Scale Reading HSR=(HSC x LC)	Observed reading OR=PSR+HSR	Correct Reading = OR$\pm$ZC
Unit	X10^{-3}m	Div	X10^{-3}m	X10^{-3}m	X10^{-3}m

Mean = ………x10^{-3}m

3) To find the breadth (b) of the beam using vernier calipers

LC=0.01 cm

ZE = ………Div

ZC = ………x10^{-2} m

S.No.	Main scale Reading (MSR)	Vernier Scale Coincidence (VSC)	Vernier Scale Reading VSR= (VSC x LC)	Observed reading OR=MSR+VSR	Correct Reading = OR$\pm$ZC
Unit	X10^{-2}m	Div	X10^{-2}m	X10^{-2}m	X10^{-2}m

Mean = ………x10^{-2}m

Procedure

The given beam is placed on the two knife edges. The length of the bar between the knife edges is measured (l).

A weight hanger is suspended at the centre of the beam and a pin is fixed vertically on the frame of the hanger as shown in Fig. Taking the weight hanger alone as the dead load the tip the pin is focused by the microscope, and is adjusted in such a way that tip of the pin just touches the horizontal cross wire. The reading on the vertical scale is noted. Now the weight is added in steps of 50 grams. Each time the tip of the pin is made to touch the horizontal cross wire and the readings are noted from the vertical scale of the microscope.

The same procedure is repeated by unloading the weight in steps of same 50 grams and the readings are noted. The thickness and the breadth of the beam are measured using screw gauge and vernier calipers respectively. The Young's modulus of the material of the beam can be calculated using the formula.

A graph is drawn taking load (M) along x axis and depression 'y'along y axis as shown in fig The slope of the graph gives the value K = y/M. Substituting the value of the slope in the given formula, the Young's modulus can be calculated.

Calculation:

Acceleration due to gravity (g) = …………….m/s^2

Distance between the two knife edges (l) = …………….x10^{-2}m

Breadth of the beam (b) = ……………. .x10^{-2}m

Thickness of the beam in (d) = …………….x10^{-3}m

Depression produced for 'M' kg of load (y) =…………….x10^{-2}m

Load applied (m) =……………......x10^{-3}K

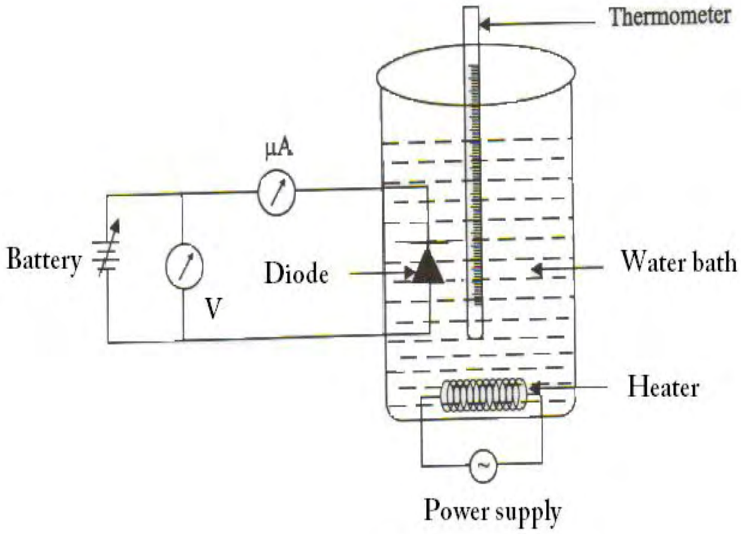
By calculation $Y = \frac{gl^3}{4bd^3} \cdot \frac{M}{y}$ Nm^{-2}

Result

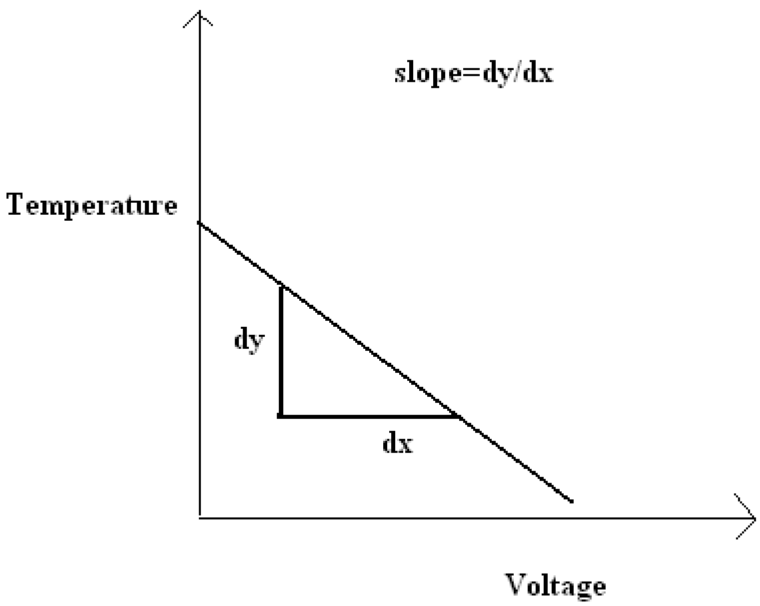
The Young's modulus of the given material of the beam

(i) By calculation = ………..Nm^{-2}

(ii) By Graph = ………..Nm^{-2}



Band gap Apparatus



Exp.No. **Date:**

8. BANDGAP DETERMINATION OF A SEMICONDUCTOR

Aim

To determine the width of the forbidden energy in a semiconductor diode.

Apparatus required

Point contact diode, heating arrangement to heat the diode, ammeter, Voltmeter, thermometer etc.

Formula

Band gap energy E_g = 0.198x Slope in eV

(Or)

Band gap energy Eg=intercept/slope

Where Slope = dy/dx

I_s → Saturation current in μA

T → Absolute temperature in Kelvin

Procedure

The circuit is given as shown in fig. The point contact diode and the thermometer is immersed in a water (or) oil bath, in such a way that the thermometer is kept nearby the diode. The power supply is kept constant (say 4 volts). The heating mantle is switched ON and the oil bath is heated up to 70C. Now the heating mantle is switched OFF and the oil bath is allowed to cool slowly. For every one degree fall of temperature the micro ammeter reading(I_s) in noted.

A graph is plotted taking 1000/T along X axis and log I_s along negative Y axis.(Since I_s is in the order of micro-amperes, log I_s value will come in negative) A straight line is obtained as shown in model graph. By finding the slope of the straight line, the band gap energy can be calculated using the given formula. The same procedure can be repeated for various constant power supplies.

Measurement of current for various temperatures

Power supply =…………….V Room temperature =…………C

Current =…………….µA

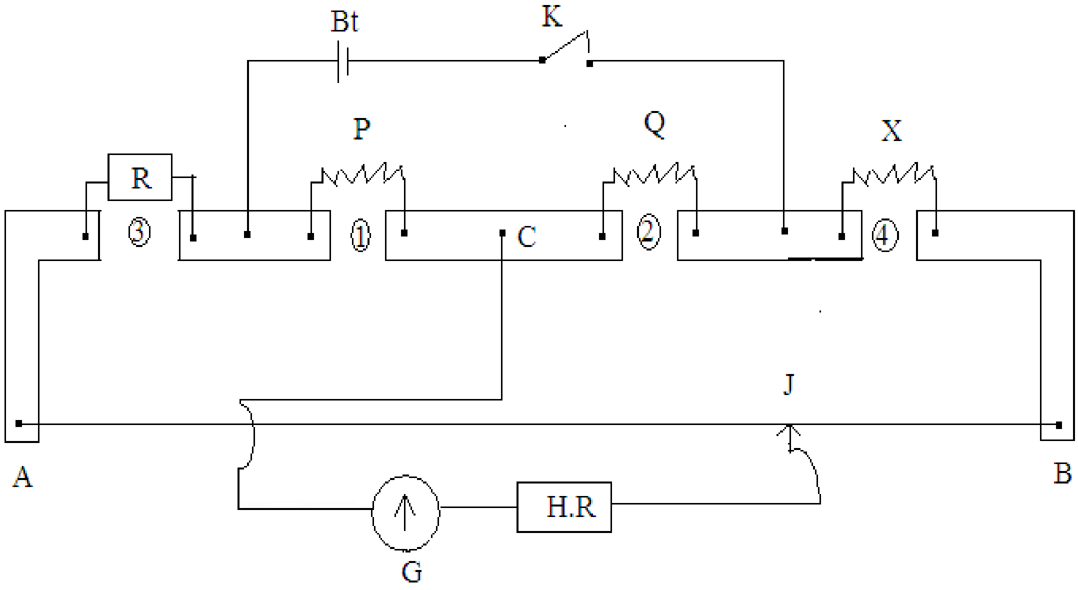
S.No.	Temp Kelvin ($T+273^{o}c$)	Voltage	$10^3/T$	Current I_s	Log I_s
Unit	C	K	(K^{-1})	(x 10^{-6} Amp)	Amp

Calculation:

Band gap energy Eg=Intercept/slope

Result:

The band gap energy of the given diode is =………………. **eV**


Bt
K
P
Q
X
R
3
1
C
2
4
J
A
B
G
H.R

Exp.No: **Date:**

9. DETERMINATION OF SPECIFIC RESISTANCE OF GIVEN COIL OF WIRE – CAREY FOSTER'S BRIDGE

AIM

To determine the specific resistance of the given coil of the wire by comparing two nearly equal resistances using a Carey Foster Bridge.

Apparatus Required

A Carey – Foster Bridge, Coil of the given wire, Leclanche cell, key, two equal resistances P and Q, Galvanometer, high resistance, jockey, known resistance box(R) etc.

Formula

(i) Resistance of the given coil of Wire $X=R+(l_1-l_2)\, r_b$ ohm.

(ii) Specific resistance of the given coil of wire $\rho = X\pi r^2/l$ ohm-m

Where

R → Known value of the resistance in the resistance box

r_b → Resistance per metre length of the bridge wire $=\frac{0.1}{la-lb}$

X → unknown resistance

la, lb → balancing lengths.

r → radius of the given coil of wire.

l → length of the given coil of wire

DETERMINATION OF UNKNOWN RESISTANCE (X)

S.No	Resistance introduced in the box R	Balancing Length AJ		$X=R+(l_1-l l_2)\ r_b$
		With R in left gap (l_1)	With R in left gap (l_2)	

THEORY

The Carey- Foster bridge consists of a one meter wire of uniform radius stretched on a wooden board. Carey- Foster bridge has four gaps in which proper resistances can be inserted. The total circuit is divided into two parts. One is primary circuit and the other secondary circuit. In primary circuit the lechlanche cell, key is connected. In the secondary circuit the galvanometer, high resistance and jockey is connected in series.

PROCEDURE

The primary and the secondary circuits are connected as shown in circuit and the equal resistance P and Q are connected in the two inner gaps. A resistance box R is included in the left gap(3) and a unknown resistance (X) is included in the right gap(4). Known value of the resistances (R) are included (0.2Ω,0.3 Ω,0.4 Ω etc.,) and the balancing length(AJ) l_1 is measure in each case and are tabulated. The positions of R and X are interchanged. The experiment is repeated for the same values of R (0.2Ω,0.3 Ω,0.4 Ω etc.,) and the balancing length(AJ) l_2 is measured.

For the determination of the resistance (r_b) per meter length of the bridge wire, a thick copper strip of zero resistance is placed in the left gap (3) and a standard resistance of 0.1 Ω is placed at the right gap (4) and the balancing length (AJ) la is noted and tabulated. Now by placing the copper strip at the right gap (4) and 0.1 Ω at the left gap (3) the balancing length (AJ = lb) is noted.

By using la and lb the value r_b is calculated. Substituting these values in the gi en formula the unknown resistance (X) of the wire is calculated.

SPECIFIC RESISTANCE

The radius of the given wire is found by using screw gauge and the length is measure by a scale. By substituting the values of X, r, l in the given formula the specific resistance of the given coil of the wire is calculated.

TO FIND THE RADIUS OF THE GIVEN COIL OF WIRE

LC=0.01 mm

ZE = ………Div

ZC = ………x10^{-3} m

S.No.	Pitch scale Reading (PSR)	Head Scale Coincidence (HSC)	Head Scale Reading HSR=(HSC× LC)	Observed reading OR=PSR+HSR	Correct Reading = OR$\pm$ZC
Unit	$\times10^{-3}$m	Div	$\times10^{-3}$m	$\times10^{-3}$m	$\times10^{-3}$m

Mean (d)= ……….x10^{-3}m

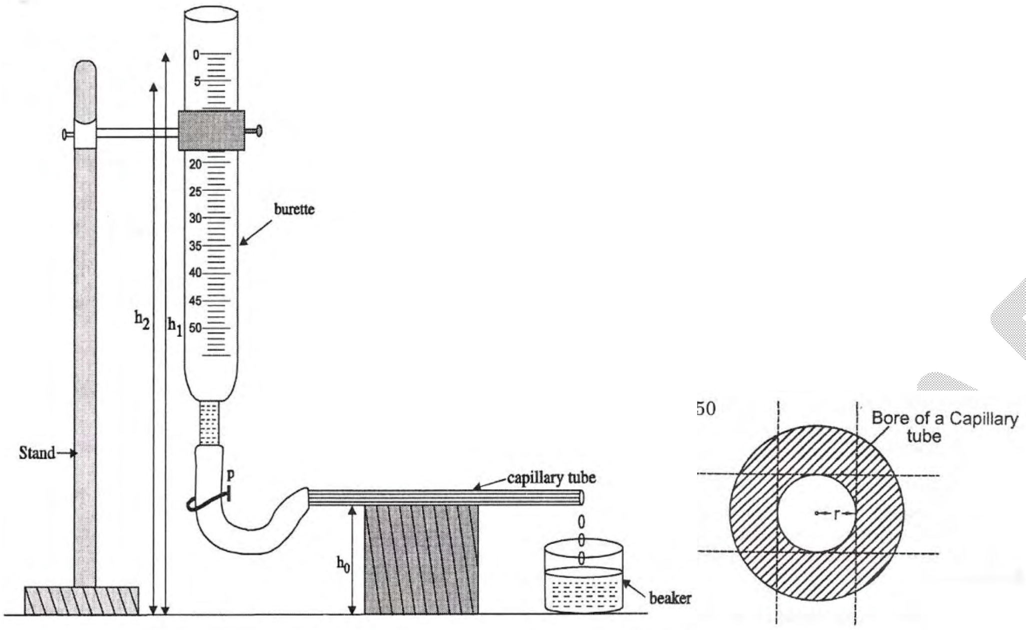
Radius of the wire= d/2 = ………………………….. x10^{-3}m

RESULT:

1. Unknown resistance of the given coil of wire (X)= …………….. ohms.

2. The specific resistance of the given coil of wire

(ρ)=……………….ohms-m



Viscosity of a liquid

1.To find the radius of the capillary tube (r)

LC=0.001 cm

Horizontal cross wire				**Vertical cross wire**			
Position	**MSR Cm**	**VSC div**	**TR=MSR+ (VSC×LC) Cm**	**Position**	**MSR Cm**	**VSC div**	**TR=MSR+ (VSCxLC) cm**
Top				Left			
Bottom				Right			

Difference (d_1) = …………cm   Difference (d_2) = …………cm

Exp.No. **Date:**

10. VISCOSITY OF A LIQUID BY POISEUILLE'S METHOD

AIM

To determine the coefficient of viscosity of a liquid of given liquid by Poiseuille's method

APPRATUS REQUIRED

1.Burette
2. Capillary tube
3.Beaker
4.Given Liquid
5.Stop Watch
6.Meter Scale
7.Rubber tube.
8.Pinch cock

FORMULA

Co-efficient of given liquid

$$\eta = \frac{\pi \rho g r^4 (ht)}{8lV} \quad \text{Newton-second/metre}^2$$

Where

g → Acceleration due to gravity in m/s^2
ρ → Density of the liquid Kg/m^3
r → radius of the capillary tube in metre
l → Length of the capillary tube in metre
V → Volume of the liquid collected in $metre^3$
h_1 → Height from table to initial level of water in the burette in metre
h_2 → Height from table to initial final of water in the burette in metre
h_0 → Height from table to mid portion of capillary tube in metre
t → Time taken for the liquid flow in second

2. Measurement of time for liquid flow

h_o= -----------------x 10^{-2}m Volume of 5cc liquid = -----------10^{-6} m^3

S.No.	Burette Reading	Time note while crossing level	Range	Time for flow of 5cc liquid	Height of initial reading h_1	Height of final reading h_2	Pressure head	ht
Unit	Cc	Second	cc	Sec	cm	cm	Cm	cm-sec
1.	0		0-5					
2.	5		5-10					
3.	10		10-15					
4	15		15-20					
5.	20		20-25					
6.	25		25-30					
7.	30		30-35					
8.	35		35-40					
9.	40		40-45					
10	45		45-50					
11.	50							

Mean height (ht) = ……………$\times 10^{-2}$ m-sec/m^3

Procedure

A clean burette is fixed to a stand. A capillary tube is connected to the burette by rubber tube and is held parallel to the table. The given liquid is filled in the burette and when the liquid level in burette comes to the zero-mark, a stop-clock is started and the time for the liquid to reach 0,5,10,15,……50cc is noted. The time taken for flow of 5cc of liquid ‘t’ is thus determined. The height (h_1, h_2) of 0,5,10,….50cc marked above the horizontal table are measured. The height ‘h’ is calculated using the relation $h =(h_1 + h_2)/2 – h_0$. The product ‘ht’ is a constant. The mean value of ‘ht’ is substituted to calculate coefficient of viscosity of the liquid.

The length of capillary tube (l) is measured and radius of the capillary tube is measured using Traveling microscope.

Calculation:

Acceleration due to gravity (g) =……………9.8 m/s^2

Density of the liquid (ρ) = ……………Kg/m^3

Radius of the capillary tube (r) =…………… $x10^{-2}m$

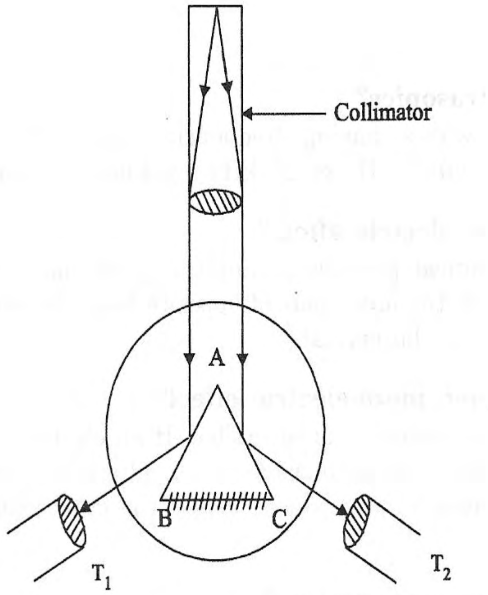
Length of the capillary tube (l) =……………$x10^{-2}m$

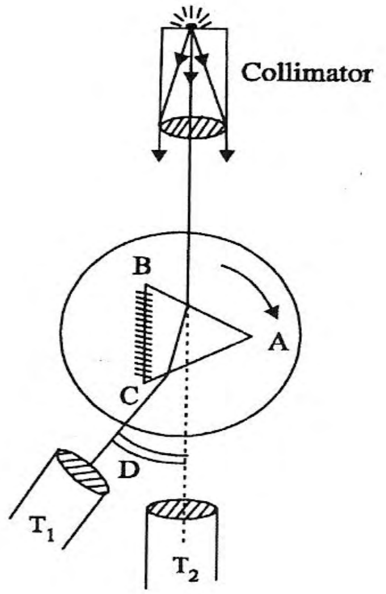
Volume of the liquid (V) =……………$x10^{-6}m^3$

$$\eta = \frac{\pi \rho g r^4 (ht)}{8lV}$$

Result :

The coefficient of viscosity of given liquid = ……….N-s/m^2





Determination of angle of Prism **Determination of angle of min.deviation**

1)To find the angle of prism (A)

LC = 1′

VSR = (VSC x LC)

Reflected Ray	**Vernier A**			**Vernier B**		
	MSR deg	**VSC deg**	**Total reading (MSR+VSR) deg**	**MSR deg**	**VSC deg**	**Total reading (MSR+VSR) deg**
Reading of image Left Side			(R_1)			(R_1)
Reading of image Right side			(R_2)			(R_2)
	$2A = (R_1$ □ $R_2)$			$2A = (R_1$ □ $R_2)$		

Mean 2A = ……………

A = …………..

Ex. No: **Date:**

11. DISPERSIVE POWER OF A PRISM – SPECTROMETER

Aim:

To determine the dispersive of the given prism using spectrometer.

Apparatus required:

Spectrometer, solid prism, mercury vapour lamp,etc.,

Formula:

Refractive index of the prism

$$\mu = \frac{\sin[(A+D)/2]}{\sin[A/2]}$$

Dispersive power of the prism in the wavelength region of λ_1 and λ_2 is

$$\omega = \frac{\mu_1 - \mu_2}{\left(\frac{\mu_1 + \mu_2}{2}\right) - 1}$$

A → Angle of the prism

D → Angle of minimum deviation

μ_1 → Refractive index of the prism for pair of one colour

μ_2 → Refractive index of the prism for other colour of the pair

Procedure:

Determination of angle of prism

The initial adjustments of the spectrometer are made.

The given prism is mounted vertically at the centre of the prism table with its refracting edge facing the collimator. Now the parallel rays of light emerging out from collimator falls almost equally on the two faces of the prism ABC as shown in fig. The telescope is turned to catch the reflected image from one face of the prism and fixed in that position. The tangential screw is adjusted until the vertical cross-wire the fixed edge of the image of the slit. The readings on both the verniers are noted. Similarly the readings corresponding to the reflected image of the slit on the other face are also taken. The difference between the two readings of the same vernier gives twice the angle of the prism. Hence, the angle of the prism 'A' is determined.

2.) To find angle of minimum deviation (D)

LC = 1′ VSR =(VSC x LC) T.R = (MSR + VSR)

S.No.	Refracted Ray readings	Vernier A			Vernier B			Angle of minimum deviation		Mean
	Lines of the spectrum	MSR	VSC	Total reading	MSR	VSC	Total reading	Ver A $(R_1 - R_2)$	Ver B $(R_1 - R_2)$	D
Unit		deg	div	deg	deg	div	deg	deg	deg	deg
1.	Direct ray									
2.										
3.										
4.										
5.										
6.										
7.										

Determination of angle of minimum deviation (D)

The slit of the collimator is illuminated by light from the mercury vapour lamp. The prism is mounted on the prism table. The prism platform is turned such that the beam of light from the collimator is incident on one of the polished face at an angle of incidence almost equal to 90. The telescope is rotated to catch the mercury spectrum obtained by refraction through the prism. The prism platform is turned in such a manner that the entire spectrum moves towards the entire ray. Minimum deviation of one particular line (say violet) is obtained. The readings of the verniers are taken. In this manner, the prism is adjusted for minimum deviation position for the other lines in the spectrum and the corresponding readings are taken. The prism is removed and the reading is taken. The angle of minimum deviation 'D' for each colour of the light is calculated.

By choosing couple of lines not close to each other from the table, the dispersive power of prism for different sets of readings are calculated and the mean dispersive power is determined.

3.) To find Dispersive power of prism

S.No.	μ_1	μ_2	$\mu = \frac{\mu_1 + \mu_2}{2}$	Dispersive power $\omega = \frac{\mu_2 - \mu_1}{\mu}$

Mean

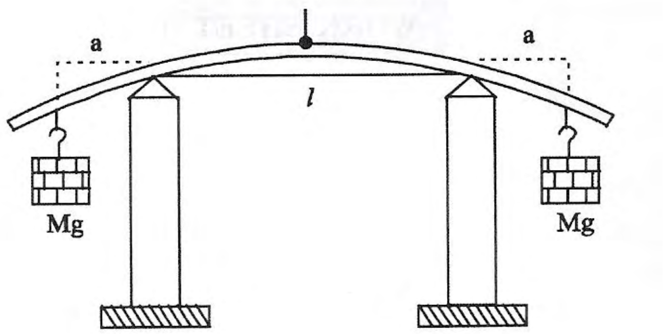
Result:

1. Angle of the prism(A) =

2. Angle of minimum deviation(D) =

3. Refractive index of the prism (μ) =

4. Dispersive power of prism =



1)To find depression 'y'

LC = 0.001cm.

TR=MSR+(VSC X LC)

S. No.	Distance between knife edges(l)	Load (M)	Microscope Reading						Mean	Elevation (y) for M Kg
			Increasing Load			Decreasing Load				
			MSR	VSC	TR	MSR	VSC	TR		
Unit	10^{-2} m	10^{-3} Kg	10^{-2}m	Div	10^{-2}m	10^{-2} m	Div	10^{-2} m	10^{-2} m	10^{-2} m

Mean (y) = ------------10^{-2} m

Expt.No. **Date:**

12. YOUNGS MODULUS BY UNIFORM BENDING

Aim:

To load determine the Young's modulus of the material of the beam by uniform bending method.

Apparatus required:

Beam (metre scale), Two knife edge supports, Two weight hangers with slotted weights, Pin, Travelling microscope

Formula

Young's modulus of the material of the beam

$$Y = \frac{3Mgal^2}{2bd^3 y} Nm^{-2}$$

By Graphical method

$$Y = \frac{3al^2}{2bd^3} \cdot \frac{1}{K} \quad \mathrm{Nm}^{-2}$$

Where

g → Acceleration due to gravity in ms^{-2}

l → Distance between the two knife edges in metre

b → Breadth of the beam in metre

d → Thickness of the beam in metre

y → Elevation produced for 'M' kg of load

a → Distance between the load and the nearest knife edge in metre

K → Slope y/M from the graph mKg^{-1}

2) To find the thickness(d) of the beam using screw gauge.

LC=0.01 mm

ZE = ………Div

ZC = ………$x10^{-3}$ m

S.No.	Pitch scale Reading (PSR)	Head Scale Coincidence (HSC)	Head Scale Reading HSR=(HSC x LC)	Observed reading OR=PSR+HSR	Correct Reading = OR$\pm$ZC
Unit	$X10^{-3}$m	Div	$X10^{-3}$m	$X10^{-3}$m	$X10^{-3}$m

Mean = ………$x10^{-3}$m

4) To find the breadth (b) of the beam using vernier calipers

LC=0.01 cm

ZE = ………Div
ZC = ………$x10^{-2}$ m

S.No.	Main scale Reading (MSR)	Vernier Scale Coincidence (VSC)	Vernier Scale Reading VSR= (VSC x LC)	Observed reading OR=MSR+VSR	Correct Reading = OR$\pm$ZC
Unit	$X10^{-2}$m	Div	$X10^{-2}$m	$X10^{-2}$m	$X10^{-2}$m

Mean =………… ……….$x10^{-2}$m

Procedure

The given beam is placed on the two knife edges. The length of the bar between the knife edges is measured(l).Two weight hangers is suspended, one each on either side of the knife edge at equal distance from the knife edge. A pin is fixed vertically exactly at the centre of the beam shown in fig. Taking the weight hanger alone as the dead load the tip of the pin is focused by the microscope, and is adjusted carefully the position of the microscope to make the horizontal cross wire coincides with the image of the tip of the pin and note the reading on the vertical scale in table. Now the weight is added in steps of 50 grams. Each time the tip of the pin is made to touch the horizontal cross wire and the readings are noted from the vertical scale of the microscope.

The same procedure is repeated by unloading the weight in steps of same 50 grams and the readings are noted. The thickness and the breadth of the beam are measured using screw gauge and vernier calipers respectively. The Young's modulus of the material of the beam can be calculated. Using the formula.

A graph is drawn taking load (M) along x axis and depression 'y' along y axis as shown in fig. The slope of the graph gives the value K = y/M. Substituting the value of the slope in the given formula, the Young's modulus can be calculated.

Calculation:

Acceleration due to gravity (g) = ... m/s^2

Distance between the two knife edges (l) = ... $x10^{-2}m$

Breadth of the beam (b) = ... $x10^{-2}m$

Thickness of the beam in (d) = ... $x10^{-3}m$

Elevation produced for 'M' kg of load (y) =.............. $x10^{-2}m$

Load applied (m) =................ $x10^{-3}K$

Distance between the load the nearest

knife edge in (a) = ... $x10^{-2}m$

Young's modulus of the material of the beam

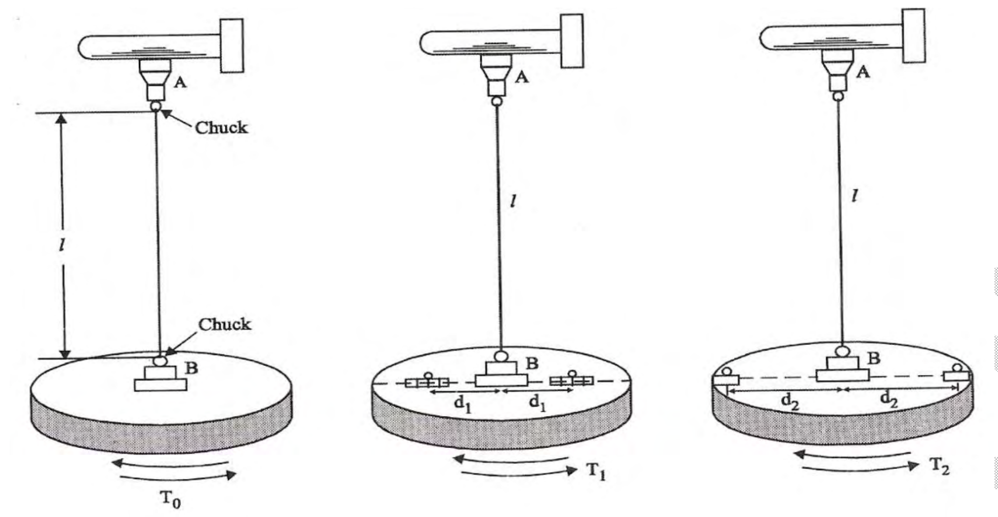
$$Y = \frac{3Mgal^2}{2bd^3y} Nm^{-2}$$

Result

The Young's modulus of the given material of the beam

(i) By calculation = ………..Nm^{-2}

(ii) By Graph = ………..Nm^{-2}



Torsional Pendulum

1.To find the time period of the disc

Length of the suspension wire (l): --------------- X10^{-2} m.

Position of the equal masses	**Time for the 10 oscillations**			**Time period**	**Square of the time period**
	Trail 1	**Trail 2**	**Mean**		
Unit	**Sec**	**Sec**	**Sec**	**Sec**	**Sec**
With out any Masses				T_0 =	T_0^2 =
With masses at closest distance d_1=……..x10^{-2} m				T_1 =	T_1^2 =
With masses at farthe distance d_2=……….X10^{-2}m				T_2 =	T_2^2 =

Expt.No. **Date:**

13. TORSIONAL PENDULUM

Aim

To determine (i) the moment of inertia of the given disc and (ii) the rigidity modulus of the material of a wire by torsional oscillations.

Apparatus Required

1. Torsional pendulum 2.Two equal cylindrical masses. 3.Stop-clock.
4.Screw gauge. 5. Metre scale.

Formula

Moment of inertia of the disc

$$I = \frac{2m(d_2^2 - d_1^2)T_0^2}{T_2^2 - T_1^2}\ kg.m^2$$

Rigidity modulus of the material of the wire

$$n = \frac{8\pi Il}{T_0^2 r^4}\ N/m^2$$

Explanation

m → Mass of one of the cylinder in Kg

d_1 → Closest distance between suspension wire and the centre of mass of the cylinder in metre

d_2 → Farthest distance between suspension wire and the centre of mass of the cylinder in metre

T_0 → Time period without any mass placed on the disc in second

T_1 → Time period when equal masses are placed at a distance d_1 in seconds

T_2 → Time period when equal masses are placed at a distance d_2 in seconds

l → Length of the suspension wire in metre

r → Radius of the wire in metre

2. To find the radius (r) of the suspension wire

Least count (LC) =…………mm

Zero error = ………..div.

Zero correction =………..mm.

S.No	Pitch Scale Reading (PSR)	Head Scale Coincide n-ce (HSC)	Head scale reading (HSR) (HSC x LC)	Observed reading (PSR+HSR)	Correct reading (OR ± ZC)
Unit	Mm	div.	mm.	mm.	mm.
1					
2					
3					
4					
5					
6					

Mean diameter of the wire (2r) =--------------------------------$X10^{-3}$m

Mean radius of the wire (r) =--------------------------------$X10^{-3}$m

Procedure

A torsion pendulum is constructed as shown in Figure.

Measure carefully the length of the suspension wire between the two chucks. Standing in front of the pendulum, gently set it in torsional oscillation without any lateral movement. Note the time for 10 oscillations. T0,the period of oscillation of the pendulum without any masses in it calculated. Take two readings. Find the mean.

Two equal cylindrical masses(m) are placed on the disc symmetrically on either side, close to the suspension wire. The closest distance 'd_1' from the centre of the mass of the cylinder and the centre of the suspension wire is found. Set the pendulum to oscillate and note the time for 10 oscillations. From that the period of oscillation T_1 is calculated. Take two readings find the mean.

Two equal masses are now moved to the extreme ends so that the edges of masses coincide with the edge of the disc and the centers are equal-distant. The distance 'd_2' from the centre of the mass of the cylinder and the centre of the suspension wire is noted. Set the pendulum to oscillate and note the time for 10 oscillations. Take two readings. Calculate the mean period of oscillation T_2.

Measure carefully, the diameter(2r) of the wire at various places, with a screw gauge. Find the mean of the diameter and calculate the radius. Note the mass(m) of the one cylindrical mass. The moment of inertia of the disc and rigidity modulus of the wire are calculated using the formula.

Calculation

Time period of oscillations (without masses) T_0 = ……………..seconds.

Time period when masses are at distance 'd_1' T_1 = …………….seconds.

Closest distance between suspension wire and the centre of mass of the cylinder d_1=……………..$X10^{-2}$ m.

Farthest distance between suspension wire and the centre of mass of the cylinder d_2=…………….$X10^{-2}$ m

Result:

1. The moment of inertia of the disc (I) =------------------Kg-m^2.
2. Rigidity modulus of the material of given wire (n) = ------------------N/m^2

APPENDIX

MEASURING INSTRUMENTS (Least count)

1. Vernier Caliper

Least Count = 1 main scale division – 1 Vernier scale division

LC = 1 MSD – 1 VSD

Value of 1 MSD = 1 cm = 0.1 cm

Number of divisions on the Vernier scale = 10 divisions

Since 9 MSD are divided into 10 VSD

i.e., 10 VSD = 9 VSD

$$1VSD = \frac{9\ MSD}{10} = \frac{9}{10} \times 0.1 = 0.009$$

But LC = 1 MSD – 1 VSD

LC= 0.1 - 0.009

LC = 0.01cm

1. Screw Gauge

$$\text{Least count (LC)} = \frac{\text{Pitch}}{\text{Total Number of divisions on the head scale}}$$

$$\text{Pitch} = \frac{\text{Distance moved by the head scale on the pitch scale}}{\text{Number of rotations given to the head scale}}$$

Number of Heads Scale Division = 100

Example

$\text{Pitch} = \frac{10mm}{10} = 1mm$ LC = $\frac{1\ mm}{100} = 0.01mm$

2. Travelling Microscope

Least Count = 1 main scale division – 1 Vernier scale division

LC = 1 MSD – 1 VSD

20 MSD = 1cm

Value of 1 MSD = $\frac{1\text{ cm}}{20}$ = 0.05 cm

Number of divisions on the Vernier scale = 50 divisions

Since 49 MSD are divided into 50 VSD

i.e., 50 VSD = 49 MSD

1 VSD = $\frac{49\text{ MSD}}{50} = \frac{49}{50} \times 0.05 = 0.049$

But LC = 1 MSD – 1 VSD

LC = 0.05 – 0.049 = 0.001cm

3. Spectrometer

Least Count = 1 MSD – 1 VSD

1 MSD = $\frac{1^o}{2} = 30'$

1 MSD = $0.5^o = 30'$

Number of division in Vernier Scale = 30

i.e., 30 VSD = 29 MSD

1 VSD = $\frac{29\text{ MSD}}{30} = \frac{29}{30} \times 0.5^o = 29'$

But LC = 1 MSD – 1 VSD

LC = 30' – 29' = 1'

PHYSICAL CONSTANTS

DENSITY

1. Water $\rightarrow$ 1000 Kgm^{-3}
2. Copper $\rightarrow$ 8900 Kgm^{-3}
3. Steel $\rightarrow$ 7800 Kgm^{-3}
4. Brass $\rightarrow$ 8600 Kgm^{-3}
5. Iron $\rightarrow$ 7500 Kgm^{-3}

YOUNGS MODULUS

1 .Box wood $\rightarrow$ 1×10^{10} Nm^{-2}

2. Teak wood $\rightarrow$ 1.7×10^{10} Nm^{-2}

3 .Wrought iron and steel $\rightarrow$ 20×10^{10} Nm^{-2}

RIGIDITY MODULUS

1. Aluminium $\rightarrow$ 2.5×10^{10} Nm^{-2}
2. Brass $\rightarrow$ 3.5 to 3.4×10^{10} Nm^{-2}
3. Cast iron $\rightarrow$ 5.0×10^{10} Nm^{-2}
4. Copper $\rightarrow$ 3.4 to 3.6×10^{10} Nm^{-2}
5. Steel(Cast) $\rightarrow$ 7.6×10^{10} Nm^{-2}
6. Steel(Mild) $\rightarrow$ 8.9×10^{10} Nm^{-2}

COEFFICIENT OF VISCOSITY(AT ROOM TEMPERATURE)

1. Water $\rightarrow$ 0.00081Nsm^{-2}
2. Kerosene $\rightarrow$ 0.002 Nsm^{-2}
3. Glycerin $\rightarrow$ 0.3094 Nsm^{-2}

THERMAL CONDUCTIVITY

1. Card board $\rightarrow$ 0.04 $Wm^{-1}k^{-1}$
2. Ebonite $\rightarrow$ 0.7 $Wm^{-1}k^{-1}$
3. Glass $\rightarrow$ 1 $Wm^{-1}k^{-1}$
4. Wood & Rubber $\rightarrow$ 0.15 $Wm^{-1}k^{-1}$

BAND GAP

1. Germanium $\rightarrow$ 0.67 eV
2. Silicon $\rightarrow$ 1.12 eV

WAVELENGTH

Sodium Vapour Lamp → 5893 A^O

Mercury vapour lamp

1. Red → 6234 A^O
2. Yellow I → 5791 A^O
3. yellow ii → 5770 A^O
4. Green → 5461 A^O
5. Blueish green → 4916 A^O
6. Blue → 4358 A^O
7. Violet I → 4078 A^O
8. Violet ii → 4047 A^O

SPECIFIC HEAT CAPACITY

1. Brass → 913 $JKg^{-1}K^{-1}$
2. Copper → 385 $JKg^{-1}K^{-1}$
3. Water → 4186 $JKg^{-1}K^{-1}$

COMPRESSIBILITY

1. Water → $4.59\times10^{-10}\ m^2N^{-1}$
2. Castor oil → $4.7\times10^{-10}\ m^2N^{-1}$
3. Kerosene → $7.5\times10^{-10}\ m^2N^{-1}$

TEMPERATURE CO-EFFICIENT OF RESISTANCE

1. Aluminium → 0.0043 per ˚C
2. Brass → 0.001 to 0.002 per ˚C
3. Copper → 0.0039 per ˚C

REFRACTIVE INDEX

1. Crown glass → 1.5
2. Air → 1.0
3. Water → 1.33
4. Flint glass → 1.56

CONSTANT & CONVERSION FACTORS

1. 1 eV → 1.606×10^{-19} J
2. Boltzmann constant k → $1.38 \times 10^{-23}\ J\ K^{-1}$