VALLIAMMAI ENGINEERING COLLEGE

SRM NAGAR, KATTANKULATHUR – 603 203

PHYSICS PRACTICALS MANUAL

(First semester B.E/B.Tech. students for the Academic Year 2014-2015)

Prepared by

Faculty members,
Department of Physics

VALLIAMMAI ENGINEERING COLLEGE

SRM NAGAR, KATTANKULATHUR – 603 203

DEPARTMENT OF PHYSICS

Instructions to the students

The following instructions must be followed by the students in their laboratory classes.

1. Students are expected to be punctual to the lab classes. If they are late, they will be considered absent for that particular session.
2. Students should strictly maintain the dress code and black shoes.
3. Students must bring their observation note, record note (completed with previous experiment) and the calculator to every lab class without fail.
4. Students are advised to come with full preparation for their lab sessions by
   - (i) Reading the detailed procedure of the experiment from the laboratory manual.
   - (ii) Completion of observation note book (i.e.) Aim, Apparatus required, Formula (with description), least count calculation, diagrams and the tabular column should be written in the observation note before entering into the laboratory.
5. Data enter in the observation note book must be by pen only.
6. Students must get attestations immediately for their observed readings.
7. Students are advised to get their results evaluated in the observation note book on the same day of that experiment.
8. Class assessment marks for each experiment is based only on their performance in the laboratory.
9. Record note has to be completed then and there and get corrected when the students are coming for the next lab class.
10. Students must strictly maintain silence during lab classes.
11. If any of the students is absent for the lab class for genuine reasons, he/she will be permitted to do the experiment during the repetition class only.
12. Students are advised to perform their experiments under safety care.
13. If any student is found causing damage to the lab equipments, he/she shall replace the same with a new.

CONTENTS

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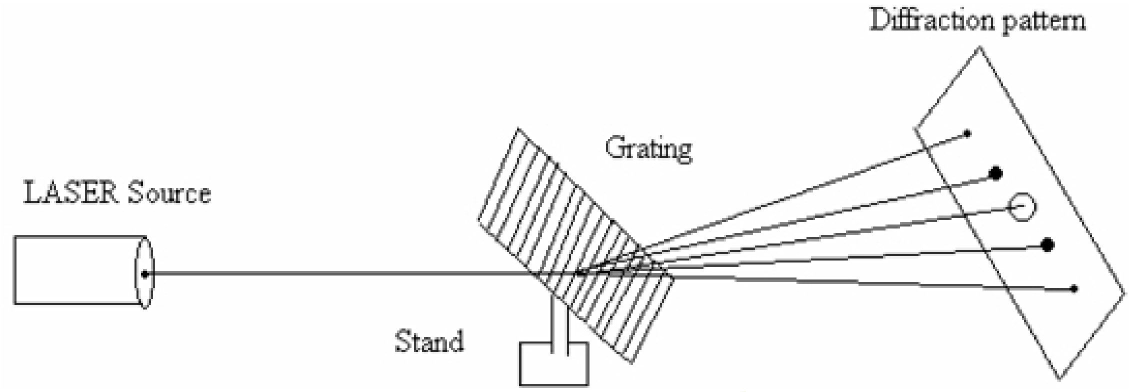

Figure 1.1 Laser Grating Experiment

Determination of wavelength of laser

Distance between the grating and the screen (D) =…….cm

S.No	Order of diffraction	Readings of the diffracted image						Mean $\theta = \frac{\theta_1+\theta_2}{2}$	$\lambda = \frac{\sin\theta}{nN}$
		Left side			Right side				
		Distance of different Orders (x_n) from the central spot	$tan\,\theta_1 = \frac{x_n}{D}$	$\theta_1 = \tan^{-1}\frac{x_n}{D}$	Distance of different Orders (xn) from the central spot	$tan\,\theta_2 = \frac{x_n}{D}$	$\theta_2 = \tan^{-1}\frac{x_n}{D}$		
Unit		cm			cm				(nm)
1	1	$x_1 =$			$x_1 =$				
2	2	$x_2 =$			$x_2 =$				
3	3	$x_3 =$			$x_3 =$				
4	4	$x_4 =$			$x_4 =$				
Mean wavelength of the given laser λ=									

Number of lines in grating per metre (N) =………..lines / metre

Ex. No. :
Date:

1. (a) DETERMINATION OF WAVELENGTH OF THE GIVEN LASER

AIM:

To determine the wavelength of the given laser using grating.

APPARATUS REQUIRED

Diode laser, grating, screen, paper and pencil.

PRINCIPLE

The laser light is exposed to the grating and diffraction takes place.

FORMULA

(1) Wavelength of the given laser

$$\lambda = \frac{\sin\theta}{nN} \quad meter$$

Symbol	Explanation	Unit
θ	Angle of diffraction	degree
n	Order of diffraction	-
N	Number of lines per meter in the grating	lines/m

PROCEDURE:

Diode laser is kept horizontally and switched on (care should be taken). The grating is held normal to the laser beam. This is done by adjusting the grating in such a way that the reflected laser beam coincides with the beam coming out of the laser. 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 wavelength of the laser light source is calculated using the given formula.

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

The number of lines in the grating is assumed as (2,500 lines per inch) 98425 lines per meter.

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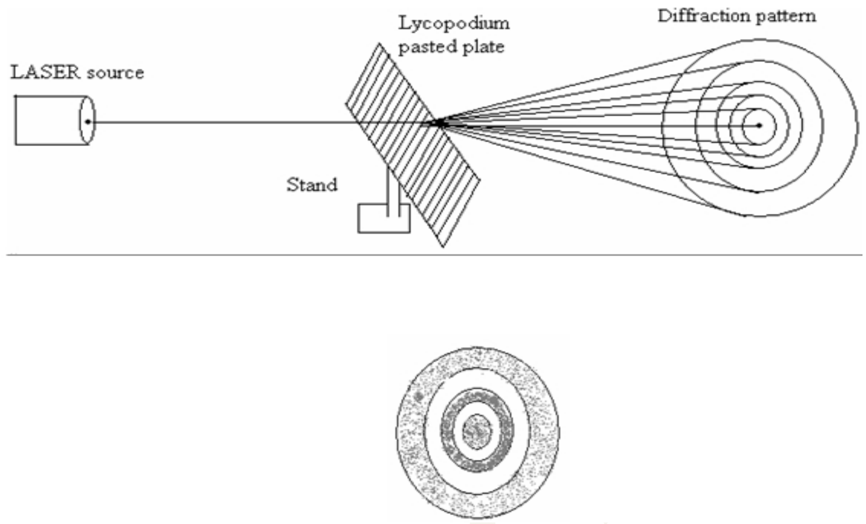

Figure 1.2. Particle size determination by Laser

S.No	**Distance between screen and glass plate (D)**	**Order of diffraction n**	**Distance between the central bright point and n^{th} fringe X_n**	**Particle Size $d = \frac{n\lambda D}{Xn}$**
Unit	cm		cm	cm
1		1		
		2		
2		1		
		2		
			Mean **d** =	

PARTICLE SIZE DETERMINATION USING LASER

AIM

To determine the size of the given micro particles (lycopodium powder) using laser.

APPARATUS REQUIRED

Diode laser, fine micro particles having nearly same size, glass plate, screen, metre scale

FORMULA

Particle size (diameter) d is given by

$$d = \frac{n\lambda D}{x_n} \; meter.$$

Symbol	Explanation	Units
n	Order of diffraction	-
λ	Wavelength of laser light used	metre
D	Distance between glass plate and the screen.	metre
x_n	Distance between central bright spot and the n^{th} ring	metre

PROCEDURE

A glass plate is taken and a fine powder of particle size in the range of micrometer is sprinkled on the glass plate. This glass plate is kept between laser light and screen. Now laser beam gets diffracted by the particles present in the glass plate. By adjusting the distance between the glass plate and the screen, (D) a circular fringe pattern is seen on the screen and the distance between the central bright point and n^{th} fringe x_n for various orders of diffraction is measured

Using the formula, the particle size is determined. The experiment is repeated for different D values.

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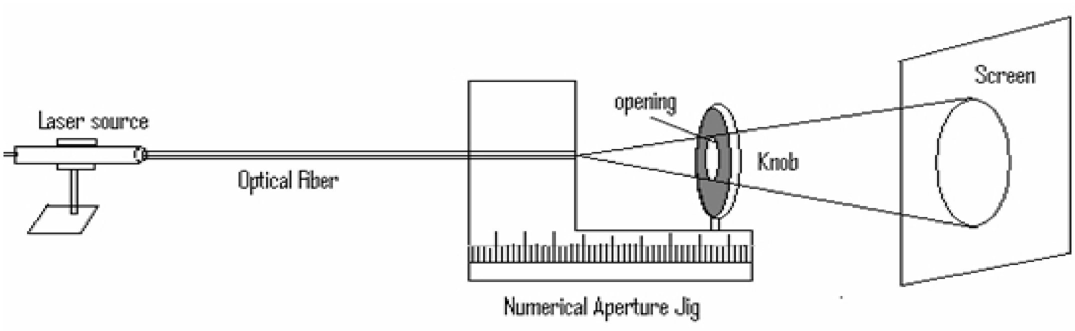

Figure 1.3.Experimental setup for acceptance angle

To determine acceptance angle

S.No	**Distance from the fiber end to circular image 'd'**	**Radius of the circular image 'r'**	**Acceptance angle** $\theta_a = \frac{r}{d} \cdot \frac{180}{\pi}\ deg$
Unit	cm	mm	deg.

1. (b) DETERMINATION OF ACCEPTANCE ANGLE IN AN OPTICAL FIBRE

AIM

To determine acceptance angle of an optical fiber.

APPARATUS REQUIRED

Laser for optical fiber light source, Laser power meter, optical fiber, optical fiber connectors. and Numerical aperture Jig.

PRINCIPLE

The principle behind the transmission of light waves in an optical fiber is total internal reflection.

FORMULA

Acceptance angle $$\theta_a = \frac{r}{d} . \frac{180}{\pi} \; deg.$$

Symbol	Explanation	Unit
r	Radius of the circular image	metre
d	Distance from fibre end to circular image	metre

PROCEDURE

Using laser, we can find the acceptance angle of the fiber optic cable. The given laser source is connected to the optical fiber 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 fiber end to circular image (d) is measured using meter scale. The radius of the circular image is also measured. Thus the acceptance angle is calculated

$\mathcal{L}$

CALCULATION

(i) Wavelength of the laser source, $\lambda = \frac{\sin\theta}{nN}$

(ii) The size of the particle, $d = \frac{n\lambda D}{x_n}\ meter.$

(iii) Acceptance angle, $\theta_a = \frac{r}{d} \cdot \frac{180}{\pi}\ deg.$

RESULTS

i) Wavelength of the given source $\boldsymbol{\lambda}$ = ------------------- meter.

ii) The size of the particle d = ___________ m.

iii) Acceptance angle θ_a = ___________ degree.

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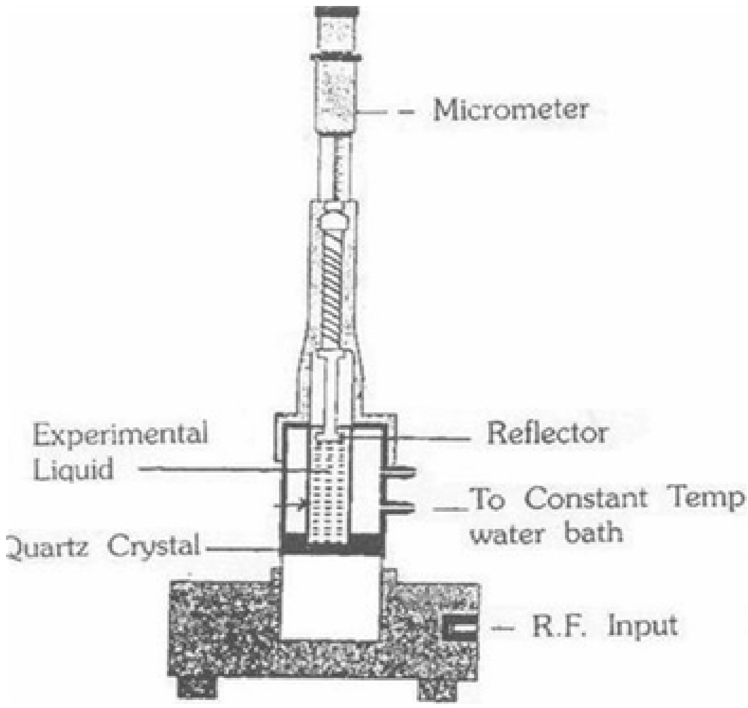

Figure 2.1. Ultrasonic interferometer

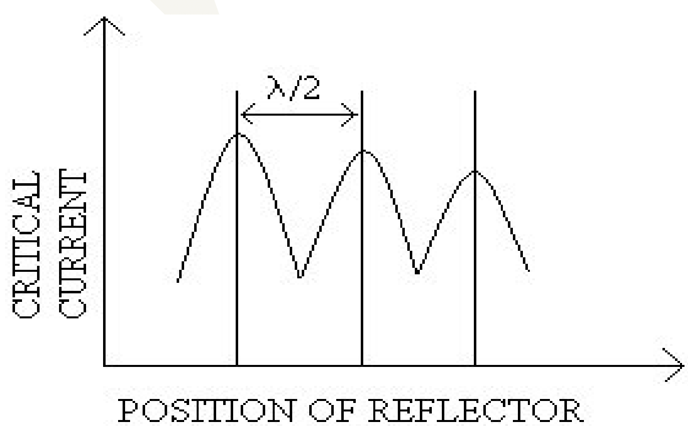

Figure 2.2.Distance moved by the reflector Vs Oscillator current

Ex.No:
Date:

2. ULTRASONIC INTERFEROMETER

AIM

1. To determine the velocity of ultrasonic wave in the medium of liquid using ultrasonic interferometer.
2. To determine the compressibility of the given liquid.

APPARATUS REQUIRED

Ultrasonic interferometer (High frequency generator, measuring cell), given liquid.

PRINCIPLE

High frequency generator, which excites the quartz crystal, generates longitudinal ultrasonic wave in the experimental liquid. Standing waves are formed within the medium. This results in the formation of resonance and causes a change in the potential difference at the generator which excites the crystal. Due to this, anode current of the generator becomes maximum. The change in the anode current can be measured from the micrometer.

FORMULAE

1) Wavelength of the ultrasonic waves,

$$\lambda = \frac{2d}{n} \; meter$$

2) Velocity of ultrasonic wave in a given liquid,

$$v = f\lambda \;\; meter/second$$

3) Compressibility of ultrasonic wave in a given liquid,

$$\kappa = \frac{1}{v^2\rho} \frac{meter^2}{newton}$$

Symbol	Explanation	Unit
f	Frequency of generator which excites the crystal	Hz
d	Distance moved in micrometer screw	m
λ	Wavelength of the ultrasonic wave	m
n	Number of oscillations	no unit
ρ	Density of the given liquid	kg/m^3

$\mathcal{L}$

To find the wavelength of Ultrasonic waves in the liquid

Given Liquid: ……………………… Frequency of the generator f = Hz

L.C = 0. 01 mm

DETERMINATION LEAST COUNT OF THE SCREW GAUGE:

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

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

Pitch = 0.5 mm/ 1 = 0.5 mm
LC = 0.5 mm/ 50 = 0.01 mm.

S. No	Number of Oscillation	Micrometer Reading			Distance moved by reflector d	wavelength λ=2d/n
		PSR	HSC	TR = PSR+ (HSC X LC)		
	Unit	x 10^{-3}m	div	x 10^{-3}m	x 10^{-3}m	x 10^{-3}m
1	**n**					
2	**n+2**					
3	**n+4**					
4	**n+6**					
5	**n+8**					
6	**n+10**					

Mean wavelength λ=

PROCEDURE

The high frequency generator is switched on and the alternating field from the generator is applied to the quartz crystal. The quartz crystal produces longitudinal ultrasonic waves. The ultrasonic wave passes through the liquid and gets reflected at the surface of the reflector plate.

If the distance between the reflector and crystal is exactly a whole multiple of the sound wavelength, standing waves are formed within the medium. This results in the formation of acoustics resonance and cause a change in the potential difference at the generator which excites the crystal. Due to this, anode current of the generator becomes maximum. The change in the anode current can be measured from the micrometer fitted with the frequency generator.

The distance between the reflector and crystal is varied using the micrometer screw such that the anode current decreases from maximum and then increases up to a maximum. The distance of separation between successive maximum or minimum in the anode current is equal to half the wavelength of the ultrasonic waves in the liquid.

By noting the initial and final position of the micrometer for two complete oscillations (maxima -minima-maxima), one can determine the distance moved by the parallel reflector.

Thus 'n' number of successive maxima or minima is recorded for a distance d. The total distance moved by the micrometer screw is given by $d = n\,\lambda/2$ metre

or

Wavelength $\lambda = 2d / n$ metre

From the value of λ, the velocity of the longitudinal ultrasonic waves is calculated using the relation, $V = f\lambda$, where f is the frequency of the generator which is used to excite the crystal. After determining the velocity of the ultrasonic waves in liquid is calculated using the formula $K=1/v^2\rho$ where ρ is the density of the liquid.

CALCULATION

Frequency of the generator	f = …………. x 10^6 Hz
Distance moved in micrometer screw	d = …………. m
Wavelength of the ultrasonic waves	λ = …………. m
Density of the given liquid	ρ = …………. kg m^{-3}
Number of oscillations	n = ………….

$\mathcal{L}$

Wavelength of the ultrasonic waves,

$$\lambda = \frac{2d}{n}$$

λ = ………… m

Velocity of ultrasonic wave in the given liquid,

$$v = f\lambda \quad meter/sec$$

v = ………… ms^{-1}

Compressibility of the given liquid,

$$\kappa = \frac{1}{v^2\rho}\,\frac{meter^2}{newton}$$

K = ………… m^2/N

RESULT

1. Velocity of the ultrasonic waves in the given liquid v = ………… ms^{-1}
2. Compressibility of the given liquid K= ………… m^2/N

$\mathcal{L}$

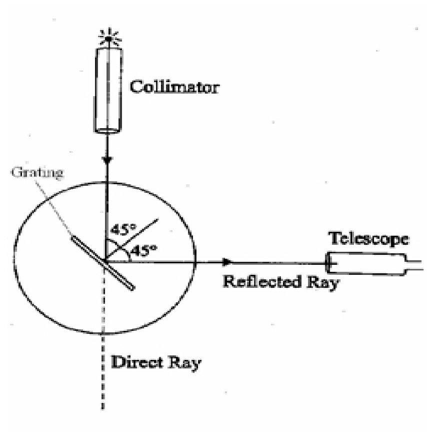

Figure 3.1.To set for normal incidence position

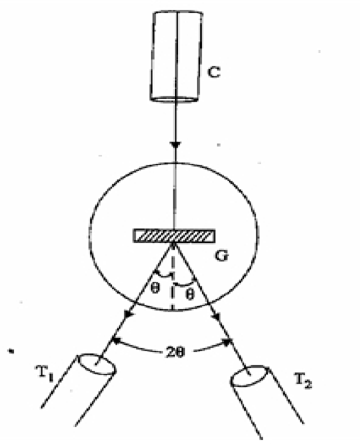

Figure 3.2. Diffracted ray from grating

To Find the Number of Lines per meter of the grating

LC= 1′

order of the spectrum n =

Wavelength of sodium vapour lamp λ = 5893Å

Spectral lines (colours)	Reading for the diffracted image												Difference Between the readings		Mean 2θ	Mean angle of diffraction	$N = \frac{\sin\theta}{n\lambda}$
	Left side						Right side										
	Vernier A A_1			Vernier B B_1			Vernier A A_2			Vernier B B_2			2θ $A_1 \sim A_2$	2θ $B_1 \sim B_2$			
	MSR	VSC	TR	MSR	VSC	TR	MSR	VSC	TR	MSR	VSC	TR					
	deg.	div.	deg.	deg.	div.	deg.	deg.	div.	deg.	deg.	div.	deg.	deg.	deg.	deg.	deg.	m
Yellow																	

Ex. No. :

Date :

3. SPECTROMETER - DETERMINATION OF WAVELENGTH OF MERCURY SPECTRUM

AIM

To determine the wavelength of the mercury (Hg) spectrum by standardizing the plane transmission grating.

APPARATUS REQUIRED

Spectrometer, Sodium vapour lamp, Plane transmission grating, spirit level Mercury vapour lamp, and reading lens.

PRINCIPLE

A plane sheet of transparent material on which a large number of equidistant opaque rulings are made with a diamond point forms grating. The space between the rulings and transparent area constitute a parallel slit. When light passes through such a grating, diffraction takes place. Angle of diffraction depends upon the wavelength of the light and number of lines per metre on the grating. So the number of lines per metre in grating and wavelength of the source can be calculated.

FORMULA

The number of lines drawn on the grating per meter

$$N = \frac{\sin\theta}{n\lambda} \quad \text{lines /metre}$$

The wavelength of the spectral lines of mercury spectrum

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

Symbol	Explanation	Unit
θ	Angle of diffraction	deg
N	Number of lines/ metre	lines/ metre
n	Order of spectrum	no unit

$\mathcal{L}$

To determine the wavelength(λ) of the prominent lines of the mercury spectrum

Least count = 1’ Order of the spectrum **n** = 1

N= ……………………………….Lines/meter TR=MSR + (VSC X LC)

Spectral lines (colours)	Vernier A (A_1)			Vernier B (B_1)			Vernier A (A_2)			Vernier B (B_2)			$2\theta = A_1 \sim A_2$	$2\theta = B_1 \sim B_2$	Mean 2θ	Mean angle of diffraction θ	$\lambda = \frac{\sin\theta}{n\,N}$
	MSR	VSC	TR	MSR	VSC	TR	MSR	VSC	TR	MSR	VSC	TR					
	deg.	div.	deg.	deg.	div.	deg.	deg.	div.	deg.	deg.	div.	deg.	deg.	deg.	deg.	deg.	meter
Violet																	
Blue																	
Green																	
Yellow																	
Red																	

PROCEDURE

(i) **Normal Incidence**

Preliminary adjustments of the spectrometer are made. The grating is mounted on the grating table with its ruled surface facing the collimator the slit is illuminated by a source of light (sodium vapour lamp). The slit is made to coincide with the vertical cross wires. The vernier scales are adjusted to read 0˚ and 180˚ for the direct ray. The telescope is rotated through an angle of 90˚ and fixed. The grating table is adjusted until the image coincides with the vertical cross wire. Both the grating table and the telescope are fixed at this position as shown in Fig.3.1. Now rotate the vernier table through 45˚ in the same direction in which the telescope has been previously rotated. The light from the collimator incident normally on the grating. The telescope is released and is brought on the line with the direct image of the slit. Now the grating is said to be in normal incidence position

The slit is illuminated by sodium vapour lamp; the telescope is released to get the diffracted image of the first order on the left side of the central direct image as shown in fig.3.2. The readings are tabulated from the two verniers V_A and V_B. Similarly readings are taken for the image of the first order on right side of the central direct image. The difference between the two readings gives 2θ, where θ is the angle of first order diffraction. The number of lines per meter (N) on the grating is calculated using the equation , $N = \frac{\sin\theta}{n\lambda}$ lines /meter.

.

(iii**) Determination of Wavelength (λ) of the Source**

The sodium vapour lamp is replaced by mercury vapour lamp. The diffracted images of the first order are seen on either side of the central direct image as shown in Fig.3.2. The readings are tabulated by coincide the vertical cross wire with the first order on the either side of the central direct image prominent lines namely violet, blue, bluish green, green, yellow, red of the mercury spectrum. The difference between the readings give 2θ, from this θ can be found. The wavelength of each spectral line is calculated using the equation, $\lambda = \frac{\sin\theta}{nN}\ meter$

DETERMINATION OF LEAST COUNT

2MSD = 1°

1MSD = 1°/2 = 0.5° = 30′

LC = 1 MSD – 1 VSD

Number of divisions in vernier scale = 30

30 VSD = 29 MSD

1 VSD = 29/30 x MSD = 29/30′ x30′ =29′

LC = 30′ – 29′

LC = 1′ (One minute)

$\mathcal{L}$

CALCULATION

Order of the spectrum $n = 1$

Wavelength of sodium vapour lamp $\lambda_1 = 5893Å$

Angle of diffraction $\theta =$ degree

1. The number of lines drawn on the grating per meter,

$$N = \frac{\sin\theta}{n\lambda} \text{ lines /meter}$$

N = ________ lines / m

2. The wavelength of the spectral lines of mercury spectrum,

$\lambda = \sin\theta / Nn$ metre

Wavelength for violet,

λ_v =……………….Å

Wavelength for blue

λ_B=……………….Å

Wavelength for green

λ_G=……………… Å

Wavelength for yellow

λ_{Y}=............................Å

Wavelength for red

λ_R =……………….Å

RESULT

(i) The Number of Lines per meter in grating N =……………….. lines/metre

(ii) Wavelength of various spectral lines

S.No	Colour of the spectrum	wavelength Å
1	Violet	
2	Blue	
3	Green	
4	Yellow	
5	Red	

ℒ

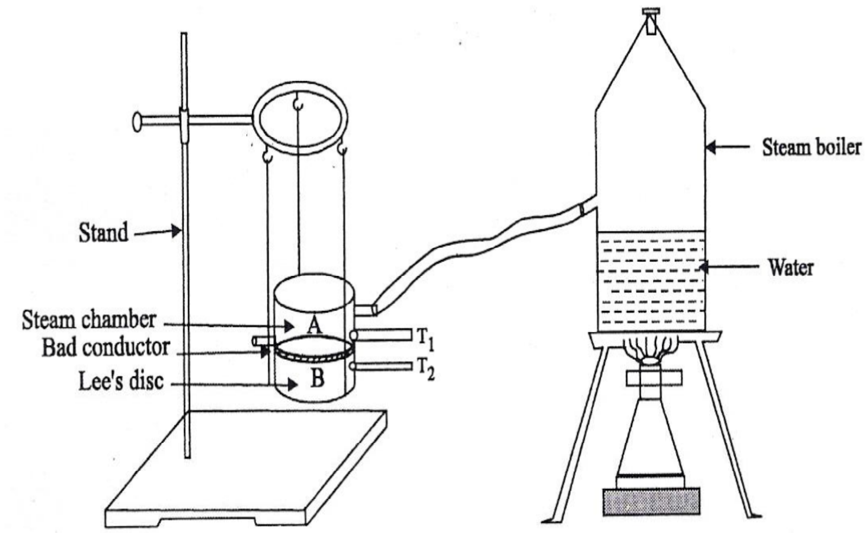

Figure 4.1Lee's Disc arrangement

To measure the radius of the metallic disc (r)

LC= 0.01 cm

Zero error = ±.............div.

Zero correction = ∓………..cm

S. No.	MSR	VSC	VSR = (VSC x LC)	Observed Reading = MSR +VSR	Correct Reading = OR +ZC
Unit	cm	div	cm	cm	cm

Mean diameter of the disc (D) = ……………………… x 10^{-2} m.

Mean radius of the disc (r) = (D/2) ………………………. x 10^{-2} m.

Ex.No. :

Date :

4. THERMAL CONDUCTIVITY OF A BAD CONDUCTOR - LEE'S DISC

AIM

To determine the thermal conductivity of a bad conductor using Lee's disc apparatus.

APPARATUS REQUIRED

Lee's disc apparatus, Bad conductors (card board, glass or ebonite), Thermometers, Stop-Clock, Steam boiler, screw gauge, vernier calipers.

PRINCIPLE

At the steady state rate of heat flowing into a system is equal to rate of heat flowing out of a system. Here the rate of heat conducted by poor conductor to block below it is equated to rate of heat radiated by the Lee's disc.

FORMULA

Thermal conductivity of a bad conductor

$$\kappa = \frac{Msd(r+2h)\left(\frac{d\theta}{dt}\right)_{\theta_2}}{\pi r^2(2r+2h)(\theta_1-\theta_2)} \quad watt\ meter^{-1} kelvin^{-1}$$

Symbol	Explanation	Unit
M	Mass of the metallic disc	kg
S	Specific heat capacity of the material of the disc	J kg K^{-1}
$\left(d\theta/dt\right)_{\theta_2}$	Rate of cooling at steady temperature θ_2	$^0C/s$
θ_1	Steady temperature of a steam chamber	^0C
θ_2	Steady temperature of the metallic disc	^0C
r	Radius of the metallic disc	metre
h	Thickness of the metallic disc	metre
d	Thickness of the bad conductor	metre

ℒ

To find the thickness of the bad conductor (d) using screw gauge

LC= 0.01mm

Zero error = ±.............div.

Zero correction = ∓……mm

S. No.	PSR	HSC	HSR=HSC x LC	Observed Reading = PSR + HSR	Correct Reading = OR +ZC
Unit	mm	div	mm	mm	mm

Mean thickness of the cardboard (d) =………………………….. $X10^{-3}$ m

To find the thickness of the metallic disc (h)

LC= 0.01 mm

Zero error = ±.............div.

Zero correction = ∓………..mm

S. No.	PSR	HSC	HSR=HSC x LC	Observed Reading= PSR +HSR	Correct Reading = OR +ZC
Unit	mm	div	mm	mm	mm

Mean thickness of the metallic disc (h) =……………………….x 10^{-3} m

PROCEDURE

The thickness of the bad conductor (say card board) and thickness of the metallic disc are determined using a screw gauge. The radius of the metallic disc is found using a vernier caliper. The mass of the metallic disc is also found by using a common balance. The readings are tabulated. The whole Lee's disc apparatus is suspended from a stand as shown in the fig.4.1. The given bad conductor (card board) is placed in between the metallic disc and the steam chamber. Two thermometers T1 and T2 are inserted in the respective holes.

Steam from the steam boiler is passed into the steam chamber until the temperature of the steam chamber and the metallic disc are steady. The steady temperatures of the steam chamber and of the metallic disc recorded by the thermometers are noted.

Now the bad conductor is removed and the steam chamber is placed in direct contact with the metallic disc. The temperature of the disc rapidly rises. When the temperature of the disc rises about 10 ^{0}C above θ_2 (Steady temperature of the disc), the steam chamber is carefully removed, after cutting off the steam supply.

When the temperature of the disc reaches 10 ^{0}C above the steady temperature of the disc. i.e $(\theta_2 + 10)^0$C, a stop clock is started. Time for every 1 ^{0}C fall of temperature is noted until the metallic disc attains a temperature $(\theta_2 - 10)^0$ C

LEAST COUNT OF THE SCREW GAUGE:

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

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

Pitch = 5 mm/ 5 = 1 mm

LC = 1 mm/ 100 = 0.01 mm.

LEAST COUNT OF THE VERNIER CALIPER:

LC = 1MSD – 1VSD

Value of 1MSD = 1/10 cm = 0.1 cm

Number of divisions on the Vernier scale = 10 divisions

Since 9MSD are divided into 10 VSD

10 VSD = 9 MSD

1 VSD = 9/10 MSD

VSD = 9/10*1/10 = 9/100 cm

LC = 1/10 – 9/100

= (10-9)/100 = 1/100 cm

= 0.01 cm

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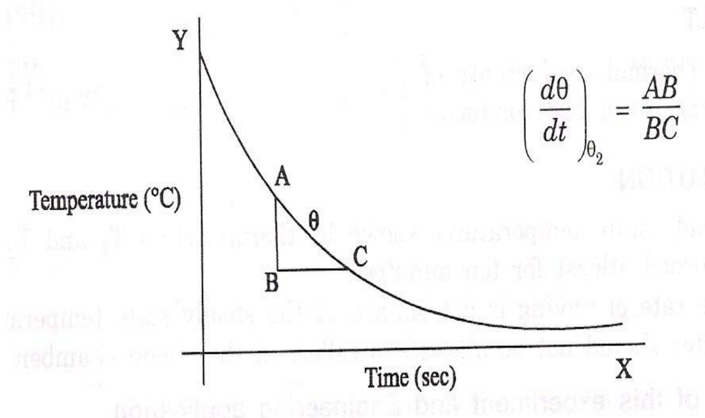
To determine the Rate of cooling of the metallic disc $\left(\frac{d\theta}{dt}\right)_{\theta_2}$



Temperature (θ)	Time (t)
°C	second

CALCULATION

Mass of the metallic disc M=…………kg.

Specific heat capacity of the solid S = 370 J $kg^{-1}K^{-1}$.

Radius of the metallic disc r = ……… x 10^{-2} metre

Thickness of the metallic disc h = ………...x 10^{-3}metre.

Thickness of the cardboard d = ……….. x 10^{-3} metre.

Steady state temperature of steam chamber θ_1 = ……………$^{\circ}$C

Steady state temperature of disc θ_2 = ……….. $^{\circ}$C

Rate of cooling $\left(\frac{d\theta}{dt}\right)_{\theta 2}$ at steady state temperature(θ_2 $^{\circ}$C) =……………$^{\circ}$C/s

(from graph)

$$\kappa = \frac{Msd(r+2h)\left(\frac{d\theta}{dt}\right)_{\theta_2}}{\pi r^2(2r+2h)(\theta_1-\theta_2)} \quad watt\ meter^{-1} kelvin^{-1}$$

K = --------------------------- W m^{-1} K^{-1}

RESULT

Thermal conductivity of the given bad conductor K = --------------------------- W m^{-1} K^{-1}

ℒ

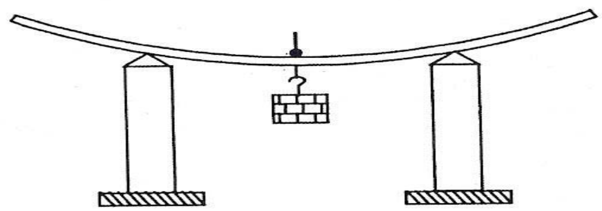


Figure 5.1 Young's modulus of the material – Non-uniform bending

DETERMINATION OF LEAST COUNT OF TRAVELLING MICROSCOPE

Least count = 1 MSD – 1 VSD

20 MSD = 1 cm

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

Number of Vernier Scale Division = 50

50 VSD = 49 MSD

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

LC = 0.05 – 0.049 = 0.001 cm

LC = 0.001 cm

To find depression 'y'

Distance between two knife edges (l) = _____ X 10^{-2} m

TR = MSR + (VSC X LC)

M = -------------------- x 10^{-3} kg L.C = 0.001 cm

S.No	Load	Microscope Readings						Mean	Depression Y for M kg
		Loading			Unloading				
		MSR	VSC	TR	MSR	VSC	TR		
Unit	x 10^{-3}kg	cm	div	cm	cm	div	cm	cm	cm
1	W								
2	W+50								
3	W+100								
4	W+150								
5	W+200								
Mean (y) = ------- x 10^{-2} m									

Ex.No. :

Date :

5. YOUNG'S MODULUS OF THE MATERIAL – NON-UNIFORM BENDING

AIM

To determine the young's modulus of the material of a uniform bar by non uniform bending method.

APPARATUS REQUIRED

Traveling microscope, Weight hanger with slotted weights, Two knife edges, Pin, Wooden bar, Vernier caliper, Screw gauge.

PRINCIPLE

When a beam symmetrically supported on two knife edge is loaded at its centre, the bent beam would not form an arc of circle. This type of bending is called non uniform bending. The maximum depression is produced at its mid point.

FORMULA

The Young's Modulus of the beam,

$$E = \frac{Mgl^3}{4bd^3y} \quad \frac{newton}{meter^2}$$

Symbol	Explanation	Unit
M	Load applied	Kg
l	Distance between the two knife edges	m
b	Breadth of the beam (meter scale)	m
d	Thickness of the beam (meter scale)	m
y	Depression produced for 'M' kg of load	m
g	Acceleration due to gravity	ms^{-2}

ℒ

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

LC = 0.01 mm

Z.E = …..div

Z.C =……mm

S. No.	PSR	HSC	HSR= HSC X LC	Observed Reading = PSR +HSR	Correct Reading = OR +ZC
Unit	mm	div	mm	mm	mm

Mean (d) =-------------------------- x10^{-3} m

To find the breadth (b) of the beam using Vernier Calipers

LC = 0.01 cm

Z.E = …..div

Z.C =……cm

S. No.	MSR	VSC	VSR=VSC x LC	Observed Reading= MSR +VSR	Correct Reading = OR +ZC
Unit	cm	div	cm	cm	cm

Mean (b) =------------------------- x10^{-2} m

PROCEDURE

The weight of the hanger is taken as the dead load '**w**'. The wooden bar is brought to elastic mood by loading and unloading it, a number of times with slotted weights. With the dead load **w** suspended from the midpoint, the microscope is adjusted such that the horizontal cross-wire coincides with the image of the tip of the pin. The reading in the vertical scale is taken.

The experiment is repeated by adding weights in steps of 50 gm each. Every time the microscope is adjusted and the vertical scale reading is taken. Then the load is decreased in the same steps and the readings are taken. From the readings, the mean depression of the mid-point for a given load can be found. The length of the wooden bar between the knife edges is measured (l).

The wooden bar is removed and its mean breadth 'b' and mean thickness 'd'are determined with a vernier caliper and a screw gauge respectively.

From the observations, Young modulus of the material of the beam is calculated by using the given formula.

$\mathcal{L}$

CALCULATION

Acceleration due to gravity	$g = 9.8\ ms^{-2}$
Distance between the two knife edges	$l =$ ………. m
Breadth of the beam	$b =$ ………… m
Thickness of the beam	$d =$ ………….. m
Depression produced for 'M' kg of load	$y =$ ………….. m
Load to calculate depression	$M =$ ………….. kg

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

$$E = \frac{Mgl^3}{4bd^3y}\ \frac{newton}{meter^2}$$

RESULT

The Young's Modulus of the given wooden bar

E = …………… newton/$meter^2$

DATA OF PHYSICAL CONSTANTS & STANDARD VALUES

S.No.	Physical Constants	Symbol	Value in SI Unit
1	Velocity of light	C	3×10^{8} m/s
2	Acceleration due to gravity	g	9.8 m/s^2
3	Planck's constant	h	6.625×10^{-34} Js
4	Charge of an electron	e	1.6×10^{-19} C
5	Avogadro number	N_A	6.023×10^{26} atoms/ k mole
6	Boltzmann constant	k	1.3×10^{-23} J/K
7	Young's modulus of the wooden beam	y	1×10^{10} Nm^{-2}
8	Young's modulus of the teak wooden beam	y	1.7×10^{10} Nm^{-2}
9	Wavelength of sodium vapour lamp	λ	D_1= 5890 Å, D_2 =5896 Å
10	Wavelength of mercury vapour lamp	λ_V λ_B λ_G λ_{YI} λ_R	4047 Å 4358 Å 5461 Å 5770 Å 6234 Å

VIVA QUESTIONS & ANSWERS

LASER PARAMETERS

1. Define LASER?

The term LASER stands for Light Amplification by Stimulated Emission of Radiation. It is a device which produces a powerful, monochromatic collimated beam of light in which the waves are coherent.

2. What is meant by active material in laser?

The material in which the population inversion is achieved is called active material.

3. What is semi conductor diode laser?

Semiconductor diode laser is a specially fabricated pn junction diode. It emits laser light when it is forward biased.

4. What are the characteristic of laser radiation?

Laser radiations have high intensity, high coherence, monochromatic and high directionality with less divergence.

5. What is stimulated emission?

The process of forced emission of photons caused by incident photons is called stimulated emission

6. Define acceptance angle

The maximum with which a ray of light can enter through one end of the fiber and still be totally internally reflected is called acceptance angle of the fiber.

7. What is the principle used in fiber optic communication system?

The principle behind the transmission of light waves in an optical fiber is total internal reflection

ULTRASONIC INTERFEROMETER

1. What are ultrasonics?

The sound waves having frequencies above the audible range. i.e, frequencies above 20,000Hz to20KHz are known as ultrasonics.

2. What is piezo – electric effect?

When mechanical pressure is applied to one pair of opposite faces of a quartz crystal, then the other pair of opposite faces develop equal and opposite electrical charges on the crystal.

3. What is inverse piezo- electric effect?

The piezo electric effect is reversible. If an electric field is applied to one pair of opposite faces of quartz crystal, alternative mechanical expansion or contraction (pressure) is produced across the other pair of opposite faces of the crystal.

4. What is an acoustic grating?

When ultrasonic waves travel through a transparent liquid, due to alternating compression and rarefraction, longitudinal waves are formed. If a monochromatic light is passed through the liquid perpendicular to the waves, the liquid behaves a diffraction grating such a grating is known as "acoustic grating"

SPECTROMETER GRATING

1. What is plane transmission diffraction grating?

A plane transmission diffraction grating is an optically plane parallel glass plate on which equidistant, extremely close grooves are made by ruling with a diamond point.

2. In our experiment. What class of diffraction does occur and how?

Fraunhofer class of diffraction occurs. Since the spectrometer is focused for parallel rays, the source and the image are effectively at infinite distances from the grating.

3. How are the commercial gratings are made?

A commercial grating is made by pouring properly diluted cellulose acetate on the actual grating and drying it to a thin strong film. The film is detached from the original grating and is mounted between two glass plates. A commercial grating is called replica grating. In our experiment we use plane type replica grating.

LEE'S DISC

1. What is thermal conductivity?

It is defined as the quantity of heat conducted per second normally across unit area of cross section of the material per unit temperature difference. It denotes the heat conducting power. Its unit is Watt meter-1 kelvin-1

2. Does the value of thermal conductivity depend on the dimension of the specimen?

No, it depends only on the material of the specimen.

3. Can this method be used for good conductors?

No, in that case, due to large conduction of heat, the temperature recorded by θ_1 and θ_2 will be very nearly the same

4. Is there any reason to take the specimen in the form of a disc?

A thin disc is taken because its area of cross section is large, while thickness is small. It increases the quantity of heat conducted across its faces.

YOUNGS MODULUS NON-UNIFORM BENDING

1. What is young's modulus?

Young's modulus is defined as the ratio of longitudinal stress to longitudinal strain.

2. What is a beam?

When the lengths of the rod of uniform cross section is very large compared to its breadth such that the shearing stress over any section of the rod can be neglected, the rod is called beam.

3. How are longitudinal strain and stress produced in your experiment?

Due to depression, the upper or the concave side of the beam becomes smaller than the lower or the convex side of the beam. As a result, longitudinal strain is produced. The change in wave length of the beam. These forces will give rise to longitudinal stress.

4. Which dimension- breath, thickness or length of the bar-should be measured very careful and why?

The thickness of the bar should be measured very carefully since its magnitude is small and it occurs in the expression 'E' in the power of three. An inaccuracy in the measurement of the thickness will produce the greatest proportional error in 'E'.

5. Why do you place the beam symmetrically on the knife edges?

To keep the reaction at the knife edges equal in conformity with the theory.